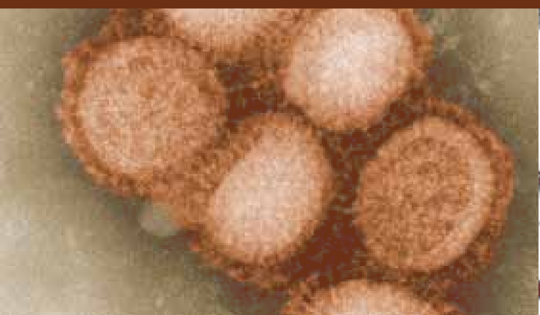
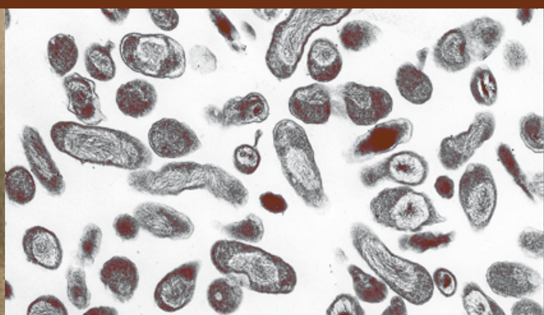



Emerging zoonoses:
Early warning and surveillance in the Netherlands


Emerging zoonoses: early warning and surveillance in the Netherlands

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Colophon

This report is published by the National Institute of Public Health and the Environment (RVM). The report describes the results of the research programme Emerging Zoonoses. This programme is carried out by a consortium of expertise institutes and coordinated by the Centre for Infectious Disease Control (CIb) on behalf of the Direction Division Knowledge and Innovation of the Ministry of Agriculture, Nature and Food Quality. The research programme was carried out under the supervision of the 'Begeleidingscommissie Emerging Zoonosen' and the steering committee.
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EmZoo project working group

Centre for Infectious Disease Control, RIVM
Braks, M.
Koopmans, M.
Havelaar, A.
Langelaar, M.
Notermans, D.
Schimmer, B.
Ransz, W.
Van der Giessen, J.
Van Duynhoven, Y.
Van, Rotterdam, B.

Faculty of Veterinary Medicine, Utrecht University
Heesterbeek, H.
Van Knapen, F.
Wagenaar, J.

Central Veterinary Institute, Lelystad
Rijsman, V.
Swanenburg, M.
Van Zijderveld, F.

Animal Health Services, Deventer
Kock, P.
Mars, J.
Van Maanen, C.
Wever, P.

Editors

Van der Giessen, J.
Van de Giessen, A.
Braks, M.

Members of the Supervisory Committee

Nijsten, J	LNV-DKI
Donker, R.	LNV-DKI
Zijlker, J.W.	LNV-VDC
Pierey, E.	LNV-VDC
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Oosterom, R.	VWA-BUR
Ottevanger, A.	VWS-VGP
L'Herminez, M.	ZonMW
Verdonk, A.	LNV-VDC
Van de Giessen, A.	RIVM-CIb
Van der Giessen, J	RIVM-CIb

Former members of the 'Supervisory Committee'

Ooms, W.	VWA-Bur
Beukers, S.	VWS-PG
Wever, C.	LNV-DKI
Lambers, J.	LNV-DKI

Steering Committee

Oppers, A. Director	LNV- VDC
Bolhuis, A. Director	VWS- VGP
Ruwaard, D. Director	VWS- PG

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Photographs lower frontpage

Influenza A virus (beeldbank RIVM 98085)
Coxiella burnetii (beeldbank RIVM 77082)
Toxoplasma gondii (CD ANOFEL 4, French Association of Medical Parasitologists, Parasitologie –Mycologie CHU-Limoges-M-L.Dardé)

Preface

Complex and partially yet unknown risk factors will lead to the introduction of new infections in the human population. Although we do not know which disease will emerge next, recent emerging infections have predominantly originated from animal reservoirs. Therefore, animal populations are considered the main reservoir for emerging infectious diseases. Establishing early warning and surveillance systems, better cooperation among different disciplines, institutions and authorities and stimulating zoonotic research will improve early warning, preparedness and response to emerging infections. This was the conclusion of the Health Council advice in 2004.

In 2006, the Ministry of Agriculture, Nature and Food Quality asked the Netherlands Centre for Infectious Disease Control (CIb) of the National Institute of Public Health and the Environment (RIVM) to coordinate an initial two-year research programme with the aim to develop a blueprint for an early warning and surveillance system in animal reservoirs in the Netherlands, under the condition that the main institutes involved in veterinary medicine and infectious disease control in the Netherlands should collaborate. In 2007, the consortium, consisting of partners from the Faculty of Veterinary Medicine, University of Utrecht, Animal Sciences Group and Central Institute of Animal Diseases Control, Wageningen University and Research Centre, the Animal health services in Deventer and RIVM/CIb started.

This report describes the results of the emerging zoonoses programme. Activities in the programme can be subdivided into activities that give direction to early warning and surveillance systems (including among other things an inventory of existing surveillance systems in animals and human, prioritisation of emerging zoonoses and identification of gaps and opportunities in detection methods and surveillance) and activities to advise the ministries of LNV and VWS about an efficient and effective infrastructure for early warning of emerging zoonoses in the Netherlands. To support programme activities, several communication tools were developed, which could serve the zoonotic arena beyond the finalisation of the programme. Differences between the veterinary and medical infectious disease chain and related difficulties in early warning have been identified, to be solved in the near future.

Early warning and follow-up actions, especially for zoonoses, need a clear framework of duties and responsibilities between the two main ministries involved. This is a prerequisite for an effective implementation of the human-veterinary early warning system in the Netherlands, with a clear description of duties, responsibilities and mandates for this signalling infrastructure.

This report is the combined result of the collaborative institutes and other experts outside the consortium. Next to the results described, the establishment of a collaborative framework consisting in experts from different institutes working together in this field, is an achievement in itself.

Prof. dr. R.A. Coutinho and Dr. J.W.B. van der Giessen

List of Abbreviations (Dutch explanation in italics)

ABRES	Interdepartemental policy platform Antibioticum Resistance
AHT	Animal Health Trust (UK)
AI	Avian Influenza
AID	General Inspectorate (Algemene InspectieDienst)
ANEMOON	*Stichting Analyse Educatie en Marien Oecologisch Onderzoek*
BAO	*Bestuurlijk Afstemmingsoverleg*
BSAVA	British Small Animal Veterinary Association
BSE	Bovine spongiforme encefalopathy
BTV	Bluetongue virus
BVD	Bovine virus diarrhea
CBS	Central Bureau for Statistics
CCHF	Crimean Congo haemorrhagic fever
CDC	Centers for Disease Control and Prevention (USA)
CDTR	Communicable Diseases Threat Report
CIb	RIVM, Centre for Infectious Disease Control
CMV	Centre Monitoring of Vectors
CSF	Cerebrospinal fluid
CVD	Cardiovascular disease
CVI	Central Veterinary Institute
DAP	*Dierenartsenpraktijk*
DEFRA	Department for Environment, Food and Rural Affairs
DWHC	Dutch Wildlife Health Centre
ECDC	European Centre for Disease Prevention and Control
EM	Erythema migrans
EMC	Erasmus Medical Centre
EMI	Expert Centre for Methods and Information (RIVM)
EmZoo	Project Emerging Zoonoses
EPI	Department for Epidemiologie en Surveillance (RIVM)
EU	European Union
EWRS	Early Warning and Response System
EZIPs	Emerging Zoonoses Information and Priority systems
FAO	Food and Agriculture Organization of the United Nations
FD	Faculty of Veterinary Medicine, UU, *Faculteit Diergeneeskunde*
GD	Animal Health Service, *Gezondheidsdient voor Dieren*
GGD	Regional Health Department, *Gemeentelijk Gezondheidsdienst*
GP	General Practicioner
GWWD	Animal Health Act, *Gezondheids- en Welzijns Wet voor Dieren*
HAIRS	Human Animal Infections and Risk Surveillance Group (UK)
HIV	Human Immunodeficiency Virus
HPA	Health Protection Agency (UK)
IBR	Infectious Bovine Rhinotracheitis
IGZ	Inspectorate for Health Care, *Inspectie voor de Gezondheiszorg*
IHR	International Health Regulations
IRAS	Institute for Risk Assessment Sciences, UU
ISIS	Infectious disease Surveillance Information System
IVN	Association for Environmental Education
JEV	Japanese Encephalitis virus
KAD	Knowledge Centre for animals Pests, *Kenniscentrum Dierplagen*
KNJV	*Koninklijke Nederlandse Jagersvereniging*
KNMvD	*Koninklijke Nederlandse Maatschappij voor Dierengeneeskunde*

LCI	National Coordination Structure for Infectious Disease Control (RIVM)
LICG	*Landelijk Informatie Centrum voor Gezelschapsdieren*
LINH	*Landelijk Informatie Netwerk Huisartsenzorg*
LIS	Laboratory for Infectious diseases and Screening (RIVM)
LMR	*Landelijke Medische Registratie*
LNV	Dutch Ministry of Agriculture, Nature and Food Quality,
LNV-DKI	Division of Knowledge and Innovation
LNV-VDC	Division of Food, Animal and Consumer
LZO	Laboratory for Zoonoses and Environmental Microbiology (RIVM)
MCA	Multi-Criteria Analysis
MEC	Milieu Educative Centre (RIVM)
MMWR	Morbidity and Mortality Weekly Report
MRSA	Methicillin Resistant Staphylococcus aureus
NOAH	National Office of Animal Health (UK)
NRBM	*Nederlands Referentielaboratorium voor Bacteriële Meningitis*
NRL	National Reference Laboratory
NVD	*Nederlandse Vereniging van Dierentuinen*
NVPB	*Nederlandse Vereniging van Plaagdiermanagement Bedrijven*
OIE	World Organisation for Animal Health
OMT	Outbreak Management Team
PAMM	*Stichting voor Laboratoria voor Pathologie en Medisch Microbiologie*
PCR	polymerase chain reaction
PD	Dutch Plant Protection Service, *Plantenziektekundige Dienst*
PDV	Product Board for Animal Feed, *Productschap Diervoeders*
PH	Public Health
PhD	Doctor of Philosophy
PI	Principle Investigator
ProMED	Program for Monitoring Emerging Diseases
PRRSV	Porcine Reproductive and Respiratory Syndrome Virus
PVE	Product Boards for Livestock, Meat and Eggs, Productschap Vee, vlees en eieren
PZ	Product board Dairy, *Productschap Zuivel*
RAVON	*Reptielen Amfibieën Vissen Onderzoek Nederland*
RIVM	National institute for Public Health and the Environment
RVF	Rift Valley fever
SARS	Severe Acute Respiratory Syndrome
SAVSNET	Surveillance Network of British Small Animal Veterinary Association
SFK	Stichting Farmaceutische Kengetallen
SIR	Suspectible-Infected-Recovered
SOVON	*Stichting Natuurinformatie Vogelonderzoek Nederland*
STEC	Shiga toxigenic Escherichia Coli
SVD	Swine Vesicular Disease
TBEV	Tick-borne encephalitis virus
TIE	Team Invasive Exotics
TSE	Transmissible Spongiform Encephalopathies
TU Delft	Technical University.Delft
UK	United Kingdom
UU	University of Utrecht
UvA	University of Amsterdam
VBD	Vector Borne disease
VD	Veterinary Doctor
VetCIS	Veterinair Centraal Informatie Systeem
VIC	*VWA-incident en crisiscentrum*
VLA	Veterinary Laboratory Agency (UK)
VMDC	Veterinary Microbiological Diagnostic Centre
VOND	*Vereniging van Opvangcentra van Niet-gedomesticeerde Dieren*

VWA	Food and Consumer Product Safety Authority
VWA-BUR	VWA, Division of Risk assessment
VWS	Dutch Ministry of Health, Welfare and Sport
VWS- VGP	VWS, Division of Food, Health Protection and Prevention
VWS-PG	VWS, Division of Public Health
VZZ	Dutch Zoological Society
WHO	World Health Organization
WNV	West Nile virus
WUR	Wagenimgen University and Research centre
ZonMW	Netherlands Organization for Health Research and Development

Content

Managementsamenvatting

Dit rapport beschrijft de resultaten van het Emerging Zoönosen-programma (EmZoo). Het ultieme doel van EmZoo was het ontwikkelen van een blauwdruk voor een effectief early warning- en signaleringssysteem voor microbiële bedreigingen die relevant zijn voor zowel de volksgezondheid als de diergezondheid. Om dit doel te bereiken was een gezamenlijke inspanning nodig van belangrijke instituten op het terrein van diergezondheid en volksgezondheid in Nederland. Hiertoe is een consortium gevormd bestaande uit de Faculteit Diergeneeskunde van de Universiteit Utrecht, het Centraal Veterinair Instituut van Wageningen UR, de Gezondheidsdienst voor Dieren en het Centrum Infectieziektebestrijding van het RIVM. De consortium-partners werkten samen in een achttal projecten gericht op de realisatie van de volgende drie doelstellingen:

1. het ontwikkelen van een systematische aanpak voor de signalering van emerging zoönosen,
2. het prioriteren van emerging zoönosen die belangrijk zijn voor Nederland, en
3. het ontwikkelen van een blauwdruk voor een early warning- en surveillance-systeem voor emerging zoönosen.

Inventarisatie van de huidige early warning- en surveillance-systemen voor de verschillende dierpopulaties en voor de humane populatie, die relevant zijn voor de volksgezondheid of de diergezondheid, liet zien dat er geschikte systemen aanwezig zijn voor vroegtijdige herkenning van klinische signalen van (emerging) zoönotische aandoeningen bij de mens en bij landbouwhuisdieren, maar in beide sectoren zijn verbeteringen mogelijk. Het huidige systeem bij landbouwhuisdieren is goed ingericht en kan aangepast worden om zoönotische agentia te signaleren die geen klinische aandoeningen veroorzaken. De bestaande structuren bij landbouwhuisdieren en de mens lijken bovendien voldoende flexibel te zijn om – indien nodig - aanpassingen te doen voor het monitoren van nieuw-opduikende (emerging) zoönotische agentia. Voor wild, exotische dieren, gezelschapsdieren en paarden zijn geen early warning-systemen aanwezig. Hetzelfde geldt voor early warning-signalen met betrekking tot opduikende infectieziekten via vectoren, zoals veranderingen in de diversiteit en het vóórkomen van vectoren en in de prevalentie van pathogenen. De recente oprichting van het Dutch Wildlife Health Centre en het Centrum voor Monitoring van Vectoren vormen een essentiële eerste stap in de richting van een signalerings-infrastructuur voor wild en vectoren.

Om risico-gebaseerde aanbevelingen te kunnen doen aangaande de selectie van pathogeen-reservoir combinaties die voor early warning en surveillance in aanmerking komen, werd een **geprioriteerde lijst van emerging zoönotische pathogenen** opgesteld. Een database werd ingericht bestaande uit 86 pathogeen-gastheer-vector-combinaties en een prioriteringssysteem werd ontwikkeld op basis van een multi-criteria-analyse. De geprioriteerde lijst geeft niet aan welke agentia het meest waarschijnlijk opduiken, maar welke de grootste bedreiging vormen. De mate van bedreiging, gerangschikt aan de hand van een set van zeven afgebakende criteria, verschilt aanzienlijk tussen de verschillende emerging zoönotische agentia en deze ranking kan gebruikt worden voor besluitvorming. Met deze transparante en flexibele methode kan nieuwe informatie snel worden toegevoegd en geanalyseerd. Tevens is een web-based Emerging Zoönosen Informatie en Prioritering-systeem (EZIPs) ontwikkeld, dat interactieve toegang tot het prioriteringsmodel mogelijk maakt. Deze website heeft ten doel om beleidsmakers te ondersteunen bij het vaststellen van prioriteiten inzake emerging zoönosen, als basis voor effectief en efficient beleid ten aanzien van preventie, surveillance en bestrijding. Bovendien kan deze website professionals behulpzaam zijn bij risicoschatting en bij wetenschappelijk onderzoek naar de prioritering van bedreigingen voor de volksgezondheid.

Op basis van deze geprioriteerde lijst werden **omissies in de systemen voor detectie en surveillance** van (endemische en niet-endemische) emerging zoönosen geïdentificeerd. Middels een inventarisatie van beschikbare diagnostische methoden werd het mogelijk om direct te bepalen of diagnostische methoden voor prioritaire surveillance-systemen beschikbaar zijn of nog ontwikkeld moeten worden. Er worden algemene aanbevelingen gedaan inzake de arbitraire top 25 van de gerangschikte zoönosen. Alle 86 pathogenen op de lijst werden bediscussieerd maar aanbevelingen aangaande specifieke surveillance-systemen voor geprioriteerde pathogenen moeten nog nader worden uitgewerkt.

Scenario-studies van vectoroverdraagbare ziekten, met inbegrip van modelering en risk mapping, bleken behulpzaam te zijn voor risk assessment van emerging vectoroverdraagbare pathogenen. Dergelijke benaderingen verdienen meer aandacht bij monitoring-programma’s van pathogenen in vector-populaties in samenhang met onderzoek naar ecologische aspecten van de transmissie van pathogenen. Een gecoördineerde activiteit is nodig om de prioriteiten en methodologieën vast te stellen voor de monitoring, analyse, preventie en bestrijding van zoönosen bij mensen, dieren en hun vectoren.

De afwezigheid van structurele surveillance-activiteiten bij exotische dieren, gezelschapsdieren en paarden, is een belangrijke omissie bij de surveillance van emerging zoönosen. Surveillance-systemen zijn nodig in deze dierpopulaties om informatie te verzamelen over de aan- of afwezigheid van geprioriteerde zoönosen. Ervaringen met de ontwikkeling van een systeem voor **syndroomsurveillance** in de humane sector werden geëvalueerd met het oog op de ontwikkeling van een syndroomsurveillance-systeem voor gezelschapsdieren en paarden, maar implementatie van een identiek systeem lijkt nu niet mogelijk te zijn. Een stapsgewijze benadering wordt aanbevolen. De inrichting van een helpdesk, waar ongebruikelijke gebeurtenissen bij gezelschapsdieren en paarden gemeld en geanalyseerd kunnen worden, analoog aan de ‘Veekijker’, zou een eerste belangrijke stap zijn in de richting van een vroegtijdige detectie-systeem, ervan uitgaande dat de helpdesk bemensd wordt met adequate expertise.

Binnen het programma is een aantal **communicatie-tools** ontwikkeld, met name een op e-mail gebaseerd informatiesysteem om informatie van en naar dierenartsen te kunnen uitwisselen, genaamd Vetinf@ct, de surveillance-database en EZIPs. Communicatie tussen het humane en veterinaire domein is essentieel. Het verder werken met de ontwikkelde communicatie-tools wordt dan ook van het grootste belang geacht om een goede signalering, risicoschatting en communicatie van zoönotische bedreigingen mogelijk te maken.

Voor een effectieve signalering van emerging zoönosen is een systematische aanpak nodig voor het ontvangen en verwerken van signalen van potentiële zoönotische bedreigingen, inclusief een snelle risk assessment en communicatie naar professionals. Samenwerking dient plaats te vinden tussen alle partijen die betrokken zijn bij de uitvoering van surveillance. Eveneens is afstemming met het beleid noodzakelijk. In dit project werd een structuur ontwikkeld en getest (als pilot uitgevoerd door de GD, het RIVM en de Voedsel en Waren Autoriteit (VWA)) voor experts in het veterinaire en humane domein om signalen uit de verschillende monitoring-systemen uit te wisselen. Verdere ontwikkeling en implementatie van een **gezamenlijke signaleringsstructuur** wordt aanbevolen. Voorwaarden voor verdere samenwerking worden beschreven, waarbij wordt uitgegaan van de inzet van de beschikbare expertise en de bestaande structuren voor surveillance, risk management en beleid. Echter, voordat een humaan-veterinaire signaleringsstructuur verder ontwikkeld en geïmplementeerd kan worden, is er een duidelijke beschrijving nodig van taken, verantwoordelijkheden en mandaten bij de early warning van potentiële zoönotische gezondheidsbedreigingen, inclusief de vertaling naar vervolgacties.

Om een blauwdruk op te leveren van een effectieve **infrastructuur**, bestaande uit samenwerkende sleutel-personen uit de veterinaire en humane gezondheidszorg, voor early warning en surveillance van emerging zoönosen in Nederland, werden eerst de veterinaire en volksgezondheidssystemen in zeven andere landen beschreven, hetgeen al aangeeft dat interactie tussen de twee domeinen in verschillende landen op verschillende wijzen is georganiseerd. Voor de Nederlandse situatie werden de verschillende taken en verantwoordelijkheden beschreven van de belangrijkste instituten die betrokken zijn bij signalering, surveillance en bestrijding van infectieziekten bij dier en mens. De VWA werd gezien als de verbindende schakel tussen de bestaande early warning-systemen in beide domeinen (vanwege de ontvangst van de veterinaire meldingen, participatie in het humane signaleringsoverleg en uitvoering van brononderzoek). In deze domeinen worden verschillende procedures gehanteerd. Zolang incidenten plaatsvinden in een van beide domeinen en niet domein-overschrijdend zijn, levert dat geen probleem op. Echter, in het geval van zoönotische incidenten moet vastgelegd worden wie er verantwoordelijk is voor het verwerken van signalen, wie verantwoordelijk is voor het bepalen van geschikte maatregelen, wie verantwoordelijk is voor besluitvorming en welke communicatie naar welke partijen en organisaties nodig is.

Het EmZoo-programma heeft concrete handvatten opgeleverd en een blauwdruk voor een veterinair-humaan geïntegreerde infrastructuur voor signalering, risicoschatting en bestrijding van emerging zoönosen in Nederland. Teneinde het doel van een zodanig geïntegreerd systeem te bereiken, zijn de volgende vervolgacties nodig:

- **Afspraken tussen het veterinaire en het humane domein over de rolverdeling** met betrekking tot de signalering en bestrijding van zoönosen, zowel inzake uitvoerende aspecten als ten aanzien van risicomanagement, beleid en risicocommunicatie.
- **Ontwikkeling en implementatie van aanvullende early warning- en surveillance-systemen** op geleide van de geprioriteerde lijst van emerging zoönotische pathogenen en van algemene surveillance-systemen voor alle relevante dierpopulaties. Er dient een modus gevonden te worden die bestaande barrières voor de uitwisseling van onderzoeksgegevens tussen de verschillende instituten en groepen wegneemt.
- **Instellling van een gezamenlijke signaleringsstructuur** om signalen vanuit alle gebieden van het humane veld en vanuit landbouwhuisdieren, paarden, gezelschapsdieren, wild, exotische dieren en vectoren (arthropoden) die relevant zijn voor de volksgezondheid of de diergezondheid bijeen te brengen, als uitbouwing van

bestaande structuren. Het EmZoo-consortium van samenwerkende instituten kan de basis vormen van deze signaleringsgroep met toevoeging van andere relevante partners. De coördinatie van de activiteiten van deze gezamenlijke signaleringsgroep dient neergelegd te worden op één plek voor een langere tijdsperiode en voorwaarden voor het functioneren van deze signaleringsgroep, met betrekking tot een mandaat voor verdere actie en communicatie tussen professionals in de twee domeinen, dienen duidelijk vastgelegd te worden.

- **Beheer van de ontwikkelde communicatie-tools**: de surveillance- en diagnostische databases, en het Emerging Zoönosen Informatie en Prioritering-systeem (EZIPs) dienen beheerd en ge-updated te worden door een EmZoo-expert-groep, en het Vetinf@ct-informatiesysteem dient gecontinueerd te worden.

Summary

This report describes the results of the emerging zoonoses programme (EmZoo). The ultimate objective of EmZoo was to develop a blueprint for an effective early warning and signalling system in the Netherlands for threats of relevance to both human and veterinary health. To reach this aim, the collaborative effort of key institutes involved in veterinary and public health in the Netherlands was requested. A consortium consisting in the Faculty of Veterinary Medicine of the University of Utrecht (UU), the Central Veterinary Institute (CVI) of Wageningen University and Research Centre, the Animal Health Service (GD) and the Centre for Infectious Disease Control (CIb), RIVM, was established and collaborated in eight projects serving the following three aims:

1. to provide a systematic approach for the signalling of emerging zoonoses,
2. to prioritise emerging zoonoses important for the Netherlands, and
3. to develop a blueprint for an early warning and surveillance system for emerging zoonoses.

An **inventory of current early warning and surveillance systems** for different animal populations and humans relevant for public and veterinary health showed that suitable systems are in place for timely recognition of clinical signals of (emerging) zoonotic diseases in humans and farm animals, but in both sectors improvements could be made. The current system in farm animals is well equipped and could be adapted to register zoonotic agents that do not cause clinical signs. Moreover, the existing structures in farm animals and humans appear flexible enough to adjust to monitoring newly identified emerging zoonotic agents, when deemed necessary. For wildlife, exotic animals, companion animals and horses, no early warning systems are in place. The same holds for registering early warning signals of the emergence of zoonoses via vectors such as changes in the diversity and abundance of vectors or pathogen prevalence in vectors. The recent establishment of the Dutch Wildlife Health Centre and Centre Monitoring Vectors are essential first steps to a signalling infrastructure for wildlife and vectors.

To provide risk-based recommendations on the selection of pathogen-reservoir combinations for early warning and surveillance, a **prioritised list of emerging zoonotic pathogens** for the Netherlands was developed. A database consisting of 86 pathogen-host-vector combinations was established and a priority setting system, based on a multi-criteria analysis, was developed. The prioritised list does not indicate which agents are most likely to emerge, but which ones pose the most threat. The threat, as ranked using a set of seven comprehensive criteria, differs considerably between the different emerging zoonotic agents and this ranking can be used for decision making. In this transparent and flexible method, new information can readily be included and analysed. A web-based Emerging Zoonoses Information and Priority system (EZIPs), which allows interactive access to the priority setting model, was developed. This website aims to assist Dutch decision makers in establishing the priority of emerging zoonoses as a basis for effective and efficient policy-making on prevention, surveillance and control. In addition, this website can also assist professionals for risk assessment purposes and scientific research into the prioritisation of public health threats.

Based on this prioritised list, **gaps in the detection and surveillance systems** for (endemic as well as non-endemic) emerging zoonoses were identified. Through an inventory of available diagnostic methods, it became possible to immediately assess whether diagnostic methods for priority surveillance systems are available or should be developed. General recommendations about the arbitrary top twenty-five of the ranked zoonoses are provided. All 86 pathogens on the list were discussed but recommendations about specific surveillance systems for prioritised pathogens need to be further defined.

Scenario studies, including modelling and risk mapping, of vector borne diseases proved to be helpful for risk assessments of emerging vector-borne pathogens. Such approaches should receive more support in monitoring programmes of pathogens in vector populations in connection with studies of the ecology of pathogen transmission. Coordinated action is required to set priorities and methodologies for monitoring, analysis and prevention and control in humans, animals and their vectors.

The absence of structural surveillance activities in exotic animals, companion animals and horses is a major gap in the surveillance of emerging zoonoses. Surveillance systems for prioritised zoonoses in these animal populations are needed to gather information about the presence or prevalence in these animal populations. Experiences with the development of a **syndromic surveillance system** in the human sector were considered for the development of syndromic surveillance in companion animals and horses but implementation of an identical system seems to be not yet possible. A stepwise approach is recommended. The designation of a helpdesk function to which unusual events in pets and horses can be reported and analysed, analogous

to the Dutch ‘Veekijker’, would be an important first step towards an early detection system, given the right expertise ‘behind the desk’.

Within this programme, several **tools for communication** were developed, especially an email service to share information between veterinarians and public health professionals named Vetinf@ct, databases of the available surveillance systems and diagnostic tools and EZIPs. Communication between the human and veterinary domain is essential. Therefore, sustaining the developed tools is considered of utmost importance in order to facilitate the signalling, risk assessment and communication of zoonotic threats.

For effective signalling of emerging zoonoses, a systematic approach for the receiving and processing of signals of potential zoonotic threats, including rapid risk assessment and communication to professionals, is needed. Cooperation should take place between all parties involved in the execution of surveillance, and also alignment with policymakers is necessary. In this project, a structure for experts in the veterinary and medical domains to exchange signals from the monitoring systems was developed and tested as a pilot with GD, RIVM and the Dutch Food and Consumer Product Safety Authority (VWA). Further development and establishment of a **joint signalling structure** is recommended. Prerequisites for further co-operation are described, based on using the available expertise and the existing structures for surveillance, risk management and policy making. However, before the human-veterinary signalling structure can be further developed and routinely implemented, a clear description of duties, responsibilities and mandates following the early warning of a potential zoonotic health threat is needed, including follow-up.

To provide a **blueprint for an effective infrastructure** of collaborating key players in veterinary and human medicine for the early warning and surveillance of emerging zoonoses in the Netherlands, the veterinary and public health systems in seven other countries were first described, indicating that interaction between the two is organised in different ways in the various countries. In the Netherlands, the different duties and responsibilities were described for the key institutes involved in signalling, surveillance and control of infectious diseases in animals and humans. The VWA was identified as the connecting link between existing early warning systems in both domains (by receipt of veterinary notifications, participation in the human signalling meeting and by source investigation). In these domains, different procedures are in place. As long as events take place in one of these domains and not in both, this does not pose a problem. In case of zoonotic events, however, it has to be defined who is responsible for processing the signals, who is responsible for designing the appropriate measures, who is responsible for decision-making and what communication to which parties or organisations is necessary.

The EmZoo-programme provided clear tools and a blueprint for an integrated veterinary-human infrastructure for the signalling, risk assessment and control of emerging zoonoses in the Netherlands. To reach the goal of such an integrated system, the following actions are needed:

- **Agreement between the veterinary and medical domains on the division of roles** with regard to the signalling and control of zoonoses, in executive aspects as well as in risk management, policy making and risk communication.
- **Development of additional early warning and surveillance systems** guided by the prioritised list of emerging zoonotic pathogens as well as general surveillance systems for coverage of all relevant animal populations. An agreement should be made that takes away existing barriers for the exchange of (research) data among the various institutes and groups.
- **Instigation of a joint signalling group** in order to bring together signals from all areas of humans, livestock, horses, companion animals, wildlife, exotics and arthropod vectors relevant to public and animal health, based on existing structures. The EmZoo group of collaborating institutes can be the basis for this national zoonoses signalling group, with the addition of other relevant partners. The coordination of the joint signalling group’s activities should be appointed in one place for a longer period of time and conditions for this signalling group with regard to its mandate for further actions and communication between professionals in the two domains should be clearly identified.
- **Sustainment of the developed tools**: the surveillance and diagnostic databases and the Emerging Zoonoses and Information and Priority system (EZIPs) should be maintained and updated by an EmZoo expert working group and the Vetinf@ct information system should be continued.

Chapter 1
Introduction and aims

1.1 Introduction

Infectious diseases like severe acute respiratory syndrome (SARS), avian influenza and more recently MRSA, have shown the large potential of micro-organisms of animal reservoirs to adapt to human hosts. About 75% of the emerging diseases in humans appears to be zoonotic (1). In 2007, zoonoses, which were already known like Q-fever and psittacosis, have had serious direct and indirect implications for public health in the Netherlands. A wide variety of animal species, both domesticated and wild, can act as reservoirs for these pathogens.

In Europe, zoonoses originating from wildlife reservoirs and/or transmitted by arthropods are expected to become more important in the future. Climate and ecological changes may favour already existing arthropods expanding to other regions and thus introducing new pathogens to native areas in Europe (2). This is not a threat for the future but a current issue. For example, *Erythema migrans* (EM), indicative of Lyme disease caused by *Borrelia spp* has tripled in the last 15 years in the Netherlands (3). Lyme disease cases are also reported more often in other countries in Europe, indicating that tick-borne diseases are becoming more important (4). In addition, in 2006, the Netherlands was faced with the introduction of *Aedes albopictus* by importing plants (Lucky Bamboo) from Asia, an endemic area of Dengue and Japanese encephalitis. This mosquito has already established itself in Southern Europe after it was imported from the United States with car tyres. In the summer of 2007, this local mosquito acted as a suitable vector for Chikungunya virus (not a zoonotic agent) introduced in Italy by a viremic patient and caused an outbreak affecting 205 humans, including one death (5).

During an expert meeting about emerging zoonoses organised by WHO, OIE and the Dutch Health Council in 2004, it was concluded that it is impossible to predict the next emerging zoonosis (6). The emergence of a zoonosis is often the result of a complex mixture of risk factors in which the intensity of contacts between the original reservoir (the intermediate reservoir and vectors) and human beings seems to be crucial. Prevention and control of the emergence of zoonoses is thus very difficult and therefore, a multiple-edged strategy consisting in improved preparedness for those zoonoses that are considered as a risk to public health. In addition, public and veterinary health systems and their interaction at national level and in Europe need to be strengthened, to also be prepared for the unexpected (2).

In the USA, the objectives of the updated CDC strategy for preventing infectious diseases were organised under four goals (surveillance and response, applied research, infrastructure and training and prevention and control) focusing on the public health sector (7). Merianos (8) recognised that the impact of emerging zoonoses can be minimised through a well-prepared and strong public health system, but only with similar systems developed in the livestock, wildlife and food safety sectors. To respond to emerging zoonoses effectively, preparedness plans, early warning systems and response capacity must be strengthened and implemented across all sectors in a coordinated way. To achieve these objectives, effective cross-jurisdictional, intersectoral and interdisciplinary collaboration is required (8). The ultimate goal of an early warning system is to limit the negative effects of zoonotic events for public health, trade in animal and animal products and animal health and wellbeing. In an ideal situation, spillover events of human pathogens from an animal reservoir should be prevented by a proactive early warning system, but the reality is that emerging zoonoses still often surface as post-spillover events. Novel schemes for preventing the spillover of human pathogens from animals can only spring from improved understanding of the ecological context and biological interaction of pathogen maintenance among reservoir hosts (9).

In 2006, the Ministry of Agriculture asked the Netherlands Centre for Infectious Disease Control to coordinate a two-year research programme with the aim to develop a blueprint of a holistic proactive early warning system for zoonoses in the Netherlands, on the condition that the main institutes involved in veterinary medicine and infectious disease control in the Netherlands should collaborate. In 2007, the consortium consisting in partners from the Faculty of Veterinary Medicine, University of Utrecht, Animal Sciences group and Central Institute of Animal Diseases Control, Wageningen University and Research Centre and the Animal Health Services, started. The programme has been divided into two successive phases. In the first phase, an inventory was made of current early warning and surveillance systems in the Netherlands and a priority-setting method for emerging zoonoses was developed. In the second phase, collaborative projects were performed resulting in a blueprint for an infrastructure for the effective and efficient management of zoonotic signals from the veterinary and public health domain.

Since many zoonotic agents threaten human health globally (1), the most important emerging zoonotic agents for the Netherlands are identified and prioritised. The prioritised list indicates which emerging zoonotic pathogens pose the largest threat in case they are introduced; however the prioritised list does NOT indicate which agents are most likely to emerge. Furthermore, good surveillance is a vital part of the strategy to prevent emerging infectious diseases, including zoonoses (7, 8, 9). Therefore, an inventory of the current surveillance systems in animal reservoirs and humans in the Netherlands is made and early warning-like systems already implemented in the Netherlands and selectively internationally, are described. Gaps in and other problems with the current early warning and surveillance systems for the most important emerging zoonoses for the Netherlands were identified using the prioritised list and the inventory of current early warning and surveillance systems. Current duties and responsibilities for notifiable zoonoses in the animal and human infectious disease domains are analysed and described. Recommendations are given for the blueprint based on the analyses made between the signalling activities in the veterinary and the human domains between RIVM and GD and the experiences after a pilot, where GD and RIVM installed a zoonoses-signalling group to practice and identify the needs for future recommendations. Recommendations are given and have resulted in a blueprint of an early warning system for emerging zoonoses

1.2 Aims

The EmZoo consortium collaborated on eight projects, all serving the following three major aims (Figure 1):

1. To provide a systematic approach for the signalling of emerging zoonoses,
2. To prioritise emerging zoonoses important for Netherlands, and
3. To develop a blueprint for an early warning and surveillance system for emerging zoonoses.

1.3 Delineation of the report

This report describes the results of the EmZoo programme and is structured in line with the three aims. For a systematic approach to early warning and surveillance, we describe the current surveillance systems of different animal reservoirs including humans, production animals, wildlife, arthropods, exotics, pets and horses and the early warning-like systems implemented are described with the aim of identifying possible deficiencies in the infrastructure. This report does not describe every system available in the Netherlands where animal reservoirs are being investigated or studied because this is too widespread. However, systems that could be relevant for our aim are recognised and mentioned. Furthermore, emerging zoonoses important for the Netherlands were prioritised using a newly developed priority-setting method. Potential risks also include those of antibiotic resistance, although these risks are not described in depth in this report because other research initiatives focus on this topic (MRSA and ABRES consortium project). For the proposed blueprint, we first described the current duties and responsibilities of the different veterinary and medical institutes for the signalling of notifiable zoonoses. It became clear that a structure for non-notifiable diseases, including most emerging zoonoses, does not exist. In this report we propose a possible blueprint for the signalling of the emerging zoonoses between the different institutes involved in the early warning and surveillance of animal and human infectious diseases. Moreover, we propose how these signals can be coordinated towards one national zoonoses signalling group. We realise that the structure in which the signalling and follow-up actions need to be taken have not yet been developed. During the programme, we identified these gaps in an effective signalling infrastructure but we do not propose a policy structure.

The following definitions are used:

Infectious diseases originating from animal reservoirs (zoonoses): diseases transmitted between vertebrate animals and man under natural conditions. This includes diseases that are transmitted through a vector (2, 10). The definition excludes, for example, Chikungunya and Dengue virus, which do not have a non-human vertebrate reservoir. This does not mean that we ignore the importance of these pathogens and it should be possible that in the future, the same systems will identify these non-zoonotic arthropod-borne pathogens.

Emerging diseases: in 1959, the World Health Organisation (WHO) defined an emerging disease as "a disease that has appeared in a human population for the first time or has occurred previously but is increasing in incidence or expanding into areas where it has not previously been reported". At the WHO Geneva conference in 2004, a new definition for emerging zoonoses was formulated: "An emerging zoonoses is a zoonosis that is newly recognised or newly evolved or that has occurred previously but shows an increase in incidence or expansion in the geographic, host, or vector range. It is noted that some of these diseases may further evolve and become effectively and essentially transmissible from human to human (e.g., HIV)" (6). The latter definition is used in this report

Reservoir: a reservoir is one or more epidemiologically connected animal and/or human population in which the pathogen can be permanently maintained and from which infection can be transmitted to human beings (with slight modifications after 11).

Early warning system: early warning systems include a chain of concerns, namely: understanding and mapping the hazard

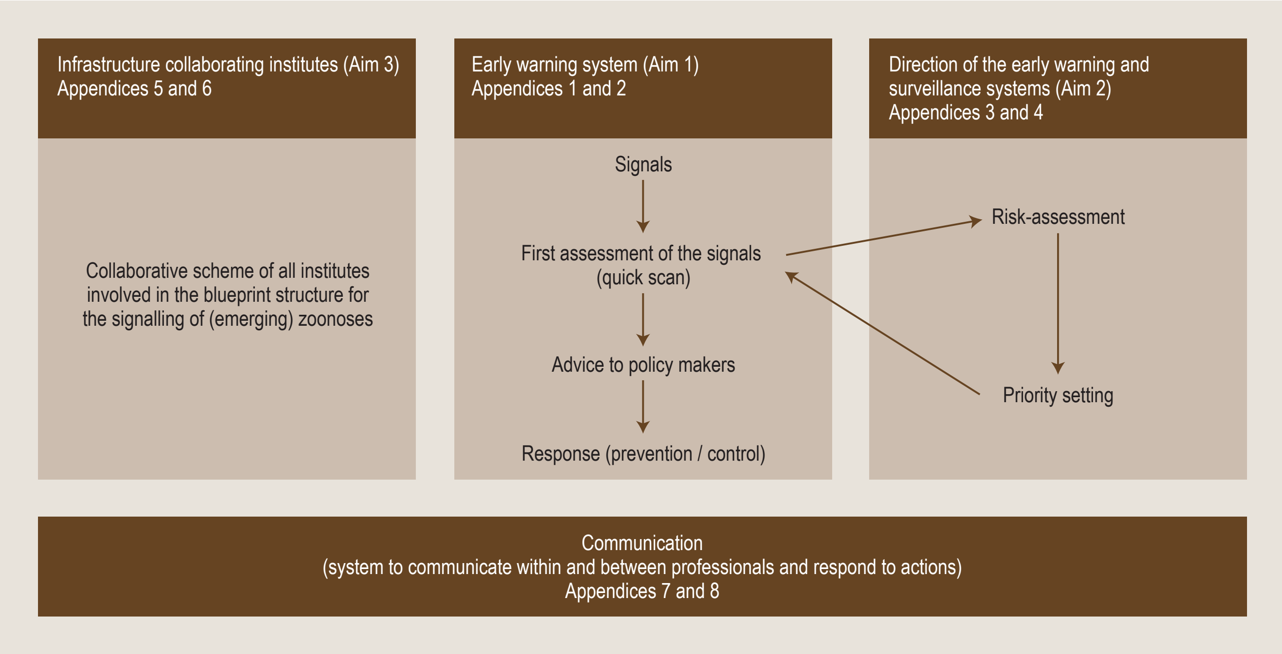

Figure 1. Early warning, direction of surveillance systems and infrastructure.

(read: threat); monitoring and forecasting impending events; processing and disseminating understandable warnings to political authorities and the population and undertaking appropriate and timely action in response to the warnings.

Surveillance / monitoring system: surveillance is defined as 'the systematic collection of data on the occurrence of specific diseases, the analysis and interpretation of these data and the distribution of consolidated and processed information to contributors to the programme and other interested persons' (12). Monitoring is defined as 'a continuous dynamic process of collecting data about health and diseases and determinants in a given population over a defined period of time but without any immediate control activities' (13).

Risk Analysis: a process consisting in three components: risk assessment, risk management and risk communication (14).

Risk Assessment: a scientifically-based process consisting in the following steps: (i) hazard identification, (ii) hazard characterisation, (iii) exposure assessment, and (iv) risk characterisation (14)

*Risk managemen*t: the process, distinct from risk assessment, of weighing policy alternatives, in consultation with all interested parties, considering risk assessment and other factors relevant for the health protection of human beings and for the promotion of fair trade practices and, if needed, selecting appropriate prevention and control options (14).

Risk Communication: the interactive exchange of information and opinions throughout the risk analysis process concerning risk, risk-related factors and risk perceptions, among risk assessors, risk managers, consumers, industry, the academic community and other interested parties, including the explanation of risk assessment findings and the bases for risk management decisions (14).

1.4 Outline/ reading guide

The aims and the delineation of this report on the Emerging Zoonoses project are described in Chapter 1. The EmZoo consortium collaborated on various projects, all serving the three major aims (Figure 1). The results of these projects are summarised and translated into recommendations in Chapter 2. Subsequently, these results are brought together and discussed in Chapter 3. Founded on the recommendations, follow-up actions to reach the goal of an integrated veterinary-medical approach for emerging zoonoses are defined in Chapter 3. The complete reports of the individual projects can be found in the Appendices (see also Table 1).

To provide a systematic approach available for the early warning and surveillance of emerging zoonoses, the different early warning and surveillance systems already operational in different animal reservoirs and humans in the Netherlands and seven other countries are assessed (Appendix 1a). Subsequently, a diagnostic technology assessment and data sharing of the available surveillance systems in the Netherlands was performed for the prioritised list. Recommendations are given based on hiatuses for improvement of the systems for emerging zoonoses (Appendix 1b). In addition, a detection proficiency test between veterinary and medical laboratories with the aim of sharing information about the performance of the different

Table 1. Scheme of related projects as reported in the Appendices.

Appendix number	EmZoo programme
	Project organisation
	Programme leadership and coordination
A	**Early warning and surveillance systems**
1a	Inventory of early warning and surveillance systems
1b	Technology assessment and data sharing for the purpose of early warning signalling
2	Syndromic surveillance in companion animals and horses
B	**Direction of the early warning and surveillance systems**
3	Information and Priority Setting System of Emerging Zoonoses
4	Scenario studies for vector-borne zoonoses
C	**Infrastructure of collaborating institutes**
5	Connecting human and veterinary early warning and signalling
6	Development of a blueprint for an effective Medical –Veterinary Network
D	**Communication**
7	Linked medical and veterinary network (vetinf@ct)
8	Communication of collaborative partners within the EmZoo programme

detection methods available was done for the proof of a principle pathogen, *Coxiella burnetii*. (Appendix 1b). For those animal populations that were identified as currently lacking any surveillance system, horses and companion animals, the usefulness of syndromic surveillance was analysed ((Appendix 2).

To achieve the second aim (to prioritise emerging zoonoses with respect to threat for the Netherlands), known zoonoses that have a high probability of emerging and/or have acquired significant public health relevance in the Netherlands were listed and prioritised. This list was compiled on the basis of several existing lists (1, 2) and updated from the literature. This list aimed to analyse infectious pathogens qualitatively and formed the point of departure for the priority setting, using quantitative analysis (multi-criteria analysis) to define the priority of emerging zoonotic pathogens. Multi-criteria analyses offer methods and techniques to structure complex decision-making (Appendix 3). Moreover, the **E**merging **Z**oonoses **I**nformation and **P**riority systems, **EZIPs**, website will be made available to assist Dutch decision makers to establish the priority of emerging zoonoses with respect to public health, as a basis for effective and efficient policy-making on control, prevention and surveillance as part of this project. To give direction to the risk assessment, we recommend to use the current modelling expertise present within the consortium institutes. Due to the increasing importance of vector-borne zoonoses, the scenarios of two different vector-borne diseases that are possibly important for the Netherlands, were studied (Appendix 4).

Finally, for the third aim, to develop a blueprint for an effective and efficient infrastructure for collaboration between the medical and veterinary key players to signal and control zoonoses, was achieved by the following activities. Connecting signalling activities within the human and veterinary domain were analysed and differences between the systems identified. Moreover, a pilot human-veterinary signalling group was installed (Appendix 5). The current duties and responsibilities are described for the key veterinary and medical institutes involved in signalling the notifiable animal and human relevant zoonoses in the Netherlands (Appendix 6). Finally, a blueprint for an infrastructure for signal emerging zoonoses is proposed (Appendix 6).

In Appendix 7, the development of a communication tool, vetinf@ct, is described. This tool enables communication between veterinary general practitioners and other professionals in animal health and the key institutes involved in human and veterinary signalling to interact in the same way as inf@ct and labinf@ct. In Appendix 8, the communication activities of the EmZoo programme are described.

In the Appendices, the full reports of the projects of the second phase of EmZoo are given (see also Table 1).

References

1. Taylor L.H., Latham S.M. and Woolhouse M.E.J. 2001. Risk Factors for human disease emergence. Philosophical Transactions: Biological Sciences, 356: 983-989
2. Van der Giessen J.W.B., Isken L.D., and Tiemersma E.W. 2004 Zoonoses in Europe: a risk to public health. RIVM report 330200002/2004.
3. Hofhuis A., van der Giessen J.W., Borgsteede F.H., Wielinga P.R., Notermans D.W., van Pelt W. 2006.

Lyme borreliosis in the Netherlands: strong increase in GP consultations and hospital admissions in past 10 years. Euro Surveill. 2006 Jun;11(6):E060629.5.
4. Parola P. and Raoult D. 2001. Ticks and tick-borne bacterial diseases in humans: an emerging infectious threat. Clinical Infectious Diseases, 32:897-928.
5. Rezza G., Nicoletti L., Angelini R., Romi R., Finarelli A.C., Panning M., Cordioli P., Fortuna C., Boros S., Magurano F., Silvi G., Angelini P., Dottori M., Ciufolini M.G., Majori G.C., and Cassone A.. 2007 Infection with chikungunya virus in Italy: an outbreak in a temperate region. Lancet, 370: 1840-1846.
6. WHO. 2004. Report of the WHO/FAO/OIE joint consultation on emerging zoonotic diseases
7. Anonymous 1998. Preventing Emerging Infectious Diseases: A Strategy for the 21st Century Overview of the Updated CDC Plan. MMWR 47(RR15); 1-14.
8. Merianos, A. 2007. Surveillance and response to disease emergence. In Wildlife and Emerging Zoonotic Diseases: The Biology, Circumstances and Consequences of Cross-Species Transmission. Eds. : J.E. Childs, J.S. Mackenzie and J.A. Richt Current Topics in Microbiology and Immunology. 315-389-443. Springer Berlin Heidelberg
9. Childs, J.E. 2007. Pre-spillover prevention of emerging zoonotic diseases; What are the target and what are the tools. In Wildlife and Emerging Zoonotic Diseases: The Biology, Circumstances and Consequences of Cross-Species Transmission. Eds. : J.E. Childs, J.S. Mackenzie and J.A. Richt Current Topics in Microbiology and Immunology. 315-389-443. Springer Berlin Heidelberg
10. WHO, 1959. Zoonoses: Second report on the joint WHO/FAO expert committee Geneva, Switzerland, World Health Organization.
11. Haydon D.T., Cleaveland S., Taylor L.H., and Laurenson M.K. 2002. Identifying reservoirs of infection: a conceptual and practical challenge. Emergence Infectious Diseases 8:1468–1473.
12. Dufour B., Audio L. 1997. A proposed classification of veterinary epidemiosurveillance networks. Revue Scientifique et Technique. 16, 746-758.
13. Doherr, M. G.; Audigé, L. 2001 Monitoring and surveillance for rare health-related events: a review from the veterinary perspective. Philos. Tr. R. Soc. London, 356, 1097-1106.
14. Codex Alimentarius Commission, 2007. Procedural Manual, 17th edition. Available from: http://www.codexalimentarius.net/web/procedural_manual.jsp (accessed: 29-10-2008)

Chapter 2
Results, conclusions and recommendations

In the following, the summaries of the different projects on the EmZoo projects are given. Full reports on the projects can be found in the appendices.

A. Early warning and surveillance systems

1a. Inventory of early warning and surveillance systems

Uneven standards of surveillance, human and animal-based, for zoonotic diseases or pathogens in the Netherlands became readily apparent during the inventory process. Systems are most extensive and well developed for human-based and farm animal based surveillance, while they are greatly underdeveloped for arthropod-based, wildlife based surveillance and exotics and even non-existent for companion animals, including horses.
Surveillance for zoonotic agents is largely based on detecting illness or infection in humans; humans serve as the sentinel species for zoonotic agents maintained in transmission cycles in which, fortunately they rarely play other than an incidental role as a dead-end host. Many well-developed functional surveillance systems are in place for farm animals. The logistics of the farm animal surveillance allows for fast and simple implementation of additional surveillance systems when necessary. In this light, the fact that surveillance in another veterinary sector, namely pets or companion animals (including horses), has not developed was an unexpected finding. Furthermore, due to close contact, pets pose a potential risk for the general public.
Surveillance for zoonotic pathogens among wildlife falls through the cracks of both veterinary and human health practices. Limited long-term wildlife surveillance systems are in place but many more efforts are needed because many zoonotic agents are maintained in wildlife reservoirs. While arthropods and their pathogens are anticipated to become more important in the future, knowledge of vector surveillance and control is suboptimal in the Netherlands. The surveillance for zoonotic diseases in exotics is concentrated at Schiphol airport, while the vast majority of legal (and illegal) exotics arrives at other European airports and enters the Netherlands by road transport. There are no registration requirements for the transport of exotics within the EU. With the increasing demand for out of the ordinary animal species, the arrival of zoonotic agents novel to the Netherlands is bound to happen and will go unnoticed if no proper surveillance system is put in place. This is a major gap in the surveillance of emerging zoonoses.

Besides the pathogen-directed surveillance systems, early warning systems defined as those systems which identify signals from different sources but all possibly of importance to indicate to the emergence of (new) pathogens, are still scarcely developed for use in animal populations. The organisation of veterinary and public health surveillance and available early warning-like systems in other countries is assessed and shows that many countries embrace the 'one health' initiative, a movement to forge co-equal, all-inclusive collaboration among physicians, veterinarians and other scientific-health related disciplines. However, many countries also realised that this does not come naturally. Different solutions, specific for the country's characteristics and needs, are in development or have already been developed. This trend is led by Denmark and the UK. Denmark has already formed a national zoonosis centre. Supervision and teaching in zoonoses and food safety are based on research carried out at the centre. In the UK, the Human Animal Infections and Risk Surveillance (HAIRS) group carries out horizon scanning to identify emerging and potentially zoonotic infections, which may pose a threat to UK public health.

Conclusions
- Early warning and surveillance systems are most extensive and well developed for humans and farm animals, while they are greatly underdeveloped for arthropods, wildlife and exotics and even non-existent for companion animals (pets and horses).
- Internationally, the communication and collaboration between veterinary health and human public health need improvement. This also holds o for the Netherlands. Only a few systems might be recognised as such, like "de veekijker" in production animals and the syndrome surveillance and early warning meetings for humans. The signalling of zoonoses would be better positioned in an integrated veterinary-human structure. After the development of the tasks of the Dutch Wildlife Health Centre and the Centre for Monitoring in collaboration with other expert institutes, wildlife and vector signals should be integrated with the integrated signalling meetings described.

Recommendations

1.1 Start or strengthen zoonotic surveillance systems for arthropods, wildlife, exotics and companion animals (pets and horses).
1.2 Strengthen linkages between human and veterinary laboratories and institutes. Instigate a joined signalling group in order to bring together signals from all areas of humans, livestock, horses, companion animals, wildlife, exotics and arthropod vectors relevant for public and animal health, based on existing structures.

1b. Technology assessment and data sharing for the purpose of early warning signalling

The aim of this EmZoo project was to identify the gaps in the detection and surveillance systems for the emerging zoonoses identified in the prioritised list in the Netherlands. Furthermore, an assessment of the comparability of *Coxiella burnetii* real-time PCR assays, used by the different institutes involved in the EmZoo project, was carried out.
First, gaps in existing surveillance systems were detected. Gaps were defined as "no surveillance exists", "insufficient surveillance", or "no/insufficient diagnostics". Two brainstorming sessions with experts were held, in which all 86 pathogens on the prioritised list were discussed. Second, an inventory of available diagnostic methods was made, to be able to see directly if diagnostic methods for preferred surveillance systems are available or should be developed. Results showed that many gaps in the surveillance exist, also for the highest ranked zoonoses on the prioritised list. It was clear that different surveillance systems should be developed for endemic and non-endemic zoonoses. So-called general surveillance systems, like tick monitoring or syndrome surveillance, which are meant for several pathogens together, can be very efficient. For some zoonoses it is important that more awareness is created among human doctors.

Results of *Coxiella* PCRs showed that in samples with high *C. burnetii* content, all six participating institutes scored similar results using their 'in-house' real-time PCR assay(s) for the detection of *C. burnetii* in the provided samples.

For the first 25 pathogens on the list, gaps were detected for the endemic zoonoses *Toxoplasma gondii, Anaplasma phagocytophilum, Chlamydophila psittaci* and for the non-endemic zoonoses: Japanese encephalitis virus, West Nile virus, Crimean-Congo hemorrhagic fever virus, Dobrava-Belgrade virus, Rift Valley Fever virus, Eastern equine encephalitis virus, Tick-borne encephalitis virus and Seoul virus. It was an arbitrary decision to concentrate on the first 25. Good reasons can be given to extend the recommendations with pathogens listed after number 25 without much more effort or cost.

General surveillance systems, like mosquito monitoring, tick monitoring and rodent monitoring should be further developed. Monitoring of relevant pathogens as identified in the prioritised list should be included in these general surveillance systems. Furthermore, syndrome surveillance for humans and syndrome surveillance for horses should be further implemented. This is described in appendix 2 (Syndromic surveillance in companion animals and horses). Because the priority listing of pathogens is dynamic and subject to future changes, the usefulness of existing surveillance systems and the need for new once requires regular evaluation. It was also recommended to keep the database of diagnostic methods up-to-date.

Conclusions

- Gaps in surveillance exist for the following endemic zoonoses: *Toxoplasma gondii, Anaplasma phagocytophilum* and *Chlamydophila psittaci*.
- Gaps in surveillance exist for the following non-endemic zoonoses: Japanese encephalitis virus, West Nile virus, Crimean-Congo hemorrhagic fever virus, Dobrava-Belgrade virus, Rift Valley fever virus, Eastern equine encephalitis virus, tick-borne encephalitis virus and Seoul virus.
- Many of these gaps can be filled by developing general surveillance systems, which, monitor for more than one pathogen at a time in an efficient way.
- For some zoonoses it is important that more awareness is created among human doctors.
- Q fever. In samples with high *C. burnetii* content, all six participating institutes scored similar results, using their 'in-house' real-time PCR assay(s) for the detection of *C. burnetii* in the provided samples. Results started to deviate considerably among institutes with decreasing *C. burnetii* DNA content and increasing content of inhibiting substances.

Recommendations

1.3 The results of the brainstorming meetings with experts, in which all 86 pathogens on the list were discussed to advise about specific surveillance systems, should be further analysed and validated. The results can be used for making the decision of whether new surveillance systems should be set up.
1.4 Start up general integrated surveillance systems: mosquito monitoring, tick monitoring, rodent monitoring, syndromic surveillance in humans, syndrome surveillance in horses.
1.5 Carry out scenario studies as an input for the designs of (general) surveillance systems.
1.6 Keep the database of diagnostic methods up to date.
1.7 It might be useful to carry out cost-benefit analyses before new surveillance systems are introduced.

2. Syndromic surveillance in companion animals and horses

The need and possible options for a syndrome surveillance system for companion animals and horses to detect (re)-emerging zoonoses were evaluated. The analysis was based on the information collected from syndromic surveillance in the human domain in the Netherlands, the running initiatives in production animals ('Veekijker') and the registration system for notifiable diseases, international developments and a literature search. The priority-setting list of 86 pathogens was used. Two pilot studies were performed: one in a diagnostic lab/expertise centre for companion animals to assess the helpdesk requests from practitioners. The other pilot was in horses, focusing on West Nile Virus surveillance. However, symptoms in the context of neurological syndromes were also recorded and analysed.

Conclusions

- For companion animals and horses a system is lacking at the moment, whereas almost half of the EZIP pathogens induce clinical symptoms in companion animals or horses. The implementation of a full-blown syndrome surveillance system will meet serious logistical constraints that need investment, to set up a harmonised reporting system, the introduction of compatible computer systems and data analysis capacity. The costs are probably considerable and before an introduction is started, the cost-effectiveness should be analysed.
- The designation of a 'helpdesk' where signals of unusual events in companion animals and horses can be reported (passive surveillance) and further analysed would be the first step towards an early detection system for these animals. An important stimulus for reporting is the availability of expertise at this helpdesk (consulting desk). This has been shown in the 'Veekijker', and it is clear from the help-desk pilot in companion animals. Besides acting as an expertise centre (to help the practitioners to solve the problem) this consulting desk should be able to offer follow-up (microbiology, pathology), in cases that meet specific criteria. Compared to the syndromic surveillance system, this approach will be relatively cheap.
- The introduction of syndromic surveillance can be considered for the more long-term. As a first step for the introduction of this syndromic surveillance, the introduction of a clinical reporting model, as used in Sweden for horses, may be considered. This would require an in-depth study of databases and diagnostic entries used by the Swedish network of clinics and insurance companies, and an evaluation of the feasibility of introducing such a system in a network of companion animal and equine practices.

Recommendations

2.1 To report and register unusual clinical cases and events in horses and companion animals to a 'helpdesk' that should be installed in the short term, as a system is lacking at the moment. Cases are evaluated and follow-up can be given.

2.2 To evaluate thoroughly the Swedish clinical registration system and the SAVSNET surveillance system for implementation in pet and horse clinics and assess the usefulness of the VetCIS system for syndromic surveillance, and – alternatively – the implications and costs of adopting the Swedish clinical registration system.

2.3 A syndromic surveillance system for companion animals and horses would have added value. Although the data collection and communication of practice management systems show gaps, a retrospective data analysis will show the power and limitations of the current system. This retrospective study can be followed by a pilot syndromic surveillance study with a limited number of practices.

2.4 A next step could be to perform a cost-benefits analysis, based on the experiences in the human field with sentinel GP stations and the experiences in Sweden for companion animals and horses. Evidentially, the cost analysis will be the easiest part, since benefits can only be evaluated after a pilot study with a network of practices for a couple of years.

B. Direction of the early warning and surveillance systems

3. Emerging Zoonoses Information and Priority-setting system

The aim of this project was to prioritise emerging zoonotic pathogens in the Netherlands for early warning and surveillance and to develop a web-based information system that also allows interactive access to the priority-setting model.

Priority setting was based on a multi-criteria analysis, in which all pathogens included in the EmZoo project were evaluated against the following attributes:

- Probability of introduction into the Netherlands;
- Transmission in animal reservoirs;

[1] Results obtained from TNO D&V are preliminary and must be reevaluated due to positive results in the negative controls. Therefore, data obtained from TNO D&V cannot be compared directly to the other participating institutes.

- Economic damage in animal reservoirs;
- Animal-human transmission;
- Transmission between humans;
- Morbidity; and
- Mortality.

Weights for these attributes were based on panel sessions with policy makers, infectious disease control specialists and medical and veterinary students and were calculated using a mathematical technique known as probabilistic inversion. The weighted scores of all pathogens, including the attendant uncertainty, were presented as the basis for priority setting. Pathogens with the highest level of risk included pathogens in the livestock reservoir with a high actual burden (e.g., *Campylobacter* spp., *Toxoplasma gondii, Coxiella burnetii*) or a low current but higher historic burden (e.g., BSE prion, *Mycobacterium bovis*), rare zoonotic pathogens in domestic animals with severe manifestations (e.g., *Capnocytophaga canimorsus*) as well as arthropod-borne and wildlife-associated pathogens, which may pose a severe threat in the future (e.g., Japanese encephalitis virus and West-Nile virus).

There were considerable uncertainties in the assessment of pathogens against the seven attributes listed above and this uncertainty is reflected in the risk scores. This may guide future research and data collection activities. The priority-setting system was developed as a flexible tool in which new information on currently included pathogens can readily be included. Furthermore, new pathogens can be added if they can be evaluated on the seven attributes.

The Emerging Zoonoses Information and Priority system (EZIPs) is a website that aims to inform professionals in zoonoses research, risk assessment and risk management. EZIPs offers a database with descriptive information on the pathogens in several categories: Taxonomy, Human and Animal Disease, Reservoirs, Transmission and Geographical distribution. In addition to the descriptive information, users can access all details of the priority-setting model and may change several aspects of the model to allow the evaluation of the robustness of the model results and to evaluate the impact of future information. Interactive aspects, including the use of weights and the levels assigned to different attributes were used. Users can also enter a new pathogen and compare its ranking to those in the database.

The current priority-setting model is based on epidemiological criteria. Risk perception, which is another important aspect for decision making, is not accounted for. An assay was produced that describes different theories of risk perception and how these may apply to emerging zoonoses.

Conclusions

- The risk of emerging zoonotic pathogens, as ranked using a set of seven comprehensive criteria, differs considerably and the ranking can be used for decision making.
- The pathogens with the highest ranks include pathogens in the livestock reservoir with a high actual burden (e.g., *Campylobacter* spp., *Toxoplasma gondii, Coxiella burnetii*) or a low current but higher historic burden (e.g., *Mycobacterium bovis*), rare zoonotic pathogens in domestic animals with severe manifestations (e.g., BSE prion, *Capnocytophaga canimorsus*) as well as arthropod-borne and wildlife-associated pathogens, which may pose a severe threat in future (e.g., Japanese encephalitis virus and West-Nile virus).

Recommendation

3.1 Maintenance of the EZIPs website and priority-setting model to include new information and additional emerging pathogens.

4 Scenario studies for vector-borne zoonoses

The project identified four possible situations of vector-borne zoonoses relevant for the Netherlands, with respect to the presence and absence of the vector or the pathogen, under the assumption that the host reservoir is present. Two situations are further explored in a scenario study. In the first situation, illustrated by Crimean Congo haemorrhagic fever, both the vector and the pathogen are currently absent. The likelihood that the tick vector will establish in the Netherlands when introduced was studied, using a so-called climate envelope model approach. In addition, we investigated whether this risk increases or decreases in the coming decades, taking into account current climate change predictions. From our results, the climate requirements of the main tick vector and current and future climate data do not suggest that they can become established. In the second situation, illustrated by Rift Valley fever, the pathogen is currently absent but several *potential* vectors are endemic in the Netherlands. For RVF, mechanistic modelling was used to investigate the risk of the spread of RVF if introduced in the Netherlands. Our results show that the role of humans in a Rift Valley fever outbreak is uncertain but the impact on humans can be considerable. This depends strongly on the host preference of the mosquitoes (is there a preference for humans or livestock?). Furthermore, a novel method for signalling first cases of RVF in livestock in the Netherlands is described. This method aims at detecting higher abortion levels as a result of RVF, possibly combined with high calf mortality. When only based on abortion levels and applied to the bluetongue outbreak, the specificity of the method seems low. The method is, however, promising and further improvements could be made to increase its specificity for the detection of an outbreak of RVF.

By joining forces within the EmZoo consortium, specific vector-borne disease (VBD) modelling characteristics and knowledge gaps are identified. Vector-borne pathogens have a complex transmission cycle between host, reservoir and vector, each largely influenced by environmental factors, which in turn vary greatly in space and time. A single model incorporating all these aspects is not available but also unlikely to be very useful if it was. State-of-the-art models, focusing on specific aspects and questions rather than trying to be all-encompassing, are needed, for example, approaches that incorporate mathematical/ mechanistic models with statistical models based on trap data and high- (e.g., land use data) and low-resolution (e.g., climate data) satellite information. In addition to model development, biological and epidemiological data are urgently needed, as high levels of uncertainty in the values of the model parameters exist, especially concerning the life history of vectors and (wildlife) reservoirs, the interface of pathogen and host and the extrapolation of trap data to exposure data.

Conclusions

- Currently, the amount of expertise, monitoring and research done in the Netherlands is relatively small and very fragmented; a structured interacting knowledge-network is essential for reliable risk assessment and public and veterinary health advice.
- Data collection and insight in the Netherlands is currently uncoordinated and limited, for example, concerning the complexities of the VBD transmission cycles, the life history of both vector and (often wildlife) hosts, their abundance and spatio-temporal dynamics and notably, also the way all these are influenced by environmental and climatic conditions.
- Given the complexities of VBD systems, epidemiological models are an essential tool in the assessment of risks to humans and animals and the assessment of the effectiveness of preventive and control measures. Even more so than is the case for directly transmitted infections in humans and animals, models are needed to both augment and insightfully connect various incomplete data sources. Due to the strong environmental influence in these systems, a hybrid type of approach is needed, where statistical models relating vector and host abundance to remotely-sensed or directly observed environmental and climate variation are linked with mechanistic models to quantify the resulting dynamics of infection and, ultimately, the risks to humans and animals and the effectiveness of prevention and control measures. Currently, such models are rare, both in the Netherlands and internationally.
- Currently, existing barriers for the exchange of data among and between the various institutions and groups exist on various levels, caused by 'ownership' and confidentiality issues between all partners and lack of trust between data producer and prospective user. These issues should be settled, to allow the many relevant and natural research partnerships and networks needed to understand and gauge VBD dynamics, emergence and risk and to collaborate free from constraints on the basis of mutual trust and respect for each other's expertise and knowledge.
- Currently, there are possibilities for surveillance of VBD based on existing monitoring instruments and data sources.

Recommendations

4.1 Zoonotic vector-borne infections emerging for the Netherlands should receive focused, structured and structural attention. Coordinated action should be taken to set priorities and methodologies for monitoring, analysis and prevention and control. Moreover, it should stimulate and facilitate interaction and collaboration between the different partners, with the ultimate aim of addressing the right questions concerning emerging vector-borne zoonoses in a manner that balances the many relevant aspects of these complex future and present disease risks.

4.2 Data collection on vectors and their hosts should be a priority, especially where the biology, ecology and epidemiology of VBD are concerned. The coordinating action suggested in recommendation 4.1 should determine the target systems for VBD risk assessment and mitigation, leading to priorities in data collection, driven by recognised gaps in knowledge, essential for taking balanced public and veterinary health decisions.

4.3 Progress in the development of improved models and applications should be stimulated by international partnerships and research networks. However, true progress is only possible with the existence of sufficiently relevant and quality data, as in recommendation 4.2, to guide construction and validation.

4.4 An agreement should be made that takes away existing barriers for the exchange of data among and between the various institutions and groups.

4.5 Surveillance should be optimised by using the results from modelling studies.

C. Infrastructure of collaborating institutes

5. Connecting human and veterinary early warning signalling

The aim of this project was to achieve a structure for the exchange and assessment of signals of health disorders in humans on the one hand and animal husbandry on the other, which should contribute to the improvement of the early detection of zoonotic diseases and improved protection of both human health and animal health. As a first step, an inventory was made of the monitoring and surveillance procedures in public health as well as animal husbandry. An inventory was also made of the procedures through which signals are translated into animal or human health policy. Procedures in both domains were translated into a general process and a comparison was made of the responsibilities of the parties involved in each step of the process in either domain. The aim was to gain understanding of the chains of monitoring and risk management, including risk communication and to identify which issues should be paid attention to make a successful connection. The next step in the project was to achieve a common structure for experts in monitoring in both domains to exchange signals from the monitoring, as performed at the CIb for public health and at the Animal Health Service for livestock. A common structure was found in regular meetings, which were held 13 times. Experiences and conclusions were translated into recommendations for a design and working methods for a joint structure for signalling zoonotic disease problems as well as for conditions that need to be fulfilled to make it successful.

Conclusions

From the project it is concluded that:

- There are differences between the public health domain and the veterinary domain with regard to responsibilities for the process from monitoring and surveillance to risk management, that need to be addressed in order to establish a successfully operating joint structure for zoonotic diseases. One difference is that in the veterinary domain responsibilities are shared between public and private partners (LNV and product boards), while public health is a purely public affair. Another difference is that in public health monitoring and surveillance on the one hand and risk management on the other (on the national level) are joined to a large extent within one single organisation (CIb), while in the veterinary domain the one organisation that performs monitoring and surveillance (AHS) is not primarily responsible for risk management.
- It has been shown to be worthwhile establishing a joint structure for sharing signals regarding zoonotic diseases in public health (CIb) and farm animals (AHS), though the number of relevant signals is limited. In order to make the joint structure function optimally, it should be extended by experts other than those from CIb and AHS.
- In order to establish a joint structure for sharing signals regarding zoonotic diseases in public health and farm animals, a joint structure for risk management must be established, which is agreed upon by relevant public parties as well as private parties in the veterinary domain. Risk communication is the most relevant issue to be addressed within this agreement.

Recommendations

5.1 An agreement must be established between policymakers from both domains, amongst which private parties in the veterinary domain, upon the structure for sharing signals as well as risk management of zoonotic diseases. The main issue to be addressed is risk communication.

5.2 The joint structure for sharing signals on zoonotic diseases between both domains can be designed as recommended within this project, including an extension by parties such as CVI, FD and also DWHC and CMV. The responsibility for the coordination of activities within this structure should be centralised.

6. Blueprint for the early warning signalling and surveillance of emerging zoonoses in the Netherlands

The aim of this project is to provide a blueprint for an effective infrastructure of collaborating key players in veterinary and human medicine for the early warning and surveillance of emerging zoonoses in the Netherlands. Two Ministries are particularly involved in the control of zoonoses: the Ministry of Agriculture, Nature and Food Quality (LNV) and the Ministry of Public Health, Welfare and Sports (VWS). Timely recognition of emerging zoonoses (early warning) is an essential first step towards an adequate response. For signalling, analysis of signals, risk assessment and implementation of control measures, mandates and responsibilities of the different players need to be clearly defined. The current duties, responsibilities and mandates were described for the key institutes involved in the signalling, surveillance and control of infectious diseases in animals and humans. For notifiable diseases, the current signalling in the medical and veterinary domain was visualised in a schematic overview, which clearly identified the Dutch Food and Consumer Product Safety Authority (VWA) as the connecting link. For non-notifiable diseases, no formal structure is present.

Conclusion

Although in humans and livestock signalling is well organised, for companion animals, exotic pets and wildlife, no early warning structures are present. The assessment and processing of signals related to only one of either the human or veterinary domain is well structured and clearly defined. Competency and authority to impose control measures are clearly defined and communication is structured. Both areas differ in the way these items are organised, but as long as operations take place in one of the areas and not in both, this does not pose a problem. For the assessment of zoonotic signals, which are (or might be) related to both areas, no formalised structure exists.

The EmZoo consortium recognises the need for a joint structure for receiving and processing (quick risk assessment and communication to decision makers and to professionals) signals of potential zoonotic threats. Prerequisites for further co-operation are described based on using the existing structures and available expertise.

Recommendations

6.1 To maintain the existing structures for surveillance, risk management and policymaking and make maximum use of existing expertise. Additional structures for the shared responsibilities on zoonoses can best be built on these existing structures.

6.2 To develop a joint appraisal framework to be used for assessment of signals in the common domain. This appraisal framework needs to be shared by specialists, risk managers and policy makers.

6.3 To instigate a joint signalling group in order to bring together signals of all areas of human, livestock, horses, companion animals, wildlife, exotics and arthropod vectors relevant for public and animal health. The EmZoo group of collaborating institutes can be the basis for this national zoonoses signalling group. Other relevant partners, such as the Dutch Wildlife Health Centre (DWHC), Centrum Monitoring van Vectoren (CMV) and Team Invasieve Exoten (TIE) could become part of this group. The coordination of the national zoonoses signalling group activities should be organised in one place, for a longer period of time.

6.4 To clearly identify conditions for this national zoonoses signalling group for mandates for further action and communication between professionals in the two domains.

6.5 Furthermore, it is considered useful to sustain and periodically update the surveillance and detection databases and EZIPs by an EmZoo expert working group and administrator and to maintain the Vetinf@ct information system.

D. Communication

7. Linked medical and veterinary network (vetinf@ct)

The aim of this project was the establishment of an easily accessible news service for the exchange of information about veterinary casuistry with zoonotic relevance. The news service has been designated vetinf@ct.
Veterinary professionals, practitioners as well as scientists and officials, are able to quickly send or receive reports on developments or incidents in the field of zoonotic infections, thus enhancing knowledge and expertise and promoting discussion among peers.
By enabling the exchange of information between comparable medical news services, a One Health Network is created that contributes to the early recognition of zoonotic threats.

A project team has determined the preconditions for the news service and the IT surroundings in which the service should ideally be run. Vetinf@ct will be run within the Animal Health Service DAP (veterinary practice) contact system. The Animal Health Service and Royal Veterinary Association of the Netherlands have both provided the addresses of veterinarians in order to ensure a high initial coverage of the news service.

Recommendations

7.1 The vetinf@ct project can continue until the end of June 2010 at the most, depending on the number of messages sent. The current set-up comes at a price tag, therefore costs need to be covered after the end of the project. Given the broad support for vetinf@ct in the Netherlands, continuation of its funding has to be considered now.

7.2 The current set-up of vetinf@ct should be evaluated after 10 messages have been distributed or otherwise in July 2011, at the latest.

Chapter 3
General discussion and follow-up actions

In this report, the development of a blueprint for an early warning and surveillance system in animal reservoirs in the Netherlands is described. This report is a collaborative effort of key institutes involved in veterinary medicine and public health in the Netherlands. This consortium consisted in partners from the Faculty of Veterinary Medicine, University of Utrecht (UU), Central Veterinary Institute, Wageningen University and Research Centre (CVI), the Animal Health Service (GD) and the Centre for Infectious Disease Control of the RIVM (CIb).

The ultimate goal of an early warning system for emerging zoonoses is to limit the negative effects of a zoonotic event for human (and animal) health.

The original aim was to develop a holistic, proactive, quantitative model to support early warning by integrating information on different risk factors based on qualitative schemes, developed in projects such as EMRISK (2005) and Foresight. It was concluded that such a plan was too ambitious, if feasible at all. There is a multitude of risk factors with undefined and variable relationships that would need to be taken into account. Quantitative data are difficult to obtain for many factors. The consortium members collaborating in the different projects within EmZoo have identified other approaches, which address more specific aspects of these objectives and have a higher feasibility. These projects were specifically chosen for this purpose and entail the strengths, weaknesses, opportunities and threats of the current early warning and detection systems (Appendix 1a, 1b), usefulness of syndromic surveillance in companion animals and horses (Appendix 2), the development of a prioritised list of emerging zoonoses (Appendix 3), scenario studies for vector borne diseases (Appendix 4) and the development of a blueprint for a human-veterinary signalling system (Appendices 5, 6) and communication tool (Appendix 7). The design of the blueprint is based on the experiences of the consortium partners in the projects.

Early warning and surveillance systems

First, an inventory of current early warning and surveillance systems for different animal populations and humans relevant for public and veterinary health was made. Suitable systems are in place to signal clinical illness in farm animals and to monitor the prevalence of specified pathogens. For wildlife, exotic animals, companion animals and horses, no early warning systems are in place. In addition, the possible presence of pathogens in arthropods or increase in their abundance goes largely unnoticed or is noticed too late because surveillance is negligible. For human illness, disease reporting mechanisms are in place but are not focused on early detection of zoonotic diseases and the majority of disease events remain without diagnosis. Therefore, although the most suitable systems are present in farm animals and humans, current surveillance and diagnostics of new zoonotic disease events is still patchy, both in humans and animals.

Prioritising early warning and surveillance systems

To provide risk-based recommendations on the selection of pathogen/reservoir combinations for early warning and surveillance, a prioritised list of emerging pathogens for the Netherlands was developed. A database consisting in 86 pathogen/host/vector combinations was established and a priority setting system, based on a multi-criteria analysis, was developed as a flexible tool, in which new information on pathogens in the current list can be readily updated. In addition, a web-based emerging zoonoses information and priority system (EZIP), which also allows interactive access to the priority-setting model, was developed. This website aims to assist Dutch decision makers in establishing the priority of emerging zoonoses as a basis for effective and efficient policy-making on prevention, surveillance and control. In addition, this website can also assist professionals for risk assessment purposes and it can be used for scientific research into the prioritisation of public health threats. The risk of emerging zoonotic pathogens, as ranked using a set of seven comprehensive criteria, differs considerably and the ranking can be used for decision making. The prioritised list does not indicate which agents are most likely to emerge but which pathogens pose the highest threat.

Based on this prioritised list, gaps in the detection and surveillance systems for the emerging zoonoses were identified and an inventory of available diagnostic methods was made, to be able to immediately assess whether diagnostic methods for priority surveillance systems are available or should be developed. Gaps in the early warning and surveillance systems from the prioritised list were identified for endemic and non-endemic zoonoses. General recommendations about the arbitrary top twenty-five of the ranked zoonoses are provided. For some zoonoses, it is important that more awareness is created among doctors, particularly in human medicine. All 86 pathogens on the list were discussed during the programme but we concluded that recommendations about specific surveillance systems for prioritised pathogens need to be further defined. Cost-efficient surveillance by, for instance, combining multiple high-priority pathogens should be further explored with the input of more experts in the specific field. Consequently, we concluded that recommendations about specific surveillance systems for prioritised pathogens need more consideration and for some pathogens targeted baseline surveys. Nevertheless, the general recommendations given in this project are valid.

Surveillance of relevant prioritised wildlife-borne emerging zoonoses should be implemented. In addition, there is a need to centralise the early warning signals from wildlife reservoirs and to communicate these with relevant partners. The initiative to establish the Dutch Wildlife Health Centre (DWHC) within the Department of Pathology of the Faculty of Veterinary Medicine in 2008 is an important step towards more surveillance activities of wildlife, including early warning of unknown and unusual morbidity and mortality. These initiatives should be carried out in collaboration with the national veterinary and public health institutes and also in close collaboration with expertise in ecology and wildlife preservation institutes.

While arthropod-borne diseases pose an increased risk in the future, knowledge of arthropod related surveillance and control is suboptimal in the Netherlands. Limited surveillance systems for tick-borne diseases in humans, animals and their vectors are in place but extended national surveillance is desirable. Mosquito-borne diseases will become of more importance in the future but mosquito surveillance in the Netherlands is currently insignificant and at best project-based. However, the recent establishment (1 July 2009) of the Centre for Monitoring Vectors (CMV) is an essential first step to a signalling infrastructure for vectors. Scenario studies, including modelling and risk mapping, of tick- and mosquito-borne diseases can facilitate the risk assessment of newly emerging arthropod-borne pathogens. This should be supported by the monitoring of pathogens in mosquito and tick populations, in connection with studies of the ecology of mosquitoes, ticks and reservoir species of the pathogens as well as the surveillance in humans and target animals. These studies are essential to understand the epidemiology of arthropod-borne diseases in the Netherlands and to assess risk. Currently, the amount of expertise, monitoring and research done in the Netherlands is relatively small and very fragmented. A structured interactive knowledge-network is essential for reliable risk assessment and public and veterinary health advice. Coordinated action should set priorities and methodologies for monitoring, analysis and prevention and control in humans, animals and their vectors. Moreover, it should stimulate and facilitate interaction and collaboration between the different partners, with the ultimate aim to address questions concerning emerging vector-borne zoonoses in a manner that balances the many relevant aspects of these complex future and present disease risks. The CMV is an excellent development to facilitate monitoring in vectors relevant for public health, in close collaboration with the questions to be addressed by public and animal health institutes.

The virtual absence of surveillance activities in exotic animals, companion animals and horses is a major gap in the surveillance of emerging zoonoses. Knowledge about the trade, especially illegal trade and health of exotic animals is limited and the consortium identified this as a major gap. The need to develop surveillance systems for exotics is identified. Development of a surveillance system for prioritised zoonoses in companion animals and horses is needed, but to assess for which zoonotic pathogens surveillance should be implemented, project-based studies to estimate the presence or prevalence of zoonotic pathogens in these animal populations should first be performed.

The usefulness of syndrome surveillance in animal reservoirs was studied for companion animals and horses. Such surveillance will have added value and a retrospective data-analysis could show the power and limitations of the current system. Experiences in the development of a syndromic surveillance system in the human sector should be used for the development of syndromic surveillance in companion animals and horses but a stepwise approach is recommended. The designation of a helpdesk-function to which unusual events in pets and horses can be reported and analysed would be an important first step towards an early detection system, given the right expertise ‘behind the desk’. This should be implemented in the short term. A second step could be a retrospective study followed by a pilot syndromic surveillance study with a limited number of practices.

Infrastructure for surveillance systems

To provide a blueprint for an effective infrastructure of collaborating key players in veterinary and human medicine for the early warning and surveillance of emerging zoonoses in the Netherlands, the different duties and responsibilities were first described for the key institutes involved in signalling, surveillance and control of infectious diseases of animals and humans. The Dutch Food and Consumer Product Safety Authority (VWA) is the connecting link between veterinary notifications and human infectious diseases, by source investigation and by participation in existing early warning systems on both sides.

The duties and responsibilities of the ministry of LNV are clearly described for mandatory notifiable animal diseases (mainly described in the Animal Health and Welfare Act and EU legislation) and those of the ministry of VWS for human infectious diseases (mainly described in the Public Health Act for infectious diseases and the International Health Regulations of the WHO). It was concluded that the assessment and processing of signals related to only one of both areas (either human or veterinary domain) is well structured and clearly defined. Competency and authority to impose control measures are clearly defined and communication is structured. Both areas differ in the way these items are organised but as long as operations take place in one of these areas and not in both, this does not pose a problem. For the assessment of zoonotic signals, which are (or might be) related to both areas, no formalised structure exists. However, in such cases, informal communication and cooperation currently takes place at several levels. This applies to both notifiable and non-notifiable diseases. In case of signals that are related to both domains, it has to be defined, who is responsible for the processing of signals, who is responsible for designing appropriate measures, who is responsible for decision making, and what communication to which parties or organisations is necessary.

The interests in both domains seem contradictory but in fact, they have shared interests: human and animal health both have economic aspects, (both prevention and treatment must be paid for after all) and the economy of animal industry is directly dependent on guarantees regarding human health. It is true that in both domains considerations are made in a different way. Therefore, in the common domain, there is a need for a common framework to assess signals. Clarifying these considerations and making them explicit is necessary and this process should be facilitated.

After an inventory of the monitoring and surveillance procedures and those through which signals are translated into animal or human health policy in the public health and veterinary health domains, it became clear that these had a different dynamic in the two chains. Therefore, understanding of the chains of monitoring and risk management, including risk communication of the two and to identify which issues should be paid attention to is necessary for making a successful connection.

The EmZoo consortium recognises the need for a joint structure for receiving and processing (rapid risk assessment and communication to professionals) of signals of potential zoonotic threats. Cooperation should take place in terms of all surveillance functions. Responsibilities for humans and animals are held but the shared responsibility in case of a zoonotic health threat needs to be addressed. Before the human-veterinary signalling infrastructure can be further developed and routinely implemented, a clear description of duties, responsibilities and mandates following the early warning of a potential zoonotic health threat is needed.

To achieve a structure for experts in both domains to exchange signals from the monitoring, a pilot structure was developed during the project between the CIb-RIVM active in signalling of human infectious diseases including zoonoses, the Animal Health Service active in disease monitoring in livestock and the VWA, active in veterinary notifiable signals and source finding for human clusters. It was concluded that conditions and working methods for a joint structure for signalling zoonotic diseases need to be fulfilled, to make a common signalling structure successful.

A joined zoonoses signalling group is advised in order to bring together signals from relevant areas from the veterinary and medical domains. This signalling group can be designed by EmZoo representative experts from the GD, CVI, UU, VWA and RIVM as core institutes. This group can be extended by the DWHC, CMV and TIE and *ad hoc* by other relevant parties. The objective is to determine if – in case of human risks originating in the veterinary domain – action is needed. If helpful for its task, the group should be able to communicate relevant signals to professionals in both fields within a mandate that needs to be defined by the policymakers. Crucial for the development and sustainability of this national zoonoses signalling group is mutual trust. Besides mutual trust, transparency for the follow up of signals is needed. One of the recommendations from the pilot group is to appoint the coordination of its activities in one place for a longer period of time. Conditions about mandates for further actions and communication between professionals in the two domains first need to be fulfilled before such a group can act successfully.

Communication is an important tool between the two domains for receiving and sharing information. Tools like Vetinf@ct, the surveillance and diagnostics database and the web-based Emerging Zoonoses Priority and Information system (EZIPs), need to be sustained to facilitate the signalling, risk assessment and communication activities.

Follow-up actions

The EmZoo programme provided clear tools and a blueprint for an integrated veterinary-human infrastructure for the signalling, risk assessment and control of emerging zoonoses in the Netherlands. To achieve this goal, the following actions are needed (based on the recommendations reported in Chapter 2):

- **Agreement between the veterinary and medical domains on the division of roles** with regard to the signalling and control of zoonoses, in executive aspects as well as in risk management, policy making and risk communication (recommendations 4.4, 5.1, 6.1–6.5).
- **Development of additional early warning and surveillance systems** guided by the prioritised list of emerging zoonotic pathogens as well as general surveillance systems for coverage of all relevant animal populations. An agreement should be made that takes away existing barriers for the exchange of (research) data among the various institutes and groups (recommendations 1.1, 1.3–1.5, 1.7, 2.1–2.4, 3.1, 4.1–4.5).

- **Instigation of a joint signalling group** in order to bring together signals from all areas of humans, livestock, horses, companion animals, wildlife, exotics and arthropod vectors relevant for public and animal health, based on existing structures. The EmZoo group of collaborating institutes can be the basis of this national zoonoses signalling group, with addition of other relevant partners. The coordination of the joint signalling group activities should be appointed in one place for a longer period of time and conditions for this signalling group with regard to a mandate for further actions and communication between professionals in the two domains should be clearly identified (recommendations 1.2, 4.4, 5.2, 6.1–6.5).
- **Sustainment of the developed tools**: the surveillance and diagnostic databases and the Emerging Zoonoses and Information and Priority system (EZIPs) should be maintained and updated by an EmZoo expert working group and the Vetinf@ct information system should be continued (recommendations 1.3, 1.6, 3.1, 5.1–5.2, 7.1–7.2).

Appendix 1a
Inventory of early warning and surveillance systems

Project leaders
Y. Van Duynhoven, RIVM, Human
P. Kock, GD, Farm animals
J. van der Giessen, RIVM, Wildlife
J. van der Giessen, RIVM Arthropods / vectors
F. van Knapen, UU, Pets and horses
J. Wagenaar, UU, International
F. van Knapen, UU, Import and exotics

Collaboration
This report is a condensed form of the results described in the interim report of first phase of EmZoo, which formed the starting point for project 'Technology assessment and datasharing for the purpose of early warning'.

Samenvatting
Gedurende de inventarisatiefase van surveillancesystemen in Nederland kwam direct naar voren dat er grote verschillen bestaan tussen humane en veterinaire surveillance van zoönotische ziektes of ziektekiemen. Systemen zijn het meest uitgebreid voor surveillance bij mensen en landbouwhuisdieren, terwijl ze veel minder ontwikkeld zijn voor vectoren, wild of exoten en niet bestaan voor gezelschapsdieren en paarden.
Surveillance van zoönotische ziektekiemen is voornamelijk gebaseerd op het detecteren van ziekte of infecties bij mensen; mensen dienen als een *sentinel* voor zoönotische agentia. Dit terwijl mensen vaak een ondergeschikte of geen rol (*dead end host*) in de transmissiecyclus spelen. Er zijn vele goed functionerende surveillance systemen voor landbouwhuisdieren operatief. De logistiek voor dergelijke systemen voorziet in de mogelijkheid om snel en eenvoudig additionele surveillancesystemen te implementeren, als het nodig mocht zijn. Dat tegelijkertijd surveillancesystemen in andere onderdelen van de veterinaire sector, namelijk gezelschapsdieren en paarden, niet ontwikkeld zijn, is verrassend. Wegens het nauwe contact met mensen, vormen gezelschapsdieren een potentieel risico voor het algemene publiek. Surveillance van zoönotische pathogenen bij wild valt tussen de wal en het schip van de humane en veterinaire surveillance. Er is een beperkt aantal surveillance systemen voor wild, maar veel meer is nodig omdat vele zoönotische pathogenen in het wildreservoir gehandhaafd blijven. Terwijl vectoren en de pathogenen die ze overbrengen gezien worden als belangrijke onderwerpen in de toekomst, is de kennis over vectoren en vectorsurveillance en –beheer suboptimaal in Nederland. De surveillance van zoönotische ziektes in exoten is geconcentreerd op Schiphol, terwijl de overgrote meerderheid van de exoten (legaal dan wel illegaal) via buitenlandse vliegvelden over de weg het land binnen komen. Er zijn geen registratieverplichtingen voor het transport van exoten binnen de Europese Unie. Met de toenemende vraag naar bijzondere diersoorten is de komst van nieuwe zoönotische pathogenen in Nederland te verwachten, maar zal onopgemerkt blijven als er geen surveillancesysteem komt. Dit is een belangrijke hiaat in de surveillance van zoönosen.

Vroege detectiesystemen worden gedefinieerd als systemen die signalen van verschillende oorsprong oppikken die de opkomst van een (nieuwe) ziektekiem aanduiden. Dergelijke vroege detectiesystemen zijn bijna niet ontwikkeld voor gebruik in dierpopulaties. De organisatie van bestaande veterinaire en volksgezondheidsurveillance en/of vroege signaleringssystemen in andere landen is onderzocht en laat zien dat vele landen het belang in zien van de ontwikkeling van dergelijke systemen waarin bovendien signalen uit het veterinaire en humane medische veld aan elkaar gekoppeld worden. Deze samenwerking, met daarnaast ook nog de samenwerking met professionals uit andere gerelateerde disciplines zoals bijvoorbeeld de ecologie, is in weinig landen een vanzelfsprekendheid. Verschillende oplossingen om toch tot een dergelijke samenwerking te komen worden ontwikkeld, waarbij ieder land zijn eigen invulling daaraan geeft. Denemarken en het Verenigd Koninkrijk zijn leiders in deze trend. Denemarken heeft een nationaal zoönosecentrum ontwikkeld. Overzicht en opleiding in zoönosen en voedselveiligheid zijn gebaseerd op onderzoek dat door dit centrum wordt uitgevoerd. In het Verenigd Koninkrijk is HAIRS (Human Animal Infections and Risk Surveillance) gevormd, een groep die nieuwe/ opkomende potentieel zoönotische infecties, die mogelijk een risico zouden kunnen vormen voor het algemene publiek, opspoort en identificeert.

Summary
Uneven standards of surveillance, human and animal-based, for zoonotic diseases or pathogens in the Netherlands became readily apparent during the inventory process. Systems are most extensive and well developed for human-based and farm animal based surveillance, while they are greatly underdeveloped for arthropod-based, wildlife based surveillance and exotics and even non-existent for companion animals including horses.
Surveillance for zoonotic agents is largely based on detecting illness or infection in humans; human serve as the sentinel species for zoonotic agents maintained in transmission cycles in which, fortunately they rarely play

other than incidental role as dead-end host. Many well-developed functional surveillance systems are in place for farm animals. The logistics of the farm animal surveillance allows for fast and simple implementation of additional surveillance system when necessary. In this light, the fact that surveillance in another veterinary sector, namely pets or companion animals (including horses), has not developed was an unexpected finding. Furthermore, due to close contact, pets pose a potential risk for the general public.
Surveillance for zoonotic pathogens among wildlife falls through the cracks of both veterinary and human health practices. Limited long-term wildlife surveillance systems are in place, but many more efforts are needed because many zoonotic agents are maintained in wild life reservoirs.
While arthropods and their pathogens are anticipated to become more important in the future, knowledge of vector-surveillance and control is suboptimal in the Netherlands.
The surveillance for zoonotic diseases in exotics is concentrated at Schiphol, while the vast majority of legal (and illegal) exotics arrives at other European airports and enters the Netherlands by road transport. There are no registration requirements for transport of exotics within the EU. With the increasing demand for out of the ordinary animal species, the arrival of zoonotic agents novel to the Netherlands are bound to happen and will go unnoticed if no proper surveillance system is put in place. This is a major gap in the surveillance of emerging zoonoses.

Besides the pathogen directed surveillance systems, early warning systems defined as those systems, which identify signals from different sources but all possibly of importance to indicate to the emergence of (new) pathogens, are still scarcely developed for their use in animal populations. The organization of veterinary and public health surveillance and available early warning-like systems in other countries is assessed and shows that many countries embrace the 'one health' initiative, a movement to forge co-equal, all inclusive collaborations between physicians, veterinarians, and other scientific-health related disciplines. However, many countries also realized that this does not come naturally. Different solutions, specific for the country's characteristics and needs, are in development or already developed. This trend is led by Denmark and UK. Denmark has already formed a national zoonosis centre. Supervision and teaching in zoonoses and food safety are based on research carried out at the centre. In the UK, the Human Animal Infections and Risk Surveillance (HAIRS) group carries out horizon scanning to identify emerging and potentially zoonotic infections, which may pose a threat to UK public health.

Introduction

An inventory of current surveillance systems for specific zoonotic pathogens in animal populations and humans in the Netherlands was made in the first phase of EmZoo. Each system is described in detail according to a defined format (Annex 1). Early warning-like systems already developed in the veterinary and public health sector are also described. In collaboration with other European countries and United States, foreign early warning systems and their applicability to the Dutch situation were investigated. Developments in this area within the EU, WHO and OIE/FAO e.g. GLEWS (global early warning system for trans-boundary animal diseases) are followed and used as guide for the enhancements of an early warning system in the Netherlands.
The inventory was performed according to working group themes summarizing animal populations and a separate group for human. Seven working groups were formed. Each work group was headed by a member of the consortium of the EmZoo project, who was responsible for the formation of the working group by gathering experts within and outside the consortium. For information from zoos, the NVD (Dutch Society of Zoos) was approached.

1. Humans

The scope in this overview of surveillance systems for zoonoses in human is to collect information on existing (enhanced) surveillance systems in the Netherlands and assess their value for detection of emerging zoonoses. Besides, the most important national early warning system for human infectious diseases is described. Finally, new surveillance systems using syndromic data and event-based surveillance for infectious diseases are presented, to explore their potential added value for early warning of zoonotic diseases in human.

Traditional surveillance systems (pathogen-specific) (Table 1)

Most existing surveillance systems are laboratory-based, except for the mandatory notification of specified diseases by physicians to the public health services. Included in the overview are:

- Active surveillance laboratory-confirmed Shiga-toxin producing *E. coli* (STEC) infections.
- Active surveillance laboratory-confirmed Listeria infections.
- Laboratory surveillance infectious diseases (LSI)
- MRSA surveillance.
- ISIS-laboratory surveillance system (operational until December 2007).
- Virological weekly surveillance reports.
- OSIRIS (mandatory notifications of specified infectious diseases).

Symptom/syndrome-based surveillance systems (Table 1)

In addition, the following syndrome-based surveillance systems are described.

- Influenza-like illness (ILI) in general practices.
- Nosocomial infections via PREZIES network.

Table 1. List of surveillance systems for human infectious diseases.

Surveillance system	Description
PREZIES nosocomial infections (syndrome-based) (1.1)	Subset of nosocomial infections. Thematic modules included (e.g. post-operative wound infections, line sepsis, ventilator-associated pneumonias) *Sentinel surveillance, case-based data*
Active surveillance Listeria monocytogenes (1.2)	Infections with Listeria monocytogenes All isolates are sent to the RIVM by primary diagnosing labs, questionnaires are provided by the public health services. *Laboratory-based, active surveillance, case-based*
LSI: laboratory surveillance infectious diseases (Salmonella and Campylobacter) (1.3)	Clinical laboratory-confirmed cases of salmonella and campylobacter (not notifiable). For salmonella also non-human data are included *Laboratory-based, passive surveillance, case-based data, coverage 64% of Salmonella and 54% of Campylobacter diagnoses*
Active surveillance STEC (1.4)	Infections with Shiga-toxin producing E. coli, All isolates are sent to the RIVM by primary diagnosing labs, questionnaires are provided by the public health services. *Laboratory-based, active surveillance, case-based*
Influenza surveillance (syndrome-based) (1.5)	Surveillance of influenza like illness (ILI and virological surveillance for a.o. influenza, RSV, rhinovirus) *Sentinel surveillance, representative submission, case-based data*
ISIS-laboratory surveillance system (1.6)	Electronic laboratory surveillance system collects until the end of 2007 laboratory data (test results of many pathogens) without clinical information. From January 2008 onwards (already prepared since half 2007), this laboratory-surveillance will be revised to meet the purpose of trend analyses of antibiotic resistance in a limited number of pathogens. *Passive surveillance, case-based data*
Surveillance of MRSA (1.7)	All first isolates are sent to the National Reference Laboratory at the RIVM, together with a questionnaire, for further typing. Laboratory-based, passive surveillance, case-based data
OSIRIS (1.8)	Online web-based system for mandatory infectious diseases a.o. anthrax, botulism, brucellosis, infection with enterohaemorrhagic E. coli, leptospirosis, malaria, plague, Q-fever, rabies, SARS, vCJD, trichinosis, viral hemorrhagic fevers, yellow fever, relapsing fever, food borne outbreaks, psittacosis *Laboratory-based, Passive surveillance, case-based data*
Syndrome-based surveillance: Retrospective analysis of respiratory, gastrointestinal and neurological syndromes (1.9)	Evaluated the added value of syndrome data for early warning of emerging infections, data taken from several existing medical registries: sick leave/work absenteeism data (CBS), general practitioner consultations (LINH), pharmaceutical prescription data (SFK), hospital admissions (LMR), ISIS laboratory surveillance and mortality surveillance data (CBS). *Syndromic surveillance*
Syndrome-based West Nile virus (and other flaviviruses) surveillance (1.10)	Cases presenting with neurological disease, unexplained by routine laboratory diagnostics of cerebrospinal fluid (CSF) are additionally tested for a.o. West-Nile virus. Also, monitoring of hospital discharge diagnoses for neurological disease with unknown cause, and until 2003 monitoring of neurological disease in horses.
Syndrome-based surveillance of bacterial meningitis/ septicaemia	Typing of isolates of patients with meningitis or septicaemia (a.o. infections with Haemophilus influenza type b, listeriosis, meningococcal disease, pneumococcal infections. *Passive surveillance, case-based*
Virological weekly surveillance report	Laboratory data from virological laboratories, aggregated data of positive test results. (a.o. *West Nile virus, Dengue virus, hantavirus, Coxiella, Rickettsiae, hepatitis E virus, Chlamydophila psittaci, influenza virus*). No denominator data on number of test performed for each pathogen *Laboratory-based, passive surveillance, aggregated data*

- Syndromic surveillance performed for emerging infections, originally as a response to bioterrorism threats (including neurological illness, monitoring for absence of poliovirus and West Nile virus, and gastroenteritis (and ILI) in general practices).

Early warning meeting

In the Netherlands, weekly meetings of the so-called ‘early warning committee’ are held to discuss signals and threats to public health caused by infectious diseases. Its main task is to assess information from various sources, both national and international, in order to recognize threats caused by infectious diseases in a timely fashion. If necessary, further outbreak investigation can be recommended, or measures to control the outbreak can be advised. The participants are microbiologists, physicians and epidemiologists from all departments of the Centre for Infectious Disease Control, and a representative from the Food and Consumer Product Safety Authority (‘Voedsel en Waren Autoriteit’, VWA). Prior to the meeting, each participant selects, from various sources of information, items (known as ‘signals’), which are considered important to discuss at the meeting. On the day of the meeting, the RIVM sends a report of the meeting to about 500 people engaged in the control of infectious diseases in the Netherlands, including physicians and nurses of the municipal health services, microbiologists, specialists in infectious disease, infection control practitioners, the Ministry of Health and the Health Care Inspectorate. The report is formulated in such a way that signals are not deducible to persons, institutions or locations. Domestic and international information sources that serve as input for the early warning committee are summarized in Table 2.

Table 2. Sources of information used by the early warning committee. Besides these formal sources, all members themselves can put forward signals to be discussed during the meeting of the early warning committee.

Origin	Source of information
Domestic	OSIRIS (an electronic system for notifiable diseases reported by Municipal Health Services)
	Weekly Virological Surveillance reports
	Disease-specific surveillance systems, like surveillance of influenza, STEC O157 etc.
	National Reference Laboratory for Bacterial Meningitis (NRBM)
	Laboratories/departments of the RIVM, including
	National Coordination Centre for Outbreak Management (LCI)
	Electronic reporting system inf@ct (confidential)
	Food and Consumer Product Safety Authority (VWA)
	Media scanning
	People engaged in infection control in the Netherlands
	Laboratory-based, Passive surveillance, case-based data
International	WHO Weekly Epidemiological Record (contains information on confirmed outbreaks)
	WHO Disease Outbreak News (information on confirmed outbreaks)
	WHO event information website (confidential, unconfirmed and verified outbreaks)
	Eurosurveillance Weekly (ECDC)
	Communicable Disease Threat Report (confidential, unconfirmed and verified outbreaks, information for risk assessment)(ECDC)
	Early warning and response system (confidential, information for risk management)(EU)
	ProMED: electronic mailing list
	OIE (World Organisation for Animal Health) (information on confirmed outbreaks)
	Review literature

2. Farm animals

Infectious zoonotic agents in farm animals can cause disease in humans either through consumption of food originated from these animals, through direct contact with the animals or contact with their excreta, or by blood-sucking arthropods. An inventory was made on early warning and surveillance systems that are already operational for zoonotic pathogens of farm animals, but also on those surveillance systems that are suitable for this purpose, but are currently not used in this way.

Generic

There are several operational continuous surveillance systems with specific aim on known zoonotic agents (avian influenza virus in poultry, *Brucella suis* in pigs, *Brucella melitensis* in small ruminants, *Brucella abortus* in cattle, TSE's in ruminants, *Trichinella* in pigs, *Salmonella* in pigs, poultry, and cattle, *Campylobacter* in poultry, *Leptospira* in cattle, *Coxiella burnetii* in cattle, *Mycobacterium* and *E. coli* O157 in various species).

Beside these specific surveillance systems, some systems are not tailor-made for one specific agent, but concentrate on risk moments, such as illness or death of animals (investigations by GD-Veekijker and diagnostic pathology), imports controls, and surveillance at slaughterhouses and are therefore more considered as early warning systems.

More detailed information can be found in the formats in Table 3. Beside the surveillance systems, a lot of samples (blood, faeces, milk, bulk milk) are received for different reasons (export, control programs, milk quality programs, etc). These samples can possibly be used for surveillance and early warning purposes.

Discussion

For the main zoonotic but not for yet unidentified emerging zoonotic threats from farm animals, adequate surveillance systems are already operational. In addition, it will be relatively easy to extend existing schemes with new, highly prioritised zoonoses from the prioritized list.

New zoonotic agents that cause disease or post-mortem changes in the animals are likely to be noticed in early warning systems like slaughterhouse surveillance, GD-Veekijker or diagnostic pathology.
New zoonotic agents that do not cause disease in animals are less likely to be noticed. Especially for those agents, new systems need to be developed.

3. Wildlife

Wildlife has been identified as an important reservoir for emerging zoonoses (WHO 2004, Vander Giessen et al. 2004). The scope of this section is to collect information on existing continuous or project-based surveillance systems, which are carried out in free ranging wildlife in the Netherlands. Here, no information is collected on captured wildlife. The major aim is to collect information

Table 3. Surveillance systems in farm animals in the Netherlands.

Surveillance system	
AI monitoring poultry	2.1
Diagnostic pathology (GD)	2.2
Bluetongue surveillance: sentinel	2.3
Surveillance *Brucella suis*	2.4
Brucella melitensis monitoring programme	2.5
BSE surveillance	2.6
Classical swine fever surveillance	2.7
Data analysis on census data (GD)	2.8
Monitoring Trichinella in slaughter pigs	2.9
Notifiable diseases	2.10
Risk assessment by collecting information about foreign countries	2.11
Surveillance of zoonotic bacteria in farm animals (VWA/ RIVM)	2.12
Scrapie surveillance	2.13
Serological and bacteriological surveillance of Salmonellosis on pig farms (PVE)	2.14
Prevalence studies cattle (GD)	2.15
Surveillance at slaughter houses (VWA)	2.16
GD Veekijker (GD) *	2.17
Brucella abortus surveillance programme for cattle	
Monitoring poultry (PVE)	

* an Early Warning system

concerning surveillance systems for infectious diseases, but also surveillance systems addressing wildlife population dynamics are presented (www.oie.int).

In 2003, the Dutch Wildlife Health Centre reviewed the research on health of free-living wildlife carried out since 1997 by researchers in the Netherlands. The aim was to identify areas of interest of Dutch research institutes on this subject. Although the aim of the review was not primarily to describe the surveillance activities, it gives an excellent overview of research including surveillance in wildlife between 1997 and 2003 in the Netherlands (1). Since 2003, some of the surveillance activities have been (dis) continued and some others have been initiated. Recently, a review was made on behalf of the Dutch Ministry of Agriculture with the aim to list current monitoring systems related to animal health present in wildlife (2). The different surveillance systems collected are summarized in this section by animal species order and the once described in a standardized format are shown in Table 4. Additional organisations involved in acquiring data on wild life are shone in Table 5.

Generic

- Causes of mass mortality in wild life populations are investigated as demanded by law (3.1).

Carnivora

- Passive surveillance of foxes (only when dead or suspected animals) for rabies is carried out by CVI.
- Since 1996, foxes have been monitored for the presence and spread of *Echinococcus multilocularis* and *Trichinella* infections in some areas in the Netherlands (RIVM). Since 2006, found raccoon dogs have been submitted for *E. multilocularis* testing. In collaboration with ecological experts, foxes have also been investigated for population dynamic features (reproduction rate, age distribution and feeding behaviour). This monitoring is, however, carried out as part of a specific project and does not have a long-term base (3.2).
- The seal rehabilitation centre in Pieterburen and EMC coordinate a monitoring system in stranded seals in the Netherlands.

Rodentia

- The main reservoir of Puumala virus (Hantaviridae) is the bank vole. In the Netherlands, rodent populations are monitored by the Dutch Zoological Society (VZZ), but the prevalence of hantavirus infections in these populations have only been determined incidentally in projects by the RIVM. In 2007, after increased numbers of human hantavirus cases were reported in Germany and Belgium, rodents were caught in Twente and Limburg to get preliminary data on the prevalence of Hantavirus infections in the Netherlands (3.3).

Chiroptera

- Bats suspected of rabies are tested for the presence of Lyssaviruses by CVI. Since 2006, active surveillance in bats has been carried out to get a better insight in the prevalence of Lyssaviruses in healthy bat, especially *Eptesicus serotinus*, populations (3.4).

Table 4. List of detailed zoonotic pathogen surveillance systems in wildlife populations.

Wild life populations	Pathogen	Institute
Bats	Lyssavirus	CVI
Foxes	*Echinococcus multilocularis*	RIVM
Migratory birds	*Avian Influenza virus*	EMC
Rodents	Hantavirus	RIVM
Wild boar	*Trichinella spp*	GD/RIVM
Artiodactyla	*many*	GD

Table 5. List of organisations concerned with monitoring distribution and populations dynamics of wildlife.

Organisation	Wildlife population
European Invertebrate Survey Nederland (EIS-NL) *	Invertebrates
Kenniscentrum Dierplagen (KAD)	Pest animals
Nederlandse Vereniging van Plaagdiermanagement bedrijven (NVPB)	Pest animals
Reptielen Amfibieën Vissen Onderzoek Nederland (RAVON)*	Reptiles, amphibians, fish
*Stichting ANalyse, Educatie en Marien Oecologisch Onderzoek (ANEMOON)**	Molluscs and sea animals
Stichting Natuurinformatie (waarneming.nl)	Wildlife (by non-professionals)
Vogelonderzoek Nederland (SOVON)*	Wild birds
Zoogdiervereniging (VZZ)*	Mammals

* Member of the Organisation of Field Research Flora and Fauna (VOFF)

Artiodactyla (even hoofed ungulates) (3.5)

- In Highland cattle, a surveillance system (serology/ blood analyses in live animals and autopsies) already exists for many years coordinated by the GD.
- Red deer and Konik horses are being monitored only by autopsies carried out on few dead animals. There is a concern that this will not reflect the health status of these populations.
- Since 2006, roe deer have been monitored for Bluetongue virus.
- Serum samples of populations of wild boar from the Veluwe and in Limburg are tested annually by serology for CVD, SVD, Aujeszky (CVI) and Trichinellosis (RIVM (3.6). The GD coordinates this.

Lagomorpha

- Rabbits and hares are monitored only in case of a specific question needed to be answered. Information is limited. Surveillance of liver fluke in hares was performed by CVI as part of a European project (Borgsteede, pers. commun.).

Neognathae (birds)

- Wild birds are monitored for Influenza A virus infections by CVI and EMC. Periodically, blood of wild birds is being tested for the presence of West Nile virus antibodies.

Game

- Meat inspection of wildlife dedicated for human consumption is also considered a monitoring system. Since 2007, certified hunters have been responsible for visual inspection of wildlife in the field. When an animal appears normal by this visual inspection, it is sent for meat inspection. There is no need to notify and register an abnormal finding nor is there a possibility to investigate the carcass for animal diseases including zoonotic disease pathogens. As mentioned before, the continuation of the Dutch Wildlife Health Centre is under investigation at the faculty of veterinary medicine (UU). This initiative offers the possibility for the need of a structural autopsy centre, which would serve as a first signal of observed abnormalities in wildlife populations.
- Hunters inform the Royal Dutch Shooting Society (KNJV) about local morbidity or mortality of wildlife. Via the KNJV, a limited number (<30) of dead animals is autopsied each year, but no formal structure is yet being set up to report or analyse these signals.

Conclusion

Introduction and spread of infectious disease from wildlife, especially new evolving diseases, are considered an important route of transmission to humans. In the Netherlands, systems monitoring the health status of wildlife are often directly linked to the control of animal infectious diseases of List A (classical swine fever, foot and mouth disease, rabies, avian influenza) and other controlled infectious diseases (Aujeszky), or because of EU zoonoses directives (trichinellosis, rabies). Annual structured monitoring programs are carried out in wild boar, free-ranging ruminant populations and migratory birds. Many other programs are carried out to get insight in specific infectious diseases and these are often short-term projects.

There is little attention for the long-term health aspects of different wildlife populations and for many wildlife populations information is lacking completely. Therefore, decreases in wildlife populations might not be understood or even recognized, while they might be caused by infectious diseases relevant to public health. This poses a structural hiatus in the development of an early warning system.

4. Arthropods/ vectors

Infections that are transmitted to humans from vertebrate animals by blood-sucking arthropods such as mosquitoes, sandflies, ticks and fleas are called arthropod-borne zoonoses. Arthropod-borne pathogens, including arboviruses, bacteria, protozoa and helminth parasites, spend part of their life cycle in cold-blooded arthropod vectors. Arthropod-borne zoonoses already present or endemic in Europe and with a potential to emerge include West Nile fever, sandfly-borne diseases such as leismaniasis, Crimean Congo Haemorrhagic Fever, tick-borne encephalitis, ehrlichiosis, bartonellosis, rickettiosis, Lyme borreliosis, and babesiosis. The main aim of this section is to collect information concerning surveillance systems for arthropod-borne pathogens, but also surveillance systems concerned with arthropod population dynamics.
The different surveillance systems collected are summarized in Table 6.

Generic

- In 2005 and 2006, Laboratory of Entomology (WUR) investigated the distributions and dynamics of arthropod vectors of zoonotic diseases. Twelve locations were selected, distributed over 4 habitats: a wetland area, 3 riverine systems, 4 peat-dominated nature reserves and 4 livestock farms. Vector populations were studied with different sampling methods, including CO_2-baited traps, resting boxes, sticky traps, tick-sampling tools and larval collections. Each location was visited weekly during the vector season (July-Oct 2005 and March-July 2006).
- The Animal Health Service (GD) through their early warning system (Veekijker) (format 1 in paragraph farm animals) passively monitors arthropod-borne pathogens in farm animals.
- Selections of arthropod-borne pathogens in humans are monitored by the RIVM through syndromic surveillances (neurological disorder).

Acari (ticks and mites)

- Between July 2005 and October 2006, Dutch veterinarians have been asked to send ticks collected from pets to the Faculty of Veterinary Medicine (UU) to test for animal and zoonotic pathogens like *Babesia*, *Borrelia*, *Anaplasma* and *Ehrlichia* species (4.1). Some additional environmental sampling of ticks has been performed.
- In 2006-2007, in a still ongoing study to monitor the prevalence of the etiologic agent of Lyme disease, *Borrelia* spp. in ticks that have bitten people, ticks collected from humans that consulted a participating general practitioner (RIVM) were tested for *Borrelia* spp. and other tick-borne pathogens (4.2).
- Since 2006, seasonal variations of tick populations at 25 locations in the Netherlands and the *Borrelia* spp. infection rate of the most important tick, *Ixodes ricinus*, have been monitored by the Laboratory of Entomology of the WUR and Association for Environmental Education (IVN) (Natuurkalender) (4.3).
- Since 2000, hard tick densities in different habitats and the presence of different pathogenic *Borrelia*, *Anaplasma* / *Ehrlichia*, *Babesia* and *Rickettsia* species found in these ticks have been studied by collaboration between RIVM and WUR (CVI/Alterra) (4.4).
- In 2002-2003, a study was carried out to monitor tick-borne encephalitis virus (TBEV) presence in ticks in the Netherlands (RIVM). Ticks were collected in surveillance of format 2. No positives were detected during that study.
- In 2007 a pilot study was initiated to monitor TBEV presence in ticks in the Netherlands (RIVM).

Diptera (mosquitoes and flies)

- Since 2006, the presence and/or establishment of the Asian tiger mosquito (*Aedes albopictus*) in the Netherlands have been monitored by the Dutch Plant Protection Service (PD), Laboratory of Entomology (WUR) and RIVM. This surveillance was initiated after the discovery of specimen in a Dutch greenhouse with imported ornamental plants from Southeast China in 2005. Although this mosquito species is a known vector for several zoonotic pathogens, the main reason behind this specific surveillance is the possible introduction of dengue virus, a human pathogen with no animal reservoir in urban cycles. Nevertheless, this survey is included as important lessons could be learned for mosquito surveillance for zoonotic diseases (4.5).
- In 2007, an entomological and virological monitoring program was initiated with a pilot study. The virological monitoring focussed on *Flaviviridae* and *Togaviridae*. (RIVM/PD) (4.6)
- Further, following an outbreak of Bluetongue, a viral disease of ruminants transmitted by Culicoides species, in the Netherlands in 2006, the PD has done surveillance on 20 farms for this genus of biting midges. This specific surveillance does not concern zoonotic pathogens, but was included for the same reason as the *Aedes albopictus* survey (4.7).
- In July 2009, the Center for Monitoring of Vectors was established to coordinate monitoring activities in vectors and together with CVI and RIVM to strengthen the knowledge on vector-borne pathogens in vectors.

Table 6. List of detailed pathogen surveillance systems in vector populations.

Arthropod populations	Pathogen
Ticks	*Borrelia spp.*
	Anaplasma spp.
	Babesia spp.
	Rickettsiae spp.
	TBEV
Mosquitoes	Flaviviridae
	Chikungunya virus

Table 7. List of illustrative zoonotic pathogens considered in companion animals and horses (comprehensive list see 3).

Zoonotic pathogen	Companion animal/ horse
Bartonella henselae	cats
Baylisascaris spp.	raccoon dog
Campylobacter spp.	many
Chlamydophila psittaci	birds
Dermatophytes causing fungi	many
Giardia duodenalis	many
Leishmania spp.	dogs
Leptospira spp.	rodents
Toxocara spp.	dogs, cats
Toxoplasma gondii	cats
West Nile virus	horse

Conclusion and recommendations

Arthropods, like all natural animal populations, are affected by abiotic and biotic factors in their environment. In the highly urbanized Netherlands, these factors are largely influenced by anthropogenic ecosystem modifications. Poikilotherm organisms and their pathogens are especially responsive to changes in abiotic factors like humidity, daylight and temperature and, consequently, by climate change. To assess emerging arthropod-borne pathogens, baseline information on arthropod populations is essential. In the Netherlands, information gathering on the distribution and dynamics of arthropod vectors of zoonotic diseases is almost exclusively project-based and not continuous.

5. Companion animals/ Horses

Obviously domesticated animals have largely contributed to a pool of infectious agents shared with the human population. Besides products of animal origin, direct contact with animals (owners, keepers) is an important transmission route. Moreover contaminated environment shared by man and animals or plant/vector transmitted zoonoses have to be regarded. For companion animals and horses, the latter two ways of transmission of zoonoses are important and will be considered in terms of what we know about these zoonoses in the Netherlands.

For none of the zoonotic agents considered (Table 7) regular monitoring/ surveillance occurs or has ever been carried out. At best in project format, some pathogens have been followed for a short period of time. Ad hoc diagnostic laboratory information sometimes may lead to recognition of increased incidence or seasonal influence, but is not a reflection of a population incidence. In October 2007, LNV in collaboration with Organisation for the Companion Animal Sector (Dibevo), Animal Protection Agency (Dierenbescherming), UU, WUR, Society of Veterinarians (Maatschappij voor de Diergeneeskunde) and Stichting Platform Verantwoord Huisdieren Bezit founded the Dutch Information Centre for Pets (LICG, Landelijk Information Centrum voor Gezelschapsdieren) to increase the information available to pet owners.

6. Exotics

Import

Diseases, once related to specific geographical areas, now have the possibility to be introduced to the Netherlands/ EU through international trade. Therefore, trade in live exotic animals is allowed only between officially recognised establishments such as institutes and zoological gardens. Only exotic animals with a proper and valid official health certificate with all required vaccinations and diagnostic tests are permitted for entry into the Netherlands. A separate certificate has to be provided for each consignment and the original must accompany the animals to the Border Inspection Post at the point of entrance into The European Community. The criteria in the health certificate related to animal and public health are prescribed in European legislation Decision 91/496/EC, Directive 92/65/EC and Decision 79/542/EC. These are implemented in national legislation. Import of products and live animals is controlled at the EU-border inspection posts. For the Netherlands that means merely (not exclusively) our major harbours Rotterdam/Amsterdam and Schiphol airport.

The Dutch Food and Consumer Product Safety Authority (VWA) is the legal guard to monitor and judge the safety of these commodities. A major part of the commodities will be shipped to other EU-member states. Unless the VWA inspection in itself is considered as monitoring, there exists no formal registration for external use (e.g. statistics, scientific questions).

In exceptional cases, the VWA will take measures and arrest commodities for further investigation. Particularly

Table 8. List of organisations concerned with exotics.

Organisation
Team Invasieve Exoten (TIE)
Nederlandse Vereniging van Dierentuinen (NVD)
Stichting AAP
Vereniging van Opvangcentra van Niet-gedomesticeerde Dieren (VOND)

in situations with live animals (zoonoses, quarantine) the system may fail due to missing facilities, economic pressure and animal welfare.

Conclusions

Introduction and consequently a spread of zoonoses from importation of live animals through border inspections posts are to be expected. The difficulty of unrecognized (sub-clinical, carrier ship) infection is insuperable unless clinical examinations and laboratory testing is to be introduced while the animals are maintained in quarantine. This would inevitably lead to animal trade through other Dutch or European airports other than Schiphol as was seen a decade ago when transport of monkeys was made more strict (economic reasons). Furthermore, the arrest of live animals without the correct forms and consequently euthanasia of the animals led to severe public's protest. Maintenance of animals longer than necessary in transport cages also leads to protest of animal welfare organisations. Products of animal origin normally come from non – endemic areas or farms certified free from the diseases mentioned in formal legislation. Fresh meat importation is only allowed from animals fit for consumption and shipped in prescribed condition (temperature, packing). If not, the authorities may condemn the commodities.

Zoo animals

Like many other animals, zoo animals may potentially harbour zoonotic agents. However, special attention is required because many zoo animals are exotics and may be host to agents not commonly seen in Europe or may carry pathogens that are closely related to human pathogens, as is the case with primates. At present, zoonotic disease in zoo animals is mostly recognized on an anecdotal base rather than through targeted surveillance. Recent incidents with tuberculosis in Bonobo primates and other species, however, clearly demonstrate the need of the implementation of a more targeted approach. An approved zoo scheme, introduced by the European legislation, explicitly addresses the zoonoses issue and is likely to bring about change. Approved zoos are obliged to implement an annual disease surveillance plan that must include appropriate control of zoonoses in the animals. Also, records pertaining to the results of diagnostic procedures, among other things, have to be kept and made available to the appropriate authority.

7. International

Early warning, surveillance, and other measures to prevent emerging infectious diseases are now high on the political agenda. To see to what extent local and national governments and international health organizations are really taking appropriate measures, this report wants to compare some recommendations from the health council report (2004) with early warning and surveillance systems in place. This is to see if anything has changed since 2004. The topics, which are addressed, are:

- Links within animal and human disease surveillance (intrasectorial collaboration)
- Wildlife surveillance
- Syndromic surveillance systems
- Links between animal and human disease surveillance (intersectorial collaboration)
- International collaboration

A summary of the extended student report (4) is described in the following. The surveillance systems in seven countries were evaluated based on information that is publicly available (mainly through internet). Evaluations were made of the public health surveillance system, the veterinary surveillance system and the collaboration between these systems.

Four large countries/continents were included: US, Canada, Japan and Australia, and three European countries (Denmark, Norway and United Kingdom). These European countries were selected based upon preliminary information that the interactions between public health and veterinary systems were quite well developed and that their systems may contain elements that can be included in other countries' system.

The limitation of this approach is that it is only a paperwork exercise. To (partly) overcome this limitation, the Danish Zoonoses Centre has been asked to review the Danish description. This has also been done for the description of the US.

For veterinary surveillance systems, two branches can be distinguished: the living animals at one side and the food of animal origin at the other side. In this analysis, the focus in the veterinary domain is on the living animals only.

In addition to the seven countries, an evaluation was made of the European surveillance systems and the global system for surveillance and response in the public health and veterinary interface.

Conclusions

As expected in industrialized countries, the results show that in each of the seven countries/ continents separate systems for public health (PH) and veterinary surveillance are well developed. The veterinary systems are under the Ministry of Agriculture (or equivalents like the Ministry for consumer affairs), whereas the public health systems are under the Ministry of Public Health.

The interaction between the PH and veterinary sector is organized in different ways in the various countries. In the US, the systems (both PH and veterinary) are characterized by the presence of many separate groups. This seems to be a hurdle for the interaction between the public health and veterinary sector. In contrast, in countries where a separate entity is organized for the interactions between PH and the veterinary sector, like the HAIRS programme in the UK and the zoonoses centres in Norway and Denmark, the interaction seems to be optimal. Important characteristic of the organizations with optimal interaction between PH and veterinary sector (like the Scandinavian Zoonoses Centres) is that these have unlimited access to both the PH as well as the veterinary data. These data are collected in each of the domains but combined in shared databases.

The Danish model is in place for many years. The data are available at the zoonoses centre where integration of the data takes place (integrated surveillance) from animal, food and public health. Besides the exchange of information between the different domains, the Danish approach also has a strong interaction between public and private domains.

In this approach a fast exchange of information is guaranteed between PH and veterinary sector, and even the private sector.

Discussion

Surveillance

Uneven standards of surveillance, human and animal-based, for zoonotic diseases or pathogens in the Netherlands became readily apparent during the inventory process. Systems are most extensive and well developed for human-based and farm animal based surveillance, while they are greatly underdeveloped for arthropod-based, wildlife based surveillance and exotics and even non-existent for pets (including horses).

Surveillance for zoonotic agents is largely based on detecting illness or infection in humans; human serve as the sentinel species for zoonotic agents maintained in transmission cycles in which, fortunately they rarely play other than an incidental role as dead-end host (5). Many well-developed functional surveillance systems are in place for farm animals. The logistics of the farm animal surveillance allows for fast and simple implementation of additional surveillance system when necessary. In this light, the fact that surveillance in another veterinary sector, namely pets or companion animals, has not developed was an unexpected finding. Furthermore, due to close contact, pets pose a potential risk for the general public.

Surveillance for zoonotic pathogens among wildlife falls through the cracks of both veterinary and human health practices. Limited long-term wildlife surveillance systems are in place, but many more efforts are needed because many zoonotic agents are maintained in wild life reservoirs.

While arthropods and their pathogens are anticipated to become more important in the future, knowledge of vector-surveillance and control is suboptimal in the Netherlands. Limited surveillance systems for tick-borne diseases are in place, but extended national surveillance is desirable. Mosquito surveillance in the Netherlands is insignificant and at best project-based.

The surveillance for zoonotic diseases in exotics is concentrated at Schiphol, while the vast majority of legal (and illegal) exotics arrives at other European airports and enters the Netherlands by road transport. There are no registration requirements for transport of exotics within the EU. With the increasing demand for out of the ordinary animal species, the arrival of zoonotic agents novel to the Netherlands are bound to happen and will go unnoticed if no proper surveillance system is put in place. This is a major gap in the surveillance of emerging zoonoses.

For the development of a surveillance system, it is essential to identify the objectives from the surveillance system. The method of information gathering[1] depends on the aim of the surveillance. For the surveillance of emerging zoonoses, systems are essential that detect the presence or introduction of new or exotic zoonotic agents in which syndromic surveillance could be a part. Further, the detection of an increase in incidences of endemic zoonoses is important. The fact that infections with zoonotic agents might be sub clinical in animals implies that these infections will be missed in passive surveillance. In addition to detect rare infections in a population large samples need to be taken. Surveillance of wildlife, arthropods and exotics is a process inherently different from human and farm animal based surveillance; establishing animal population estimates for defining rates,

[1] Passive surveillance is defined by reporting of clinical indications by professionals in the field, while active surveillance is defined by the systematic collection of data in a preselected population.

such as infection rates is much more problematic in the former. Factors as validity and accuracy of data but also and economic consideration play an important role in the feasibility of the objective of the surveillance.

Early warning

Besides the pathogen directed surveillance systems, early warning systems defined as those systems, which identify signals from different sources but all possibly of importance to indicate to the emergence of (new) pathogens are still scarcely developed for their use in animal populations. An extensive summary of the organization of veterinary and public health surveillance and available early warning-like systems in other countries has been given. In all systems described, the communication and collaboration between veterinary health and human public health need improvements. This holds also for the Netherlands. Only a few systems might be recognized as such, like “de veekijker” in production animals and like syndrome surveillance and the early warning meetings for humans. The latter need to be extended in a structured way including the assessments of veterinary signals made at the GD. After the development of tasks of The Dutch Wildlife Health Center in collaboration with expert institutes, wildlife signals should be integrated with the early warning meetings described. The conclusion after analysing the international systems is that the optimal interaction can be achieved when an independent body (zoonoses centre) is responsible for the analysis and reporting of the common trends of zoonoses and therewith for the trends in emerging zoonoses.

Recently, Merianos (6) depicts the essence of an effective system for surveillance and response to disease emergence eloquently. Four key elements are recognized: early warning systems, risk based surveillance, improving pathogen identification and improving information management for the early detection of emerging diseases.

- Early warning systems are based on predominantly epidemiological surveillance in the form of event based and case based activities. Both lead to improved awareness and knowledge of the distribution of the disease or infection and depending on the completeness and quality of the data collected might forecast the evolution of an outbreak. Development strengthening and implementation of early warning and response functions within integrated national disease surveillance systems are critical steps in building the core capacities. Supporting effective surveillance are the routine clinical, laboratory and epidemiological information systems that can provide valuable baseline data and are often the source of data that help identify and track unusual disease events.
- Targeted surveillance of high–risk settings and populations can provide cost-effective early warning of infection. The effectiveness of existing local and national human and animal disease surveillance systems to detect known and novel zoonoses should be routinely evaluated to identify gaps and weaknesses.
- Laboratory diagnosis is an essential component of disease surveillance. Both for the routine confirmation of diseases and for rapid determination of the etiological agent during outbreaks. There is an urgent need to strengthen linkages between national clinical and veterinary reference laboratories.
- Effective surveillance for emerging zoonoses requires the exchange of information among public health authorities, veterinary services and wildlife sector. Information management should include systems to support the alert and event confirmation functions of early warning systems. All sectors should aim to improve or develop information systems for epidemiological intelligence, verification status, laboratory investigations and field operations. In addition mechanisms and communication technologies that facilitate the rapid exchange of epidemic intelligence across the health, livestock and wildlife sectors as required should be implemented and tested as part of the emergency preparedness.

Recommendations

1. Start or strengthen zoonotic surveillance systems for arthropods, wildlife, exotics and companion animals (pets and horses).
2. Strenghten linkages between human and veterinary laboratories and institutes. Instigate a joined signalling group in order to bring together signals from all areas of humans, livestock, horses, companion animals, wildlife, exotics and arthropod vectors relevant for public and animal health, based on existing structures.

References

1. Rijks J. 2003. Review of recent research on wildlife health and welfare in the Netherlands. Report *Dutch Wildlife Health Center*.
2. Mansier, M. and Francois, R. 2007. Een inventarisatie van uitgevoerde onderzoeken in het kader van signalering en controle op dierziektes. LNV rapport.
3. Van Knapen F., Overgaauw P.A.M. en Kroeze B.J. 2010. Monitoring van zoönosen bij gezelschapsdieren in Nederland. Rapport 1003. Institute for Risk Assessment Sciences (IRAS) Divisie Veterinaire Volksgezondheid Universiteit Utrecht.
4. Sikkema, R and J. Wagenaar 2007. Msc Thesis. International early warning and surveillance systems for infectious diseases.

5. Childs, J.E. 2007. Pre-spillover prevention of emerging zoonotic diseases; What are the target and what are the tools. In *Wildlife and Emerging Zoonotic Diseases: The Biology, Circumstances and Consequences of Cross-Species Transmission*. Eds. : J.E. Childs, J.S. Mackenzie and J.A. Richt Current Topics in Microbiology and Immunology. 315-389-443. Springer Berlin Heidelberg.
6. Merianos, A. 2007. Surveillance and response to disease emergence. In *Wildlife and Emerging Zoonotic Diseases: The Biology, Circumstances and Consequences of Cross-Species Transmission*. Eds.: J.E. Childs, J.S. Mackenzie and J.A. Richt Current Topics in Microbiology and Immunology. 315-389-443. Springer Berlin Heidelberg.

Surveillance format

1. *Disease/pathogen description*

a. Include information about the disease / pathogen under surveillance. Is it a bacterium/virus/parasite etc? In which animal species?
b. Are there key references describing the system?

2. *Purpose/ rationale and surveillance objectives*

a. Describe the **purpose and rationale** of the surveillance system (why surveillance is needed, who has requested it, and how is it used). Is the system still in developmental stages?
b. List the **surveillance objectives** of the system. Did the objectives change over time?
c. Draw a **flow chart** of the system. (identify **the stakeholders / responsible parties** (individuals/ groups) responsible for all aspects of the surveillance)
d. List the **outcomes (products, deliverables) of the surveillance system**.
e. Is the surveillance system installed because of legal grounds/regulations or is it a private system? If it is under legislation, which law/regulation is it based on?

3. *Population description and characteristics*

a. What is the **population/animal (product) reservoirs under surveillance**? Define the population of animals under surveillance and describe the scope / coverage of the surveillance (i.e. national, regional, local).
b. **Case definition**. Describe the health event(s)/disease/ pathogens/vectors under surveillance. What are the case definitions used?
c. What is the **period of time of the data collection**? Start date surveillance?
d. What information is collected? From which sources?
   - Main variables collected/subjects? - Where are the samples taken? (location, where in the chain?)
   - Which kind of samples are taken? - How many samples are taken?
   - Who is responsible for taking samples? - Who is responsible for testing samples? (which laboratory?)
   - Who provides the surveillance information?
   - Frequency of data collection (continuous, periodical, event-based)?
   - How is the information transferred?
   - How is the information stored? Who maintains the database?
   - Accessibility to other institutes, how can the data be accessed?
e. Data quality issues: validity/completeness? (geographic) representativeness? timeliness (how many days after onset illness/diagnosis data in system)?

4. *Analysis, data presentation and reporting*

a. Who analyzes the data and how often? How are the data interpreted?
b. Are surveillance reports periodically produced?
c. How often are reports disseminated? To whom are reports distributed (external/ internal)?
d. What actions are taken based on the surveillance?

5. *Resources and Evaluation*

a. List resources needed to run the surveillance system Which human, financial and other resources are required to run the surveillance system. How is the surveillance system financed? (government, unions, industry etc.)
b. Has the surveillance system ever been evaluated? If yes, does the system fulfill its stated objectives and meets accepted standards?

DESCRIPTION OF EARLY WARNING SYSTEMS/ MEETINGS

Within your field: are there any meetings / alert systems to signal unusual events / clusters/ outbreaks?

Appendix 1b
Technology assessment and datasharing for the purpose of early warning

Project leader
M. Swanenburg, Central Veterinary Institute

Project team
CVI: M. Swanenburg, W.H.M. van der Poel
GD: J. Mars
RIVM: M.A.H. Braks, J.W.B. van der Giessen, H. Sprong, D.W. Notermans, C. Reusken, W. van Pelt
UU: J. Wagenaar

Pilot Q-fever
RIVM: B.J. van Rotterdam (project leader), A. Kroneman, D.W. Notermans, F. Reubsaat, A. de Bruin
CVI: H. J. Roest
GD: J. Mars
TNO D&V: N. Zegers.
JBZ: P. Schneeberger.
PAMM: J. van de Bovenkamp

Summary
The aim of the EmZoo project was to identify the gaps in the detection and surveillance systems for the emerging zoonoses as identified in the prioritized list in The Netherlands. Furthermore, an assessment of the comparability of *Coxiella burnetii* real-time PCR assays, used by the different institutes involved in the EMZOO project, was carried out.

First, gaps in existing surveillance systems were detected. Gaps were defined as "no surveillance exists", "insufficient surveillance", or "no/insufficient diagnostics". Two brainstorm sessions with experts were held, in which all 86 pathogens on the prioritized list were discussed. Second, an inventory of available diagnostic methods was made, to be able to see directly if diagnostic methods for preferred surveillance systems are available or should be developed. Results showed that many gaps in surveillance exist, also for the highest ranked zoonoses on the prioritized list. It was clear that different surveillance systems should be developed for endemic and non-endemic zoonoses. So called general surveillance systems, like tick monitoring or syndrome surveillance, that are meant for more pathogens together, can be very efficient. For some zoonoses it is important that more awareness will be created among human doctors. Results of *Coxiella* PCR's showed that in samples with high *C. burnetii* content, all six participating institutes scored similar results using their 'in-house' real-time PCR assay(s) for the detection of *C. burnetii* in the provided samples.

For the first 25 pathogens on the list, gaps were detected for the endemic zoonoses *Toxoplasma gondii, Anaplasma phagocytophilum, Chlamydophila psittaci,* and for the non-endemic zoonoses: Japanese encephalitis virus, West Nile virus, Crimean-Congo hemorrhagic fever virus, Dobrava-Belgrade virus, Rift Valley Fever virus, Eastern equine encephalitis virus, Tickborne encephalitis virus and Seoul virus. It was an arbitrary decision to concentrate on the first 25. Good reasons can be given to extent the recommendations with pathogens listed after number 25 without much more effort and costs.

General surveillance systems, like mosquito monitoring, tick monitoring and rodent monitoring should be further developed. Monitoring of relevant pathogens as identified in the prioritised list should be included in these general surveillance systems. Furthermore, syndrome surveillance for humans and syndrome surveillance for horses should be further implemented. This is described in project 3.2 (Syndromic surveillance in companion animals and horses). Because the priority listing of pathogens is dynamic and subject to future changes, the usefulness of existing surveillance systems and the need for new once requires regular evaluation. It was also recommended to keep the database with diagnostic methods up-to-date.

Samenvatting
Het doel van dit project was om witte vlekken in de diagnostiek en surveillance systemen voor opduikende zoönosen van de geprioriteerde lijst te identificeren.

Witte vlekken werden gedefinieerd als 'geen surveillance beschikbaar', 'onvoldoende surveillance', of 'geen / onvoldoende diagnostiek' beschikbaar. Er werden twee brainstormsessies met experts gehouden, waarbij alle 86 pathogenen van de geprioriteerde lijst werden besproken. Ten tweede werd een inventarisatie van beschikbare diagnostische methoden gemaakt, waarbij direct zichtbaar werd of diagnostiek voor de voorgestelde surveillance systemen beschikbaar was of juist moet worden ontwikkeld. Er werden vele witte vlekken geïdentificeerd, zelfs voor de hoogst geprioriteerde zoönosen. Het is duidelijk dat surveillance systemen ontwikkeld moeten worden voor zowel endemische als niet endemische zoönosen. Voor de eerste 25 zoönosen op de geprioriteerde lijst, werden witte vlekken geïdentificeerd voor de endemisch voorkomende zoönosen *Toxoplasma gondii*, *Anaplasma phagocytophilum*, *Chlamydophila psittaci*, en voor de niet endemische zoonosen: *Japanse encephalitis* virus, *West Nile* virus, *Crimean Congo haemorhagische koorts* virus,

Dobrova-Belgrade virus, *Rift Valley* virus, *Eastern Equine Encephalitis* virus, *Tick borne encephalitis* virus en *Seoul* virus. Het was een arbitraire beslissing om naar de top 25 zoönosen te kijken en er kunnen goede redenen zijn om ook aanbevelingen te doen over surveillance systemen voor zoönosen, die boven plaats 25 waren geprioriteerd, met niet zoveel meer inspanning en kosten.
Voor sommige zoönosen is het van belang dat huisartsen meer bewust worden van het voorkomen van deze zoönosen. Generieke surveillance systemen voor muggen, teken en knaagdieren zullen ontwikkeld moeten worden. In deze systemen worden meerdere pathogenen, voorkomend in hetzelfde reservoir, bestudeerd. Syndroomsurveillance voor de mens en paarden zouden verder geïmplementeerd moeten worden. Syndroomsurveillance is nader beschreven in appendix 2 (syndroomsurveillance in gezelschapsdieren en paarden).
Tevens is in dit project de vergelijkbaarheid van de *Coxiella burnetti* real time PCR testen, die gebruikt worden in verschillende instituten, vastgesteld. Resultaten van de *Coxiella* PCR lieten zien dat in monsters met een hoge load aan *Coxiella*, alle zes de instituten dezelfde resultaten behaalden met hun eigen test om *Coxiella* aan te tonen.
Omdat de geprioriteerde lijst van pathogenen een dynamisch proces is, waarbij veranderingen in de toekomst mogelijk zijn, is regelmatige evaluatie van de bestaande surveillance systemen en de behoefte aan nieuwe systemen noodzakelijk. Een andere aanbeveling is om de database met beschikbare diagnostische methoden aktueel te houden.

Introduction

In the first phase of the EmZoo project existing active and passive, humane and veterinary surveillance systems were described. From this inventory we learned that many different monitoring and surveillance systems exist in the Netherlands. It was however concluded that also a considerable number of gaps exist in this field.
Also in phase 1, the setting up of a list of prioritized (possibly emerging) zoonoses was initiated. In phase 1 the list of zoonoses and the list of gaps were not related. Besides, at that time it was not clear which technological possibilities are available for diagnosing the different pathogens on the list.
The aim of this project was to identify the gaps in surveillance systems for the most important emerging zoonoses in the Netherlands. Also, an inventory was made of diagnostic methods, available in the Netherland, for the pathogens on the list, to make clear where diagnostic methods are missing. Furthermore, a pilot was carried out with the aim to share information between the veterinary and human domain on the methodology and sensitivity of PCR based semi-quantitative detection of *Coxiella burnetii* DNA.

Materials and methods

Identifying gaps in existing surveillance

In the report of phase 1 surveillance was defined as: “the systematic collection of data on the occurrence of specific diseases, the analysis and interpretation of these data, and the distribution of consolidated and processed information to contributors to the program and other interested persons”. Surveillance can be divided into active and passive surveillance. In an active surveillance systems samples are collected routinely according to a defined schedule. In a passive surveillance system samples are only collected when a person or animal is suspected of a certain disease.

Monitoring was defined as: “a continuous dynamic process of collecting data about health and diseases and determinants in a given population over a defined period of time, but without any immediate control activities.

In general the following two distinct aims for the implementation of a surveillance systems are recognized:
1. To serve as a tool in Early Warning system for the introduction of new pathogens
2. To monitor the prevalence of endemic diseases for assessments of risk for public and animal heath.

The distinct aims demand a different approach. For Early Warning purposes, systems and/or activities focus on detecting rare events and have to deal with many unknowns. While for endemic disease surveillance, accurate measures of disease incidence is its main goal.

The following four surveillance types with respect to the parameter that is considered can be distinguished:
1. Pathogen surveillance that focuses on pathogen detection and identification.
2. Serological surveillance that involves diagnosing disease prevalence by monitoring immunological responses to presence or passage of pathogens in the blood of animals or humans.
3. Syndrome surveillance that focuses on trends by analyzing data on clinical symptoms or phenomena without pathogen identification.
4. Risk surveillance that does not focus on prevalence of pathogens or clinical features in animals or humans, but on detecting risk factors for disease transmission.

The former two are standard used surveillance types for monitoring endemic diseases while the latter two are more generally applied for early warning or preparedness purposes.

In chapter 4 in the report of phase 1, existing early warning and surveillance systems in the Netherlands were described. An overview of these systems is given in annex 1.

An important aim of the actual project was to identify "gaps" in the existing systems.
We defined gaps as:

- If no surveillance system is present for a pathogen on the list of 86 prioritized zoonoses (diagnostic methods are available).
- If a surveillance system is present, but it is not sufficient (for example: not for the right animal species, not suitable for the purpose, etc).
- If a surveillance system is needed, but no appropriate diagnostic methods are available.

These criteria were judged by experts for each of the 86 pathogens on the list, with more emphasis on the 25 highest ranked zoonoses.

Inventory of diagnostic methods

When it is concluded that a surveillance system is needed for a certain pathogen, it is necessary to have diagnostic methods available for detecting this pathogen in the involved animal species (including man) and/or the possible arthropod vector of this pathogen. Therefore, an inventory was made of diagnostic methods that are available and (routinely) used in the Netherlands, and the methods that are currently being developed. The inventory was carried out by all participating consortium partners. Per consortium partner a list was filled out, with the following information per pathogen:

- Is/are (a) diagnostic method(s) available for this pathogen?
- Animal species: for which animal species (or man) is this test available?
- Type of test: for example PCR, antibody detection, microscopy, culture.
- Matrix: for which matrix is this assay available? (e.g. urine, faeces, blood, organs, etc)

For human diagnostics (regional laboratories and more specialized laboratories) it was also registered if these diagnostic methods are carried out routinely or seldom.

The data about diagnostics were entered into an Access database, which made it possible to systematically look through the data. Practical examples:

- It is concluded that for pathogen X no sufficient surveillance system is present, but that such a system is needed. It is suggested to look in horses and mosquitoes for this pathogen. In the database diagnostic methods for pathogen X in horses and mosquitoes can be found.
- It is concluded that a surveillance system for pathogen Y is needed in poultry. For pathogen Z there is already a system in poultry, in which blood samples are tested. It might be efficient to combine the surveillance for Y with surveillance for Z, assuming that blood samples are already collected. In the database it can be looked up if there is a diagnostic method available to diagnose pathogen Y in blood samples.

Two brainstorm meetings with experts were held to discuss about the gaps in surveillance and diagnostics. This was done for all 86 pathogens on the prioritized list.

Results

An important criterion for determining if a surveillance system is necessary, and how this system should be designed, is the fact if this zoonosis is endemic in the Netherlands or not. For endemic zoonoses the aim of a surveillance system is to follow trends in time and to determine the effect of prevention and intervention/control measures.
When a zoonosis is not (yet) endemic, it makes no sense to collect many samples and try to detect the pathogen. In those cases, it is of importance to follow trends in neighbouring countries or globally, and to detect the pathogen as soon as possible after introduction in the Netherlands.
The most important gaps and recommendations for the 25 highest ranked zoonoses are summarized in table 1a and 1b.

The pathogens can be further subdivided in smaller groups with different implications for risk management.
Endemic pathogens (Table 1a):

- Pathogens with a documented high disease burden (*Toxoplasma gondii* and *Campylobacter* spp.), the high level of threat underlining the need for additional risk management interventions.
- Recently emerged pathogens (*Coxiella burnettii* and MRSA), the high level of threat supporting the current emphasis on their prevention and control.
- Pathogens with a low burden but a high threat (*Streptococcus suis*), the high level of threat supporting continued control activities. Surveillance to follow trends in time and more awareness in medical domain.
- Pathogens that are very common in the host animal, which can lead to severe symptoms in infected persons (*Capnocytophaga canimorsus*, *Bartonella hensalae*); surveillance in reservoir animals is not so useful (only to determine the effect of prevention/intervention measures), but more awareness in general practitioners is very important.
- Rare zoonotic pathogens which may lead to severe symptoms and/or high case-fatality ratios in infected persons (*Anaplasma phagocytophilum*, *Leptospira interrogans, Chlamidophila psittaci*, European Bat Lyssavirus). For these pathogens passive surveillance is needed to detect any potential increase in human disease incidence at an early stage. Additional active surveillance in animal reservoirs including vector populations need to be considered.

Non-endemic pathogens (Table 1b):
Some of the non-endemic pathogens are ranked high because of high mortality or morbidity rates; others are ranked high, because the probability for introduction in

the Netherlands is high. Especially those with a high risk of introduction are of importance.

- Classical zoonotic pathogens for which effective control programmes have been implemented (Influenza A virus (A) H5N1, *Mycobacterium bovis*, Rabies virus (classic)). The high threat justifies continued attention, mainly by passive surveillance of case reports from humans and additional active surveillance in animal sources (avian influenza A H5N1) and passive surveillance in animals (rabies, bovine tuberculosis).
- The classical zoonotic pathogens *Yersinia pestis* and *Francisella tularensis* with high threat but as far as now known non endemic status need further attention by following trends and awareness of possible introductions e.g. by exotic pet trade. Further development of detection methods and surveillance in rodents might be considered.
- Exotic pathogens that have never before been identified in the Netherlands (Japanese encephalitis virus, West Nile virus, Crimean Congo hemorrhagic fever virus, Dobrava-Belgrade virus, Rift Valley fever virus, equine encephalitis virus, Seoul virus) for which surveillance programmes in animal reservoirs and humans should be developed with high priority after scenario studies are performed.

Important gaps:

Toxoplasma gondii was ranked in the top of the zoonoses list. At this moment no real surveillance system is present, but Toxoplasma is notifiable in animals. It is not known exactly how many people get infected each year, and it is also not known how many animals are infected. It is very important to introduce good prevention measures. It is also recommended to periodically perform a recurrent surveillance system in humans (seroprevalence) for trend analysis (e.g. in Pienter), registration of patients, and determining the effect of prevention measures. For animals surveillance systems risk based monitoring is needed e.g. in wild boar, outdoor ranging pigs etc. based on the outcome of current (PhD 2007-2010 RIVM/IRAS) and future research.

- *Anaplasma phogocytophilum*: Ticks are the vector for this zoonosis, but the prevalence in tick is low (0,1-0,5%). Diagnostic tests for animals are not very specific. Therefore, it is important to develop a better diagnostic test for animals. Anaplasma should be included in a general tick monitoring system to follow trends in time.
- *Chlamydophila psittaci*: At present no surveillance system exists. When a human infection is detected, animals are examined to search the source of infection. It is recommended to carry out research to determine the incidence in birds. Further research is needed to develop a surveillance system.
- Japanese encephalitis virus: It is important to perform an extended scenario study into the risk of the emergence of this virus, and potentially concluding to set up a detection system for this zoonosis, because of its high rank on the list. Circulation of JEV can be monitored in mosquitoes, pigs, waterfowl and horses. Surveillance in pigs is based on monitoring seroconversion as infection in swine is generally unapparent, except for stillbirths and abortions when pregnant sows are infected and aspermia when boars are infected. Horses may develop fatal encephalitis but they represent incidental, dead-end hosts while pigs, waterfowls and certain mosquito species are amplifying hosts essential in the JEV lifecycle.
  It is recommended to include this virus in a general mosquito surveillance system (see further). It is also recommended to develop a test for detecting the presence of the virus in pigs. Furthermore it is recommended to include JEV monitoring in a general bird (waterfowl) monitoring, for example in combination with AI.
- West Nile virus: It is not known if this virus is already endemic in the Netherlands, but it is endemic in parts of Europe. The chance for introduction in the Netherlands is considered high. At this moment, RIVM and GD are working on the first steps for setting up a surveillance system. It is recommended to include this virus in general mosquito monitoring, and also in syndromic surveillance in horses and humans with encephalitis. It might be helpful to do surveillance in birds (for example combine it with AI surveillance in outdoor sentinel chickens).
- Crimean-Congo hemorrhagic fever virus: both the main vector and the pathogen are currently absent in the Netherlands. In a scenario study within the EmZoo project, it was concluded that the chance of establishment of the vector now or in the future, considering the expected climate change, is very low. At this moment, surveillance of the pathogen itself is therefore not useful. However, it is important to know if the vector-tick is present. This could be included in a general tick monitoring. However, vector competence of this virus in endemic ticks in the Netherlands is not known.
- Dobrava-Belgrade virus: The host of this virus are yellow-necked mice (*Apodemus flavicollis*). Currently only a few little populations of these mice are present in the Netherlands. It is recommended to follow developments abroad, and monitor locations of yellow-necked mice in the Netherlands, as part of general rodent monitoring program.
- Rift Valley fever virus: No commercial diagnostic test is available to detect this virus in animals or humans. Some in-house tests are in development, but these are not as robust and specific as needed. Therefore, it is recommended to develop such a test. Surveillance of this virus should be included in a general mosquito monitoring.

For *Streptococcus suis, Capnocytophaga canimorsis* and *Bartonella henselae* it is especially important to make people more aware of the existence of this pathogen. These pathogens are very common in their host animals. Relevant surveillance in animals might be useful to follow trends in time and/or to determine effects of newly introduced intervention measures.

General surveillance systems

General surveillance systems are surveillance systems that cover more than one pathogen within one system, for example by testing one sample for more than one pathogen. In the above mentioned recommendations some general surveillance systems were suggested. Such systems should be multi-component including infectious animal diseases, infectious human diseases (not only zoonoses) and reservoir population dynamics .

Rodent monitoring

A wide variety of small rodents, including rats, voles and mice, are reservoir of pathogens which form a threat to public or veterinary health. Of the pathogens prioritized within the EmZoo project, 85% has a wildlife reservoir among which rodents represent a major group. There is no national insight in rodent-pest (*Rattus rattus, Rattus norvegicus* and *Mus musculus*) population dynamics since rodent control is privatized in the Netherlands.

Research into the presence of pathogens in rodent populations in the Netherlands is very limited, fragmented and unstructured. As a consequence, no data are available on the prevalences and the temporal and spatial variations of these pathogens in rodent populations. Pathogen prevalence in rodent reservoirs and zoonotic transmission to humans are related to rodent population dynamics. Rodent population structure and density directly influence the abundance of infected rodents and therewith the human risks at exposure to pathogens for directly transmitted diseases (e.g. hanta virus and Ljungan virus infections). Although these correlations are less understood concerning the epidemiology of multihost pathogens like parasitic and vector-borne diseases in which rodents have a role as pathogen reservoir (e.g. Toxoplasmosis, Trichinellosis, Borrelia spp. infection, tick-borne encephalitis), the structural monitoring of rodent population densities and demography is essential for early warning, risk assessment and risk management purposes concerning both directly and indirectly transmitted rodent-borne diseases.

A general systematic rodent monitoring programme should be set up in the Netherlands to ensure a timely detection of public health risks due to the abundant presence of rodent disease reservoirs. This programme should comprise the monitoring of both rodent population densities and pathogen prevalences in case of trend monitoring of endemic pathogens in rodents, but is also important for early warning of newly introduced pathogens. Indicators for high densities and pathogen circulation therein, involving parameters concerning rodent and pathogen ecology, should be identified (research programme) and continuously or periodically monitored, depending on the pathogen. To ensure multiple end-users, this monitoring programme should be used from a broader perspective, not only for public health, but also including the risk of high rodent densities for veterinary health, biodiversity and agricultural damage.

Monitoring of ticks and tick-borne diseases

Ticks are vectors of a wide variety of pathogens which form a threat for public and veterinary health. More than 11 of the 86 pathogens prioritized within the EmZoo project are transmitted by ticks. For uncertain reasons, the incidence of Lyme borreliosis is on the rise in the Netherlands. Most likely, the incidence of other tick-borne diseases has increased concurrently. However, insights why there is an increasing incidence of Lyme diseases is lacking as there is no structural surveillance operational for veterinary and public health related tick-borne diseases. A general systematic ticks and tick-borne diseases surveillance programme should be implemented to ensure a timely detection of emerging public health risks caused by ticks. This programme should comprise the monitoring of endemic tick populations, and ensure the detection and spread of newly introduced ticks (e.g. *Dermacentor* ticks). Also, the presence of endemic (e.g. *Borrelia burgdorferi* s.l.) and high-risk (e.g. tick-borne encephalitis virus) tick pathogens should be monitored on a regular basis. Indicators for high densities/activities of ticks and the pathogens circulation therein, involving parameters concerning climate conditions, reservoir host, pathogen ecology and options to implement relevant control measures, should be identified in research programs, and eventually included in a national surveillance program.

Mosquito surveillance

Together with ticks, mosquitoes are the most important vectors of pathogens that threaten the public and veterinary health. Eighteen of the 86 pathogens prioritized within the EmZoo project are transmitted by mosquitoes. Best current knowledge is that none of these pathogens are endemic in the Netherlands. As for ticks, a general systematic mosquito and mosquito-borne diseases surveillance program should be implemented to ensure a timely detection of emerging public health risks caused by mosquitoes. This programme should comprise the monitoring of endemic mosquito populations, and ensure the detection and spread of newly introduced mosquitoes (as illustrated by the detection of *Ae. atropalpus*).

Over 35 mosquito species are known to be endemic in the Netherlands. Among them, certain species are potential vectors of pathogens of the prioritized list. Currently, information on abundance and the seasonal and geographical distribution of these species is absent, limiting risk assessments for mosquito-borne diseases. In addition important lessons can be learnt from the rapid spread of the invasive exotic (e.g. *Ae. albopictus* in Italy). It prompted the Netherlands to start mosquito surveillance at sites of import in 2007 to detect invasion as early as possible. As a result, other invasive mosquito species are detected in these surveillance activities, such as *Ae. atropalpus* very recently in the Netherlands. In July 2009, the Center for Monitoring of Vectors was established to coordinate monitoring activities in vectors and together with CVI and RIVM to strengthen the knowledge on vector-borne pathogens in vectors. Data for determining relative abundances of known and suspected vector species are collected by several methods, depending on the vector(s) and how these species are best collected. This could be either by adult trapping (e.g. *Culex pipiens*), larval dipping (e.g. *Culex pipiens*), or egg counts (oviposition traps, e.g. *Ae. albopictus*), or a combination. In addition to their vector potential, mosquitoes can be a notorious nuisance. Several areas in Europe experience mosquito nuisance for certain periods of the season. In those cases, surveillance is mostly used to determine the locations and timing of mosquito control activities, and to determine control activities efficacy afterwards (validation).

Syndrome surveillance

This is described in more detail in project 3.2 (Syndromic surveillance in companion animals and horses).

Q fever pilot

Materials and methods

The aim of this project was to share information between the veterinary and human domain on the methodology and sensitivity of PCR based semi-quantitative detection of *Coxiella burnetii* DNA. The causative agent of Q fever, *Coxiella burnetii*, was chosen as a proxy to test for the possible effect on test outcome when samples are being analysed at different laboratories both from the human and veterinary field. Given the current Dutch situation, especially in the field of Q fever research and diagnostics, comparable methods in both before mentioned fields are strongly needed in order to address the ongoing Q fever epidemic in the Netherlands using a one health approach.

In this project, a PCR ring trial was carried out to compare different diagnostic PCR methods. Participating institutes included laboratories from both human and animal health agencies. The Laboratory for Infectious Diseases and Perinatal screening (RIVM-LIS) and the laboratory for Zoonoses and Environmental Microbiology (RIVM-LZO) were representatives of the National Institute for Public Health and the Environment (RIVM). The Central Veterinary Institute (CVI) and the Animal Health Service (GD) were representatives of the animal health agencies. In addition the Jeroen Bosch Hospital in 's Hertogenbosch and the Pathology and Medical Microbiology Foundation (Stichting PAMM) in Veldhoven participated as hospital lab representatives . Last but not least TNO Defense, Security and Safety joined.

Nucleic acid extracts were prepared from the C. burnetii nine-mile strain (RSA 493) by RIVM-LZO in collaboration with CVI and dispatched frozen on February 10, 2010 to the participating institutes. Each testing laboratory received a panel of fifteen blinded nucleic acid samples coded A-O. Samples A, D, G, and J contained a 10-fold dilutions series, ranging from a 10^{-4} to a 10^{-7} dilution prepared from a genomic DNA stock of *C. burnetii* nine-mile strain (RSA 493) obtained from Institute Virion\Serion in Germany. Samples C, F, I, L, and O were complex samples containing PCR inhibitors. These samples were prepared by spiking a PCR inhibiting (but negative for *C. burnetii*) DNA extract, obtained from a surface area swab, with genomic DNA from the *C. burnetii* nine-mile strain (RSA 493) stock. A 10-fold dilution series, ranging from a 10^{-1} to a 10^{-5} dilution of *C. burnetii* genomic DNA stock was prepared in a PCR inhibiting DNA extract background.

Samples B, E, H, K, and N were *C. burnetii* DNA samples prepared by CVI. Sample M was a negative control sample, containing only milli-Q. Testing laboratories were unaware of the *C. burnetii* content of the samples being tested. Sample descriptions are given in Table 1. Each participating laboratory tested the panel of nucleic acid extracts using their 'in house' real-time PCR assay(s). In some laboratories the samples were tested using more than one real-time PCR assay. Each real-time PCR assay was used to test the nucleic acid samples using 2 replicate reactions for each template. The amount of DNA template to be added to the PCR mixtures was set at 3 microliters per reaction.

Results

The comparison shows that the most common target selected for real-time PCR assays for *C. burnetii* is the *IS1111* insertion element that is present in multiple copies in the *C. burnetii* genome. Some laboratories use additional real-time PCR assays for *C. burnetii* detection (often in multiplex format), in which single copy genes like *com1* or *sod*, are also targeted. The results for each participating laboratory are summarized in Table 2. The results of the Pathology and Medical Microbiology Foundation (Stichting PAMM) in Veldhoven are not included, because they are not yet available. All institutes used 3 μl of DNA template in the PCR reactions, except CVI, which used 5 μl of DNA template and GD, which reported results for 3 µl and 5 µl (their normal input) of DNA template. All laboratories were able to test the samples adequately using 2 replicate reactions for each target, although several participating laboratories noted that the amount of available DNA template (20 μl) of each sample was a limiting factor. Results are indicated with the symbols + (Positive, or *C. burnetii* detected), **+D** (Positive at 10x dilution), +* (*C. burnetii* detected nearby detection limit, or dubious results), - (Negative, or no *C. burnetii* detected), and ? (positive water control: not determined). The results show that some of the complex PCR inhibiting samples (I, L, and O) were quite challenging for most laboratories. The laboratories CVI and RIVM-LZO additionally tested a 10-fold dilution of these samples. This procedure always improved the outcome of the assay results by positive outcomes for *C. burnetii* targets where undiluted samples showed negative or undetermined results, due to inhibition. GD uses an internal control bases on ruminant GAPDH. Since this IC was negative for all the samples, the conclusion was drawn that the DNA samples did not originate from ruminant biological matrices. Therefore, it was not possible to observe inhibition or partial inhibition, and consequently samples were not retested diluted. In contrast, RIVM-LIS was able to obtain positive results of undiluted samples I, L, and O. Samples K and N, although containing *C. burnetii* DNA, showed no positive results in any of the real-time PCR assays tested.

Discussion

In this project we identified the gaps in the surveillance/early warning of (emerging) zoonoses in the Netherlands. It must be realized that the aim of this inventory was to identify the most important gaps, to use as a guideline for policy makers. Although all 86 zoonoses on the prioritized list were described, it is probably not desirable to really have surveillance systems for all 86 zoonoses. Policy makers should, with help from researchers, consider for which zoonoses a system should exist and how these systems should be set-up. This report should be used as a guide for thinking about the re-arrangement of surveillance and early warning systems in the Netherlands. The design and further details can be discussed with experts on these zoonoses.

The aims of surveillance systems are very different for endemic zoonoses and for non-endemic zoonoses. Therefore, it should be known if a zoonosis is endemic, before starting to design a new surveillance system. When the pathogen uses a vector for transmission between animals, it should also be known if the specific vector is present.

When thinking of the design of surveillance systems for emerging zoonoses, the "problem" is that you cannot predict which zoonoses will be the first to emerge in the Netherlands. In this project we worked with a list of 86 pathogens, but of course many more pathogens can cause a zoonoses. Especially those pathogens, that are not endemic at this moment, are not easy to monitor. For these pathogens it might be very important to continually watch the situation in neighboring countries, to perform risk analysis to identify risk factors, and have a continuous syndrome surveillance operational in man and animals.

The advantage of general surveillance systems like mosquito monitoring or rodent monitoring are very obvious. They do not only look for specific pathogens, but also whether the specific vector (mosquito monitoring) or host animal (rodent monitoring) is present and at the population dynamics of these reservoirs. This works much more efficient than testing samples for a pathogen of which it is not known if it is already endemic.

An efficient surveillance system requires adequate diagnostic methods. An inventory was made of available diagnostic methods in the Netherlands. In this project, the consortium shared the information about their available detection methods and relevant methods in development. When focusing on the first 25 zoonoses on the prioritized list, no sufficient methods are available for *Anaplasma phagocytophilum*, Japanese encephalitis virus and Rift Valley fever virus. It is strongly recommended to start developing efficient diagnostics for these pathogens.

Some endemic zoonoses are very common in their host animals (for example *Bartonella* and *Capnocytophaga*, also *Streptococcus suis* infections). Having an extended surveillance system for these pathogens is more or less useless, because the pathogen will be detected "everywhere". Periodic surveillance (for example every 5 years) could be useful to follow trends in time and when new preventive measures are introduced, so that the effect of these measures can be determined. However, for this kind of zoonoses it is most important to make general practitioners aware of the existence of these zoonoses.

The whole list of 86 zoonoses was evaluated and discussed (results not included). Recommendations were given for the first 25. Of course, this is an arbitrary number based on trivial arguments (first 25!). Good reasons can be given to extent the surveillance systems with pathogens listed after number 25 without much more effort and costs. Moreover, it is recommended to keep the contents of the database up-to-date and periodically evaluate the contents and available detection and surveillance systems with the updated prioritized EZIP.

Conclusions

- Gaps in surveillance exist for the following endemic zoonoses: *Toxoplasma gondii*, *Anaplasma phagocytophilum* and *Chlamydophila psittaci*.
- Gaps in surveillance exist for the following non-endemic zoonoses: Japanese encephalitis virus, West Nile virus, Crimean-Congo hemorrhagic fever virus, Dobrava-Belgrade virus, Rift Valley fever virus, Eastern equine encephalitis virus, tick-borne encephalitis virus and Seoul virus.
- Many of these gaps can be filled in by developing general surveillance systems, which, in an efficient way, monitor for more than one pathogen at the time.
- For some zoonoses it is important that more awareness will be created among human doctors.

Conclusions Q fever

In samples with high *C. burnetii* content, all six participating institutes scored[1] similar results using their 'in-house' real-time PCR assay(s) for the detection of *C. burnetii* in the provided samples. Results started to deviate considerably between institutes with decreasing *C. burnetii* DNA content and increasing content of inhibiting substances.

Recommendations

1. The results of the brainstorm meetings with experts, in which all 86 pathogens on the list were discussed to advice about specific surveillance systems, should be further analysed and validated. The results can be used for making the decision if new surveillance systems should be set up.
2. Start up general surveillance systems: mosquito monitoring, tick monitoring, rodent monitoring, syndromic surveillance human, syndrome surveillance horses.
3. Carry out scenario studies as an input for the designs of (general) surveillance systems.
4. Keep the database with diagnostic methods up-to-date.
5. It might be useful to carry out cost-benefit analyses, before new surveillance systems are introduced".

Table 1a. Endemic zoonotic pathogens

Pathogen	Rank	Surveillance human	Surveillance animal	Surveillance arthropods	Diagnostics	Recommendations
Toxoplasma gondii	2	I	N	NR	Y	Prevention and control
Coxiella burnetii	4	Y	Y	N	Y	Presently an outbreak situation. Otherwise, keep existing systems, additional tick and wildlife monitoring.
Campylobacter	5	Y	Y	NR	Y	Control, prevention
Anaplasma phagocytophilum	8	N	N	I	I	Diagnostic development human and animals, include in tick surveillance
Streptococcus suis	9	N	N	NR	Y	Better awareness in humans; pathogen surveillance in pigs
Leptospira spp.	10	Y	Y	NR	Y	Rodent surveillance
Capnocytophaga canimorsis	17	N	N		Y	More awareness in human doctors that this pathogen exists
Chlamydophila psittaci	20	N	Y	NR	Y	Birds in case of source tracking, more research needed….
MRSA	22	Y	N	NR	Y	Keep existing systems
Bartonella henselae	24	N	N	I	Y	More awareness in human doctors, improve diagnostics in humans.
European bat lyssa virus	25	N	Y	NR	Y	Periodically active surveillance in bats, keep existing control systems

Y= yes
N = no
I = insufficient
NR=not relevant

[1] Results obtained from TNO D&V are preliminary and must be reevaluated due to positive results in the negative controls. Therefore, data obtained from TNO D&V cannot be compared directly to the other participating institutes.

Table 1b. Non-endemic zoonotic pathogens

Pathogen	Rank	Surveillance human	Surveillance animal	Diagnostics	Recommendations
Avian influenza virus	1	Y	Y	Y	Keep existing systems
Japanese Encephalitis virus	3	N	N	I	Syndromic surveillance; gather knowledge, mosquito diagnostics ready.
Mycobacterium bovis	6	Y	Y	Y	Keep existing systems
BSE	7	Y	Y	Y	Keep existing systems
West Nile virus	11	Y	I	Y	More structural syndromic surveillance horses and humans; monitoring sentinel chickens using AI logistics. General mosquito monitoring
Crimean Congo hemorrhagic fever virus	12	N	N	Y	Incorporate in tick surveillance system
Dobrava belgrade virus	13	N	N	Y	Monitoring locations specific reservoir yellow-necked mouse; awareness situation in other countries
Rabies virus	14	N	Y	Y	Keep existing systems
*Yersinia pestis**	15	N	N	Y	Awareness and if relevant quick scan in rodents
Rift valley fever virus	16	N	N	N	Mosquito monitoring; development of diagnostic test
*Francisella tularensis**	18	N	N	Y	Quick scan in rodents/lagomorphs; include in tick monitoring….
Eastern equine encephalitis virus	19	N	N	Y	Mosquito monitoring; human and horses syndromic surveillance
Tickborne encephalitis virus	21	N	N	Y	Awareness situation in other countries. Tick monitoring. Monitoring antibodies in wildlife.
Seoul virus	23	N	N	Y	Rodent monitoring

* Not sure that it is non-endemic, but no nationally acquired human cases occur.

Table 2: Results of the detection real-time PCR assay ringtrial of 5 participating institutes. Note that GD scored positive on sample J when 5 uL was used.

Sample no.	Sample description	RIVM-LIS		RIVM-LZO	CVI	JBZ	TNO D&V			GD R&D	GD Routine
		IS1111 & com1	*IS1111*	*IS1111 & com1*	*IS1111 & hypo**	*IS1111*	*com1*	*QpH1f1f2*	*sod*	*IS1111*	*IS1111*
A	gDNA *C.burnetii* 10^{-4}	+	+	+	+	+	+	–	+	+	+
D	gDNA *C.burnetii* 10	+	+	+	+	+	–	–	–	+	+
G	gDNA *C.burnetii* 10^{-6}	+	+	+	+	+	–	–	–	+	+
J	gDNA *C.burnetii* 10^{-7}	+	–	+	+	+	"	–	–	–	–
M	N.C. (Milliq)	–	–	–	–	–	"	–	–	–	–
B	CVI *C. burnetii* DNA sample nr.2	+	+	+	+	+	+	–	–	+	+
E	CVI *C. burnetii* DNA sample nr.4	+	+*	+	+	+	–	–	–	+	+
H	CVI *C. burnetii* DNA sample nr.6	+	–	+	+*	+*	–	–	–	–	–
K	CVI *C. burnetii* DNA sample nr.8	–	–	–	–	–	?	–	–	–	–
N	CVI *C. burnetii* DNA sample nr.10	–	–	–	–	–	?	–	–	–	–
C	gDNA *C.burnetii* 10^{-1} in PCR inhibiting background	+	+	+	+	+	+	+	+	+	+
F	gDNA *C.burnetii* 10^{-2} in PCR inhibiting background	+	+	+	+	+	+	+	+	+	+
I	gDNA *C.burnetii* 10^{-3} in PCR inhibiting background	+	+	+ D	+ D	–	?	+	+	–	–
L	gDNA *C.burnetii* 10^{-4} in PCR inhibiting background	+	+	+ D	+ D	–	?	–	+	–	–
O	gDNA *C.burnetii* 10^{-5} in PCR inhibiting background	+	+	+ D	+ D	–	?	–	–	–	–
Multiplex or Singleplex reaction		Multiplex	Singleplex	Multiplex	Multiplex	Singleplex	Singleplex	Singleplex	Singleplex	Singleplex	Singleplex
Reaction mix manufacturer		Roche	Roche	BioRad	Quanta	in-house'	Roche	Roche	Roche	LSI	LSI
Reactie volume (ul)		25	20	20	unknown	25	20	20	20	unknown	unknown
DNA template volume toegevoegd		3	3	3	5	3	3	3	3	3	3

+	Positive, or *C. burnetii* detected
+ D	Positive, or *C. burnetii* detected at 10x dilution
+*	*C. burnetii* detected nearby detection limit, or dubious results
?	Positive water control: not determined
–	Negative, or no *C. burnetii* detected

Annexes

Annex 1: Overview of existing surveillance systems

	Name Surveillance system	Popul.	Surveillance system: general	specific	passief	active	Freq.	Data analyzing institute: GD	CVI	RIVM	UU	VWA	other	Collecting body	species	sample	Signal	Contact	Financing source
1. Human																			
1_1	PREZIES nosocomial infections (syndrome based	H		x	x		C			x				hospital	human	wounds/ body fluid	Culture	RIVM	VWS
1_2	Active surveillance *Listeria monocytogenes*	H		x		x	C			x				Hospital	human	blood/ body fluid	Culture	RIVM	VWS
1_3	Laboratory surveillance infectious diseases *(Salm.* and *Campyl)*	H		x	x		C			x				GP	human	feces / blood	Culture	RIVM	VWS/VWA
1_4	Active surveillance *STEC*	H		x		x	C			x		x		GP/VWA	human	feces	Culture or toxin	RIVM	VWS/VWA
1_5	Influenza surveillance (syndrome-based)	H	x			x	C			x			EMC	GP	human	nose/throat swabs	Cult/PCR/case definition	EMC	VWS
1_6	ISIS-laboratory surveillance system	H	x		x		C			x				GP	human	any kind	lab results	RIVM	VWS
1_7	Surveillance of *MRSA*	H		x		x	C			x				GP	human	?	Culture	RIVM	VWS
1_8	OSIRIS (human notifiable disease registration	H	x		x		C			x				GP/GGD	human	any kind	lab and case definition	RIVM	VWS
1_9	Syndrome-based surveillance retrospect. Respirat/ Gastro/ Neuro	H	x			x	C			x				GP	human	any kind	lab and case definition	RIVM	?
1_10	Syndrome-based flaviviruses surveillance	H		x		x	I			x				hospital	human/ horse	cerebral fluid	ELISA and case definition	RIVM	?
1_11	Early warning committee ('Signalerinsoverleg')	H	x		x		C			x				VWA/GGD/RIVM	human	any kind	any signal/ oddity	RIVM	VWS
2. Farm Animals																			
2_1	*Avian Inf luenza*(AI) monitoring poultry	F		x		x	C	x				x	PVE	VD	poultry	blood	ELISA	?	LNV
	Avian Influenza surveillance Wild birds	F					C						EMC		divers	Cloacal/Tracheal swabs	PCR	CVI	LNV
2_2	Diagnostic pathology	F	x		x		C	x				x		GD	all	post mortem inv.	any test	?	LNV/PVE/PZ
2_3	*Bluetongue* surveillance: sentinel	F		x		x	C	x				x		GD	ruminants	milk	ELISA	?	LNV
2_4	Surveillance *Brucella suis*	F		x		x	C	x				x		AI station	AI boars	blood	ELISA/CBR	CVI	AI/ LNV
2_5	*Brucella melitensis* monitoring programme	F		x		x	C	x				x		VD	sheep/ goat	blood	ELISA/CBR	CVI	LNV
2_6	*BSE* surveillance	F		x		x	C	x				x		?	cattle	?	histo/immunochemistry	?	LNV
2_7	*Classical Swine Fever* surveillance	F		x	x		C	x				x		GD	pigs	pig tonsils	PCR	?	LNV
	CSFV surveillance wild boar	W					C								wild boar		PCR	CVI	
2_8	Data analysis on census data	F	x		x		C	x				x		GD	cattle	cattle	epid. trends	?	LNV/PVE/PZ
2_9	Monitoring *Trichinella* in slaughter pigs	F		x		x	C	x				x		SH	pigs/wild boar/ horses	diaphragm	digestion	?	SH
2_10	Notifiable diseases	F	x		x		C	x				x		farmers/VD	even toed ungulates	all	all	CVI	LNV
2_11	Risk assessment from information about foreign countries	F		x		x	C	x				x		GD	even toed ungulates	info	Foot Mouth Disease	?	LNV
2_12	Surveillance of zoonotic bacteria in farm animals	F	x			x	C	x				x		VWA	farm animals	feces	Zoon Bact isolation	VWA	LNV
2_13	*Scrapie* surveillance	F		x		x	C	x				x		GD	sheep/ goat	brain	histopath	GD	LNV
2_14	Serological / bacteriological surveillance of *Salmonellosis* pig farms	F		x		x	C	x				x	PVE	VD/Slaught	pigs	blood/swabs	ELISA/ culture	GD/PVE	PVE/ farmers/ SH
2_15	Prevalence studies cattle	F	x			x	C	x				x		VD	cattle	milk/blood	ELISA Salm/Lept+others	GD	PV/PZ
2_16	Surveillance at slaughter houses (VWA)	F	x		x		C	x				x		SH	all slaughtered animal	anormalities	any		SH
2_17	Livestock-scope ('Veekijker')	F	x		x		C	x				x		farms	All	anormalities	any	-	LNV/PVE/PZ
	Caliciviridae	F	x		x		I			x				VWA	pigs	feces	PCR	RIVM	VWA
	Coronaviridae	F	x		x		I			x				VWA/GD	cattle	feces	PCR	RIVM	VWA
	NRL shell fish	Fi		x		x	C			x				VWA	shell fish	Shellfish	Culture (Ecoli/ Salm)	RIVM	VWA
3. Wildlife																			
3_1	Mass mortality of wildlife	W	x		x		C					x		?	water fowl/birds of prey	?	botulism		?
3_2	*Echinicoccus multilocularis*	W		x		x	P			x		x		hunters	foxes/ raccoon dog	body	lab results	RIVM	VWA/ EU
3_3	*Hantavirus*	W	x	x		x	I			x		x		RIVM?VZZ	3 species of mouse	blood	serology/PCR	RIVM	VWA
3_4	*Rabies*	W		x	x	x	C		x	x		x	Nat	GP/CVI/VWA?Nat	bats/ cats_dogs_foxes	blood/swabs/feces	EBLV	CVI	?
3_5	Even-hoofed ungulates	W	x			x	C					x		owners	even hoofed ungulates	many	many	GD	owners
3_6	*Trichinella*	W	x		x		C			x		x		hunters	foxes/ raccoon dog/ wild boar	many	digestion	RIVM	VWA
	Coxiella burnetii	W	x			x	I			x				RIVM/pest control	rodents	spleen, lung	PCR	RIVM	RIVM/VWA/UU
	Coronaviridae	W	x	x	x	x	I			x			EMC	VWA/DWHC/private	bats/ cats_dogs_foxes	tissues, feces	PCR	RIVM	RIVM
	Lj ungan virus	W	x			x	I			x				RIVM/VZZ	rodents	brain	PCR	RIVM	RIVM/VWA
4. Vectors																			
4_1	Tick-borne pathogens (veterinary)	P/V	x		x	x	I				x			VD	pet dogs cats	tick	pcr	UU	UU
4_2	Tick-borne pathogens (human)	H	x		x		I			x				GP	human	serum	ELISA	RIVM	VWS
4_3	Tick density and pathogen (WUR)	V	x			x	I						WUR	volunteers	field	tick	Borrelia burg.	WUR	WUR
4_4	Tick density and pathogen (RIVM)	V	x			x	I		x	x			Alt.	RIVM/CVI/Alt.	field	tick/mice	PCR	RIVM/CVI	VWA
4_5	Asian tiger mosquito, *Aedes albopictus*	H/V		x		x	P			x				CMV	greenhouses	mosq	PCR dengue	RIVM	VWS
4_6	Arboviruses	V	x			x	I			x				CMV	field	vector	PCR	RIVM	VWA
4_7	Culicoides	V		x		x	C		x					CMV	field	culicoides	BTV pos	CVI	LNV

Abbreviations (of non-Emzoo consortiummembers)

Alt.: Alterra, Wageningen; EMC: Erasmus Medical Center, Rotterdam; EU, European Committee; Nat. :Naturalis Leiden; PVE: Productschap Vee Vlees en Eieren

PZ: `ProductschapZuivel; SH: Slaughterhouses; VD: Veterinary Doctor; VWA: Voedsel en Waren Authoriteit

Name surveillance system	
Popul.	Human or animal population under surveillance
H	Human
F	Farm animals: production animals, cattle, pigs, small ruminants, and poultry
Fi	Fish and shell fish for food production,
W	Wildlife including every vertebrate animal living in the wild in the Netherlands
V	Vectors includinc arthropods potenitally transmitting pathogens
P	Pets and horses including every animal held as a pet, including exotic reptiles, birds, amfibia ed.
Surveillance system (SS)	
general	SS is not pathogen specific
specific	SS is pathogen specific
passive	SS receives data when cases occur, e.g. notifiable diseases system, or autopsie
active	SS actively seeks for data e.g. random sampling
I	Incidential: meaning data gathered only in one project
P	Periodic: data gathered on a certain frequency
C	Continuous: data is gathered continuously
Data analyzing institute	Insititute that is responsible for the data processing
Collecting body	Person, institute or other body that collects sample/ data for dianostic analyses
species	Human or other animal species of which samples are taken
sample	sample type (serology, pcr, microbiol., sensus etc)
Signal	what is recorded for diagnostic purposes
Contact	institutes that overviews data
Financing source	who is financing the surveillance

Appendix 2
Syndromic Surveillance in companion animals and horses

Project leader
Jaap A. Wagenaar, Faculty of Veterinary Medicine, Utrecht University, Utrecht, the Netherlands and Central Veterinary Institute of Wageningen UR, Lelystad, the Netherlands.
Kees van Maanen, Animal Health Service, Deventer, the Netherlands.

Advisors
Armin Elbers, CVI-WUR
Chris Bartels, Henriette Brouwer-Middelesch, GD
Chantal Reusken, Kees van den Wijngaard and
Marion Koopmans, CIb-RIVM
Mirjam Nielen, Lisa Veneberg, UU

Summary

The need and possible options for a syndrome surveillance system for companion animals and horses to detect (re)-emerging zoonoses was evaluated. The analysis was based on the information collected from syndromic surveillance evaluation in the human domain in the Netherlands, the running initiatives in production animals (*'Veekijker'*) and the registration system for notifiable diseases, international developments, and literature search. The priority setting list of 91 pathogens was used. Two pilot studies were performed: one in a diagnostic lab/expertise centre for companion animals to assess the helpdesk requests from practitioners. The other pilot was in horses focusing on West Nile Virus surveillance. However, also symptoms in the context of neurological syndromes were recorded and analysed.

We conclude that for companion animals and horses any organized surveillance system is lacking at the moment whereas almost half of the EZIP pathogens induce clinical symptoms in companion animals or horses. The implementation of an electronic syndrome surveillance system will meet logistical constraints that need an investment to set up a reporting system, introduction of compatible computer systems, and data analyzing capacity. The costs are probably considerable and before an introduction will be started, the cost-effectiveness should be analyzed. However, for companion animals and horses the designation of a 'helpdesk' where signals of unusual events can be reported (passive surveillance) and further analyzed would be the first step towards an early detection system. An important stimulus for reporting is the availability of expertise at this helpdesk (consulting desk). This has been shown in the *Veekijker*, and is clear from the help-desk pilot in companion animals. Besides acting as an expertise center (to help the practitioners solving the problem) this consulting desk should be able to offer follow-up (microbiology, pathology) in cases that meet specific criteria. Compared to the syndromic surveillance system, this approach will probably be relatively cheap. The introduction of syndromic surveillance should be preceded by a retrospective study showing the power and limitations of the current data, and a small pilot study. The introduction of a clinical reporting model as used in Sweden for horses may be considered. This would require an in depth study of databases and diagnostic entries used by the Swedish network of clinics, and insurance companies, and an evaluation of the feasibility of introducing such a system in a network of companion animal and equine practices.

Samenvatting

De waarde, haalbaarheid en beperkingen van syndroom surveillance bij gezelschapsdieren en paarden voor het opsporen van (her)opkomende zoönosen werd bepaald. De analyse is gebaseerd op informatie uit een syndroom surveillance project in het humane domein, de Veekijker, registratie van aangifteplichtige ziekten, internationale initiatieven en literatuur gegevens. Als basis diende de prioriteringslijst van 91 pathogenen. Als onderdeel van dit project zijn twee pilot studies uitgevoerd: één in een diagnostisch laboratorium/kenniscentrum voor gezelschapsdieren waarbij de vragen van practici zijn vastgelegd en gerubriceerd. De tweede pilot was gericht op de detectie van West-Nile virus in paarden (syndroom- en lab-gebaseerd). We concluderen dat er op dit moment voor gezelschapsdieren en paarden geen enkel georganiseerd systeem is voor het opsporen of faciliteren van registratie van (her)opkomende zoönosen terwijl in de EZIP lijst veel pathogenen wel klinische symptomen geven in gezelschapsdieren of paarden. De implementatie van een syndroom surveillance systeem wordt op dit moment belemmerd door het ontbreken van een geharmoniseerde rapportage systemen, een verscheidenheid aan praktijkmanagement systemen en het ontbreken van analyse capaciteit voor gegevens. Invoering van het systeem met een gewenste dichtheid vergt waarschijnlijk een relatief grote investering. Daarom zou voordat de beslissing genomen wordt daadwerkelijk tot invoering over te gaan een kosten-baten analyse uitgevoerd moeten worden. Op korte termijn zou een eerste stap gemaakt kunnen worden door een helpdesk in te stellen voor gezelschapsdieren en paarden waar meldingen binnen kunnen komen die door experts geëvalueerd worden en waarna eventueel vervolg onderzoek ingesteld kan worden. Dit naar analogie van de Veekijker en als vervolg op de pilot voor gezelschapsdieren.

De expertise die voorhanden is bij het meldpunt (helpdesk) is essentieel om meldingen te stimuleren. Dit is een relatief goedkope eerste stap om op een, weliswaar passieve maar georganiseerde manier, signalen uit het veld op te pikken. Een retrospectieve studie waarbij de bruikbaarheid van de huidige gegevens wordt geanalyseerd, mogelijk gevolgd door een pilot study, behoren tot de volgende stappen. Als eerste stap voor de introductie van syndroom surveillance kan de invoering van een registratiesysteem van klinische en therapeutische parameters overwogen worden zoals dat in Zweden is opgezet. Hiervoor moet eerst een verdere analyse plaatsvinden van het Zweedse netwerk van klinieken en verzekeringsmaatschappijen en de onderliggende technische voorwaarden.

Introduction

Conclusions from the first phase

In the First Phase of the Emerging Zoonoses (EmZoo) project it was noticed that early detection systems, monitoring and surveillance systems for zoonotic diseases in pets and horses are lacking. One of the recommendations was ''permanent or regular monitoring in the animal population and/or environment should be established…''. In the overall statement of the project two recommendations were the basis for this syndrome surveillance project:

1. Development of a surveillance system for prioritised zoonoses in pet animals and horses. To assess for which zoonoses surveillance should be implemented, first project-based studies to assess the prevalence in these animals should be performed.
2. The usefulness of syndrome surveillance in animal reservoirs should therefore be studied.

Defining the scope of the project

There are different systems for surveillance: **active surveillance** in which a (preferably statistically representative) fraction of the population is sampled to determine the prevalence of a pathogen with a defined certainty. **Passive surveillance systems** are dependent on what is reported or what samples are submitted by e.g. physicians or veterinarians working in the field, not based upon any agreed sampling scheme. This information is much more fragmented and usually not suitable for statistical evaluation. In passive surveillance systems, diseases or pathogens may be missed, even when they are present in relatively high frequency. In active surveillance systems statistical algorithms can be used to signal disease events with frequencies above a certain statistical threshold. Disease events that remain below that threshold will not be detected.

Secondly surveillance systems can be divided into **clinical surveillance**, **laboratory (pathogen) surveillance**, and **syndromic surveillance**. In some cases these systems may be combined.

Clinical surveillance is the detection of clinically suspected cases. Depending how characteristic symptoms are for a specific disease, this system is not very specific when not followed by lab confirmation. However, the clinical surveillance is usually combined with a confirmation in the laboratory (**lab-based surveillance**). This makes the system specific for certain pathogens. Lab-based surveillance can also be run independently of clinical surveillance. Two examples are the collection of blood samples at the slaughterhouse for the detection of *Salmonella* infections in pigs and to monitor the disease-free status for Swine Vesicular Disease. The definition of **syndromic surveillance** is: (real time) collection, process, analysis and feed back of (veterinary) health care data available prior or independent of disease diagnosis. One of the aims of syndromic surveillance is to identify unexpected health events (outbreaks). Examples from the human health care system of syndromic surveillance are trends in lab-submissions, hospitalisations, data from pharmacies (prescription data), and mortality. Ideally data are collected and analysed real time to reduce the time interval between signal and potential action.

It is important to realize that in general classical surveillance systems (clinical/lab-based surveillance) are not capable to detect new emerging zoonoses with a non-specific clinical presentation, especially those with minor clinical impact, at an early stage.

Within the scope of the EmZoo project, the aim of **early detection** is to detect emerging zoonotic diseases in animal populations (preferably before the pathogen is introduced in humans) and human populations. Important is that the laboratory is able to identify the causative pathogen; even if that pathogen is rare or maybe unknown. The detection of unknown (new) pathogens is extremely complex and expensive as general detection systems for any infectious agent should be in place. There are a few laboratories in the world working on this approach. Within this project, we focus on the pathogens on the EZIP-list .

For this project it is important to differentiate between zoonoses that are present (vs absent) in the Netherlands, and whether the pathogens cause clinical symptoms (yes or no) (Table 1).

Table 1. Categorization of diseases

	Present in NL	Absent in NL
Clinical symptoms	1	2
No clinical symptoms	3	4

It is clear that pathogens not causing any clinical symptom cannot be detected by any system except for a lab-based surveillance (active or passive). As laboratory-based systems are not included in this project, diseases in the groups 3 and 4 are not discussed in this project.

The aim of this project was:
1. To determine the value and the feasibility of implementing a syndromic surveillance system for pets and horses for the detection of emerging zoonotic diseases.
2. If the added value of implementing a syndromic surveillance system is clear, a blueprint will be developed how this system can be implemented in the Netherlands (costs, participating parties).

Material and methods

As part of this project there have been two expert meetings to exchange information and develop ideas for syndromic surveillance systems.
Besides information from the literature, we have used in this project:
1. The results of the syndromic surveillance evaluation in the human health care sector available from the RIVM.
2. The information available at the Animal Health Service on the (passive) syndromic surveillance in production animals named 'Veekijker'.
3. Information on early detection systems on notifiable animal diseases available at CVI.
4. Information from the KNMvD.
5. Information on a syndromic surveillance system running in the UK (SAVSNET).
6. Analysing the EZIP-list (Emerging Zoonoses Information and Priority System) with the 91 highest ranked zoonoses.
7. A 3 months pilot for registration of questions raised by practitioners calling the VMDC.
8. WNV surveillance in horses in the Netherlands, data 2009.
9. Secondary databases in equine research, doctoral thesis Johanna Penell, Uppsala, Sweden, 2009.

Results

1. ***Syndrome surveillance in the humans***
   The aim of introducing syndromic surveillance is early detection of outbreaks of unusual infectious diseases. The development was strongly supported by anthrax issues, the detection of SARS and the threat of pandemic influenza. Improvements in the field of electronic collection and storage of health data was another trigger for the development of the system. Outbreaks of uncommon or unknown pathogens can be potentially detected by syndromic surveillance.
   A project performed in the Netherlands to assess the value of syndromic surveillance in humans concluded that respiratory, gastro-intestinal and neurological syndromes are suitable to track nationwide disease dynamics, whereas respiratory and possibly neurological syndromes seem most suitable for detecting local outbreaks (with comparatively few signals in time to investigate). GP, pharmacy, hospital and mortality registries gave the best reflection of pathogen trends. Of course, real time registration is preferred for syndromic surveillance to facilitate immediate action. The data quality, including high coverage of the system are crucial for local outbreak detection with sufficient sensitivity and specificity. For the interpretation of the data there is a need for baseline data collected over a couple of years.

2. ***Data available from the* Veekijker *(syndromic surveillance in production animals)***
   The *Veekijker* ''rund'' is a helpdesk for veterinarians and cattle farmers. They can obtain information from cattle specialists. After registration of a case, the Animal Health Service (AHS) can decide to have a follow-up to obtain more information (farm visit, pathology, toxicology). The aim of the *Veekijker* is i) early detection of well known exotic diseases, ii) early detection of new or emerging diseases, iii) description and analysis of trends and developments of cattle health, iv) a help-desk for health and disease-related questions from farmers and practitioners. The strength of the system is the fact that the registration is not just ''for the record'' but that it is backed by additional information and, in some cases, active follow-up. In this way the monitoring is combined with advice. On a weekly basis there are about 50 contacts with veterinary practices and 50 contacts with farmers. The system runs from 2004 and the participation is quite stable over the years. A newly started project under the umbrella of the *Veekijker* is combining the information from 5 sources (Identification and Registration data, Rendering plant, Milk control station, Dutch Cattle Improvement organization, and Animal Health Service). These data will be combined and analysed for trends. The experience of the AHS with syndromic surveillance is that data should be available at one place, under the conditions of uniform data collection with a uniform, complete and timely data collection.

3. ***Experience for notifiable diseases***
   With regard to the reporting of a possible suspicion of notifiable diseases (FMD, CSF, AI in the differential diagnosis), economical aspects play an important role, in particular the economical consequences of such a report (e.g. movement restrictions for the farm). However, this should not be exaggerated because nowadays PCR-tests will in most cases give a diagnostic result within 24 hours. In order to improve early detection of a possible introduction of notifiable diseases, the use of exclusion diagnostics is recommended in case of non-specific clinical signs observed on farms. This system is now in operation in the Netherlands.

4. ***Information on patient database systems (KNMvD)***
   At the moment there are 7 different systems (praktijk management systemen PMS) in use in veterinary practices. The communication possibilities between these systems are limited. The KNMvD initiated Vetbase which implemented the VetCIS database (Centraal Informatie Systeem). This system is compatible with all PMS and aiming for the registration of veterinary medicines. The system is currently focusing on production animals because of the regulations. This system can be potentially introduced in the companion animal sector for registration of medicines and treatments.

5. ***Information of a syndromic surveillance system running in the UK (SAVSNET)***
   The SAVSNET surveillance project is a project in the United Kingdom to establish the current status of disease in the small animal population. There are two projects. The first project aims to select the diagnostic data of 25 laboratories across the UK. The second project aims to collect data from 765 veterinary premises nationally. This is possible because one of the leading UK veterinary database companies (20% of the market) wanted to cooperate. SAVSNET is managed by researchers at the University of Liverpool. At the moment of finalizing this report the SAVSNET is still in the phase of setting up the collaboration with labs and practices. There are no data available yet.

6. ***Analysing the EZIP-list (Emerging Zoonoses Information and Priority System) with the 86 highest ranked zoonoses***
   In another project within EmZoo a database has been compiled comprising zoonoses with the highest ranking of 'threat'. We screened the list of pathogens for their capability to induce clinical signs in companion animals and horses as such pathogens can be potentially be detected by a syndromic surveillance system. The result of this inventory is listed in Table 2.

7. ***Pilot for registration of questions raised by practitioners contacting the Veterinary Microbiological Diagnostic Center (VMDC)***
   To assess to what extent a helpdesk function similar to the '*Veekijker*' is currently in place at one of the Dutch veterinary diagnostic laboratories analysing a large number of samples from companion animals, the contacts were registered and categorized for a period of 3 months (November 2009 – February 2010), 3 days a week. A total of 16 weeks with 48 registration days were included. This laboratory (Veterinary Microbiological Diagnostic Center of the Faculty of Veterinary Medicine, Utrecht, the Netherlands) has a staff of board certified veterinary microbiologists and acts as a centre of expertise, not only for advice regarding diagnostics and therapeutic approaches but also for consultancies on infectious diseases including zoonoses.
   Based upon the contacts, it is clear that practitioners, people working in medical profession and policymakers are looking for information and are willing to report when they can get advise. Of the total of 111 consultancies over the 48 registration days, 52 were related to zoonotic diseases or antimicrobial resistance. Most of the consultancies are on already confirmed pathogens or (multi)-resistant micro-organisms: potential transmission of Methicillin Resistant *Staphylococcus aureus* or MR-*Staphylococcus pseudintermedius* to humans, risk of transfer of Extended Spectrum Beta-Lactamases from animals to humans; information requests for risks and treatments of *Salmonella*, *Campylobacter*, *Borrelia*, *Giardia* and fungal infections. Two times specific questions on bite-incidents were presented. One of the remarkable 'upcoming' information requests is on the supposed potential reservoir of *Dientamoeba fragilis* in dogs and the transfer to humans. The reason for this emerging topic is not identified yet. The main conclusion is that an information point like the VMDC may act as a registration desk like the *Veekijker* for large animal practitioners.

8. ***Insurance databases in equine research and syndromic surveillance***
   In the veterinary field, the ideal situation, *i.e.* a large primary, active database with currently recorded, up-to-date information on all individuals and disease events in the population will rarely be accomplished. In Sweden, knowledge on disease occurrence in the equine population was also lacking. Therefore Johanna Penell has recently delivered a doctoral thesis on the usefulness of secondary data (data not produced primarily for research) to investigate disease occurrence in populations without primary data collection. In Sweden there is a rather unique situation in that 75% of the horse population is insured, and that there is also a nation-wide clinic database including information on all visits to a network of equine clinics (n=25). Also the use of a diagnostic registry for recording diagnostic information aims at standardizing the diagnostic information, similar to that in the insurance database (where recording of diagnoses is based on the same registry).
   The data quality in one insurance database and one database from a national equine clinic network was evaluated. For diagnostic information, the agreement in insurance data was 84% whereas the completeness (proportion of problems in the clinical records recorded in the database) and correctness (proportion of recorded disease events in the database truly occurring) of clinic data was 91% and 92%, respectively. The data quality in both databases was found adequate for research purposes, with due consideration of variation in data quality among

Table 2: Pathogens selected from the EZIP list capable to infect companion animals and horses with the syndrome.

Clinical symptom and endogenous in the Netherlands	Infected species	Predominant syndrome
Chlamydophila psittaci	avian	respiratory
Q fever	cat/dog	abortion?
E coli shigatixon	cat/dog	gastro-intestinal
Salmonella (multiresistant strains)	cat/dog/horse/reptile	gastro-intestinal
Leptospira interrogans	Dog/horse	systemic
Cowpox virus	cat/rat	cutaneous
Giardia lamblia/duodenalis	cat/dog	gastro-intestinal
European bat lyssa virus	cat/dog	neurological
Yersinia enterocolitica	mammals	gastro-intestinal
Anaplasma phagocytophila	horse	systemic
Mycobacterium avium	avian	Respiratory
Pasteurella multocida	cat/dog	Respiratory
Borrelia spp.	dog	systemic/locomotion
Staphylococcus aureus methicilline resistant (MRSA)	horse	Superficial infections (skin lesions, surgery)
Toxocara canis	dog	no clinical syndrom/gastro-intestinal
Influenza A virus (avian)H5N1	avian	respiratory
Clostridium difficile	dog/horse	gastro-intestinal
Clinical symptom and exogenous in the Netherlands	**Infected species**	
Brucella suis	pets/horses	no clinical syndrom/abortion
Dirofilaria immitis	cat/dog	respiratory/circulation
Leishmania spp	dog/horse	cutaneous/systemic
West Nile	horse (dog)/avian	neurological
Classic rabies virus	cat/dog	neurological
Yersinia pestis	cat/rodent	systemic
Francisella tularensis	rabbit/rodent/(dog/cat subclinical)	systemic
Eastern equine encephalitis virus	horse	neurological
Venezuelan equine encephalitis virus	horse	neurological
Western equine encephalitis virus	horse	neurological
Burkholderia pseudomallei	horse	respiratory
Japanese encephalitis virus	horse	neurological
Borna virus disease	all mammalia	neurological
No clinical symptom and endogenous in the Netherlands	**Infected species**	
Bartonella hensela	cat	
Capnocytophaga canimorsus	dog	
Toxoplasma gondii	cat	
Echinococcus multilocularis	dog	
No clinical symptom and exogenous in the Netherlands	**Infected species**	
Echinococcus granulosus	dog	
Rickettsia slovaca	dog	
Rickettsia conorii	dog	
Tickborne encephalitis	dog	

disease problems. Presentation of disease indices from the two databases provided useful information on disease occurrence in horses throughout Sweden. The author stresses the fact that disease statistics need to be obtained from the specific population of interest.

Of course there are still deficiencies in the system for application in the framework of syndromic surveillance, for example lack of timeliness of data, lack of registration of symptoms (often only the diagnosis with for the insurance database only the possibility to enter one diagnosis instead of multiple diagnoses), but especially the clinic database could be used to monitor changes in disease patterns, health routines and treatment procedures over time in different horse categories in Sweden.

9. ***WNV surveillance 2009 in the equine population***

Halfway the vector season 2009 a surveillance study for WNV in horses was granted by VWS and CIb-RIVM, and carried out by GD. The surveillance consisted of an active component (testing equine blood samples

Table 3: Clinical symptoms in percentages and relative percentages (with respect to localisation) as registered on anamnestic forms submitted for WNV surveillance (n=17).

Clinical parameters	Normal	Low	High	Yes	No	Frontlegs	Hindlegs	Rump	Head
Temperature	53%	0%	47%						
Respiration	65%	0%	35%						
Pulse	59%	0%	41%						
Temperament	35%	53%	12%						
Appetence	59%	35%	6%						
Sight	76%	24%	0%						
Muscle tremors				41%	59%	100%	100%	14%	29%
Ataxia				88%	12%	53%	100%		
Paresis/paralysis				47%	53%	38%	100%		
Facialis paralysis				6%	94%				
Tooth grinding				18%	82%				
Colic				12%	88%				

submitted to GD for other reasons for antibodies against WNV in an anonymous way) and a passive component (practitioners were asked to submit blood samples from horses with neurological symptoms, samples were investigated for antibodies against WNV). This component started September 15th (as soon as the study was granted) and ended November 30th 2009, so a study duration of 2.5 months. Practitioners were also asked to submit anamnesis information, and most of them (n=19) did so. The symptoms registered are shown as an example in Table 3.

Although the table contains data from a limited number of submission, it illustrates that registration of neurological symptoms in (clinical) databases could provide highly relevant information with respect to the baseline situation in the Netherlands, and subsequently provide early detection signals for incursion of zoonotic emerging diseases (most of the diseases mentioned in Table 2 where horses are involved would invoke neurological symptoms).

Discussion

The first step in the analysis was the evaluation of the EZIP list for clinical symptoms in pets and horses as showing clinical symptoms was defined as a prerequisite to detect these pathogens by syndromic surveillance. The list shows that 39 of the 91 pathogens are capable to infect pets or horses. Eight of the pathogens do not induce clinical symptoms in dogs, cats and horses. The remaining 31 pathogens induce clinical symptoms in animals and could potentially be included in syndromic surveillance. The syndromes related to these diseases should be carefully defined when including in syndromic surveillance as weakly defined syndromes are one of the causes of 'false-positive' reports. They could be a considerable burden on the system and could absorb much capacity. Alternative elements in the syndromic surveillance as included in the human system (prescriptions and pharmacy, absenteeism) for detecting trends in diseases in pets and horses may be the prescription data. In veterinary health care there are no separate pharmacies but practices are prescribing medicines by themselves and keep their own database. A system that offers systematic collection of prescription data is the newly introduced VETCIS system. This database, introduced under the umbrella of the Royal Dutch Veterinary Association, is currently focussing on prescription-data of antimicrobials in large animal practice as requested by the Dutch Ministry of Agriculture, Fisheries and Food Quality. However, the system can also be used to collect data on medicine use in small animal practices and horses. However, as said, this system is currently under development in large animal practice and not generally accepted by small animal practice. For the more long term, this system offers great opportunities. Another source for syndromic data from companion animals and horses may be mortality data from small animal cemeteries, crematoria, and rendering plants, but the fraction of companion animals that are officially buried, cremated, or offered to rendering plants is that small that it is not a sensitive system. For horses data from rendering plants might be more relevant. Pathology data should also be incorporated. In the Netherlands a limited number of pathology facilities is available, mainly concentrated in FD and GD, but also in a number of private practices offering pathology services.

In registration systems, syndromes can be reported using standardized codes or, alternatively, using Natural Language Programming, an approach that convers symptoms and diagnosis mentioned in free-text into syndromic categories (Chapman et al., 2005a, 2005b; Hripcsak et al., 2009; South et al., 2007). However, to collect information from different veterinary practices, the software reporting systems need to be compatible. At the moment there are seven Practice Management Systems and the compatibility of these systems is poor. To come to introduction of syndromic surveillance by a tight network of practices, this item has to be centrally led. Comparable with the VETCIS system, there may be a role for the KNMvD.

The human syndromic surveillance systems has shown that local outbreaks will only be detected if the system has a high coverage. This means that many practices have to join the system and should be willing to report data. In the Netherlands there are 1250 veterinary practices of which 54% is companion animals, 5% horses, 3.5% companion animals and horses, 27% mixed and the remaining 11% registered as production animals only or 'other'. To determine the geographical coverage an in depth analysis has to be done but it may be clear that for a high coverage a considerable number of practices has to be included.

For large animal practitioners, the Animal Health Service has a system up and running (*Veekijker*) that serves as a contact point where unusual events can be reported. Practitioners are willing to contact and report because of the fact that they use the desk for expert-consultancy. In a selection of cases there may be even a follow-up (farm visit, lab analysis, pilot studies). This makes it attractive for practitioners to report. At the moment there is a lack of any reporting system for horses and pets. From a pilot at the VMDC it is clear that, when practitioners can get consultancies, they contact the expert-desk. Although the coverage of the VMDC desk is not analysed, in the past this lab has shown to detect alarming increases in methicillin resistance and ESBLs in companion animals. We therefore propose that on the short term a help-desk with an immediate consultancy option should be installed. With the introduction of this system we have to realize that it is important to have easily accessible, well structured and sustainable systems for registration and the capacity for trend analysis and expert follow-up. For horses a combined system with AHS, and Faculty of Veterinary Medicine can be imagined. For pets a system running at the Faculty of Veterinary Medicine is envisioned. In both cases it should not be restricted to infectious diseases.

In Sweden, there is a rather unique situation in that many companion animals and horses are insured, and insurance companies are cooperative in sharing their databases for research purposes. Also a nation-wide clinic database exists including information on all visits to networks of clinics. Since the data quality in both databases was found adequate, disease indices from the two databases provided useful information on disease occurrence. The system could be explored as a potential model for future syndromic surveillance in the Netherlands. Also in Sweden, however, lack of timeliness of data, and lack of registration of symptoms (often only the final diagnosis, therapy and prescription of medicines are registered) are still pitfalls for a strong syndromic surveillance system.

The SAVSNET surveillance project in the United Kingdom was created and financially supported by a broad consortium of different stakeholders from government (DEFRA, NOAH), private animal health organizations (AHT), veterinarian organizations (BSAVA), and pharmaceutical industries (Pfizer, Intervet Schering Plough, Dechra, Merial, Virbac, Vetsolutions, Novartis). Apart from funding, such a broad consortium holds the advantage that the most relevant stakeholders are represented and can carry the message out to their clients and members.

Recommendations

1. To report and register unusual clinical cases and events in horses and companion animals to a 'helpdesk' that should be installed on short term as any system is lacking at the moment. Cases are evaluated and follow-up can be given.
2. To evaluate thoroughly the Swedish clinical registration system and the SAVSNET surveillance system for implementation in pet and horse clinics and assess the usefulness of the VetCIS system for syndromic surveillance, and – alternatively – the implications and costs of adopting the Swedish clinical registration system.
3. A syndromic surveillance system for companion animals and horses will have added value. Although the data collection and communication of practice management systems show gaps, a retrospective data-analysis will show the power and limitations of the current system. This retrospective study can be followed by a pilot syndromic surveillance study with a limited number of practices.
4. A next step could be to perform a cost-benefit analysis, based on the experiences in the human field with sentinel GP stations, and the experiences in Sweden for companion animals and horses. Evidentially, that the cost analysis will be the most easy part, since benefits can only be evaluated after a pilot study with a network of practices for a couple of years.

References for further reading

1. Balter S, Weiss D, Hanson H, Reddy V, Das D, Heffernan R. Three years of emergency department gastrointestinal syndromic surveillance in New York City: what have we found? MMWR Morb Mortal Wkly Rep 2005 ;54 Suppl:175-80.
2. Bourgeois FT, Olson KL, Brownstein JS, McAdam AJ, Mandl KD. Validation of syndromic surveillance for respiratory infections. Ann Emerg Med 2006;47:265. e1.
3. Buckeridge DL. Outbreak detection through automated surveillance: A review of the determinants of detection. J Biomed Inform 2007;40:370-9.
4. Buehler JW, Berkelman RL, Hartley DM, Peters CJ. Syndromic surveillance and bioterrorism-related epidemics. Emerg Infect Dis 2003;9:1197-204.
5. Chapman WW, Christensen LM, Wagner MM, Haug PJ, Ivanov O, Dowling JN, et al. Classifying free-text triage chief complaints into syndromic categories with natural language processing. Artif Intell Med 2005;33:31-40.

6. Chapman WW, Dowling JN, Wagner MM. Classification of emergency department chief complaints into 7 syndromes: a retrospective analysis of 527,228 patients. Ann Emerg Med 2005; 46(5):445-55.
7. Cooper DL, Smith GE, Chinemana F, Joseph C, Loveridge P, Sebastionpillai P, et al. Linking syndromic surveillance with virological self-sampling. Epidemiol Infect 2008;136:222-4.
8. Cooper DL, Smith GE, Edmunds WJ, Joseph C, Gerard E, George RC. The contribution of respiratory pathogens to the seasonality of NHS Direct calls. J Infect 2007;55:240-8.
9. Cooper DL, Smith GE, Regan M, Large S, Groenewegen P. Tracking the spatial diffusion of influenza and norovirus using telehealth data: a spatio-temporal analysis of syndromic data. BMC Med 2008;6:16.
10. Egenvall A, Nødtvedt A, Penell J, Gunnarsson L, Bonnett BN. Insurance data for research in companion animals: benefits and limitations. Acta Vet Scand. 2009 Oct 29;51:42.
11. Egenvall A, Penell J, Bonnett BN, Blix J, Pringle J. Demographics and costs of colic in Swedish horses. J Vet Intern Med. 2008 Jul-Aug;22(4):1029-37.
12. Egenvall A, Penell JC, Bonnett BN, Olson P, Pringle J. Mortality of Swedish horses with complete life insurance between 1997 and 2000: variations with sex, age, breed and diagnosis. Vet Rec. 2006 Mar 25;158(12):397-406.
13. Egenvall A, Penell JC, Bonnett BN, Olson P, Pringle J. Morbidity of Swedish horses insured for veterinary care between 1997 and 2000: variations with age, sex, breed and location. Vet Rec. 2005 Oct 8;157(15):436-43.
14. Flamand C, Larrieu S, Couvy F, Jouves B, Josseran L, Filleul L. Validation of a syndromic surveillance system using a general practitioner house calls network, Bordeaux, France. Euro Surveill 2008;13.
15. Heffernan R, Mostashari F, Das D, Karpati A, Kuldorff M, Weiss D. Syndromic surveillance in public health practice, New York City. Emerg Infect Dis 2004;10:858-64.
16. Hope K, Durrheim DN, d'Espaignet ET, Dalton C. Syndromic Surveillance: is it a useful tool for local outbreak detection? J Epidemiol Community Health 2006;60:374-5.
17. Hripcsak G, Soulakis ND, Li L, Morrison FP, Lai AM, Friedman C et al. Syndromic surveillance using ambulatory electronic health records. J Am Med Inform Assoc 2009; 16(3):354-61.
18. Kaufmann AF, Meltzer MI, Schmid GP. The economic impact of a bioterrorist attack: are prevention and postattack intervention programs justifiable? Emerg Infect Dis 1997;3:83-94.
19. Penell JC, Bonnett BN, Pringle J, Egenvall A. Validation of computerized diagnostic information in a clinical database from a national equine clinic network. Acta Vet Scand. 2009 Dec 10;51:50.
20. Penell JC, Egenvall A, Bonnett BN, Pringle J. Validation of computerized Swedish horse insurance data against veterinary clinical records. Prev Vet Med. 2007 Dec 14;82(3-4):236-51.
21. Penell JC, Egenvall A, Bonnett BN, Olson P, Pringle J. Specific causes of morbidity among Swedish horses insured for veterinary care between 1997 and 2000. Vet Rec. 2005 Oct 15;157(16):470-7.
22. Reingold A. If syndromic surveillance is the answer, what is the question? Biosecur Bioterror 2003;1:77-81.
23. Rockx B, Asten LV, Wijngaard CV, Godeke GJ, Goehring L, Vennema H, et al. Syndromic surveillance in the Netherlands for the early detection of west nile virus epidemics. Vector Borne Zoonotic Dis 2006;6:161-9.
24. Rodriguez VA, Silverman ME, Cochrane DG, Eskin B, Ohman-Strickland P, Rothman J, et al. Biosurveillance of ED visits for gastroenteritis. Am J Emerg Med 2007;25:535-9.
25. Smith G, Hippisley-Cox J, Harcourt S, Heaps M, Painter M, Porter A , et al. Developing a national primary care-based early warning system for health protection--a surveillance tool for the future? Analysis of routinely collected data. J Public Health (Oxf) 2007;29:75-82.
26. South BR, Gundlapalli AV, Phansalkar S, Shen S, Delisle S, Perl T et al. Automated detection of GI syndrome using structured and non-structured data from the VA EMR. Advances Dis Surveill 2007; 4(62).
27. Stoto MA, Schonlau M, Mariano LT. Syndromic Surveillance: Is it Worth the Effort? *Chance* 2004;17 :19-24.
28. Van den Wijngaard C, van Asten L, van Pelt W, Nagelkerke NJ, Verheij R, de Neeling AJ, et al. Validation of syndromic surveillance for respiratory pathogen activity. Emerg Infect Dis 2008;14:917-25.
29. Van den Wijngaard CC, van Asten L, van Vliet JA, van Pelt W, Koopmans M. [Syndromic surveillance for the detection of outbreaks of unusual infectious diseases]. Ned Tijdschr Geneeskd 2005;149:2243-5.
30. Vergu E, Grais RF, Sarter H, Fagot JP, Lambert B, Valleron AJ, et al. Medication sales and syndromic surveillance, France. Emerg Infect Dis 2006;12:416-21.

Appendix 3
Information- and priority setting system of emerging zoonoses

Project leader
A.H. Havelaar, CIb-RIVM

Project team
M.A.H. Braks, M. Langelaar, D. Notermans,
J. van der Giessen, T. Kortbeek, D. Beaujean, CIb-RIVM
J. Selier, EMI-RIVM
F. van Rosse, J.A. Heesterbeek, B. Berends, UU
D. Kurowicka, R.M. Cooke, TU-Delft
F. van Zijderveld, CVI-WUR
E. Boekhorst, C. van Woerkum, J. de Jonge, L. Frewer, Management, Economische & Consumenten Studies, WUR

Collaboration
Various partners within and outside the EmZoo consortium carried out the project. The priority-setting model was developed in a close collaboration between RIVM and UU, while TU-Delft developed the mathematical methods for data analysis. Experts of RIVM, UU en CVI were involved in the validation of the database for the priority setting model. An interactive website was developed in collaboration with EMI-RIVM. A literature survey into risk perception of emerging zoonoses was executed by MEC-WUR.

Samenvatting
De doelstelling van dit project was het prioriteren van emerging zoönotische pathogenen ten behoeve van early warning en surveillance, en het ontwikkelen van een internet gebaseerd informatiesysteem dat een interactieve toegang biedt tot het prioriteringsmodel. Prioritering was gebaseerd op een multi-criteria analyse, waarbij alle in het EmZoo project opgenomen pathogenen werden geëvalueerd ten aanzien van de volgende attributen:

- Kans op introductie in Nederland;
- Verspreiding in het dier reservoir;
- Economische schade in het dier reservoir;
- Dier-mens overdracht;
- Transmissie tussen mensen;
- Morbiditeit en
- Mortaliteit.

Weegfactoren voor deze attributen werden gebaseerd op een panel sessie met beleidsmedewerkers, specialisten in infectieziektebestrijding en medische en veterinaire studenten, en werden berekend met behulp van een wiskundige methode die bekend staat als probabilistische inversie. De gewogen scores van alle pathogenen, met bijbehorende onzekerheid, werden gepresenteerd als de basis voor prioritering. Pathogenen met de hoogste risico scores omvatten pathogenen van landbouwhuisdieren met een hoge actuele humane ziektelast (b.v. *Campylobacter* spp., *Toxoplasma gondii*, *Coxiella burnetii*), een huidig lage maar historisch hoge ziektelast (b.v. *Mycobacterium bovis*), zeldzaam voorkomende zoönotische pathogenen in (landbouw)huisdieren die ernstige ziekteverschijnselen bij de mens kunnen veroorzaken (b.v. BSE prion, *Capnocytophaga canimorsus*) en pathogenen die zijn geasocieerd met arthropoden of wilde dieren die in de toekomst een groot risico kunnen veroorzaken (b.v. Japans encefalitis virus and West-Nijl virus).

Summary
The aim of this project was to prioritize emerging zoonotic pathogens in the Netherlands for early warning and surveillance, and to develop a web-based information system that also allows interactive access to the priority setting model.
Priority setting was based on a multi-criteria analysis, in which all pathogens included in the EmZoo project were evaluated against the following attributes:

- Probability of introduction into the Netherlands;
- Transmission in animal reservoirs;
- Economic damage in animal reservoirs;
- Animal-human transmission;
- Transmission between humans;
- Morbidity and
- Mortality.

Weights for these attributes were based on panel sessions with policy makers, infectious disease control specialists and medical and veterinary students, and were calculated using a mathematical technique known as probabilistic inversion. The weighted scores of all pathogens, including the attendant uncertainty, were presented as the basis for priority setting. Pathogens with the highest level of risk included pathogens in the livestock reservoir with a high actual human disease burden (e.g. *Campylobacter* spp., *Toxoplasma gondii*, *Coxiella burnetii*) or a low current but higher historic burden (e.g. *Mycobacterium bovis*), rare zoonotic pathogens in livestock or domestic animals with severe disease manifestations in humans (e.g. BSE prion, *Capnocytophaga canimorsus*) as well as arthropod-borne and wildlife associated pathogens which may pose a severe risk in future (e.g. Japanese encephalitis virus and West-Nile virus).
There were considerable uncertainties in the assessment of pathogens against the seven attributes listed above, and this

uncertainty is reflected in the risk scores. This may guide future research and data collection activities.The priority setting system was developed as a flexible tool, in which new information on currently included pathogens can be readily included. Furthermore, new pathogens can be added if they can be evaluated on the seven attributes.

The Emerging Zoonoses Information and Priority system (EZIPs) is a website that aims to inform professionals in zoonoses research, risk assessment and risk management. EZIPs offers a database with descriptive information on the pathogens, in several categories: Taxonomy, Human and Animal Disease, Reservoirs, Transmission, and Geographical distribution. In addition to the descriptive information, users can access all details of the priority setting model and may change several aspects of the model, to allow evaluation of the robustness of the model results, and to evaluate the impact of future information. Interactive aspects including the use of weights, and the levels assigned to different attributes. Users can also enter a new pathogen and compare it's ranking to those in the database.

The current priority setting model is based on epidemiological criteria. Risk perception, which is another important aspect for decision making, is not accounted for. An essay was produced that describes different theories of risk perception, and how these may apply to emerging zoonoses.

Introduction

In the first phase of the EmZoo project, a database was built with information on 92 emerging zoonotic pathogens that were selected by the consortium. In addition, a quantitative priority setting method was developed and a first panel session to determine the weight of the selected criteria was held. Both activities were described in detail in the report of the first phase, March 2008.

Information on the selected zoonotic pathogens needed to be completed and partly validated. In addition, the effect of uncertainties on both the scores and the weights also needed to be taken into consideration In addition, to accommodate the need of professionals (researchers, policy makers) to access and assess the database information, an interactive web application needed to build.

The priority setting method applied in the first phase was new and not fully developed yet. In the second phase the method was evaluated, further developed and improvements were implemented.

Material and methods

The project consisted of the following elements.

I. Information system

a. To draw up a program of demands for the information system. In consultation with researchers and the project Supervisory Committee it was decided to build a web application.
b. To build a proto type information system and finalize the validation of the information from the first phase.
c. To perform a users test.
d. To launch a prototype.
e. To develop a user guide.
f. To implement improvements and incorporate information from second phase.

II. Priority setting

The quantitative method of priority setting is further developed according the following phases:

a. Evaluation
   Interviews were held with concerned parties each with special roles: researchers, technical experts, participants of panel sessions, members of the Supervisory Committee. The acquired information was used to guide the further development of the model.
b. Reformulation the scientific criteria and their operationalization.
   In the first phase 9 scientific criteria were formulated, each with decision rules and a limited number classes to assign a score to each zoonotic pathogen on the list. Considering the results of the evaluation a new set of 7 criteria was formulated. The decision rules were also critically evaluated and when necessary improved.
c. Panel sessions
   New panel sessions with different groups of participants were organized to determine the weights of the new set of seven criteria. In principle, the set up of the panel sessions was similar to those in the first phase,
d. Data analyses
   Data acquired from the panel sessions were analyzed using a method for probabilistic inversion developed by the TU Delft and converted into weight factors for the criteria.
e. Gathering of additional information and validation of the database of the zoonotic pathogens as developed in phase 1.
f. Integration
   Data acquired were integrated, which resulted in a new ranking of the zoonotic pathogen on the list with respect to their threat for the public health in the Netherlands. Uncertainties in scores could be revealed quantitatively.

III. Development of a proxy for risk perception.

In the first phase, risk perception was one of the nine criteria used in the priority setting method, which did not do justice to the importance of perception in the risk management, and conceal the specific meaning of perception in risk management. For this reason, this issue received special attention in the second phase.

Results

The results are described in several separate reports, which are separately available for the assigning authority (LNV), but will not be made public. In case of acceptance, a paper will be published in a peer-reviewed scientific journal (Annex 1). In the following the titles and summaries of the reports are given.

Milou Toetenel. Surveillance and response systems for infectious diseases and the validation and improvement of the priority setting of emerging zoonoses MSc thesis, Wageningen University June 2008.

The National Institute for Public Health and Environment (RIVM) coordinates a two-year research project about Emerging Zoonoses (EmZoo project). One of the aims of the project is to compile and prioritize a list of the most relevant zoonoses that might emerge in The Netherlands. A list of 92 zoonotic pathogens has been compiled and prioritized by experts. Nine criteria per zoonotic pathogen were defined that describe their threat/severity. The values of the criteria per pathogen were determined. The weight of each criterion in the priority setting process was determined using a panel session. The validation of and improvements to the priority setting method are described in the second part of this report. Validation showed that the values assigned by the experts to the criteria, were not objective. Therefore, to use additional information for the pathogens, new values to the criteria were assigned by the student (M.T.). This information was included in the model. Unfortunately, not all information necessary was available. As a result, not an exact value but a range of values was assigned to some criteria. A new prioritized list was made using Monte Carlo simulation. In addition, nearly no information in literature could be found for criterion four. Since this gave rise to a large amount of uncertainty in the end result, this criterion was modified into another criterion that describes the essence but, for which more information was available. This modification resulted in a different prioritized list. To keep in mind, the weight assigned to the original criterion in panel sessions is not of value anymore now the criterion has been modified. At last, by using Monte Carlo simulation, the variable weight factors for each criterion were included in the model to produce a more realistic normalized list.
Multivariate analysis showed which criterion influences the final ranking the most and which interactions between the criteria are present. A comparison made between weighted and unweighted scores showed that the weight factors do affect the ranking. Comparing the new ranking with the one the experts made, showed that the new ranking is a little different.The different systems explained in this report and the final prioritized list give an overview of workable organizations, the measures taken in case of an outbreak and for which zoonotic pathogens these measures have to be effective.

Marieta A.H. Braks , Floor van Rosse, Catalin Bucura, Milou Toetenel, Juanita A. Haagsma, Dorota Kurowicka, J. (Hans) A.P. Heesterbeek, Merel F.M. Langelaar, Roger M. Cooke and Arie H. Havelaar. Prioritizing emerging zoonoses in the Netherlands. Manuscript submitted for publication and attached in the Annex.

To support the development of early warning and surveillance of emerging zoonotic pathogens in the Netherlands, a quantitative, stochastic multi-criteria model was developed. The threat level was based on seven criteria, reflecting the epidemiology and impact of these pathogens on society. Criteria were weighed, based on the preferences of a panel of judges with a background in infectious disease control.
Pathogens with the highest level of threat included pathogens in the livestock reservoir with a high actual burden (e.g. *Campylobacter* spp., *Toxoplasma gondii*, *Coxiella burnetii* or or a low current but higher historic burden (e.g. BSE prion, *Mycobacterium bovis*), rare zoonotic pathogens in domestic animals with severe manifestations (e.g. *Capnocytophaga canimorsus*) as well arthropod-borne and wildlife associated pathogens which may pose a severe threat in future (e.g. Japanese encephalitis virus and West-Nile virus).

Floor van Rosse. Evaluation and improvement of the EmZoo model to prioritize emerging zoonoses MSc thesis, Utrecht University, July 2009.

Introduction
In 2006, the Ministry of Agriculture asked the Netherlands Centre for Infectious Disease Control to coordinate a research program with the aim to make an inventory of early warning systems for zoonoses in the Netherlands and to prioritize most threatening emerging zoonoses for the Netherlands. Prioritization of pathogens was done with a Multi Criteria Analysis. Nine criteria were defined, 92 pathogens were scored with help of decision rules belonging to criteria, weights were assessed in a panel session with 11 policymakers, and data were aggregated. The interim result showed a promising method to prioritize emerging zoonoses, but also showed a lack of face-validity. The aim of this research project is to evaluate and –where necessary- improve the EmZoo model to prioritize emerging zoonoses.

Phase 1- Evaluation
To investigate whether criteria, decision rules, or the derivation of weights need improvement, interviews were held with 13 people who played different roles in the project. Also literature on prioritizing methods, another MSc thesis on the EmZoo project, and results from a questionnaire handed out after the panel session to derive weights were used for evaluation. Evaluation resulted in a list of future improvements: Two of the nine criteria should be reconsidered, criteria that describe spreading of a pathogen should be re-designed, and discrimination within the different criteria should be checked. Scores for new designed criteria should be derived again, while scores for criteria that do not change should be checked again. New weights should be derived with panel sessions with different groups of people.

Phase 2- Improvement
Two criteria were removed, some criteria outcomes and/or decision rules were changed somewhat, and spreading criteria were designed again. Panel sessions were conducted with a group of students, a group of policymakers, and a group of infectious disease specialists. Participants prioritized five sets of seven scenarios. Scenarios existed of hypothetical pathogens with different values for each criterion. Scenarios did not majorize each other, which means that participants had to choose some criteria to be more important than other ones. Data were analyzed at Delft University with the probabilistic inversion method. Different variants of analysis were explored. The variant with the least error of fit was chosen for conducting the main analysis. New weights were calculated. In data aggregation, uncertainties in scores were taken into account and were shown as error bars in the graph with the end scores of all 92 pathogens

Discussion
The EmZoo method to prioritize emerging zoonoses has been improved; face validity of the results improved. Nevertheless some more improvements could be made in future: Criteria to define spread of a pathogen were hard to design because information about parameters to define spread is lacking for several pathogens.

Elisa Boekhorst. Predicting Risk perception of Emerging Zoonoses. MSc thesis Wageningen Universiteit, maart 2010.

Background
The planning of effective public health surveillance of zoonoses starts with prioritization of risks. In risk prioritization, risk perception has gained momentum and on top of an epidemiological risk estimation of emerging zoonoses the EmZoo research group considers the application of public risk perception measurement an important aspect.

Purpose
Apart from exploring the current understanding of risk perception, the aim of this essay is to give a reasoned argumentation explaining why certain aspects are more relevant for surveillance of risk perception specifically for emerging zoonoses.

Method
This essay reviews the applicability of four theories; the psychometric paradigm, the social amplification of risk framework, the health belief model and finally the protection motivation theory, that can be used to measure the public risk perception in view of the specificities of emerging zoonoses. Comparing these four established theories and assessing their application possibilities for emerging zoonoses.

Results
Three aspects of risk perception of zoonoses; lack of knowledge, the multisectoral interests and information and fear, seem to be most important and should somehow be implemented in any application of measuring risk perception of emerging zoonoses. Besides the method and critics on the four theories these aspects the SARF seems to include most aspects that might be of relevance for risk perception of emerging zoonoses. The usability of this model is however limited, it might be to complicated to make operational. The psychometric paradigm is less detailed and needs limited adoption of variables. It gives however limited insight in other influencing factors besides the level of knowledge and the severity of the hazard. Both the PMT and the HBM give a framework and potential variables, they focus however to a large extent on the actual behaviour and usually measure risk perception after a certain risk is already known. Little is known about the application for estimation beforehand. This is also the case for the SARF, since what influences ripple effects is considered so dynamic, very limited research has tried to predict this aspect.

Conclusions
Some limitations have been indicated in all four models. None of the models seems to be fit directly to be used in public risk perception surveillance of emerging zoonoses. In all cases variables need to be adapted or developed.

The website EZIPs (Emerging Zoonoses information and Priority system) is avaialble as a prototype via ww.rivm.nl/ezips. A decision on broader accesabilty needs to be taken in consultation with consortium partners and client. Several aspects are relevant in this respect. It is not advisable to continue hosting EZIPs on the RIVM site bacause this does not do justice to the fact that the system was developed by a consortium. Alternative possibilities need to be considered, taking into account costs, maintenance and availability. An additional budget will be needed. Within the EmZoo project there was not sufficient budget to implement the newly developed help text. Furthermore, neither the final results of the priority setting model nor the validated database are implemented in the current prototype. In addition to one-time costs for updating, annual costs for maintenance need to be considered (see Annex 2).

Conclusions

1. The risk of emerging zoonotic pathogens, as ranked using a set of seven comprehensive criteria, differs considerably and the ranking can be used for decision making.
2. The pathogens with the highest ranks include pathogens in the livestock reservoir with a high actual burden (e.g. *Campylobacter* spp., *Toxoplasma gondii*, *Coxiella burnetii*) or a low current but higher historic burden (e.g. *Mycobacterium bovis*), rare zoonotic pathogens in domestic animals with severe manifestations (e.g. BSE prion, *Capnocytophaga canimorsus*) as well as arthropod-borne and wildlife associated pathogens which may pose a severe threat in future (e.g. Japanese encephalitis virus and West-Nile virus).

Recommendation

Maintenance of the EZIPs website and priority setting model to include new information and emerging pathogens.

Related projects

The results of this research is used in Appendix 1b.

Output

See also Report in Result section
DISCONTOOLS WP2 meeting Brussels, Belgium, October 2008, Oral presentation
International Meeting on Emerging Diseases and Surveillance IMED, Vienna Austria February 2009, Poster presentation
MedVetNet meeting Madrid, Spain June 2009 Poster Presentation
Vectors without borders. Int. Conference of Soc. Vector Ecology SOVE Antalya Turkey October 2009 Poster presentation
Dutch Assoc. of Medical Microbiologists (NVMM), Spring meeting Papendal April 2010 Papendal, Netherlands, Oral presentation
Emerging Diseases in a changing European eNvrironment (EDEN) final meeting, May 2010 Montpellier France. Poster Presentation

Annex 1

Paper submitted for publication:
Prioritizing emerging zoonoses in the Netherlands

Authors
Arie H. Havelaar, Floor van Rosse, Catalin Bucura, Milou A. Toetenel, Juanita A. Haagsma, Dorota Kurowicka, J. (Hans) A.P. Heesterbeek, Niko Speybroeck, Merel F.M. Langelaar, Joke W.B. van der Giessen, Roger M. Cooke and Marieta A.H. Braks

Author affiliations
National Institute for Public Health and the Environment, Bilthoven, the Netherlands (A.H. Havelaar, J.A. Haagsma, M.F.M. Langelaar, J.W.B. van der Giessen, M.A.H. Braks); Utrecht University, Utrecht, the Netherlands (A.H. Havelaar, F. van Rosse, J.A.P. Heesterbeek); Delft University of Technology, Delft, the Netherlands (C. Bucura, D. Kurowicka, R.M. Cooke); Wageningen University and Research Centre, Wageningen, the Netherlands (M.A. Toetenel), Institute of Tropical Medicine, Antwerp, Belgium and Institute of Health and Society, Université Catholique de Louvain, Brussels, Belgium (N. Speybroeck).

Abstract
To support the development of early warning and surveillance systems of emerging zoonoses, we present a general method to prioritize pathogens using a quantitative, stochastic multi-criteria model, parameterized for the Netherlands. A risk score was based on seven criteria, reflecting assessments of the epidemiology and impact of these pathogens on society. Criteria were weighed, based on the preferences of a panel of judges with a background in infectious disease control.

Pathogens with the highest risk for the Netherlands included pathogens in the livestock reservoir with a high actual human disease burden (e.g. *Campylobacter* spp., *Toxoplasma gondii*, *Coxiella burnetii*) or a low current but higher historic burden (e.g. *Mycobacterium bovis*), rare zoonotic pathogens in domestic animals with severe disease manifestations in humans (e.g. BSE prion, *Capnocytophaga canimorsus*) as well as arthropod-borne and wildlife associated pathogens which may pose a severe risk in future (e.g. Japanese encephalitis virus and West-Nile virus).

Introduction
Human health is threatened by a wide variety of pathogens transmitted from animals to humans. Effective and efficient policy-making requires focusing on the most relevant of these zoonoses. The HAIRS Group in the UK (1) has developed qualitative decision trees to assess the zoonotic potential of emerging diseases (2) and to classify the risk to public health, based on probability and impact of infection (3). In the Netherlands, a systematic approach for early warning and surveillance of emerging zoonoses and a blueprint for an efficient network of collaborators from the medical and veterinary professions to prevent and control emerging zoonoses are being developed by a consortium of national institutes in the EmZoo consortium. To support this task, a prioritized list of emerging zoonotic pathogens of relevance for the Netherlands was needed.

Priority setting is a multi-dimensional problem, in which technical information is often intertwined with value judgments. Traditionally, a priority setting procedure entails asking a limited number of experts to reach consensus. An example of this approach in the domain of emerging zoonoses has been published in France (4). This method is relatively straightforward, but not very transparent and the repeatability is low. Currently, semi-quantitative methods are frequently used in which criteria are divided into a limited number of classes (e.g. low, medium and high). Criteria may also be scored on arbitrary scales (e.g. 0, 1, …, 5), while scores for all criteria are aggregated to produce an overall score. An example of this approach was published in Belgium (5), and a similar approach was taken for animal diseases by McKenzie *et al*. (6) in New Zealand. Here, the transparency and the repeatability are improved, but the classes are chosen rather arbitrarily. Linear relations between the different classes of a criterion or between criteria are often assumed but are not supported by data. For the current project, the aim was to develop a quantitative method to rank emerging zoonoses using clearly interpretable criteria, expressed on natural numerical scales. Furthermore, weights were incorporated for these criteria, elicited by a systematic procedure from a panel of judges, independent from the authors or scientific experts in the project. The method was designed to simultaneously be the basis of a web-based knowledge management system.

- The quantitative method is based on the well-established multi-criteria analysis (MCA) method. This method has been used in many decision making contexts including animal health (7). MCA offer methods and techniques to structure complex decision-making.

After completing the different phases, information can be introduced or modified without the necessity to completely redo the analyses. This is especially valuable in the priority setting of emerging zoonoses, where information changes constantly.

Methods

Selection of pathogens
Of 1415 known species of human pathogens, there are 868 zoonotic pathogens (8), but only a limited number of them is considered relevant for the Netherlands.

Information from recent published studies on emerging zoonoses in the Netherlands (9) and from other European countries (4, 10-14) was taken into account. Furthermore, relevant information was gathered from signals of emerging zoonoses from internet sources of public health and veterinary organizations including the WHO, OIE, HPA and CDC and ProMED-mail[1]. In addition, expert members of the EmZoo consortium were invited to suggest additional pathogens. This process resulted in a long-list, including all pathogens (174) mentioned as emerging zoonoses in one of the sources mentioned above. Only pathogens with a proven zoonotic potential (2) were included in our final list. To condense the resulting long-list to a more manageable short-list, five additional decision rules were applied. A zoonotic pathogen was excluded from the list if:

- Non-human primate species form its only known reservoir. These reservoir species are not likely to occur as free ranging species in Europe and the pathogens have little public health significance other than very specific occupational risks, e.g. Simian foamy virus.
- Its specific only known reservoir species is absent in Europe, e.g. Sin nombre virus.
- Its vector (in case of a vector-borne zoonotic pathogen) family (not vector species) is absent in Europe, e.g. *Trypanosoma* spp.
- The zoonotic aspects of the disease are rare, e.g. *Sporothrix schenkii*.
- The zoonotic aspects involved a single species jump, e.g. new influenza H1N1 or HIV.

This analysis finally resulted in a short-list of 86 emerging zoonotic pathogens of relevance for the Netherlands (see database in Web-Annex 2), which are evaluated by the risk-ranking method.

Listing and structuring of criteria

We quantified the risk to public health of emerging zoonoses by applying seven criteria that covered the complete pathway from introduction to societal impact (Figure 1). All criteria were scored on a natural scale, and were divided into 4-5 levels; often covering several orders of magnitude in terms of effects (see Table1 and Web-Annex 1). For subsequent analysis, each class was represented by a point estimate, representing a central value in the range.

Evaluating pathogens on the selected criteria

Where possible, levels were assigned to pathogens based on published literature. Values were to reflect the current situation in the Netherlands, given the existing level of prevention and health care including vaccination and infrastructure (water supply, sewerage, food safety controls) *et cetera*. We, therefore, mainly used data from industrialized countries. For many pathogens currently available data were insufficient, and in those cases we tried to evaluate criteria using simple decision rules. In the absence of both sufficient data and decision rules, expert opinion was employed. All assignments were made from the societal perspective, i.e. the impact on all affected parties and sectors of economy was considered. Uncertainty was expressed by assigning a pathogen to more than one level.

Determining the weight of each criterion

Weights were based on panel sessions with different groups of participants, representing different segments of society:

(i) Risk managers from the Dutch Ministries of Agriculture and Public Health (n = 7);
(ii) Infectious disease specialists from medical microbiological laboratories and from regional public health services (n = 11)
(iii) Students in the medical and veterinary faculties of Utrecht University (n = 11).

Each panel session started with an explanation of the objectives and approaches of the project. Panel members were invited to comment on the approach and ask questions about any aspect. Discussion was specifically stimulated on the criteria and their scores, as ranking these was the core task of the panel members.

For the ranking exercise, five groups of seven scenarios were generated. Each scenario (designated by a two letter code, e.g. QJ) represented a hypothetical zoonotic agent, by randomly choosing a level for each criterion, subject to certain constraints: scenarios were chosen as not to 'majorize' each other (i.e. no scenario should have a higher risk level on all criteria than any other in the same set), and implausible scenarios (i.e. with low animal prevalence yet very high costs) were omitted. Each scenario was presented to the panel members on a small card (Figure 2). Panel members were asked to place the scenario that they considered to represent the lowest risk to the left of their table and the highest risk scenario to the right. They were then asked to arrange the remaining five scenarios in between these two extremes, in order of increasing risk. To alleviate potential effects of training and fatigue, the five groups of seven scenarios (denoted by G1, …., G5) were offered to one half of the panel members in the order G1, G3, G5, G4, G2 and to the other half in the order G3, G2, G4, G1, G5. Data were entered in a Microsoft Excel spreadsheet independently by two analysts, and any discordance was resolved by referring to the original data sheets.

Panel rankings were checked for consistency in two ways. Firstly, scenario group G2 included two scenarios that also occurred in G1, G3 contained two scenarios from G2 and so on. Consistency was evaluated by calculating the number of pairs that were ranked differently (with a maximum of 4). Secondly, all panel members received G2 again by (e-)mail

[1] ProMED-mail, the Program for Monitoring Emerging Diseases, is a program of the International Society for Infectious Diseases and is the global electronic reporting system for outbreaks of emerging infectious diseases & toxins, open to all sources.

two weeks after the session and were asked to re-rank the scenarios. Results were considered inconsistent if the rank of a scenario shifted two or more positions, and the number of inconsistencies (with a maximum of 30) were counted.

Data-analysis was carried out by probabilistic inversion, as fully described by Kurowicka *et al*. (15), and consisted of the following steps:

- Evaluation of randomness.
- Transformation of values (Table 1).
- Optimization of constraints.
- Main analysis (probabilistic inversion)

A simpler method to prioritize infectious diseases for surveillance was proposed by Krause *et al*. (16). To compare with our approach to elicit preference-based weights, panel members were also asked to directly assign a rank order to the seven criteria and mean ranks were calculated.

Aggregation of data

A linear model was applied, which combined the mean weights from the panel session with transformed values for all 86 zoonotic agents. The model calculates the score S_i of a pathogen as:

$$S_i = \sum_{j=1}^{7} B_j X_{ij}$$

where X_{ij} is the (transformed) value assigned to pathogen i on criterion j and B_j is the weight of criterion j.

These results were then normalized to a value between 0 and 1 by calculating the scores for the pathogen with the highest and lowest theoretical risk (i.e. for which the values on all criteria were at the highest or the lowest level).

Uncertainty in the transformed scores was included as discrete distributions with equal weights, and quantified by Monte Carlo simulation in @RISK Professional Version 5.0 (Palisade Corporation, Ithaca, NY USA), an add-in to Microsoft Excel.

Sensitivity analysis

To assess the impact of different model assumptions on the outcomes, several alternative scenarios were evaluated. These included:

- Equal weights. Instead of using the preference-based weights from the panel sessions, each criterion was assigned an equal weight.
- Semi-quantitative method. Instead of assigning a transformed value to each level as shown in Table 1, values of 1 … 5 were assigned to all criteria. Scores were calculated using equal weights.
- Deterministic model. An interactive website (Emerging Zoonoses Information and Priority system (EZIPs; http://ezips.rivm.nl) was developed that allows the user to change scores for any pathogen on each criterion to evaluate the possible impact of uncertain or modified information. It is also possible to compute scores with equal weights or to introduce a new pathogen and compare it with pathogens already in the database. For technical reasons, a stochastic model could not be implemented in the website and, therefore, uncertain values were replaced by single estimates. Single estimates were chosen so that the score was as close to the mean score from the stochastic model as possible. However, as there are only few levels per criterion, deviations could not be avoided. In addition to the results of the MCA, the website also contains descriptive information on all pathogens in 5 categories: Taxonomy, Human and Animal Disease, Reservoirs, Transmission, and Geographical distribution.

Cluster analysis

Based on an adapted version of the methodology used in Cardoen et al. (5), groups of different importance were identified by Classification and Regression Tree analysis (CART Version 6.0, Salford Systems, San Diego, California, USA (17)). As the normalized score is a continuous variable, we aim to obtain subgroups with minimal within group variance (grouping zoonoses with similar importance). Starting with all the pathogens the method will in first instance obtain a binary split into two groups (nodes) that are most homogeneous with respect to the normalized score. The two subgroups will then be further split so that the “purest” subgroups are obtained. The process is then continued until the nodes can not be further “purified” using a technique called cross-validation (18). In contrast with (5), we did not use the mean total scores per disease (i.e. one value per disease) as input, but the output of the Monte Carlo simulations. This accounts for the existing uncertainty in the normalized scores. The categorical variable comprising the names of the pathogens was used as a discrimination variable. In this way, Monte Carlo samples of the same pathogen were kept together in the different clusters of pathogens.

Results

Listing and structuring of criteria

Details of criteria are given in Table 1, a full description can be found in Web Annex 1, including decision rules for assigning levels in absence of data.

Evaluating pathogens on the selected criteria

A full table of scores of criteria of each of the 86 pathogens is presented in Web Annex 2.

Determining the weight of each criterion

An example of a group of randomly generated scenarios that were ranked in panel sessions is presented in Table 2. Results of the analysis of consistency are presented in Figure 3. The consistency between ranking in the panel session and the repetition after two weeks was good: 11 panel members did rank the scenarios in the same order in both sessions, and 10 provided only one answer that was not consistent with the previous ranking (Figure 3a). 6% of scores resulting from ranking the same group after two weeks were considered inconsistent, and no panel member scored more than 20% inconsistencies (Figure 3b). It was concluded that scores were sufficiently consistent to warrant further analysis. The results for group 1 (G1) are given in Table 3 as an example. Scenarios GF and WL represent the highest risk by the panel's opinion, while NW and QJ are considered to represent the lowest risk. Scenario VG is ranked as of medium risk, and there is considerable disagreement between the panel members on the risk of scenarios JR and ZC.

Including all signals in the model in which four or more panel members ranked the scenario at a particular position in the analysis (as indicated in Table 3 for G1) resulted in 51 constraints to be taken into account from the combined dataset of G1, G2 and G5. The scores of two out of five groups were not significantly different from random ordering and these groups were excluded from further analysis. The linear model was sufficient to reproduce the panel members' preferences.

Table 4 shows, for each criterion, the weights obtained and their standard deviation. Panel members considered the human case-fatality ratio and animal-human transmission the most important criteria, whereas they considered transmission between animals, human morbidity and economic damage in animals least important. The coefficient of variation (standard deviation / mean) varied between 14 and 28%, reflecting deviating opinions between panel members about the relative importance of criteria.

Table 4 compares the weights derived by probabilistic inversion with the simple ranking method as proposed by Krause *et al*. There is no significant correlation between both methods ($p = 0.29$, linear regression).

Aggregation of data

Figure 4 shows the results of combining in the linear model the levels per pathogen with the mean weights as described above. The distributions reflect the valuations of a random stakeholder, given uncertainty on criteria levels of the zoonoses. The model appears to have good discriminative power. Within the possible range for normalized scores of 1 to 0, there is a rather continuous decrease in normalized scores from 0.68 for the pathogen with the highest risk (Influenza A virus (avian) H5N1) to 0.15 for the pathogens with the lowest risk (Dhori virus). The error bars around the normalized scores reflect uncertainty about the epidemiological characteristics of the pathogens, which is particularly large for many exotic viruses. Note however that the uncertainty tends to be greater for pathogens with lower normalized scores. Inspection of Web Annex 2 shows that the greatest uncertainty was associated with criteria relating to transmission in the animal reservoir (C2) and from animals to humans (C4). There was little uncertainty in the transmission between humans (C5).

Sensitivity analysis

Figure 5 shows relatively good correlation between scores obtained with the baseline model using preference-based weights and an alternative model in which each criterion is given equal weight. Yet, even relatively small differences in scores may significantly affect the ranking of pathogens, as can be seen from a comparison of the top-25 pathogens according to both models (Table 5).

A comparison between the quantitative method proposed in this paper and the semi-quantitative method currently used by many authors showed that despite a general tendency for ranks to increase in parallel, the discriminative power of the quantitative method was much larger. The semi-quantitative method can only assign a discrete number of scores, whereas the quantitative method uses the full scale in a continuous manner. Rankings according to both methods may also be quite different (Figure 6). Most pathogens were ranked from five places lower to 15 places higher, but extremes from 16 places lower to 25 places higher did occur.

Cluster analysis

Three statistically different groups of importance were identified by CART and are indicated by (dashed) lines in Figure 4. The optimal number of subgroups was 29, but for the sake of practical use of the results, we report the three main clusters only. The clusters comprise 18, 28 and 40 pathogens, respectively. Splitting the tree further in e.g. five clusters subdivided the cluster with the lowest normalized scores and hence is not very informative for risk management purposes.

Among the first cluster including 18 pathogens with the highest normalized scores, there are one prion, 7 viruses, 9 bacteria and one protozoan parasite. 8 are already present in the Netherlands while 10 are not. Helminths are not represented in this group.

Compared to the results of the 600 Monte Carlo simulations only a slight difference was noted when doing the analysis with 200 Monte Carlo simulations (one pathogen shifted from one group to another). The results with 400 Monte Carlo simulations were exactly the same as the results of the 600 Monte Carlo simulations, indicating that the results were 600 simulations were more than sufficient.

Discussion

We describe a fully quantitative, stochastic method to rank the risk of emerging zoonotic pathogens for the Netherlands. The approach differs from several previously published methods. We decided to restrict the number of criteria. With higher numbers, it becomes increasingly complex to develop validated databases in which pathogens are assigned to multiple possible values. Furthermore, choosing between different scenarios as was done in our panel studies becomes less meaningful as respondents will only use a limited number of criteria to base their judgment on. By choosing criteria at a high level of integration, we do, however account for many criteria that are used in similar exercises, either explicitly by incorporating them in decision rules or implicitly in the transmission criteria.

In contrast to most current approaches, we scored our criteria using associated numerical scales, rather than non-informative *ad-hoc* scales. We suggest that our quantitative approach is less arbitrary in assigning values to possible levels that a criterion can take, and is therefore more realistic. We also introduce preference-based weights in the calculation of the pathogen scores. The weights are reflecting the preferences of a panel of decision makers, in our case professionals involved in infectious disease control. Our comparative analysis shows that using weights does affect ranking, but to a lesser extent than introducing numerical scales. We also found that our elaborate method of establishing weights through choice experiments provided weights that were very different from those obtained with a simple ranking exercise.

Assigning levels to the 86 pathogens on the short-list was found to be a difficult process that required several iterations involving literature studies and evaluation by pathogen-specific experts. Nevertheless, considerable uncertainty remains, part of which was expressed in uncertainty ranges around the normalized scores. By identifying the factors that contribute most to the uncertainty in quantified risk for pathogens with high normalized scores, these results can be used to prioritize additional data collection and analysis. The current method can easily be updated to incorporate new data in a transparent way. Furthermore, the web tool allows all users of the system to explore the impact of different value assignments in an interactive mode.

The pathogens with the highest score according to the baseline model would be proposed as priorities for risk management activities. Subdivision into smaller groups with different implications for risk management is suggested. This is illustrated by considering the 18 pathogens in the cluster with the highest normalized scores. A major subdivision is between pathogens already established in the Netherlands and pathogens that are not. Surveillance and risk management strategies are likely to be different for these categories.

The model for priority setting presented here is based on criteria reflecting the epidemiology and societal impact of zoonotic diseases. Risk perception by the general public is not included in this model, but may pose additional challenges to policy makers. Further work to include risk perception as a second dimension in the priority model is recommended.

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Conflicts of interest

None disclosed

Biographical sketch

Arie Havelaar, PhD MSc has a background in microbiology and epidemiology. His research interests focus on the application of quantitative methods, in particular risk assessment modeling, to support decision making in control of foodborne and zoonotic infections.

References

1. Walsh AL, Morgan D. Identifying hazards, assessing the risks. Vet Rec. 2005;157(22):684-7.
2. Palmer S, Brown D, Morgan D. Early qualitative risk assessment of the emerging zoonotic potential of animal diseases. BMJ. 2005;331(7527):1256-60.
3. Morgan D, Kirkbride H, Hewitt K, Said B, Walsh AL. Assessing the risk from emerging infections. Epidemiol Infect. 2009;137(11):1521-30.
4. Valenciano M. Définition des priorités dans le domaine des zoonoses non-alimentaires. Paris, France: Institut de Veille Sanitaire; 2001.
5. Cardoen S, Van Huffel X, Berkvens D, Quoilin S, Ducoffre G, Saegerman C, et al. Evidence-Based semiquantitative methodology for prioritization of foodborne zoonoses. Foodborne Pathog Dis. 2009;6(9):1083-96.
6. McKenzie J, Simpson H, Langstaff I. Development of methodology to prioritise wildlife pathogens for surveillance. Prev Vet Med. 2007;81(1-3):194-210.
7. Mourits M, Oude Lansink AGJM. Multi-criteria decision making to evaluate quarantaine disease control strategies. In: Oude Lansink AGJM, editor. New approaches to the economics of plant health. Heidelberg, Germany: Springer; 2007. p. 131-44.
8. Taylor LH, Latham SM, Woolhouse ME. Risk factors for human disease emergence. Philos Trans R Soc Lond B Biol Sci. 2001;356(1411):983-9.
9. Van der Giessen J, Isken LD, Tiemersma EW. Zoonoses in Europe: a risk to public health Bilthoven, the Netherlands: National Institute for Public Health and the Environment; 2004. Report No.: 330200002.
10. Vorou RM, Papavassiliou VG, Tsiodras S. Emerging zoonoses and vector-borne infections affecting humans in Europe. Epidemiol Infect. 2007;135(8):1231-47.

11. King LJ, Marano N, Hughes JM. New partnerships between animal health services and public health agencies. Rev Sci Tech. 2004;23(2):717-25.
12. Brown C. Emerging zoonoses and pathogens of public health significance - an overview. Rev Sci Tech. 2004 Aug;23(2):435-42.
13. Tait J, Meagher L, Lyall C, Suk J. Foresight. Infectious Diseases: preparing for the future. T2: Risk Analysis. London: Office of Science and Innovation; 2006.
14. Fauci AS. Emerging and reemerging infectious diseases: the perpetual challenge. Acad Med. 2005;80(12):1079-85.
15. Kurowicka D, Bucura C, Cooke R, Havelaar A. Probabilistic inversion in priority setting of emerging zoonoses. Risk Anal. 2010:e-pub ahead of print.
16. Krause G. Prioritisation of infectious diseases in public health - call for comments. Euro Surveill. 2008;13(40).
17. Steinberg D, Colla PL. CART: tree-structured non-parametric data analysis. San Diego, CA: Salford Systems; 1995.
18. Speybroeck N, Berkvens D, Mfoukou-Ntsakala A, Aerts M, Hens N, Van Huylenbroeck G, et al. Classification trees versus multinomial models in the analysis of urban farming systems in Central Africa. Agricultural Systems. 2004;80:133-49.

Table 1. Quantifying criteria to assess risk of emerging pathogens

Criterion	Description	Unit	Levels	Value (*x*)	Scaled value (*x'*)*	Transformed value (X)*
C1	Probability of introduction into the Netherlands	% / year	< 1	0.5	0.005	0.000
			1-9	5	0.05	0.435
			10-99	50	0.5	0.869
			100	100	1	1.000
C2	Transmission in animal reservoirs	Prevalence per 100,000 animals	< 1	0	0.0000001	0.000
			1-100	50	0.00005	0.386
			100-1,000	500	0.0005	0.528
			1,000-10,000	5,000	0.005	0.671
			> 10,000	50,000	0.1	0.857
C3	Economic damage in animal reservoirs	Million euro per year	<1	0.5	0.0005	0.000
			1-10	5	0.005	0.303
			10-100	50	0.05	0.606
			> 100	500	0.5	0.909
C4	Animal-human transmission	Prevalence per 100,000 humans	1-100	50	0.00005	0.000
			100-1,000	500	0.0005	0.233
			1,000-10,000	5,000	0.005	0.465
			>10,000	50,000	0.1	0.767
C5	Transmission between humans	Prevalence per 100,000 humans	< 1	0	0.0000001	0.000
			1-100	50	0.00005	0.386
			100-1,000	500	0.0005	0.528
			1,000-10,000	5,000	0.005	0.671
			> 10,000	50,000	0.1	0.857
C6	Morbidity (disability weight)	None	< 0.03	0.02	0.02	0.000
			0.03-0.1	0.06	0.06	0.281
			0.1-0.3	0.2	0.2	0.589
			> 0.3	0.6	0.6	0.869
C7	Mortality (case-fatality ratio)	%	0	0	0.0000001	0.000
			0-0.1	0.05	0.0005	0.528
			0.1-1	0.5	0.005	0.671
			1-10	5	0.05	0.814
			10-100	50	0.5	0.957

* Point estimates *x* were first scaled (*x'*) between 0 (best possible option) and 1 (worst possible option). C1, C6 and C7 are naturally bounded between 0 and 1; for C2, C4 and C5 a worst possible option of the prevalence of 100,000 per 100,000 was used. For C3, a worst possible option of 1,000 M€ was used. Best possible options of 0 were replaced by 0.0000001. Subsequently, transformed scores were calculated as $X = 1 - \log(x')/\log(x'_{ref})$, where x'_{ref} is the scaled score for the best possible option.

Table 2. Example of randomly generated scenarios (Group 1).

Code	QJ	VG	GF	JR	ZC	WL	NW
C1	5	50	50	0.5	50	50	50
C2	10	0.5	10	0.05	0.5	0.5	0.5
C3	50	50	5	50	50	50	50
C4	0.5	0.05	0.5	0.5	0.05	10	0.05
C5	0.5	10	0.5	10	0.05	0	0.05
C6	0.2	0.6	0.02	0.2	0.6	0.06	0.2
C7	5	0.5	50	50	5	50	0.5

The Table shows the code names of the seven randomly generated scenarios (QJ, VG, …) and the values assigned to each of the seven criteria (C1-C7, for details see Table 1).

Table 3. Example of results of ranking random scenarios within Group 1.

Rank	1st	2nd	3rd	4th	5th	6th	7th
QJ	2	**9**	**11**	4	2	0	1
VG	0	0	**5**	**7**	**11**	3	3
GF	0	0	0	**6**	**5**	**9**	**9**
JR	**7**	1	1	4	4	**7**	**5**
ZC	1	**10**	**8**	**6**	3	1	0
WL	2	1	1	1	4	**9**	**11**
NW	**17**	**8**	3	1	0	0	0

QJ-NW represent scenarios in Group 1 (see Table 2). 1st rank represents the scenarios with the lowest risk while 7th rank represents the scenarios with the highest risk. For example, scenario QJ was ranked as the lowest risk by 2 panel members. All rows and columns add up to 29, the total number of participants.

Results in bold (greater than 4) remain after elimination of weak signals to reduce the number of constraints for probabilistic inversion; hence the number of constraints is reduced from 49 to 16.

Table 4. Comparison between preference-based weights (this paper) and direct ranking (16).

	Preference-based weights		Direct ranking
	Mean weight	**SD**	**Mean rank**
C1	0.418	0.100	4.14
C2	0.292	0.040	2.41
C3	0.337	0.069	1.41
C4	0.626	0.103	5.22
C5	0.339	0.096	5.29
C6	0.181	0.028	4.45
C7	0.643	0.113	5.24

Table 5. Comparison of top-18 pathogens with highest risk according to normalized scores with preference-based or equal weights.

Rank	Preference based weights	Impact	Equal weights
1	Influenza A virus (avian) H5N1	=	Influenza A virus (avian) H5N1
2	*Toxoplasma gondii*	=	*Toxoplasma gondii*
3	Japanese encephalitis virus	=	Japanese encephalitis virus
4	*Campylobacter spp.*	↓↓	*Mycobacterium bovis*
5	*Mycobacterium bovis*	=	*Coxiella burnetii*
6	BSE prion	=	Rift Valley fever virus
7	*Coxiella burnetii*	=	*Streptococcus suis*
8	*Anaplasma phagocytophila*	↓↓	BSE prion
9	*Streptococcus suis*	=	*Yersinia pestis*
10	*Leptospira interrogans*	↓↓	Dobrava-Belgrade virus
11	West Nile virus	↓↓	*Capnocytophaga canimorsus*
12	Crimean-Congo hemorrhagic fever virus	⇓	*Campylobacter spp.*
13	Dobrava-Belgrade virus	↑↑	*Leptospira interrogans*
14	Rabies virus (classic)	⇓	*Anaplasma phagocytophila*
15	*Yersinia pestis*	↑↑	West Nile virus
16	Rift Valley fever virus	↑↑	*Mycobacterium avium*
17	*Capnocytophaga canimorsus*	↑↑	Eastern equine encephalitis virus
18	*Francisella tularensis*	⇓	California encephalitis virus

Legend

=	not more than 2 places up or down
↓↓	not more than 2 places up or down
↑↑	more than 2 places up
⇓	only in top 18 preference based weights
Bold	not in top 18 equal qweights

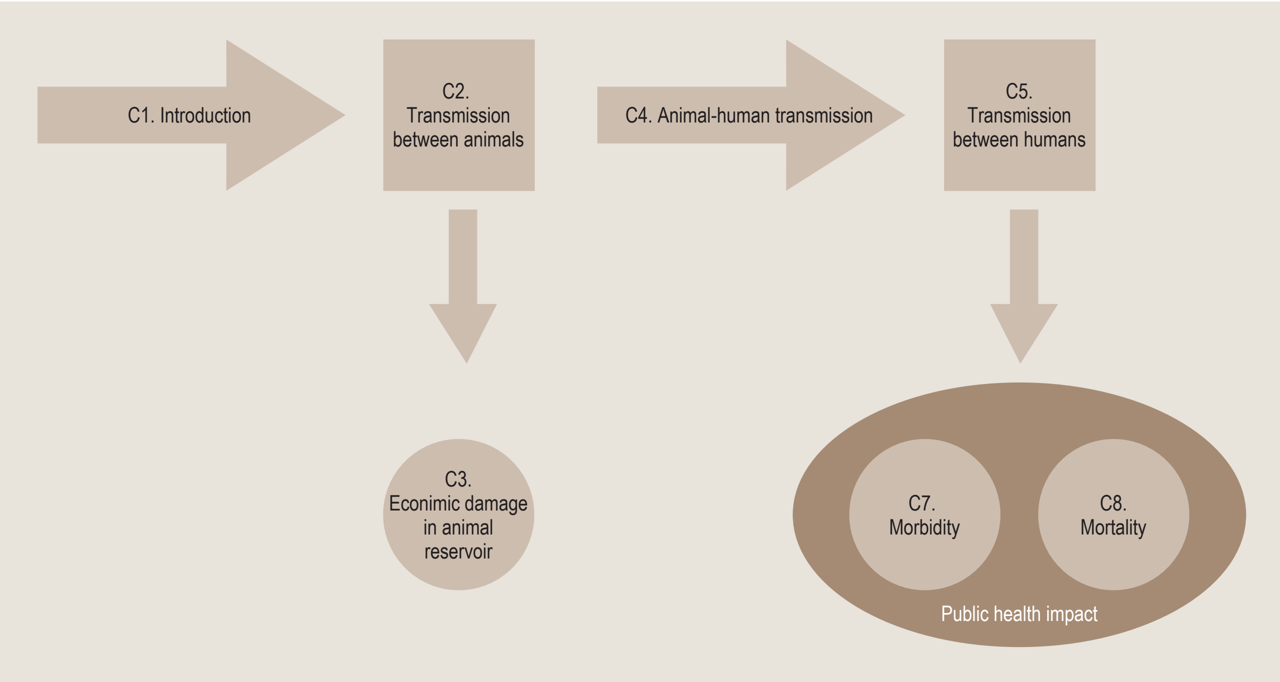


Figure 1. Flow chart of the pathway from introduction of a zoonotic pathogen to public health impact, represented by 7 criteria (C1-C7) from which the risk to public health of emerging zoonoses was derived.

		QJ
1.		*5*
2.		*10*
3.		*50*
4.		*0,5*
5.		*0,5*
6.		*0,2*
7.		*5*

Figure 2. Example of card of a a randomly generated scenario (QJ) used in the panel session to determine the relative weights of criteria. The numbers 1-7 represent the criteria C1-C7 (for details see Table 1).

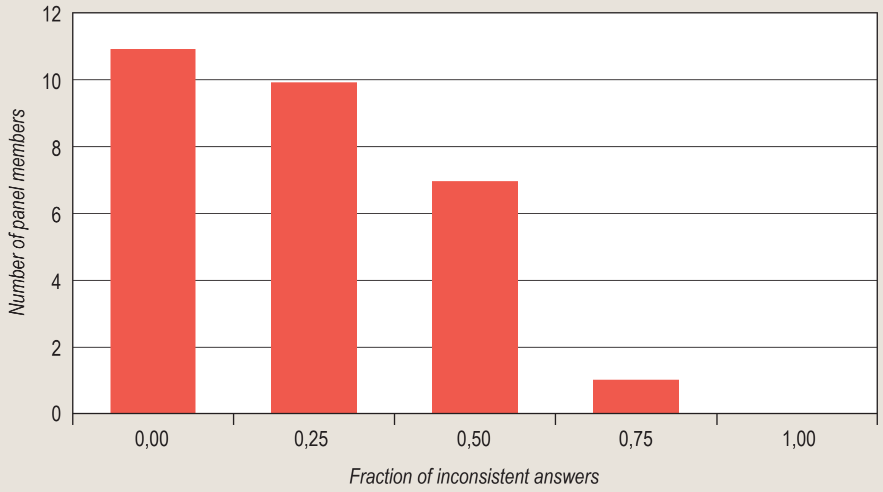
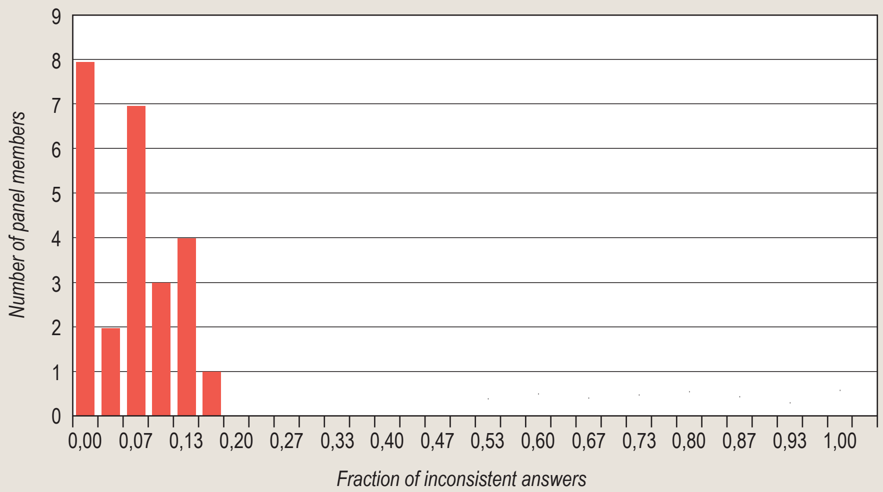


Figure 3. Results of the analysis of consistency in the ranking by the individual panel members.
a. Repeated pairs of scenarios.



b. Repeated group after 2 weeks.

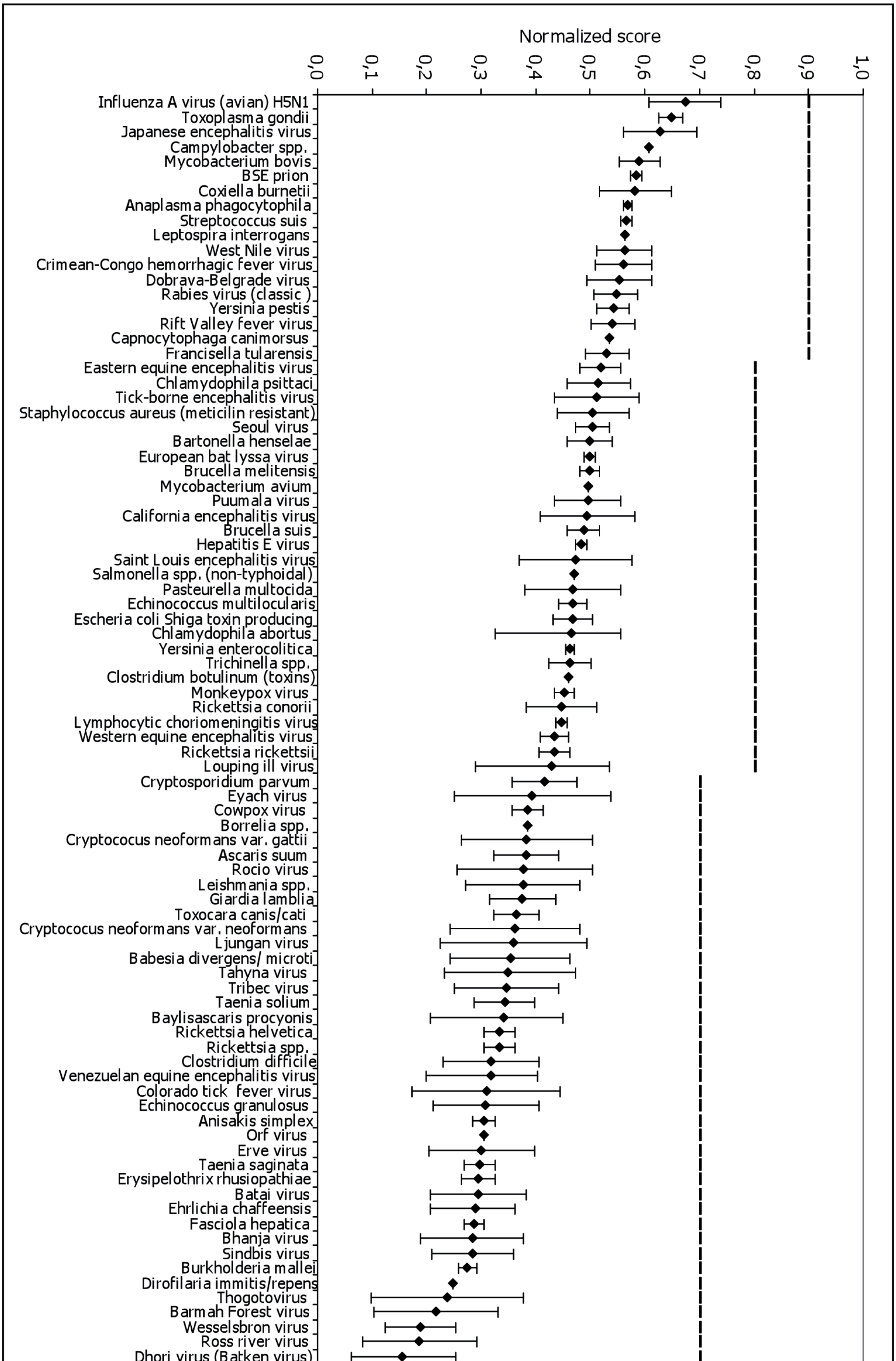


Figure 4. Emerging zoonotic pathogens relevant for the Netherlands (x-axis), prioritized according normalized scores (y-axis, means and 90% confidence intervals based on Monte Carlo simulation).

Three groups of statistically different importance were identified by Classification and Regression Tree analysis and are represented by dashed lines. Mean (standard deviation) of the full dataset: 0.423 (0.124). Mean (standard deviation) of the three clusters: 0.577 (0.047); 0.476 (0.044); 0.317 (0.083).

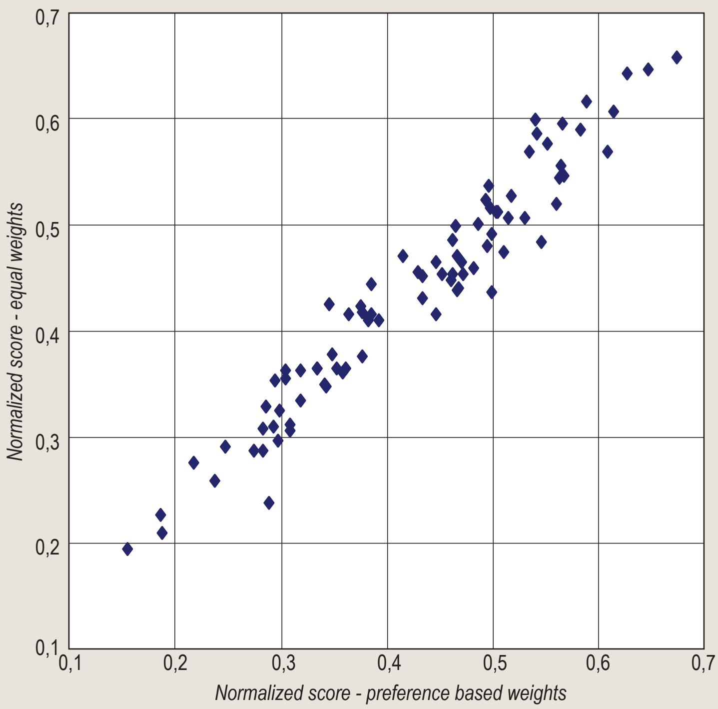


Figure 5. Comparison of normalized scores using preference-based weights and equal weights.

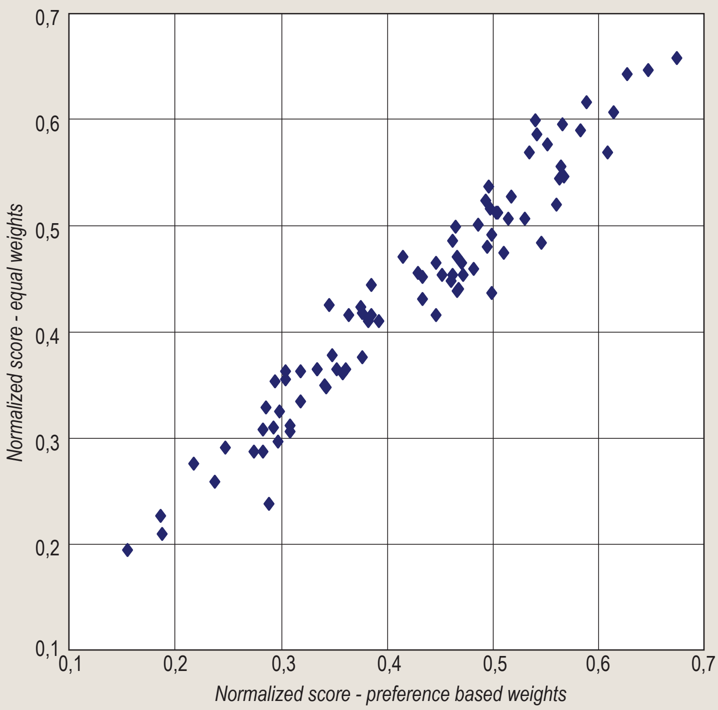


Figure 6. Comparison of ranking using quantitative and semi-quantitative model.

Web Annex 1. Criteria: definitions, ranges, point estimates, and decision rules.

1: Probability of introduction of the pathogen in the Netherlands

Criterion
Probability of introduction of pathogen.

Definition
This criterion describes the probability that a zoonotic pathogen will be introduced in the Netherlands in the following year. This probability depends on the introduction of an infected entity (infected reservoirs, vectors, human cases or food). Moreover, it depends on the prevalence of an infection in such an entity and the intensity in which those entities enter the Netherlands. The result depends on the type of entity in question.

Ranges and point estimates:
The probability of introduction of a pathogen will be estimated using the decision rules described below appointing it to one of four probability intervals:

- < 1%, point estimate 0.5%
- 1-9%, point estimate 5%
- 10-99%, point estimate 50%
- 100%.

Decision rules

Import of animals (farm animals, pets and exotics) and food

< 1%: The infection exists in the countries that export to the Netherlands, but these countries have an effective control program and/or the Dutch import control is effective;

1-9%: The infection does exist in the countries that export to the Netherlands but these countries do not have an effective control program, and the Netherlands do not have an effective program either or import only limited number of animals [< 1000/year] or food [< 1000 ton/year];

10-99%: The infection exists in the countries that export to the Netherlands, and these countries do not have an effective control program neither does the Dutch have an effective import control and many live animals [> 1000/year] or food [> 1000 ton/year] are imported;

100%: The infection exists among animals living in the Netherlands.

Wildlife species (including reservoirs and vectors)

<1% : Wildlife species do inhabit countries surrounding the Netherlands, but no infection has been found while it has been investigated;

1-9%: Wildlife species inhabit countries surrounding the Netherlands, but possible infections have not been investigated

10-99%: Wildlife species inhabit countries surrounding the Netherlands and an infection has been detected

100%: Infected wildlife species have been found in the Netherlands.

Humans

<1% : Humans from endemic areas stay in the Netherlands less than one day (transit) or Dutch people travel to endemic areas;

1-9% : Humans from endemic areas stay in the Netherlands longer than one day ;

10-99%: Infection exists among humans inhabiting the Schengen countries;

100%: The disease is indigenous to the Netherlands. The presence of the pathogen is documented.

2: Transmission between animals

Criterion
Fraction of animal reservoir infected.

Definition
This criterion describes the prevalence of infections in animal reservoirs.

Ranges and point estimates
- <1 infections per 100,000 animals per year, point estimate 0%
- 1-100 infections per 100,000 animals per year, point estimate 0.05%
- 100-1,000 infections per 100,000 animals per year, point estimate 0.5%
- 1,000-10,000 infections per 100,000 animals per year, point estimate 5%
- >10,000 infections per 100,000 animals per year, point estimate 50%

Decision rules
None

3: Economic damage in animal reservoir

Criterion
Economic costs

Definition
This criterion describes the costs for the Dutch society given the discovery of an infection in the Dutch animal

reservoir, and transmission between animals has occurred. The costs relate to the agricultural sector (production animal farms, suppliers, slaughter houses, and food industry) and the government. The costs include costs associated with control of the disease (culling, vaccination, compensation etc) and the costs of lack of occupancy of stables, loss of breeding animals, lost returns and the damage to the market through the loss of a share in the market for a long period of time and loss in the tourist industry. These costs depend on preceding criteria, because a zoonotic agent that also causes animal diseases and spreads quickly will demand more intense and expensive control measures.

Ranges and point estimates

The costs of the emerging pathogen will be estimated using the decision rules described below appointing it to one of four intervals:

- <1 M Euro per year, point estimate 0.5 M Euro per year
- 1-10 M Euro per year, point estimate 5 M Euro per year
- 10 – 100 M Euro per year, point estimate 50 M Euro per year
- >100 M Euro per year, point estimate 500 M Euro per year

Decision rules

<1 M Euro per year: In the Netherlands, farm animals do not get ill or only a few animals get ill and control is done at the level of the animal itself.
1 - 10 M Euro per year: In the Netherlands, farm animals can get ill and control is done at the level of the farm itself.
10 – 100 M Euro per year: In the Netherlands, farm animals can get ill and control is done at the level of the section or region.
>100 M Euro per year: In the Netherlands, farm animals can get ill and control is done at national or international level.

4. Transmission from animals to humans

Criterion

Fraction of humans infected by animal-human transmission.

Definition

This criterion describes the prevalence of infections in humans caused by infected.

Ranges and point estimates

- 1-100 infections per 100,000 humans per year, point estimate 0.05%
- 100-1,000 infections per 100,000 humans per year, point estimate 0.5%
- 1,000-10,000 infections per 100,000 humans per year, point estimate 5%
- >10,000 infections per 100,000 humans per year, point estimate 50%

Decision rules

None

5. Transmission between humans

Criterion

Fraction of humans infected by human-human transmission.

Definition

This criterion describes the prevalence of infections in humans caused by human to human transmission.

Point estimates

- <1 infections per 100,000 humans per year, point estimate 0%
- 1-100 infections per 100,000 humans per year, point estimate 0.05%
- 100-1000 infections per 100,000 humans per year, point estimate 0.5%
- 1,000-10,000 infections per 100,000 humans per year, point estimate 5%
- >10,000 infections per 100,000 humans per year, point estimate 50%

Decision rules

None

6. Morbidity

Criterion

Loss of health related quality of life

Definition

This criterion reflects the effect of the disease on the health related quality of life. The value of the criterion is anchored between 0 (full health) en 1 (worst possible health state) and depends on both the severity and the duration of the disease. For a large number of diseases such disability weights have already been published.

Point estimates

Four intervals for the morbidity are used

- disability weight < 0.03; point estimate 0.02
- 0.03 < disability weight < 0.1; point estimate 0.06
- 0.1 < disability weight < 0.3; point estimate 0.2
- disability weight > 0.3; point estimate 0.6

Decision rules

The scores are obtained by analogy of illnesses already in the list below.

Table. Comparison between preference-based weights (this paper) and direct ranking (16).

Disease label	Duration (in days)
Very mild (disability weight < 0.03)	
Otitis media	14
Hepatitis	30
Folliculitis	7
Cystitis	14
Gastroenteritis, severe	10-15
Conjunctivitis	7
Tonsillitis	7
Bronchitis	14
Mild (0.03<disability weight < 0.1)	
Allergic rhinitis	119
Reactive arthritis	42
Tinea pedis	183
Eczema	35
Otitis externa	35
Gastroenteritis, hospitalized	7-14
Laryngitis	7
Sinusitis	183
Irritable bowel syndrome	183
Haemolytic uremic syndrome	30
Visual disorder, mild	365
Hepatitis	92
Gastroenteritis, chronic	183
Influenza	14
Moderate (0.1<disability weight < 0.3)	
Inflammatory bowel disorder	183
Reactive arthritis	183
Tuberculosis	365
Chronic pulmonary disease (bronchitis, asthma, emphysema)	365
Diabetes mellitus	365
High (disability weight > 0.3)	
Renal failure	365
Guillain-Barré syndrome	365
Visual disorder, severe	365
Paraplegia	365
AIDS	365
Meningitis	
Dementia	365

In case a pathogen can cause more than one disease, or if there are vulnerable groups, a population weighted average is applied.

7. Mortality

Criterion

Case fatality ratio

Definition

This criterion describes the case-fatality ratio of the illness, which depends on the nature of the infection and the health status of the infected person.

Point Estimates

Five intervals are used:

- 0%
- 0-0.1%, point estimate 0.05%
- 0.1-1%, point estimate 0.5%
- 1-10%, point estimate 5%
- 10-100%, point estimate 50%

Decision rules

None

In case a pathogen can cause more than one disease, or if there are vulnerable groups, a population weighted average is applied. This also implies that that if fatal cases only occur in vulnerable groups, the case-fatality ratio in that group should be multiplied by the relative size of the vulnerable group in the population.

Web Annex 2. Database.

		Criteria	**C1**	**Introduction**		**%/year**	**C2**	**Transmission animals**			**%**	**C3**	**Econ. damage animals**		**m€/YEAR**
		Weight	**0,418**				**0,292**					**0,337**			
		Value	0.5	5	50	100	0	0,005	0,05	0,5	10	0,5	5	50	500
		Normalized value	0	0,435	0,869	1	0	0,386	0,528	0,671	0,857	0	0,303	0,606	0,909
Category	**Family**	**Species**													
Prions		BSE prion	0	0	1	1	1	0	0	0	0	0	0	0	1
Viruses	Arenaviridae	Lymphocytic choriomeningitis virus	0	0	1	0	0	0	0	1	1	1	0	0	0
Viruses	Bunyaviridae	Batai virus	0	0	1	0	0	1	1	1	0	1	1	0	0
Viruses	Bunyaviridae	Bhanja virus	0	0	1	0	0	1	1	1	0	1	1	0	0
Viruses	Bunyaviridae	California encephalitis virus	0	1	0	0	0	0	1	1	0	0	1	1	0
Viruses	Bunyaviridae	Crimean-Congo hemorrhagic fever virus	0	0	1	0	1	1	0	0	0	1	0	0	0
Viruses	Bunyaviridae	Dobrava-Belgrade virus	0	0	1	0	0	0	0	1	1	1	1	0	0
Viruses	Bunyaviridae	Erve virus	0	0	1	0	1	1	1	1	1	1	1	0	0
Viruses	Bunyaviridae	Puumala virus	0	0	0	1	0	0	0	1	1	1	1	0	0
Viruses	Bunyaviridae	Rift Valley fever virus	0	1	0	0	0	0	0	1	1	0	0	0	1
Viruses	Bunyaviridae	Seoul virus	0	0	1	0	0	0	0	1	1	1	1	0	0
Viruses	Bunyaviridae	Tahyna virus	0	0	1	0	0	1	1	1	0	1	1	0	0
Viruses	Flaviviridae	Japanese encephalitis virus	0	1	0	0	0	0	1	1	0	0	0	0	1
Viruses	Flaviviridae	Louping ill virus	0	0	1	0	0	1	1	1	0	0	0	1	1
Viruses	Flaviviridae	Rocio virus	1	0	0	0	1	1	1	1	1	1	1	0	0
Viruses	Flaviviridae	Saint Louis encephalitis virus	1	1	0	0	0	0	1	1	0	0	1	0	0
Viruses	Flaviviridae	Tick-borne encephalitis virus	0	0	1	0	0	0	1	1	0	1	0	0	0
Viruses	Flaviviridae	Wesselsbron virus	1	0	0	0	0	1	1	1	0	1	1	0	0
Viruses	Flaviviridae	West Nile virus	0	0	1	0	0	0	0	1	1	0	1	0	0
Viruses	Hepeviridae	Hepatitis E virus	0	0	0	1	0	0	0	1	1	1	0	0	0
Viruses	Orthomyxoviridae	Dhori virus (Batken virus)	1	0	0	0	1	1	1	1	0	1	1	0	0
Viruses	Orthomyxoviridae	Influenza A virus (avian) H5N1	0	0	1	0	0	0	0	1	1	0	0	0	1
Viruses	Orthomyxoviridae	Thogotovirus	1	0	0	0	0	1	1	1	0	1	1	0	0
Viruses	Picornaviridae	Ljungan virus	0	0	1	0	0	0	1	1	0	1	0	0	0
Viruses	Poxviridae	Cowpox virus	0	0	0	1	0	0	0	1	0	0	1	0	0
Viruses	Poxviridae	Monkeypox virus	0	1	0	0	0	0	0	1	0	0	1	0	0
Viruses	Poxviridae	Orf virus	0	0	0	1	0	0	0	1	0	0	1	0	0
Viruses	Reoviridae	Colorado tick fever virus	0	1	0	0	0	1	1	1	0	0	1	0	0
Viruses	Reoviridae	Eyach virus	0	0	1	1	0	1	1	1	0	1	1	0	0
Viruses	Reoviridae	Tribec virus	0	0	1	0	0	1	1	1	0	1	1	0	0
Viruses	Rhabdoviridae	Rabies virus (classic)	0	0	1	0	0	0	0	1	1	0	1	0	0
Viruses	Rhabdoviridae	European bat lyssa virus	0	0	0	1	0	0	0	1	1	1	0	0	0
Viruses	Togaviridae	Barmah Forest virus	1	1	0	0	0	1	1	1	0	1	1	0	0
Viruses	Togaviridae	Eastern equine encephalitis virus	0	1	0	0	0	0	1	1	0	0	1	0	0
Viruses	Togaviridae	Ross river virus	1	1	0	0	0	1	1	1	0	1	0	0	0
Viruses	Togaviridae	Sindbis virus	0	0	1	0	0	1	1	1	0	1	0	0	0
Viruses	Togaviridae	Venezuelan equine encephalitis virus	0	1	0	0	0	1	1	1	0	0	1	0	0
Viruses	Togaviridae	Western equine encephalitis virus	0	1	0	0	0	1	1	1	0	0	1	0	0
Bacteria	Anaplasmataceae	Ehrlichia chaffeensis	1	1	0	0	1	1	1	0	0	1	0	0	0
Bacteria	Bartonellaceae	Bartonella henselae	0	0	0	1	0	0	0	0	1	1	1	0	0
Bacteria	Brucellaceae	Brucella melitensis	0	0	1	0	0	0	0	0	1	0	0	1	0
Bacteria	Brucellaceae	Brucella suis	0	0	1	0	0	0	0	1	1	0	0	1	0
Bacteria	Burkholderiaceae	Burkholderia mallei	1	0	0	0	0	1	1	1	0	1	0	0	0
Bacteria	Campylobacteraceae	Campylobacter spp.	0	0	0	1	0	0	0	0	1	0	1	0	0
Bacteria	Chlamydiaceae	Chlamydophila abortus	0	0	0	1	0	0	0	0	1	0	1	0	0
Bacteria	Chlamydiaceae	Chlamydophila psittaci	0	0	0	1	0	0	0	0	1	1	0	0	0
Bacteria	Clostridiaceae	Clostridium botulinum (toxins)	0	0	0	1	0	1	0	0	0	1	0	0	0
Bacteria	Clostridiaceae	Clostridium difficile	0	0	0	1	0	1	0	0	0	1	1	0	0
Bacteria	Coxiellaceae	Coxiella burnetii	0	0	0	1	0	0	0	1	1	0	0	1	0
Bacteria	Ehrlichiaceae	Anaplasma phagocytophila	0	0	0	1	0	1	1	0	0	0	1	0	0
Bacteria	Enterobacteriaceae	Escheria coli Shiga toxin producing	0	0	0	1	0	0	0	1	0	1	0	0	0
Bacteria	Enterobacteriaceae	Salmonella spp. (non-typhoidal)	0	0	0	1	0	0	0	1	0	0	1	0	0
Bacteria	Enterobacteriaceae	Yersinia enterocolitica	0	0	0	1	0	0	1	1	0	0	1	0	0
Bacteria	Enterobacteriaceae	Yersinia pestis	0	1	0	0	0	0	0	1	1	0	1	0	0
Bacteria	Erysipelothrichidae	Erysipelothrix rhusiopathiae	0	0	0	1	0	0	0	1	1	1	1	0	0
Bacteria	Flavobacteriaceae	Capnocytophaga canimorsus	0	0	0	1	0	0	0	0	1	1	0	0	0
Bacteria	Francisellaceae	Francisella tularensis	0	0	1	0	0	0	0	1	1	0	1	0	0
Bacteria	Leptospiraceae	Leptospira interrogans	0	0	0	1	0	0	0	1	0	0	1	0	0
Bacteria	Mycobacteriaceae	Mycobacterium avium	0	0	0	1	0	0	1	0	0	0	1	0	0
Bacteria	Mycobacteriaceae	Mycobacterium bovis	0	0	1	0	0	0	1	1	0	0	0	1	0
Bacteria	Pasteurellaceae	Pasteurella multocida	0	0	0	1	0	0	1	1	1	1	1	0	0
Bacteria	Rickettsiaceae	Rickettsia conorii	0	1	1	0	0	0	1	1	0	1	1	0	0
Bacteria	Rickettsiaceae	Rickettsia helvetica	0	0	0	1	0	0	1	1	0	1	1	0	0
Bacteria	Rickettsiaceae	Rickettsia rickettsii	0	1	0	0	0	0	1	1	0	1	1	0	0
Bacteria	Rickettsiaceae	Rickettsia spp.	0	0	0	1	0	0	1	1	0	1	1	0	0
Bacteria	Spirochaetaceae	Borrelia spp.	0	0	0	1	0	0	1	0	0	1	0	0	0
Bacteria	Staphylococcaceae	Staphylococcus aureus (meticilin resistant)	0	0	0	1	0	0	0	1	1	0	1	0	0
Bacteria	Streptococcaceae	Streptococcus suis	0	0	0	1	0	0	0	0	1	0	1	0	0
Fungi	Sporidiobolacea	Cryptococus neoformans var. neoformans	0	0	0	1	0	0	1	1	0	1	1	0	0
Fungi	Sporidiobolacea	Cryptococus neoformans var. gattii	0	0	0	1	0	0	1	1	0	1	1	0	0
Protozoa	Babesiidae	Babesia divergens/ microti	0	0	0	1	0	0	1	1	0	1	0	0	0
Protozoa	Cryptosporidiidae	Cryptosporidium parvum	0	0	0	1	0	0	0	1	1	0	1	1	0
Protozoa	Diplomonadidae	Giardia lamblia	0	0	0	1	0	0	0	1	1	1	1	0	0
Protozoa	Sarcocystidae	Toxoplasma gondii	0	0	0	1	0	0	0	1	1	0	1	0	0
Protozoa	Trypanosomatidae	Leishmania spp.	0	0	1	0	0	1	1	0	0	0	1	0	0
Helminths	Ascaridoidea	Anisakis simplex	0	0	0	1	0	0	0	1	1	0	1	0	0
Helminths	Ascaridoidea	Ascaris suum	0	0	0	1	0	0	0	1	1	1	1	0	0
Helminths	Ascaridoidea	Baylisascaris procyonis	0	0	0	1	1	1	0	0	0	1	1	0	0
Helminths	Ascaridoidea	Toxocara canis/cati	0	0	0	1	0	0	0	1	1	1	1	0	0
Helminths	Fasciolidae	Fasciola hepatica	0	0	0	1	0	0	1	1	0	0	1	0	0
Helminths	Filarioidea	Dirofilaria immitis/repens	0	0	0	1	0	0	1	0	0	1	0	0	0
Helminths	Taeniidae	Echinococcus granulosus	0	0	0	1	0	1	0	0	0	1	1	0	0
Helminths	Taeniidae	Echinococcus multilocularis	0	0	0	1	0	0	1	1	0	1	0	0	0
Helminths	Taeniidae	Taenia saginata	0	0	0	1	0	1	1	0	0	1	1	0	0
Helminths	Taeniidae	Taenia solium	1	1	0	0	1	0	0	0	0	1	0	0	0
Helminths	Trichuroidea	Trichinella spp.	0	0	0	1	0	0	1	1	0	0	1	1	0
		High threat	0	0	0	1	0	0	0	0	1	0	0	0	1
		Low threat	1	0	0	0	1	0	0	0	0	1	0	0	0

		Criteria	C4	Transm. Anim. -> hum.		%	C5	Transmission humans			%	C6	Morbidity		-	C7	Mortality			%
		Weight	0,626				0,339					0,181				0,643				
		Value	0,005	0,05	0,5	10	0	0,005	0,05	0,5	10	0.02	0.06	0.2	0.6	0	0,05	0,5	5	50
		Normalized value	0	0,233	0,465	0,767	0	0,386	0,528	0,671	0,857	0	0,281	0,589	0,869	0	0,528	0,671	0,814	0,957
Category	Family	Species																		
Prions		BSE prion	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1
Viruses	Arenaviridae	Lymphocytic choriomeningitis virus	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
Viruses	Bunyaviridae	Batai virus	1	1	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0
Viruses	Bunyaviridae	Bhanja virus	1	1	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0
Viruses	Bunyaviridae	California encephalitis virus	1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0
Viruses	Bunyaviridae	Crimean-Congo hemorrhagic fever virus	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1
Viruses	Bunyaviridae	Dobrava-Belgrade virus	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Viruses	Bunyaviridae	Erve virus	1	1	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Viruses	Bunyaviridae	Puumala virus	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0
Viruses	Bunyaviridae	Rift Valley fever virus	1	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0
Viruses	Bunyaviridae	Seoul virus	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0
Viruses	Bunyaviridae	Tahyna virus	1	1	1	1	1	0	0	0	0	0	1	1	0	1	0	0	0	0
Viruses	Flaviviridae	Japanese encephalitis virus	1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1
Viruses	Flaviviridae	Louping ill virus	1	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0
Viruses	Flaviviridae	Rocio virus	1	1	1	0	1	0	0	0	0	0	0	1	1	0	1	1	1	1
Viruses	Flaviviridae	Saint Louis encephalitis virus	1	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1
Viruses	Flaviviridae	Tick-borne encephalitis virus	1	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0
Viruses	Flaviviridae	Wesselsbron virus	0	1	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Viruses	Flaviviridae	West Nile virus	0	1	1	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0
Viruses	Hepeviridae	Hepatitis E virus	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0
Viruses	Orthomyxoviridae	Dhori virus (Batken virus)	1	1	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0
Viruses	Orthomyxoviridae	Influenza A virus (avian) H5N1	1	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1
Viruses	Orthomyxoviridae	Thogotovirus	1	1	1	0	1	0	0	0	0	0	1	1	0	1	1	0	0	0
Viruses	Picornaviridae	Ljungan virus	1	1	1	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0
Viruses	Poxviridae	Cowpox virus	1	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0
Viruses	Poxviridae	Monkeypox virus	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	0
Viruses	Poxviridae	Orf virus	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Viruses	Reoviridae	Colorado tick fever virus	1	1	1	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0
Viruses	Reoviridae	Eyach virus	1	1	1	0	1	0	0	0	0	0	1	1	0	1	1	0	0	0
Viruses	Reoviridae	Tribec virus	1	1	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0
Viruses	Rhabdoviridae	Rabies virus (classic)	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1
Viruses	Rhabdoviridae	European bat lyssa virus	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1
Viruses	Togaviridae	Barmah Forest virus	1	1	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0
Viruses	Togaviridae	Eastern equine encephalitis virus	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1
Viruses	Togaviridae	Ross river virus	1	1	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0
Viruses	Togaviridae	Sindbis virus	1	1	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Viruses	Togaviridae	Venezuelan equine encephalitis virus	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0
Viruses	Togaviridae	Western equine encephalitis virus	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0
Bacteria	Anaplasmataceae	Ehrlichia chaffeensis	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0
Bacteria	Bartonellaceae	Bartonella henselae	0	1	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0
Bacteria	Brucellaceae	Brucella melitensis	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0
Bacteria	Brucellaceae	Brucella suis	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0
Bacteria	Burkholderiaceae	Burkholderia mallei	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
Bacteria	Campylobacteraceae	Campylobacter spp.	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0
Bacteria	Chlamydiaceae	Chlamydophila abortus	1	0	0	0	1	0	0	0	0	0	1	1	0	1	1	1	1	0
Bacteria	Chlamydiaceae	Chlamydophila psittaci	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	1	0
Bacteria	Clostridiaceae	Clostridium botulinum (toxins)	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0
Bacteria	Clostridiaceae	Clostridium difficile	1	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0
Bacteria	Coxiellaceae	Coxiella burnetii	1	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	1	0
Bacteria	Ehrlichiaceae	Anaplasma phagocytophila	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0
Bacteria	Enterobacteriaceae	Escheria coli Shiga toxin producing	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	1	0
Bacteria	Enterobacteriaceae	Salmonella spp. (non-typhoidal)	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0
Bacteria	Enterobacteriaceae	Yersinia enterocolitica	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0
Bacteria	Enterobacteriaceae	Yersinia pestis	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1
Bacteria	Erysipelothrichidae	Erysipelothrix rhusiopathiae	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Bacteria	Flavobacteriaceae	Capnocytophaga canimorsus	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0
Bacteria	Francisellaceae	Francisella tularensis	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0
Bacteria	Leptospiraceae	Leptospira interrogans	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0
Bacteria	Mycobacteriaceae	Mycobacterium avium	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0
Bacteria	Mycobacteriaceae	Mycobacterium bovis	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0
Bacteria	Pasteurellaceae	Pasteurella multocida	1	1	1	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0
Bacteria	Rickettsiaceae	Rickettsia conorii	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0
Bacteria	Rickettsiaceae	Rickettsia helvetica	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Bacteria	Rickettsiaceae	Rickettsia rickettsii	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
Bacteria	Rickettsiaceae	Rickettsia spp.	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Bacteria	Spirochaetaceae	Borrelia spp.	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0
Bacteria	Staphylococcaceae	Staphylococcus aureus (meticilin resistant)	1	1	0	0	1	1	0	0	0	0	1	0	0	0	1	0	0	0
Bacteria	Streptococcaceae	Streptococcus suis	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0
Fungi	Sporidiobolacea	Cryptococus neoformans var. neoformans	1	1	0	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0
Fungi	Sporidiobolacea	Cryptococus neoformans var. gattii	1	1	0	0	1	0	0	0	0	0	1	1	0	1	1	0	0	0
Protozoa	Babesiidae	Babesia divergens/ microti	1	1	0	0	1	0	0	0	0	1	1	1	0	1	1	0	0	0
Protozoa	Cryptosporidiidae	Cryptosporidium parvum	1	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0
Protozoa	Diplomonadidae	Giardia lamblia	1	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0
Protozoa	Sarcocystidae	Toxoplasma gondii	0	0	1	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0
Protozoa	Trypanosomatidae	Leishmania spp.	1	1	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	0
Helminths	Ascaridoidea	Anisakis simplex	1	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0
Helminths	Ascaridoidea	Ascaris suum	0	1	1	0	1	0	0	0	0	1	1	1	0	1	0	0	0	0
Helminths	Ascaridoidea	Baylisascaris procyonis	1	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	0	0
Helminths	Ascaridoidea	Toxocara canis/cati	0	1	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0
Helminths	Fasciolidae	Fasciola hepatica	1	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0
Helminths	Filarioidea	Dirofilaria immitis/repens	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
Helminths	Taeniidae	Echinococcus granulosus	1	0	0	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0
Helminths	Taeniidae	Echinococcus multilocularis	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	0
Helminths	Taeniidae	Taenia saginata	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0
Helminths	Taeniidae	Taenia solium	0	1	0	0	0	1	1	0	0	0	0	1	1	0	1	0	0	0
Helminths	Trichuroidea	Trichinella spp.	1	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0	0	0
		High threat	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1
		Low threat	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0

Annex 2

Wageningen University - Department of Social Sciences
Chair Group Communication and Innovation sciences

Predicting Risk Perception of Emerging Zoonoses

A literature essay on applicable determinants of risk perception

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Elisa Boekhorst

Commissioner
Arie Havelaar

Supervisors
Cees van Woerkum
Janneke de Jonge

Preface

Thanks to Arie Havelaar, Janneke de Jonge, Cees van Woerkum, Desiree Beaujean, Guus den Hollander, Ric van der Poll, Anne Knol, Juliane Ruzante

Abstract

Background
The planning of effective public health surveillance of emerging zoonoses starts with an estimation of the risks. In risk analysis, risk perception has gained momentum and in parallel of epidemiological risk estimation the EmZoo research group considers the assessment of public risk perception an important aspect for a complete policy advice.

Purpose
The aim of this essay is to give a reasoned argumentation explaining why certain aspects are more relevant for surveillance of (individual) risk perception for emerging zoonoses. This will help to develop both a tool to prioritize zoonoses for policy purposes, as well as a starting point for the development of enhanced risk communication strategies for zoonoses.

Method
This essay reviews what aspects of emerging zoonoses could influence risk perception specifically; by assessing the applicability of four theories that are being used to measure the public risk perception; the psychometric paradigm (PP), the social amplification of risk framework (SARF), the health belief model (HBM) and the protection motivation theory (PMT). In addition these four established theories have been compared assessed on their application possibilities for emerging zoonoses.

Results
Three aspects characterizing emerging zoonoses; lack of knowledge, the multisectoral interests and information and fear, seem to be important in terms of the risk perception and should be implemented in any application of measuring risk perception of emerging zoonoses. The SARF seems to include most aspects that might be of relevance for risk perception of emerging zoonoses. The usability of this model is however limited as it might be too complicated to operationalise completely. The PP is not used for the whole process of risk perception but focuses only on the most common factors. Therefore it can be used to compare many different hazards the variables commonly used need limited adaptation. This approach however gives limited insight in other influencing factors besides the most important factors, the level of knowledge and the severity of the hazard. The behavioural models the PMT and the HBM both encompass a process framework describing potential variables, they focus however to a large extent on the actual behaviour and usually measure risk perception after a certain risk is already known. Little is known about the application for estimation beforehand. This is also the case for the SARF, since what influences ripple effects is considered dynamic and very limited research has tried to predict this aspect.

Conclusions
Some limitations have been indicated in all four models. None of the models seems of direct use in surveillance of risk perception concerning emerging zoonoses. In all models variables need to be adapted or developed, hence there is a necesscity to tailor make the application. Furthermore application is strongly depending on the objective of measuring risk perception. Two options can be proposed. The psychometric paradigm can provide insights in the public risk perception of zoonoses in comparison with other hazards. It can potentially also be used to compare perception of different zoonoses although the fact that most emerging zoonoses are unknown to the public may result in a lack of resolution. This could potentially be over come by clustering emerging zoonoses in groups with more or less similar characteristics. The SARF can be used as a background framework of all aspects influencing risk perception. A potential application could be the development of systematic real rime, review of information flows in of news media and social networks resulting in a early warning system for all 86 zoonoses individually.

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1. Introduction

1.1 Background

In the last years the Netherlands has faced different outbreaks of so called emerging zoonoses with possibly far-ranging implications for public health. In this essay the term zoonoses is used according to the definition of the WHO.

A wide variety of animal species, both domesticated and wild, can act as reservoirs for these pathogens. Examples of zoonoses are: Severe Acute Respiratory Syndrome (SARS), avian influenza, Meticillin Resistant Staphylococcus Aureus (MRSA), Salmonella and more recently Q fever. In addition to these examples there are numerous zoonoses of potential importance. The relative threats of these zoonoses and subsequently their risk for the Dutch population are however difficult to predict. In this essay, attention will be given to the importance of risk perception with respect to strategic risk policy and the relative threat of emerging zoonoses.

1.2 Risk estimation

How to take care of risks for the society is of great importance for the Dutch government. In terms of health risks, the ministry of health is responsible for policy regarding (the improvement of) public health. The focus so far has been on prevention and early tracing of life-threatening and chronic diseases, accomplished by immunization and screening programmes. The choice of admissible risk levels should however be placed in a broader political context. In terms of technical policy decisions concerning risk in the Netherlands, an equal protection of the population is maintained, which can be expressed by a number. Traditionally, the design of managing risks was to translate this technical risk into policy for the management of both prevention and communication. This approach to health risk assessment aims to produce the best possible numerical estimate of the chance or probability of adverse health outcomes for use in policy making (3). In the Netherlands this expressed number is that nobody should be subject to a risk over one in a million (10-6) (4). The feasibility of this decision rule of maximum tolerated risk exposure proved however to be problematic in certain situations. Hollander et al. (5) mention the case of *Legionella*, in which the agreed policy resulted in individual risk level above one in a million. Relying on mainly natural science approaches to risk assessment and management did not always achieve the expected results (3). Accordingly, uncertainty, variability and complexity of a risk can make quantitative modelling problematic, therefore simply calculating the absolute risk to die can be challenging. Besides there are numerous aspects that play a role in risk assessment, such as qualitative and socio psychological factors like social acceptability (5).

1.3 Risk perception

Public risk perception plays an important role for successful implementation of prevention, control and management measures (6). It can be argued that the planning of all these measures is in itself part of the risk and therefore the risk is as much a socio- political issue as a biological issue (7). In other words, the risk is not solemnly a number and can be understood in a larger social cultural and economic context. Analysis of the public perception of a health risk is therefore an important aspect in both surveillance for policy decision making and the planning of (preventive) measures. The issue how to address risk perception in risk analysis has been discussed over many years. The Health Council of the Netherlands published in 1995: *Committee on risk measures and risk assessment. Not all risks are equal* seeking to answers the question when a certain risk is acceptable to a person. This document focuses on risk decision making and may be seen as a key document in the discussion to add aspects of risk perception to risk assessment. The rapport *"Coping rationally with risks"* issued by the ministry of housing spatial planning and the environment in 2003 further emphasizes to add subjective aspects to the mentioned decision rule of subjected risk. One of the points addressed is which aspects influence public risk perception, showing the growing importance of this matter in the domain of risk assessment. Given this importance, according to Smith (8) as well as Reynolds and Seeger (9), one of the main lessons concerning risk perception learned from the SARS epidemic is the need for a more holistic approach when dealing with, in this case, emerging infectious disease hazards. Holistic, in the sense that the strong focus on emergency responsiveness should change towards a focus on preventive preparedness including preceding knowledge of risk perception aspects due to the limited timeframe of a potential outbreak.

1.4 Prioritizing emerging zoonoses

In the context of the research program Emerging Zoonoses (EmZoo) a list of 86 emerging zoonoses have been identified as specifically relevant for the Netherlands. This list has been developed in order to assess the risk, eventually leading to policy priority of potential diseases and subsequently their potential outbreaks.

Apart from the list of relevant emerging zoonoses the first phase of the EmZoo project was to investigate which zoonoses are most important / form the largest potential threat. A system has been developed on the basis of which the zoonoses can be related and "objectively" evaluated in terms of this potential threat. One dimension, the epidemiological risk, has been investigated. This dimension is composed of seven criteria, introduction, transmission, economic damage in animal reservoir, animal human transmission,

transmission between humans, morbidity and mortality in humans. These criteria represent epidemiological aspects of the zoonoses based on natural science. The EmZoo research group considers risk perception of great importance to the prioritization of the threat of emerging zoonoses. Since research concerning risk perception belongs more field of social science and might be fundamentally different from the epidemiological criteria and risk perception may lead to different risk management actions, the EmZoo research group wishes to consider risk perception as a separate dimension.

The primary priorities when dealing with emerging zoonoses are generally; first the identification of the modes of transmission and second, identification of control strategies in both the human as the animal population. In other words, the first priority is seeking knowledge how to deal with the zoonosis. This knowledge is the input of a control strategy. A component of this strategy for humans will be treatment of already infected people. However, in terms of control and eventually policy making in the long run, the main objective will be to prevent people from getting sick. Therefore the key focus when dealing with emerging zoonoses is of a preventive nature for both veterinary and human health. When assuming both the modes of transmission and the control strategies for a zoonosis have been identified, the next step would be to develop a way to communicate these aspects towards the public. In this regard, lessons can be learned from previous outbreaks. A key finding is that the effectiveness of the control of outbreaks of new emerging zoonoses will largely depend on the behaviour of the population and their willingness to adhere to recommended preventive measures (10). Giving proper attention to risk communication towards the public concerning potential health problems is therefore crucial. Knowledge about how people experience and perceive the risks of zoonoses is limited. In this aspect it remains a challenge to gain knowledge in what way policy messages and measures such as enhanced surveillance or risk communication can influence the perception of the risk. This is in particularly important considering the current "risk society" (11) and the great interest of mass media for (potential) outbreaks. There is a fine line in risk communication. On the one hand, exaggerated messages concerning zoonoses in the media may lead to panic and influence public life and the economic situation. On the other hand, the public may think a zoonosis is not a serious threat and hence not pay heed to special precautions. According to the research project; *"Risk perception of infectious diseases; developing instruments to measure risk perception and implementing instruments for risk communication in order to control (outbreaks of emerging) infectious diseases"* (12), there are currently no evidence-based frameworks available for taking into account risk perception in risk communication before or during the control of outbreaks of (emerging) zoonoses/infectious diseases. Local and national public health authorities are however frequently confronted with both preventive risk communication and outbreaks. An estimation of the risk perception of the public concerning a zoonosis beforehand can therefore be helpful in the development of risk communication.

Zoonotic outbreaks such as the Bovine Spongiform Encephalopathy (BSE) crisis and more recently the Q fever epidemic in the Netherlands have caused public unrest. Q fever recently received enormous media attention both before and after the government determined a package of interventions. This package of interventions was determined in order to decrease the largest epidemiological reservoir, namely goats carrying the bacteria causing the disease. Despite the implementation of these measures on a large scale, much of the media attention revolved around uncertainty and the (political) process involving this package of interventions. This political process also involves a certain unease concerning the potential collision of interests between human health and the economical benefits of the veterinary sector. It remains however unclear in what way the different interests of these groups influence risk perception and if the public perceives the risk of emerging zoonoses differently than other hazards. Subsequently over the years, the question arises as to what influences the risk perception of the public in the case of emerging zoonoses.

1.5 Research objective

Risk perception has been studied from many perspectives. In order to gain more insight, research into individual perceptions of the risk of a zoonosis may help to develop both a tool to prioritize zoonoses for policy purposes, as well as the development of enhanced risk communication strategies for zoonoses. The basis of this literature review focuses in seeking an answer to the question:

In order to answer this research question, different aspects will be discussed. Chapter two focuses on what specific aspects of emerging zoonoses potentially influence the risk perception of the public. Listed are aspects found to influence public risk perception. In chapter three attention will be given to the aspect risk and subsequently risk perception leading to a rough overview describing the field of risk perception. The later chapters describe four theories that are used to describe or measure risk perception. By combining the aspects of risk perception for emerging zoonoses and the given overview of the different ways to measure risk perception chapter eight leads to a consideration of the most important aspects for surveillance of risk perception for emerging zoonoses in chapter nine. In addition consideration is given to the future steps.

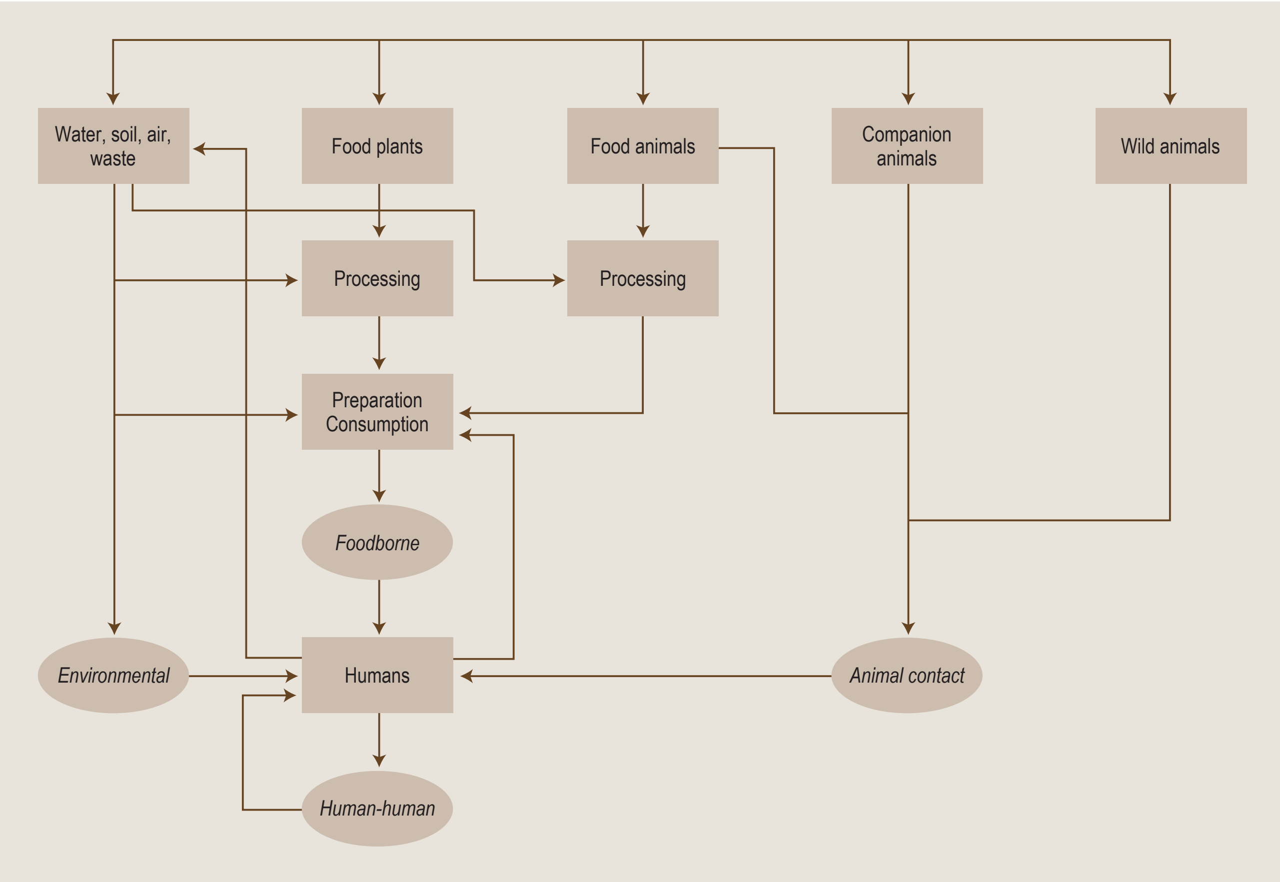

Figure 1. Routes of transmission of zoonotic pathogens.
Source EFSA, 2008 (14)

2. Specificities of emerging zoonoses

According to Brug et al. (13) application of risk perception methods for infectious diseases are thus far not been specifically researched, let alone specific application for zoonoses. Furthermore, they conclude there is a gap in research on the applicability of the determinants used in risk perception research concerning emerging infectious diseases. In order to gain insight into which determinants measuring risk perception have potential use for emerging zoonoses, attention must first be given to the characteristics of zoonoses. As mentioned in chapter one, a zoonosis originates from an animal reservoir and is transmissible from vertebrate animals to humans. The figure below strives to provide insight in the different routes of transmission and subsequently how an individual can get exposed and therefore ill. Two aspects are hereby of importance: at the top side of the figure a list of reservoir possibilities is given. Underneath the corresponding way a person can be exposed to a zoonosis. The main factors of exposure as can be seen in figure 1, developed by the European Food Safety Authority are preparation and consumption, direct animal contact and via the environment. Globalisation and subsequently travelling is sometimes also mentioned as a potential attributor; however it is not considered a main point of exposure in most research.

Besides the causal routes of attribution portrayed in figure 1 the human risk of acquiring a zoonosis is affected by multiple other factors influencing the emergence of a disease. These factors include ecological, environmental or demographic that place people in increased contact with the zoonotic agent (15). For example in the case of *Echinococcus multilocularis*, a zoonosis in which humans can be infected via faeces of a fox, it has been shown that environmental, occupational, behavioural and socio economic factors all influenced the individual risk of acquiring *E. multilocularis* (7). In addition, in terms of risk assessment and prevention of zoonoses, the recent political attention concerning the Q fever epidemic showed again how important the political factor is in the risk of a zoonosis. For example by means of regulations in the veterinary sector. This could be controlling regulations, like limiting the amount of animals that can be held, or through granting building licences for farms. Multi-factorial risks are however not exceptional but rather common in health risks or risk in general for that matter. The real question that arises is which specific aspects of zoonoses set them apart. Subsequently appropriate attention to the application which determinants measure risk perception should been given. Brewer et al. (16) conducted an meta analysis of influenza studies concerning risk perception of influenza. Assessment wise they formulated three separate dimensions of risk perception; perceived likelihood, perceived severity and perceived susceptibility. These aspect can most likely also be used for zoonoses.

As mentioned in chapter one, in light of the EmZoo project 86 zoonoses have been identified considered relevant for the Netherlands (Braks et al, 2010). These selected zoonoses are caused by a variety of pathogens, bacteria, viruses, helminthes, protozoa fungi and a prion. In consequence of this diversity of organisms, their modes of transmission also differ to a large extent. For example, salmonella is transmitted mostly through food consumption whilst Q fever is airborne. In other words, the only commonly shared characteristic between these diseases is that they originate from an animal reservoir and are (directly) transmittable to humans. In the literature three aspects characterizing zoonoses where found the most important concerning risk perception in this context: First, the lack of knowledge of the public, second the multi sectoral area with complex interest and provision of information and finally fear of zoonoses.

2.1 Lack of knowledge

Although there is limited information concerning the specificities of emerging zoonoses and public risk perception, one aspect is mentioned several times. According to Holmes (2008) the main difference of communicating about emerging infectious diseases compared to obvious risks, such as flooding, is the "lack of shared understanding of the need for action". Dealing with emerging diseases there will be less evidence to draw on for the public (17). Since all zoonoses can also be considered infectious diseases this argument can be considered relevant for zoonoses as a sub group. Moreover, two specific papers on zoonotic risk perception; zoonotic infections of dogs (18) as well as a helmintic zoonosis (7), have shown that limited public knowledge had a large influence on risk perception. While the risk of chronic diseases with a larger mortality like cardiovascular diseases are recognized with predisposing factors that have been almost the same for years, many of the zoonoses are relatively new and have not yet caused problems for the public health in the Netherlands. New threats however emerged during the last decades, on a larger scale like avian influenza or BSE, or emerging in new areas like the West Nile Virus (19, 20). People have in most cases limited control over exposure to or contracting of a zoonotic disease. Possibly this explains why infectious diseases like zoonoses can cause large public unrest. Knowledge and uncertainty are therefore important aspects in theories measuring risk perception when it concerns zoonoses.

2.2 Multisectoral area, complex interests and provision of information

Since most zoonoses have impacts on the animal population (domesticated or wild) as well as in the human population, the direct consequence of this characteristic is that in addition to the health sector, the veterinary sector and the environmental sector are mutual stakeholders. Individually for most people human public health is priority number one. If this is however the number one priority in overall risk assessment can be debated. What interest why at which moment is one of the reasons of public unrest. It could bring about uncertainty and trust issues, despite the fact that veterinary, environmental and human health professionals cooperate together and are even aiming for integration for example through the *One health approach* (21). The two sectors in origin typically serve a different need. Therefore in some aspect they have different interests and will provide different information. Furthermore, the multidisciplinary aspects of any zoonosis might cause these different interests to clash, for example on economical grounds. All these points, such as communication concerning these different interest can influence the risk perception of the public to some extent. In the case of BSE in the United Kingdom, the experience of an the inquiry commission regarding the entire period let to the conclusion that a policy of openness was the correct approach. By expressing and exploring doubts openly the public is capable of responding rationally and are more likely to accept reassurance and advice if and when it comes (22). Trust is closely related to the acceptance of information. According to Slovic (23) trust in expert knowledge will make people more acceptant of the risk. Hansen et al (24) add however that if a person already has a strong judgment towards a certain potentially hazardous activity, such as the consumption of food potentially infected with a zoonosis, *"they will confer trust upon a source which provides a risk message congruent to their attitude, but distrust a source which provided a dissonant message"*. Furthermore disagreement between experts has been shown to act as an amplifier of risk perception (25).

2.3 Fear

As mentioned in the first aspect, zoonoses are infectious diseases and when dealing with infectious diseases historically the word fear is of importance. According to Pappas et al. (20) historically the most significant psychological unrest in relation to human health is related to infection. Lately emerging infectious diseases attracted substantial scientific and media attention. In a historical overview of emerging infectious diseases Morens, Kolkers and Fauci (26) however suggest that infectious diseases have occurred throughout the history and will remain a challenge in the future. The reason for psychological unrest or public fear can be found in the characteristics of infection: transmissible, imminent and invisible (20). This fear might have some relation with the fact that people have very limited control over all these aspects. They further argue thatin contrast of the relative stabile fear for more burdensome diseases, like chronic conditions, , "germ panic" nevertheless consistently re-emergences causing psychological unrest.

3. Addressing perceived risks of emerging zoonoses

In different fields, risk and the perception of risk have been studied to a large extent. There are therefore numerous theories which describe risk perception based on different aspects and how to estimate the perception.

3.1 Addressing risk perception

What is risk perception? To answer this question, attention must first be given to the concept of "risk". According to the report *"Coping rationally with risks"* (5) a risk is a multidimensional concept, which can both be calculated in an "objective" quantitative way as well as be seen as a social "construct". The dominant conceptualisation of risk is "the chance of injury, damage, or loss" (Webster dictionary) assuming this risk can objectively be quantified by risk assessment (23). The idea that risk can be described as: probability x harm (sometimes a scenario is added) fits into this perspective. In other words, risk is about rationally weighing the negative consequences of an uncertainty. What influences the public opinion is specifically researched in the field of social sciences. Many social science analyses reject the notion of solemnly rationally weighing the negative consequences, arguing instead that risk is inherently subjective and not "out there". Risk is in this sense seen as a dynamic process. Furthermore is it more and more recognized that current knowledge of reality is limited and thus knowledge about the way risk develops is limited as well (5). A risk by this perspective is what humans invented to help them understand and cope with the dangers and uncertainties of life. The 'social perspective' therefore dismisses the idea of "real risk" or "objective risk" (23).

It is clear that the interpretation of the concept of risk has a direct influence on ideas about how people perceive risks. An integrated way of describing risk perception beyond the mentioned different ways of conceptualising a risk is given by Sjoberg et al. (2004):

Differences in terms of what influences and subsequently how to measure risk perception are sometimes assigned to gaps between different professions or groups. Pidgeon, Kasperson and Slovic (2003) go a step further. In their research concerning the perception of the public to a certain health risk they argue that risk perception and risk communication literatures in itself is still seriously fragmented.

In social science literature risk perception is often used as a component of describing behaviour or behavioural change, either for individuals or groups. For example this is the case in the area of health promotion. In this context, different models have been developed in which risk perception is a central element to explain behaviour or behavioural change as illustrated by the Health Belief Model (HBM) or the Protection Motivation Theory (PMT). In the book: *"Exploring risk perceptions of emerging infectious diseases"*, Onno de Zwart uses the PMT as a general theoretical framework and starting point for exploring risk perception of emerging infectious diseases (10). According to Zwart, the current limited information in this area gives heed to the need of more insight in risk perception.

3.2 Fields of risk perception

In order to give an overview of the dominant public perception of emerging zoonoses, first attention must be given to the dominant theories measuring risk perception. When looking into the sectors potentially related to risk perception of zoonses, it becomes clear a zoonosis is not just a health related risk, other influencing fields might be environmental related risk or food related risk. These in many ways overlapping fields describing risk perception could potentially give insight for this research. Not only are this different fields of research, with different tools and theories. Due to the scale of these different areas of potential interest and the sheer size of the field of risk perception, certain assumptions have to be made to fit the time, limiting the scale of this research. Therefore four dominant theories have been chosen through overview and review articles concerning risk perception.

3.3 Dominant theories

In the next four chapters these four dominant theories regarding the measurement of risk perception will be explained by means of; background, methodology, limitations and their relevance for zoonoses. These four theories are, respectively, psychometric paradigm, social amplification of risk framework, health belief model and to conclude the protection motivation theory.

4. Psychometric Paradigm

The psychometric paradigm is repeatedly mentioned as the leading contender in the field of risk perception and risk communication (27, 28). The psychometric paradigm assumes that with appropriate design of survey instruments, factors that influence individual risk perception can be quantified (23). The idea behind research in line with the psychometric paradigm is that lay and expert people do not deal with risk the same way. In fact, it argues that judgments about risk generally differ between people (29). By using an expressed preference approach, research with a psychometric approach seeks to provide a neutral analysis of the different ways in which risks are perceived (24, 27).

4.1 Background

The origin of the psychometric paradigm lies at the hands of Chauncey Starr. His theoretical research started with the question how to weight technological risks against benefits, in other words, how safe is safe enough? (29) In his work Starr used a revealed preference approach, assuming that societies develop a balance between risks and benefits. He found that people are willing to accept a certain risk if the benefits exceed the danger, he describes these risks as voluntary (30). Following this work of Starr, Fischhoff et al (31) were the first to describe the psychometric model. This model has been extended since the launch by Fischhoff et al in 1978. The basis of the model is a theoretical framework that assumes risk perceived by the public is multidimensional and not merely a trade off between benefits and risk perceptions. Thus an individual may be influenced by a wide array of psychological, social, institutional and cultural factors (23). Furthermore research using this approach assumes that these factors and their interrelationships can be quantified and modelled. (23) Hereby identifying and quantifying similarities and differences in risk perception among individuals and groups (32).

4.2 Methodology

Structured psychometric scaling methods with a number of explanatory scales are used to produce quantitative measures of perceived risk, perceived benefit and other aspects of perceptions (27, 33) In these scales several hazards such as BSE, and pesticide residue, are listed that were rated by people as high risks, although experts did not always rate them high (28). Multivariate analysis techniques are then used, leading to a quantitative representation of risk perception, unveiling the factors that determine risk perception (33). The hazards are subsequently mapped in a two dimensional space, as can be seen in figure 2 . Through factor analysis the mean ratings of each hazard on the scales are compared, resulting in the main factors describing the variance. Hazards then can be compared on the basis of risk perception. In the earlier mentioned first study by Slovic (31) nine dimensions were used as scales on which people had to rate the "perceived riskiness" of a large number of risks. In subsequent studies the amount of scales differs, usually eighteen (2). Nevertheless the nine single dimensions the participants were asked to rate in this first article concerning risk perception by the psychometric paradigm where:

These dimensions are asked to rate in a single scale. For example to operationalise the first dimension voluntarily. The scale can be described as; to what extent the population is exposed to the risk associated with each activity, substance or technology voluntarily. Participant can rate this question from low (1), involuntarily to high (7), voluntarily. For the dimension severity of the consequences the scale can be described as; should the risk associated with this activity, substance or technology occur, how likely is it to produce fatal consequences with the rating option of low (1), non fatal, to high (7) fatal.

Through factor analysis two main factors explained much of the variance: the level of dread and the level of knowledge in science and of those exposed. In following research most studies showed the same two factors explaining the largest part of variance; the first was dread risk (severity) and the second if the risk was known. However a third factor was found in later research, the number of people exposed to the hazard. To explain what can be understood by dread risk, Slovic (23) presents a broad definition of experts; the perceived lack of control, dread, catastrophic potential, fatal consequences and the inequitable distribution of risk and benefits. Furthermore experts define unknown risk as unobservable, unknown, new and delayed in their manifestation of harm.

The figure on the next page illustrates the two dimensional map from a research regarding risk perception in relation to food consumption and food production amongst a consumer panel of a private research company. This figure exemplifies the importance of two components of risk; unknown and severity, where the latter reflects the dread dimension of risk perception (34). As can be seen in figure 2, Salmonella and bacterial contamination in the right bottom quadrant are relatively known and considered severe. Genetic Manipulation (GM) in the top of the figure is however relative unknown and in terms of severity in the middle. Known voluntary lifestyle risks such as alcohol and high sugar or fat diets are rated relatively low in terms of perceived severity.

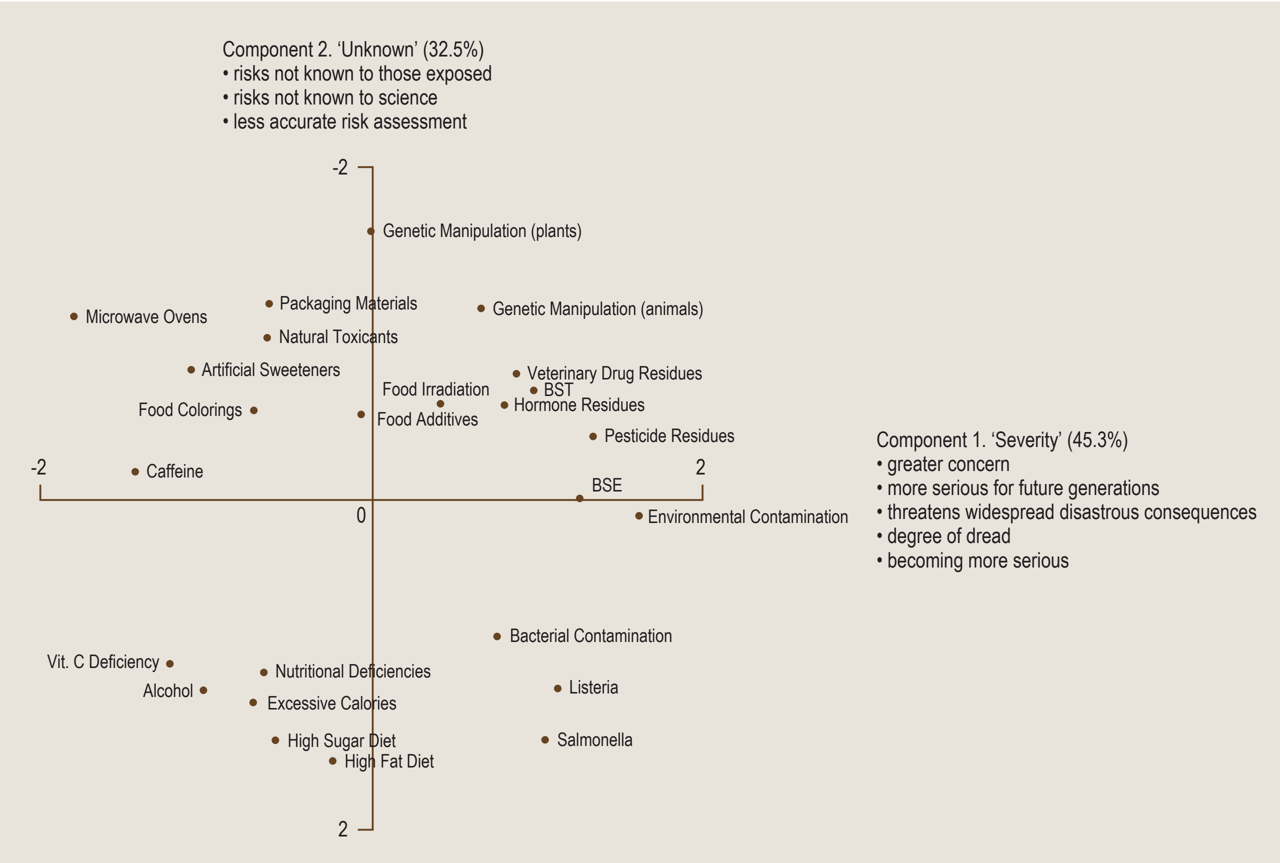

Figure 2. Location of food-related potential hazards within the two-component space.
Source: Sparks and Sheperd 1994

4.3 Criticism on the psychometric paradigm

One of the criticism regarding many psychometric studies is the potential bias due to academic convenience sampling used to assemble respondents for the research (27). Another potential limitation of psychometric research is the use of mean data, less subjected to error and not taking individual differences in risk perception into account. They aggregate the data in order to perform factor analysis (35), whilst many studies have shown risk perception differs amongst individuals. Siegrist et al (35) further suggest that personality factors such as the general level of trust and confidence play a role in explaining risk perception.

4.4 Implications for zoonoses

The main advantage of research in line with the psychometric paradigm is the possibilities it offers of quantifying and comparing hazards. For risk perception of zoonoses this advantage will give a direct link with prioritization of emerging zoonoses for policy. However in the psychometric paradigm tradition, very general hazards were used rather than specific hazards. For example what respondents think of when asked to rate the general hazard "gene technology" could be different, maybe they thought of genetically modified food, or drugs. Since zoonosis are most likely considered specific hazards for people and most zoonoses will be unknown, people potentially have to rate their perception about something they are not familiar with, which might be problematic. Since this possibly causes limited explanatory power as has been the main potential limitation in research of Siegrist et al. (35) who used more specific hazards . Furthermore the sampling strategy might also be a point of issue. Due to the need of extensive questionnaires, surveillance by this method might be difficult. Adding all 86 zoonoses to a list of hazards would extent the survey tremendously. It does not seem realistic to ask participants to rate such a large number of hazards.

Furthermore, zoonoses will most likely score high on the dimension scaling how known a hazard is due to a lack of knowledge from the public. Since this scale has been found to explain a large part of the variance and participants are not familiar with the zoonosis, combining a large amount of zoonoses like 86 to a list of hazards could influence the results; decreasing the explanatory value and therewith the validity of using this method for this group of diseases. This could be prevented by combining smaller selections of zoonoses to the hazard lists in a random way. The question arises however that if individuals have no knowledge of the zoonosis, some basis information must be given in order to rate them and how this information can be given without biasing the measurement.

As mentioned in chapter three, due to the multi sectoral interest along the causal routes of a zoonosis, information and trust in expert knowledge are aspects that should be addressed when measuring risk perception of zoonoses. In the PP these aspects could be measured in the one dimensional ratings, therefore these aspects fit into the model, however where never found to explain the risk perception.

5 Social amplification of risk

The social amplification of risk framework (SARF) tries to explain the various processes through which activities with potential health hazards may become the focus of social and political concern. Subsequently this focus may lead to risk amplification or the opposite, risk attenuation (36). Risk perception is therefore a result of a process by which individuals and groups "learn to acquire or create experiences of risk" (37). The driving force explored in this framework is media coverage (17).

5.1 Background

In order to overcome the fragmented nature of risk perception and risk communication research in the late 1980s, Kasperson, Kasperson, Renn and collegeas (36, 38, 39) developed an integrative theoretical framework, the SARF. This framework integrates findings from a wide range of theoretical and social science studies. In the context of the social amplification framework there is no such thing as absolute or socially determined risk. Originally risk only had meaning in this framework to the extent that it is a reflection of how people interact within a social context (36). In later research this notion was expanded, arguing that culture also has an impact (37). The framework can be used to explain in what way both social and individual factors influence public risk perception by means of amplifying, reduction or even modifying perception. If amplification modifies the perception of a certain hazard this can potentially result in or "ripple" to secondary results such as stigmatization of people, places and ideas (40) or even to economic losses (36). In figure 3 these ripple effects are shown as effects on different levels, such as industrial, company and victims.

As shown in figure 3, according to SARF the process of amplification starts with a risk event "E", risk perception and subsequently behaviour is influenced by psychological, social, and institutional factors. People gather and react to information, after risk event E individuals or groups then select the characteristics of that risk, sending their interpretation via their personal information channel. Besides this channel the SARF argues that influence takes place by means of a network of formal, such as the media, and informal personal channels or mechanisms (41). People experience risk first of all by these signals (42). Kasperson and Kasperson further argue that such signals are subject to predictable transformations as they filter through "various social and individual amplification station(s)". In figure 3 these stations are described as risk related behaviour, by means of institutions, groups and individuals, leading to particular interpretations and responses by members of the social network of a person.

Social amplification in turn describes why some hazards or events seem to create so called ripple effects with secondary and tertiary impacts spreading like the ripple effects of a stone in the water beyond the initial effects of the hazard. The media may contribute as a primary amplifier. These secondary and tertiary impacts could include the demands for regulatory action by the government, loss of sales, loss of trust in decision authorities or industry, litigation and stigmatisation of a community or product or facility (43).

5.2 Methodology of the social amplification framework

Since empirical examination of the SARF is rare, there is no single method for using this framework. The framework mainly gives an overview of which factors influence risk perception. Risk perception determinants are important in measuring risk perception, this model does not stipulate how to actually measure these components. For example, to research the relation between risk perception of BSE and media attention, Frewer et al (44) used the model by developing a 7 point rating scale questionnaire where participants rated their level of agreement after which a principal component analysis was conducted. In contrast, Lewis et al (40) used the framework by comparing media attention for BSE with media attention for the Golf war in that time by means of the number of news articles.

5.3 Criticism on the social amplification framework

The SARF provides a useful terminological framework, however the usability of this framework is limited to studies of the general process determining social attention to risk (45). Sjöberg et al. further argue that more empirical data is needed to further develop the SARF by means of formulation specific theories which leads to testable hypothesis. Not only are current empirical examinations of the SARF rare, they must be opportunistic to some extent (46). The framework namely implies that it is difficult to predict when conditions that trigger risk amplification or attenuation of a risk event will occur. Without foreknowledge of such risk events, planned empirical data collection assessing public

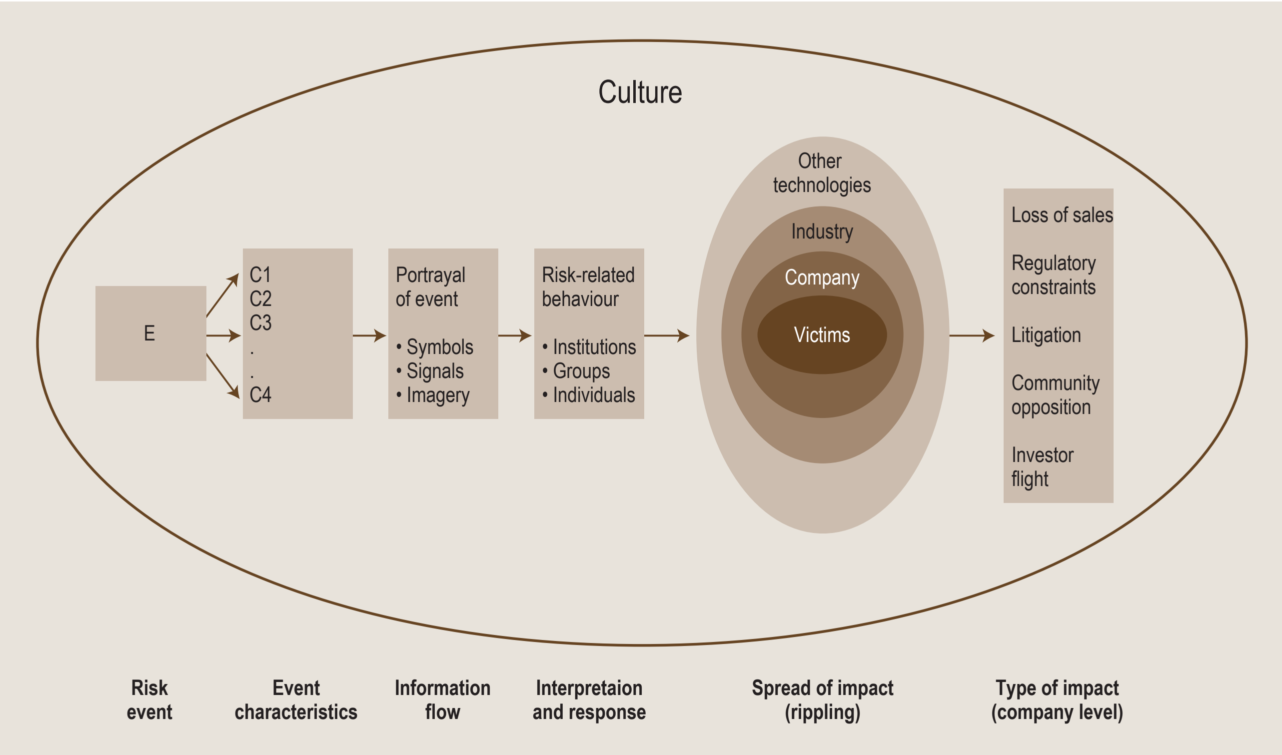

Figure 3. Social amplification framework (simplified commercial example version).
Source: Kasperson et al. 1988(36)

attitudes before and after amplification or attenuation has occurred is difficult. (46). A number of attempts to test SARF empirically suggest that SARF can however explain some of the underlying causes and factors influencing social responses (43). Yet, the secondary and tertiary ripple effects proved more difficult to examine. In particular the durability of the effects, and the factors which lead to an issue remain "controversial or receding" (47). Frewer et al. add that these difficulties in predicting when conditions are likely to result in amplification effects make it difficult to examine changes in risk perception that are "contemporaneous with increases and/or decreases in social or media discussion of the risks associated with a particular risk event" (46).

5.4 Relevance for emerging zoonoses

The BSE crisis has often been described as a "textbook example" of the social amplification of risk (48, 49). Only after the connection of BSE with the human Creutzfeldt Jacob Disease did public perception of risk associated with beef consumption increased in the UK (50). The scope and structuring of the SARF allows the generation of policy suggestions, in terms of planning the proper approach to risks. In terms of applicability for zoonoses, the general framework seems to fit the complex process of risk perception for zoonoses very well. It shows exactly those difficulties of the process of risk perception that risk prioritization of emerging zoonoses is potentially aiming for. However, the framework is thus far mainly used to address manifestations of amplification and attenuation (36) and does not address the core relevance for risk perception of emerging zoonoses surveillance namely, the development of normative criteria for judging the outcomes of social risk amplification and gaining insight in the potential risk perception beforehand. The complexity of the SARF makes the application for surveillance somewhat unpractical. In terms of early warning and surveillance this framework however provides those factors that were found to be of importance for public risk perception of emerging zoonoses, such as fear, familiarity and the multi sectoral field with different interest at stake. Potentially this model can be used as a general framework. Furthermore the conception that public risk perception can be intensified and attenuated by social process provides the basis of research in the specific relation of the media and risk perception as during the BSE crisis. This idea has for example been researched in the study concerning newspaper coverage of food safety issues and consumer confidence by Jonge et al. (51) resulting in a positive relation.

6. Health Belief Model

The main concept of the Health Belief Model (HBM) is that the decision to engage in healthy behaviour depends on the personal beliefs or perceptions about a disease and the strategies available to decrease its occurrence (52). In other words, people weigh the perceived health threat versus an evaluation of the recommended behaviour. The model hereby attempts to explain and predict the actual behaviour.

6.1 Background

The HBM is a value-expectancy theory, regarding behaviour as a subjective value of an outcome. The HBM is one of the oldest models of health behaviour. It was developed during the ninteenfifties by social psychologists Hochbaum et al. (52) in order to understand why people do not partake in preventive and early warning surveillance programmes, such as vaccination or screening (53). Originally the model suggested that decision making in public health was apart from socio demographic factors, influenced by four basis premises; perceived susceptibility of the risk, perceived severity of the risk, perceived benefits of preventive behaviour and perceived barriers to the behaviour (53). In addition, the model was in later years also used to describe other behavioural aspects and more complex health behaviour such as lifestyle related changes, smoking cessation and healthy eating. The variable self efficacy was then added. Self efficacy relates to “the conviction that one can successfully execute the behaviour required to produce the desired outcome” (54). Among other research to Schafer et al. found in the application of HBM to food risk self efficacy amongst the factors of most impact on public behaviour (55).

6.2 Methodology

The aspects of the HBM can be measured and used by a variety of techniques ranging from surveys to clinical interviews. In figure 4 the previously explained premises are translated into the following; the likelihood of behaviour to reduce a threat depends on the expectation together with the perceived threat. Expectations encompass the two basic premises perceived benefits minus barriers in addition to the added factor, perceived self efficacy. As can be seen in figure 4 another dimension is added, labelled “cue to action”. That is, the HBM suggest a change of behaviour can be influenced by events or people, for example concerning zoonoses a cue to action might be that a family member with Q fever can influence other family members to take precautions when dealing with goats. Furthermore in figure 4 the top indicates that an individual’s background influences the initiation of any behaviour, the individual socio demographic factors therefore inherently influence all aspects of health behaviour.

6.3 Criticism on the Health Belief Model

The HBM has generated a widespread application of research and has been accepted by different fields of health professionals, including physicians, dieticians and health educators. The model has therefore been evaluated over the years, identifying several limitations. One of the main criticisms suggests that the HBM is in fact not a model, but a collection of variables possibly describing healthy behaviour (57). According to Rimer (58) most concepts of the research have received substantial empirical support. This relates however to the following. There has been scale development in some topic areas. Nevertheless different researchers measure variables differently and there is no clear development of the collection of variables. Strecher and Rosenstock cautioned users of the HBM to be mindful when using components of the model, since variables measured out of the context of the model makes results difficult to explain. Phuannukoonon et al. argue that especially tropical disease control programs have used the HBM despite the limitation of the application and usefulness. The limitations they mention is related to the scope of the model. It remains limited in addressing broader dynamics involved in disease control, such as social, cultural, economic and community dynamics (59). The model is used for Leppin (60) furthermore suggests that behavioural models such as the HBM mainly focus on how risk perceptions and other cognitions influence behaviour. In other words risk perception as an aggregation of individual assessment. Therefore the question how risk perceptions are formed has been met with little attention (60) while this aspect, in combination with the mentioned broader scope is futile for the surveillance of emerging zoonoses.

6.4 Implications for zoonoses

In terms of surveillance of zoonoses, knowledge about the health threat is measured in this model since it is an aspect of perceived severity and perceived susceptibility. The focus of the HBM lays however at the weighing of the threat in combination with an action of the participant. The main ideas concerns a sort of cost benefit analysis how people conceive a health threat and subsequently how they look at their risk behaviour to cope with the threat. This aspect of how people behave might be of interest for zoonoses as well. However, in many cases there are not directly clear existing measures developed for decreasing the individual risk of an emerging zoonose. In Thailand the HBM has been adopted as the principle theory for dengue haemorrhagic fever (DHF) prevention and control (59) and contributes mainly to the development and evaluation of control messages for DHF. This model provides specific insights in terms of behavioural determinants. The multi sectoral aspect of emerging zoonoses as described in chapter three is not an explicit consideration within the HBM. Only *cues for action* might give room for that aspect. Finally the aspect of fear has been addressed in this model by means of the aspect perceived susceptibility and severity. When used to measure risk perception for emerging zoonoses this model provides elements that can be used as tools to develop a suitable surveillance survey for emerging zoonoses.

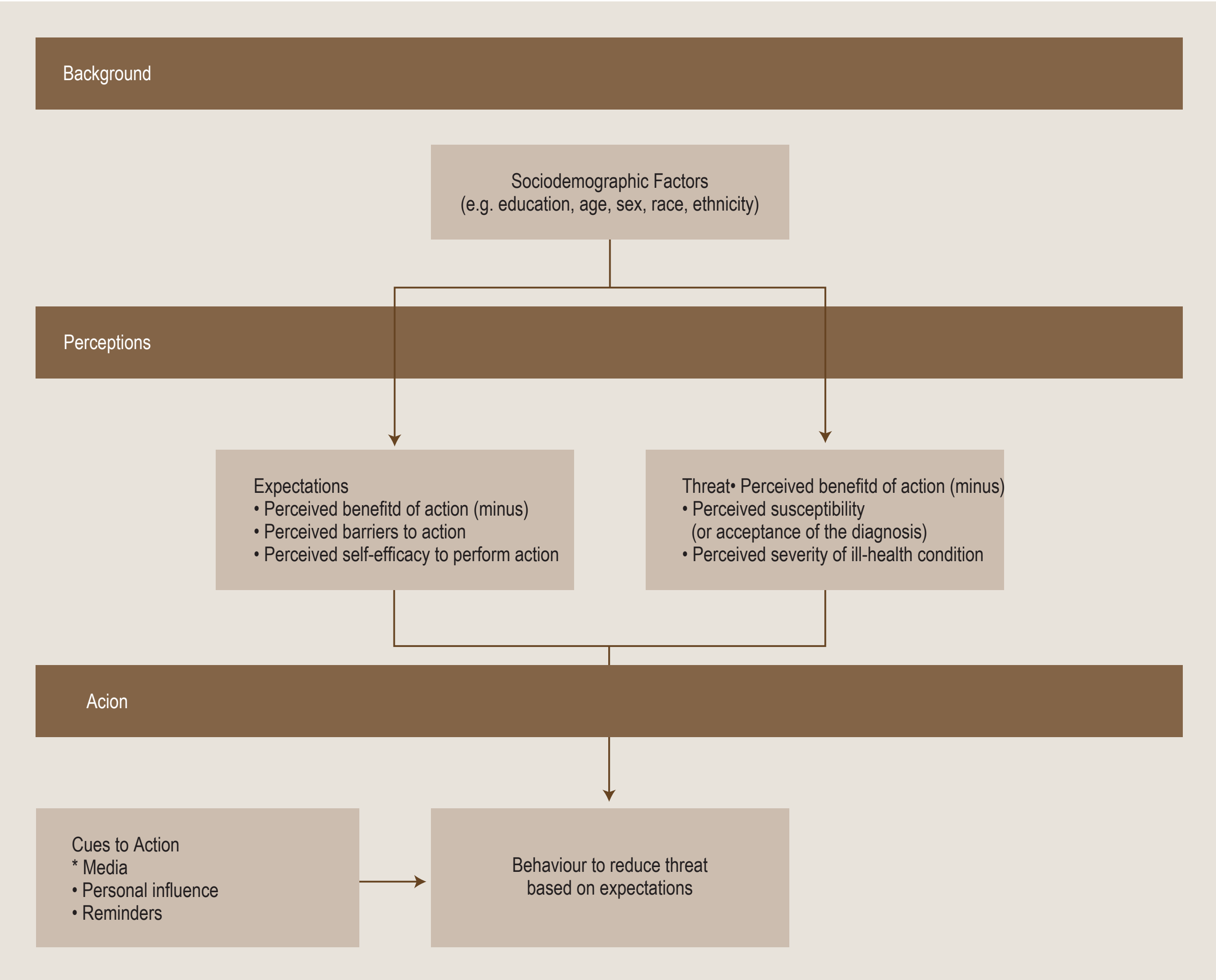

Figure 4. Health Belief Model.
Source: Rosenstock I., Strechter et al. (1994) (56)

7. Protection Motivation Theory

The Protection Motivation Theory (PMT) is part of health related behaviour research approaches which focus on the question of how individual risk perception influences decision making and consequently behaviour (60). Thus in this model risk perception is not the central aspect, it is merely one component relating to health behaviour and attitude. Furthermore in the PMT risk is defined in line with the likelihood of contracting a disease.

7.1 Background

One of the dominant theories describing behaviour is the PMT (61, 62). The original Protection Motivation Theory (PMT) as described by Rogers (61) investigates the effects of fear appeals on persuasion. This research focused on the effects of threatening health information on attitude and behaviour change of the public (62). The theory has been developed from a category of theories with expectancy and value constructs.(61, 62).

The main variable to explain behaviour in the protection motivation theory is the idea that a certain behaviour is the result firstly of perceived values and secondly expectation of the outcome (63). Accordingly, the two underlying processes influencing behaviour that are used in the model to specify and explain these variables are threat appraisal and coping appraisal.

As shown in figure 5, two possible strategies in precautionary behaviour can be distinguished, the maladaptive and the adaptive response. This means either healthy (adaptive) or not healthy (maladaptive) behaviour. As mentioned, in the original model the protection motivation depends on two aspects; threat and coping appraisal, illustrated in the middle of figure 5. Threat appraisal encompasses different concepts: the perception of the severity of a health risk is combined with the perceived vulnerability of a person to determine the perceived threat. A person however also values certain intrinsic and extrinsic rewards for the risk. For example the pleasure of petting an animal when dealing with the threat of a zoonosis can be considered a non-negligible reward.

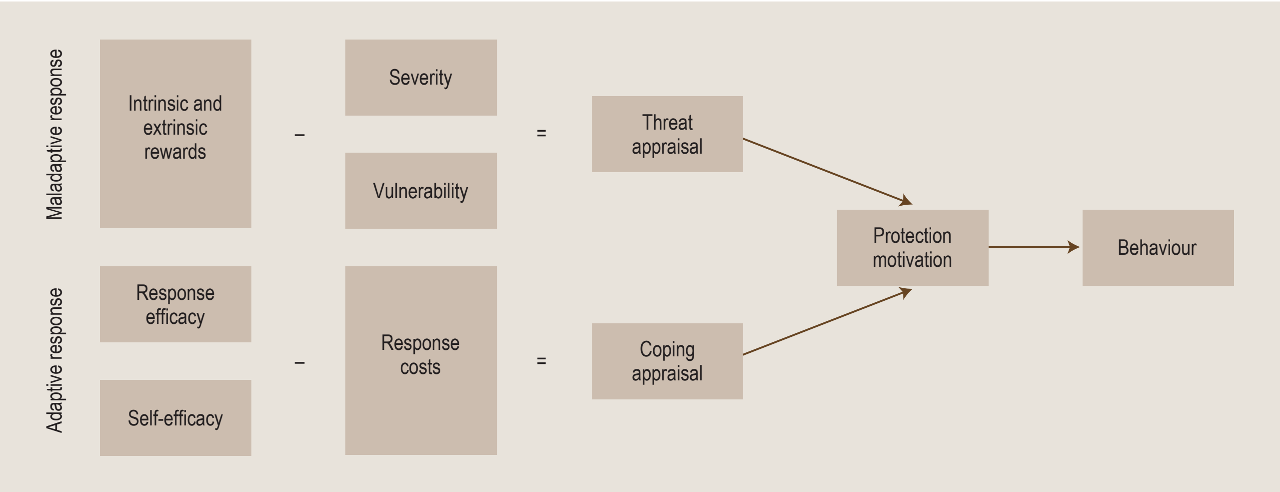

Figure 5. The Protection Motivation Theory.
Source: Zwart, 2008 (64)

These intrinsic and extrinsic rewards minus the perceived severity and vulnerability lead to a certain threat appraisal or risk perception. On the other hand, an individual his or her coping appraisal also encompasses three factors. The first, self efficacy is already explained in the previous chapter concerning the Health belief model. Self efficacy relates to the perception of an individual to be able to successfully execute the behaviour required to produce the desired outcome (54). Second, response efficacy deals with the efficiency someone beliefs the protection motivation (the response) will lead to decreasing of the perceived risk. Finally the PMT argues that subtracting response cost from both response efficacy and self efficacy leads to the coping strategy.

7.2 Methodology

The most recent version of the theory assumes that the motivation to protect oneself from danger is a positive linear function of beliefs that: the threat is severe, one is personally vulnerable, one can perform the coping response (self efficacy) and the coping response is effective (response efficacy) (65) .The PMT is mainly used as a general theoretical framework for example for influencing and predicting various health related behaviors. Besides the PMT shares large similarities with the HBM in terms of the application of research, it ranges from questionnaires to clinical interviews but surveys and experiments are favoured. In most research rating scales are used to measure threat appraisal and coping appraisal in which participants need to rate for example their perceived severity, vulnerability and comparative vulnerability.

7.3 Criticism on the Protection Motivation Theory

Many of the criticism on the HBM also relates to the PMT. As the HBM this model assumes a rational process of risk perception. An important limitation is that not all variables in this model have been identified (66). According to Zwart (64) the PMT specifically lacks affective factors such as social aspects influencing risk perception.

7.4 Implications for zoonoses

The PMT in fact has already been used as a framework measuring risk perception in emerging infectious diseases like SARS and avian influenza (64). Like the HBM the aspect of knowledge of the participant is one of the measured aspects. Perceived severity, vulnerability and susceptibility are important aspects that give some insight in the fear of participants. However the scope of perceived risk perception in this model is so focussed on the participants weighing for protection motivation there is limited room for influencing factors like received information or emotional aspects such as fear and trust. The PMT uses a more rational approach, considering individuals make an assessment of the risks. For emerging zoonoses the multi sectoral area might be of potential influence of the risk perception. This aspects is not addressed as such in this model. In the earlier mentioned research in emerging infectious diseases like SARS one of the aspects that has been added were aspects of affectivity.

8. Results and discussion

In searching aspects that can predict a very high or very low public risk perception four models where reviewed in order to see which aspect might be useful for predicting risk perception of emerging zoonoses for surveillance and therewith policy prioritization. The table in appendix 1 gives an overview of those aspects describing first, the various methods, critics of the method, and finally the three specific aspects most relevant for zoonoses; lack of knowledge, multi sectoral and fear.

The *background* of the different models model shows the complexity of the dynamic process labelled risk perception. As a result the biggest difference between the models lays in the way each model tries to simplify this process of risk perception. The psychometric model focuses on comparing risk estimates on group data, while the two behavioural models focus on aspects influencing the individual or group risk perception while the SARF focuses on the whole process including signallers like the media.

In terms of *method*, the SARF provides merely a framework with somewhat broad factors that lead to some extent towards an individual risk perception. The HBM, PMT are both models in which risk perception can be seen as a descriptive factor of why people behave in a certain way. The PP on the other hand, provides a more structured way of scaling the perception of risk and by this scaling gives insight which aspects are most relevant for risk perception based on more or less commonly used scales. In that aspect, the PP is different from the other three theories, choosing per definition a quantitative method, while the HBM, PMT and SARF have been used both for quantitative and qualitative research. Also in terms of variables, the HBM and PMT have no predefined ready to use set of variables for emerging zoonoses. A choice can be made of variables that seem fit to the specific research as long as they are used to describe to different aspects of these models. For example how to measure self efficacy is not pre defined. For a large part previous research methods can be used. The PMT has for example already been used for SARS, a disease that resembles a zoonosis to a great extent. The SARF does not have a predefined aspect either. This framework however assumes underlying relations that can be used to describe risk perception. In order to use the framework a new set of variables must be designed.

Some limitations have been indicated in all four models. Concerning the psychometric paradigm the issue of aggregated data has been mentioned several times. Research has shown that individual preferences and characteristics influence the risk perception. Furthermore in most psychometric research the risks participants are asked to rate risks that are rather broad and known to the participant, like alcohol. Asking participants for a specific hazard like the zoonotic Pumaala virus potentially influences the results, since people are most likely not familiar with this virus and have no information besides the name to base their rating on. In order to simultaneously rate specific hazards and broader hazards, adaptations need to be made.

In chapter two, three aspects that are of particular importance for zoonoses have been defined. In terms of the aspect *lack of knowledge* all models implement this by different variables. In the psychometric paradigm the lack of knowledge could be measured by; newness of the risk and level of knowledge in science about the risk. These variables are commonly used in scaling risks, the factor of how known a hazard is, has even been found as one of the main aspects of explaining the variance of risk perception within research using the psychometric paradigm. Within the HBM and the PMT the actual knowledge of an individual about the hazard or risk is not a specific component, it is however usually measured. For example in the PMT by the denominator threat appraisal and in the HBM by the denominator threat.

One of the shared characteristic of emerging zoonoses is de *the multi sectoral area, complex interests and provision of information* due to the different sectors, such as the human and veterinary health sector that are involved. The impact of this specific characteristic of the risk of zoonoses is not easy to measure since this is not an easily defined variable. However in the SARF this aspect is one of the main components. As mentioned before, in the SARF there are no predefined variables. So there is not an existing method how to measure this impact. In the psychometric paradigm one could use many variables, however none of which have been found describing most of the variance. Finally in both the behavioural models the PMT and HBM, this aspect does not partake in the general model. Only the HBM aspect "cues to action" would enable this aspect directly into the model.

The aspect *fear* is especially measured by the psychometric paradigm under the denominator level of dread. This aspect has actually been found to describe most of the variance and therefore seems repeatedly to be of great importance for the risk perception of hazards. In addition the level of perceived control and the level of perceived involuntariness could also give insight in the level of fear. In both behavioural models fear is an aspect that is taken into account by means of other variables. In the PMT it could be measured by the variables vulnerability and severity, hinting towards the level of worry or fear, also called perceived threat in the model. In the HBM the measurement of the level of fear is less clear, it could be measured by the perceptions of both expectations and threats. In the SARF fear is easily implemented in the first process, especially in relation to the so called step, risk related behaviour, individual interpretation and response.

9. Conclusions and implications

Even though risk perception seems to be a very thought out concept, there are many differentiating factors not only in definition of the concept, also in research methods. The four models of focus for this research have been used to measure risk perception and each have pros and cons that limit or enhance their usability for surveillance of emerging zoonoses to some extent.

The psychometric paradigm seems to include most of the specific aspects required for measuring risk perception of emerging zoonoses. Compared to the other three methods this model however seems to be a simplification of the process. Especially since the aspect of multi sectoral interests and information is limitedly measured. Therefore it is more difficult to see if this aspect is influencing the risk perception, while for policy reasons this is very relevant information. The SARF on the other hand might be too complex to be able to give insights beforehand. First of all, due to the assumed dynamic process besides, the second part of this framework, the spread of the impact, is extremely difficult to measure, hardly any research has been done, only after a certain outbreak of the risk, like BSE.

In addition the psychometric paradigm uses aggregated data, while other research indicates that individual socio demographical characteristic might influence the risk perception. In this model it would be difficult to see if the risk perception differs between certain groups, while this is of relevance for risk surveillance. Furthermore the psychometric paradigm usually uses fairly broad definitions of hazards. In terms of specific zoonoses this could be problematic.

The psychometric paradigm is less detailed and needs limited adaptation of variables. It gives insight in the comparability of the hazards and gives limited insight in other influencing factors besides the level of knowledge and the severity of the hazard. It can potentially also be used to compare perception of different zoonoses although the fact that most emerging zoonoses are unknown to the public may result in a lack of resolution. This could potentially be over come by clustering emerging zoonoses in groups with more or less similar characteristics.

The PMT and HBM seem to be rather similar. The key aspects of both models exemplify a rational process of an individual, while the HBM includes the aspect clues to action. The usability of these models is rather high, since both can be adapted by choosing variables to measure the different aspects influencing risk perception. This aspect of adapting by fitting the variables to the specific situation is however at the same time one of the main critics for both models. Since the variables differ between researchers and research areas the validity of each variable or combination of variables could be an issue.

In conclusion, none of the models seems to be fit directly to be used in public risk perception surveillance of emerging zoonoses. In all cases variables need to be adapted or developed. The SARF seems to include most aspects that might be of relevance for risk perception of emerging zoonoses. The usability of this model is however limited, it might be to complicated to functionalise. The SARF can be used a background framework of all aspects influencing risk perception. A potential application could be the development of systematic real rime, review of information flows in of news media and social networks resulting in a early warning system for all 86 zoonoses individually.

Both the PMT and the HBM give a framework and potential variables, they focus however to a large extent on the actual behaviour and usually measure risk perception after a certain risk is already known. Little is known about the application for estimation beforehand. This is also the case for the SARF, since what influences ripple effects is considered so dynamic, very limited research has tried to predict this aspect.

10. References

1. Szyfres pnaab. Zoonoses and Communicable Diseases Common to Man and Animals. 3th edition ed: PAHO.
2. Sjöberg L, Moen, B.& Rundmo, T. . Explaining risk perception. An evaluation of the psychometric paradigm in risk perception research. 2004.
3. WHO. Chapter three Perceiving risks; 2002.
4. VROM. Omgaan met risico's. 1989.
5. Hollander G, de Hanemaaijer, A. . Nuchter omgaan met risico's; milieu en natuurplanbureau (MNP)- RIVM: Bilthoven: RIVM; 2003.
6. Macpherson CNL. Human behaviour and the epidemiology of parasitic zoonoses. International Journal for Parasitology. 2005;35(11-12):1319-31.
7. Hegglin D, Bontadina F, Gloor S, Romig T, Deplazes P, Kern P. Survey of public knowledge about Echinococcus multilocularis in four European countries: Need for proactive information. BMC Public Health. 2008;8.
8. Smith RD. Responding to global infectious disease outbreaks: Lessons from SARS on the role of risk perception, communication and management. Social Science & Medicine. 2006;63(12):3113-23.
9. Reynolds B, Seeger MW. Crisis and emergency risk communication as an integrative model. Journal of Health Communication. 2005;10(1):43-55.
10. De Zwart O, Veldhuijzen IK, Elam G, Aro AR, Abraham T, Bishop GD, et al. Perceived threat, risk perception, and efficacy beliefs related to SARS and other (emerging) infectious diseases: Results of an international survey. International Journal of Behavioral Medicine. 2009;16(1):30-40.
11. Beck SJ. Review of 'Risk, communication and health psychology'. Health Communication. 2007;21(1):97-9.

12. Zwart Od. Risk perception of infectious diseases; developing instruments to measure risk perception and implementing instruments for risk communication in order to control (outbreaks of emerging) infectious diseases. 2008-.. [cited; Available from: http://www.zonmw.nl/nl/system/zoekresultaten/delfi/projecten-database/project-detail/?Tx_videlfiprojecten_pi1%5Bproject_id%5D=4600269242
13. Brug J, Aro AR, Richardus JH. Risk perceptions and behaviour: Towards pandemic control of emerging infectious diseases: International research on risk perception in the control of emerging infectious diseases. International Journal of Behavioral Medicine. 2009;16(1):3-6.
14. EFSA. Scientific Opinion of the Panel on Biological Hazards on a request from EFSA; Overview of Methods for source attribution for human illness from food borne microbiological hazards. The EFSA Journal. 2008;764(1-4).
15. Morse SS. Factors and determinants of disease emergence. OIE Revue Scientifique et Technique. 2004;23(2):443-51.
16. Brewer NT, Chapman GB, Gibbons FX, Gerrard M, mccaul KD, Weinstein ND. Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. Health Psychology. 2007;26(2):136-45.
17. Holmes BJ. Communicating about emerging infectious disease: The importance of research. Health, Risk & Society. 2008;10(4):349-60.
18. Katagiri S, Oliveira-Sequeira TC. Prevalence of dog intestinal parasites and risk perception of zoonotic infection by dog owners in Sao Paulo State, Brazil. Zoonoses Public Health. 2008 Oct;55(8-10):406-13.
19. WHO. Future trends in veterinary public health. World Health Organization technical report series. 2002;907:i-vii, 1-85, back cover.
20. Pappas G, Kiriaze IJ, Giannakis P, Falagas ME. Psychosocial consequences of infectious diseases. Clinical Microbiology and Infection. 2009;15(8):743-7.
21. Zinsstag J, Schelling E, Wyss K, Mahamat MB. Potential of cooperation between human and animal health to strengthen health systems. The Lancet. 2005 2006/1/6/;366(9503):2142-5.
22. Phillips L, Bridgeman J, Fergusan- Smith M. The Bovine Spongiform Encephalopathy (BSE) Inquiry (the Phillips Inquiry): findings and conclusions (Volume 1). London: The Stationery Office; 2000.
23. Slovic P. The perception of risk; 1999.
24. Hansen J, Holm L, Frewer L, Robinson P, Sandøe P. Beyond the knowledge deficit: recent research into lay and expert attitudes to food risks. Appetite. 2003;41(2):111-21.
25. Pidgeon N, Kasperson RE, Slovic P. The Social Amplification of Risk. 2003.
26. Morens DM, Folkers GK, Fauci AS. Emerging infections: a perpetual challenge. The Lancet Infectious Diseases. 2008;8(11):710-9.
27. Sjöberg L. The methodology of risk perception research. Quality and Quantity. 2000;34(4):407-18.
28. Abraham T. Risk and outbreak communication: lessons from alternative paradigms. Bulletin of the World Health Organization. 2009;87:604-7.
29. Slovic P. Perception of risk. Science. 1987 Apr 17;236(4799):280-5.
30. Starr C. Social benefit versus technological risk. What is our society willing to pay for safety? *Science* 1969;165:1232-8.
31. Fischhoff B, Slovic P, Lichtenstein S, Read S, Combs B. How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. Policy Sciences. 1978;9(2):127-52.
32. Slovic P, Fischhoff B, Lichtenstein S. Rating the risks: the structure of expert and lay perceptions. Environmental impact assessment, technology assessment, and risk analysis Proc, Les Arcs, 1983. 1985:131-56.
33. Slovic P. The Perception of Risk. 2000.
34. Sparks P, Shepherd R. Public perceptions of the potential hazards associated with food production and food consumption: An empirical study. Risk Analysis. 1994;14(5):799-806.
35. Siegrist M, Keller C, Kiers HA. A new look at the psychometric paradigm of perception of hazards. Risk Anal. 2005 Feb;25(1):211-22.
36. Kasperson RE, Renn O, Slovic P, Brown HS, Emel J, Goble R, et al. The social amplification of risk: A conceptual framework. Risk Analysis. 1988;8(2):177-87.
37. Pidgeon N, Kasperson RE, Slovic P. 2003.
38. Kasperson RE. The social amplification of risk: Progress in developing an integrative framework. Social Theories of Risk. 1992:153-78.
39. Burns WJ, Slovic P, Kasperson RE, Kasperson JX, Renn O, Emani S. Incorporating structural models into research on the social amplification of risk: Implications for theory construction and decision making. Risk Analysis. 1993;13(6):611-23.
40. Lewis RE, Tyshenko MG. The impact of social amplification and attenuation of risk and the public reaction to mad cow disease in Canada. Risk Analysis. 2009;29(5):714-28.
41. Masuda JR, Garvin T. Place, culture, and the social amplification of risk. Risk Analysis. 2006;26(2):437-54.
42. Kasperson R, Kasperson J. Hidden Hazards. In: Mayo D, Hollander R, editors. Acceptable Evidence: Science and Values in Risk Management. Oxford: Oxford University Press; 1991.

43. Petts J, Horlick-Jones T, Hargreaves D, mclachlan S, Löfstedt R. Social Amplification of Risk: The Media and the Public. Health and Safety Executive. 2001.
44. Frewer LJ, Miles S, Marsh R. The media and genetically modified foods: evidence in support of social amplification of risk. Risk Anal. 2002 Aug;22(4):701-11.
45. Sjöberg L, Peterson M, Fromm J, Boholm Å, Hanson S-O. Neglected and overemphasized risks: the opinions of risk professionals. Journal of Risk Research. 2005;8(7):599 - 616.
46. Frewer LJ, Miles S, Marsh R. The Media and Genetically Modified Foods: Evidence in Support of Social Amplification of Risk. Risk Analysis. 2002;22(4):701-11.
47. Metz WC. Historical application of a social amplification of risk model: economic impacts of risk events at nuclear weapons facilities. Risk Analysis. 1996;16(2):185-93.
48. Michel S, Jocelyn R, Claude F, Antoine F. Risk Perception of the “Mad Cow Disease” in France: Determinants and Consequences. Risk Analysis. 2005;25(4):813-26.
49. Kasperson RE, Jhaveri N, Kasperson JX. Stigma and the social amplification of risk: Toward a framework of analysis. Risk, Media and Stigma Understanding Public Challenges to Modern Science and Technology. 2001:9-27.
50. Fife-Schaw C, Rowe G. Research Note: Extending the application of the psychometric approach for assessing public perceptions of food risk: some methodological considerations. Journal of Risk Research. 2000;3(2):167 - 79.
51. De Jonge J, van Trijp H, Goddard E, Frewer L. Consumer confidence in the safety of food in Canada and the Netherlands: The validation of a generic framework. Food Quality and Preference. 2008;19(5):439-51.
52. Hochbaum G.
53. Rosenstock I, Strecher V, Becker M. Historical Origins of the Health Belief Model. Health Education Monographs. 1974;Vol. 2(No. 4.).
54. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev. 1977 Mar;84(2):191-215.
55. Schafer RB, Schafer E, Bultena GL, Hoiberg EO. Food safety: An application of the health belief model. J Nutr Educ. 1993;25:17-24.
56. Rosenstock I., Strecher V, Becker M. The Health Belief Model and HIV risk behavior change. In: diclemente RJ, Peterson JL, editors. Preventing AIDS: Theories and methods of behavioral interventions. New York Plenum Press; (1994). P. Pp. 5-24.
57. Abraham C, Sheeran P. The health belief model. In: Conner M, Norman P, editors. Predicting Health Behaviour: Research and Practice with Social Cognition Models. 2nd edition ed. Buckingham: Open University Press; 2005. P. 28-80.
58. Rimer B. Chapter 7. Perspectives on intrapersonal theories of helath behavior. . In: Glanz K, Rimer BK, Lewis FM, editors. Health behavior and health education; Theory, research and practice. 3th ed: John Wiley and Sons, Inc; 2002. P. Pp. 144- 59.
59. Phuanukoonnon S, Brough M, Bryan JH. Folk knowledge about dengue mosquitoes and contributions of health belief model in dengue control promotion in Northeast Thailand. Acta Tropica. 2006;99(1):6-14.
60. Leppin A, Aro AR. Risk perceptions related to SARS and Avian influenza: Theoretical foundations of current empirical research. International Journal of Behavioral Medicine. 2009;16(1):7-29.
61. Rogers RW, Deckner CW. Effects of fear appeals and physiological arousal upon emotion, attitudes, and cigarette smoking. Journal of Personality and Social Psychology. 1975;32(2):222-30.
62. Maddux JE, Rogers RW. Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change. Journal of Experimental Social Psychology. 1983;19(5):469-79.
63. Neuwirth K, Dunwoody S, Griffin RJ. Protection motivation and risk communication. Risk Analysis. 2000;20(5):721-34.
64. Zwart Od. Exploring risk perception of emerging infectious diseases. Rotterdam: Erasmus MC; 2008.
65. Stroebe W. Social psychology and health 2. Buckingham: Open University Press; 2000.
66. Rogers RW. A protection motivation theory of fear appeals and attitude change. Journal of Psychology. 1975;91:93-114.

Attachment 1

Table 1. Overview of tools to measure risk perception for emerging zoonoses.

	Method	Critics	Lack of knowledge	Multi – sectoral	Fear
Psychometric paradigm	Psychometric scaling based on a number of explanatory scales Mapping several hazards Mainly using mean data	No segregation for individual perception Zoonotic hazards might be to specific	Could be measured by: • Newness of the risk • Level of knowledge in science about the risk	Could be measured by many aspects: • Level of knowledge in science • Extent of the risks • Severity of the consequences of the risk	Measured by: • Level of dread In addition to • Level of control • Level of involuntariness
Social Amplification of risk framework	General framework for researching relations No specified variables	Framework for processes Limited empirical examinations No clear variables To complex to examine ripple effects	Could fit to: • Information flow • Interpretation and response	Considered very important aspect in: • Information flow • Interpretation and response • spread of impact (rippling)	Not specifically mentioned, possibly fits under: • interpretation and response of an individual
Health belief model	General framework Mainly using surveys and interviews Variables differ between researchers Rating scale survey measuring aspects of risk perception	Should use whole model not just components No clear variables Limited attention how risk perception is formed	Could fit to: • Perceived susceptibility • Perceived severity	Could fit to: • Cues to action • Perceived susceptibility	Could be measured in the overall category of perceptions by both: • Expectations • Threat
Protection Motivation theory	General framework Mainly using surveys and interviews Rating scale survey measuring aspects of risk perception		Could be measured by: The overall category • Maladaptive response • Adaptive response	Not specifically mentioned, could fit in: • Response efficacy • Response cost	Could fit in: • Vulnerability • Response cost

Appendix 4
Scenario studies for vector-borne zoonoses

Project leader
M.A.H. Braks, Laboratory for Zoonoses and Environmental Microbiology, CIb-RIVM

Project team
E.A.J. Fischer and A.A. de Koeijer, CVI-WUR (PI: RVF part 1)
J. Mars, C. Van Maanen and G. van Schaijk, GD (PI: RVF part 2)
M.A.H. Braks and K. Takumi, CIb-RIVM (PI: CCHF)
J.A.P. Heesterbeek and N. Hartemink, UU (PI: Recommendations)

Samenvatting
Binnen het project zijn vier potentiële situaties van vector-overgedragen infecties in Nederland geïdentificeerd, ten aanzien van de aan- of afwezigheid van de vector of het pathogeen, onder de aanname dat een gastheer reservoir aanwezig is. Twee situaties zijn verder onderzocht. In de eerste situatie, geïllustreerd met Krim Congo hemorrhagische koorts, zijn de vector en pathogeen beide afwezig. De kans dat de teek (vector), na introductie, zich zal vestigen in Nederland is bestudeerd, gebruikmakende van een zogenaamde 'climate-envelop' model. Verder is onderzocht of het risico toe- of afneemt in de komende decennia, wanneer de voorspellingen in klimaatsverandering in acht worden genomen. Uit onze resultaten is gebleken dat het door de klimaatseisen van de belangrijkste tekenvector en het huidige en verwachte toekomstig klimaat onwaarschijnlijk is dat de teek zich kan vestigen. In de tweede situatie, geïllustreerd met Rift Valley koorts (RVF), is het pathogeen op dit moment afwezig, echter zijn verschillende potentiële vectoren endemisch in Nederland. Mechanistische modellering is gebruikt om het risico op een uitbraak van RVF na introductie van het pathogeen in Nederland te bestuderen. Onze resultaten tonen aan dat de rol van mensen in een RVF uitbraak onzeker is, maar dat het effect van een uitbraak op mensen aanzienlijk kan zijn. Het effect hangt sterk af van de gastheerpreferentie van de betrokken steekmuggen (is er een voorkeur voor mensen of vee?). Verder is er een nieuwe methode voor het signaleren van het eerste geval van RVF in de veestapel beschreven. Deze methode had tot doel om een toename in het aantal abortussen door RVF op te speuren, gecombineerd met hoge kalver-mortaliteit. Bij blauwtong, waarbij alleen naar het abortus niveau gekeken werd, leek de specificiteit van de methode laag te zijn. Echter, de methode is veelbelovend en verbeteringen om de specificiteit voor de detectie van RVF op te voeren zijn mogelijk.

Door de krachten binnen het EmZoo consortium, specifiek voor vector-overgedragen infecties, te bundelen zijn specifieke modelleeraspecten en kennishiaten geïdentificeerd. Vector-overgedragen pathogenen hebben een complexe transmissiecyclus tussen gastheer, reservoir en vector, die allen grotendeels beïnvloed door omgevingsfactoren, welke op hun beurt sterk variëren in tijd en ruimte. Eén enkel model, waarin alle aspecten samenkomen, bestaat niet, en is waarschijnlijk ook niet erg bruikbaar als het er was. Vooruitstrevende modellen, die concentreren op specifieke aspecten en vragen en die niet trachten alle aspecten samen te voegen zijn nodig, zoals benaderingen die mathematische/procesmatige modellen met statische modellen gebaseerd op muggenvangsten, en hoge (bv. landgebruikdata) en lage resolutie (bijv. klimaatdata) satellietinformatie combineren. Verder zijn biologische en epidemiologische data dringend nodig voor modelontwikkeling. Nu bestaan er nog grote onzekerheden in de waarden van de modelparameters, vooral in de biologie van de vector en reservoirs in het wild, de interactie tussen pathogeen en gastheer, en de extrapolatie van muggen collectie en blootstelling data.

Summary
The project identified four possible situations of vector-borne zoonoses relevant for the Netherlands, with respect to the presence and absence of the vector or the pathogen, under the assumption that the host reservoir is present. Two situations are further explored in a scenario study. In the first situation, illustrated by Crimean Congo haemorrhagic fever, both the vector and the pathogen are currently absent. The likelihood that the tick vector will establish in the Netherlands when introduced was studied, using a so-called climate envelope model approach. In addition we investigated whether this risk increases or decreases in the coming decades, taking into account current climate change predictions. From our results, the climate requirements of the main tick vector and current and future climate data do not suggest that they can become established. In the second situation, illustrated by Rift Valley fever, the pathogen is currently absent, but several *potential* vectors are endemic in the Netherlands. For RVF, mechanistic modelling was used to investigate the risk on spread of RVF if introduced in the Netherlands. Our results show that the role of humans in a Rift Valley fever outbreak is uncertain, but the impact on humans can be considerable. This depends strongly on the host preference of the mosquitoes (is there a preference for humans or livestock?). Furthermore, a novel method for signalling first cases of RVF in livestock in the Netherlands is described. This method aims at detecting higher abortion

Table 1. Different types of VBD situations based on the current presence (√) or absence (-) of either pathogen or vector in The Netherlands.

Pathogen	Vector	Example zoonotic pathogen
-	-	*Crimean Congo Haemorrhagic Fever virus*
√	-	*Leishmania spp.*
-	√	*Rift Valley Fever virus*
√	√	*Borrelia spp.*

levels as a result of RVF possibly combined with high calve mortality. When only based on abortion levels and applied to the bluetongue outbreak, the specificity of the method seems low. The method is, however, promising and further improvements could be made to increase the specificity for detection of an outbreak of RVF.
By joining forces within the EmZoo consortium, specific vector borne disease (VBD) modelling characteristics and knowledge gaps are identified. Vector-borne pathogens have a complex transmission cycle between host, reservoir and vector, each largely influenced by environmental factors, which in turn vary largely in space and time. A single model incorporating all these aspects is not available, but also unlikely to be very useful if it was. State of the art models, focussing on specific aspects and questions rather than trying to be all-encompassing, are needed, for example, approaches that incorporate mathematical/ mechanistic models with statistical models based on trap data, and high (e.g land use data) and low resolution (e.g. climate data) satellite information. In addition to model development, biological and epidemiological data are urgently needed, as high levels of uncertainty in the values of model parameters exist, especially concerning the life history of vectors and (wildlife) reservoirs, the interface of pathogen and host, and the extrapolation of trap data to exposure data.

Aims and delineation

Analysing infectious disease emergence is a complex and dynamic process involving biological, environmental, social, economical and other factors. Predictive infectious disease models are used to understand and anticipate disease emergence and predict the time, size and spatial spread of an ensuing epidemic. Decision makers use the results of predictive infectious disease models to prepare for, and potentially to prevent epidemics, plan and evaluate disease control strategies and methods to mitigate effects of epidemics, and to optimally allocate resources. As part of the second phase of EmZoo, a *Work package* called *Scenario studies* was developed with the aim to focus on the modelling of vector-borne diseases (VBD). VBD modelling has received relatively little attention in the literature compared to directly transmitted infections, but 46 % of the prioritized list of emerging zoonoses is obligatory or facultatively vector-borne.

Project Scenario studies started with making an inventory of the expertise in epidemiological modelling, specifically for VBD's, presents within the EmZoo consortium, by asking each institute to fill in a questionnaire, followed up with a visit by the project leader, and concluded with a joint workshop.

In vector-borne diseases, common to most infectious agents, three distinct phases are recognized, i Introduction, ii Spread and iii Persistence. Each phase of a particular disease requires a different modelling approach. The introduction of a pathogen or vector, whether into Europe from other continents, or into the Netherlands from other European countries, depends on factors such as trade intensity, (air and road) traffic intensity, wind patterns, bird migration behaviour, which are, as yet, less tangible for current epidemiological modelling approaches. For this reason we focused mainly on the second and third phase, to study what happens after an introduction from outside of an infectious agent or its vector has occurred.

Four different types of VBD situations are identified according to current presence or absence of either pathogen or vector, assuming suitable host species are present (See Table 1).
In the following, two scenario studies of emerging vector borne zoonoses from the preliminary prioritized list of important emerging zoonoses (described in the report of the first phase), Crimean Congo haemorrhagic fever CCHF) and Rift Valley fever (RVF), are described. In the first scenario study, the likelihood that the vector of CCHF virus will establish in the Netherlands now and in the future taking climate change prediction into account is investigated using climate envelope modelling. In the second scenarios study the role of man in the initial spread of RVF in the Netherlands is investigated using a mechanistic modelling approach. In addition in the latter, a method using spatial scan statistics for the early detection of RVF cases in livestock is explored.

By joining the forces of the expertise present within the EmZoo consortium in the collaboration for the two scenario studies, specific modelling issues and knowledge gaps with respect to VBD's will be identified and when possible filled, we aim to boost the current knowledge in hopes to assist decision makers to answer questions raised with respect to new vector borne zoonotic threats. Recommendations for VBD modelling approaches and collaboration are also given.

Basics of infectious disease modelling

Models of infectious diseases are conceptually categorized into mechanistic (also called process-based) models and statistical models. In a statistical model, association between data and other observable quantities are quantified. Statistical models do not typically describe explicitly the biological processes that generate the data. Thus, a statistical model can be deployed even when the knowledge about relevant biological processes is incomplete or even missing completely. For example, remote sensing data from satellites, together with vector-catch data from different places and time points, can be used to determine which of the many environmental and climatic variables (such as vegetation density, average day-time temperature) are typically statistically associated with presence (or absence) of the vector species. This leads to the identification of regions and time periods where a vector species could possibly survive, and to estimates of its potential abundance. In this way, the analysis identifies which variables are likely to be most relevant for the vector, but it does not immediately provide a mechanistic reason for why and how these variables shape the dynamics of the vector. Because vectors are particularly influenced by climatic and environmental conditions, this type of analysis has proved to be very useful in studying VBD. Identification of climatic factors associated with an increased incidence of human hantavirus infection (1) is an example of the use of such statistical models for non-VBD. In a mechanist model, biological processes underlying the maintenance of infectious disease in a population of host species are described, based on (often large) sets of assumptions. Susceptible-Infected-Recovered (SIR) model is the simplest prototype of mechanistic models in infectious disease modelling (2, 12). Prime focus of the SIR model (and many variants thereof, collectively called 'compartmental models') is a process in which a susceptible (S) individual may become infected due to exposure to the infectious agent during a contact with an infectious (I) individual, which recovers (R) with a certain rate. For VBD, one then recognises (at least) two species of host: the vector species and the (vertebrate) host, each with their own SIR-classes, where appropriate. Assumptions underlying SIR-type models are concerned with effects and processes at the individual level, and with interaction between individuals. The model then allows one to investigate the population (epidemiological) consequences of spread between individuals. For example, a large variability in infectious period between individuals has been shown to reduce the probability of disease emergence (3). Another example is the possibility to study the effect of including seasonal variation in different parameters, highly relevant for vector-borne diseases (4, 5).

The use of advanced statistical methods in combination with mechanistic models is a promising development in infectious disease modelling, and may in fact prove to be essential for studying VBD. The combination of both types of model has been used to investigate malaria and climate in Africa (8), to test the assumption of transmission of cowpox between rodents (9), and to model time series of childhood diseases (10). This approach is highly data-intensive.

Both types of models are part of a methodology to achieve specific research goals. We give some specific examples. The so-called climate envelope method is a methodology to illustrate a possible distribution of vectors (11). In this method, distributions of a vector in two geographically distinct but climatologically similar places are assumed to be the same. The basic reproduction number R0 (12) is a quantity used to assess the potential for an infectious agent to become established in a new population, when it is introduced. The quantity is also related to the effort required to control the infectious agent (13). It is defined as the expected number of new cases of an infection, caused by one infected individual, in a fully susceptible population. Methods exist to calculate R0 from mechanistic epidemiological models (12), and to estimate it from outbreak or endemic surveillance data. The concept of R0 is widely used in infectious disease modelling. Risk mapping is a method to estimate the risk to humans by integrating vector borne disease data into one map. The quantity R0 can play an important role to identify regions where there is a risk of establishment for a given infectious agent, and hence a risk for human exposure when the agent would be introduced (43). Components of a risk map may consist of vector distribution, host species distribution, human population density, landscape ecology, remote sensing data, projected climate scenarios, and mechanistic and statistical models to link the triangle consisting infectious agent – host – and vector.

Scenario study: Crimean Congo Haemorrhagic Fever virus

Introduction

The virus that causes the Crimean Congo Haemorrhagic Fever belongs to the family of the Bunyaviridae, genus Nairovirus. It was originally isolated in 1944-45 in the Crimean peninsula in the north of the Black Sea, during an outbreak in Soviet military personnel. In 1956 it was found in Kinshasa, Congo. Although primarily a zoonosis, sporadic cases and outbreaks of CCHF affecting humans do occur. The disease is endemic in many countries in Africa, Europe and Asia. During 2001-2002, cases or outbreaks have been recorded in Kosovo, Albania, Iran, Pakistan, Turkey and South Africa. CCHF is a severe disease in humans, with a high mortality rate. Fortunately, human illness occurs infrequently, although animal infection may be more common (14). Recently CCHF received worldwide attention, because a United States army soldier died in Germany in September 2009, after succumbing to CCHF contracted from a tick bite while serving in Afghanistan.

Transmission cycle

CCHF virus circulates in enzootic cycles between ticks and vertebrates. The CCHF virus may infect a wide range of domestic and wild animals. Animals become infected with CCHF from the bite of infected ticks. Humans who become infected with CCHF acquire the virus from direct contact with blood or other infected tissues from livestock during this time, or they may become infected from a tick bite. The majority of cases have occurred in those involved with the livestock industry, such as agricultural workers, slaughterhouse workers and veterinarians. The mortality rate from CCHF is approximately 30%, with death occurring in the second week of illness. In those patients who recover, improvement generally begins on the ninth or tenth day after the onset of illness (14)

Primary vectors for CCHFV hard ticks belonging to the subfamily *Amblyomminae*, genus *Hyalomma*, occurring in Asia, Europe, North and South Africa. *Hyalomma* ticks are sturdy and hardy ticks that can survive in habitats with extreme climatological conditions including low humidity (that are detrimental for other hard tick genuses like Ixodes) and scarcity of host and/ or shelters. *Hyalomma* ticks appear to originate from the desert regions of Kazakhstan en Iran (15). Members of the tick species complex *Hyalomma marginatum*, also named Mediterranean tick, are hold responsible for the transmission and spread of CCHFV. These ticks aggressively seek out vertebrates including humans for a blood meal (15). Outbreaks occur predominantly when favourable climatic condition coincides with environmental changes that increase the survival of hosts and ticks. In Turkey, there was a clear spatial correlation between habitat suitability for the tick, landscape fragmentation and risk for CCHF (16). *Hyalloma* ticks are so called two-host ticks of which the larvae and nymphs feed on one and the same host, while the adult ticks feed on another. The first two stages feed mainly on small mammals, lizards and birds, while the adults feed on large mammals including livestock and incidental also humans. The lifecycle from egg to adult tick within this species complex takes minimal two weeks.

Generally *Hyalomma* ticks obtain CCHFV when feeding on infected reservoirs, small mammals, during the first two stadia. An infected tick transmits CCHFV transstadially to the following stages and in the adult stage to livestock and humans. Cattle are viremic the first week after infection. Although most birds are immune for infection, ostriches appear to be sensitive and show a high prevalence of CCHFV infection in endemic regions (17). The recent epidemic of this disease in Turkey (18) raises the question of whether populations of the tick exist in the city or rather that passerine birds imported the ticks by into the many small vegetation patches existing within the urban areas (19).

Geographical distribution

The geographical distribution region of CCHFV in Europe, Asia and Africa lies within the geographical distribution region of the *Hyalomma* ticks. Animals and humans outside this tick distribution region are at extreme low risk for acquiring CCHF. In Europe CCHFV is found in South Ukraine, South Russia, Moldavia, Bulgaria, Albania, Macedonia, Serbia, Kosovo, Croatia, Bosnia, Montenegro, Greece, Hungary and Turkey. In the South of France and South of Portugal serological indications for the circulation of CCHFV are found (20).

The epidemiology of CCHFV largely depends on the ecology of the tick vectors. In temperate zone like Europe, human cases occur during the higher tick activity between early spring and autumn. Factors that affect the survival, moulting and reproduction of the tick vectors affect the epidemiology of CCHFV directly. Mid-March and early April is the main period of mass arrival of birds in Spain on their way to northern Europe. According to data on moulting of engorged nymphs under laboratory conditions, about 300 ºC cumulative degrees above the developmental zero (14–16 ºC) are necessary to complete the moult (21, cited in 22). Temperatures between September and December are critical for the establishment of permanent populations. Cumulative temperatures between September and December have an average of 800 C in places where the tick has permanent populations and below 400 C in sites not colonized by *H. marginatum* (22).

Method

Climate envelope models use current distributions of species to construct an idea of the climatic conditions that suit them. Distribution of a vector in two geographically distinct but climatologically similar places is assumed to be the same. The method is applied to illustrate possible distribution of the vector at places other than the places where the vector is sampled. This envelope can also be used to see where species could live under predictions of future climate.

We will use this approach to investigate the risk that the tick vector can establish in the Netherlands when introduced. Historical daily mean temperature at De Bilt was retrieved from the database using Mathematica (Wolfram Research Inc., Champaign Illinois).

In addition we investigate whether this risk increases or decreases in the coming decades taking the climate change predictions into account. The fourth assessment report of the Intergovernmental Panel on Climate Change (23) reported

Table 2. First day of the year where the cumulative degree of 300 ºC is reached.

Year	Current situation	1 ºC increase	2 ºC increase	3 ºC increase
1998		05-sep-1998	06-aug-1998	20-jul-1998
1999	12-sep-1999	14-aug-1999	31-jul-1999	18-jul-1999
2000		29-aug-2000	08-aug-2000	21-jul-2000
2001	15-okt-2001	16-aug-2001	30-jul-2001	21-jul-2001
2002		19-aug-2002	03-aug-2002	22-jul-2002
2003	10-aug-2003	31-jul-2003	19-jul-2003	10-jul-2003
2004		28-aug-2004	09-aug-2004	31-jul-2004
2005		28-aug-2005	28-jul-2005	15-jul-2005
2006	26-jul-2006	20-jul-2006	14-jul-2006	06-jul-2006
2007		08-aug-2007	17-jul-2007	30-jun-2007
2008	09-sep-2008	02-aug-2008	24-jul-2008	04-jul-2008
mean		18-aug	28-jul	15-jul

Table 3. Cumulative daily mean temperature.

Scenario	Cumulative daily mean temperature
Current situation	36 ºC
Average yearly 1 ºC increase	58 ºC
Average yearly 2 ºC increase	89 ºC
Average yearly 3 ºC increase	124 ºC

that in the northern temperate Europe temperature increases of 1.5. -2.5 ºC may occur over the next few decades as a result of global warming. KNMI 06 scenario for 2050 with respect to 1990 is summarized in the KNMI report. In this report summer mean temperature will rise +0.9 ºC to +2.8 ºC and the winter mean temperature +0.9 ºC to +2.3 ºC.

Results

Considering the current climatic conditions in the Netherlands, the minimum cumulative degree of 300 ºC for moulting for Hyalomma ticks brought by immigrating birds in the end of March would be reached at end of July in a warm year (2006) or not at all (6 out of 11 preceding years). With the current climate predictions the change of a tick moulting when arriving in spring is increasing (Table 2).

The cumulative daily mean temperature above the developmental zero of 15 ºC in de Bilt between September 1 and December 31 in the period 1998 – 2008 is 36 ºC on average (Table 3), which is much lower than the 400ºC, the condition that characterize the regions where *Hyalomma* ticks are absent. When considering three possible scenarios in which the average yearly average temperature increases 1, 2 and 3 ºC, the cumulative daily mean temperature in de Bilt between September 1 and December 31 will still be under the required minimum value (Table 3).

Conclusion

Between July 2005 en October 2006 Utrecht Centre for Tick-borne diseases of the UU Veterinary Faculty received over 4000 ticks from nearly 250 Dutch veterinarians, among them one tick belonging to the *Hyalomma marginatium* species complex found on a horse (24, 25). We assume that regularly ticks are introduced into the Netherlands. Although migratory birds are carriers of immature Hyalomma ticks and could potentially introduce them into currently Hyalomma-free areas in the spring, their climate requirements and current climate data do not suggest that they can become established.

A scenario study (26) on the effects of climate change on the distribution of ectoparasites shows the increased chance of the establishment of ticks and their pathogens from Africa to the rest of the world in the coming 100 years. Interestingly the *Hyalomma* ticks were specifically mentioned as the genus with the largest habitat expansion. In a recent study one of the main drivers for the impact of climate change on the risk of CCHFV in Europe would appear through change in the chances of immature *H. marginatum* ticks' moulting). Gale et al. (27) made a case that the current risk of CCHFV incursions (through release from infected ticks attached to migrating birds) into northern Europe being lower than for southern Europe. Our results specifically with future climate projections for the Netherlands confirm this.

Use of climate envelope models has been contentious (28, 29), not least because they omit a number of factors that may be as or more important than climate in controlling species distribution, for example human activity, interactions with other species and pure chance. With respect to the latter, larvae and nymphs of *H. marginatum* are regularly found on migrating birds being transported between continents. The establishment of the tick species in a new environment is therefore limited by the favourable microclimatic conditions for moulding (27) and sufficient numbers of conspecies and of appropriate hosts for reproduction (16). The chance that this route introduces CCHFV is assessed to be rather low because of the low infection rate of the tick species attached on birds (30). Temperature and rainfall regulate the distributions of many invertebrates. The weight of evidence suggests that at very broad scales, rainfall and temperature (rather than alternative drivers such as host occurrences, soil type or vegetation) are the primary determinants of tick species ranges (26). At smaller scales, there is also strong evidence for the regulatory role of climate as a driver of tick population abundances which justifies our choice for using climate envelope model approach to assess the risk for establishment of the main vector of CCCHV, *H. marginatum*.

Scenario study: Rift Valley Fever virus

General introduction

In Europe, vector-borne zoonotic diseases like Rift Valley Fever (RVF) are increasingly appreciated as threat to animal and human health. Rift Valley Fever is an important disease in Sub Saharan Africa for both ruminants (cattle, sheep and goats) and man. Infected persons mainly experience a flu-like illness, but several complications have been described with 1% mortality. Hence, RVF in man is a public health problem during an outbreak. In livestock, the disease results in significant economic losses due to death and abortion among RVFV-infected animals. The rate of abortion among infected ewes and cows for example is almost 100% and mortality in newborn animals is very high (31).

In the animal hosts, mosquitoes mainly transmit RVFV. Direct transmission between livestock animals has been suggested (32), but no conclusive data are presented. Humans can get infected by mosquitoes, but also by direct contact or aerosol exposure to infected animal blood and tissues. Even ingestion of raw milk might cause infections. Vertical transmission in humans is reported (33, 34), but not for other mammal hosts.

Of the African vector-species of RVF, *Culex pipiens* s.l. is present in The Netherlands (although uncertain which sub-species or hybrid). *Aedes vexans arabiensis* was a major vector in the Arabian outbreak 35) and the subspecies *Aedes vexans vexans* occurs in the Netherlands. Other species with proven vector competence (between hamsters) are *Ochlerotatus caspius* (36), *Aedes cinereus* (37), and w mechanic transmission by *Stomoxys calcitrans* (38) are all present in the Netherlands. *Ae. vexans* and *O. caspius* are thought to transmit the virus to their eggs in analogy with other aedines (39).

This scenario study is divided into two parts. First, we investigate the role of man as host in the potential of an outbreak, and in the second part explore the possibilities of a surveillance system based on abortion data and mortality data routinely collected by the Animal Health Service.

The role of man in the initial spread of Rift Valley Fever in the Netherlands: a modelling approach

Introduction

Rift Valley fever can infect a wide range of mammals, including man and many livestock species. Cattle, sheep, goat, horses and asses are indicated as important livestock hosts in the African epidemiology, and these livestock species are present in significant numbers in the Netherlands. Rift Valley fever in man is a public health problem during an outbreak in livestock. It is however unclear to what extend man contributes to the epidemic of Rift Valley fever. We will study the potential contribution of humans as a host on the possibility of an outbreak. Important differences between humans and livestock are a higher preference of vectors for livestock, a shorter infectious period of humans (1) and a twice as large livestock population.

Methods

The model

We employ a previously developed mathematical model, which is still under development. It describes the dynamics of Rift Valley fever virus in a mixed host population with various host species. The model is schematically shown in Figure 1. The model is quantified based upon an extensive review of literature. From this model, we derive a version of a reproduction ratio, an important quantity in the epidemiology of infectious diseases. In this case we define the quantity R_{season}, as the expected number of new infections (man or livestock) in the second generation after introduction of one infectious individual at a point of time in the season. This is equal to the per generation growth given that all relevant conditions (temperature, humidity, etc) remain constant. Hence, R_{season} gives an idea of the initial potential of an outbreak, but this quantity does not necessarily have the threshold property of an R0 (40). In this report, we will calculate R_{season} for a time in the year that temperature and vector population sizes are suitable for disease spread (i.e. 31st of May).

Modelling the role of man

Man has a special niche in an area with livestock and vectors, because man lives in houses usually separated from the livestock. Additionally, humans take protective measures against insect bites (e.g. repellents, bed nets). Humans differ

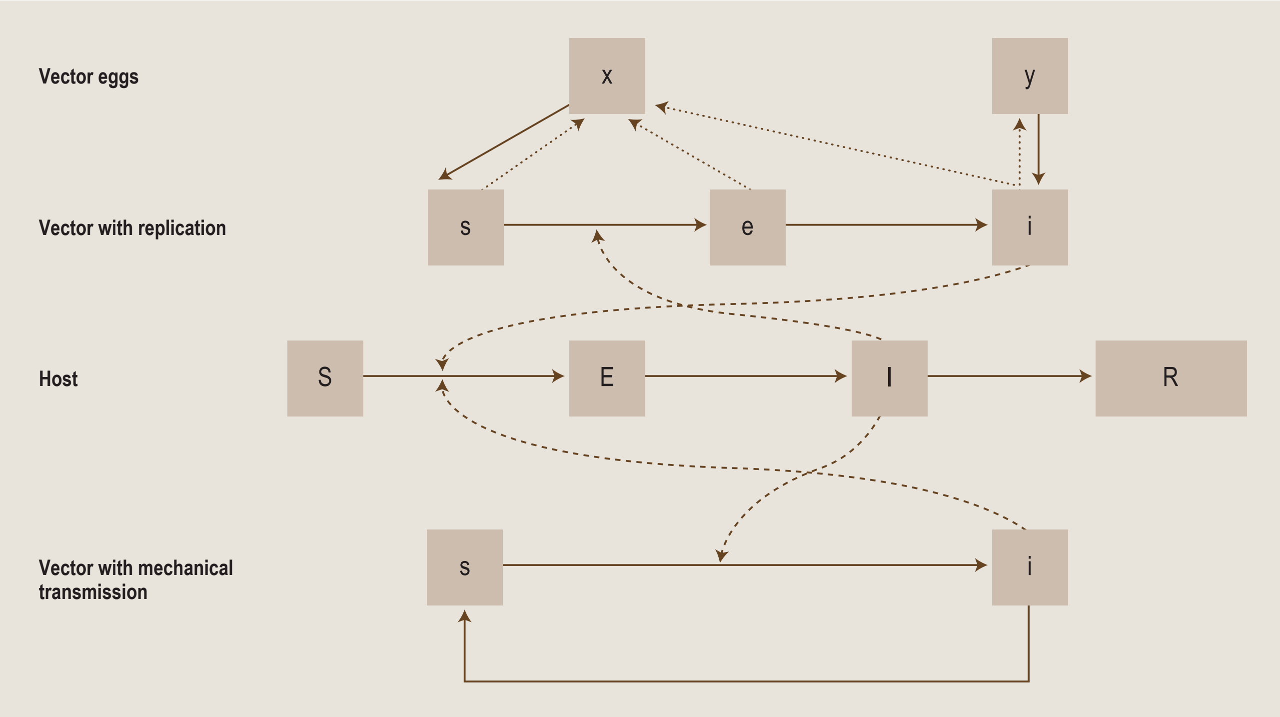

Figure 1 Schematic overview of the model. Solid arrows indicate transitions to other infection states, dashed arrows indicate influences on the rate of transition, and dotted lines indicate production of eggs. After infection by bites of infectious vectors (i) indicated by a dashed arrow, the host has a gammadistributed latent (E) period of 1 day and infectious (I) period of 5 days for livestock and 3.5 days for man. Vectors are infected by bites on infectious hosts (dashed arrow) with two types of vectors: biological and mechanical transmitting vectors. Biological transmission involves replication in the vectors with a temperature-dependent extrinsic incubation period (e) before passing on to the infectious (i) state. These vectors remain infectious until death. Depending on the species, none or 0.7% of the eggs produced by infectious vectors will be infected (y) and produce infectious individuals. The mechanical vectors do not have a extrinsic incubation period being immediately infectious. These vectors lose the infection after on average 24 hours and do not produce infected eggs.

in the length of the infectious period (3.5 days against 5 for livestock) (31), which influences the transmission potential. This raises the question to what extend man contributes to an outbreak of Rift Valley fever. The calculations are done for constant numbers of vectors and hosts. We assume that there are a threefold more livestock animals than humans.

The role of man as host is investigated for two cases: Case 1 the vector populations targeting on humans are different from those targeting at livestock. This case is investigated for a continuum of unseparated, partially, and completely separated vector subpopulations feeding on man or livestock (see Figure 2). We assume a constant total population size for vectors. In completely separated vector subpopulations half will bite man en half will bite livestock. The total number of bites per mosquito remains equal. The level of separation is defined as the fraction of the separated populations that bite only one host, livestock or humans. When this fraction is 1, separation is absolute and when the level of separation is 0 all vectors bite both humans and livestock. With the model we can determine the impact of the level of separation between two populations on the outbreak potential.

In case 2 is investigated what the role of humans is when the actual preference for humans is less than the host preference measured by landing catches or blood meal analyses. Host preference is defined as the probability of that a vector bites a certain host in the presence of an equal number of other hosts. For this second case, reported preferences reported in literature are taken as the maximum preference for man. However, by taking measures (such as bed nets, repellents, insect screens) man can reduce the number of bites on human substantially, which we assume to be reverted to other animals, such as livestock. This can be modelled by assuming a lower preference for man than measured by landing catches, while the total number of bites on livestock and man together remains equal (i.e. more bites on livestock).
Lastly after studying these cases, we will look at the potential reduction of biting rate in completely separated populations. When the populations of vectors are completely separated, it is possible that the vector population biting man has a lower biting rate than determined by the length of the gonotrophic cycle, because of the already mentioned preventive measure expand the searching time of vectors.

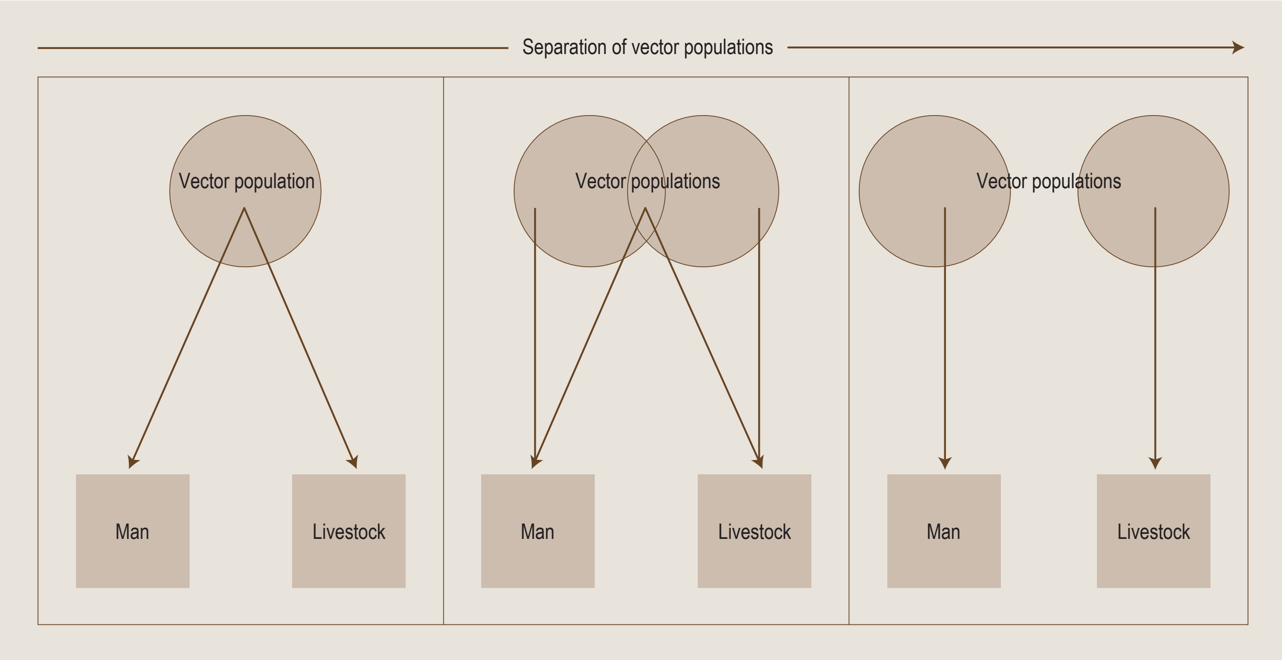

Figure 2 Separation of vector populations. From left to right the circles depicting the vector populations become separated. In the left panel, there is one vector population biting both man and livestock and in the right panel, vectors bite either exclusively on man or exclusively on livestock. In the middle panel a fraction of the population bites both man and livestock and the remaining populations bite exclusively on man or livestock.

Results

Separated vector populations biting man and livestock (case 1) or a reduced preference for humans (case 2) result in different expectations on the initial spread of Rift Valley fever virus. Compared to the unseparated population, by separating the vector populations (case 1) a higher proportion of bites are directed at man, which is a host with a shorter infectious period. This will initially cause a decrease of R_{season}. However, as the populations become more and more separated, the effect of an increased vector-host ratio will increase the R_{season} for the human population substantially (Blue line in Figure 3). The vector-host ratio is the number of vectors per host is an important variable in the epidemiology of vector borne diseases (41). When the preference for man is assumed to be lower than estimated from data (case 2), R_{season} increases because more bites are directed at livestock with longer infectious periods. Hence, R_{season} will monotonously increase with reduced preference for man.

The vector-host ratio is a very important variable in the potential of an outbreak and by separating the population the vector-man ratio has become high. This follows from the negative effect of host density in vector-transmitted infections, which is inverse to the situation with direct transmission, where higher densities lead to higher transmission (41). Hence, a situation with separated vector populations for man and livestock has a higher probability of an outbreak, than a situation where all vectors are biting both man and livestock

In the scenario with two totally separated vector populations, epidemics occur either in man or livestock with each having a specific R_{season} determining the potential of an outbreak in that host (man or livestock). In the case that half of the vector population bites only humans (and the other half exclusively livestock), the R_{season} for humans is higher than that of livestock. The R_{season} for humans is largest, because of the higher vector-host ratio. The possibility of an outbreak in either host decreases with a decreasing biting rate (Figure 4).

Discussion

In this scenario study, we showed the possible role of man on the potential of an initial outbreak. We showed that it is of importance to know to what extend vector species specialize on (or by habitat are restricted to) man and/or livestock. Furthermore, we showed that reducing the biting rate is an effective way of reducing the risk of an outbreak.

The model used for this analysis is still being analysed further and may be extended further for more detailed studies. Also many of the parameters are unknown, especially for the Dutch conditions. Therefore, only the qualitative results are given. The model does not take human behaviour, which include travel and commuting, into account, because this has not been studied in sufficient detail.

The outcomes of this study show the positive and negative influences on the probability of an outbreak of separated vector populations if the virus is introduced. Different mechanisms determine the magnitude of R_{season}. For completely or near completely separated vector populations,

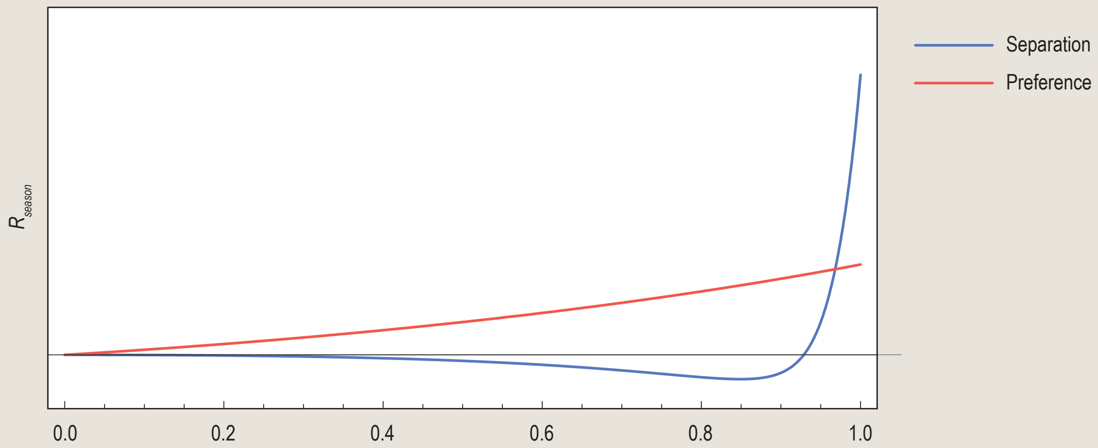

Figure 3. Separation (blue line) or reduced preference (red line) of humans increases the potential of an outbreak in the (livestock) population. The X-axis gives either the level of separation or the reduction in preference for man. A separation of 0 means that there is one vector population biting both man and livestock.

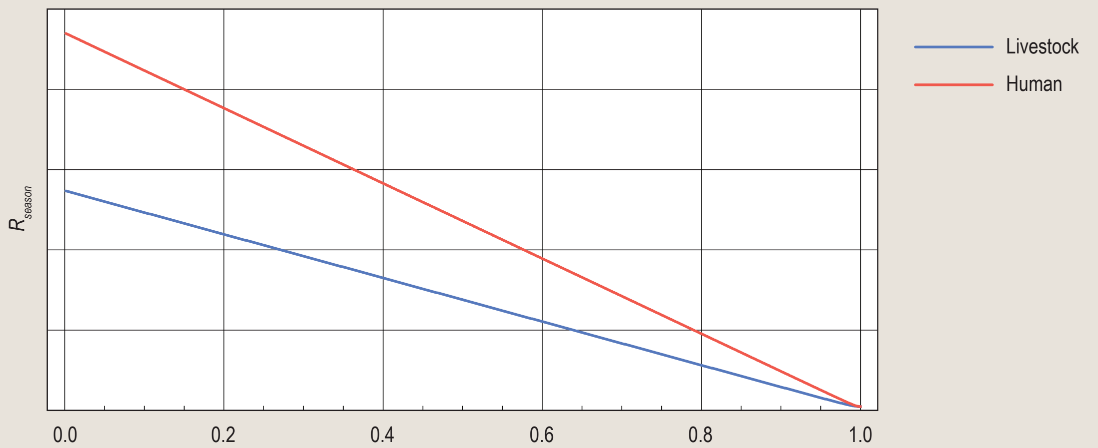

Figure 4 R_{season} as a function of the reduction of the biting rate on man and biting rate on livestock.

the vector-host ratio in man determines the magnitude of R_{season}. At low and intermediate separation of the populations the shorter infectious period of man reduces R_{season}. It will be interesting to find whether vector population are indeed separated and if not to what extend there is exchange between populations.

In the second part of this study we showed that reducing the biting rate in man with completely separated populations can prevent an outbreak solely carried by man. Although this might eliminate the contribution of man to the outbreak, man could still become infected through other routes (slaughterhouse, laboratory etc.)

Exploratory study for the early detection of Rift Valley Fever in the Netherlands based on syndrome surveillance

Introduction

In case of an introduction of RVFV in The Netherlands, it is important to detect this as soon as possible in order to prevent establishment of infections in local mosquito populations. Because the symptoms in most infected humans are not very specific, the first human cases might escape our attention. In order to detect an introduction of RVFV as soon as possible, it might be useful to focus on ruminant hosts. Surveillance in ruminants should focus on the main symptoms: abortions and mortality.

Table 4. Quality of the data that are available for the early detection of Rift Valley Fever based on syndrome surveillance.

Data	Compulsory?	Compliance	Uniform data	Useful for syndrome surveillance
Blood samples from aborting cows	Yes	~25%	Yes	Yes
Foetuses from aborting cows	No	~2% for cows	Yes	Yes
Blood samples or fotuses from aborting sheep and goats	No	rare*	Yes	Yes
Rendering data concerning calf mortality	Yes	~100%	Yes	Yes
Rendering data concerning lamb mortality	Yes	~100%	No	Less suitable

*elevations of blood samples and/or fotuses from ab orting sheep and goats are expected in case of introduction of (emerging) infectious diseases causing high abortion rates

In The Netherlands, farmers are obliged to submit blood samples of aborting cows between 100-260 days of gestation to the Animal Health Service (AHS) for Brucellosis monitoring. Compliance is about 25%. In addition, aborted foetuses from cattle can be submitted for pathology voluntarily. There is no compulsory submission of blood samples of aborting sheep and goats to the AHS. For sheep and goats, numbers of voluntary admitted foetuses and submitted blood samples from aborting sheep/goat can be analyzed.

The data from both cattle and small ruminants can be used for the establishment of syndrome surveillance, detecting elevations in the numbers of submitted blood samples and foetuses in certain areas. However, syndromic data should have high coverage and high quality data to be able to detect outbreaks sufficiently fast. Nevertheless, when these data are randomly distributed over The Netherlands these data can be useful for detection and confirmation of unforeseen disease events or outbreaks. These data can be analyzed in real time. Concurrently, calf and lamb mortality can be monitored using rendering data and cadaver submission data to the AHS to specify an outbreak of RVFV a bit more. The spatial scan statistic can be used to detect possible elevations in the proportion of cows, sheep and goats with abortions and calf and lamb mortality in time and space. Especially the combination of abortions and high calf and/or lamb mortality is indicative for RVFV infections. These analyses could be used to selectively contact suspected herds or apply diagnostic procedures to suspected animals or herds therewith implementing an efficient risk based surveillance system for RVFV in The Netherlands.

In this exploratory study we explored if the available data could be used for syndrome surveillance. The spatial scan statistic was used to detect possible elevations in the proportion of herds that submitted blood samples from aborting cows.

Exploration of the data

The following data can be used for the early detection of RVF in The Netherlands based on syndrome surveillance:

- Submitted blood samples from aborting cows for Brucellosis monitoring.
- Submitted blood samples from aborting sheep and goats.
- Submitted foetuses from aborting cows and sheep and goats.
- Rendering data concerning calf mortality.
- Rendering data concerning lamb mortality.

An overview of the quality of the data is given in Table 4. Data concerning blood samples from aborting cows for Brucellosis monitoring are uniformly gathered and compulsory, but compliance is about 25%. However, when these data are randomly distributed over The Netherlands, these data can be useful for detection and confirmation of unforeseen disease events or outbreaks. This was investigated (see example in this study).

Foetuses from aborting cows can voluntarily be submitted to the AHS for pathology. These data are uniformly gathered, but the number of herds submitting foetuses is very low. Combining data concerning foetuses from aborting cows together with blood samples submitted for Brucellosis monitoring may be useful for real time syndrome surveillance.

The third data source concerns blood samples or foetuses from aborting sheep and goats. Sheep and goat farmers can voluntarily submit blood samples or foetuses from aborting sheep to the AHS for monitoring. These data are uniformly gathered, but submission is rare. However, elevations of blood samples or foetuses from aborting sheep and goats are expected in case of introduction of infectious diseases causing high abortion rates. Therefore, these data may be useful for real time syndrome surveillance.

Rendering data concerning calf mortality are compulsory and compliance is around 100%. Moreover, these data are uniformly gathered and therefore very useful for syndrome surveillance.

Rendering data concerning lamb mortality are also compulsory and compliance is around 100%. However, these data are not uniformly gathered. The reason for this is that lambs can be registered in three different ways:

1. Professional farms have a barrel and when a few lambs die on-farm these will be presented in the barrel for the rendering driver. These lambs are registered as “lamb”, but the rendering driver is not allowed to count the number of dead lambs. It is possible that the herd owner does not report the precise number of dead lambs.

2. Small-scale farms do not always have a barrel. If lambs are not presented in a barrel, no distinction is made between lambs and adult animals by the rendering plant.

Example of using the spatial scan statistic for detection of possible elevations in the proportion of cows with abortions in time and space

For this example, we used data of blood samples from aborting cows that were submitted to the AHS in the period January 2007-September 2009. Based on these data, we were able to detect regions that submitted more blood samples from aborting cows than would have been expected. However, we also wanted to determine the validity of the surveillance. In the study period January 2007-September 2009, a bluetongue infection occurred in The Netherlands that caused higher abortion rates in cows. The bluetongue infection period was used to determine the validity of the surveillance.

Materials and Methods

Type of data and representativeness of the data

Data of blood samples of cows that aborted between 100-260 days of gestation submitted to the AHS in the period January 2007-September 2009 were available. The location (i.e. province) of herds that submitted blood samples of aborting cows was compared with the location of all Dutch herds that have female cows older than 2 years present on-farm in the period January 2007-September 2009. In this period, Bluetongue virus infected a large number of herds and consequently many abortions were observed.

Spatial scan statistic

The spatial scan statistic was used to detect possible clusters of aborting cows (high rates) in time and in space. For the spatial scan statistic analyses, we used the space-time permutation model. For this model, only cases, i.e. the number of submitted blood samples from aborting cows, their spatial location and the time for each case are required. The number of observed cases in a cluster is compared to what would have been expected if the spatial and temporal locations of all cases were independent of each other so that there is no space-time interaction.

For the detection of possible elevations in the proportion of cows that aborted, we aggregated all submitted blood samples of aborting cows per 4-digit postal code as well as per 2-digit postal code. As RVF will probably only be transmitted by mosquitoes and other blood-feeding insects in The Netherlands, we expect that the initial transmission is not so fast and therefore we used month as time unit. In case of moving animals, the infection can be transmitted over long distances. In general, in Africa an epizootic period can last 10 days in sheep herds, and 8 to 16 weeks in cattle herds (FAO fact sheet).

Two different cluster analyses were carried out using SaTScan v7.0.3 (42) or the first analysis we used data per 4-digit postal code and for the second analysis we used data per 2-digit postal code. The spatial scan statistic imposes a series of circular windows around each of the 2-digit or 4-digit postal code area centroids. For each centroid, the radius of the window varies continuously in size from zero to an upper limit of not more than 50% of the study area. An infinite number of distinct geographical circles is created, each of them being a possible candidate for a cluster. For each location and size of the scanning window, the alternative hypothesis is that there is an elevated rate of abortions within the window, compared with outside the window. Once the window with the greatest likelihood ratio statistic is identified, the sampling distribution of the likelihood ratio is evaluated using a Monte Carlo test (999 simulations). We considered a result significant at the 5% level ($P \leq 0.05$).

Validity of the surveillance

In the study period January 2007-September 2009 a bluetongue infection occurred in The Netherlands that caused higher abortion rates in cows. In July 2007 the first cattle herds were found to have seroconverted against bluetongue. The last herds that seroconverted were found in December 2007. From November 2007, an increasing number of farmers reported an increasing number of aborting cows. We assumed that from September 2007-February 2008 it can be expected that more cows aborted as a result of the bluetongue infection and that farmers admitted blood samples from aborting cows caused by bluetongue. In this study, the bluetongue infection period was used to determine the validity of the surveillance. All significant clusters were compared with the period from September 2007-February 2008.

Results

Distribution of herds submitting blood samples from aborting cows

The number of blood samples from aborting cows was 13,472 in 2007, 12,700 in 2008 and 7,823 in 2009 (1-3rd quarter). The blood samples from aborting cows were geographically distributed over The Netherlands (Fig. 5). Based on the spread of the samples across The Netherlands, these data seem suitable for syndrome surveillance. Further investigations are necessary to determine whether these herds are representative for all Dutch dairy herds for relevant characteristics of RVFV (e.g. grazing regime).

Space-time permutation model

Based on the number of blood samples from aborting cows per 2-digit postal code, 8 significant clusters were found.

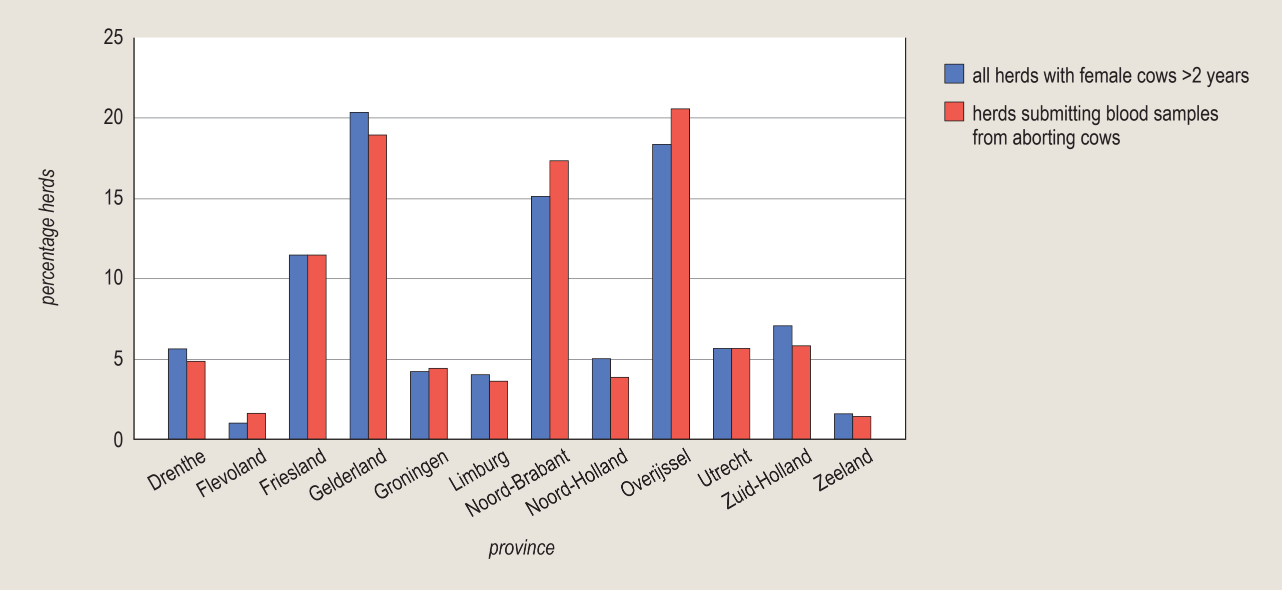

Figure 5. Distribution of herds submitting blood samples from aborting cows and all Dutch herds with female cows older than 2 years in The Netherlands.

Three clusters (37.5%) were found in the period (September 2007-December 2008) in which abortions due to bluetongue could occur (green coloured clusters in Fig. 6). This means that we found 5 false positive clusters (62.5%), because no other known infections were present in the current study period that could have caused increased abortion rates among cattle (red coloured clusters in Fig. 6). The cluster found in May-August 2007 was assigned as a false positive cluster. This period was one of high alertness and the first clinical signs of bluetongue were found in July 2007. Thus, bluetongue related problems were unlikely in this period.

The results from the model using blood samples from aborting cows per 4-digit postal code showed 35 significant clusters (not shown). Six clusters (17.1%) were found in the period in which abortions due to bluetongue could occur (September 2007-December 2008). Twenty-nine clusters (82.9%) were assigned as false-positive. Eight of these 29 clusters were found in the period of high alertness (April-August 2007), which could have stimulated farmers to submit blood samples from aborting cows to the AHS. However, bluetongue related problems were unlikely in this period.

Discussion

This first exploratory study gave an example of how syndrome surveillance can be used to detect possible elevations in aborting cows for the early detection of RVF. This is only one aspect of such a system; first of all, the results should be combined with other data sources relevant for RVFV, e.g. calf mortality, and lamb mortality. Secondly, such a system can also be developed for other infectious or emerging diseases causing high abortion rates in cattle. The results of the present study showed that higher rates of aborting cows were associated with the bluetongue infection in 2007. However, many false-positive results (low specificity) can be expected, because other reasons might have driven an elevated number of submitted blood samples form aborting cows. The aspecificity of the surveillance was associated with a period of high alertness, which could have stimulated farmers to submit blood samples from aborting cows to the AHS. In addition, a new practitioner or new policy from al local veterinary practice can stimulate farmers to submit blood samples from aborting cows. Reducing the number of false-positives would reduce the costs related to follow-up. Thus, before taking follow-up actions (i.e. farm visits), the results could be discussed with fertility experts. Secondly, data sources about other diseases that might cause abortions for example positive Salmonella or IBR could be combined with data on aborting cows to determine the association between these diseases and the presence of high abortion rates.

In this study, we used a space-time permutation model for the detection of possible elevations in aborting cows. The advantage of this model is that only cases are required. However, if the background population increases or decreases faster in some areas than in others, there is risk for population shift bias, which may produce biased p-values when the study period is longer than a few years. In this study, we used a period of 2 3/4 years and because this period was relatively short it was assumed that the background was consistent over the years. Nevertheless, when data about several years will be used for syndrome surveillance, it is recommended to use Poisson distributed models as well to take changes in the background population into account.

It is possible that aborting cows are subject to seasonal influences or herd type differences. In addition, some veterinary practices can stimulate the submission of blood samples from aborting cows more than other ones.

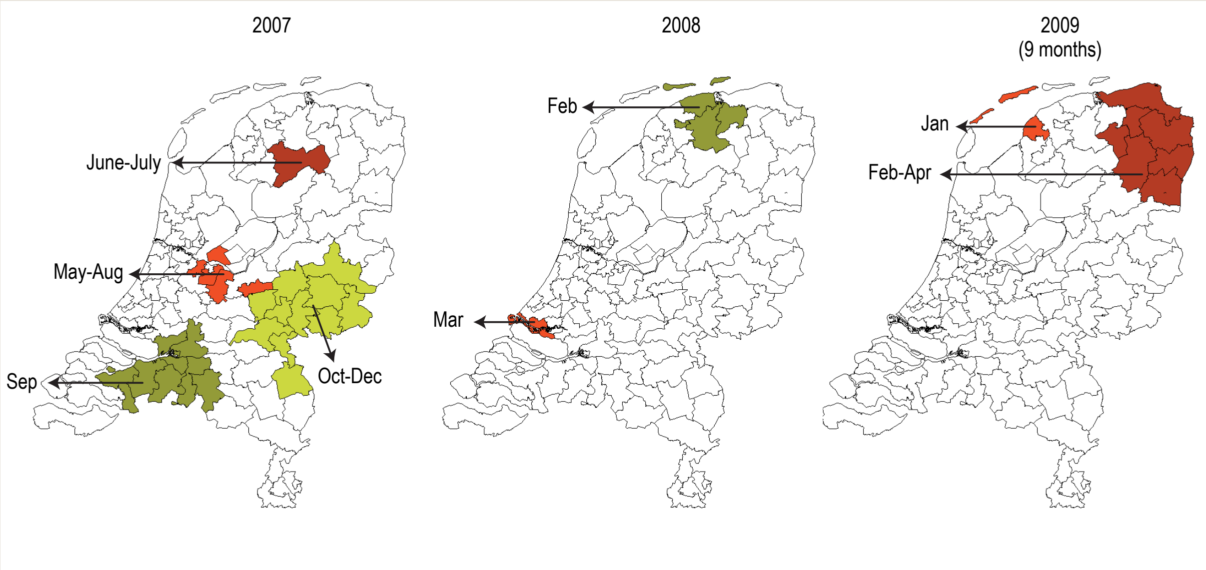

Figure 6. Distribution of herds submitting blood samples from aborting cows and all Dutch herds with female cows older than 2 years in The Netherlands.

In the current study no correction was made for seasonal influences, herd type and veterinary practice differences. In follow-up studies it is recommended to determine the effect of these and other relevant covariates in both space-time permutation and Poisson models.
Further study is necessary to determine the costs related to the false-positive results. In addition, in follow-up studies it should be investigated whether data concerning foetuses from aborting cows, sheep and goats and data concerning calf mortality can contribute to the early detection of RVF using syndrome surveillance.

Conclusion of Project Scenario study

Specific aspects in vector-borne zoonoses modelling

In this study we identified four possible situations of vector-borne zoonoses to occur in the Netherlands, with respect to the presence and absence of the vector or the pathogen, under the assumption that the host reservoir is present. In two scenario studies, two of these situations were further investigated by using an example. By joining forces within the EmZoo consortium the following specific vector borne disease modelling issues and knowledge gaps are identified. Vector-borne pathogens have a complex transmission cycle between host, reservoir and vector, each largely influenced by environmental factors, which in turn vary largely in space and time. In addition, often multiple vector species or life stages are involved in the transmission and multiple vertebrate host species are involved in maintaining the natural cycle of the pathogen. This complexity can be integrated in a model system, but sufficiently detailed knowledge and data of the basic biology, epidemiology and ecology of most vector-borne diseases is missing. Even more difficult than developing a model is the estimation of values for the parameters in such a model. High levels of uncertainty exist in the data. Basic population data of potential vectors or vertebrate hosts are lacking in the Netherlands, and also in general. In cases in which vector trapping data are available, extrapolation to exposure data is difficult. In most cases, even trapping data are unavailable or available from too few locations and time points to be useful. Knowledge of vector competence of endemic potential vectors for emerging zoonotic pathogens is (nearly) absent.

Due to the complexity of vector borne disease systems, compounded by the effects of a highly variable environment, the current available models are unable to predict outbreaks. Assessment of the risk of establishment of vector-borne zoonoses includes several aspects, such presence of vectors, ability to spread given presence of vectors and population size and life history of vectors (abundance, overwintering). Control of vector-borne zoonoses is facilitated by rapid detection of an outbreak. For this, state of the art models that incorporate mathematical/ process based models with statistical models based on trap data, and high (e.g. land use data) and low-resolution (e.g. climate data) satellite information need to be developed.

The project identified knowledge gaps in model building and parameter fitting, showing the necessity and chances for future research. Models can be utilized for gaining insight into the complexity of these zoonoses and for scenario studies into control and mitigation. Exact values of parameters are difficult to assess but biological limits exist. In state of the art models, uncertainties in the numerical estimates of ingredients can be translated into uncertainty estimates for the outcome. The importance of a given parameter for the determination of that outcome can be assessed in sensitivity analysis, bringing focus to future empirical and observational research by identifying key parameters whose values need to be known most accurately. Nevertheless, the current statistical and mechanistic models based on empirical data can be used to predict the probability of establishment and spread and used to investigate uncertainties in and sensitivity for biotic and abiotic parameters. Additionally, these models can be used to create risk or R_0 maps, which can be used to indicate risk areas.

For the creation of these maps detailed input, especially on vector abundance, is needed. Vector monitoring, geographic data and remote sensing are essential in that respect. Both assessment of the risk of establishment of a vector or a disease can help to increase awareness and take timely preventive measures. Disease surveillance is essential to detect an outbreak. This requires a system that can be used routinely. The system needs to have low costs, *i.e.* easy accessible data and a high specificity. Risk mapping and climate change models can be used to increase the performance of such systems.

Humans take a special place in vector-borne diseases. For many VBD, humans are incidental hosts, and in fact often dead-end hosts (in the sense that humans are not able to pass on the infection), and play a minor role in the persistence of those VBD.

Specific expertise within the consortium

From the inventory (interview, questionnaire and workshop) and the collaboration in this project, we conclude that the expertise with respect to epidemiological modelling differs between consortium members due to differences in

- Financing resources: private sector (e.g. product boards) versus public domain. The latter can be further divided into department of LNV, VWS of Education, and resulting in different interests, duties and responsibilities with respect to the acquired data.
- Pathogens of interest: medical (RIVM, UU) versus veterinary (CVI, GD, UU) or zoonotic pathogens (all four).
- Access to data source: veterinary practices (GD), human population (RIVM), research projects (UU), or reference laboratories (CVI, RIVM).
- Status of disease: endemic (GD, RIVM, UU) versus emerging (RIVM, CVI, UU, GD).
- Research questions: support of policy decisions/ questions from the financing source (GD, CVI, RIVM) or fundamental (UU).

Conclusions

1. Currently, the amount of expertise, monitoring and research done in the Netherlands is relatively small, and very fragmented; a structured interacting knowledge-network is essential for reliable risk assessment and public and veterinary health advice. A coordinated action should set priorities and methodologies for monitoring, analysis, and prevention and control. Moreover, it should stimulate and facilitate interaction and collaboration between the different partners, with the ultimate aim to address the right questions concerning emerging vector-borne zoonoses in a manner that balances the many relevant aspects of these complex future and present disease risks.
2. Data collection and insight in the Netherlands is currently uncoordinated and limited, for example concerning the complexities of the VBD transmission cycles, the life history of both vector and (often wildlife) hosts, their abundance and spatio-temporal dynamics, and notably also the way all these are influenced by environmental and climatic conditions. The coordinating action suggested in Conclusion 1 should determine the target systems for VBD risk assessment and mitigation, leading to priorities in data collection, driven by recognized gaps in knowledge, essential for taking balanced public and veterinary health decisions.
3. Given the complexities of VBD systems, epidemiological models are an essential tool in the assessment of risks to humans and animals and the assessment of the effectiveness of preventive and control measures.. Even more so than is the case for directly transmitted infections in humans and animals, models are needed to both augment and insightfully connect various incomplete data sources. Due to the strong environmental influence in these systems, a hybrid type of approach is needed, where statistical models relating vector and host abundance to remotely-sensed or directly observed environmental and climate variation, are linked with mechanistic models to quantify the resulting dynamics of infection and, ultimately, the risks to humans and animals and the effectiveness of prevention and control measures. Currently, such models are rare, both in the Netherlands and internationally. Progress should be stimulated by international partnerships and research networks. However, true progress is only possible with the existence of sufficient, relevant and quality data, as in Conclusion 2, to guide construction and validation.
4. Currently, existing barriers for the exchange of data among and between the various institutions and groups exist on various levels, caused by 'ownership' and confidentiality issues between all partners and lack of trust between data producer and prospective user. These issues should be settled to allow the many relevant and natural research partnerships and networks needed to understand and gauge VBD dynamics, emergence and risk to collaborate

free from constraints on the basis of mutual trust and respect for each others expertise and knowledge.
5. Currently, there are possibilities for surveillance of VBD based on existing monitoring instruments and data sources.

Recommendation

1. Zoonotic vector-borne infections, emerging for the Netherlands, should receive focussed, structured and structural attention.
2. Data collection on vectors and their hosts should be a priority, especially where the biology, ecology and epidemiology of VBD are concerned.
3. Progress in development of improved models and applications should be stimulated by international partnerships and research networks. However, true progress is only possible with the existence of sufficient, relevant and quality data, as in recommendation 2, to guide construction and validation.
4. A structure should be found and implemented that takes away existing barriers for the exchange of data among and between the various institutions and groups.
5. Surveillance should be optimized by using the results from modeling studies.

Related projects

This Project Scenario Studies is related to Priority Setting project (Appendix 3) of EmZoo. Two vector borne zoonotic pathogens that ranked in the top 25 of the prioritized list in the first phase were chosen as topic in the scenario studies. Through the participation of consortium partner UU in an Integrated Project of the European Commission (KP6) EDEN (Emerging Diseases in a changing European eNvironment) an indirect but important link with this State of the Art European project.

Output

Not applicable

Acknowledgement

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References

1. Tersago, K., Verhagen, R., Servais, A., Heyman, P., Ducoffre, G., Leirs, H., 2009. Hantavirus disease (nephropathia epidemica) in Belgium: effects of tree seed production and climate. Epidemiol Infect 137, 250-256.
2. Anderson, R.M., May, R.M., 1991. Infectious diseases of humans, dynamics and control. Oxford University Press, Oxford.
3. Lloyd-Smith, J.O., Schreiber, S.J., Kopp, P.E., Getz, W.M., 2005. Superspreading and the effect of individual variation on disease emergence. Nature 438, 355-359.
4. Ireland, J.M., Norman, R.A., Greenman, J.V., 2004. The effect of seasonal host birth rates on population dynamics: the importance of resonance. J Theor Biol 231, 229-238.
5. Bacaer, N., Gomes, M.G., 2009. On the final size of epidemics with seasonality. Bull Math Biol 71, 1954-1966.
6. Teunis, P., Takumi, K., Shinagawa, K., 2004. Dose response for infection by Escherichia coli O157:H7 from outbreak data. Risk Anal 24, 401-407.
7. Ghil, M., Vautard, R., 1991. Interdecadal oscillations and the warming trend in global temperature time series. Nature 350, 324-327.
8. Pascual, M., Ahumada, J.A., Chaves, L.F., Rodo, X., Bouma, M., 2006. Malaria resurgence in the East African highlands: temperature trends revisited. Proc Natl Acad Sci U S A 103, 5829-5834.
9. Begon, M., Feore, S.M., Bown, K., Chantrey, J., Jones, T., Bennett, M., 1998. Population and transmission dynamics of cowpox in bank voles: Testing fundamental assumptions. Ecology Letters 1, 82-86.
10. Finkenstadt, B., Grenfell, B.T., 2000. Time series modelling of Childhood diseases: a dynamical system approach. Journal of the Royal Statistical Society. Series C 49, 187-205.
11. Kovats, S., 2008. Health Effects of Climate Change in the UK 2008. In, Health Protection Agency, pp. 124.
12. Diekmann, O., Heesterbeek, J.A.P., 2000. Mathematical Epidemiology of Infectious Diseases. John Wiley & Sons, Chichester.
13. Roberts, M.G., Heesterbeek, J.A., 2003. A new method for estimating the effort required to control an infectious disease. Proc Biol Sci 270, 1359-1364.
14. Whitehouse, C.A. (2004). Crimean-Congo haemorrhagic fever. *Antiviral research*. 64: 145-160.
15. Kettle, D.S. 1995. *Medical and Veterinary Entomology*. 2nd ed. by D.S. Kettle, University Press Cambridge, UK. p. 726.
16. Estrada-Peña, A., Zatansever, Z. Garfill, A., Aktas, M, Uzun, R., Ergonul, O., and Jongejan, F. (2007) Modeling the spatial distribution of Crimean-Congo Hemorrhagic fever outbreaks in Turkey. *Vector- Borne. Zoon. Diseases*. 7: 667-678.
17. Swanepoel, R., Leman, P.A., Burt, F.J., Jardine J, Verwoerd DJ, Capua I, Brückner GK, Burger WP.. (1998) Experimental infection of ostriches with Crimean-Congo haemorrhagic fever virus. *Epidemiol. Infect*. 121: 427-432.

18. Karti, S.S., Odabasi, Z., Korten, V. Yilmaz, M., Sonmez, M., Caylan, R., Akdogan, E., Eren, N., Koksal, I., Ovali, E., Erickson, BR., Vincent, MJ., Nichol, ST., Comer, JA., Rollin, PE., Ksiazek, TG. (2004) Crimean-Congo hemorrhagic fever in Turkey. *Emerg. Inf. Dis.* 10:1379-1384.
19. Vatansever Z, Gargili A, Aysul NS, Sengoz G, Estrada-Peña A. 2008 Ticks biting humans in the urban area of Istanbul. *Parasitol Res*.102(3):551-3..
20. Ergonul, O. Whithoouse C.A. (2007) Crimean-Congo Hemorrhagic Fever A Global Perspective Springer Netherlands.
21. Emelyanova, I. N. (2005) "Seasonal changes and host adaptability of ticks of the species *Hyalomma marginatum* in the Stavropol territory," Zurnal Mikrobiologii, epidemiologii I immunobi- ologii, no. 4, pp. 115–118, 2005 (Russian).
22. Gray J. S., H. Dautel, A. Estrada-Peña, O. Kahl, and E. Lindgren (2009) Effects of Climate Change on Ticks and Tick-Borne Diseases in Europe. Interdisciplinary Perspectives on Infectious Diseases
23. Christensen, J. H., B. Hewitson, A. Busuioc, et al., "Regional climate projections," in Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, S. Solomon, D. Qin, M. Manning, et al., Eds., pp. 847–940, Cambridge University Press, Cambridge, UK, 2007.
24. Nijhof AM, Bodaan C, Postigo M, Nieuwenhuijs H, Opsteegh M, Franssen L, Jebbink F, Jongejan F. 2007 Ticks and associated pathogens collected from domestic animals in the Netherlands. *Vector Borne Zoonotic Dis* 7(4):585-95
25. BuR 2008 *Advies BuR inzake Crimean Congo Haemorrhagic Fever virus (CCHF) 2008* based on Moorman, R, C. Reusken and M. Braks Crimean Congo Haemorrhagic Fever virus: Risico. Preventie en bestrijding
26. Cumming G S. and D. P. Van Vuuren (2006) Will climate change affect ectoparasite species range? *Global Ecol. Biogeogr.* 15: 486-497
27. Gale, P. Estrada-Peña, M. Martinez, R.G. Ulrich, A. Wilson, G. Capelli, P. Phipps, A. de la Torre, M.J. Muñoz, M. Dottori, V. Mioulet, A.R. Fooks (2010) Feasibility of developing a risk assessment for the impact of climate change on the emergence of Crimean-Congo haemorrhagic fever in livestock in Europe: a Review. J. Applied Microbiology.
28. Beale CM, Lennon JJ, Gimona A (2008) Opening the climate envelope reveals no macroscale associations with climate in European birds. Proc. Natl Acad Sci USA 105:14908–1491
29. Peterson A. T., N. Barve, L. M. Bini, J. A. Diniz-Filho, A. Jimenez-Valverde, A. Lira-Noriega, J. Lobo, S. Maher, P. de Marco, E. Martinez-Meyer, Y. Nakazawa, and J. Soberon (2009) The climate envelope may not be empty Proc. Natl. Acad. Sci. USA 2009 106:E47.
30. Burt. F.J. and Swanepoel, R. (2005) Molecular epidemiology of African and Asian Crimean-Congo haemorrhagic fever isolates. *Epidemiol. Infect.* 133: 659-666.
31. Swanepoel R, Coetzer JAW. Rift Valley Fever. In: Coetzer JAW, Tustin RC, editors. Infectious Diseases of Livestock. Cape Town: Oxford University Press Southern Africa; 2004.
32. Zeller HG, Fontenille D, TraoreLamizana M, Thiongane Y, Digoutte JP. Enzootic activity of Rift Valley fever virus in Senegal. Am J Trop Med Hyg. 1997 Mar;56(3):265-72.
33. Adam I, Karsany MS. Case report: Rift Valley Fever with vertical transmission in a pregnant Sudanese woman. J Med Virol. 2008 May;80(5):929.
34. Arishi HM, Aqeel AY, Al Hazmi MM. Vertical transmission of fatal Rift Valley fever in a newborn. Annals of Tropical Paediatrics. 2006 Sep;26(3):251-3.
35. Jupp PG, Kemp A, Grobbelaar A, Leman P, Burt FJ, Alahmedt AM, et al. The 2000 epidemic of Rift Valley fever in Saudi Arabia: mosquito vector studies. Med Vet Entomol. 2002 Jun;16(3):245-52.
36. Turell MJ, Presley SM, Gad AM, Cope SE, Dohm DJ, Morrill JC, et al. Vector competence of Egyptian mosquitoes for Rift Valley fever virus. Am J Trop Med Hyg. 1996 Feb;54(2):136-9.
37. Gargan TP, Clark GG, Dohm DJ, Turell MJ, Bailey CL. Vector Potential of Selected North-American Mosquito Species for Rift-Valley Fever Virus. Am J Trop Med Hyg. 1988 Mar;38(2):440-6.
38. Hoch AL, Gargan TP, 2nd, Bailey CL. Mechanical transmission of Rift Valley fever virus by hematophagous Diptera. Am J Trop Med Hyg. 1985 Jan;34(1):188-93.
39. Linthicum KJ, Davies FG, Kairo A, Bailey CL. Rift-Valley Fever Virus (Family Bunyaviridae, Genus Phlebovirus) - Isolations from Diptera Collected during an Inter-Epizootic Period in Kenya. J Hyg-Cambridge. 1985;95(1):197-209.
40. Bacaer N, Gomes MG. On the final size of epidemics with seasonality. Bull Math Biol. 2009 Nov;71(8):1954-66.
41. De Koeijer AA, Elbers ARW. Modelling of vector-borne diseases and transmission of bluetongue virus in North-West Europe. In: Takken W, B.G.J K, editors. Emerging pests and vector-borne diseases in Europe. Wageningen: Wageningen Academic Publishers; 2007. p. 99-112.
42. Kulldorff M. A spatial scan statistic. Commun Stat-Theor M. 1997; 26(6):1481-96.
43. Hartemink, N.A. et al, V*ector-borne diseases: the basic reproduction number* R_0 *and risk maps*, PhD thesis, 2009, Utrecht University.

Questionnaire responses

Questionnaire response CVI

Q1: What kind of mathematical models is used at your institute?

The approach and thus kind of model is chosen based upon the question and possibilities (e.g. data availability). However, clear transparent models are preferred. Biological mechanistic approach with few parameters is therefore our most common tool .The models are deterministic or probabilistic and if necessary simulations for more complex issues about transmission and space. Occasionally we apply a pure statistical approach, especially in spatial models. Risk modeling method are used, such as scenario tree models, and (simple) dose-response models

Q2: Are GIS applications involved in the modeling?

Yes, Analysis of GIS data on registered epidemics to determine a spatial transmission kernel (Using Mathematica). These results can be visualized in ARCGIS as riskmaps or used for epidemic simulations.

Q3:. Which infectious disease(s) / pathogen(s)is (are) are subject of the modeling at your institute?

BSE (Bovine spongiform encephalopathy), Scrapie, FMD (Foot-and-Mouth Disease), CSF (Classical Swine Fever), Avian Influenza (HPAI, LPAI), Aujeszky's disease, Bovine tuberculosis, Paratuberculosis, AHS (African Horse Sickness), RVF (Rift Valley Fever), Salmonella, Campylobacter,VTEC (verotoxin producing E.coli), Antibiotic resistance, Bluetongue

Q4: What is the purpose of the modeling / Which question needs to be answered?

Our main purposes are

- Risk assessment of introduction and spread
- Optimization of efficacy of early warning
- Optimization of surveillance and control (such as vaccination strategies)
- Declaring of freedom of disease
- Spatial risk (riskmaps)

Q5: Which part of the transmission chain (figure below) is included in the models?

Figure. Transmission chain of infectious disease. The squares symbolize factors and the arrows the input to the next factor.

- Introduction risk (into the country) in risk modeling
- Exposure and infection in dose-response models.
- We have much experience with transmission models within farms, but also between farms (spatial spread) and combination of within-farm and between farm models. Our transmission models include contact pattern and infectiousness (here given under spread, exposure and infection but usually not separated) and mortality.
- Usually we do not incorporate morbidity explicitly in our models. However, we often include detection based on the number of infectious animals specifically for control and surveillance scenarios. Sometimes we do include morbidity explicitly (called clinical signs) especially when early warning is based on observations of farmers and/or veterinarians. In some sectors, epidemics are not noticed until massive death (e.g. avian influenza) or abortion storms (e.g. Rift Valley Fever).

Q6: Is there additional expertise on scenarios studies and or other information you want to share?

Most studies on the control of disease such as CSF or FMD are done by scenario studies simulating different control strategies. Actually too much to name, but most is published.

Questionnaire response GD

Q1: What kind of mathematical models is used at your institute?

- Biological mechanic approach/mathematical models/ simulation models.
- Statistical approach/empirical model.

GD uses both types of models

Q2: Are GIS applications involved in the modeling? If yes…..

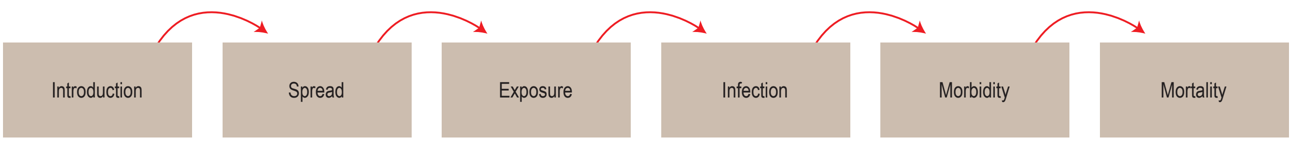
Yes, space-time cluster analysis with Satscan and MapInfo.

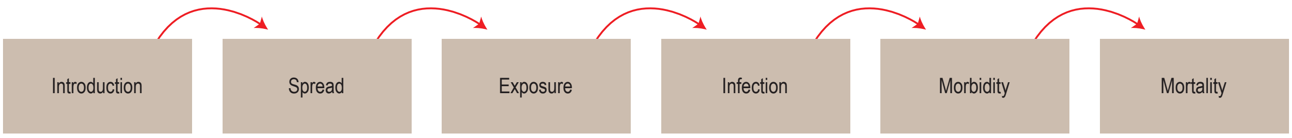
Q3:. Which infectious disease(s) / pathogen(s)is (are) are subject of the modeling at your institute?

Ruminants: Leucosis, Bluetongue, salmonellosis, IBR, BVD, Neosporosis, Leptospirosis, Paratuberculosis, Q-fever, echinococcus.
Pigs: PRRSV, Salmonellosis, MRSA,
Poultry: Salmonellosis, Mycoplasma gallisepticum

Q4: What is the purpose of the modeling / Which question needs to be answered?

Often our main purpose is to evaluate control measures or intervention strategies for infectious diseases. We carry out scenario studies to obtain epidemiological (prevalence, incidence, transmission) and economic consequences (costs and benefits) of disease control.





Q5: Which part of the transmission chain (figure below) is included in the models?
Figure above. Transmission chain of infectious disease. The squares symbolize factors and the arrows the input to the next factor.
All. We often focus on between-herd and within-herd spread of diseases.

Q6: Is there additional expertise on scenarios studies and or other information you want to share? If yes, …
Our scenario studies are often focused on the effects of interventions on the epidemiology and economics of diseases.

Q7: Please check the following list of publications we found and update/ complete when needed

GD publishes confidential quarterly reports for the Monitoring and Surveillance of ruminant, pigs and poultry health. Part of this work is modelling of infectious diseases. Some but not all of these modelling studies are published in international journals.

This list of publications can be requested with the GD.

Questionnaire response UU
These answers describe the epidemiology group at the Faculty of Veterinary Medicine, Utrecht, consisting of about 20 researchers, divided over the chairs of Prof Arjan Stegeman (Veterinary Epidemiology of Infectious Diseases) and Prof Hans Heesterbeek (Theoretical Epidemiology).

Q1: What kind of models is used?
We use mechanistic, mathematical models and statistical models. In some cases, notably recently in studying vector-borne infections, we try and combine the two approaches. Our overall approach is to understand observed population phenomena by studying processes at the individual level, and to show how these phenomena emerge from interactions between individuals. We try to merge experimental and field (observational)data as much as possible in the construction and parametrization of our models, and part of the group carries out their own experiments. Models are used both for qualitative insight and for quantitative calculations. Part of the work is devoted to the development of new quantitative methods for population dynamics of infectious diseases.

Q2: Are GIS applications involved?
Yes, in two projects. The first is the EDEN project where PhD student (now postdoc) Nienke Hartemink merges mechanistic modelling of the basic reproduction number R0 with vector abundance estimates that are derived from remotely sensed data in heterogeneous landscapes. The methods have been developed using bluetongue in ruminants and leishmaniasis in dogs as guiding examples with data. This is collaboration with high and low resolution remote sensing experts from the Catholic University of Leuven and Oxford University. The second project is the study of the spread of highly pathogenic avian influenza in Thailand (PhD project of Thanawat Tiensin).

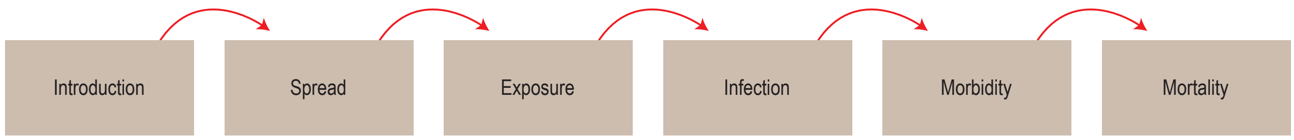
Q3: Which infectious diseases are studied?
Within EDEN we have worked on: BTV, leishmania, malaria, west nile virus and various tick-borne pathogens. Modelling is done for outbreaks of: influenza (pandemic), plague (also data collection), smallpox, mrsa (also data collection)
Modelling is done for endemic infections: paratuberculosis (aslo experiments and data collection), mastitis (data collection, experiments and economic modelling), campylobacter (data collection, experiments)

Q4: Questions to be answered?
The purpose of our modelling is to promote understanding of population processes of infectious diseases by realising an integration of knowledge in a very precise way that cannot be achieved by individual-level experiments alone. Ultimately this understanding contributes to better understanding of population consequences of individual-level control and intervention.

Q5: Which part of the transmission chain?
Mostly introduction, spread at population level, but also the interaction between the pathogen and the immune system at the individual level. Statistical models are used in the latter part of the chain you give, by studying patterns of morbidity and mortality.

Q6: Additional information?
No

Q7 Publications
Only publications of one member of the group are listed. Publications of Hans H can be found at the following link (up to 2008; 2009 has not been entered yet):



http://igitur-archive.library.uu.nl/search/search.php?language=nl&m=advanced&c=&community=&collection=&v1=&n1=q&s1=s&o1=&v2=&n2=t&s2=s&o2=&v3=&n3=a&s3=s&o3=&v4=Heesterbeek&n4=c&s4=s&vkgb=on&ryf=&ryt=&tpcnt=on

Questionnaire response RIVM

Q1: What kind of mathematical models are used at your institute?
Dose response model for risk assessment of an infection in humans
Differential equations for dynamics of pathogen transmissions
Maximum likelihood for statistical analyses of data
Monte Carlo simulation for models in which many statistical distributions are used
Markov Chain Monte Carlo for parameter estimations in a high dimension

Q2: Are GIS applications involved in the modeling? If yes…..
Visualizing sample locations
Determining regions where climatological and other environmental conditions permit establishment of a mosquito species
Predicting tick densities based on remote sensing datasets, i.e. MODIS
Creating a risk map of zoonotic and vector borne infections in humans

Q3:. Which infectious disease(s) / pathogen(s)is (are) are subject of the modeling at your institute?
Echinococcus multilocularis, Trichinella spiralis, Borrelia burgdorfi, Hantavirus
Salmonella spp., Campylobactor spp.
Influenza virus, Pertusis, HIV, Hepatitis virus

Q4: What is the purpose of the modeling / Which question needs to be answered?
What is the risk to humans?
Is the pathogen spreading into a wider geographical region?
What are the effects of possible control measures?
Can the pathogen be persistently transmitted in the population of a given host species?
What is the relative importance of routes by which humans are exposed to a pathogen?

Q5: Which part of the transmission chain (figure below) is included in the models?
Figure above. Transmission chain of infectious disease. The squares symbolize factors and the arrows the input to the next factor.

Introduction, Spread, Exposure, Infection, Morbidity, Mortality

Q6: Is there additional expertise on scenarios studies and or other information you want to share? If yes, …
No

Q7, Please check the following list of publications we found and update/ complete when needed.
Literature list can be requested from Braks.

Appendix 5
Verbinding van veterinaire en humane monitoring van Gezondheid

Projectleider
P.J.M. Wever, Gezondheidsdienst voor Dieren

Projectteam
F. van Zijderveld CVI-WUR
P. Kock, P. Wever, GD
M. Kretzschmar, J. van der Giessen, B. Schimmer, Cib-RIVM
O. Stenvers, VWA
J.W. Zylker, LNV
S. Beukers, VWS
A. van Lenthe, PVE

Samenwerking
In het project is vergeleken hoe de keten van monitoring van gezondheid tot en met risicomanagement functioneert in enerzijds de veehouderij en anderzijds de volksgezondheid. De partijen met een formele rol in de monitoring en surveillance (Centrum Infectieziektenbestrijding (CIb) en Gezondheidsdienst voor Dieren (GD)) hebben een gezamenlijk overleg ingericht om signalen uit beide domeinen met elkaar te bespreken. Dit overleg heeft circa 13 keer plaatsgevonden en is uitgebreid met de Voedsel en Waren Autoriteit (VWA). Het gezamenlijke overleg wordt gedragen door een set van afspraken m.b.t. de samenstelling en frequentie van het overleg en de wijze waarop met informatie wordt omgegaan.
Verder zijn vanuit het project initiatieven genomen om ook de betrokken beleidsinstanties in gezamenlijk overleg te doen komen tot afspraken over de onderlinge samenwerking bij de aansturing van monitoring en surveillance en het risicomanagement.

Samenvatting
Dit project had tot doel om te komen tot een gestructureerde uitwisseling en gezamenlijke beoordeling van signalen over gezondheidsproblemen uit de volksgezondheid en de diergezondheid, ter verbetering van de vroege signalering van zoönosen en de reactie op signalen en daarmee verbetering van de bescherming van de humane en veterinaire (volks)gezondheid.
Als eerste stap is in kaart gebracht op welke wijze de monitoring van gezondheid plaatsvindt in enerzijds de volksgezondheidzorg en anderzijds de diergezondheidszorg in de veehouderij. Daarbij is ook in kaart gebracht op welke wijze signalen uit de monitoring worden vertaald naar beleid. Uit beide werkwijzen is een generiek proces gedestilleerd en vergeleken is hoe verantwoordelijkheden voor stappen in dat proces in beide domeinen zijn belegd. Het doel hiervan was een beter beeld te krijgen van het functioneren van de beide ketens van monitoring en risicomanagement en in beeld te krijgen waar aansluitingsproblemen zijn te verwachten en moeten worden opgelost.
De tweede stap was het inrichten van een gezamenlijk overleg tussen de deskundigen die zijn betrokken bij de twee kernsystemen: het signaleringsoverleg van het CIb en de veterinaire monitoring zoals ingevuld via de GD-Veekijker. Gaandeweg is dit overleg uitgebreid met VWA. Het overleg heeft 13 maal plaatsgevonden en is geëvalueerd door betrokkenen.
Ervaringen en conclusies uit dit project zijn vertaald naar aanbevelingen voor inrichting en functioneren van het gezamenlijke signaleringsoverleg en randvoorwaarden die daarvoor moeten worden ingevuld.

Summary
The aim of this project was to achieve a structure for exchange and assessment of signals of health disorders in humans on the one hand and animal husbandry on the other hand, which should contribute to improvement of early detection of zoonotic diseases and improved protection of both human health and animal health. As a first step an inventory was made of the monitoring and surveillance procedures in public health as well as animal husbandry. Also an inventory was made of the procedures through which signals are translated into animal- or human health policy. Procedures in both domains were translated into a general process and a comparison was made of responsibilities of parties involved in each step of the process in either domain. The aim was to gain understanding of the chains of monitoring and risk management, including risk communication and to identify which issues should be paid attention to for making a successful connection.The next step in the project was to achieve a common structure for experts in monitoring in both domains to exchange signals from the monitoring as performed at the CIb for public health and at the Animal Health Service for livestock. A common structure was found in regular meetings, which were held 13 times. Experiences and conclusions were translated into recommendations for a design and working methods for a joint structure for signalling zoonotic disease problems as well as for conditions that need to be fulfilled to make it successful.

Introductie

Zowel in de veterinaire gezondheidszorg als in de humane gezondheidszorg bestaat een infrastructuur om te volgen welke ontwikkelingen er zijn in het optreden van gezondheidsproblemen. Deze infrastructuur is in beide gevallen ingericht om daar waar nodig en gewenst snel en adequaat te kunnen handelen om specifieke problemen met infectieziekten beter te doorgronden, op te lossen, in de toekomst te voorkomen of de consequenties ervan op te vangen. Omdat een flink aantal zoönosenverwekkers (en soms andere oorzaken van gezondheidsproblemen) een rol kan spelen in beide domeinen en vanuit het ene domein effect kunnen hebben op het andere, is samenwerking tussen de betrokkenen uit beide domeinen noodzakelijk. Tot op heden ontstond de samenwerking op *ad hoc* basis en was de samenwerking incident gestuurd. Een vaste structuur waarin wordt samengewerkt is niet beschikbaar, noch voor wat betreft de uitwisseling van signalen uit de monitoring, noch voor wat betreft de beleidsmatige verantwoordelijkheden voor de opvolging daarvan. Deze situatie is ongewenst, temeer daar verwacht wordt dat in de toekomst vaker met elkaar zal moeten worden opgetrokken vanwege een toenemend belang van emerging zoönosen. Dit constaterende heeft het ministerie van Landbouw, Natuur en Voedselveiligheid (LNV) het programma EMerging ZOOnosen opgezet. Dit project was onderdeel van dat programma.

Alle betrokkenen zijn er van overtuigd dat een sterkere verbinding tussen de monitoring in de volksgezondheid en de monitoring bij dieren zal leiden tot een effectievere inzet van de instrumenten en middelen voor monitoring en vervolgens verbetering van de gezondheid. De ervaringen met een aantal incidenten hebben geleerd dat in beide domeinen voor een deel wordt gedacht vanuit een zelfde kader, maar zeker ook dat er verschillen zijn, die overwonnen moeten worden om samenwerking te verbeteren. Deze verschillen komen tot uitdrukking wanneer het bijvoorbeeld gaat over keuzes met betrekking tot vrijgave van persoonsgegevens, interpretatie van onderzoeksresultaten, de actie die wordt ingezet op basis van bepaalde signalen of de wijze waarop het publiek wordt geïnformeerd. Samenwerken zal alleen effectief worden indien de verschillen worden overbrugd door afspraken te maken, voor zowel de uitwisseling van signalen, als ook over te ondernemen vervolgacties.

Dit project had tot doel om te komen tot een gestructureerde uitwisseling en beoordeling van signalen m.b.t. de volksgezondheid en de diergezondheid. In dit project zijn stappen gezet om deze verbinding te leggen, enerzijds tussen betrokken deskundigen en anderzijds tussen betrokken beleidsmakers. Dat laatste was noodzakelijk omdat het proces van monitoring naadloos overloopt in het proces van risicoanalyse en deze processen dus niet los van elkaar kunnen worden gezien. Het zwaartepunt lag echter bij de deskundigen.

In dit deelproject is de bestaande monitoring in beide domeinen niet ter discussie gesteld. Ook heeft het project zich beperkt tot de monitoring van gezondheid bij de mens en bij landbouwhuisdieren. Monitoring van paarden, gezelschapsdieren, wild en vectoren zijn geen onderwerp geweest binnen dit project.

Materiaal en methode

Voor het project is een inventarisatie gemaakt van bestaande monitorings- en surveillance activiteiten en de structuren voor risicoanalyse voor infectieziekten bij de mens en in landbouwhuisdieren Daarbij is op hoofdlijnen uitgewerkt bij welke organisaties verantwoordelijkheden zijn belegd voor monitoring en surveillance en het risicomanagement. Daarbij is het model zoals weergegeven in figuur 1 gebruikt. Op grond van de beschikbare documentatie m.b.t. de werkwijzen voor monitoring in de volksgezondheid, monitoring bij landbouwhuisdieren en aangifteplichtige dierziekten, die in dit verslag zijn samengevat (bijlagen 3,4,5), is een 'generiek' proces beschreven voor monitoring en surveillance en risicoanalyse. Hierbij is aangesloten bij relevante definities zoals gehanteerd door de World Organisation for Animal Health (OIE) (tabel 1). Voor beide domeinen is vervolgens beschreven bij welke organisatie / functionaris bepaalde stappen in het proces zijn belegd. Ook de risicocommunicatie is in dit verband beschouwd. Doel hiervan was wederzijds beter begrip te krijgen van de gang van zaken in beide domeinen en punten in beeld te brengen die aandacht vragen bij de aansluiting.

Voorts is als pilot een gezamenlijk overleg ingericht van het signaleringsoverleg zoals dat functioneert bij het CIb en het veekijkeroverleg zoals dat functioneert bij GD. Bij het ontbreken van bestaande kaders is een set van afspraken gemaakt waarmee afspraken werden vastgesteld waarbinnen deze pilot kon worden uitgevoerd (bijlage 1). Doel hiervan was ervaring op te doen en een eerste stap te zetten naar een permanente structuur.

Tenslotte is in een aantal overleggen met betrokken medewerkers van LNV, het ministerie van Volksgezondheid, Welzijn en Sport (VWS) en productschappen besproken op welke wijze invulling kon worden gegeven aan afspraken tussen beleidsinstanties die verantwoordelijk zijn voor de continuïteit van monitoring en voor de risicoanalyse. Doel hiervan was te komen tot een convenant terzake tussen deze organisaties.

Resultaten

1. ***Verantwoordelijkheden in het proces van monitoring en risicoanalyse***

   In dit hoofdstuk (zie overzicht 1) wordt een beschrijving gegeven van het proces van monitoring en risicoanalyse.

Daarbij wordt aangegeven hoe verantwoordelijkheden zijn belegd. Uit deze beschrijving zijn de volgende conclusies te trekken:

- In beide domeinen zijn alle stappen in het proces van monitoring en risicoanalyse belegd. Op ad-hoc basis weten partijen elkaar onderling te vinden.
- In het veterinaire domein is sprake van organisatorische scheiding tussen de verantwoordelijkheden voor signalering (door deskundigen, bijvoorbeeld bij GD, CVI) en de verantwoordelijkheden voor formele risicoanalyse (door beleid, bijvoorbeeld LNV, PVV). Uiteraard is er wel altijd sprake van een voorselectie van signalen door deskundigen, alvorens deze worden doorgeleid naar beleid. Voor volksgezondheid liggen deze verantwoordelijkheden vaak in één organisatie. Alleen in crisissituaties in de volksgezondheid is er een bewuste scheiding aangebracht tussen het professionele, inhoudelijke advies over de te volgen maatregelen (adviserende deel van het risicomanagement, dat ligt bij het Outbreak Mangement Team (OMT) en het bestuurlijke besluit over de uitvoering in het Bestuurlijk Afstemmingsoverleg (BAO) of VWS.
- In het veterinaire domein is de verantwoordelijkheid voor formele risicoanalyse eenduidig en op landelijk niveau belegd, namelijk bij het ministerie van LNV of productschappen. In de volksgezondheid zijn verantwoordelijkheden voor risicoanalyse op meerdere plaatsen belegd: zowel CIb als Gemeentelijke Gezondheidsdiensten (GGD'en) hebben hier taken, die los van elkaar kunnen worden uitgeoefend. Echter, de verantwoordelijkheid voor de bestrijding (risicomanagement) ligt bij de lokale overheid voor het merendeel van de humaan aangifteplichtige ziekten. De GGD voert de bestrijding uit in opdracht van de burgemeester. In bepaalde situaties, in geval van epidemieën met potentieel nationale en internationale implicaties (bijvoorbeeld de groep A aangifteplichtige ziekten), komt de regie van de bestrijding in handen van de minister van VWS. De adviserende en uitvoerende dienst op landelijk niveau is het CIb.
- Op het vlak van diergezondheid speelt het bedrijfsleven, via de productschappen, een belangrijke rol als opdrachtgever voor de monitoring en in veel gevallen ook als beleidmatig verantwoordelijke voor risicoanalyse. Monitoring en risicoanalyse in de volksgezondheid zijn volledig publieke aangelegenheden.

2. ***Gezamenlijk overleg signalering zoönosen.***
Het gezamenlijke signaleringsoverleg van GD en CIb, later aangevuld met VWA, is na 13 bijeenkomsten geëvalueerd door de deelnemers. De pilot is gestart in een aftastende sfeer. De afspraken waren zodanig dat signalen werden gedeeld, maar dat bij benodigde vervolgactie de inbrenger van het signaal de volledige verantwoordelijkheid behield voor elke volgende stap.
De volgende punten komen naar voren uit de evaluatie:

- Delen van signalen uit de monitor verbetert onderling vertrouwen en versterkt het wederzijdse begrip voor ieders denkwereld en zienswijze.
- Delen van signalen uit de monitor en van kennis verbetert de beoordeling van signalen en de rapportage daarover. Een vaste samenstelling wordt hierbij als waardevol beschouwd.
- In het overleg bleek dat naast het delen van signalen ook het delen van meer algemene informatie over de (dier)gezondheidssituatie als waardevol wordt beschouwd, ook al is daar niet een ontwikkeling die als signaal zou worden beschouwd.
- Het aantal relevante signalen bleek beperkter dan verwacht en rechtvaardigt een lagere frequentie van overleg dan ééns per 2 weken, zoals in de pilot. Het werd als belangrijk beschouwd om elkaar fysiek te treffen.
- Inbreng van andere partijen (Centraal Veterinair Instituut (CVI), Faculteit Diergeneeskunde (FD), Dutch Wildlife Health Centre (DWHC) en Centrum Monitoring Vectoren (CMV) is gewenst, maar het is voor de deelnemers aan de pilot nog de vraag of het zinvol is dat alle partijen bij elke bijeenkomst aanwezig zijn.
- Het gezamenlijke signaleringsoverleg moet voor een goede werking op een logische wijze aansluiten bij een duidelijke structuur voor risicoanalyse, waarin de beleidverantwoordelijken voor volksgezondheid en diergezondheid samenwerken. Zolang deze structuur er niet is, kan de gezamenlijke signalering niet tot volle wasdom komen. Belangrijk hierbij is dat VWS, LNV én productschappen afspraken maken over de wijze waarop in de risicoanalyse wordt omgegaan met signalen uit de gezamenlijke monitoring. Dit vloeit voort uit de gedeelde verantwoordelijkheid van overheid en bedrijfsleven in de monitoring van diergezondheid.

In bijlage 2 is het volledige evaluatierapport weergegeven.

3. ***Afspraken tussen beleidsmakers***
Het gezamenlijke overleg tussen beleidsmedewerkers van LNV, VWS en productschappen binnen dit project heeft (nog) niet tot een concreet resultaat geleid. Buiten het project is door LNV en VWS gewerkt aan een voorstel om de samenwerking op het vlak van zoönosen vorm te geven in een vaste structuur, echter nog zonder inhoudelijk overleg met de veehouderij sector. Vastgesteld kan worden dat de tijd er nog niet rijp voor was om dit onderdeel binnen dit project af te ronden.

Overzicht 1. Procesmatige weergave van het proces van signalering tot verlenen van opdracht voor maatregelen. In de middelste kolom is het generieke proces weergegeven; in de linker en de rechter kolom is aangegeven hoe de verantwoordelijkheden zijn belegd in de beide domeinen.

Veterinair	Algemeen	Volksgezondheid
GD-veekijker-overleg: deskundigen van verschillende disciplines binnen GD. Er zijn overleggen voor rundvee, varkens, pluimvee en kleine herkauwers. Bronnen: Veekijker, pathologie, data-analyse, prevalentiemetingen, literatuur, nieuws. Het overleg betreft diergezondheid in brede zin. Verder vindt uithoofde van een toezichthoudende taak (b.v. vleeskeuring, exportonderzoek) signalering plaats bij **VWA** en **CVI**.	**1. Verzamelen van signalen**: door systematische analyse van diverse bronnen worden signalen verzameld m.b.t. de doelpopulatie. Dit levert een lijst op met signalen.	**Signaleringsoverleg CIb**: deskundigen van diverse onderdelen van het CIb, aangevuld met medewerker van de VWA. Geraadpleegde bronnen zijn: OSIRIS, Virologische weekstaten, surveillance systemen en literatuur of ad hoc ingebrachte signalen vanuit externe partijen Er is één overleg dat gaat over infectieziekten.
Deelnemers **GD-veekijker** overleg, eventueel na raadpleging van deskundigen van andere instituten, waaronder deskundigen uit de volksgezondheid. Bij signalering vanuit toezicht: **VWA/CVI** eventueel in overleg met andere deskundigen.	**2. Beoordeling van signalen**: Gevaren identificatie en/of risico beoordeling **door deskundigen**: Op basis van direct beschikbare informatie worden signalen beoordeeld om te bepalen of er opvolging aan moet worden gegeven. mogelijke uitkomsten zijn ruwweg: i. er is geen risico (onbelangrijk). ii. signaal is niet scherp genoeg; op beperkte schaal nadere informatie verzamelen om te komen tot indeling in i of iii of iv. (niet onbelangrijk). iii. er is sprake van een risico dat volgens beproefde aanpak kan worden afgehandeld (belangrijk). iv. er is sprake van een risico dat vraagt om een beleidsbeslissing over vervolgactie (belangrijk) Resultaat is een lijst van signalen met daaraan gegeven relevantie.	Deelnemers **signaleringsoverleg CIb**, eventueel na raadpleging van deskundigen van andere instituten, waaronder veterinaire instituten.
Eén of meer deelnemers aan het **GD-veekijker** overleg, eventueel aangevuld met **externe deskundigheid**. Bij signalering vanuit toezicht: **VWA/CVI** eventueel in overleg met andere deskundigen.	**3. Uitvoering van beperkt nader onderzoek**: Signalen die niet scherp genoeg zijn worden nader onderzocht. Resultaat is een rapportage, waarop alsnog een gevarenidentificatie en/of risicobeoordeling plaatsvindt door de deskundigen.	Eén of meer deelnemers aan het **signaleringsoverleg CIb**, eventueel aangevuld met **externe deskundigheid**.
De monitor-verantwoordelijke voor de diersector binnen **GD** meldt het signaal met een advies (voor zover mogelijk) aan vertegenwoordigers / beleidsmedewerkers van **LNV, PVV, PPE** en /of **PZ** en **VWA** in de begeleidingscommissie monitoring. Bij signalering vanuit toezicht: melding aan LNV/VWA.	**4. Melden** van belangrijke signalen aan risicomanagers die nauw zijn betrokken bij de monitoring. Doel hiervan is te informeren en/of te komen tot een beleidsbeslissing over te treffen vervolgactie. Resultaat is een melding aan risicomanagers.	Deelnemers van het **signaleringsoverleg CIb** koppelen signalen terug naar medewerkers LCI en GGD(-en).
Beoordeling vindt plaats door **beleidsmedewerkers van LNV** en / of **productschappen** (alleen productschappen als het niet de LNV-verantwoordelijkheid betreft). Zij bepalen vervolgactie.	**5. Risicobeoordeling van het signaal door risicomanagers**. Beoordeeld wordt of vervolgactie moet plaatsvinden op grond van het signaal. Zonodig wordt hierover advies ingewonnen bij deskundigen (deskundigen overleg). Resultaat is een beoordeling van het signaal door risicomanagers.	Medewerkers **CIb** en/of **GGD** bepalen vervolgactie.
Risico-analyse wordt uitgevoerd door voor het betreffende signaal geschikt geacht panel van **deskundigen van (meestal) GD** en/ of **CVI** en/of **VWA** en/of **CIb**. Opdracht is afkomstig van LNV of productschappen.	**6. Deskundigen overleg**. Als onvoldoende informatie beschikbaar is om verantwoorde beleidsbeslissingen te nemen wordt een deskundigen advies ingewonnen. Resultaat is een deskundigen advies.	Risico-analyse wordt uitgevoerd door **medewerkers van CIb** en/of **GGD, soms aangevuld met anderen, waaronder veterinaire instituten**. Bij serieuzere signalen vindt dit plaats onder de noemer van een ad hoc expert meeting of het Outbreak Mangement Team o.l.v. de **directeur CIb**
Door beleidsmedewerkers LNV en/of **productschappen**. Afhankelijk van de ernst van de situatie is hier in meer of mindere mate de departementsleiding bij betrokken.	**7. Vaststellen te treffen maatregelen**. Zonodig wordt hierover advies ingewonnen bij deskundigen (deskundigen overleg). Resultaat is een set van voorgestelde te nemen maatregelen.	Door **medewerkers van CIb** en/of **GGD of door de directeur CIb** en/of **GGD**. In geval van een maatregel, waarbij de afweging is om nog geen OMT in te stellen, zal de maatregel door het responseteam van het CIb worden behandeld (voorzitterschap: LCI). Voor ernstige dreigingen brengt het OMT een advies uit aan het Bestuurlijk Afstemmings Overleg (BAO) dat het advies op bestuurlijke gronden toetst en de Minister van VWS adviseert over het te volgen beleid. Wanneer er meerdere departementen betrokken zijn, kan een IBT bijeengeroepen worden (Interdepartementaal Beleids Team).

Veterinair	Algemeen	Volksgezondheid
Directeur LNV-VDC / VWA en in ernstige situaties de departementsleiding en eventueel de minister van LNV	**8. Opdracht voor uitvoering van maatregelen**	**Directeur CIb / LCI en/of GGD en/of Minister VWS**
• Belangrijke signalen worden door GD gemeld aan de vertegenwoordigers van LNV, productschappen en VWA. Melden gebeurt direct nadat de bevinding is gedaan, of via de kwartaalrapportage, afhankelijk van de (vermoedelijke) noodzaak van handelen. Bevinden worden samengevat in een jaarrapportage. • Communicatie naar derden over signalen vindt vaak plaats door GD, met instemming van LNV en /of productschappen. Communicatie gaat via de GD-media (website, GD-veterinair, GD-herkauwer etc.) en externe media (b.v. Tijdschrift voor Diergeneeskunde). • Naar mate het publieke / collectieve belang groter is nemen partijen zelf (LNV, schappen, standorganisaties) een groter deel van de communicatie of zelfs de gehele communicatie voor hun rekening. • Jaarlijks maakt GD een jaarverslag op dat wordt verspreid naar een brede doelgroep zowel binnen als buiten de diergezondheidszorg.	**9. Risicocommunicatie (buiten crises)**	• Tijdens elk signaleringsoverleg wordt besloten welke items in het signaleringsverslag komen. Dit verslag wordt verspreid naar een breed publiek van werkers in de openbare gezondheidszorg (GGD-en, medisch microbiologen etc). Tevens wordt een selectie van signalen ingebracht in een vaste rubriek in het Infectieziekte Bulletin van het CIb en het Tijdschrift voor Diergeneeskunde als de signalen ook voor dierenartsen relevant zijn. • Indien een groot risico wordt gesignaleerd wordt VWS geïnformeerd. • CIb communiceert zelfstandig over signalen die van publiek belang zijn. Indien gewenst, worden veldpartijen voorafgaand aan publiek maken van signalen geïnformeerd.

Discussie

De pilot die is uitgevoerd in dit project maakt duidelijk dat het uitwisselen van signalen tussen het veterinaire domein en de volksgezondheid aan beide kanten meerwaarde heeft en verwacht mag worden dat dit ook positief zal bijdragen aan de samenwerking in het verdere traject van risicoanalyse. De pilot is in die zin zeer geslaagd, ook al was het aantal relevante signalen beperkt gebleven.

Vervolgstap is dat het gezamenlijke overleg een definitieve structuur krijgt. De vorm voor die definitieve structuur is grotendeels al aangereikt vanuit de ervaringen in de pilot. Openstaande punten hebben betrekking op de invulling van de coördinatie en de wijze waarop signalen worden gecommuniceerd met het brede veld van professionals. Dit zijn belangrijke aspecten van een goed functionerend gezamenlijk signaleringsoverleg. Vastgesteld is echter ook dat het delen van signalen niet los kan worden gezien van de wijze waarop wordt besloten tot opvolging van de signalen. De openstaande punten kunnen pas worden ingevuld als hier duidelijkheid over is ontstaan.

Voor een optimaal functionerend gezamenlijk signaleringsoverleg, is het dus absoluut randvoorwaardelijk dat er kaders worden gesteld vanuit de beleidsverantwoordelijken. De monitoring van diergezondheid in de veehouderij is een gedeelde verantwoordelijkheid van het ministerie van LNV en productschappen. Daarom moet het zo zijn dat bij het vaststellen van de beleidsmatige kaders ook plaats is voor betrokkenheid van de productschappen. Het is bijzonder jammer dat tijdens het project hier nog geen stappen in zijn gemaakt.

Dit project is uitgevoerd in een bijzonder roerige omgeving, waarin beleidsmakers met Q-koorts een ongekend zwaar dossier onderhanden hadden op het snijvlak van volksgezondheid en veehouderij. Het gezamenlijke risicomanagement is zwaar op de proef gesteld en de ministers van LNV en VWS hebben besloten om de samenwerking tussen LNV en VWS in het Q-koorts dossier te evalueren. De ministeries hebben daartoe samen een commissie ingesteld, die gevraagd wordt aanbevelingen te geven voor de samenwerking in de toekomst. Verwacht mag worden dat resultaten van het onderzoek ook gebruikt kunnen worden voor het inrichten van de gezamenlijke signalering.

Voor zowel de volksgezondheid als de diergezondheid is het natuurlijk van belang kennis te hebben van risico's vanuit dieren die in het wild leven en andere gehouden dieren dan landbouwhuisdieren, alsmede van risico's vanuit vectoren. In andere onderdelen van het EMZOO programma (m.b.t. paarden en gezelschapsdieren) en daarbuiten (DWHC, CMV) wordt de basis gelegd om de monitoring op deze vlakken aanzienlijk te versterken. In dit project zijn deze zaken buiten beschouwing gebleven, maar natuurlijk is het delen van signalen tussen de hierbij betrokken deskundigen van belang om zo snel mogelijk nieuwe gevaren en risico's in beeld te krijgen en maatregelen te kunnen treffen. In de pilot is dit ook onderkend.

In dit project is nog weinig aandacht geweest voor verschillen tussen beide domeinen in zaken als risicoperceptie, probleemanalyse, cultuur, die ongetwijfeld een rol zullen spelen bij het tot stand brengen van een goede samenwerking. Om goed met dit soort aspecten om te kunnen gaan, zal in de basis sprake moeten zijn van gelijkwaardigheid in de samenwerking en zal er aandacht voor moeten zijn bij het gezamenlijk optrekken. Ook hier is een belangrijke taak weggelegd voor de beleidsmakers.

Conclusies

1. Gebleken is dat er verschillen zijn tussen 'volksgezondheid' en het veterinaire domein met betrekking tot de verantwoordelijkheden in het proces van monitoring en surveillance tot en met risicomanagement, die aandacht moeten krijgen om tot een succesvolle samenwerking te komen. Een belangrijk verschil is dat in het veterinaire domein verantwoordelijkheden worden gedeeld tussen private en publieke partijen (LNV en productschappen), terwijl volksgezondheid een volledig publieke verantwoordelijkheid is. Een ander belangrijk verschil is dat in de volksgezondheid de verantwoordelijkheid voor uitvoering van monitoring en surveillance en die voor risicoanalyse op nationaal niveau in één hand liggen (CIb), terwijl dit in het veterinaire domein de organisatie die voor een groot deel verantwoordelijk is voor monitoring en surveillance (GD) niet primair verantwoordelijk is voor risicoanalyse.
2. Uit het project blijkt dat het waardevol is om een gezamenlijke structuur in te richten voor het delen van signalen over zoönosen vanuit volksgezondheid en veehouderij, ook al is het aantal signalen beperkt gebleven. Door het ontbreken van beleidsmatige kaders is de voorlopige werkvorm nog niet de optimale.
3. Om te komen tot een optimaal functionerende gezamenlijke structuur voor het delen van signalen over zoönosen tussen het veterinaire domein en 'volksgezondheid', moet een gezamenlijke structuur voor risicoanalyse worden ingericht, gebaseerd op afspraken tussen betrokken publieke organisaties en private organisaties in het veterinaire domein. Risicomanagement en in het bijzonder risicocommunicatie is het belangrijkste onderdeel van dergelijke afspraken.

Aanbevelingen

- Beleidsmakers uit beide domeinen, waaronder private partijen, moeten afspraken maken over de structuur voor het delen van signalen als mede risicoanalyse voor zoonosen. Risicocommunicatie moet hierin een belangrijk aspect zijn.
- De gezamenlijke structuur voor het delen van signalen over zoönosen kan vorm worden gegeven zoals aanbevolen binnen dit project, inclusief de uitbreiding met CVI, FD, DWHC en VMC. Coördinatie van de activiteiten van het gezamenlijk overleg zou voor langere tijd op één plek moeten worden belegd.

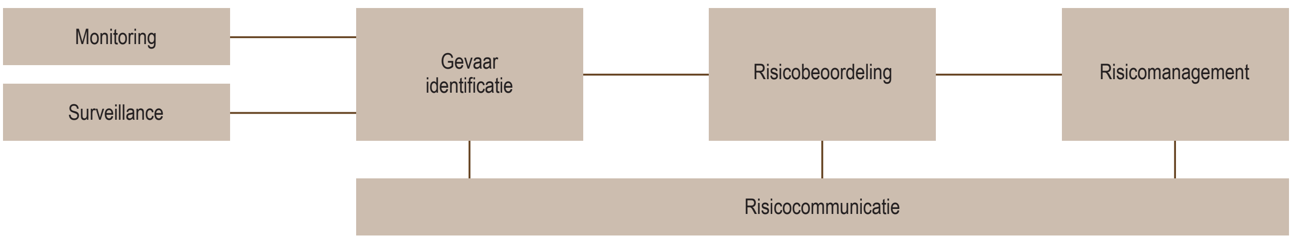
Dankwoord

Naast de betrokkenen in de projectgroep worden de deelnemers aan het gezamenlijke signaleringsoverleg tijdens de pilot bedankt voor hun bijdrage aan het project: H. van Beers, P. Vellema, T. Fabri, L. van Wuijckhuise, Anita Suijkerbuijk, Ton Oomen, Daan Notermans.

Tabel 1. In dit rapport gebruikte terminologie in relatie tot terminologie gehanteerd door de OIE.

Term in dit document	Term volgens OIE	Beschrijving OIE
Gevaar	Hazard	A biological, chemical or physical agent in, or a condition of an animal or animal product with the potential to cause an adverse health effect.
Gevaren idententificatie	Hazard identification	The process of identifying the pathogenic agent which could potentially be introduced.
Monitoring	Monitoring	The intermittent performance and analysis of routine measurements, aimed at detecting changes in the environment or health status of a population.
Risico	Risk	The likelihood of the occurrence and the likely magnitude of the biological and economic consequence of an adverse event to animal or human health.
Risico beoordeling	Risk assessment	The evaluation of the likelihood and the biological and economic consequences of entry, establish and spread of a hazard.
Risico management	Risk management	The process of identifying, selecting and implementing measures that can be applied to reduce the level of risk.
Risico communicatie	Risk communcation	The interactive exchange of information among risk assessors, risk managers and other interested partners
Risico-analyse	Risk analysis	The process composed of hazard identification, risk assesment, risk management and risk communication.
Monitoring	Surveillance[1]	The systematic ongoing collection, collation and analysis of information related to animal health and the timely dissemination of information to those who need to know so that action can be taken.

[1] In Nederland wordt de term 'monitoring' doorgaans gebruikt voor wat de OIE bestempelt als zowel 'monitoring' als 'surveillance'. Daarom wordt hieronder alleen over 'monitoring' gesproken, maar wordt de lading van beide OIE-termen bedoeld.



Figuur 1. Samenhang tussen monitoring en surveillance en risicoanalyse

Bijlage 1. Afspraken rondom de pilot verbinden monitoring veterinair en humaan

Invulling proeffase (“pilot”)

Alhoewel dit proefdraaien vóór opstellen van een convenant tussen de opdrachtgevers plaats vindt, is tijdens de EmZoo-vergadering instemming gegeven van VWS, LNV en Productschappen voor de pilot-werkwijze zoals die hieronder is beschreven.
RIVM en GD maken een opzet voor de structuur van een gezamenlijk signaleringsoverleg. Deze structuur wordt dan gedurende de pilot fase getoetst en verder aangepast en verbeterd.
Vooraf nemen een of twee mensen van het RIVM nemen een of meerdere keren deel aan het signaleringsoverleg van GD en andersom, om een indruk te krijgen hoe het overleg verloopt en wat voor signalen worden besproken.

Doelen

Belangrijkste doel van het twee wekelijkse overleg is om de structuur van de gezamenlijke signalering verder uit te werken en vorm te geven op basis van de ervaringen die daarmee gedurende de pilot fase worden opgedaan. Tijdens de pilot wordt onderzocht welke signalen van belang zijn en wat er nodig is om te komen tot definitieve afspraken.

Frequentie

2* per maand (vermoedelijk te hoge frequentie; gaandeweg vaststellen of dit noodzakelijk is)

Samenstelling

RIVM: Vier vertegenwoordigers van het CIb (een uit elk lab EPI, LIS, LZO, LCI) + M. Kretzschmar
GD: vertegenwoordiger per diersoort + P. Kock
Gedurende de pilot wordt een vaste samenstelling aangehouden.

Locatie

Alternerend RIVM en GD

Voorzitterschap en eerste aanspreekpunt

Mirjam Kretzschmar (RIVM) en Petra Kock (GD) zijn alternerende voorzitter.
Vaste contact persoon voor het uitwisselen van signalen en eerste aanspreekpunt voor informatie- uitwisseling en vragen zijn Mirjam Kretzschmar of Joke van der Giessen (nader in te vullen) en Petra Kock.

Agenda

- Inbreng signalen per organisatie en achtergrond; inclusief interpretatie en/of vraagstelling aan andere organisatie.
- Reactie andere organisatie: Bekend? Relevant? Aanvullende info?
- Gezamenlijke conclusie: aanpassing interpretatie? Iets verder uitzoeken?

Vaste items op de agenda van het twee wekelijkse overleg kunnen verder zijn evaluatie van hoeveel signalen zijn er en hoe werkt het.

In te brengen signalen

Alle signalen met een mogelijk zoönotisch aspect komen in principe in aanmerking.
De keuze van signalen moet in eerste instantie breed worden ingezet om tot een consensus te komen over wat voor de andere kant van belang is. Tijdens de pilot kan worden vastgesteld wat de wenselijkheid is om het zo breed te houden.
Privacy-gevoelige informatie wordt alleen gedeeld als dat noodzakelijk is voor het gesprek (aanvullingen / interpretatie aanhorende partijen mogelijk maken).

Verslaglegging

De volgende zaken worden vastgelegd: inbrengende partij, signaal (inclusief interpretatie), discussie, gezamenlijke conclusie, actiepunten. Eerst concept, binnen 24 uur reageren, dan definitief. Verspreiding van verslag en info alleen tussen de deelnemende personen; geen verdere verspreiding vanuit dit overleg.

Opvolging van signalen

De pilot betreft een verkenning. In deze fase wordt de informatie puur vertrouwelijk gedeeld. De inbrengende partij is degene die zonodig vervolgacties onderneemt via de gebruikelijke structuur (informeren beleid, nader onderzoek inzetten, …), waarbij de intentie is om waar dat passend is gebruik te maken van elkaars deskundigheid en infrastructuur. Er volgt *geen* communicatie over de besproken signalen door anderen dan de inbrengende partij naar personen buiten het overleg.

Evaluatie na 3 maanden = 6 vergaderingen

De pilot wordt op de volgende punten geevalueerd:

- Mate waarin de pilot bijdraagt aan de project-doelstelling.
- Beschrijvend: aantal/soort behandelde signalen.
- Toegevoegde waarde van het delen van signalen?
- Frequentie aanpassen?
- Andre samenstelling?
- Andere afspraken over vervolgacties gewenst?
- Verslaglegging.
- Privacy-afspraken.

Deze punten moeten worden bezien in het licht van een definitief te maken afspraak. De evaluatie moet aanbevelingen opleveren voor de daarvoor te maken afspraken.

Discussiepunten

- Op den duur kan het twee wekelijkse overleg ook via telefoon conferentie.
- Of de frequentie twee weken moet zijn moet in de praktijk getoetst worden.

Langere termijn doelen:

- Een gezamenlijk signaleringsoverleg waarin de humane en de veterinaire signalen worden besproken.
- Opbouwen van een HAIRS achtige structuur, waarin ook een risico assessment van de signalen plaatsvindt.

Bijlage 2. Evaluatie van de pilot verbinden humane en veterinaire monitoring

Pilot verbinden humane en veterinaire signalering; Evaluatie, conclusies en aanbevelingen

Achtergrond

Deelproject 2.2 *(Verbinding van veterinaire en humane monitoring van gezondheid)* van de tweede fase van het Consortium Emerging Zoönosen heeft als doel om "te komen tot een gestructureerde uitwisseling en beoordeling van signalen uit de volksgezondheid danwel diergezondheid, ter verbetering van de vroege signalering en de reactie op signalen en daarmee bescherming van de humane en veterinaire (volks)gezondheid".

Binnen dit deelproject is als pilot een gezamenlijk overleg ingericht van het signaleringsoverleg zoals dat functioneert bij het CIb en het Veekijkeroverleg zoals dat functioneert bij GD. Bij het ontbreken van bestaande kaders is een set van afspraken gemaakt waarmee de randvoorwaarden werden vastgesteld waarbinnen deze pilot kon worden uitgevoerd. Doel van de pilot was ervaring op te doen en een eerste stap te zetten naar een permanente structuur.

De eerste bijeenkomst heeft plaatsgevonden op 15 september 2009. In totaal zijn 13 overleggen gevoerd met een frequentie van eenmaal per twee weken.

Aan de pilot namen deel:
van de zijde van het RIVM: Ton Oomen (LCI), Daan Notermans (LIS), Joke van der Giessen (LZO), Anita Suijkerbuijk (EPI) en Mirjam Kretzschmar,
van de zijde van GD: Linda van Wuijckhuise (rundvee), Hetty van Beers (varkens), Piet Vellema (kleine herkauwers), Teun Fabri (pluimvee) en Petra Kock,
en van VWA: Marcel Spierenburg en Mauro De Rosa (beide VIC).

Activiteiten gedurende de pilot fase

- Informatie uitwisselen over opbouw, werkwijze en verantwoordelijkheden in de deelnemende organisaties.
- Uitwisselen van oudere en recente signalen om te komen tot een inzicht in welke signalen wederzijds relevant zijn.
- Discussie over gestructureerde manier van inschatting van risico (quick scan).
- Discussie over de gewenste communicatie naar buiten n.a.v. bespreking van signalen (na de pilotfase).

Evaluatie

Mate van bijdragen aan projectdoelstelling

- Ervaringen zijn positief door ontstane onderling vertrouwen en wederzijds begrip voor elkaars denkwereld en gezichtspunten, die bijdragen aan een totaalbeeld van een aandoening (dit inzicht werkt ook positief buiten deze pilot). De relaties kunnen ook worden gebruikt t.b.v. aanvullende kennis bij signalen binnen eigen surveillance.
- Een vertegenwoordiger van de VWA is pas in een later stadium van de pilot gaan deelnemen. Deze aanvulling heeft merkbaar toegevoegde waarde.
- De toegevoegde waarde van het overleg kan verder verbeteren als na het beëindigen van de pilot een goede vorm kan worden gevonden om andere experts bij onderwerpen te betrekken.

Aantal en soort signalen

- Aantal in te brengen signalen is van zowel RIVM – als GD-zijde beperkter dan vooraf werd gedacht.
- Bij groeiend onderling vertrouwen worden ook makkelijker punten ingebracht waarvan de inbrenger twijfelt of het een signaal betreft, o.a. ten behoeve van verbreding van het eigen beeld.
- Naast het inspelen op nieuwe signalen bestaat ook de behoefte om informatie over meer algemeen aanwezige pathogenen met zoönotisch karakter met elkaar te delen. Ook zaken die onveranderd zijn op een bepaald gebied kunnen voor de andere partij wel nieuw en relevant zijn. (te bespreken aan de hand van een overzicht van algemeen bestaande problemen per diersoort en de mens).
- Voor de toekomst is het gewenst om ook over alimentaire zoönosen input te krijgen vanuit VWA.

Toegevoegde waarde van het delen van signalen

- De uitwisseling zoals die tijdens de pilot heeft plaatsgevonden is positief ervaren door de deelnemers
- Ingebrachte signalen hebben geleid tot verkenning van problemen en mogelijke afspraken over communicatie naar belangengroeperingen.
- Voor de toekomst is het goed denkbaar dat uit dit overleg de mogelijkheid voortvloeit om van elkaars expertise gebruik te maken ter verbetering/onderbouwing van werkwijzen in de eigen organisaties of tussen organisaties.

- Het kan toegevoegde waarde hebben om signalen uit andere bestaande systemen in dit overleg in te brengen, met het doel om ze in bredere verbanden te kunnen beoordelen en op die manier tot snellere detectie te komen. (Beslissing over opvolging van die signalen op zich is dan elders al belegd).

Frequentie

- Gedurende de pilot vond 1 overleg per 2 weken plaats. Deze frequentie heeft snel bijgedragen aan het doel van de pilot, maar het aantal signalen is niet groot genoeg om deze frequentie te handhaven. Voorstel voor na de pilot, in geformaliseerde situatie: 1x per maand. Bij potentiële calamiteiten: frequenter. Om andere organisaties aan te laten sluiten aanvankelijk ook nog frequenter.

Samenstelling

- Voor goede resultaten is een beperkte vaste groep deelnemers gewenst die ook vrij frequent fysiek bijeen komt. De verbreding met andere deskundigen kan worden ingevuld met een lagere frequentie.
- Op dit moment is er geen inbreng vanuit het Dutch Wildlife Health Centre, de Faculteit Diergeneeskunde, het Centraal Veterinair Instituut, het Centrum Monitoring Vectoren (nu onderdeel van de Plantenziektekundige Dienst), of van de GGD-en. Dit is wel gewenst, het lijkt echter niet zinvol om al deze mensen iedere maand aan tafel te hebben.
- De pilotfase is vormgegeven met een vaste groep mensen van RIVM, GD en VWA. Binnen de pilot was geen vervanging geregeld. Hierdoor kon wel snel onderling vertrouwen groeien, maar wanneer een van de deelnemers was verhinderd viel daarmee meteen een belangrijk deel van de inbreng van de betreffende organisatie weg. Hier moet een oplossing voor komen zonder dat dit als gevolg heeft dat een hele vergadering voornamelijk uit vervangers zou kunnen bestaan (beperking aantal vervangers).

Coördinatie

Tijdens de pilotfase is voorzitterschap en secretariaat roulerend ingevuld door RIVM en GD. Dit heeft voordelen, maar deze frequente wisselingen brengen tevens met zich mee dat er geen eenduidige coördinatie voor het overleg is. Zeker als meer organisaties gaan deelnemen, bestaat daarmee het risico op communicatiestoornissen die de continuïteit belemmeren. Het is wenselijk de centrale coördinatie voor langere tijd op één plek te beleggen, op een voor alle partijen aanvaardbare wijze.

Communicatie

Het is mogelijk dat naar aanleiding van de bespreking van een signaal in het overleg door de deelnemers wordt geconcludeerd dat communicatie met derden (niet zijnde deelnemers of opdrachtgevers) hierover wenselijk is. De doelen hiervan moeten zijn: het verkrijgen van meer informatie uit beide domeinen over het betreffende signaal en professionals in beide domeinen informatie verschaffen die in hun dagelijkse werk van belang is. Inhoud en communicatiekanalen kunnen hierop per geval afgestemd worden. Het ligt voor de hand bestaande communicatiekanalen in beide domeinen te benutten. Hierover zijn nu nog geen formele afspraken gemaakt. Een complicatie hierin is dat de gebruikelijke werkwijze van de verschillende betrokken organisaties onderling verschilt.
Een mogelijkheid kan zijn de deelnemers aan het overleg in voorkomende gevallen een voorstel te laten formuleren òf, aan wie, met welke bewoording verder wordt gecommuniceerd en dit voor te leggen aan de beleidsbepalers.

Vergaderlocatie

Een vergaderlocatie tussen de deelnemende organisaties in, goed bereikbaar met openbaar vervoer en met de auto is gewenst evenals een vergadertijdstip aan het begin of eind van de werkdag. Dit zal het zeker een goede deelname van mensen uit allerlei windstreken bevorderen.

Conclusies en aanbevelingen

Concluderend wordt gesteld dat de gehanteerde werkwijze een duidelijke bijdrage levert aan de doelstellingen van het deelproject, namelijk om te komen tot een gestructureerde uitwisseling en beoordeling van signalen.

Voor de toekomst wordt door de pilotgroep aanbevolen:

- Een vaste kerngroep elkaar eenmaal per maand op vaste basis te laten treffen.
- Deze kerngroep minimaal te laten bestaan uit een aantal vaste deelnemers vanuit RIVM, GD en VWA (de oorspronkelijke pilotgroep kan hiertoe dienen).
- CVI en FD voor te leggen of zij deel willen uitmaken van deze kerngroep.
- Bij acute signalen op dat moment extra overleg te laten plaatsvinden.
- Naast de kerngroep een bredere expertgroep in te richten met:
  - o experts uit een brede groep instituten en organisaties.
  - o een uitbreiding van de experts uit RIVM, GD en VWA (waarmee tevens vervanging bij afwezigheid van kerngroepleden geregeld kan worden).

  Deze brede deskundigengroep wordt uitgenodigd signalen in te brengen en wordt uitgenodigd bij de bespreking van signalen die hun expertise betrekken. Agendaleden per instituut/organisatie ontvangen tevens de notulen van het overleg.
- De kerngroep verantwoordelijk te laten zijn voor de continuïteit binnen het eigen instituut.

Uit de pilot vloeit tevens de conclusie voort dat het wenselijk is dat:

- Afspraken worden gemaakt over een coördinatiepunt, tevens aanspreekpunt voor alle deelnemers.
- Helderheid wordt verschaft over hoe signalen worden opgevolgd die volgens de deelnemers aan het gezamenlijke signaleringoverleg beleidsmatige acties cq. verder onderzoek vereisen.
- Afspraken worden gemaakt over de gewenste werkwijze voor communicatie naar derden (professionals in beide domeinen) naar aanleiding van relevante signalen.

Bijlage 3. GD Diergezondheids-monitoring

Inleiding

Het is van belang om de diergezondheid in de Nederlandse veehouderij op een hoog niveau te houden en eventuele uitbraken van (besmettelijke) dierziekten vroegtijdig op te sporen, vanwege garanties voor volksgezondheid en voedselveiligheid, voor vrijwaring van landen waarnaar geëxporteerd wordt, voor dierwelzijn, continuïteit van bedrijfsvoering, imago, voorkomen van calamiteiten etc. Beleidsmakers bij de overheid en in de sector hebben betrouwbare en actuele informatie nodig ter onderbouwing van beleidskeuzes (lange termijn) en beslissingen in actuele situaties. Daarnaast is er behoefte aan informatie i.v.m. verplichte (Europese) rapportages.

Werkwijze van de diergezondheidsmonitoring

Om in deze informatiebehoefte te kunnen voorzien is door de GD voor de sectoren rund, varken, pluimvee en kleine herkauwers een diergezondheidsmonitoring ingericht met als doelstellingen:

- Zicht houden op trends en ontwikkelingen van bekende aandoeningen.
- Het opsporen van uitbraken van bekende, niet endemische aandoeningen.
- Het opsporen van nog onbekende aandoeningen.

Het systeem bestaat uit een aantal elkaar aanvullende en samenhangende middelen waarmee informatie wordt verzameld over de gezondheidssituatie van de Nederlandse veestapel (zie figuur 1). De middelen zijn deels reactief (initiatief ligt bij de veehouders en dierenartsen) en deels proactief (initiatief ligt bij GD). De informatie uit de diverse middelen wordt integraal beoordeeld in het Veekijker-overleg. Indien een signaal onvoldoende sterk of duidelijk is, maar wel relevant lijkt, wordt door onderzoek van beperkte schaal actief en gericht meer informatie verzameld. Elk kwartaal rapporteert GD over de bevindingen aan de opdrachtgevers/financiers. Indien nodig (als directe actie gewenst kan zijn) wordt tussentijds gerapporteerd.

Actie in de vorm van bijvoorbeeld uitgebreid onderzoek of bedrijfsblokkade behoort niet tot de monitoringsactiviteiten. GD speelt hierbij alleen een rol na aanvullende opdrachten van opdrachtgevers. Traceren naar individuele bedrijven op basis van informatie waarover GD rapporteert is in principe alleen mogelijk als er wettelijke verplichtingen aan de orde zijn.

De Veekijker heeft binnen de monitoring een tweeledige functie:

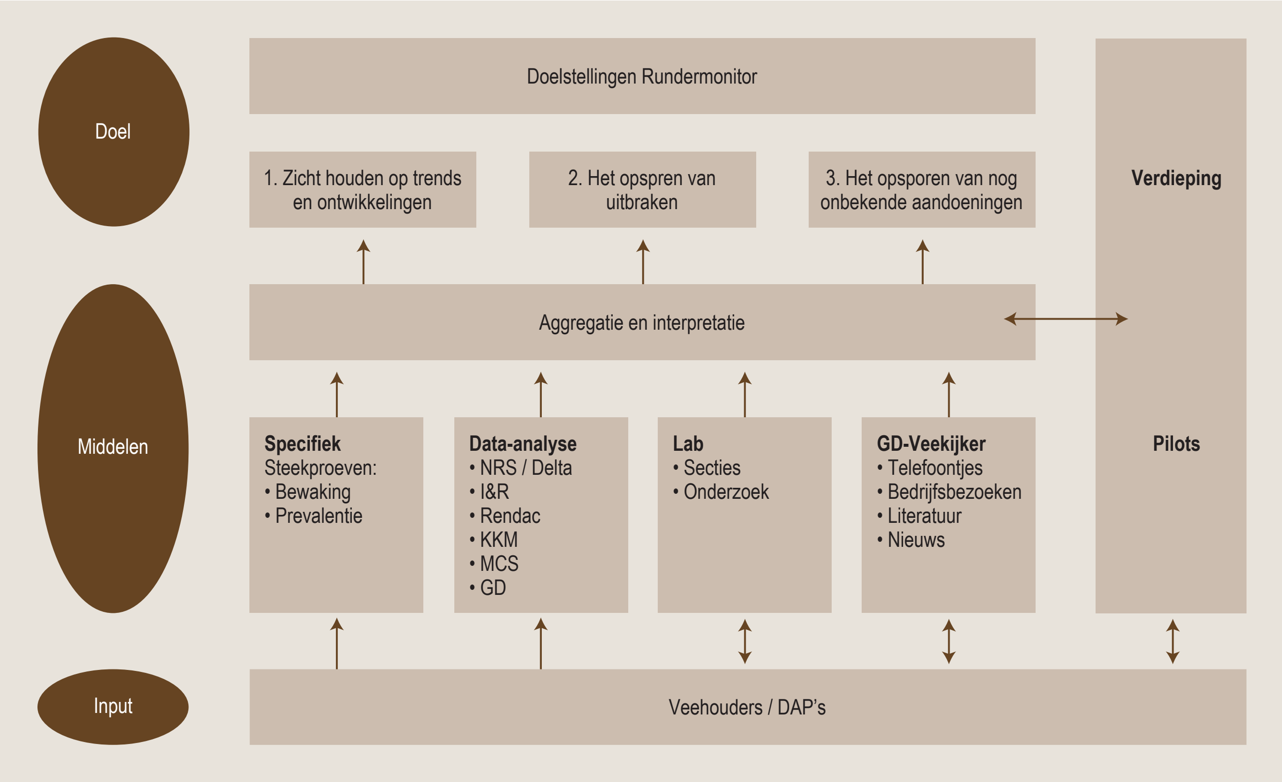
1. Informatie verzamelen; reactieve monitoring
   Door directe contacten met dierenartsen en veehouders worden signalen over gezondheidsproblemen uit het veld ontvangen. Het initiatief voor deze contacten ligt overwegend bij veehouders en dierenartsen.
2. Basis-structuur voor aggregatie en interpretatie.
   Naast de informatie uit het middel GD-Veekijker zelf, wordt ook informatie vanuit de verschillende onderdelen van de monitor hier geaggregeerd en geïnterpreteerd. GD-Veekijker vormt daarmee het hart van de monitor.

In de figuur op de volgende pagina wordt de onderlinge samenhang tussen de doelstellingen en de middelen van de monitor weergegeven.

Reactieve monitoring

Bij reactieve monitoring ligt het initiatief voor het inbrengen van monitorinformatie bij veehouder en dierenarts. Veehouders en dierenartsen worden gestimuleerd om bij GD-Veekijker ziektebeelden te melden die afwijken van wat men al kent en om hiervan materiaal in te zenden voor pathologisch onderzoek. Door de specialisten van GD wordt advies verstrekt over de aanpak van het betreffende probleem. Desgewenst bezoeken specialisten een bedrijf om de gemelde problemen terplekke te kunnen beoordelen. De contacten en inzendingen stellen GD op haar beurt in staat relevante ontwikkelingen op diergezondheidsgebied en relevante signalen uit het veld op te vangen. De informatie wordt voornamelijk verzameld via telefonische consulten (ca 10.000 per jaar) en pathologisch onderzoek (ruim 9000 per jaar). Via DAP-contact, een internet-toepassing voor informatie uitwisseling met dierenartsenpraktijken, kunnen ook meldingen worden ontvangen waarbij geen nadere advisering wordt gevraagd.

Informatie vanuit de praktijk wordt volgens protocollen vastgelegd. Bij beoordeling van de informatie wordt ook de informatie betrokken die wordt ontvangen door contacten met andere instituten. Ook informatie betreffende de diergezondheidssituatie in het buitenland, die van invloed kan zijn op de Nederlandse bedrijven, wordt actief verzameld. (persoonlijke contacten, internet, literatuur).
Reactieve monitoring is zeer geschikt voor het opsporen van nieuwe aandoeningen en niet-endemisch in Nederland



voorkomende aandoeningen en bekleedt daarmee ondermeer een vroegsignaleringsfunctie binnen de monitoring.

Voorwaarden voor een goed functionerende reactieve monitor

Vanzelfsprekend is *kennis* over de sector, over gangbare ziekten daarbinnen en kennis over exotische ziekten van belang. Reactieve monitoring is een vrijwillig proces dat alleen functioneert als het aantrekkelijk is voor veehouders en dierenartsen om er informatie "naar toe te brengen". Dat betekent naast goede *bekendheid* en *bereikbaarheid* dat het systeem toegankelijk en aantrekkelijk moet zijn en dat vertrouwen in een zorgvuldige afhandeling cruciaal is. *Toegankelijkheid* en *aantrekkelijkheid* zijn in de GD werkwijze gegarandeerd doordat gratis advies kan worden gegeven, door laagdrempelig pathologisch onderzoek, doordat wordt bijgedragen aan een diagnose voor individuele problemen (en daarmee het bieden van een oplossing voor gezondheidsproblemen) en feedback over de nationale diergezondheidssituatie. *Vertrouwen* en vertrouwelijkheid worden gewaarborgd door protocollair omgaan met de verkregen informatie.

Aggregatie en interpretatie

Informatie uit elk van de middelen wordt op gestructureerde, uniforme wijze verzameld en vastgelegd. Binnen elk onderdeel vindt een interpretatieslag plaats door de direct betrokkenen. Overall interpretatie vindt plaats in het Veekijker-overleg, waaraan wordt deelgenomen door de Veekijker-dierenartsen, pathologen, en specialisten/deskundigen op het gebied van epidemiologie, virologie, bacteriologie, toxicologie en immunologie. Informatie uit alle monitoringsinstrumenten en andere relevante beschikbare bronnen wordt ingebracht. De verslagen van de Veekijker-overleggen worden alleen intern verspreid. Op de verzendlijst staan GD-medewerkers die uit hoofde van hun functie op de hoogte moeten zijn van de bevindingen en medewerkers die extra informatie of inzichten kunnen toevoegen.

Verdieping (pilots en nader onderzoek)

Bij een schijnbare afwijking ten opzichte van de normale situatie (signalen kunnen niet worden benoemd als een bekende aandoening, of een onverklaarde toename van een bepaalde bevinding) zal nader onderzoek worden ingesteld middels een pilot. Pilots zijn relatief beperkte onderzoeken, waardoor onderscheid kan worden gemaakt tussen schijnbaar belangwekkende signalen en werkelijke afwijkingen van de normale situatie, die van belang kunnen zijn voor sector of volksgezondheid.

Relatie met de opdrachtgevers; begeleidingscommissies

De gedeelde behoefte aan monitoringsinformatie van overheid en sector vindt zijn weerslag in de financiering. Omdat veehouders voor een groot deel van de activiteiten zelf belang hebben, is sprake van een bijdrage voor een aantal van de diensten. Het grootste deel van de kosten wordt echter op 50/50 basis gedragen door het Ministerie van LNV en het collectief van de veehouders (PVV, PPE, PZ).

Per diersector (rund, varken, pluimvee, kleine herkauwers) is een monitoringsbegeleidingscommissie in gesteld. De Begeleidingscommissies zijn het primaire platform waarop overleg wordt gevoerd tussen GD en de financiers. Niet alleen worden de kwartaalrapportages aan de Begeleidingscommissies voorgelegd, alvorens deze worden verzonden aan de financiers, ook wordt er voorgestelde verbeteringen van de monitor getoetst en wordt door hen een eerste oordeel gegeven over eventuele opvolging van bevindingen. De Begeleidingscommissies komen elk in beginsel 4 maal per jaar bijeen en rapporteren aan de financiers (PVV, PPE, PZ en LNV).

Samenstelling

De begeleidingscommissies bestaan uit vertegenwoordigers van de productschappen PVV, PPE en PZ en van LNV en vertegenwoordigers van VWA, de veehoudersorganisaties en ketenpartijen. De begeleidingscommissies worden voorgezeten door het GD directielid dat verantwoordelijk is voor de betreffende sector, de manager monitoring van de betreffende sector is ambtelijk secretaris.

Taken en rol Begeleidingscommissies

1. Kennis nemen van de rapportages, een eerste beoordeling daarover geven en de rapportages voorzien van adviezen aan LNV en productschappen. De begeleidingscommissies zijn tevens het eerste meldpunt voor de GD als het gaat om constateringen in de monitor die direct gemeld dienen te worden (zie gedragslijn positieve bevindingen).
2. Voor het zo goed mogelijk functioneren van de monitor is meedenken door de opdrachtgevers en tijdig kaders stellen gewenst. Regelmatig wordt getoetst of de verschillende instrumenten nog steeds optimaal bijdragen aan het doel.
3. Technische en financiële toetsing als voorbereiding op beleidsbeslissingen in bestuurlijke kaders; borging dat budgetten effectief en efficiënt besteed worden.

Rapportage aan opdrachtgevers

Rapportage verloopt langs drie lijnen:

- Elk kwartaal (kleine herkauwers elk half jaar) wordt een schriftelijke rapportage gemaakt van bevindingen, inclusief interpretatie. Schriftelijke rapportage en bijbehorende adviezen worden besproken in de begeleidingscommissie.
- Indien de betrokken deskundigen de wenselijkheid van directe actie niet kunnen uitsluiten wordt direct na signalering met een onderbouwd advies gerapporteerd over bevindingen. Hiervoor is een protocol opgesteld dat door LNV en productschappen geaccordeerd is. (zie verder)
- Een maal per maand vindt mondelinge rapportage plaats uit de varkens- en de rundveemonitoring aan VWA.

Het ondernemen van actie o.b.v. bevindingen

Regelmatig vragen monitoringsbevindingen om enige vorm van vervolgacties. Hierbij kan aan allerlei zaken worden gedacht, van het instellen van fundamenteel onderzoek tot het isoleren van bedrijven. Vervolgacties op basis van de monitoringsbevindingen zijn geen onderdeel van de GD-monitoring. De bevoegdheid en verantwoordelijkheid van GD eindigen bij de rapportage van de bevindingen, inclusief interpretatie en aanbevelingen, aan de opdrachtgevers. Besluitvorming hierover is een taak van overheid en/of bedrijfsleven. GD kan hierbij een rol spelen op hun verzoek.

Communicatie veehouders en dierenartsen

Dierenartsen en -in tweede instantie- veehouders worden met enige regelmaat gewezen op de mogelijkheid om GD-Veekijker in te schakelen. Om effectief te kunnen functioneren worden bovendien regelmatig bevindingen teruggekoppeld naar dierenartsen en veehouders, o.a. middels artikelen, lezingen, internet en e-mail nieuwsbrieven. Het eerste doel van de informatieverstrekking is om veehouders en dierenartsen te motiveren om in aangewezen gevallen contact op te nemen met GD-veekijker of materiaal in te sturen voor onderzoek (m.n. secties). Door de juiste informatie en voorlichting te geven kan bovendien worden bereikt dat er een goede voorselectie wordt gemaakt van ‘aangewezen gevallen’. Door het verschaffen van informatie aan het veld worden veehouders en dierenartsen tevens in staat gesteld adequaat te reageren op nieuwe ontwikkelingen.

Afspraken rondom verspreiding monitoringsinformatie

De monitoringsopdrachtgevers hebben gezamenlijk de kaders vastgesteld voor verspreiding van de rapportages en de informatie die hieruit komt. Gezien de gevoelige informatie die de monitoringsrapportages kunnen bevatten worden deze niet algemeen verspreid. Leidend is dat deze verspreiding zodanig is dat relevante informatie op de juiste plek komt zodat acties kunnen worden ingezet. Op hoofdlijnen is het volgende afgesproken:

Rapportages

De resultaten van het monitoren door de GD van runderen, varkens, pluimvee en kleine herkauwers worden elk kwartaal dan wel half jaar (kleine herkauwers) in een rapportage opgenomen. Deze rapportages worden besproken in de desbetreffende begeleidingscommissies monitoring (waar LNV, VWA, productschappen en veehoudersorganisaties deel van uitmaken) en worden ook beschikbaar gesteld voor diverse functionarissen van LNV en VWA en de leden van de diverse commissies te weten: de AdviesCommissies Runderen, Kalveren, Pluimveegezondheidszorg en Schapen & Geiten, de Commissie Diergezondheid en Kwaliteit Runderen (DKR) en de Commissie Varkenshouderij (alleen de eigen diersoort rapportage per specifieke commissie).

Daarnaast ontvangen de direct betrokkenen bij de GD ook een rapportage.
Op basis van de Wet Openbaarheid van Bestuur (WOB) zijn de opdrachtgevers (LNV en PVE/PZ) niet verplicht tot verspreiding van documenten. De GD dient ten alle tijden een verzoek, van een willekeurig persoon, tot verkrijgen van informatie uit de rapportages te weigeren. Indien deze persoon dan een formeel verzoek indient bij LNV of de productschappen tot verstrekking van deze informatie zal per geval bekeken moeten worden of hier op basis van de WOB gehoor aan moet worden gegeven.

Inhoud uit de rapportages

De monitoringsrapportage bevat voor een deel algemene informatie die voor iedereen beschikbaar zou moeten zijn en via de GD verspreid kan worden in haar voorlichtingsmateriaal (en website). Voorbeelden hiervan zijn: Melding over het ongevoelig worden van bepaalde bacteriën voor bepaalde antibiotica (gevoeligheidspatronen) maar ook zaken zoals een leverbotprognose of het feit dat de graskuilen van matige kwaliteit zijn. Dit soort informatie moet voor mogelijke gebruikers beschikbaar komen.
Specifieke problemen en voorkomende aandoeningen dienen (mits goed vertaald door de GD) in de GD bladen (GD varken/rund/pluimvee en GD veterinair) te worden opgenomen. De betreffende begeleidingscommissie monitoring dient te bepalen welke onderwerpen dit betreft.

Werkwijze bij ‘positieve’ bevindingen uit de monitor

In het kader van monitoring wordt regelmatig een ‘positieve’ bevinding gedaan. Hiermee wordt bedoeld: een bevinding die mogelijk of zeker directe actie van de opdrachtgevers vraagt:

1. Risico voor de volksgezondheid kan niet uitgesloten worden of
2. Risico voor ongewenste verspreiding van een dierziekte kan niet uitgesloten worden.
3. Er is sprake van een aangifteplichtige ziekte.
4. Er is sprake van een meldingsplichtige ziekte.

Voor aangifte- en meldingsplichtige ziekten wordt verwezen naar de wettelijke kaders.
Om op eenduidige wijze om te gaan met bevindingen waarbij er risico’s bestaan voor volksgezondheid, of voor ongewenste verspreiding van een diergezondheidsprobleem is een gedragslijn opgesteld, waarvan onderstaande de hoofdpunten zijn.

Uitgangspunten

- De informatie die ten grondslag ligt aan de ‘positieve’ bevinding komt meestal binnen uit de reactieve monitoring (GD-Veekijker of sectiezaal); bij uitzondering langs andere weg.
- In alle gevallen waarbij veehouders of dierenartsen de hulp inroepen van de GD, worden zij, voorzover mogelijk, voorzien van een adequaat en verantwoord advies. Dit geldt dus ook voor de positieve bevindingen.

Informeren opdrachtgevers

- De basis-afspraak met LNV, PVV, PPE en PZ is dat de GD anoniem melding doet van bevindingen waarbij er risico’s bestaan voor volksgezondheid, of voor ongewenste verspreiding van een diergezondheidsprobleem.
- Uit de wet vloeit voort dat de GD direct gepersonifieerd melding doet van gevallen waarin (mogelijk) meldingsplichtige ziekten in het geding zijn.
- Het ministerie van LNV kan de GD sommeren persoonsgegevens te verstrekken bij eerder gemelde anonieme informatie.
- De financiers en niet de GD besluiten welke vervolgacties plaats vinden en sturen die aan.
- De financiers (en niemand daarbuiten) worden geïnformeerd door de manager monitoring, nadat de veehouder en de practicus zijn geïnformeerd over deze stap. Als aanspreekpunt fungeren de leden van de begeleidingscommissies.
- Indien de GD wordt gesommeerd persoonsgegevens te verstrekken worden veehouder en practicus daarover door de GD op de hoogte gebracht.

Gedragslijn GD

- Indien een positieve bevinding niet kan worden uitgesloten vindt direct overleg plaats met de manager monitoring. In dit overleg worden afspraken gemaakt over de noodzakelijke communicatie over de bevinding. De manager monitoring stelt in overleg met de deskundigen vast of risico’s zeker zijn, mogelijk zijn, dan wel uitgesloten kunnen worden.
- Over bevindingen die vermoedelijk directe actie van de opdrachtgevers monitoring vragen worden deze onverwijld geïnformeerd (zie hierboven).
- In andere gevallen, waarin risico’s echter niet uitgesloten kunnen worden, wordt vastgesteld of en zo ja welk nader onderzoek (bedrijfsbezoek, sectie etc.) wenselijk is om het risico uit te sluiten, of de opdrachtgevers gefundeerd te kunnen informeren over het risico. Nader onderzoek kan worden ingezet als het noodzakelijk is om meer zicht te krijgen op het eventuele risico, er een duidelijke hypothese kan worden geformuleerd voor dat onderzoek, het binnen redelijke tijd kan worden afgerond en geen onnodige risico’s met zich meedraagt.
  De veehouder en de betrokken practicus worden hierna door de betrokken medewerker ingelicht over het vervolg. Hierbij wordt aandacht besteed aan:
  - advisering (ook m.b.t. risico’s voor de veehouder zelf of zijn omgeving)
  - eventueel mogelijke consequenties voor de bedrijfsvoering
  - wat de verdere gang van zaken zal zijn
  - indien nodig wordt de veehouder gevraagd mee te werken aan nader onderzoek.

Nadat resultaten van nader onderzoek beschikbaar zijn, overleggen de betrokken deskundigen en de manager monitoring wederom. De manager monitoring stelt in overleg met de deskundigen vast of ook na nader onderzoek het risico niet is uitgesloten of bevestigd. Ook wordt besproken, welke ondersteuning nog zal worden geboden aan de veehouder.

Bijlage 4. Signaleringsoverleg CIb

Inleiding

Grote en kleine epidemieën van infectieziekten in binnen- en buitenland doen zich regelmatig voor. Van de overheid wordt verwacht dat deze op de hoogte is van epidemieën om zo nodig, pro- en reactief gerichte bestrijdingsmaatregelen te nemen om (verdere) verspreiding in Nederland te voorkomen. Het behoort tot de taken van het RIVM om te signaleren of zich landelijke dreigingen voordoen op infectieziektegebied en de overheid hierover te informeren. Op verzoek van de Inspectie voor de Gezondheidszorg (IGZ) is hiertoe op 1 januari 1999 door het RIVM het zogenaamde “signaleringsoverleg” in het leven geroepen.

Structuur: Het signaleringsoverleg

Het signaleringsoverleg is een multidisciplinair overleg van het RIVM waarin signalen over uitbraken, epidemieën en andere dreigingen op het gebied van infectieziekten in binnen- en buitenland wekelijks worden besproken.

Doelstelling en werkwijze van het signaleringsoverleg

De doelstelling van het overleg is het genereren en beoordelen van betrouwbare signalen op het gebied van infectieziekten. Voorafgaand aan het signaleringsoverleg worden diverse nationale en internationale surveillancebronnen (indicator-based en event-based surveillancebronnen) gericht op toename van bestaande of opkomst van nieuwe infectieziekten, geraadpleegd. Een selectie van deze signalen wordt vervolgens ingebracht in het signaleringsoverleg.

Wat is een signaal?

Er zijn verschillende redenen om een signaal te bespreken tijdens het signaleringsoverleg. Het signaal kan een mogelijke dreiging voor de volksgezondheid in Nederland betekenen, er is veel media aandacht voor het onderwerp of die is te verwachten, het signaal komt voort uit bestaand onderzoek of vraagt om nader onderzoek, of het signaal kan leiden tot kennisvermeerdering of dienen als informatieverstrekking. De signalen worden door de deelnemers besproken. Naast informatie uit surveillancebronnen kunnen ook op andere wijze signalen het overleg bereiken, bijvoorbeeld uit contacten met het eigen werkveld van de deelnemers of van arts-microbiologen en artsen infectieziekten bij GGD’ en.

Relevante signalen kunnen bijvoorbeeld zijn: een stijging in de aangifte van een bepaalde infectieziekte, een epidemie in het buitenland die mogelijk gevolgen heeft voor de Nederlandse volksgezondheid of een onverwachte verandering in de epidemiologie, preventie, therapie of diagnostiek van een infectieziekte. Ook kunnen signalen lacunes in preventie- en bestrijdingsbeleid zichtbaar maken.

Deelnemers aan het signaleringsoverleg

Deelnemers aan het signaleringsoverleg zijn afkomstig van vier laboratoria/eenheden van het Centrum Infectieziektebestrijding (Cib) van het RIVM: Laboratorium voor Infectieziekten en Screening (LIS), Laboratorium voor Zoönosen en Omgevingsmicrobiologie (LZO), Epidemiologie en Surveillance (EPI) en Landelijke Coördinatie Infectieziektebestrijding (LCI). Daarnaast is ook de VWA (Voedsel- en Warenautoriteit) vertegenwoordigd.

Wekelijks overzicht

Het overleg resulteert in een overzicht van infectieziektesignalen dat diezelfde dag als een electronische nieuwsbrief per e-mail verzonden wordt naar professionals in de gezondheidszorg die werkzaam zijn op het terrein van de infectieziektebestrijding en -epidemiologie en die uit eigen waarneming signalen aan het signaleringsoverleg kunnen leveren (artsen infectieziekten, arts-microbiologen, hygiënisten e.d.). In het overzicht wordt een dusdanige formulering gekozen dat signalen niet herleidbaar zijn tot specifieke instellingen of individuele patiënten. Meer informatie is te vinden in de richtlijn herleidbaarheid van instellingen en patiënten bij berichtgeving in het verslag van het signaleringsoverleg.
Ieder die beroepsmatig voor toezending van het wekelijks overzicht in aanmerking denkt te komen kan zich aanmelden door een mail te sturen naar signaleringsoverleg@rivm.nl.

Online archief signaleringsoverleg

De besloten website http://signaleringsoverleg.infectieziekten.eu/ bevat het archief van het signaleringsoverleg. Alle infectieziekten signalen die vanaf september 2000 in dit overleg aan de orde zijn geweest zijn op deze internetsite te vinden. Via de knop ‘Verslagen index’ is het gehele verslag per overleg, vanaf januari 2002, te raadplegen. Daarnaast is het mogelijk om alle informatie met betrekking tot één signaal op te vragen achter de knop ‘Signaal index’.

Informatiebronnen t.b.v. het signaleringsoverleg

Nationale informatiebronnen

- Meldingen van infectieziekten (Wet Publieke Gezondheid) OSIRIS: de aangiften van alle GGD’en worden anoniem opgeslagen in een database. Nagegaan wordt of er bijzondere clusters of incidenten zijn.

- Virologische weekstaten: 17 virologische laboratoria sturen wekelijks een vaste selectie van hun laboratoriumdiagnoses naar het RIVM. Een overzicht wordt weergegeven in de 'Virologische weekstaten'; trends in toe- en afname worden gevolgd.
- Influenzasurveillance.
- Laboratoriumdiagnostiek in het RIVM (LIS, LZO).
- Berichten uit het veld via de deelnemers aan het overleg (LCI) of direct gemeld aan het signaleringsoverleg via e-mail: signaleringsoverleg@rivm.nl.
- Informatie uit de media via de bibliotheek nieuwsattendering van het RIVM.

Internationale informatiebronnen

- Eurosurveillance, een wekelijks bulletin dat op internet verschijnt en dat met name outbreaks van infectieziekten in Europa beschrijft.
- Weekly Epidemiological Record en Disease Outbreak News, twee elektronische berichtgevingen van de Wereldgezondheidsorganisatie (WHO).
- Morbidity and Mortality Weekly Report (MMWR, een wekelijks bulletin van het Centers for Disease Control and Prevention).
- Program for Monitoring Emerging Diseases (ProMED), een wereldwijd elektronisch rapportagesysteem.
- Besloten websites of meldingsystemen:
  - o Europese early warning and response system (EWRS) van de EU.
  - o Communicable Diseases Threat Report (CDTR) van het ECDC.
  - o Event Information Site van de WHO.
  - o Ziektespecifieke websites: bijvoorbeeld over poliomyelitis (WHO).

Randvoorwaarden en beperkingen van het signaleringsoverleg

Iedere afdeling van het CIb draagt er zorg voor dat een afgevaardigde deelneemt aan het overleg. Daarvoor zijn in totaal ongeveer 1500 uren capaciteit ingepland per jaar. Het signaleringsverslag wordt aan ongeveer 1300 lezers via de mail toegestuurd. Deze lezers komen uit verschillende beroepsgroepen, onder andere artsen en verpleegkundigen infectieziektebestrijding in GGD'en, arts-microbiologen, ziekenhuishygiënisten, beleidsmedewerkers, dierenartsen, etc.

Of een bepaald signaal moet leiden tot actie wordt bepaald door de deelnemers aan het signaleringsoverleg in overleg met betrokken GGD'en en onderzoekers van het CIb. Ook worden signalen eerst gecommuniceerd naar en afgestemd met direct betrokken voor dat ze in een verslag publiek worden gemaakt. Daardoor kan soms een tijdsverschil zijn tussen optreden van een signaal en de publicatie via het signaleringsverslag.

Het is moeilijk om vast te stellen of en hoeveel signalen en uitbraken gemist worden door het signaleringsoverleg. De nieuwe Wet Publieke Gezondheid zal mogelijk bijdragen aan een betere signalering (meer aangifteplichtige infectieziekten en minder onderrapportage doordat ook laboratoria een meldingsplicht hebben). Ook niet onbelangrijk is de bereidheid van clinici om signalen te melden via de signaleringsmailbox (incidenten binnen ziekenhuizen laten zich namelijk niet zo gemakkelijk vangen in bestaande structuren). Internationale signalen kunnen worden getoetst aan de signalen van het ECDC, die ook een early warning systeem in stand houdt. Wekelijks wordt de website van de IHR (International Health Regulations) en het EWRS (Early Warning and Response System) gescand op relevante signalen. De afdeling LCI van het CIb is Focal Point voor de IHR en contactpersoon voor het EWRS en neemt deel aan het signaleringsoverleg. Zo nodig kan de LCI signalen uit het signaleringsoverleg communiceren naar de IHR en EWRS.

Richtlijn herleidbaarheid van instellingen en patienten bij berichtgeving in het verslag van het signaleringsoverleg

Afbakening

In deze richtlijn wordt met instellingen bedoeld: de instellingen (ziekenhuizen, verpleeghuizen, maar ook commerciële organisaties als campings en hotels, etc) waar een signaal is opgemerkt dat kan duiden op een probleem op het gebied van infectieziekten. Met patiënten wordt bedoeld: mensen die onderwerp van het signaal zijn: mensen met (vermoedelijk) een infectieziekte, zieken, mensen at risk etc. Voor de leesbaarheid wordt in deze richtlijn voor al deze gevallen gekozen voor de benaming "patiënt".

Patiënten

Wanneer een signaal aangaande een patiënt wordt ingebracht, gebeurt dit altijd anoniem. Patiëntgegevens (NAW gegevens) zijn nooit bekend bij het signaleringsoverleg. Bij de formulering van het verslag wordt gekozen voor een omschrijving waardoor patiënten individueel niet herleidbaar zijn. Privacy van patiënten komt niet in het geding.

Instellingen

In principe worden namen van instellingen, waar een probleem op het gebied van infectieziekten speelt, niet opgenomen in het verslag, tenzij deze al bekend zijn uit publieke mediaberichten. Plaats- of streeknamen worden niet genoemd als hierdoor het probleem te herleiden zou zijn tot een specifieke instelling of patiënt(en). Hier kan vanaf worden geweken wanneer er een volksgezondheidsbelang is dat het noodzakelijk maakt de naam van de instelling of de plaatsnaam te noemen, bijvoorbeeld om meer patiënten op te sporen gerelateerd aan de problemen die spelen in de betreffende instelling.

Het signaleringsoverleg bepaalt of er sprake is van een dergelijk volksgezondheidsbelang. Het opnemen van naam van de instelling of plaatsnaam vindt vervolgens plaats na overleg met de directeur van het CIb van het RIVM. Indien het noodzakelijk is de naam van een instelling te noemen, wordt vóór het verslag wordt verstuurd, overlegd met een vertegenwoordiger van de directie van de betreffende instelling over de wijze waarop dit gebeurt.

Personen/organisaties die een signaal inbrengen

De naam van de persoon of de organisatie die een signaal inbrengt (bijvoorbeeld arts microbioloog, GGD) wordt zoveel mogelijk, met toestemming van de betrokkene, genoemd in het verslag, tenzij het noemen van de naam een signaal herleidbaar maakt tot een specifieke patiënt of een bepaalde instelling. In geval van herleidbaarheid tot een specifieke patiënt wordt de naam van degene die het signaal inbrengt niet opgenomen in het verslag. Voor wat betreft de herleidbaarheid tot een bepaalde instelling geldt dat degene die het signaal inbrengt erop wordt gewezen dat met het noemen van zijn/haar naam veelal ook de instellingsnaam indirect bekend wordt. Formulering van het signaal in het verslag vindt plaats in overleg met degene die het signaal heeft ingebracht.

Klachtenregeling

Een klacht wordt gemeld bij de voorzitter of secretaris van het signaleringsoverleg. De klacht wordt behandeld volgens de klachtenprocedure van EPI _SOP_102.

Bijlage 5. Signalering meldingsplichtige ziekten veehouderij

Wettelijke Basis en Beleidsverantwoordelijkheid

De meldingsplicht voor besmettelijke dierziekten is geregeld in de Gezondheids- en Welzijns Wet voor Dieren (GWWD). In de Regeling preventie, bestrijding en monitoring van besmettelijke dierziekten en zoönosen en TSE's staan de besmettelijke dierziekten genoemd waarvoor een meldingsplicht is ingesteld. Het Ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV) draagt beleidsverantwoordelijkheid voor besmettelijke dierziekten. Voor zover deze aandoeningen een zoönotisch karakter hebben, draagt het Ministerie van Volksgezondheid, Welzijn en Sport (VWS) eveneens beleidsverantwoordelijkheid.

Een ziekte kan als besmettelijke dierziekte worden aangewezen als de ziekte zich snel kan uitbreiden, ernstige schade kan berokkenen of een gevaar voor de volksgezondheid oplevert (zoönosen). De aard van sommige besmettelijke dierziekten maakt dat na een melding onmiddellijk bestrijdingsmaatregelen worden ingesteld (b.v. AI, MKZ), terwijl dat bij andere aandoeningen (b.v. salmonellose) niet het geval is. In tabel 1 is weergegeven welke zoönosen meldingsplichtig zijn voor mens en dier.

Meldingen en betrokken instanties

De meldingsplichtigen volgens de GWWD dienen de meldingen bij de meldkamer van de Algemene Inspectiedienst (AID) te doen. De AID is de opsporingsdienst van LNV die verantwoordelijk is voor de handhaving van wet- en regelgeving in de veehouderij.
Het opvolgen van dierziektemeldingen is een taak van de Voedsel en Warenautoriteit (VWA). De VWA valt voor deze werkzaamheden onder LNV en is verantwoordelijk voor het toezicht op de hele food en feed keten, inclusief de keuring van slachtdieren. De VWA is tevens belast met de uitvoering van de dierziekte bestrijding. De VWA maakt ook onderdeel uit van het Staatstoezicht op de Volksgezondheid en onderhoudt op deze manier een rechtstreekse lijn met VWS.
Na een melding stuurt de VWA een specialistenteam op pad dat een onderzoek bij de betreffende dierhouderij instelt. Het specialistenteam bestaat uit dierenartsen van de VWA en de GD en de dierenarts practicus van het bedrijf. Voor zover daar vanwege het klinisch beeld aanleiding toe is, wordt de dierhouderij verdacht verklaard en kunnen vanaf dat moment beperkende maatregelen worden opgelegd. Een verdenking dient altijd door monsteronderzoek bevestigd dan wel uitgesloten te worden. Als het gaat over meldingsplichtige dierziekten is het Centraal Veterinair Instituut (CVI), met uitzondering van parasitaire aandoeningen, waarvoor het Rijksinstituut voor Volksgezondheid en Milieu (RIVM) is aangewezen, het aangewezen laboratorium. Het CVI is door LNV als referentielaboratorium voor de meldingsplichtige besmettelijke dierziekten aangewezen. De meldingsplicht geldt voor dierhouders, dierenartsen en veterinaire laboratoria. In een aantal gevallen (b.v. trichinellose, campylobacteriose) is alleen de dierenarts meldingsplichtig.

Behalve primaire meldingen van houders van dieren en veterinaire practici komen meldingen ook voort uit verschillende dierziekte monitoringprogramma's die door de GD (b.v. brucellose), productschappen (b.v. salmonellose), VWA (slachthuissurveillance, o.a. op bovine tuberculose) of door verschillende actoren, waaronder het Dutch Wildlife Health Centre (DWHC, voor wildlife) worden uitgevoerd.

Voor zover meldingsplichtige besmettelijke dierziekten zoönotisch van aard zijn kunnen ook humane infectieziektesignalen in bepaalde gevallen leiden tot het instellen van een onderzoek bij een dierhouderij (o.a. psittacose in dierenspeciaalzaken, tuberculose op rundveebedrijven).

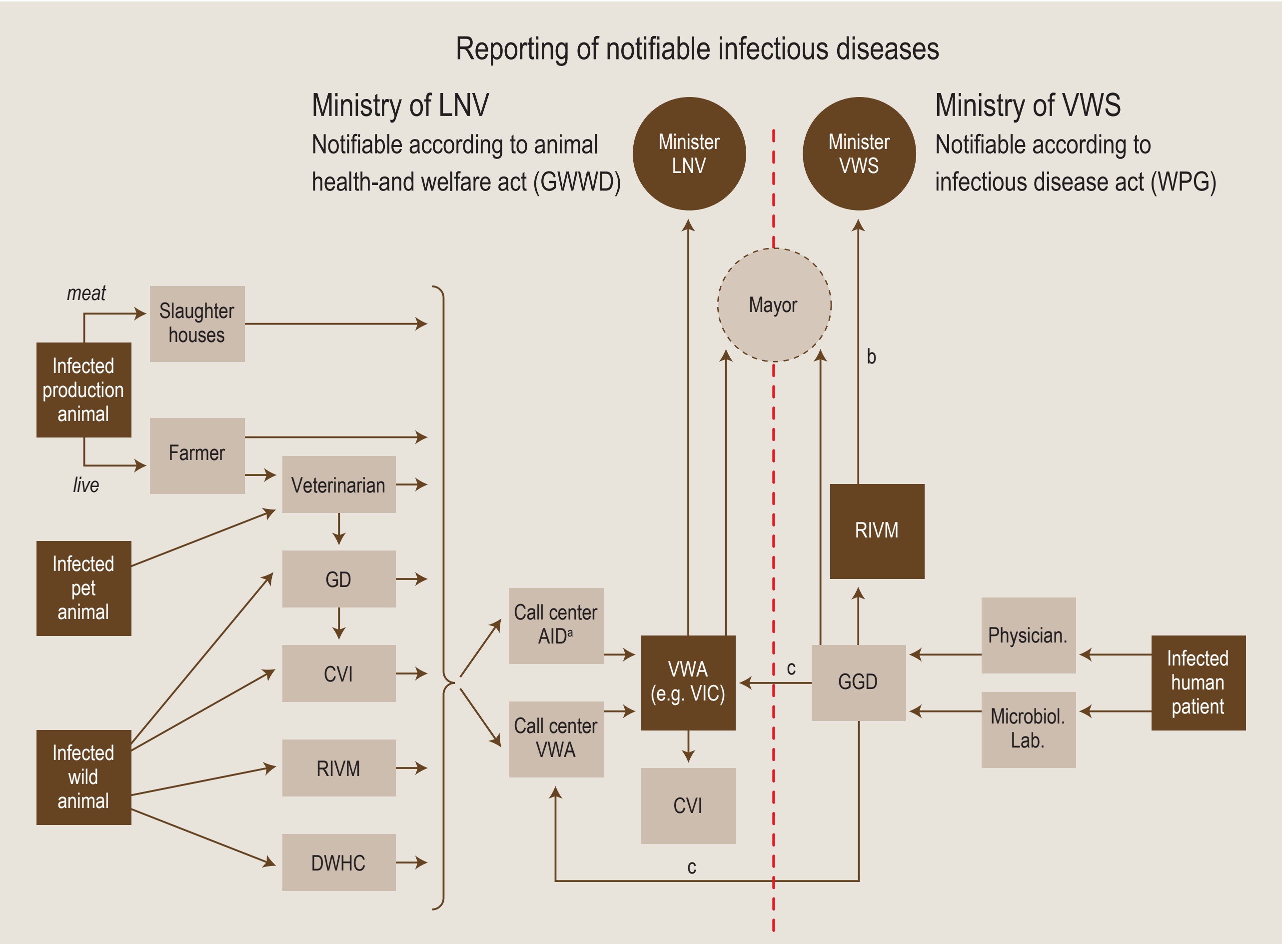
Tabel 1. Meldingsplichtige dierziekten (zoonosen)

Zoönose	WPG	GWWD	Bestrijdings-plichtig	Melding door houder	Melding door dierenarts / onderzoeksinstelling
Anthrax	X	X		X	X
Aviaire influenza	X	X	X	X	X
Botulisme	X	-		-	-
Brucellose	X	X	X	X	X
TSE's/(v)CJD	X	X	X	X	X
Malleus	-	X		X	X
Campylobacteriose	-*	X		-	X
Echinococcose	-	X		-	X
EHEC/STEC	X	-		-	-
Leptospirose	X	X		-	X
Listeriose	X	X		-	X
Monkey pox	-	X		X	X
Psittacose	X	X		X	X
Q-fever	X	X		X	X
Rabies	X	X		X	X
Rift Valley Fever		X	X	X	X
Salmonellose	-*	X		-	X
SIV	-	X		X	X
Toxoplasmose	-	X		-	X
Trichinellose	X	X		X	X
Tuberculose	X	X		X	X
Tularemie	-	X		X	X
Virale hemorrha-gische koorts	X	X		X	X
Virale paarden encefalitiden **	X	X		X	X
Yersiniose	-X	X		-	X

WPG: Wet Publieke Gezondheid ; GWWD: Gezondheids en Welzijnswet voor dieren
*: wel mogelijk als voedeslinfectie voor zover vastgesteld bij 2 of meer patiënten met een onderlinge relatie wijzend naar voedsel als bron.
** Bij de mens is alleen West Nile Virus relevant.

Signalen zijn in dit geval afkomstig van Gemeentelijke Gezondheidsdiensten (GGD) die het voorkomen van zoönotische infecties bij de mens aan de VWA meldkamer kunnen melden.
De VWA hanteert bij het beoordelen van alle meldingen een algoritme voor de inschatting van de ernst van de betreffende melding. Volgens procedure worden alle dierziektemeldingen als ernstig incident of crisis beoordeeld, het geen inhoudt dat LNV te allen tijde op de hoogte wordt gesteld. Als de betreffende dierziekte zoönotisch van aard is, licht de VWA ook VWS in. Van alle dierziektemeldingen wordt een overzicht gegenereerd dat wekelijks aan diverse belanghebbenden bij LNV en VWS wordt verzonden.

De structuur van de meldingenstroom wordt in figuur 1 weergegeven.



Figuur 1. Meldingsstromen met betrekking tot voor dieren aangifteplichtige infectieziekten (Zie ook Appendix 6).

Appendix 6
Development of a blueprint for an effective medical-veterinary network to prevent (emerging) zoonoses in the Netherlands

Project leader
J.W.B van der Giessen, RIVM

Project team
Consortium working group

Summary

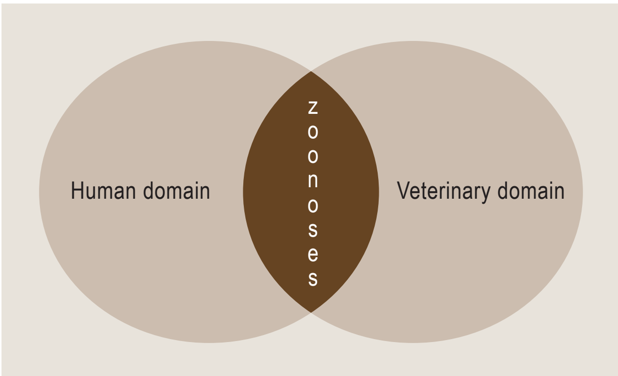
The aim of this project within EmZoo is to provide a blueprint of an effective infrastructure of collaborating key players in veterinary and human medicine for the early warning and surveillance of emerging zoonoses in the Netherlands. Two Ministries are in particular involved in the control of zoonoses: the Ministry of Agriculture, Nature and Food Quality (LNV) and the Ministry of Public Health, Welfare and Sport (VWS). Timely recognition of emerging zoonoses (early warning) is an essential first step towards an adequate response. For signaling, analysis of signals, risk assessment, and implementation of control measures, mandates and responsibilities of the different players need to be clearly defined.
In this project, the current duties, responsibilities and mandates were described for the key institutes involved in signaling, surveillance and control of infectious diseases of animals and humans.
For notifiable diseases the current signaling in the medical and veterinary domain was visualized in a schematic overview, which clearly identified the Dutch Food and Consumer Product Safety Authority (VWA) as the connecting link. For non-notifiable diseases no formal structure is present.
Although human and livestock signaling is well organised, for companion animals, exotic pets and wildlife no early warning structures are present.
The EmZoo consortium recognizes the need for a joint structure for receiving and processing (quick risk assessment and communication to decision makers and to professionals) of signals of potential zoonotic threats. Prerequisites for further co-operation are described, based on using the available expertise and the existing structures for surveillance, risk management and policy making.

Samenvatting

Het doel van dit project is om een blauwdruk van een effectieve infrastructuur van samenwerkende hoofdrolspelers werkzaam in het veterinaire en humane medische veld te maken voor de vroegsignalering van opduikende zoönosen. Twee Ministeries zijn vooral betrokken bij de bestrijding van zoönosen: het Ministerie van Landbouw, Natuur en Voedselkwalitieit (LNV) en het Ministerie van Volksgezondheid, Welzijn en Sport (VWS). Tijdige herkenning van opduikende zoönosen (early warning) is een essentiële eerste stap naar een adequate respons. Voor een adequate signalering van zoönosen, risico inschatting en de implementatie van bestrijdingsmaatregelen, is het noodzakelijk dat verantwoordelijkheden en de mandaten van de verschillende hoofdrolspelers helder gedefinieerd worden. In dit project zijn de huidige verplichtingen, verantwoordelijkheden en mandaten van de hoofdrolspelers beschreven, die zijn betrokken bij de signalering, surveillance en bestrijding van infectieziekten voor de mens en dierziekten. In het geval van aangifteplichtige infectieziekten, is de huidige signalering van humane en dierziekten gevisualiseerd in een schematisch overzicht, waarbij duidelijk is dat de Voedsel en Warenauthoriteit (VWA) de verbindende schakel is tussen beide domeinen. Voor niet-aangifteplichtige ziekten ontbreekt nu nog een formele structuur van signalering. Hoewel de humane signalering en de signalering van dierziekten afkomstig van de veehouderij goed geregeld is, is een structuur voor de vroegsignalering van infectieziekten voor gezelschapsdieren, exotische dieren en wild niet aanwezig. Het EmZoo consortium erkent de noodzaak voor een gezamenlijke structuur om mogelijke potentiële zoönosen snel te signaleren en te verwerken (snel risico inschatting en communicatie voor het beleid en professionals), die gebaseerd zal moeten zijn op de beschikbare kennis en de bestaande structuren van surveillance, risico-inschatting en beleid.

1. Introduction

Zoonoses are defined as infectious diseases that are naturally transmittable between vertebrate animals and humans. Therefore these infectious diseases affect both the human



and the veterinary domain, albeit that the impact on both sides can be very different.

Zoonotic diseases may be transmitted to humans by livestock (cattle, swine, poultry, sheep and goats), by companion animals (cats, dogs, horses, exotic animals), by wildlife (mice, rats, foxes, ducks, geese, etc.) and by zoo animals, often belonging to 'exotic species'. Furthermore: arthropods like sand flies, mosquitoes, ticks and fleas may play an important role in the transmission of zoonotic diseases to humans.

Several organisations have a role in the signaling and control of zoonoses, at both policy and execution level, in the veterinary and human domain. For an effective signalling and control of zoonoses, intensive cooperation between involved parties needs to be organised and formalised. This is a challenge that is actually addressed internationally and at different levels and is now often called the "One Health Concept". Therefore, the situation is not unique for the Netherlands. In each country however, systems are adapted to the local situation. In this project it is evaluated which conditions are already met in the Netherlands. First, we describe which structures for signaling, risk management and control in both the human and the veterinary domain are in place and what areas they cover. From that situation recommendations are made for reinforcements and a future blueprint.

Material and methods
This project builds on the results of all other EmZoo projects. Within the EmZoo programme a significant amount of information is put together with regard to existing systems for monitoring and surveillance as well as responsibilities for risk analysis, risk assessment and prioritizing. In the results of the EmZoo project represented in Appendix 1.a, an overview is given of systems that are in place for monitoring and surveillance within the different categories mentioned. In Appendix 2 an evaluation of possible systems for syndromic surveillance in horses and pets is reported. In Appendix 3 results from the development of a system for prioritizing zoonoses, to support making decisions on directing the surveillance itself. In Appendix 1.b. results are reported are presented from an inventory of monitoring and surveillance systems, including availability of specific diagnostic instruments for the top 25 zoonotic agents from the prioritised list of 86 diseases presented in Appendix 3. In Appendix 5, for livestock and humans an overview is given of the processes from gathering signals to risk management, including responsibilities within the public health domain and the veterinary (livestock) domain.

A general description of a monitoring and surveillance structure (MOSS) is given in Section 2. Section 3 gives a summarised description of the current situation. Analysing

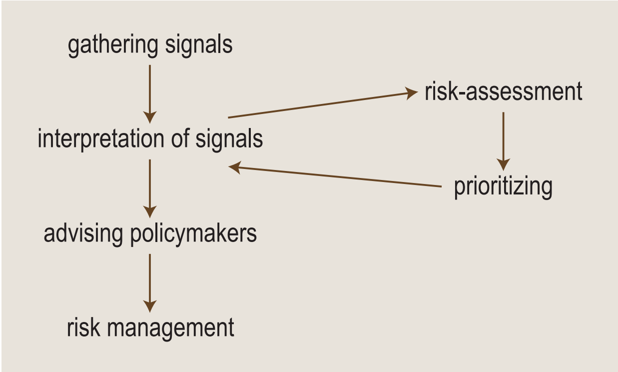


Figure 1: general overview of any monitoring and surveillance structure (General MOSS system)
(NB: In this scheme the terms "risk assessment" and "prioritizing" represent the long term (re-)direction of the surveillance itself.)

this situation results in conclusions and definition of problems to be addressed which is described in Section 4. Recommendations for improvements and a future blueprint are presented in Section 5.

2. General MOSS description

Figure 1 gives a very general overview of any monitoring and surveillance structure. Every stage in this scheme represents a separate duty and responsibility. All aspects should be considered when thinking about a future blueprint, individually and in relation to each other.

3. Current situation

The following descriptive analysis of the existing situation and possibilities for improvement on the subjects under study can be made:

1. ***Gathering signals and interpretation of signals:***
   - For both humans (within GGD, Cib-RIVM) and livestock (within GD, VWA and CVI) strong monitoring and surveillance systems are in place for notifiable and non-notifiable diseases. These include signaling and direct interpretation and assessment of signals. It should be noted that zoonotic pathogens that do not cause clinical signs in animals, may not be noticed within the current systems. However, in case monitoring on such zoonotic pathogens is deemed to be necessary, the existing structures are flexible to adjustment. Furthermore, within the project reported in appendix 5, a pilot was executed for sharing signals from public health and livestock among CIb, GD and VWA, in which it was concluded that sharing signals and assessing them together is useful and feasible.
   - For wildlife it was concluded that several systems are in place to monitor presence of zoonotic agents in wild boar, free-ranging ruminants and migratory birds. Furthermore many (often short term) projects

are performed to monitor presence of zoonotic agents in several species of wildlife. However, apart from the EmZoo programme, the Dutch Wildlife Health Centre (DWHC) was installed at the Faculty of Veterinay Medicine (FVM), commissioned with the early warning of mortality and the coordination of disease monitoring in wildlife.
- For companion animals and horses it was concluded that signals may be picked up by chance, but that no structured monitoring and surveillance systems are in place.
- For exotic species it was concluded that signals may be picked up by chance, but no structured monitoring systems are in place. Regarding zoos however it was noticed that European legislation prescribes an annual disease monitoring plan for zoos.
- For arthropod vectors it was concluded that there was no continuous structure for gathering information on distribution and dynamics of populations. However, apart from the EmZoo programme, both relevant ministries (LNV and VWS) have installed the Centre for Monitoring Vectors (CMV), which should fill this gap. By cooperation with other institutes also presence of pathogens in vectors should be part op the monitoring system on arthropod vectors.

2. ***Advising the competent authorities (risk managers).***
   - Results from monitoring and surveillance (notifiable diseases) in man are reported and advised about within the public health domain e.g.: physicians, specialist doctors and medical laboratories to GGD, GGD to RIVM, RIVM to VWS).
   - Results from monitoring in livestock are structurally reported and advised about to LNV, the product boards and VWA by GD.
   - The DWHC reports to LNV and several institutes are informed on findings by the DWHC.
   - The CMV reports to both LNV and VWS, and also several institutes are informed on findings by the CMV.
   - For zoos the European legislation prescribes reporting of the results of the annual disease surveillance plan to the authorities. Most probably this is VWA.
   - For other animals no monitoring and surveillance systems are in place. Suspicion of notifiable diseases (by practitioners most probably) must be reported to VWA.

3. ***Risk management***
   - In the veterinary domain (livestock) apart from public entities (LNV, VWA), also non governmental organisations (product boards) play a role, while in public health risk management is a purely public affair.
   - In the veterinary domain (livestock) responsibilities for monitoring and surveillance (CVI, GD) are separated from responsibilities for risk management (LNV, VWA, product boards), while in public health, on the national level divisions of the RIVM are responsible for large parts of both functions.

4. ***Long term direction of surveillance: Risk assessment and prioritizing***
   - Several organisations (within the EmZoo consortium and other) have expertise for and perform risk assessment. There is some cooperation, but not structural.
   - A system was developed for prioritizing emerging zoonoses, based on 7 criteria, such as probability of introduction in the Netherlands, transmission in animal reservoirs and morbidity. The system has been developed as a flexible tool, in a way that new knowledge can be incorporated easily in order to (fine)tune priorities and new diseases can easily be added.
   - In combination with the prioritizing tool, the inventory of existing monitoring and surveillance activities and the overview of the availability of diagnostic instruments provide important ingredients for improving the early warning systems for zoonotic diseases.

5. ***Current structure for notifiable diseases***
   At present, cooperation between institutes and governmental organisations is formalised in case of notifiable diseases. This structure also applies for notifiable zoonoses. A total of 14 zoonoses are notifiable diseases according to both the GWWD and WPG, while 7 zoonoses are notifiable by the WPG but not the GWWD, and 11 are notifiable by the GWWD, but not by the WPG (Table 1).
   However, it is not clearly defined how decision-making and taking actions are divided in situations where responsibilities are overlapping.
   The VWA is the only connecting body for early warning and further investigation, such as source investigation, between human and animal disease notifications (Figure 2).

4. Conclusions/ problem identification

Signaling

For the human and the livestock domain, it was concluded in EmZoo phase I, that the signalling part is well arranged and structured. The signalling function is carried out by appropriate experts.

For some areas (e.g. horses, companion animals and exotic pets), the signalling function is insufficient. In one of the projects in the second phase of EmZoo (which is reported in

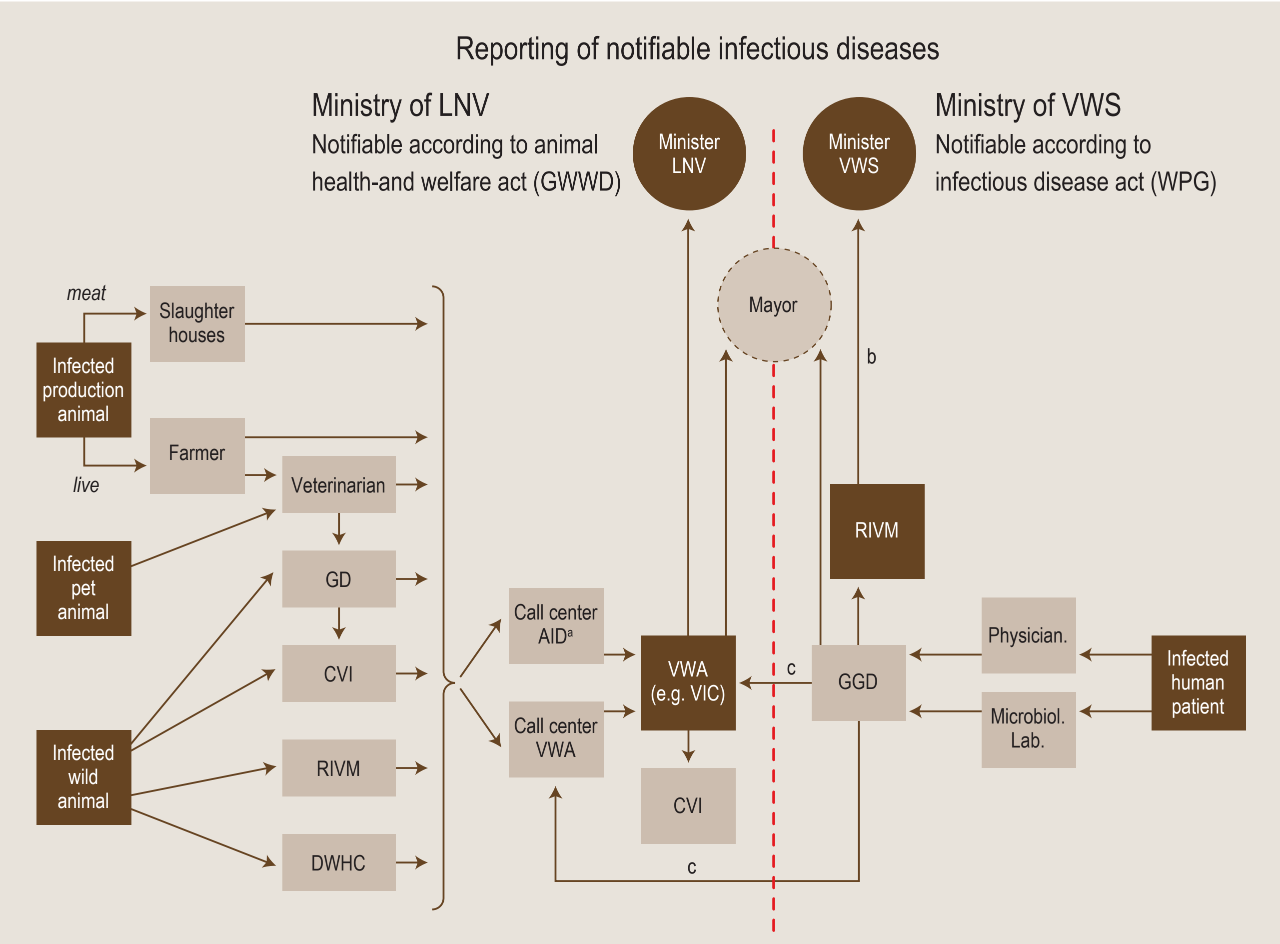


Figure 2. Reporting of notifiable infectious diseases.

[a] In addition to the main port of entrance for reports of animal notifiable infectious disease (Call Center AID), reports are received through Call center VWA (Unit Meldkamer), Central reporting counter animal diseases LNV, Piquet Service Veterinary Incidence Center (VIC) and Regional Office VWA.

[b] In case of a threat of a zoonotic disease for the general public, the Minister of VWS is informed.

[c] GGD regional offices request through the call center of the VWA (Unit Meldkamer) for source finding in response to human cases of certain notifiable zoonotic disease.

Appendix 2) options for syndromic surveillance have been evaluated. It was concluded that designation of a helpdesk-function to which unusual events in pets and horses can be reported and analysed would be an important first step towards an early detection system, provided that the right expertise would be available 'behind the desk'. For other areas the signalling function has to be developed further upon existing structures, for example in vectors and wildlife (CMV and DWHC).

Monitoring of zoonotic diseases that are asymptomatic in animals depends on pathogen specific systems (random or risk based sampling and laboratory testing). For many of these pathogens in livestock such systems are in place.

Sharing of signals from the human health area and livestock area is valuable and can be extended to signals from other areas such as vectors and wildlife.

Assessment and interpretation of signals

It is concluded that assessment and processing of signals related to only one of both areas (either human or veterinary domain) is well structured and clearly defined. Competency and authority to impose control measures are clearly defined and communication is structured. Both areas differ in the way these items are organised, but as long as operations take place in one of these areas and not in both areas, this does not pose a problem.

For assessment of signals that are (or might be) related to both areas, no formalised structure exists. However, in such cases informal communication and cooperation does take place at several levels. This applies to both notifiable and non-notifiable diseases.

In case of signals which are related to both domains it has to be defined who is responsible for processing of signals, who is responsible for designing appropriate measures, who is responsible for decision-making, and which communication to which parties or organisations is necessary.

At present, if only the signalling function would be combined, and the participating organisations would all continue their own reporting scheme, three different parties might subsequently decide to take measures: the Ministry of Agriculture, the Ministry of Human Health, and the agricultural industry.

In both the human and animal domain important issues are at stake. Interests can be weighed differently in the human and in the animal domain, and a natural combined appraisal framework does not exist. The interests in both domains seem contradictory, but in fact they have shared interests: Human and animal health both have economic aspects, (both prevention and treatment must be paid for after all), and the economy of animal industry is directly dependent on guarantees regarding human health. It is true that in both domains considerations are made in a different way. Therefore in the common domain there is a need for a common framework to assess signals. Clarifying these considerations and making them explicit is necessary and this process should be facilitated.

Risk management
To improve the protection of human health, cooperation should take place in terms of all surveillance functions. This includes cooperation by policymakers. Responsibilities for both the human and the veterinary domain are covered, but the shared responsibility in case of zoonoses needs to be addressed.
Involvement of the agricultural industry in risk management is useful.
Before the human-veterinary signalling infrastructure can be further developed and routinely implemented, a clear description of duties, responsibilities and mandates following the early warning of a potential health threat is needed. This description should involve all existing risk managing parties, including the product boards for the veterinary domain.
Veterinary stakeholders (such as the dairy and meat industry) need to be committed to this national signalling group for a successful performance.

Long term direction of surveillance: Risk assessment and prioritizing
In both domains extensive expertise and functionality for risk assessment and prioritization of diseases is present. The EZIPs tool is helpful for indicating which emerging diseases should be considered to get priority for research, diagnostic development and active surveillance. However, the expertise for this (both technical as well as substantive) needs to be maintained.
In all organizations involved in EmZoo, expertise in these areas is available. However, there is no structured use of competences, and sometimes there is even competition.

Communication
Open communication with professionals in the field seems to be largely hampered by crucial differences in the organisation structure of responses to signals in the medical and veterinary domain. CIb has more autonomy for taking actions in collaboration with local responsible parties in control when a relevant signal needs follow up. In contrast, in the veterinary domain the Ministry of Agriculture and/or the other stakeholders in the veterinary domain decide upon the follow up of the veterinary signals.

5. Future blueprint

Given the findings and conclusions, it is desirable for the future blueprint to be based on maintaining the existing structures for surveillance, risk management and policymaking, and to make maximum use of existing expertise. The signalling can be complemented where white spots are identified and it is advisable to strengthen the cooperation between the various institutes. It is important that agreements are made on the division of roles in the common field, in execution as well as in risk management and policy making.

Signalling and interpretation of signals
In addition to existing structures, it is advised to instigate a joined signalling group in order to bring together signals of all areas human, livestock, horses and companion animals, wildlife, exotics and vectors. The objective is to determine if - in case of human risks originating in the veterinary domain - action from risk managers is advised. Input for the group are "raw" signals, output is an advice to risk managers to consider action (ranging from additional research to eradication).
The EmZoo pilot group of collaborating institutes of project 2.2 (GD, RIVM, VWA together with FVM and CVI) can form the basis of a national zoonoses signalling group. In addition, other relevant partners such as Dutch Wildlife Health Center (DWHC), Center Monitoring Vectoren (CMV) and Team Invasive Exoten (TIE) could become part of this group. This group consisting of representatives of collaborating core institutes has to meet on a regular basis to exchange and assess signals. If deemed necessary further exploration of a signal can be instigated. Other specialists can be consulted and the group can also advice that a forum of specialists confer on a specific topic.
If helpful for its task, the group can communicate relevant signals to professionals in both fields within a mandate that needs to be defined by the policymakers. The designed Vetinf@t electronic service is considered a useful application to communicate effectively between professionals as is EZIPs to policy makers.
Crucial for the development and sustainability of the national zoonoses signalling group is mutual trust. Besides mutual trust, transparency for the follow up of signals is needed.
One of the recommendations from the pilot group is to organize the coordination of its activities at one place for a longer period of time. For the coordination of both the signalling group as well as the specialist group, equivalent coverage of both domains is important. Since a mutual appraisal framework for the common domain is not available

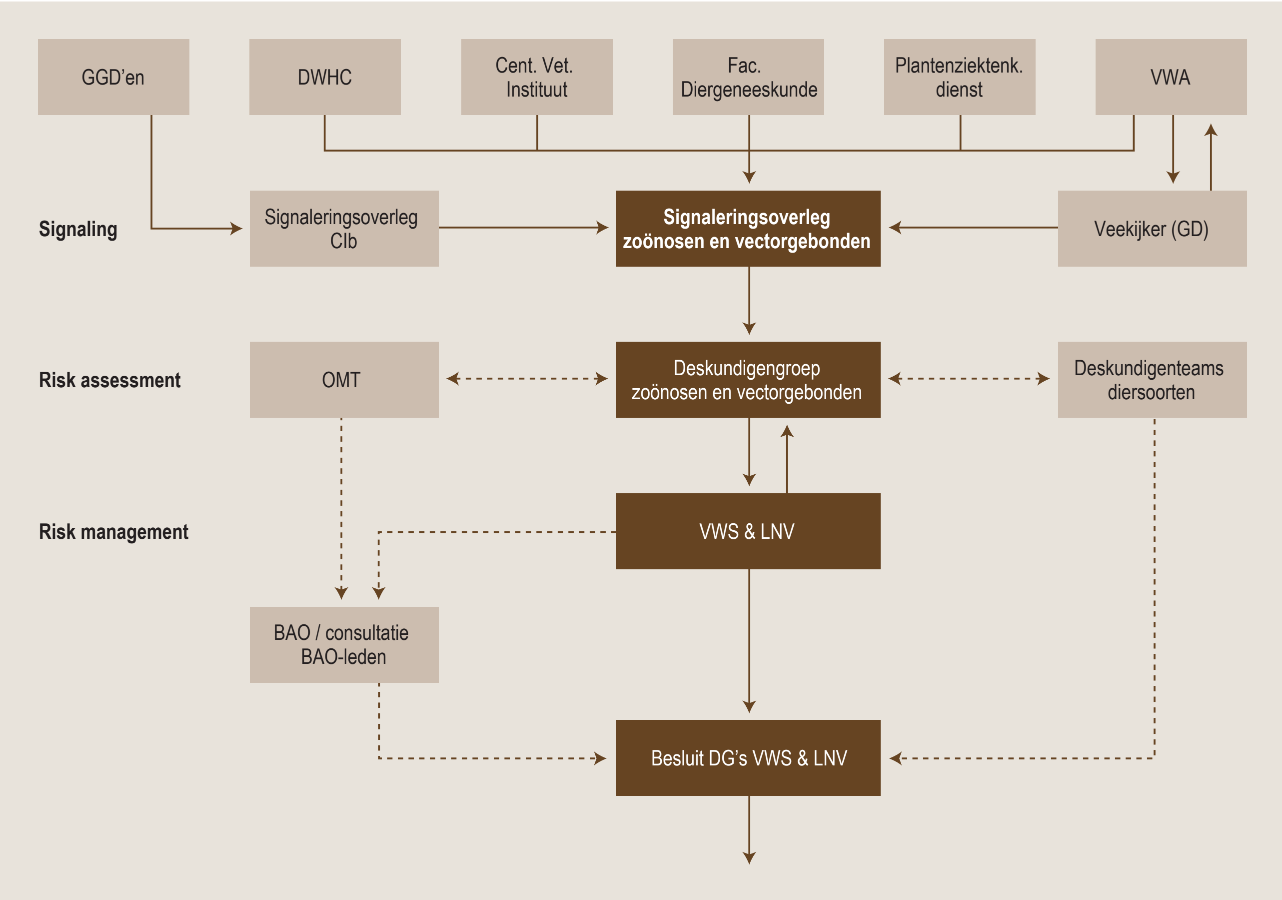


Figure 3. Schematic concept design of joint signaling, risk assessment and risk management of zoonoses (from the zoonosen visie van LNV, in prep.).

yet, in particular in the beginning it should be made crystal clear which considerations are made by the specialists and on which grounds, in order to define shared conclusions.

Risk Management

Early warning and follow up actions especially for zoonoses need a clear framework of duties and responsibilities between the Ministry of Agriculture, Nature and Food Quality (LNV) and the Ministry of Public Health, Welfare and Sport (VWS) and the organized agriculture industry. Mandates on the setting of norms and taking of action in the different areas need to be defined.

It is suggested that signals from the national zoonoses signalling group can be reported to and discussed with all three policy making / risk managing parties together.

Currently, LNV and VWS are working together to develop a policy framework for zoonoses control in the Netherlands. Figure 3 gives a schematic concept of a framework for zoonoses control as designed by both ministries.

The development of this zoonoses policy is an achievement in itself, because a clear framework of duties and responsibilities between the Ministry of LNV and the Ministry of VWS for effective policy supporting prevention and control of zoonoses is needed.

Long term direction of surveillance: Risk assessment and prioritizing

It is recommended that an administrator for the EZIP tool is appointed, commissioned with making an updated prioritization every two years, based on the most recent knowledge of experts in all EmZoo-institutes. The results can be used to formulate an advice on new research, diagnostic development and active surveillance.

Recently performed research and risk assessments can be input for updating the EZIPs tool. Risk Assessment can also be valuable to decide on how to address a new threat that surfaces from EZIPs.

In both Prioritization and Risk Assessment cooperation between RIVM, CVI, FVM and GD and use of all available expertise adds value.

Overview of institutes involved in monitoring and surveillance in the Netherlands (human and veterinary)

Dutch Food and Consumer Product Safety Authority (VWA)

- Forms part of the State Inspectorate for Public Health with the main tasks of investigating the state of public health and the determinants that are relevant for that as well as indicating measures to improve public health.

- Responsible for inspection and supervision of the food production chain, including food, feed and animals.
- Responsible for border inspections with regard to food safety and animal health under the EU legal framework.
- Responsibility with regard to food-borne infections and zoonoses and is involved in meat inspections.
- Registration and control of (infectious) animal diseases, including zoonoses in animals.
- Crisis organization (control notifiable animal diseases including zoonoses in animals and management of food related incidents).
- Independent risk assessment and risk communication
- Advises Ministries of LNV and VWS on food safety and animal health issues, including zoonoses.
- Commissions food safety and veterinary public health related research.

Central Veterinary Institute (CVI)

- National Reference laboratory for animal diseases mentioned in the GWWD.
- National Reference laboratory for Antibiotic resistance, TSE/BSE, Campylobacteriosis, and Brucellosis and Tuberculosis in animals, according to EC regulation.
- Diagnostic laboratory for crisis organization.
- Export testing of life animals.
- Advises the Ministers of LNV and VWS for policy making for endemic and non endemic (zoonotic) infectious diseases (epidemiology, prevention and control).
- Research (EPIZONE), diagnostics, development of vaccines and monitoring/surveillance programs in animal populations incl. wildlife and fish.
- Biosafety 3 and 4 (animals) facilities.

Centre for Infectious Diseases Control (RIVM).

- Strengthening of infectious disease control; communication on behalf of the government, with both professionals (national and international) and the general public.
- Collecting and disseminating national and international human and animal surveillance data.
- Signaling/early warning in case of a threat to public health.
- Advises the Minister of VWS and LNV for policy making (prevention and control).
- Instruct professionals and municipalities, and takes the lead in issues exceeding the responsibility of individual Municipal Health Services (GGD) and national threats.
- CIb conducts several monitoring and surveillance programs regarding zoonoses and zoonotic agents (bacteria, viruses and parasites) in humans and selected animal populations (including wildlife) or material of animals (EmZoo Interim report, 2008).
- Development of guidelines and protocols for professionals.
- CIb conducts research for the Ministries of VWS, LNV and VROM, EU and EFSA/ECDC.
- Responsible for national network for diagnostics of infectious diseases and of GGD's.
- National and Community Reference Laboratory for *Salmonella* and the National Reference laboratories for Zoonotic Parasites and Bivalves molluscs as described in directives.
- Biosafety 3 facility, biosafety 4 (human) facility in progress.
- National contact point for issues with respect to International Health Regulations of the WHO.

Animal Health Service

- Animal health monitoring (e.g. brucellosis, aviain Influenza salmonellosis etc) on behalf of government and agricultural boards (PBO's).
- Monitoring of exotic OIE list diseases.
- Several monitoring and surveillance programs regarding zoonoses and zoonotic agents (bacteria, viruses and parasites) in animals (including wildlife) (EmZoo interim report, 2008).
- Collecting and disseminating national and international animal health surveillance data.
- Signaling/early warning in case of a threat to animal and/or public health.
- Advises the Ministry of agriculture and the Agricultural Boards for policy making (prevention and control).
- Export diagnostic under supervision of CVI.
- Detection of new or emerging diseases in animals ((mainly production animals) on behalf of government and Agricultural boards.
- Description and analysis of trends and developments of various aspects of animal health.
- I&R swine.
- Development of knowledge.
- Development and implementation of diagnostics and programs improving the animal health status.
- Diagnostic laboratory for veterinarians, farmers, Ministry of LNV etc. also large sample flows.

Faculty of Veterinary Medicine (FVM, Utrecht)

- Education of veterinarians and Post Graduate courses on Epidemiology and Infectious Diseases for veterinarians and non-veterinarians.
- Microbiological diagnostic Laboratory mainly pet animals and horses.
- Advice and research on behalf of LNV, VWS, PVE and others e.g. Veterinary Epidemiology and microbiology.
- OIE Reference Laboratory for Campylobacter in tandem with CVI (Dutch data included in reporting).
- WHO Collaborating Centre for Campylobacteriosis in tandem with CVI (Dutch data included in reporting).

Table 1. Overview of notifiable zoonoses for veterinary (GWWD) and medical (WPG) domain in the Netherlands.

Zoonosis	GWWDa	WPGb
Anthrax	√	√
Avian influenza	√ [c]	√ [d]
Botulism	-	√
Brucellosis	√	√
BSE/(v)CJD	√	√
Glanders	√	-
Campylobacteriosis	√ [f]	- [e]
Echinococcosis	√ [f]	-
Food-borne infection (cluster)	-	√
Hantavirus	-	√
Leptospirosis	√ [f]	√
Listeriosis	√ [f]	√
Monkey pox	√	-
Methicillin-resistant *Staphylococcus aureus* (community cluster)	-	√
Newcastle disease	√	-
Psittacosis	√	√
Q-fever	√	√
Rabies	√	√ [d]
Rift Valley Fever	√ [c]	-
SARS	-	√ [d]
Salmonellosis	√ [f]	- [e]
SIV	√	-
STEC	-	√
Toxoplasmosis	√ [f]	-
Trichinellosis	√	√
Tuberculosis	√	√
Tularemia	√	-
Viral haemorrhagic fever	√	√ [d]
Viralhorse encephalomyelitis, including West Nile fever	√	√
Yersiniosis	√ [f]	√

[a] GWWD: Animal Health- and Welfare Act ('Gezondheids- en Welzijnswet voor Dieren')

[b] WPG: Infectious Diseases Act ('Wet Publieke Gezondheid' started 1 December 2008)

[c] Notifiable Animal Diseases for which immediate control actions are demanded ('Bestrijdingsplichtige dierziekten')

[d] Notifiable Human Diseases to be reported upon suspicion, while the others are reported only upon confirmed diagnosis

[e] Notifiable only if two or more cases are present and suspected to be linked to the same food source

[f] Notifiable according to art 100 (GWWD): only for veterinarians and laboratories

- Board certified veterinary microbiologists, pathologists and specialists Veterinary Public Health and Epidemiologists.
- Annual rapport on zoonoses in pets and exotics to EFSA by Dept. Infectious Diseases and Immunology. (VMDC).

Dutch Wildlife Health Centre

- o Central focal point for wildlife health (pathology en microbiology)
- o Signaling and diagnostics of morbidity and mortality in wildlife
- o Reporting OIE listed wildlife diseases
- o Central database on wildlife diseases (collecting data CVI, RIVM, GD, EUR)

Private veterinary laboratories

- Diagnostics (salmonellosis, BSE) and export testing under supervision of CVI.

Appendix 7
Linked medical and veterinary network (vetinf@ct)

Project manager
O. Stenvers, VWA and CIb-RIVM

Project team
M. Swanenburg, CVI-WUR
P. Kock, GD
M. Langelaar, B. Schimmer, Cib-RIVM
J. Wagenaar, F. van Knapen, UU

Collaboration
The institutes involved in the EMZOO consortium, namely the Animal Health Service (GD), the Central Veterinary Institute (CVI), the Centre for Infectious Disease Control (CIb) and the Faculty of Veterinary Medicine (UU) joined forces with the Royal Veterinary Association of the Netherlands (KNMvD) and the Food and Consumer Product Safety Authority (VWA) and started a news service to communicate signals from the veterinary field with public health relevance.

Samenvatting
Dit project had als doel het opzetten van een laagdrempelig communicatie middel voor de informatie uitwisseling over veterinaire casuïstiek met een zoonotische component. De naam van deze berichtendienst is vetinf@ct.
De veterinaire beroepsgroep wordt middels vetinf@ct in staat gesteld snel berichten te ontvangen en te sturen over ontwikkelingen of incidenten op het gebied van zoonotische infecties, waardoor kennis en expertise worden vergroot en intercollegiaal overleg wordt bevorderd.
Door de mogelijkheid over en weer informatie uit te wisselen tussen vergelijkbare berichtendiensten in het medisch domein ontstaat een One Health netwerk dat een bijdrage levert aan de vroege herkenning van zoonotische bedreigingen.
De berichtendienst kan tijdens crises een bijdrage leveren aan snelle communicatie tussen alle direct betrokkenen, zowel in de veterinaire als de medische domeinen.
Er werd een projectteam gevormd dat zich boog over de randvoorwaarden voor de berichtendienst, en na heeft gedacht over de inbedding in een ICT omgeving die recht doet aan de geformuleerde doelen. Uiteindelijk werd ervoor gekozen de berichtendienst bij GD DAP contact onder te brengen. Om een hoge initiële dekking van de berichtendienst te bewerkstelligen werd gebruik gemaakt van adresbestanden van de GD en de KNMvD.

Summary
The aim of this project was the establishment of an easy accessible news service for the exchange of information about veterinary casuistry with zoonotic relevance. The news service has been designated vetinf@ct.
Veterinary professionals, practitioners as well as scientists and offícals, are enabled to quickly send or receive reports on developments or incidents in the field of zoonotic infections, thus enhancing knowledge and expertise and promoting discussion among peers.
By enabling the exchange of information between comparable medical news services a One Health Network is created that contributes to the early recognition of zoonotic threats.
A project team has determined the preconditions for the news service and the IT surroundings in which the service ideally should be run. Vetinf@ct will be run within the Animal Health Service DAP (veterinary practice) contact system. The Animal Health Service and Royal Veterinary Association of the Netherlands have both provided addresses of veterinarians in order to ensure a high initial coverage of the news service.

Introduction
Veterinary practitioners will in most cases notice the occurrence of symptoms of zoonotic diseases and other disorders in animal reservoirs that can be important for public health. Thus vigilant practitioners are of great importance for the early detection of new zoonotic threats. With regard to this, veterinary institutes and laboratories of course play an important role as well, as far as additional diagnostics are performed.
Major zoonotic diseases, such as bovine tuberculosis, are notifiable under the Animal Health and Welfare Act. Other important diseases that currently do not occur in the Netherlands, such as tick borne disease, that can pose a threat to abattoir personnel when infected farm animals are slaughtered, are, however not notifiable.
The central government has been aware of this for years. The problem of wasting cattle in the nineties, which proved not to be related to an infectious disease, caused the Ministry of Agriculture to establish a reporting desk for practitioners situated at the GD called livestock scope (veekijker). The livestock scope enables farm animal practitioners to get help on issues of uncomprehended casuistry. It specifically targeted at farm animals and has, in view of 10.000 annual consultations, been proven to be a great success. The GD gives feedback on the information gained through the livestock scope at several levels (among other things digital newsletters for veterinarians and the DAP-contact newsletter), but due to the confidential nature of the consultations detailed sharing and easy access of information is not possible just like that. Furthermore, the

livestock scope is not meant for companion animals or wild life.
Hence there is need for a system for the exchange of information within the veterinary profession that is easily accessible and meant for a broad range of animal groups.
As zoonoses inherently occur in animal reservoirs and humans, it is important to exchange information about zoonoses with the medical field.
Since 2001, the Preparedness and Response Unit of CIb has maintained an electronic message service called inf@ct. Inf@ct is meant for infectious disease professionals and relevant umbrella organizations. After inf@ct commenced, additional message services for medical microbiology (labinf@ct) and occupational health end safety (arbo-inf@ct) have been established. By exchanging information between medical message services and vetinf@ct, a One Health Network is formed that contributes to early signalling, detection and knowledge exchange between the fields of expertise involved. This is especially true for zoonotic disorders in man and / or animals that are asymptomatic or go without specific symptoms.

Materials and methods

The design and the conditions of the message service have been inspired by the inf@ct message service for infectious disease control specialists:

1. Access only for professionals
By restricting access to vetinf@ct to veterinary professionals it is possible to exchange information of which details have yet to be confirmed and guarantee approachability. The closed character of the message service facilitates communication during crisis.

2. Editorial office
The members of the project team and a representative of the KNMvD form an editorial office. The editors will judge received messages and may accompany them by an editorial note.

3. Archive
Messages that have been sent can be consulted in an archive.

Two project meetings were held in which the imbedding of the message service, the necessity of an editorial statute and the best way to approach the veterinary profession were discussed.

Results

Vetinf@ct has been operational since December of 2009. The first message was sent in February of 2010 (appendix 1).

Imbedding and management
By using the inf@ct lay-out several aspects were fixed from the beginning: approachability and quality control of contents by an editorial office.

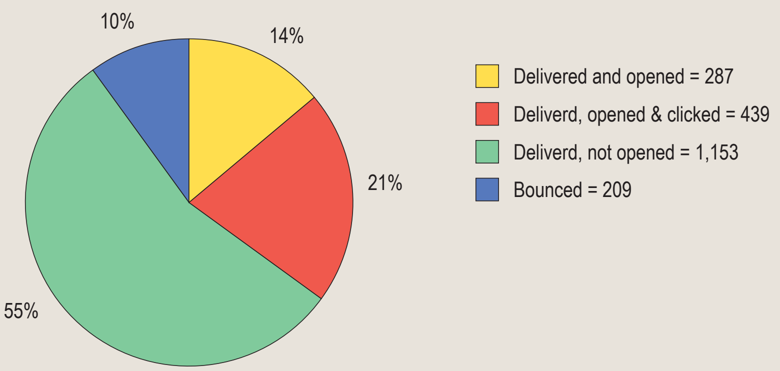
There were several options for the imbedding of the message service:
1. Use of the LCI inf@ct server
2. Use of the GD DAP contact server
3. Combination of GD DAP contact (farm animals) en KNMvD message service

Eventually option 2 was chosen because it was felt that maintaining a veterinary message service by a public health institute seemed illogical and using two different services was to laborious. By using the GD DAP contact ICT surroundings, it is possible to provide messages with full HTML functionality (among other things possibility for signing out within message). After having been agreed upon by the vetinf@ct editors, a message will by lay-outed by the DAP contact editorial office.

Coverage
It was agreed that it would be necessary to achieve a high initial coverage oft the message service. This was accomplished by combining address files of GD DAP contact (farm animal practitioners) and KNMvD (companion animal practitioners). Currently, the list of recipients is being extended with veterinarians working for governmental agencies or institutes.
Veterinarians that cannot be reached by GD DAP contact or are no member of the KNMvD may subscribe to vetinf@ct by sending an e-mail application. The e-mail address redactie@vetinfact.com is available for this purpose.

Editorial statutes
There has been discussion within the project team about the benefits of having an editorial statute. It is conceivable that divergent views may arise, e.g. about the desirability of spreading a certain message. Eventually, it has been decided to start the message service without an editorial statute, as huge problems were not foreseen. It has been agreed that incoming messages will be forwarded to the editors, who will than have two working days time to deliver comments before a decision is made whether a message will be spread within the vetinf@ct network. When an editor is absent, he or she will arrange a replacement. The project manager is responsible for the communication back and forth with message services in the medical field.
Messages may originate from the editors, subscribers or one of the other complementary message services.

Archive
The archive is accessible after joining through clicking a link in the first received vetinf@ct message.



Disclaimer

A disclaimer has been drawn up in order to create clarity about copyright issues and the legal status of messages.

- By placing a message the user agrees with the distribution of it to the other members of the vetinf@ct message service.
- If it is deemed necessary in the interest of public health, the editorial office may decide to forward messages to 1) the inf@ct, labinf@ct or arbo-inf@ct networks or 2) to the CIb. The editorial office respects the privacy of persons, companies or institutions.
- Messages will be placed with the name and affiliation of the author unless he or she states otherwise.
- No copyrights can be derived from submitted messages.
- Vetinf@ct messages are in view of their nature not to be regarded as scientific publications. Submitted messages may, however, give rise to scientific research and publications. If this is the case, this will not be done without acknowledgement of the source.

Remaining Information

Remaining information for submitters is available in appendix 2. This information shall be accessible through HTML functionality within messages.

First message

The First vetinf@ct message has been sent to more than 2000 recipients, of 35% whom (726 persons) have actually viewed the message. This is a lot, as this a new and unknown newsletter for most of the recipients who might otherwise regard it as spam. In comparism, the DAP contact newsletter is actually viewed by 50% of the recipients on the average. The rather high percentage of bounced mail is probably due to unfamiliarity with the newsletter, thus making recipients regard it as spam, too. This cannot be prevented.

As a result of the first message 445 persons have actively subscribed to the newsletter. Only 8 persons have chosen to actively decline and will be deleted from the addressee file. The remaining persons did not explicitly decline or agree but do have a client relation with one of the senders. This group will, together with active subscribers, receive the following newsletter.

Discussion

The EMZOO consortium has underscored the necessity of a veterinary message service from the beginning. By establishing vetinf@ct this need has now been met. As all important veterinary players are represented in the editorial office and the initial coverage of the veterinary field is high, contributions can be expected right from the beginning. As yet, only one message, originating from the GD, has been sent. The success of the message service will depend on submissions from the veterinary field. Since vetinf@ct has been operational for two months only, it is not yet possible to draw conclusions about the acceptance of vetinf@ct in the veterinary field.

The performance of the editorial office cannot be assessed due to the short time vetinf@ct has been operational. After the definite end of the project in June of 2010 this shall still be reported.

Recommendations

1. The vetinf@ct project can continue until end of June 2010 at the most, depending on the number of messages sent. The current set-up is comes at a price tag, therefore costs need to be covered after the end of the project. Given the broad support of vetinf@ct in the Netherlands, continuation of its funding has to be considered now.
2. The current set-up of vetinf@ct should be evaluated after 10 messages have been distributed or otherwise in July 2011, at the latest.

Related projects

This project is related to Appendix 5 Connection of veterinary en medical health monitoring.

Output

Article in “Tijdschrift voor Diergeneeskunde’, December 1st, 2009, Annex 3.

Annex 1

Als u deze nieuwsbrief niet kunt lezen. klikt u hier.

Vetinf@ct

nieuws over zoönosen voor veterinairen

editie 1 - februari 2010

Nieuw: vetinf@ct
Vetinf@ct is een nieuwsbrief voor veterinairen over zoönosen die wordt uitgegeven door CVI, faculteit Diergeneeskunde van de Universiteit Utrecht, GD, KNMvD en RIVM. Als u zich nu aanmeldt, dan ontvangt u de e-mailnieuwsbrief op het moment dat er ontwikkelingen of incidenten over zoönotische infecties te melden zijn. Door zo snel mogelijk hierover te communiceren wordt er een belangrijke bijdrage geleverd aan de dier- en volksgezondheid.

Ja ik meld me aan

Nee ik meld me niet aan

Vragen over deze nieuwsbrief? Mail naar redactie@vetinfact.com.

Vlekziekte
Vlekziekte is vooral bekend uit de varkenshouderij. Sinds enkele jaren duikt vlekziekte echter steeds vaker op bij kippen en in het bijzonder bij leghennen. Vlekziekte kan voorkomen bij varkens, schapen, vogels, reptielen en vissen. Bij vogels is de ziekte niet alleen beschreven bij kalkoenen en kippen maar ook bij eenden, ganzen, fazanten, kwartels en parelhoenders. Bij leghennen zien we een verhoogde uitval, diarree en een productiedaling. Bij sectie vertonen deze dieren een beeld van een bacteriële infectie met een gezwollen lever, nieren en milt.

Ook incidenteel bij mensen
De oorzakelijke bacterie -*Erysipelothrix rhusiopathiae*- geeft echter niet alleen problemen bij dieren, maar ook bij mensen. Het is voornamelijk een beroepsziekte die voorkomt bij dierenartsen, slagers, veehouders en slachthuispersoneel. Mensen worden besmet via beschadigingen van de huid, vaak aan de handen. Bij een sectie kan een dierenarts zich bijvoorbeeld prikken aan het uiteinde van een rib waardoor de bacterie vanuit de kip bij de dierenarts binnendringt via het ontstane wondje. Er is geen risico op besmetting via inademing of consumeren van vlees of eieren.

Het afgelopen jaar zijn twee sectiezaalmedewerkers van de GD besmet geraakt met deze bacterie. Eerder is ook vlekziekte vastgesteld bij een practicus. Verschijnselen beginnen meestal enkele dagen na besmetting met jeuk die later overgaat in pijn. De huid wordt rood en de infectieplaats wordt dik. Wordt er niet ingegrepen dan kan de infectie zich via de lymfeknopen verspreiden door de rest van het lichaam. De lymfeknopen zwellen hierbij op en doen pijn. Er ontstaat uiteindelijk een systemische infectie. Een mogelijke, maar zeer zeldzame complicatie is een endocarditis. Ga altijd naar de huisarts als u vermoedt dat er sprake is van een vlekziekte-infectie en attendeer hem of haar op uw vermoedens. Doordat een vlekziektebesmetting maar sporadisch voorkomt, kan deze mogelijkheid gemakkelijk over het hoofd worden gezien. Een infectie is goed te behandelen.

Iets te melden?
Heeft u informatie die interessant is voor vetinf@ct? Mail dit dan naar redactie@vetinfact.com. De informatie moet betrekking hebben op zoönosen. Door informatie te sturen, geeft u de redactie van vetinf@ct toestemming de informatie te gebruiken voor de vetinf@ct, inf@ct en labinf@ct nieuwsbrieven. Indien er een belang voor de volksgezondheid is, kunnen berichten ook worden doorgestuurd aan het Centrum Infectieziektenbestrijding. Uiteraard worden de privacybelangen hierbij altijd in acht genomen.
LET OP: bij meldingsplichtige aandoeningen dient u uiteraard altijd VWA op de hoogte te stellen. Voor advies kunt u altijd de gebruikelijke bronnen (GD, RIVM, CVI, UU en KNMvD) raadplegen.

Vetinf@ct is een gezamenlijke uitgave van CVI, faculteit Diergeneeskunde van de Universiteit Utrecht, GD, KNMvD en RIVM. Deze nieuwsbrief is speciaal opgezet voor veterinairen en wordt verstuurd op het moment dat er actuele informatie over zoönosen is.

GD | rivm | CENTRAAL VETERINAIR INSTITUUT WAGENINGEN UR | Universiteit Utrecht | KNMvD

Annex 2

Doelstelling

De elektronische Vetinf@ct berichtendienst is bedoeld als een laagdrempelig communicatiemiddel om onder de vlag van de One Health gedachte de vroege signalering van zoonotische aandoeningen te bevorderen. Veterinaire professionals worden in staat gesteld snel berichten te ontvangen en te sturen over ontwikkelingen of incidenten op het gebied van zoonotische infecties waardoor kennis en expertise worden vergroot en intercollegiaal overleg wordt bevorderd. Zo doende wordt een bijdrage geleverd aan de verbetering van de dier- en volksgezondheid. Vetinf@ct is complementair aan de inf@ct en labinf@ct berichtendiensten die respectievelijk zijn bedoeld voor professionals in de humane infectieziektenbestrijding en medische microbiologie. In voorkomende gevallen kunnen berichten in alle drie de netwerken worden uitgezet. De snelle communicatie tussen alle direct betrokkenen op het gebied van de infectieziekten in de veterinaire de medische domeinen, met name van belang tijdens incidenten, wordt op deze manier gefaciliteerd.

Disclaimer

Door het plaatsen van een bericht op de vetinf@ct-site gaat de gebruiker akkoord met de distributie van het bericht naar de leden van de vetinf@ct berichtendienst.

- Indien er vanuit het belang voor de volksgezondheid daar aanleiding toe is kan de redactieraad besluiten geplaatste berichten 1) door te sturen naar de inf@ct of labinf@ct netwerken, 2) te communiceren met het Centrum infectieziektenbestrijding. De redactieraad neemt daarbij de privacybelangen van betrokken personen, bedrijven of instellingen worden in acht.
- Berichten worden, tenzij de inzender kenbaar maakt dat niet op prijs te stellen, met de naam van de opsteller en zijn affiliatie geplaatst.
- Aan geplaatste berichten kunnen geen auteursrechten worden ontleend.
- Vetinf@ct berichten zijn gelet op hun aard niet als wetenschappelijke publicatie te beschouwen. Geplaatste berichten kunnen aanleiding geven voor wetenschappelijk onderzoek en publicaties. Indien dat het geval is, zal dit niet zonder bronvermelding geschieden.

Vraag en antwoord

Voor wie is Vetinf@ct bedoeld?

Vetinf@ct is uitsluitend bedoeld voor personen uit de volgende beroepsgroepen

- Landbouw- en gezelschapsdierenpractici
- Veterinaire professionals bij inspecties, beleid en productschappen
- Veterinaire pathologen, microbiologen, virologen, parasitologen of epidemiologen

Bij 'twijfelgevallen' bepaalt de redactie of iemand toegelaten wordt als lid.

Waarom is Vetinf@ct niet toegankelijk voor iedereen?

Vetinf@ct-berichten gaan altijd over infectieziekten bij dieren die relevant kunnen zijn voor de volksgezondheid en zijn uitsluitend bedoeld voor veterinaire beroepsgroepen in Nederland. Door het besloten karakter is het mogelijk informatie uit te wisselen waarvan de gegevens nog niet altijd bevestigd zijn. Collega's uit het veld kunnen hierop reageren. Het kan hierbij dus ook gaan om informatie waarvan het ongewenst is dat dit bekend wordt bij een groter publiek, bijvoorbeeld via krant of tijdschrift.

Door het aantal deelnemers tot veterinaire professionals te beperken, blijft gewaarborgd dat het om een vakinhoudelijke informatie-uitwisseling gaat. Op deze manier kan Vetinf@ct bijdragen aan het vergroten van kennis en expertise en intercollegiaal overleg.

Tijdens crisis kan Vetinf@ct bovendien zorgen voor snelle communicatie met alle direct betrokkenen.

Hoe kan ik lid worden? (Voorbeeld)

Aanmelden kan via de website. Klik in de linker menubalk 'Aanmelden'. Het aanmeldformulier verschijnt. Behoort u tot een van de genoemde beroepsgroepen, ga dan verder. Vul het elektronische formulier in en klik op 'Aanvraag versturen'. Na acceptatie van uw aanmelding ontvangt u een e-mail met uw inloggegevens. Aanmeldingen op privé e-mailadressen worden niet geaccepteerd.

Welke berichten zijn geschikt voor Vetinf@ct?

Vetinf@ct-berichten gaan altijd over infectieziekten bij dieren die relevant kunnen zijn voor de volksgezondheid en zijn altijd actueel.

Een bericht moet van belang zijn voor collega's, bijvoorbeeld in verband met directe actie (signaleren, alertheid), een snelle discussie, om inzicht te vergroten of kennisvermeerdering.

Waarom heeft Vetinf@ct een redactie?

De redactie bewaakt de kwaliteit van de inhoud en de kwantiteit van de berichten. Hierdoor treedt er geen 'vervuiling' op en blijft het kwalitatief hoogwaardige karakter gewaarborgd. De redactie is inhoudelijk deskundig. Zij beoordeelt de berichten op inhoud, nieuwswaarde en spoedeisendheid. Eventueel voorziet zij berichten van commentaar.

Wie mag berichten plaatsen?

Alle deelnemers kunnen op persoonlijke titel berichten maken en insturen. De redactie screent alle berichten en bepaalt of en wanneer een bericht naar de leden verstuurd wordt.

Hoe kan ik een bericht insturen?
U kunt een bericht insturen door een e-mail naar redactie@vetinfact.com te verzenden. Het bericht wordt binnen 48 uur bekeken door een van de redactieleden. De redactie bepaalt of en wanneer uw bericht naar de leden wordt verstuurd.

Kan ik in een vetinf@ct bericht ook vragen over diagnostiek van ziekteverwekkers kwijt?
Vetinf@ct is niet bedoeld als diagnostich forum.

Hoe vaak ontvang ik berichten?
De frequentie van de Vetinf@ct-berichten hangt af van wat er zich zoal voordoet op het gebied van zoonosen. In de praktijk betekent dit dat u soms meerdere berichten per maand ontvangt en soms maanden lang geen.

Hoe kan ik een bericht terugvinden?
Alle Vetinf@ct-berichten worden bewaard in een archief. Dit archief is door leden te raadplegen op de website. Log in op Vetinf@ct. Klik op 'Berichten' 'Archief'. U kunt zoeken in het archief door een zoekterm in te vullen. Vervolgens krijgt u een overzicht van alle Vetinf@ct-berichten die voldoen aan uw zoekopdracht.

Wachtwoord vergeten?
Neem contact op met het redactiesecretariaat: xxx , telefoon xxx.

E-mailadres gewijzigd?
Stuur een e-mail met uw nieuwe e-mailadres naar: xxx

Werkadres gewijzigd?
Stuur een e-mail met uw nieuwe werkadres naar xxx

Ik wil niet langer berichten ontvangen. Hoe meld ik me af?
Afmelden kan door in een bericht op de knop/de HTML link 'afmelden' te klikken.

Annex 3

IN VETERINAIR VERBAND

Emzoo-consortium en KNMVD lanceren berichtendienst voor zoönosen

Op 15 november 2009 lanceren het Emzoo-consortium en de KNMVD een elektronische berichtendienst voor dierenartsen: vetinf@ct. Deze berichtendienst is bedoeld voor de snelle en laagdrempelige uitwisseling van informatie en casuïstieken over zoönosen. De opzet is complementair aan al bestaande berichtendiensten voor professionals in de infectieziektenbestrijding (inf@ct) en de medische microbiologie (labinf@ct). De naamgeving weerspiegelt dit. Samen vormen deze drie berichtendiensten één 'One Health Netwerk' waarin informatie over zoonotische infecties over en weer kan worden uitgewisseld tussen het veterinaire en het medische domein.

Vetinf@ct is een gezamenlijke inspanning van de leden van het Emzoo-consortium en de KNMVD. De berichtendienst is uitsluitend bedoeld voor dierenartsen die werkzaam zijn in de praktijk, het onderzoek, de wetenschap of het beleid. Door de deelnemers te beperken tot veterinaire professionals, blijft een vakinhoudelijke informatie-uitwisseling gewaarborgd. Op deze manier kan vetinf@ct bijdragen aan het vergroten van kennis en expertise en intercollegiaal overleg. Het besloten karakter van de berichtendienst maakt het mogelijk informatie uit te wisselen, ook al zijn de gegevens nog niet altijd bevestigd. Daarbij kan het ook gaan om informatie waarvan het vooralsnog ongewenst is dat ze bekend wordt bij een groter publiek, bijvoorbeeld via krant of tijdschrift. Tijdens een crisis kan Vetinf@ct bovendien zorgen voor snelle communicatie met alle direct betrokkenen. Alle op de berichtendienst aangesloten collega's kunnen reageren op de verzonden berichten.

Vetinf@ct-berichten gaan over infectieziekten die relevant zijn voor de volks- en diergezondheid, en zijn altijd actueel. Berichten moeten van belang zijn voor collega's, bijvoorbeeld in verband met het belang van directe actie (signaleren, alertheid), een snelle discussie, het vergroten van inzicht of kennisvermeerdering.

REDACTIE

Een redactie, gevormd door leden van het Emzoo-consortium en de KNMVD, bewaakt de kwaliteit van de inhoud en de kwantiteit van de berichten. Hierdoor treedt er geen 'vervuiling' op en blijft een kwalitatief hoogwaardig karakter gewaarborgd. De redactie is inhoudelijk deskundig. Zij beoordeelt de berichten op inhoud, nieuwswaarde en spoedeisendheid en bepaalt of en wanneer een bericht naar de leden wordt verstuurd. Berichten kunnen eventueel van commentaar worden voorzien. De redactie stemt met de redacties van inf@ct en labinf@ct af welke berichten tussen het veterinaire en het humane domein over en weer worden gestuurd.

Alle deelnemers kunnen na login via de website www.aaa.bb op persoonlijke titel berichten maken en insturen.

De frequentie waarmee berichten worden verzonden, hangt af van wat zich voordoet op het gebied van zoonosen. In de praktijk kan dat betekenen dat soms meerdere berichten per maand kunnen worden verzonden terwijl er ook maanden lang geen berichten kunnen worden verzonden.

Een voorbeeld van een zoönosegerelateerd incident waren de van tularemie verdachte prairiehonden. (Foto: Johan Klein Haneveld)

SUCCES

Het succes van de berichtendienst hangt af van een hoge initiële dekking. Daarom wordt gebruik gemaakt van e-mailadresbestanden van landbouwhuisdieren- en gezelschapsdierenpractici van de GD en de KNMVD. Niet praktiserende collega's kunnen zich op www.aa.bb op berichten abonneren. Collega's die de ontvangst van de berichten niet op prijs stellen, kunnen de dienst eenvoudig stopzetten door het aanklikken van een link in het bericht.

In het verleden zijn er verschillende incidenten geweest waarbij een snelle informatie-uitwisseling tussen medici en dierenartsen wenselijk was. Tot de verbeelding spreken in dit verband bijvoorbeeld de van tularemie verdachte prairiehonden, H7N7 aviaire influenza en uitbraken van boviene tuberculose. De redactie van vetinf@ct hoopt dat deze nieuwe dienst bijdraagt aan de verbetering van de communicatie tussen mensen- en dierenartsen en dat door dit initiatief de 'One Health'-gedachte in Nederland blijvend voet aan de grond krijgt.

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Appendix 8
Communication with participants and interested parties

Project manager
W.J.G. Ransz, RIVM/CIb

Cooperation
In this project we have cooperated with the Communications department of the Ministry of Agriculture, Nature and Food Quality. Moreover, the communication plan has been discussed in the Supervisory Committee. All members of the consortium have had the opportunity to contribute.

Samenvatting
Het doel van het communicatietraject is een zorgvuldige informatievoorziening over het onderzoeksprogramma Emerging Zoönosen binnen het consortium, aan alle belanghebbenden in het veterinaire en humane veld en aan de media. Het gemeenschappelijke belang van alle betrokken partijen is om te komen tot een blauwdruk voor een vroegsignalerings- en surveillancesysteem voor emerging zoönosen vanuit diverse dierreservoirs in Nederland.
Direct betrokkenen moeten weten wat er binnen het onderzoeksprogramma gebeurt.
Speciale aandacht is geschonken aan de tijdigheid en volgorde van informatievoorziening.
De boodschap moet op een open en voor de doelgroepen geschikte manier gepresenteerd worden. Afgesproken is dat de berichtgeving getrapt verloopt en dat de volledige context van de problematiek zo goed mogelijk weegegeven wordt.

Summary
The main goal of the communication project was to supply information about the research programme Emerging Zoonoses within the consortium, to all interested parties and to the media. The common interest of all parties involved is to deliver a blue print for an early warning and surveillance system with regard to emerging zoonoses in the Netherlands. Those who are directly involved, must know what is happening in the research programme. In particular we have paid attention to timing and order of information supply.
The message must be presented transparently and appropriately for the target groups. The complete context of the issues has to be presented in the coverage.

Results
Early 2007 the Ministry of Agriculture, Nature and Food Quality organised a kick off meeting for the research programme Emerging Zoonoses. The Centre for Infectious Disease Control of the RIVM contributed to this meeting. The kick off meeting was intended for all parties involved and anyone interested.
The communication plan describes how the research programme arranges the information supply from and within the programme. Special attention has been paid tot the order of information supply.
In June 2010 the results of the research programme have been presented at a final symposium.