National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

An improved method of crisis response evaluation

Better Learning from Crises

RIVM Report 2018-0035

H.J. Manuel et al.

National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

An improved method of crisis response evaluation

Better learning from crises

RIVM Report 2018-0035

Colophon

DOI 10.21945/RIVM-2018-0035

H.J. Manuel (author), RIVM,
H.J.M. Aarts (author), RIVM
R. de Jonge (author), RIVM
E. Kuipers (author), RIVM
L.G.C. Schol (author), RIVM
J.E. van Steenbergen (author), RIVM
P.A.M. Uijt de Haag (author), RIVM

Contact:
H. J Manuel
Centrum Veiligheid\Advisering Beleid en Inspectie
henkjan.manuel@rivm.nl

This investigation has been performed by order and for the account of RIVM, within the framework of SPR.

This is a publication of:
National Institute for Public Health and the Environment
P.O. Box 1 | 3720 BA Bilthoven
The Netherlands
www.rivm.nl/en

Synopsis

An improved method of crisis response evaluation

The RIVM houses so-called response units that take action in different types of emergency, such as environmental accidents, food contamination or outbreaks of infectious diseases. Afterwards, the assistance provided is always evaluated in order to improve responses to future crises. However, the current evaluation method does not offer enough handles for improvement. The RIVM therefore proposes an improved, structured method of evaluating the response to crises. The proposed method provides insight into the underlying causes of failures in crisis response in order to help resolve such failures.

The current evaluation reveals a recurrence of certain types of failure, indicating that these have not been adequately addressed. Currently, after an incident, an assessment is made of the deployment of the response unit, whether this corresponds with the desired deployment and, if not, in what way it might have deviated from the desired deployment. There is no fixed guideline that describes how an evaluation should be carried out. As a result, evaluations differ in methods of implementation and depth.

For this project we investigated the literature on methods known to expose the underlying causes of failures. The combination of two methods (simple timeline and the ‘5 Whys’) seems to be the most appropriate way to improve evaluation. The amount of time required to implement the method and how easily the organization can learn the method are taken into account.

This research also shows that before the evaluation is carried out, it must first be established which factors are required for a good response (critical control points). This could be the availability of a desired number of people or a certain skill. These factors will then be taken into account in a subsequent deployment.

The RIVM initiated this research itself and financed it from the Strategic Program RIVM (SPR). The SPR is intended to provide the RIVM with the expertise and facilities needed to adequately perform the tasks of the clients and the bodies the RIVM is working with, now and in the future.

Keywords: emergency response, incident investigation, Root Cause Analysis, timeline, ECFA+, 5 Whys, 3CA, evaluation, after action report

Publiekssamenvatting

Een verbeterde methode om de crisisrespons te evalueren

Het RIVM heeft zogeheten responseenheden die in actie komen bij verschillende soorten incidenten, zoals milieuongevallen, voedselgerelateerde incidenten of incidenten met infectieziekten. De verleende hulp wordt naderhand altijd geëvalueerd om in de toekomst nog beter op incidenten te kunnen reageren. De huidige evaluatiewijze biedt daarvoor echter te weinig handvatten. Het RIVM stelt daarom een verbeterde, gestructureerde methode voor om de inzet te evalueren. Deze methode biedt inzicht in achterliggende oorzaken van haperingen, waardoor ze beter kunnen worden aangepakt.

In de huidige evaluatie komen vaak dezelfde verbeterpunten terug en lijken ze niet te worden aangepast. Momenteel wordt na een incident op hoofdlijnen geëvalueerd welke inzet is geleverd, of die overeenkomt met de gewenste inzet en waardoor hij eventueel afweek. Er bestaat geen vaste richtlijn die beschrijft hoe een evaluatie moet worden uitgevoerd. Daardoor verschillen de methoden in uitvoering en diepgang.

Voor dit project is in de literatuur onderzocht welke methoden bekend zijn om de achterliggende oorzaken van haperingen bloot te leggen. Een combinatie van twee methoden (‘eenvoudige tijdlijn’ en ‘5 x Waarom’) lijkt het meest geschikt om de evaluatie te verbeteren. Hierbij is gelet op de hoeveelheid tijd die nodig is om de methode in de praktijk uit te voeren en hoe gemakkelijk de organisatie de methode kan aanleren.

Uit dit onderzoek blijkt ook dat vóórdat de evaluatiemethode wordt uitgevoerd, eerst duidelijk moet zijn wat op orde moet zijn voor een goede respons (kritische controlepunten). Dat kan bijvoorbeeld de beschikbaarheid van een gewenst aantal mensen zijn of een bepaalde vaardigheid. Bij een volgende inzet kan daar dan op worden gelet.

Het RIVM heeft dit onderzoek zelf geïnitieerd en gefinancierd vanuit het Strategisch Programma RIVM (SPR). Het SPR is bedoeld om het RIVM te voorzien van de expertise en kwaliteit om nu en in de toekomst de taken van de opdrachtgevers adequaat uit te kunnen voeren.

Kernwoorden: ongevalonderzoek, crisis respons, achterliggende oorzaken, tijdlijn, ECFA+, 5 x waarom, 3CA, evaluatie, after action review

Contents

Summary

The National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieu, RIVM) houses a number of important emergency response functions for deployment in the event of various types of incidents. These incidents may include chemical spills, nuclear accidents, outbreaks of infectious diseases and contamination of drinking water.

As in any learning organization, responses to such incidents are evaluated. A study of previous evaluations revealed that certain issues seemed to be recurring despite recommendations to deal with them. The question therefore arises: are we missing the underlying causes of response failures? Could it be that the evaluations remedy the direct symptoms of inadequate responses, while leaving the underlying weaknesses of the response functions present to manifest themselves again at the next crisis?

This research project was initiated with the aim of devising a better-focussed crisis response evaluation method, with the condition that it should be as practicable and as little time-consuming as possible.

First, a literature survey was conducted to investigate which methods exist for crisis response evaluation. Only a small number of relevant studies were identified, suggesting that a lot of work needs to be done in this area. The literature suggests that root cause analysis (RCA) methods can be helpful in determining the underlying causes of response failures. The literature also mentions that a first step should be to determine critical control points (CCPs), i.e. the things that need to be managed to prevent or reduce risks and that are within the control of the organization. For this purpose, Hazard Analysis and Critical Control Points (HACCP), which is used widely in food safety, can be used.

Next, a survey was done on the RCA methods used for emergency response. Drawbacks to the use of RCA in general and specifically for emergency response functions that are mentioned in the articles were assessed. These include costliness, steepness of learning curves and human factors such as mutual trust and liberty to speak.

It is necessary to describe how incidents progressed over time to get an idea of the factors that played a role in an incident. For this, different techniques can be used. A simple timeline depicts who did what over the course of time. This can be done in a list/table or graphically. Events and Causal Factors Analysis (ECFA) is a method of showing the interaction of different actors' responses over time.

Based on the surveys and discussions with experts in RCA methods we chose two combinations of techniques to be tested on a short list of incidents. The combinations were simple timeline/5 Whys as a concise method and ECFA+/3CA (Control Change Cause Analysis) as a more elaborate method. The short list was produced from a long list of incidents involving RIVM response functions, by using a number of criteria. Among these were: whether response to the incident was

undertaken by the RIVM; how recent the incident was; and whether it had already been evaluated.

We then tested the two combinations on two incidents. In each case a meeting was held with a number of people from the response function to determine the CCPs. This generated a list of CCPs such as timeliness of response, capacity of the response team and provision of information. Next, separate interviews were held to (further) determine the timeline and the interaction between actors and to prioritize the CCPs and identify possible omissions. With this accumulated information the CCPs were transcribed into questions that could be targeted with the different RCA methods. For each of the two incidents, a meeting was then held with a number of the participants that had been interviewed earlier. A short explanation was given of the two techniques and they were applied to the same questions to determine the relative effectiveness of the two techniques.

After the meetings, the observed progress towards the underlying root causes given were evaluated to determine the overall performance of the two combinations. We determined that both simple timeline and ECFA+ were time-consuming in the first step of the combination, where ECFA+ was the more time-consuming method, which did not bring much extra insight to the table. In the second step of the combination the 5 Whys method seemed to progress more naturally towards a possible root cause than 3CA, although the progression was more pronounced in one case than the other. As 3CA takes more time to explain and seemed to converge largely on the same root cause, we concluded that the combination simple timeline/5 Whys was best suited to improving crisis response evaluations, with the addition that 5 Whys could benefit from the categorization of the 3CA method into organizational, cultural, managerial, administrative and legal factors.

The revised method was then tested on a third case study: the response to a recent incident. The same procedure was used to help sharpen the method. It was found that some of the control points formulated in the initial meeting could not be met by the response function, which meant that some root causes could not be remedied by the organization. This emphasized the importance of distinguishing between control points and critical control points (CCPs) in order to target the root causes that can be controlled by the organization.

In some cases it might nevertheless be helpful to determine root causes that are outside the span of control of an organization for discussion with third parties. Discussion might then lead to a better understanding and even to a possible solution of those root causes by a third party.

Based on the work done as described above we propose the following method for evaluating the response functions of the RIVM:

1. Describe the response function and determine the CCPs. A method such as HACCP can be used to determine them. It must be assured that the control points are within the span of control of the organization (CCPs).
2. Describe the case with a simple timeline. This can be quite time-consuming and therefore we recommend facilitating this

significantly by making the CCPs part of the organizational structure. By using the CCPs as items on the agenda and headings in incident logbooks it will be much easier to track their development over time.

3. Conduct a root cause analysis by using the 5 Whys method, possibly in combination with 3CA factors to help focus on a solution.
4. Implement and evaluate this method.

To test the reception of the method, invite feedback and receive ideas for further development, a workshop with external parties was organized. The method was well received and a number of points for further consideration were raised. The two main points were:

1. Although the proposed method is as little time-consuming as possible, participants expressed the concern that it would still be too time-consuming to be used for every incident and recommended developing a 'light' version of the method. The full method could then be used for larger incidents (or incidents with a greater potential for learning) and the light version for medium and small incidents.
2. It was recommended that external parties should be involved in the method. At the start of the project we discussed this and decided that we would focus specifically on RIVM response functions to determine the CCPs. However, some CCPs are related to external parties (such as communication agencies) and the evaluation of the method might benefit from the involvement of external parties that could give an objective view of our work.

1 Introduction

Although the safety level in our society has never been higher, society is also becoming increasingly risk-averse and has ever higher demands on safety in various domains, such as the environment, food and health. Crises involving safety issues nowadays receive large-scale (media) attention, which is further amplified by the use of social media. Recent examples of such crises in the Netherlands are the large-scale industrial fire at Chemie-Pack in Moerdijk (2011), the outbreak of *Escherichia coli* (EHEC) bacteria in sprouted seeds (2011), the contamination of eggs by dioxins in Harlingen (2013) and the outbreak of Salmonella thompson in salmon (2012). As there is a high demand for safety, the response of the public authorities to such incidents must be timely and of very high quality.

The National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieu, RIVM) includes important emergency response functions for dealing with various types of crisis, such as chemical spills, nuclear accidents, outbreaks of infectious diseases and drinking water contamination. The RIVM carries out these response functions in partnership with a large network of (mostly public) organizations.

Fortunately, crises are rare events. However, their rarity is itself a complicating factor in the process of learning. Therefore, each crisis should be seen as a unique opportunity to learn and improve future response actions. The same goes for large-scale response exercises. Responses to accidents and response exercises are usually evaluated afterwards. These evaluations focus on the inadequacies in the emergency response and the recommendations aim to improve the procedures and technical tools used in future responses. The evaluation type varies considerably, ranging from simple standard questionnaires (what went wrong and how can future responses be improved?) to an in-depth analysis of the response. However, similar recommendations often appear in consecutive evaluations, suggesting that the learning capacity of organizations is limited. Therefore, the question arises whether the evaluations address the root causes of inadequate responses: it is possible that, although the direct symptoms of inadequate responses are remedied, underlying weaknesses of the response system remain present and manifest themselves again at the next crisis.

In order to learn from crises, it is important that evaluations reveal the underlying weaknesses of the emergency response system. For the evaluation of responses to infectious disease outbreaks, for example, a literature research into evaluation methods showed that a generic framework for the evaluation was missing. The RIVM's National Coordination Centre for Communicable Disease Control (Landelijke Coördinatie Infectieziektebestrijding, LCI) therefore developed a simple general audit framework (Van Ouwerkerk et al., 2009). The framework consists of three steps, each in answer to a question: (i) How did the outbreak response proceed (factual reconstruction)?; (ii) How should the outbreak response have proceeded (what guidelines and legislation

exist)?; and (iii) Why are there differences between what happened and what should have happened? Although the framework provides a standard method of evaluation, a systematic approach to revealing the underlying flaws is not included.

In order to overcome this shortcoming, an exploration of the applicability of other evaluation methods was undertaken. In particular, root cause analysis (RCA) methods were studied. RCA is a tool for investigating the underlying causes of problems or accidents by continued questioning as to why an accident happened until weaknesses in the safety management system are revealed. As an example, the tool Storybuilder was developed by an international consortium led by the RIVM to determine the root causes of labour accidents (Aneziris et al., 2008). The Storybuilder analysis not only determines which barriers to an accident failed prior to the accident, but also identifies which underlying weaknesses of the management system caused the barriers to fail.

There are many RCA methods available, and their use depends on the goal of the analysis, its depth, the resources available and the expertise of the analysts. For example, an overview of RCA methods by Van Alphen et al. (2009) describes 20 different RCA methods extensively, and even more methods are identified. The selection of an appropriate RCA method is therefore not straightforward.

Root cause analysis is not limited to accidents, but is also used to investigate the weaknesses of systems. In cooperation with the RIVM, students of the Technical University of Delft piloted the use of RCA methods in the evaluation of the response to the outbreak of Q-fever (2007 and later) and Salmonella (2006) in the Netherlands (Yabba, 2012; Zhu, 2012). They applied a combination of two methods, ECFA (Event Causal Fact Analysis) and 3CA (Control Change Cause Analysis) to make a reconstruction of the sequence of events and causal chains and to analyse the (root) causes. They compared the findings of their evaluation with the findings and recommendations of the traditional method of evaluation and concluded that the traditional evaluation method insufficiently assessed the root causes; the recommendations of previous evaluations were on a general level and rather vaguely formulated. When RCA methods were applied, valuable new insights emerged. The use of RCA methods was new for this setting, and the results of this pilot study were promising. However, it was also concluded that more work needed to be done, to investigate applicability of the pilot method to other response units of the RIVM.

Emergency response functions are an important part of the RIVM's responsibilities; therefore, the RIVM has an interest in improving emergency response management. This interest was confirmed by the signing[1] of a declaration of intent with the organizations PGV Nederland[2] and IFV/AGOZ[3] to improve emergency response management by bringing together policy, science and practice, increasing the use of

[1] Signed on 9 April 2014 at the conference 'Academisering van de Crisisbeheersing'.
[2] Public Health and Safety in the Netherlands (Publieke Gezondheid en Veiligheid Nederland), the combination of Municipal Health Services (GGD) and the Disaster Management Organization (GHOR).
[3] Institute of Physical Safety (Instituut Fysieke Veiligheid/Academie voor GHOR en Opgeschaalde Zorg).

evidence-based approaches and applying scientific knowledge in practice. The three parties agreed to make existing knowledge more widely available, to generate new knowledge by research and to secure the knowledge by incorporating it in education programmes.

Therefore, the RIVM initiated a Strategic Research Project to improve its emergency management functions by translating developments and tools in the area of accident investigation into new tools in the area of emergency response management. The project aims to develop expertise and tools for better incident evaluation at the RIVM, including the use of links to partner institutes.

In this project, we focus on improving the evaluation method itself. However, the evaluation of the emergency response is part of a learning process – and organizational learning capacity depends on many factors (Koornneef and Hale, 2004). The transition of the emergency response management organization to a continuous learning organization therefore involves more than an improved method of evaluating past crisis responses: the improved evaluation method should be embedded in a management system geared towards self-improvement. In any case, improvement of the evaluation of past incidents focussing on the underlying flaws of the emergency response system is an essential step towards becoming a continuous learning organization.

As described above, there are several ways to improve the evaluation process. A common approach is the after action review (AAR), which, like the aforementioned framework developed by LCI, asks what was supposed to happen, what actually happened and why there were differences. AAR methods cost relatively little time but may not reach the underlying problems. RCA methods are more likely to grasp these underlying problems but will cost (much) more time. For this project we wanted to develop an efficient method of evaluation by combining the strong points of several methods, if possible, and thus bridge the gaps between them.

1.1 Assumptions

In this study, we make the assumption that the response organizations have the potential to act on points raised in previous evaluations. Thus, we assume that the PDCA (Plan, Do, Check, Act) loop, as used for continual improvement of processes and products, is closed. We assume that any recurrence of evaluation recommendations is not simply the result of the fact that the organization did not act upon those recommendations and thus did not close the PDCA loop.

1.2 Aim of the project

The aim of the project is to improve crisis response in the Netherlands in situations where the RIVM has a central response function by enhancing institutional learning capacity. For this purpose, a structured method of evaluating previous crises and crisis response exercises would be developed by selecting and modifying existing evaluation methods, in particular RCA methods. The method should identify the underlying weaknesses of the crisis response system, thus providing a powerful tool for learning from past responses to accidents and from response

exercises. Furthermore, the method should be time-efficient and focus from the start on the most important factors in crisis response. In this way, an improved evaluation of past responses should result in improved response functions of the RIVM and its links to partner institutes. Furthermore, the collaboration and exchange of knowledge of the different response functions within the RIVM strengthen its institutional learning capacity. Finally, the result should be useful for organizations with a similar function, such as the Municipal Health Services (GGDs) and Disaster Management Organizations (GHORs).

The objectives of this project can be summarized as follows:

- To determine if RCA methods are better equipped or beneficial as an extra tool for use in the evaluation of crisis response functions than the ‘standard’ means (e.g. questionnaires).
- To determine the criteria for selecting the methods to be used in the evaluation of various crisis response functions.
- To select and apply the most suitable (modified) method per crisis.
- To disseminate the results via workshops, publications, etc.

Furthermore, the project promotes the exchange of experiences and knowledge between the various emergency response organizations within the RIVM.

2 Crisis response at the RIVM

The RIVM has several designated emergency response functions. This chapter gives an overview of the different emergency response functions and the role of the RIVM.

2.1 Infectious disease outbreaks

Infectious disease outbreaks regularly occur in the Netherlands as well as abroad. Coordinated action is necessary in the event of an outbreak of infectious disease or a (potential) threat such as the spread of resistant micro-organizms[4] (RIVM, 2012). The Centre for Infectious Disease Control (Centrum voor Infectieziektebestrijding, CIb) of the RIVM has a coordinating role in the control of outbreaks of infectious diseases in the Netherlands. This includes national surveillance of infectious disease outbreaks, detection and monitoring of threats at the national level, issuing to medical professionals of warnings of imminent risks, and signalling of outbreaks if they occur. Together with its partners, the CIb evaluates the possible risks to public health in the event of an outbreak or the threat of an outbreak. The CIb also advises the Ministry of Health, Welfare and Sport and other professionals about the appropriate prevention and control policies. In order to quickly and adequately advise the Minister of Health, Welfare and Sport – and in the case of zoonoses, the State Secretary for Economic Affairs, Agriculture and Innovation – the director of the CIb can convene an Outbreak Management Team (OMT) or a Council of Experts (Deskundigenberaad, DB), consisting of experts and representatives of various professional organizations. This scientific multi-disciplinary risk analysis is fundamental to the control of infectious diseases.

In terms of emergency response, the CIb is responsible for the coordination of control measures and for communication with the various crisis management parties and the public.

2.2 Food safety-related infections, and poisoning

Sudden and extensive food-related infections and poisonings are registered and investigated by the Netherlands Food and Consumer Product Safety Authority (Nederlandse Voedsel en Warenautoriteit, NVWA). During outbreaks of food infections, the relevant GGDs monitor and coordinate the prevention and control actions in close collaboration with the NVWA, which is responsible for tracing the source of the outbreak and implementing measures to prevent further exposure (e.g. recalls, closing of production). If national coordination is required, the CIb has the same role as in infectious disease outbreaks. Additionally, the CIb provides information to the public about food infections and preventive measures.

[4] The description is partly copied from RIVM (2012).

2.3 Zoonotic disease outbreaks

As zoonotic diseases are also infectious diseases, the CIb is responsible for the management of zoonotic disease outbreaks, along the same lines as described above. However, in zoonotic disease outbreaks the veterinary sector also holds an important responsibility and therefore collaboration with the veterinary field is crucial in outbreak management. As a result of the sub-optimal management of the Q-fever outbreak in 2012, crisis management was standardized for all zoonotic outbreaks (alert, assess, manage). This protocol takes the same form as the risk assessment for other human infectious diseases but includes the veterinary responsibility and collaboration.

2.4 Nuclear accidents

In the event of an accident involving radionuclides, the RIVM provides information on expected radiation doses. For this purpose, the RIVM manages the National Radioactivity Monitoring Network and deploys vehicles to conduct additional on-site measures. The RIVM also collects measurements taken by other institutes in order to present an integrated overview of the radiological situation in the Netherlands to decision makers during an incident.

2.5 Environmental incidents

In the case of incidents with important environmental and health impacts, the responding emergency services can request assistance from the Environmental Accident Support unit (Milieuongevallendienst, MOD) of the RIVM. This usually occurs when the emergency services require specific expertise, such as when a large-scale fire is emitting potentially harmful substances.

The MOD supports the fire department and local aid workers with on-site measurements with advanced measuring equipment and dispersion calculations to assess inflicted areas. After analysing the measurements the likely effects on health and the environment are assessed. In the event of a national disaster, the RIVM collaborates with other organizations such as the KNMI, RIKILT and DCMR and sets up an umbrella organization called the Crisis Expert Team for the Environment and Drinking Water (Crisis Expert Team – Milieu en Drinkwater, CET-Md, previously called Beleidsondersteunend team Milieu-incidenten, BOT-Mi).

2.6 Biological, chemical and radiological threats

The RIVM plays an important role in the investigation of suspicious objects to ascertain their chemical, biological or radiological composition, within the framework of the Protocol Suspicious Objects (Protocol Verdachte Objecten, PVO). The RIVM also hosts the National Laboratory Network for Terrorist Attacks (Landelijk Laboratorium Netwerk terreur aanslagen, LLN-TA), a network of laboratories that can be employed in the event of the discovery of suspicious objects or terrorist attacks. The objects are first screened at the BSL3 laboratory (Biosafety level 3) and tested for the presence of chemical, biological, radiological or nuclear agents and then sent to other laboratories in the LLN-TA network for specific chemical or biological testing if needed.

2.7 Public health disasters

The RIVM conducts or supports health screenings after disasters at the request of the respective public administrations. This entails the screening of victims, residents or aid workers, using questionnaires or other methods, and the checking of health records.

After a disaster, the public administration can request independent advice from the Expert Group for Health Research. The Centre for Health Impact Assessment (Centrum voor Gezondheidsonderzoek bij Rampen, CGOR) is responsible for composing and alerting the Expert Group, which consists of experts from various disciplines: environmental health experts, behavioural experts, health lawyers, toxicologists, etc. They must respond to the request within 24 hours. Their recommendations should include whether health screenings are advisable or not, and how they should take place. The recommendations of the Expert Group are available to the public.

2.8 Other crises and responses

Crisis response can also be organized on an ad hoc basis, e.g. in cases with large media attention. Examples are side-effects of vaccinations, and the possible health impacts of playing sports on synthetic turf fields comprising rubber granulate.

3 Design and methods

The purpose of this study is to develop a structured method for time-efficiently evaluating crises and crisis response exercises. By using (and where necessary modifying) existing evaluation methods, we aim to identify underlying weaknesses of the crisis response system, thus providing a powerful tool for learning from past responses to incidents and from response exercises.

This study was composed of four phases. Phase I consisted of the selection of two previously evaluated emergency response cases for re-evaluation and a literature review of evaluation methods in general and root cause analysis (RCA) methods in particular, from which we selected two RCA methods to be tested on the case studies. These cases were re-evaluated during phase II, using the two different RCA methods for comparison. Thus, four evaluations were conducted in total. During phase III, the outcomes of the different methods were analysed and compared with the previously conducted evaluations to determine the added value of RCA. As a result, recommendations were drafted on the best method for future evaluations. During phase IV, a newly selected case was evaluated using the refined method resulting from the previous three phases. As a result, a recommended evaluation method is proposed.

An overview of the study design can be seen in Figure 1. Each phase will be elaborated on separately in the following chapters.

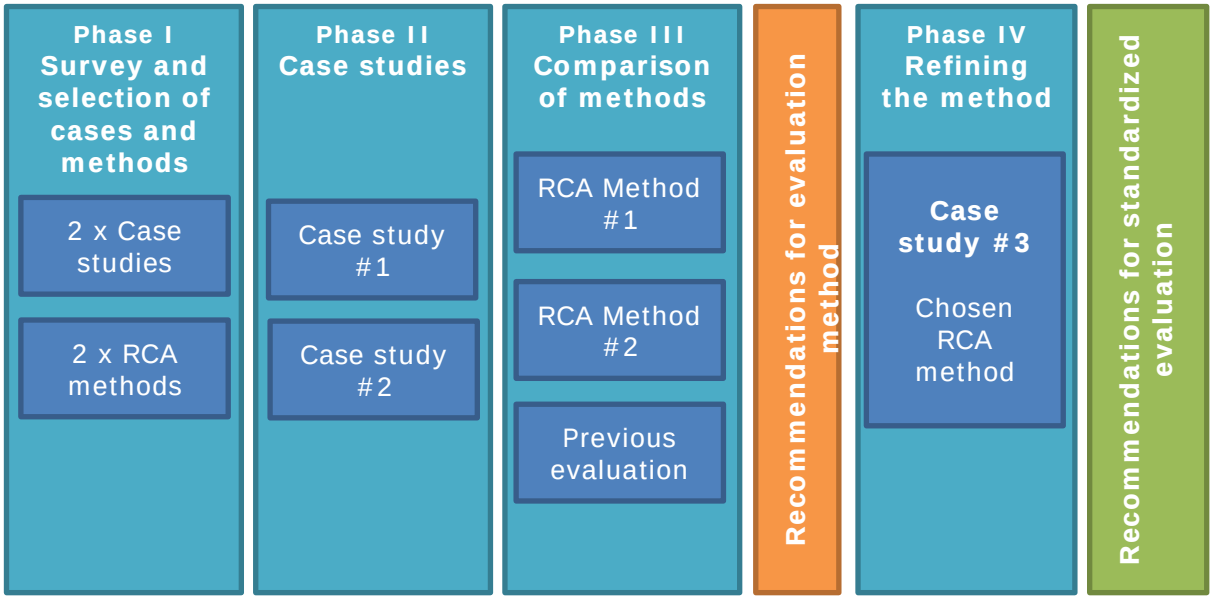


Figure 1: Schematic overview of the study design

4 Emergency response case studies

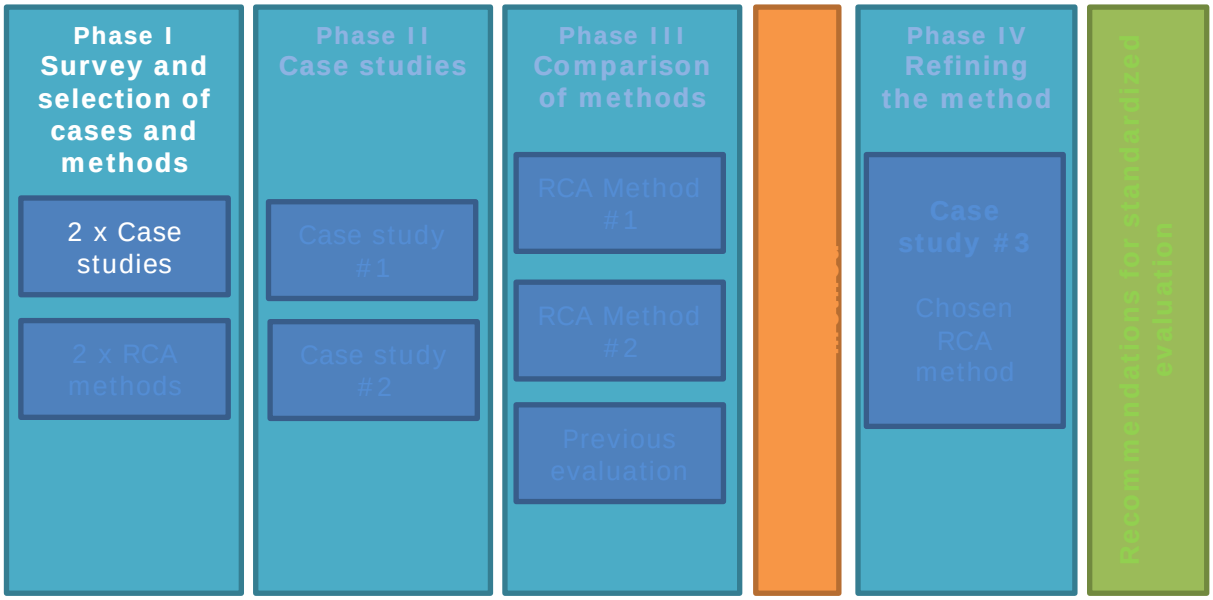


Figure 2: Schematic overview of the study design – Phase 1 selection of case studies

In Phase I, two emergency response cases were selected for re-evaluation (see Figure 2). For this purpose, a survey of past accidents and past large-scale exercises was carried out. Data were collected through interviews with the coordinators of the crisis response organizations within the RIVM, the communications department of the RIVM, and a search in Icaweb[5] in all available cases. This resulted in a total of 36 cases.

To select two cases for re-evaluation, selection criteria were determined through discussion within the project team. The criteria were divided into knock-out criteria (the case is not selected if the knock-out criteria are met) and preference criteria (to select the most relevant cases):

Knock-out criteria

1. The case is not related to a designated response function of the RIVM.
2. The case is more than five years old. As such it may not be relevant to current response functions and for relevant documents to be available.
3. No previous evaluation has been conducted and is available for review.

[5] Icaweb is the information system of the CET-Md.

Preference criteria

1. The cases must have involved cooperation with multiple partners such as local authorities, local relief workers and partner institutes in order to identify weaknesses in cooperation.
2. A real case is preferred over an exercise.
3. A more recent case is preferred over an older case.
4. The two cases selected must relate to different designated response functions.

The 36 cases were scored according to these criteria. (The survey and table of scores can be found in Annex I.) From this scoring, two cases were selected, namely the explosion and fire at Shell Moerdijk (2014), a chemical and environmental incident, and the contamination of salmon with Salmonella thompson (2012), a food-related infectious disease outbreak.

5 Root cause analysis methods

5.1 Introduction

In Phase I, we also selected two evaluation methods for the re-evaluation of the selected case studies (see Figure 3). For this purpose, we carried out literature surveys of evaluation methods in general and root cause analysis (RCA) methods in particular. RCA is a tool used to investigate the underlying causes of problems or accidents. RCA methods are commonly used in accident investigations to reveal the underlying causes of an accident and weaknesses in safety management systems. Nowadays they are also used across multiple disciplines to identify 'basic and causal factors underlying variations in performance' (Wu, 2008).

We started with a review of evaluation methods for crisis response in order to determine whether there were already existing, proven methods, and then reviewed the literature on RCA as an evaluation method.

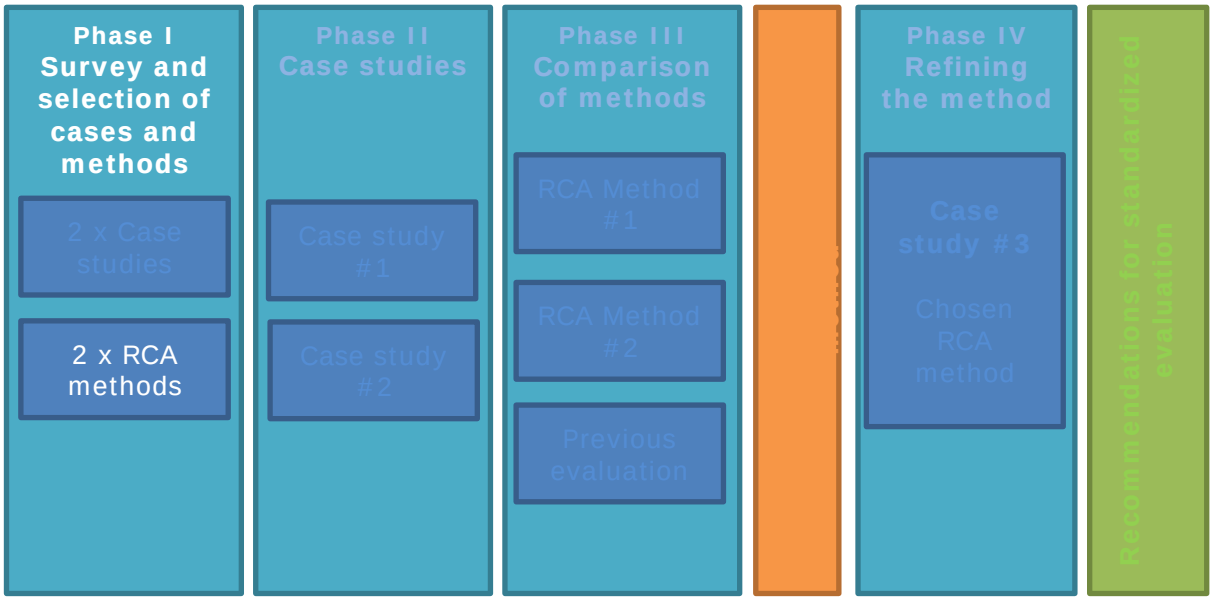


Figure 3: Schematic overview of the study design – Phase 1 selection of RCA methods

5.2 Literature review

5.2.1 *Evaluation methods for crisis response*

A systematic literature search was conducted in order to explore whether defined evaluation strategies existed for crisis response and, if so, which were the most established methods. An overview and description of the relevant articles can be found in Annex II. The literature search was supplemented by a review of other documents, such as scientific reports and Master's theses.

Van Ouwerkerk et al. (2009) published a generic framework for the evaluation of outbreak management. In this framework, three questions need to be answered:

1. *How did the crisis response proceed?*
   Reconstruct the procedure to clarify the outbreak development and outbreak response.
2. *How should the crisis response have proceeded?*
   Describe the desired outbreak response based on existing procedures, documents and legislation.
3. *Why are there differences between what happened and what should have happened?*
   Analyse the answers and provide insight into the differences.

It became apparent that this audit framework did not provide enough guidance, because consecutive evaluations often cited similar recommendations.

Two studies (Yabba, 2012; Zhu, 2012) attempted to augment and expand on the third question of this audit framework (i.e. 'Why are there differences between what happened and what should have happened?'). By applying RCA methods, these were able to identify previously unidentified causes of problems.

In addition to RCA, the literature review showed that there are many different approaches to evaluation: Hazard Analysis and Critical Control Points (HACCP), quality indicators, after action reports, disaster phase framework, questionnaires, flow diagrams, etc. Different industries use different evaluation strategies. For example, HACCP is primarily used in the food industry. In contrast, both the engineering and healthcare industries commonly make use of (variations of) RCA. Given that the response functions of the RIVM are extensive and cover various domains, this raised the question of whether a single evaluation method would be comprehensive enough for RIVM-wide application.

Many articles highlight the importance of evaluation to organizational learning (see e.g. ESReDA, 2015). An evaluation is a first step in the learning process, and corrective actions need to be identified and implemented.

5.2.2 Root cause analysis as an evaluation method

A second systematic literature search was conducted in order to explore the potential of RCA methods for evaluation. An overview and description of the relevant articles can be found in Annex III.

There are many RCA methods available, and choice depends on the goal of the analysis, its required depth, the resources available and the expertise of the analysts (Van Alphen et al., 2009). The selection of an appropriate RCA method is therefore not straightforward. 'Acceptance of the findings and organizational learning will be helped if the method is transparent, [is] proportional to the incident type and allows participation. Finally, methods should be conceptually simple and understandable, [and] comprehensive and should be recognized by the industry of interest' (Pranger, 2009).

The literature search also revealed that there are many similarities between the different RCA methods. It was concluded that the choice of a specific method is less important than the way in which it is used; a

systematic approach is essential (personal communication with Van Alphen). This conclusion is supported by Stoto (2009).

Additionally, due to the similarities between RCA methods, it follows that different approaches, or elements from different RCA methods, can be combined as appropriate to the situation and can yield better results than the application of a single method: ‘there is also broad consensus that RCA represents a toolbox of approaches rather than a single method’ (Nicolini, 2011).

Overall, the consensus is that RCA is an organizational tool (Stoto, 2009; Pranger, 2009; Wu, 2008), as most RCA methods identify organizational factors as root causes. Consequently, RCA contributes to organizational learning, thereby making it a suitable method for the analysis of emergency response management.

When applying RCA, it is important to know when you have found a root cause. Root causes can be identified by four characteristics (Rooney and Vanden Heuvel, 2004):

1. They are specific.
2. They can reasonably be identified.
3. They are causes over which management has control.
4. They are causes for which effective actions can be generated.

5.3 Selection of RCA methods

A selection of RCA methods was made on the basis of the literature search and personal communication with Van Alphen. This resulted in five potentially suitable approaches:

1. Combination of fishbone diagram and 5 Whys method.
2. Combination of fishbone diagram and pareto analysis.
3. 3CA (Control Change Cause Analysis).
4. PRISMA.
5. Tripod.

These approaches are described in Annex IV.

As mentioned above, RCA is a well established and often used method in accident investigations. However, accident investigations are often characterized by one clear and specific incident to which the causal chain can be traced. Response analysis is more about investigating a process and not a single incident. In addition to the RCA method, therefore, a factual reconstruction of the process in time is needed in order to identify the critical events during this process. In turn, these critical events can be treated as ‘incidents’. Then, a causal chain can be established for these incidents.

Two different methods for reconstructing the process in time were considered:

1. Simple timeline. A straightforward (graphical) representation of the facts and actions in time
2. Event Causal Fact Analysis (ECFA+). In ECFA+ significant events are described per actor (person of critical function in the

response organisation). Per agent ‘the agency of change’, ‘the change’ and ‘the object of change’ are recorded.

Next, selection criteria were determined through discussion within the project team. The criteria were divided into knock-out criteria (the case is not selected if the knock-out criteria are met) and preference criteria (to select the most relevant cases). The following criteria were used for the selection of RCA methods:

Knock-out criteria

1. The method can not provide a causal relation between factors.
2. The method does not give an in-depth analysis to identify the complexity between events.
3. The method is not able to identify organizational weaknesses in order to improve organizational learning capacity.

Preference criteria

1. The evaluation can be conducted by the response team with little external support.
2. The time and human resources required to conduct the evaluation must be feasible and it must be possible to integrate these into the activities of the RIVM.

An overview of the scoring of the RCA methods on these criteria can be found in Annex IV. Two contrasting methods were selected:

- Timeline/5 Whys was chosen as a succinct method.
- ECFA+/3CA was chosen as an elaborate method.

Both methods meet the knock-out criteria, as both can identify causal relations between different factors and focus on the organizational factors of incident analysis. However, they differ in a number of ways. The 5 Whys method is straightforward and easy to understand, and therefore potentially less time- and resource-consuming. Furthermore, its simple structure suggests that it is flexible in use.

The ECFA+/3CA method is elaborate and consists of more actions to perform. Its protocol dictates a certain method of factual reconstruction (ECFA+) as well as of RCA (3CA). This suggests that it is a more time- and resource-consuming method. However, its elaborate structure may be beneficial as it offers more guidance than the 5 Whys method. Furthermore, it may facilitate uniformity across future evaluations, which would enable easy tracking of progress.

5.4 Description of the methods selected

The chosen methods are briefly outlined below.

Timeline/5 Whys

The simple timeline gives an overview of the sequence of events and possible problems that occurred along the way and that can be targeted by the 5 Whys method. The 5 Whys strategy entails analysing a problem and trying to find the root cause by asking ‘Why?’ or ‘What caused this problem?’ The number 5 is generally regarded as a rule of thumb; a root

cause can be obtained after just 3 questions, or 7 questions might be required.

The 5 Whys method helps to determine the cause–effect relationships in a problem or a failure event. The method starts with a statement of the situation and a question as to 'why' it occurred. The answer to this question is then turned into a second why question, and so forth. A systematic approach is important because only then can it support the existence of a causal link between problem and root cause. Only if questions and answers are linked is there certainty that an effect was due to the stated cause.

A potential pitfall of this method is that it is tempting to assume we know what will fix a problem before thoroughly examining it. However, obvious explanations often conceal yet more underlying problems, and such assumptions may hinder a successful analysis of the underlying causes.

ECFA+ / 3CA

ECFA+ is a tool for factual reconstruction. It can be described as a set of guidelines to help researchers work systematically to establish the sequence of events in a particular scenario. The goal is not only to structure events, but also to identify gaps in the timeline. ECFA+ provides a graphic display of the event timeline, and allows the actions of multiple actors to be placed alongside each other and compared. The result is called an 'ECFA+ chart'. Significant events are described in terms of 'the agency of change', 'the change' and 'the object of change'.

Visualization is an important part of the ECFA+ method. It is usually a team exercise and an iterative process. Events must be sufficiently explained by supporting evidence. It is at the discretion of the evaluation team to determine whether an event is sufficiently supported. The starting point of the ECFA+ chart is the moment the 'control of outcomes is compromised' (Noordwijk Risk Initiative Foundation, 2007). The end point is the moment the 'control of outcomes is restored'.

ECFA+ is a physical method, which means writing a description of events on pieces of paper and then displaying these on a board or wall in order to structure the events. The finished ECFA+ chart is then transcribed onto computer for recordkeeping.

On the basis of the ECFA+ chart, the 'risk-increasing events' are selected and further analysed via 3CA. 3CA is an RCA tool that is used to explain the difference between actual and expected performance in relation to the chosen events. The question that guides this process is 'what processes caused the actual outcome instead of the expected one (as dictated by protocols, guidelines, etc.)?'. The evaluator drills down to the root cause by going through specific questions, as shown in Table 1.

Table 1: Questions for 3CA method

1	Significant event	What is the significant event or problem that has been identified by ECFA+?
2	Change to person or thing	Which undesirable event has occurred?
3	Agent of change	Who or what caused this undesirable change?
4	Adverse effect of change	What are the direct adverse consequences of this undesirable change?
5	Work controls or protective barriers	What processes in the system could have prevented this undesirable change or mitigated its effects? A distinction is made between 5 barriers: organizational, cultural, managerial, administrative, and legal.
6	Failure of controls/barriers	In what way was each of the controls or barriers mentioned in (5) ineffective?
7	Upstream processes	Which upstream processes and management factors led to the ineffectiveness of the aforementioned barriers?
8	Root causes	What are the underlying causes of the ineffectiveness of the processes and management factors mentioned in (7)?

HACCP

In order to be time-efficient, it was decided to include a Hazard Analysis Critical Control Points (HACCP) process in the evaluation method. Control points are defined as steps in the process whose successful outcome is necessary for the successful outcome of the response; critical control points (CCPs) are control points that are within the control of the response organization. In other words, should these steps go wrong, it is likely that the response will be negatively affected. CCPs are by definition within the control of the response organization and therefore can be used in the evaluation process to improve the response. By focussing on the CCPs, a more time-efficient evaluation can be made.

6 Case studies

In phase II, the two selected case studies were evaluated with the two chosen evaluation methods (see Figure 4).

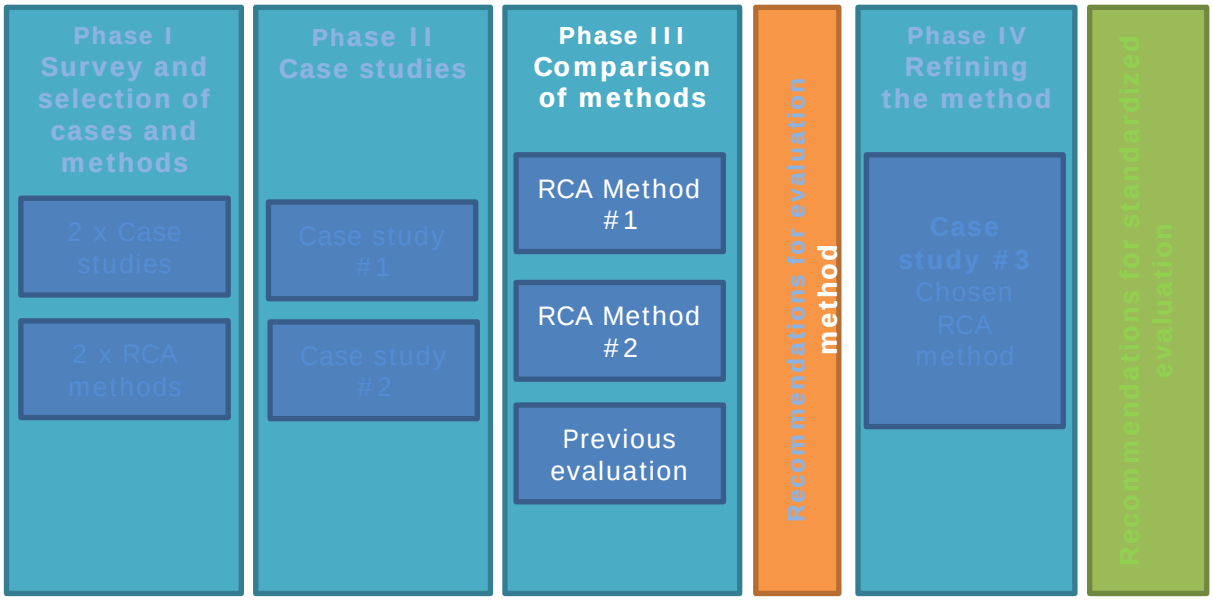


Figure 4: Schematic overview of the study design – Phase II evaluation

6.1 Case study design

Root cause analysis is performed on specific undesirable or problematic events. The identification of these specific events within each case involved a number of steps. In step 1, two expert meetings were held to conduct an HACCP of the emergency response process in relation to food-related infectious diseases and chemical incidents. The outcome of these meetings was an inventory of CCPs in a typical response situation. In step 2, a factual reconstruction was performed of the specific RIVM response activities during the Salmonella thompson outbreak in 2012 and the explosion at Shell Moerdijk in 2014. Two methods of factual reconstruction were explored, which resulted in two different timelines for each case. First, a simple timeline was constructed by chronological sequencing of events. Second, reconstruction was done using the ECFA+ method (Noordwijk Risk Initiative Foundation, 2007). During step 3, the CCP inventory drafted during step 1 was applied to the factual reconstruction (step 2). The outcome was a list of undesirable events or 'problem statements'. Finally, in step 4, two different RCA methods were applied to the problem statements identified in step 3. A schematic overview of the case study design can be seen in Figure 5.

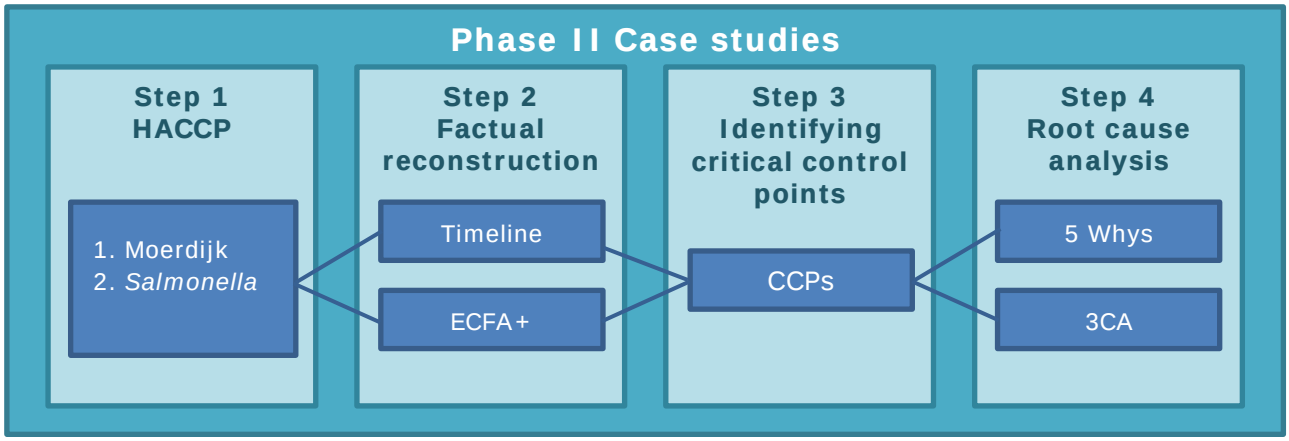


Figure 5: Schematic overview of the case study design

To prevent or at least reduce cross-contamination of the different methods, we carried out the different components of the case study in a specific order. The succinct method of factual reconstruction (timeline) plus RCA was always performed prior to the elaborate method. In this way, we minimized the possibility that the structure of the elaborate method would spill onto the succinct, less structured method.

Step 1: HACCP
For this purpose, two group meetings were held with experts in food-related infectious disease outbreaks and experts in chemical incidents, respectively. The outcome of these meetings was an inventory of CCPs in a typical response to a food-related infectious disease outbreak.

Step 2: Factual reconstruction
Factual reconstruction was performed twice for each case study, using the different methods described previously. The documentation used for this exercise consisted of written sources such as guidelines and regulations, evaluation reports, status reports, and communications between the different partners involved in the response. Additional data were collected through semi-structured interviews with key figures involved in the response, in order to fill gaps in the initial construction and sequencing of events. The outcome of this step was two event sequences for each case: one simple timeline and one ECFA+ chart.

Step 3: Identifying undesirable events
Interviews were held with key figures in each case. Interviewees were asked to take note of the CCPs (generated by the HACCP) and apply them to the case in order to identify events they considered undesirable. Additionally, there was an opportunity to raise undesirable issues that might have been missed in step 1. Furthermore, the CCPs were revisited and reassessed to determine their validity and relevance to the evaluation. The transcripts of the interviews were analysed by the project members with Atlas.ti, a tool for systematically analysing unstructured texts. This helped in determining the most important events and identifying possible outliers. The outcome of this step was a list of undesirable events that occurred during each case.

Step 4: Root cause analysis
The list of identified undesirable events was prioritized and three were selected for RCA. Group meetings were held with the interview respondents from each case. During these meetings, the two RCA methods were applied to the selected undesirable events. Afterwards, the different RCA methods were assessed to determine their effectiveness and value to the evaluation.

6.2 Case study 1 – Chemical accident emergency response

6.2.1 Case description

On 3 June 2014, at around 10.48 p.m., two large explosions took place at Shell Moerdijk, followed by a large fire. They took place in an installation in which chemicals were produced from ethylbenzene for the plastics industry. At the moment of the explosion, two workers were in the vicinity of the explosions. They were hit by the shock waves and by flying hot and burning catalyst pellets, resulting in bruises and second-degree burns. The other employees on duty were in the control room at the time and remained unharmed. The explosion resulted in a large, intense fire characterized by extensive production of smoke. The smoke that emerged from the fire passed over het Hollands Diep to the Safety Region South Holland – South (Zuid-Holland Zuid, ZHZ). Crisis teams were appointed in the source area, Moerdijk, as well as in the ZHZ region. At the request of the Safety Region ZHZ, the crisis response was scaled up to involvement of the national Crisis Expert Team for Environment and Drinking water (at that time called Beleidsondersteunend team Milieuincidenten, BOT-Mi). The Environmental Accident Support unit (Milieuongevallendienst, MOD) of the RIVM went on site to carry out measurements and take samples in the area of Strijensas, north of the location of the fire.

6.2.2 Methods

As previously described, the evaluation of this case consisted of four steps. First, a meeting was held with experts to determine the organizational structure and CCPs in a typical response to chemical and environmental incidents. Second, a factual reconstruction of the event and response was made and the list of CCPs was divided into three categories (see Section 6.2.3.1). These categories were then used as the basis for the third step, in which interviews were held with the personnel involved in the response to the Shell Moerdijk incident, based on an interview guide (Annex VI, in Dutch). The goal of these interviews was to identify the CCPs that were relevant to the Moerdijk incident. The fourth step took the form of a group meeting to test the two RCA methods of evaluation. The results of these evaluations were then compared with the previously conducted evaluation.

6.2.3 Results

6.2.3.1 Step 1: HACCP for chemical incident response

The organizational structure for the response to chemical and environmental incidents is shown in Annex V (in Dutch). Using HACCP we selected CCPs for re-evaluation. These were defined as steps in the process whose successful outcome is necessary for the successful outcome of the response. In other words, should these steps go wrong, it is likely that the response will be negatively affected. A reasonable number of CCPs emerged from the meetings, which were divided into categories. In a response phase the CPPs will likely be interwoven and by treating them as separate items in categories it is ensured that each of these categories will be given due attention in an evaluation. The three main categories that were identified were:

- *Activation phase*: relating to, for example, the alerting of the MOD, contact between the MOD and the 'client' (safety region or public domain) and the process of scaling up to BOT-mi;
- *Capacity of the MOD*: relating to e.g. material and human resources, or technical support;
- *Rapidity of response*: relating to e.g. the speed of arrival of the response team on the scene, of the analysis of the incident and of the delivery of advice to the safety region or public domain.

Consensus on the CCPs was easily reached, and it was possible to obtain a priority list of CCPs within a short time. This priority list of CCPs was later used in step 3: i.e. applied to the case in order to identify critical events:

1. Quick alerting of the MOD in the activation phase
2. Adequate training and equipment of the MOD
3. Quick analysis of the samples and interpretation

6.2.3.2 Step 2: Factual reconstruction

Factual reconstruction was performed to reveal the chain of events and to offer respondents a tool for recollecting critical events. The starting point for both timelines was determined to be the moment of the explosion. The end point for both timelines was set as the publication of the final report and consequently the cessation of MOD activities. The sources used to compile the reconstruction were documents such as logbooks, written correspondence, and public and internal reports.

First, a simple timeline was constructed (Annex VII). Decision-making on the inclusion of events was principally guided by the CCPs established during step 1. Although decision-making on the visualization was sometimes difficult, the final construction of the timeline proved to be a straightforward process. Because the majority of activities were condensed within the first few hours of the response, initially the timeline felt 'unbalanced'. Thus, we chose to magnify the time frame of the first 24 hours. This enabled us to present a less cluttered view of the activities of the MOD.

Second, an ECFA+ chart was constructed (Annex VIII). Although this method proved to be more time-consuming than initially expected, it had a number of important advantages. By means of this method we were able to identify certain gaps in the timeline. For example, during

the construction of the first timeline, it was not immediately apparent that the location of the second field team was not well documented and that a few actions of that second team were partly missed. This only became clear during the construction of the ECFA+ chart. Furthermore, many respondents indicated that they were involved only in a small part of the response and thus did not recognize their activities in the timeline as a whole. The ECFA+ format offered a visual solution for this issue, as the events were structured depending on the actor involved in the events. Thus, we created a timeline where each of the main players in the response chain could be identified; the ECFA+ approach allowed us to visualize the interaction between the different players.

There were conflicting opinions about the value of these factual reconstructions. Around half of the respondents thought the ECFA+ sheet looked rather 'complex', and much of the information was not deemed relevant to their 'part of the response'. Additionally, there were doubts whether this level of detail gave added value to the evaluation.

'Dat was voor mij van belang omdat ik bij het veldteam zat […] maar dat zijn verder dingen die niet voor mij van belang zijn. Dus daar heb ik ook geen zicht op.'
('That was relevant to me because I was part of the field team […] but as for the rest, those are things that aren't relevant to me. So I don't have any insights regarding those.')

'Zo'n enorme tijdlijn, daar gaat wel aardig wat werk in zitten. Ik weet zelf ook niet precies wat de toegevoegde waarde zou zijn […] om het helemaal op detail niveau uit te werken.'
('Such a huge timeline involves quite a bit of work. And I am not entirely sure what would be the added value […] of going into that level of detail.')

However, the other half stated that they thought the ECFA+ sheet gave a useful overview of the response and added insights. Reconstruction was deemed to be especially useful during large-scale incidents, due to the chaotic nature of unfolding events.

'Met grootschalige incidenten is een reconstructie heel fijn. Dan is het te groot, en een reconstructie kan helpen met bepalen wat is er allemaal gebeurd, waarop hebben we een bijdrage geleverd, et cetera.'
('During large-scale incidents, a reconstruction is really useful. Because the incident is so big, a reconstruction can help to determine what actually happened, where we contributed, etc.')

6.2.3.3 Step 3: Identifying undesirable events

As explained, the CCPs established during step 1 were used to identify the undesirable events that were specific to the response to the Shell Moerdijk fire. Many respondents indicated that it was difficult for them to remember specific events, due to the time that had passed between the incident and this current evaluation. Nonetheless, the respondents brought up several issues.

On the topic of the *activation phase*, several respondents felt that the field team could have been activated earlier to arrive sooner at the

location. Not only in the Moerdijk case, but also in other cases, they felt that the collective ‘sense of urgency’ ’could be improved.

‘Ja, maar dat heb ik eigenlijk bij elke inzet – en bij deze ook – het gevoel dat we sneller op pad hadden kunnen gaan. Dan is de sense of urgency ook nog niet zo hoog als je hier bij het RIVM staat.’
(‘Yes, but I have that feeling with every case – this one too – that we could have set off sooner. The sense of urgency isn’t that high when you are still at the RIVM.’)

Additionally, several respondents wondered whether the MOD could be more proactive in its activation. Although protocol dictates that the MOD should go into action only when an official request is filed by the respective safety region, this often causes delays. Many of the field team had seen the explosion on the news almost half an hour before they received the phone call.

‘Daar zit gewoon een half uur tussen, tussen dat we het gezien hebben op het nieuws en dat de coördinator belt dat er iets gaat gebeuren. De vraag is of je in zo’n geval, waarvan het eigenlijk overduidelijk is dat er wel iets gaat gebeuren, of je al pro-actiever zou kunnen zijn. […] Moet je dan nog wachten op de vraag uit de regio?’
(‘There was half an hour in between when we saw it on the news and the moment the coordinator called us into action. The question is, if it is an obvious case, could we be more proactive? […] Should we even wait for the region to call us?’)

Respondents mentioned some problems concerning the provision of material (linked to the CCP of capacity of the MOD), and some discussion arose about the deployment of the handheld XRF during the second field visit. Some wondered whether this could have been deployed sooner.

‘We wisten dat er chroom was vrijgekomen, maar als je ziet wanneer we het effectgebied van het chroom uiteindelijk hebben vastgesteld, was dat één dag later. Terwijl uiteindelijk kwamen ze erachter je met een handheld XRF heel snel het contourgebied bepalen. Naar mijn idee hadden ze veel sneller dat hele gebied kunnen afkaderen met die handheld.’
(‘We knew that there had been a discharge of Cr-6, but if you look at when we determined the effect area – that was one day later. Eventually they found out that you could demarcate the area pretty quickly with the handheld XRF. In my opinion they could have used the handheld XRF a lot sooner.’)

‘Nee, ik denk niet dat je in het algemeen kan stellen dat het beter is om meteen met zo’n handheld scanner rond te gaan rijden. Want in de meeste gevallen zal dat helemaal niet zinvol zijn, en kost het juist meer tijd. Dus ik denk dat we het niet anders hadden moeten doen dan dat het gegaan is.’
(‘No, I don’t think you can say that it is better to immediately start driving around with the handheld scanner. In most cases it won’t be useful and it’ll cost more time. So I don’t think we should have done it differently.’)

Furthermore, lack of coordination with the fire department led to confusion with the field team, as the number of air samples the fire department delivered was excessive. It became difficult to track all the different samples.

‘Gedurende de nacht kwamen er heel veel meetploegen van de brandweer zelf, met monsters. […] Dus op een bepaald moment had ik daar 2 tafels helemaal vol liggen met allemaal plastic zakjes […] Toen dreigde wel enigszins het overzicht kwijt te raken. Als ik ze rechtstreeks aangestuurd had dan had ik ze misschien een tiende van de monsters laten nemen.’
(‘During the night, many field teams from the fire department came and delivered samples to us. […] So at a certain point I had two tables filled with plastic bags […] That was when I slightly started to lose oversight. If I had coordinated with them directly, I would have probably told them to take maybe a tenth of the number of samples.’)

A second sample-related issue was that the field team collected different types of sample, which posed a problem for analysis.

‘Normaal nemen wij veegmonsters van gladde oppervlakken, en we nemen grasmonsters en soms gewasmonsters. In dit geval hadden ze ook nog bodemschraapsel monsters genomen, oftewel het bovenste laagje van de aarde met een kwastje bijeengeveegd. Alleen je hebt dan geen referentie materiaal, dus het is heel lastig om dat te beoordelen.’
(‘Normally we take swipe samples from smooth surfaces, and grass or vegetation samples. In this case they had also taken soil scrapings, i.e. the top layer of the soil with a small brush. But we didn’t have any reference material, so it was difficult to analyse these.’)

Finally, some frustration was caused by the fact that a significant number of samples proved to be useless due to the misplacement of filters.

‘Toen we een week later weer luchtmonsters gingen nemen tijdens het weekend, of er nog eventueel chroomstoffen in de lucht zouden kunnen zitten. Daar hebben we toen apparatuur neergezet die het hele weekend gemonsterd heeft. En toen bleek bij nader inzien dat de filters niet goed in de apparatuur gezeten hebben. Dus toen was meer dan de helft van de monsters waardeloos.’
(‘When we returned a week later to take air samples […] to see if there was still a trace of Cr-6, we placed equipment that took samples the whole weekend. And then we found out that the filters hadn’t been placed correctly, so more than half of the samples were useless.’)

With regard to the *rapidity of response*, several respondents felt that there was undue pressure from BOT-mi to deliver the analysis results. These results usually are checked against the normal background by the research leader to give them meaning but in this case some were used ‘as is’ what lead to erroneous conclusions.

‘Als je het binnen het RIVM houdt, kun je alle nuances erbij houden, maar al wel wat aangeven. Als je het aan BOT-mi geeft, gaan andere partijen er ook mee aan de slag, en dan weet je niet in hoeverre dat groter wordt.’

('As long as it is inside RIVM, you can give preliminary results, keeping all the nuances. If you give the results to BOT-mi, other parties will use them, and you don't know how big it will grow.')

Finally, the analysis of results was delayed by the presence of a previously unnoticed false positive spike.

'In die luchtmonsters, en dan vooral in de monsters van de brandweer, zat er een raar organisch piekje waar de GCMS van dienst nog wel wat tijd ingestoken heeft ... om er achter te komen dat het een stofje dat vrijkomt uit het plastic zakje waar je de monsters mee neemt.'
('In those air samples, and especially the samples from the fire department, there was a weird organic spike which the GCMS technician spent a lot time trying to analyse … only to find out that it was a substance originating from the plastic bag itself.')

During the interviews in step 3, the CCPs were discussed to see if they could be used for the Moerdijk case or whether revisions were needed. Our main finding was that the CCPs did not fit all aspects of the response to the Moerdijk case as well as expected. Rather, they seemed more concentrated around the fieldwork and activities in the first few hours of the response. Additionally, they seemed less applicable to the issues experienced by other team members such as the leader of the investigation team (onderzoeksleider, OZL) and the Investigation Coordinator. This resulted in the addition of a separate category 'cooperation'. As an example there had been poor communication with external parties such as Shell and the NVWA, especially in the first few hours of the response:

'In de nacht waarin ik de metingen gedaan heb was al vrij snel duidelijk […] dat er toch wel iets van de Shell in het milieu terechtgekomen was. […] En dat heeft volgens mij heel lang geduurd, dat de Shell een tijd lang zei 'dat kan helemaal niet, dat kunnen wij niet geweest zijn', en daarna schoorvoetend wel. Dus er was weinig communicatie over.'
('During the night I took samples, it became clear fairly quickly […] that some substances from Shell had leaked into the environment. […] And it took a long time; Shell kept saying, 'It's not possible. That couldn't have been us', and then they admitted it reluctantly. So there was very little communication.')

'Ik heb op een bepaald moment de NVWA gebeld, om 5 uur 's ochtends of in ieder geval belachelijk vroeg. […] In eerste instantie ben ik teruggebeld door de NVWA door een zeer geïrriteerd persoon […]. Het was duidelijk dat dat even de tijd nodig had voordat zij ook in de gaten hadden dat er misschien toch een gezondheidsprobleem zou kunnen spelen op het gebied van chroom.'
('At a certain point I called the NVWA, at 5 o'clock in the morning or in any case ridiculously early. [...] At first my call was returned by a very annoyed person […]. So it became clear that they needed some time to realize that there may be a health risk regarding Cr-6.')

Respondents also mentioned two huge positives. First was the establishment of a 'crisis centre' at the RIVM, pulling in representatives of various external parties.

‘Dus het BOT-mi was hier, de GGD was aanwezig, en de VR was er. Om eigenlijk, ja “dit zijn de vragen, dit is de data die we hebben, deze resultaten moeten nog komen; waar moeten we onze tijd aan besteden en wat is voor jullie op dit moment van belang?”. En dat ging gewoon heel prima.’
(‘BOT-mi was here, the GGD was present, and the Safety Region, so we could exchange information: ‘These are the current questions; these are our data; these results are still pending; where should we concentrate our efforts?; what is currently important to you?’. And that worked very well.’)

Second, the RIVM took the initiative of organizing an informal evaluation session. This session was very well received – also by the external parties.

‘Volgens mij is de sessie die we toen hebben georganizeerd heel positief ervaren door de regio. Uit de regio kwamen er toch een man of vier, het was best een goeie opkomst. En een goed proces, ik zou het iedereen willen aanraden om dat zo te doen.’
(‘I think the session we organized back then was very well received by the region. They arrived with around four people, so it was a good turnout. And a good process; I would recommend it to everyone.’)

Although these two actions were seen as positive to the Moerdijk response, our own observation is that the success of both the crisis centre and the information session was not followed up in subsequent responses. Nor has either action been formalized into a protocol or guideline.

6.2.3.4 Step 4: Root cause analysis

To identify the root causes of the previously identified undesirable events, a group meeting was held with the same interview respondents – i.e. respondents with different response functions. The meeting spanned two hours. The first half of the meeting was intended to discuss the succinct 5 Whys method, and the more elaborate 3CA method was tabled for the second half. Three problem statements were selected for root cause analysis. However, due to time constraints, both RCA methods were performed only on the first statement.

1. There is insufficient transfer of knowledge and information within the MOD:
   a. Undue attention was given to a false positive spike in the air samples.
   b. Successful initiatives, such as the ‘crisis centre’ and evaluation session, were not implemented in subsequent responses.
   c. Filters were misplaced in sample equipment.
2. A lack of communication with the fire department led to redundancy of samples.
3. MOD is not pro-active in its activation phase.

The first problem statement was formulated as a collection of several separate issues. After some debate, the group decided that the 5 Whys method was better suited to one specific issue. Thus, with regard to the first statement, the first Why question was framed as follows: ‘*Why was undue attention given to a false positive spike in the air samples?*’ It

appeared that the false positive spike was known to a number of technicians, but not all. This led to a second question: '*Why was the GCMS technician not informed of the false positive spike from the air sample bag?*' The group postulated multiple reasons, such as that there are no rules or procedures in place regarding potential false positive spikes. Moreover, while attempts had been made to solve this issue, such solutions had never been systematized. This led us to the third Why question: '*Why were these solutions not systematized?*'The group answered that there was no systematic approach to implementing improvements, and that the time spent on training is insufficient to bring these problems to light. This led us to the fourth Why question: '*Why is there no systematic approach to implementing improvements?*' In answer to this, the group speculated that individual responsibility is lacking; there is no feeling of ownership. In answer to the fifth question, '*Why there is no feeling of ownership?*', the group stated that because MOD activities are regarded as external to the general workload, employers are reluctant to allocate time to such tasks. Therefore, it is difficult for the team to give priority to MOD activities over regular work. The results of the 5 Whys exercise are summarized in Table 2.

Table 2: Summary of the 5 Whys exercise for case study 1

Problem statement 1: There was insufficient transfer of knowledge and information within the MOD: - Undue attention was given to a false positive spike in the air samples.	
Why 1	Why was undue attention given to a false positive spike in the air samples? • Because the GCMS technician was not informed of the likelihood of a false positive spike from the air sample bags.
Why 2	Why was the GCMS technician not informed of the likelihood of a false positive spike from the air sample bags? • Because there is no standard analysis procedure for most GCMS technicians. • Because the information table (regarding risk values) is not used, or its use is not systematized.
Why 3	Why were these solutions not systematized? • Because there is no systematic approach to implementing improvements. • Because time spent on training is insufficient to bring these problems to light.
Why 4	Why is there no systematic approach to implementing improvements? • Because there is no feeling of ownership for problematic issues, or implementation of solutions.
Why 5	Why does no one feel ownership of these problems? • Because MOD activities are separated from general tasks. • Because there are few incidents, so few chances to build experience. • Because there are no procedures for implementing solutions. (root cause)

During the second half of the meeting, the 3CA method was applied to problem statement 1, i.e. 'Undue attention was given to a false positive spike in the air samples' (Table 3). The five possible categories of protective barriers (organizational, managerial, administrative, cultural, legal) were used to formulate question 5 of the 3CA method. The result was a list of four potential barriers or work controls, as can be seen in

Table 3. Due to time constraints the same question on the missing knowledge of GCMS technicians about the potential presence of this false positive spike was tackled in steps 6 and 7.

Table 3: Summary of the 3CA exercise for Case study 1

1	Significant event	Undue attention was given to a false positive spike in the air samples.
2	Change to person or thing	Wrong values were reported
3	Agent of change	GCMS technician
4	Adverse effect(s) of change	• Misreporting of results • Delay in reporting results • Withdrawal of published results • Reputational damage to the RIVM
5	Work controls or protective barriers	• Knowledge of GCMS technicians about false positive spike • Checklists that warn for potential false positive spikes • Validation of results by second GCMS technician • Critical appraisal of results by OZL
6	In what way was each measure at (5) ineffective?	• Missing knowledge with GCMS technician about potential false positive spike • *(Other barriers were not dealt with due to time constraints)*
7	In what ways did upstream processes fail to identify or prevent the problems noted in (6)?	• No one informed the GCMS technician • The GCMS technician failed to remember due to rare encounters with this spike • Insufficient training in analysis of air samples • Insufficient communication between GCMS technicians
8	Why did the failures in 7 occur?	• No feeling of ownership of information-sharing

Comparing the two methods, it seems that the 3CA method is a more convergent approach to finding the root cause, while the 5 Whys method leads to more general and sometimes divergent ‘causes’. Attention should be given to guide the Whys approach into a more convergent direction.

It should be noted a GCMS technician was not present at the meeting to provide more information on the subject, which meant that a large part of the discussion was speculative. Thus, future evaluations would benefit from conducting RCA with a larger and more diverse group.

6.2.3.5 Conclusions

The application of the CCPs generated from the HACCP to the RCA met with some difficulties. Our main finding was that the CCPs did not fit all aspects of the response to the Moerdijk case as well as expected. Rather,

they seemed more concentrated around the fieldwork and activities in the first few hours of the response. Additionally, they seemed less applicable to the issues experienced by other team members such as the OZL and the coordinator. This resulted in including fourth category for CCPs: 'cooperation'. Like the 'cooperation' CCP in the Salmonella case (see Section 6.3), this could be further divided into cooperation with internal and external partners. The list of CCPs should therefore be reassessed and possibly adapted during the evaluation of other cases.

On the topic of factual reconstruction, a number of challenges emerged. The construction of the timeline was regarded as rather time-consuming, and some did not agree that it was a useful addition to the evaluation. In contrast, the ECFA+ chart was found to offer clear benefits, i.e. by means of this method we were able to locate certain gaps in the timeline. Furthermore, many respondents indicated that they were involved only in a small part of the response. The ECFA+ format offered a visual solution for this issue, as the events were structured depending on the actor involved in the events. Furthermore, ECFA+ protocol dictates a certain manner of describing events, i.e. they should be formulated in terms of actor – object – change. This proved to be a succinct and useful method of description, and as such was also implemented during construction of the simple timeline.

Two evaluations were previously made of the response to the Moerdijk case. An internal evaluation was conducted via an online questionnaire sent to all those involved in the response; 24 out of 26 respondents filled it in. From these answers, measures for improvement were drafted. Additionally, in this specific case an informal evaluative meeting was held with BOT-mi, RIVM and the Safety Regions. At this meeting, two points of interests for the RIVM emerged. First, the RIVM and MOD were appraised for taking the initiative in establishing a crisis centre and organizing an information session. Second, there was discussion whether the handheld XRF could not have been deployed sooner to demarcate the area affected by Cr-6.

The internal evaluation expanded on a larger number of issues, many of which correspond with the undesirable events identified during the current evaluation. From this we can conclude that, despite its challenges, the application of CCPs is an effective approach to identifying undesirable issues.

Finally, respondents indicated that they thought the main problem with MOD evaluations was that there is often little follow-up. Recommendations are formulated as individual tasks, which means that there is no collective feeling of responsibility. They indicate that RCA could be beneficial to the MOD, as it facilitates a collective search for solutions.

6.2.3.6 Recommendations

- Although the CCPs generated from the HACCP initially posed some challenges, the idea to construct a list and use them in further evaluations was met with enthusiasm. It is recommended that the list of CCP categories includes a fourth CCP category: 'cooperation'. Like the 'cooperation' CCP in the Salmonella case (see Section 6.3), this can be divided into cooperation with

internal and external partners. This list should be reassessed and possibly adapted during evaluation of a future case.
- The factual reconstruction received a mixed response from respondents regarding its value to the evaluation. However, especially the ECFA+ chart showed clear benefits in detecting informational gaps and creating an overview. Thus, it is recommended that factual reconstruction is not performed on the complete response, but rather on specific periods which require more insight. The preferred method for this would be ECFA+ due to the aforementioned aspects.
- As previously mentioned, the factual construction was very time-consuming. The largest contributing factor is that existing documentation and records were not suitable for the extraction of CCPs. Consequently, the majority of the time was spent filtering and organizing the information extracted from the documentation. Thus, it is recommended that the CCPs are to be used as items on the agenda during response meetings and as headings in incident logbooks. Thus it will be much easier to track their development over time later on.
- 5 Whys and 3CA were equally well received by the respondents. It was observed that the 5 Whys method is a more organic and divergent process of RCA. In contrast, 3CA seems to be a more convergent approach to RCA. As each method has its merits for MOD evaluations, it is recommended that specific components of the two methods be combined into one method.
- It was recognized that recommendations drafted following MOD evaluations receive little follow-up. RCA could be a solution to this, as it facilitates a collective search for solutions. Moreover, performing an RCA with a group can provide a platform for communication and mutual understanding between partners. Thus, RCA can also add value to organizational learning within the RIVM.

6.3 Case study 2 – food contaminated with Salmonella thompson

6.3.1 Case description

During the late summer of 2012, the Netherlands was confronted by an epidemic of salmonellosis, an infectious enteric disease usually caused by the consumption of food contaminated by Salmonella bacteria. Thousands of people suffered from diarrhoea, abdominal cramps and fever. For a small number of elderly patients, the disease appeared to contribute to their demise. However, most people recovered completely after a short period. The culprit was discovered to be a strain of Salmonella not frequently identified in the Netherlands, i.e. Salmonella thompson. The source of the epidemic was found to be smoked salmon produced by the Dutch fish company Foppen Paling & Zalm, which has a large share of the Dutch smoked salmon market. This, and the popularity of smoked salmon and smoked salmon products, explains the rapid and massive spread of cases throughout the country. At the end of the outbreak, the RIVM had registered 1,149 cases. For many people, the symptoms of salmonellosis are not a reason to visit the doctor. These cases are therefore not reported and/or registered, and of those visiting a general practitioner only a minority are tested for Salmonella. Thus, on the basis of similar epidemics in the past, the RIVM estimates that the actual number of

cases was around 23,000. The actual number of deaths is also presumed to be larger than the four cases reported.

6.3.2 Methods

As previously described, this case study evaluation consisted of four steps. First, a meeting was held with experts to identify the CCPs in a typical response to food-related infectious disease outbreaks. The outcome of these meetings was a list of CCPs. Second, a factual reconstruction was conducted of the RIVM-specific response activities. Third, the previously drafted list of CCPs was applied to the factual reconstruction, in order to identify a list of 'undesirable' or 'unusual events' during the outbreak response. Interviews were held with the respondents in the Salmonella case to identify these events, based on an interview guide (Annex X, in Dutch). Additionally, the previously drafted CCPs were revisited and reassessed to see if they could be successfully applied to the Salmonella case or whether revisions were needed. Finally, the two selected RCA methods were used to identify the root causes of these undesirable events. The results of this evaluation were then compared with the previously conducted or 'primary' evaluation.

6.3.3 Results

6.3.3.1 Step 1: HACCP for infectious outbreak response

The organizational structure of the response to food-related incidents is shown in Annex IX (in Dutch). Using HACCP we selected CCPs for re-evaluation. CCPs are defined as steps in the process whose successful outcome is necessary for the successful outcome of the response. In other words, should these steps go wrong it is likely that the response will be negatively affected. A reasonable number of CCPs emerged from the meetings, which we divided into four main categories:

- *Cooperation* (i.e. two-way communication) with central partners involved in the emergency response;
- *Provision of information* (i.e. one-way communication) to the media, the public, and peripheral partners in the emergency response;
- *Case control study*, including for example, rapid and adequate typology, contamination source identification, analysis of questionnaire results.
- *Capacity* of the response team, e.g. sufficient human or technical resources, or the potential for rapidly scaling up the response.

Consensus on the CCPs was easily reached, and it was possible to obtain a priority list of CCPs within a short time. This priority list of CCPs was later used during step 3, when it was applied to the case in order to identify critical events.

6.3.3.2 Step 2: Factual reconstruction

Factual reconstruction was performed to reveal the chain of events and to offer respondents a tool for recollecting critical events. The starting point for both reconstructions was determined to be the moment the Centre for Infectious Diseases, Epidemiology and Surveillance (Centrum Infectieziekteonderzoek, Diagnostiek en Screening, IDS) reported the rise of salmonellosis cases. The end point for both timelines was determined to be the official end of the outbreak as proclaimed by the VWA. The

sources used to compile the reconstructions were documents such as weekly proceedings and public and internal reports.

First, a simple timeline was constructed (Annex XI). Decision-making on the inclusion of events was principally guided by the CCPs established during step 1. Although decision-making on the visualization was sometimes difficult, the final construction of the timeline proved to be a straightforward process. Additional information to reflect the course of the outbreak itself, such as a graph of the reported incidences, was added at a later stage.

Second, an ECFA+ chart was constructed (Annex XII). The primary purpose of this method is to reveal causal relations between events. However, this proved to be very difficult if not impossible for the salmonellosis outbreak. Moreover, the method compels the evaluator to concentrate on the details of events. This makes it less suited to a response process that takes place over a long period, e.g. a couple of months, as it is unfeasible to determine exactly what happened when and in what order.

Both factual reconstructions proved to be labour-intensive and time-consuming, and took approximately a month to complete both. However, the majority of time was spent filtering and organizing the information extracted from the documentation. Moreover, the documentation had to be frequently revisited, to ensure that all information was available and complete. This suggests that time and effort could be significantly reduced if extra attention is paid to logging and recordkeeping so that timeline reconstruction can be facilitated.

During the interviews in step 3, respondents unanimously regarded factual reconstruction as a useful tool, for a number of reasons. Many indicated that it helped them to gain an overview of the structure sequence of the events.

‘Dat kan helpen om scherp te krijgen wat er wanneer is gebeurd, want je geheugen laat je toch wel in de steek’.
(‘It can help to clarify what happened and when, because your memory fails you sometimes.’)

‘Het is wel een praktische manier als je ergens over wilt praten, om overzichtelijk te maken hoe dingen tegelijkertijd zijn gebeurd’
(‘It’s a practical way to discuss something, to make clear how certain things happened simultaneously.’)

During the outbreak, not all information is available when it is needed or in chronological order. Therefore, a factual reconstruction can benefit the evaluation process.

‘De informatie komt niet zo mooi binnen als dat dat nu met terugwerkende kracht op papier komt.’
(‘We don’t receive the complete information during the outbreak as it is now written on paper afterwards.’)

‘Vaak gebeuren er heel veel dingen tegelijk, en is het een vrij chaotische periode.’
(‘Often a lot of things happen all at once, and it is a very chaotic time.’)

However, respondents also indicated that they were involved in only a small part of the response, and thus they were not able to evaluate the process of the response in its entirety. Consequently, some felt that it made the timeline difficult to read, as it contained information that they did not regard as relevant to them.

‘Soms is er een uitbraak aan de gang en dan ben je natuurlijk heel erg met je vak bezig, dus daar concentreer je je dan op. Maar om het goed in de tijd vast te leggen wordt wel eens vergeten, en dan moet je dat achteraf doen. Dat is lastig.’
(‘Sometimes during an outbreak you’re preoccupied with your own activities and responsibilities, so you focus on that. To properly keep an activity log is something you often forget. So you have to do it afterwards. That’s difficult.’)

‘We werden natuurlijk het meest geconfronteerd toen de OVV6 zich ermee ging bemoeien. Dan is het natuurlijk wel heel handig als je een tijdlijn hebt.’
(‘Of course, we were most challenged when the OVV6 got involved. That’s when a timeline of events is a very useful thing to have.’)

The ECFA+ format offered a visual solution for this issue, as the events were structured depending on the actor involved in the events. Thus, we created a timeline where each of the main players[7] in the response chain could be identified; the ECFA+ approach allowed us to visualize the interaction between the different players.

Further suggestions were offered by the respondents to facilitate the visualization of the course of the outbreak response. For example, the addition of the number of news and social media messages could reflect the urgency and sensitivity of the outbreak in the timeline. Furthermore, we were informed that there have been recent ICT developments in patient data that could provide an opportunity in the future to improve visualization of an outbreak.

6.3.3.3 Step 3: Identifying undesirable events

As explained, the previously established CCPs were used to identify the undesirable events that were specific to the S. thompson outbreak response. Many respondents indicated that it was difficult for them to remember specific events, due to the time that had passed between the incident and the current evaluation. Nonetheless, the respondents mentioned several issues.

On the subject of *cooperation*, some felt that there is a degree of separation between the departments of CIb. Some departments have

[6] OVV = Onderzoeksraad voor de Veiligheid (Dutch Safety Board).
[7] CIb; LCI; EPI (Centre for Infectious Diseases Epidemiology and Surveillance); LIS/IDS (laboratorium voor infectieziekten diagnostiek en screening); NVWA; GGDs and laboratories; external partners (e.g. Foppen).

overlapping mandates, and the coordination of tasks is experienced as insufficient.

‘Er is intern binnen het RIVM niet altijd overeenstemming wie welke taken heeft. Het laboratorium heeft dat wel helder, maar het coördineren van de bestrijding is een taak van de LCI. En het aanleveren en analyseren van de data is de taak van EPI. Die taken lopen een beetje door elkaar heen.’
(‘Internally at the RIVM there isn’t always consensus about the allocation of tasks. It is clear for the laboratory, but the coordination of outbreak control is a task of the LCI. And producing and analysing data is assigned to the EPI. Those roles are sometimes mixed up.’)

‘Maar de lijn van samenwerking was niet altijd dat je één CIb was, meer dat je allemaal afdelingen hebt die hun dingetje doen. Maar dat heeft niet tot problemen of iets dergelijks geleid, maar als je dat meer gezamenlijk doet dan werkt het gewoon makkelijker.’
(‘But our way of cooperation was not that we were always ‘one’ CIb. It was more as if we had different departments who all had their own tasks. It didn’t lead to any major problems, but it would have made things easier if we’d acted collectively.’)

Additionally, a few respondents indicated that they wished for more diversity of expertise during the meetings, as in their view it would improve the efficiency of the outbreak response.

‘Ik ben van mening dat hoe meer mensen vanuit verschillende hoeken je laat kijken naar iets, hoe meer je er aan hebt. […] Ik had dat ook graag in de praktijk gezien […] Maar blijkbaar is het toch formeel zo dat dat niet altijd kan.’
(‘I think that the more disciplines are involved, the more valuable it is. […] I would have liked to see that in practice […] But apparently things are too formally arranged for that.’)

Cooperation with the GGD was sometimes experienced as ‘uneasy’, especially during the case-control study. There was the impression that the GGD has less ‘sense of urgency’[8], and consequently takes more time to scale up its activities.

‘Met name in het begin zit je natuurlijk te wachten op feedback van uit de GGD, om toch de nodige data voor je patient-controle onderzoek te krijgen. En laat ik zeggen dat de “feeling of urgency” bij de GGD’en wat anders lag dan bij ons. Wij hadden gewoon erg veel haast omdat de cases erg snel opliepen, terwijl dat voor de GGD’en, ja die zien dat natuurlijk niet op dat hogere aggregatie niveau zoals wij dat zien.’
(‘Especially in the beginning we have to wait for feedback from the GGD, to obtain the necessary data for our case-control study. And I have to say that the ‘feeling of urgency’ was a bit different with the GGD. We were in a rush because of the increase in cases, while the GGD doesn’t have the aggregated data that we do and thus do not see the many cases as we do.’)

[8] One interviewee stated the opposite: that in general the RIVM does not always feel a sense of urgency.

Additionally, there were several undesirable issues regarding cooperation with the NVWA. Although there were no issues on the individual level, there were some difficulties with the organization. For example, the NVWA showed reluctance to deliver samples for quantitative analysis.

‘Dat vragen we iedere keer als er een outbreak is, geef ons nou monsters. […] Nou daar hebben ze geen medewerking aan verleend. En dat vond ik wel jammer. Want dat is iedere keer komt dat aan de orde.’
(‘We ask every time there is an outbreak, please give us the samples. […] But they didn’t cooperate. I thought that was a shame, because this is an issue every time.’)

‘Op individueel niveau verliep dat wel goed. We hebben een paar keer bijeenkomsten gehad die wisten allemaal heel goed waar ze het over hadden. Mijn indruk was dat de samenwerking binnen het bedrijf […] niet ideaal verliep. Die rollen waren niet helder, en ik vond ze daar ook niet altijd even duidelijk in.’
(Things went well at the individual level. We had a few meetings, and they all knew very well what they were talking about. My impression was that the coordination within the organization was not ideal. Those roles weren’t clear, and they weren’t clear in communicating those roles either.’)

There was some discussion whether there could have been more cooperation with Foppen, and what form this should have taken. Opinions were divided on this issue.

‘Nou wat mij betreft was er geen samenwerking met Foppen, want dat zou verkeerd zijn.’
(‘As far as I’m concerned there was no cooperation with Foppen at all, because that would have been wrong.’)

‘Ik denk dat je wel contact moet hebben, maar je moet aangeven […] waarom je wel of niet openheid geeft.’
(‘I think there should be some contact with Foppen, but we have to make clear […] why we should or shouldn’t provide certain information.’)

With regard to *information provision*, there were a number of hiccups in relation to communication with the media. On two occasions, press releases from the RIVM caused some consternation among external parties. First, starting October, the media reported a statement by the RIVM about the existence of another Salmonella outbreak in the USA and possible correlation with the Dutch outbreak. This message caused consternation in the Center for Disease Control (CDC) as well as Foppen.

‘Het persbericht dat is uitgegaan vanuit hier zei niks over dat het “zeker weten gelinkt” was, maar zo is het wel door de kranten uitgelegd. […] Wij hebben ook aangegeven “zo stond het niet in ons persbericht”. Alleen ja, we hadden kunnen bedenken dat de pers dat ging doen, daar hebben we niet aan gedacht.’
(‘The press release from here did not state that it was ‘linked for sure’, but the newspapers interpreted it this way. […] We said ‘it was not stated this way in the press release’. However, we could have imagined

that the press would interpret it this way; we did not think carefully enough about this.')

Second, in mid-October the RIVM released a message concerning the rising number of cases, while the NVWA and Foppen released a message around the same time regarding the success of the recall of the contaminated Salmon. This led to uncertainty and confusion among consumers. The rising number of cases was due to the fact that people stored the Salmon in freezers and later ate them and that the salmon was still part of other parts of the supply chain.

'Wij communiceerden een toename van het aantal gevallen, terwijl dat haaks stond op de NVWA dat alle producten gerecalled waren, dus dat er eigenlijk geen besmette producten meer op de markt konden komen. Wij meldden een toename, en die berichten zijn allebei correct. Alleen het geeft het idee, de ene haalt iets van de markt en de ander zegt "er is een toename". Dus dan denkt de gemiddelde burger, er is een toename dus er is nog steeds iets niet loos.'
('We communicated an increase in the numbers, whereas this was opposite to the NVWA's recall of products, so no more contaminated products could come onto the market. We reported an increase, and both messages were correct. However, it gives the idea, one recalls it from the market and the other states 'there is an increase'. So, Joe Public thinks there is an increase so there is still something wrong.')

However, respondents felt the need to put the problems with the press in perspective. Many agreed that there was a definite learning curve in the coordination of press releases. After the initial hiccups, there was clear communication with partners such as the NVWA.

'Waar het een klein beetje lastig ging was de afstemming van de persberichten die moest worden uitgedaan. Maar uiteindelijk is dat ook allemaal redelijk goed verlopen.'
('There were a few bumps in the road when it came to coordination of the press release. However in the end this went pretty well.')

On the topic of the *case-control study*, the epidemiological department experienced several delays in obtaining its data. A major contributing factor was the poor cooperation with the GGD, which caused delays in receiving the patient questionnaires from the GGD.

'Als de GGD'en wat sneller waren geweest had het [vinden van de bron, red.] misschien een weekje eerder gekund.'
('If the GGD had been a little quicker, then we could have [found the source] maybe a week sooner than we did.')

In contrast, respondents were very positive about the absolute discretion showed by all patients until the RIVM publicly announced the existence of the outbreak. This was especially advantageous for the course of the response, as it significantly reduced the chances of bias in the case-control study.

‘Je hebt toch 100 mensen geïnterviewd. Er hoeft er maar één naar Hart van Nederland te stappen, en dan is het in het nieuws. […] Maar dat is dus gelukkig niet gebeurd.’
(‘We interviewed around 100 people. Only one would have had to talk to the media and it would have been on the news. […] But luckily that didn’t happen.’)

Concerning the capacity of the response team, two issues were mentioned. First, a small number of CIb employees experienced their workload in the initial weeks as disproportionally high and stressful.

‘Dat was een heel pittig leermoment voor mij, want ik kwam om in het werk. […] Ja, je komt ook zo om in het werk dat je ook niet logisch nadenkt.’
(‘That was a hard learning experience for me, because I was buried in work. Yes, there was so much that I didn’t think clearly either.’)

Second, some respondents mentioned that the recordkeeping during the response was not sufficiently detailed or complete to be useful during the evaluation process.

During the interviews, it was observed that there is much overlap between the different selected CCP categories. This is expected, as the outbreak response is an integral, iterative process. However, the advantage of treating these categories as separate issues is that sufficient attention is paid to each of these components. For example, cooperation is interwoven through the entire outbreak response, which makes it beneficial to place extra emphasis on cooperation – especially because it is a ‘soft’ factor, which makes it difficult to pinpoint those specific cases where (lack of) cooperation was the problem.

Overall, respondents were positive about the CCPs, as these guided them towards selecting critical and relevant events for evaluation.

A few additions and changes were suggested by the respondents. For example, as not all outbreak responses include case-control studies, it was suggested that the CCP category ‘case-control study’ could be changed to the more encompassing term ‘source tracking’. This would make the list of CCP categories more applicable to other types of infectious disease outbreaks. Furthermore, it was suggested that media and media pressure could be a separate CCP, as the RIVM is a responsive organization, and aligns many of its activities to the pressure exerted by the media in particular situations. However, media (pressure) cannot be a CCP according to the definition that it should be within the span of control of the organization. It can be used a separate item to be aware of in response situations.

6.3.3.4 Step 3: Root cause analysis

To identify the root causes of the previously identified undesirable events, a group meeting was held with the same interview respondents. Members of four RIVM-CIb departments were present at this meeting. The meeting spanned two hours. The first half of the meeting was intended to cover the succinct 5 Whys method, and the more elaborate

3CA method was scheduled for the second half. Three problem statements were selected for root cause analysis:

1. 'During the case-control study, there was a delay in receiving the patient questionnaires from the GGD.'
2. 'At the start of the response, a few team members experienced a disproportional workload compromising their efficiency and effectiveness.'
3. 'The manner of recordkeeping during the response did not give sufficient guidance to the evaluation team.'

During the first half of the meeting, the 5 Whys methodology was applied to problem statements 1 and 2. The first set of Why questions was therefore framed as follows: '*Why was there a delay in receiving the questionnaires from the GGD?*' The group postulated multiple reasons, such as the length of the questionnaires, the lack of priority given to them by the GGD, and the difficulty of reaching patients. To formulate the 5 Whys tree, the group chose to follow the branch of 'difficulty with reaching patients'. This led to the second Why question: '*Why is it that patients often cannot be reached?*' Again, a number of underlying causes were postulated, such as that patients have often already recovered and have gone back to work. In addition, the GGD usually calls patients during office hours, when a large number of patients do not answer their phone, are busy or are reluctant to talk. During the dialogue about the third Why question, the group remarked that many underlying causes are interlinked. An underlying cause may appear on the second level of the Why tree for one issue, and on the third level for another issue. For example, while determining underlying causes for the third Why, the group returned to a cause that was mentioned at the second level. This led to discussion about how to continue from this point. The group decided to stop the discussion and move on to the second statement.

Table 4: Summary of the first 5 Whys exercise for Case study 2

Problem statement 1: During the case-control study, there was a delay in receiving the patient questionnaires from the GGD.	
Why 1	Why was there a delay in receiving the questionnaires from the GGD? • Long questionnaires • Time-consuming exercise for the GGD • Outbreak occurred during holiday period • GGD did not send questionnaire to patients on time; questionnaires not always a priority (for both GGD and patients) • Difficult to reach patients
Why 2	Why is it that patients often cannot be reached? • Patients have already recovered and gone back to work • Patients can be reached but don't prioritize the questionnaire • GGD calls during work hours when patients are busy or reluctant to talk
Why 3	Why have patients often already recovered by the time they are contacted? • GGD does not send questionnaire to patients on time; questionnaires are not a priority for GGD
Why 4	-
Why 5	-

The second set of Why questions, in response to the problem statement 'At the start of the response, a few team members experienced a disproportional workload', was framed as follows: '*Why do a few members experience a disproportional workload at the start of the response (which decreases the effectiveness of a response from the RUIVM)?*' As in the first exercise, the group brought forward multiple reasons. For example, this outbreak had a high impact on the communications department. The outbreak yielded a great deal of interest from the media, while the communications department has relatively few staff. Even four years later, they were still receiving questions about the case. Second, the general workload for the CIb departments is already high. That means that during the course of an outbreak, they are forced to reprioritize their tasks. Moreover, at the start of an outbreak there is always uncertainty about the level of emergency, which makes prioritization even more difficult. Furthermore, the salmonellosis outbreak occurred during the holiday period, which meant that the departments were understaffed.

This led to the second Why question: '*Why is it difficult for staff to reprioritize their workload?*' This question appeared to be difficult to answer, and few reasons were mentioned. Instead, a discussion emerged about the nature of the different processes at the start of the outbreak response. As the workload was especially high for the case-control study, the group changed the question to '*Why is it difficult to prioritize the workload for the case-control study?*' The answer of the group was unanimous: that the amount of work it takes to obtain patient data is disproportionally high as compared to data on other diseases. From this, the third Why question was formulated: '*Why does the case-control study take a disproportional amount of work?*' The group stated that many hours go into calling patients, GGDs and laboratories in an effort to obtain the data. From this, the fourth and final Why question was formulated: '*Why does it take a lot of effort to obtain patient data?*' This led the discussion to the topic of legislation, which prevents the RIVM from obtaining patient data directly. The group determined that this was a root cause, from which the recommendation follows that legislation should be adapted to allow the RIVM access to patient data. This would increase the rate at which patient data is gained so that the RIVM can give a proper response.

The group failed to finish the 5 Whys problem statements within the allocated time of the meeting, implying that the 5 Whys method requires more time than initially expected.

Table 5: Summary of the second 5 Whys exercise for Case study 2

Problem statement: At the start of the response, a few team members experienced a disproportional workload.	
Why 1	Why do a few members experience disproportional workload at the start of the response? • High impact on communications department due to a lot of interest and pressure from the media • Generally high workload for CIb departments, which are forced to reprioritize • Holiday period; departments were understaffed
Why 2	Why is it difficult for staff to reprioritize their workload? • Uncertainty about level of emergency at the start of the outbreak makes it difficult to prioritize work • Difficult to convince other employees that their projects have lower priority Why is it difficult to reprioritize the workload for the case-control study? • The case-control study takes a disproportional amount of work
Why 3	Why does the case-control study take a disproportional amount of work? • It takes a lot of effort to obtain patient data
Why 4	Why does it take a lot of effort to obtain patient data? • Legislation prevents the RIVM from obtaining patient data directly. The RIVM is not licensed to review patient data(root cause).

During the second half of the meeting, the 3CA method was applied to problem statement 1, i.e. ‘There was a delay in receiving the questionnaires from the GGD’ (Table 6). The five possible categories of protective barriers (organizational, managerial, administrative, cultural, legal) were used to formulate question 5 of the 3CA method. The result was a list of four potential barriers or work controls, as can be seen in Table 6. Interestingly, legislation emerges as a root cause from this exercise as well, even though the problem statement was different.

The group also failed to finish both 3CA exercises within the allocated time. We speculate that this is partly due to the learning curve, as it takes a while for people to get accustomed to applying the method.

Table 6: Summary of the 3CA exercise for Case study 2

1	Significant event	There was a delay in receiving the questionnaires from the GGD.
2	Change to person or thing	Delay in receiving questionnaires
3	Agent of change	GGD, EPI
4	Adverse effect of change	Delay in tracking the source of the outbreak, thereby delay in outbreak control
5	Work controls or protective barriers	• The RIVM conducts the patient interviews itself or supports the efforts of the GGD by supplying additional manpower • Communication with the GGD • Binding agreements with the GGD • Offer online access to questionnaires
6	In what way was each measure at (5) ineffective?	• The GGD has high internal workload • Often they only have knowledge of their own patient sample and fail to see the overall size of the outbreak • The RIVM has little manpower to conduct all patient interviews.
7	In what way did upstream processes fail to identify or prevent the problems noted in (6)?	• Salmonellosis is not obligated to be reported, which makes overall communication difficult • The RIVM has no mandate to enforce actions
8	Why did the failures in 7 occur?	• Current legislation is not suited to the (RIVM's) effective response to such crises.

The 3CA exercise proved to be more laborious than the 5 Whys method. Additionally, the group reasoned that the 3CA approach unintentionally led to blaming individuals, due to the nature of questions 1 to 4. Furthermore, we observed that the 5 Whys method is a more organic process of RCA, and respondents indicated that they preferred a more organic approach to tackling problems.

In general, the RCA meeting did not lead to new insights in the group as a whole. This may be due to the fact that this outbreak took place in 2012 and that the issues it raised have often been discussed and debated since. However, some respondents indicated that they had heard problems of which they were previously unaware. For example, one respondent stated that they were previously unaware of the disproportionate workload experienced by others. This is an added benefit of RCA, in that it provides a platform for communication and mutual understanding between partners.

6.3.3.5 Conclusions

Overall, respondents were positive about the application of HACCP. They indicated it gave them a tool for selecting CCPs, while preventing them from forgetting any important issues. Another advantage is that the priority list generated during this case study could be transferred to

future evaluations of future outbreaks. This also facilitates organizational learning, as consecutive evaluations can be easily compared, in order to see whether progress has been made in the meantime.

Nonetheless, there are also a number of challenges. Our main observation was that the outbreak response comprises many partners, which makes the evaluation of the category ‘cooperation’ rather complex. As well as being linked to several external partners, the RIVM-CIb itself consists of multiple departments, each responsible for different aspects of the response. However, although the external partners may be different for each crisis, the RIVM-CIb regularly collaborates with the GGDs and laboratories, or with the NVWA in the case of food-related outbreaks. This suggests that at the start of the evaluation, it may be helpful to draft an inventory of the parties that were involved in the response. This draft also offers a possibility to curtail or expand the evaluation, by determining which particular collaboration(s) one wishes to evaluate.

The simple timeline was very well received by the respondents. However, the ECFA+ chart has one obvious advantage over the simple timeline, which is the separation of activities between the different departments. Furthermore, ECFA+ protocol dictates a certain manner of describing the events, i.e. they should be formulated in terms of actor – object – change. This proved to be a succinct and useful method of description, and as such was also implemented during construction of the simple timeline. The possibility for combining different aspects of these methods should be further explored.

Although no internal evaluation was carried out by the RIVM, the OVV conducted an extensive evaluation of the response to the outbreak, which includes the activities and performance of RIVM. Although the OVV found no cause to question the duration of the case-control study, a few criticisms emerged from its investigation. One observation was that there is a long delay between a patient’s reported first day of illness and the date they receive a questionnaire from the GGD. Protocols require that the GGD approaches the healthcare providers by phone to ask for permission to view patient data. By that time, usually more than ten days will have passed since the infection. Consequently, many answers to the food questionnaires are dubious, since it is difficult for people to remember what they ate ten days or more ago and where they purchased it. Additionally, part of the patient population was hospitalized, which made it difficult or impossible for the GGD to conduct the questionnaires.

Another issue was the sense of urgency experienced by the RIVM and the GGDs. The OVV observed that this was low at the start of the outbreak, and only increased when the number of cases increased. Although the RIVM asks the GGDs to distribute the food questionnaires with a certain priority, each GGD allocates its own priorities based on local assessments. This means that the efforts of the GGDs differ per region. Additionally, in this case, the RIVM indicated to the OVV its reluctance to ask the GGDs to assign a higher priority, for fear of ‘crying wolf’.

Lastly, the OVV assessed that the governmental organizations and food companies did not coordinate their communication strategies; nor did their strategies focus on increasing public trust. During the outbreak, diverse and sometimes conflicting messages appeared in the media. The OVV concluded that this undermined consumer trust in food safety and in the proficiency of the parties involved.

Due to the extent of the OVV evaluation, the RIVM did not conduct an internal evaluation. Yet, comparison between our study and the OVV report shows that a number of new issues have emerged. The OVV report focussed on problems with external consequences, while our current evaluation shows that there are also internal issues with negative consequences for the outbreak response. This leads us to conclude that internal evaluations have added value.

However, the method of our current evaluation proved to be reasonably time-consuming, in particular step 3 of the case study. Our choice of using interviews was dictated by the fact that a few years had passed between the incident and this current evaluation. Individual interviews were therefore considered the easiest way to obtain information. During future evaluations, group meetings would be the preferred method as they take less time than individual interviews. Surprisingly, some respondents indicated that they preferred individual interviews, because these allowed more privacy and space to discuss sensitive issues. However, most respondents strongly preferred collective evaluations, preferably with all CIb departments.

‘Ik vind het altijd prettig om dit soort dingen in een team te doen, ik put nu echt uit mijn eigen herinneringen. Je vult elkaar gemakkelijker aan, en je brengt dingen gemakkelijker in perspectief als je dat met meerdere mensen doet.’
(‘I always prefer to do these things in a team, because right now I am really drawing from my own memories. It is easier to complement each other, and to put things into perspective, when you do it with more people.’)

While response teams are expected to deploy this new method in future evaluations, our study design gave some respondents the idea that an external expert should coordinate the evaluation, because (s)he would bring a ‘fresh or neutral outlook’ to the case.

‘Iemand binnen het CIb, die kan dat heel goed doen en daar is geen bezwaar tegen. Maar het liefst niet iemand die dan direct vanaf het begin af aan erbij betrokken is.’
(‘Someone inside the CIb would be perfectly capable; there are no objections to that. But preferably not someone who was involved from the start.’)

‘Want het is ook zo dat je iemand moet hebben die kritische vragen stelt. En als je het team zelf vraagt, dan wordt het natuurlijk mooier voorgesteld dan het is in werkelijkheid, dat is zo eenmaal.’
(‘[An external expert is preferred] because it’s better to have someone who asks critical questions. If you leave it up to the team itself, you will

get a rosier outlook than what really happened; that's just the way it is.')

Choices between individual interviews or group meetings, and between internal or external guidance, should be made in the context of each evaluation. While these decisions do not influence the choice of RCA method, they are important to consider.

During the RCA meeting, we observed that with both RCA methods there was a learning curve. Respondents seemed slightly hesitant in the beginning, although this hesitancy soon faded. The 5 Whys method is essentially a linear approach. However, during the group meeting we observed that the undesirable events inherent in this type of response require a more organic process of RCA and the 5 Whys method is able to facilitate this as well. Respondents also indicated that they preferred a more organic approach to tackling the problems. Our most valuable observation is that the use of the RCA method provided a platform for communication and mutual understanding between partners.

Although the 3CA exercise proved to be more laborious than the 5 Whys method, certain components of 3CA were regarded as very useful. In particular, the categorization of work controls (organizational, managerial, administrative, cultural, legal; see Table 1) was very useful for generating potential underlying causes.

6.3.3.6 Recommendations

- HACCP was unanimously regarded as a useful means of filtering and selecting CCPs. An additional benefit is that HACCP need not be performed for each individual evaluation. The priority list can be retained and applied to future evaluations. In turn, this facilitated comparison between evaluations and consequently organizational learning. It is, however, recommended that the list is critically appraised for each evaluation and adapted if necessary.
- Although the factual reconstruction was regarded as useful, it was very time-consuming. The largest contributing factor was that existing documentation and records were not suitable for the extraction of CCPs. Consequently, the majority of time was spent filtering and organizing the information extracted from the documentation. Thus, it is recommended that documentation and records drafted during outbreak be already adapted to reflect the CCPs to be evaluated.
- The simple timeline was very well received by the respondents. Moreover, it is a format that is used incidentally by the RIVM-CIb. However, the ECFA+ chart has one obvious advantage over the simple timeline, which is the separation of activities between the different departments. Furthermore, ECFA+ protocol dictates a certain manner of describing the events, i.e. they should be formulated in terms of actor – object – change. This proved to be a succinct and useful method of description, and as such was also implemented during construction of the simple timeline. The possibility of combining different aspects of these two methods should be further explored.

- Choices between individual interviews or group meetings, and between internal or external guidance, should be made in the context of each evaluation. This is dependent on the extent or sensitivity of the issues at hand. While these decisions do not influence the choice of RCA method, they are important to consider.
- During the RCA meeting, respondents indicated a clear preference for the 5 Whys evaluation method – primarily due to the fact that the 5 Whys method is a more organic process of RCA. Respondents also indicated they preferred a more organic approach to tackling problems. Thus, 5 Whys was their preferred method of RCA. It was nevertheless thought to be beneficial for the method to be supplemented by elements of 3CA, such as the work control categories.

6.4 Recommended evaluation method

Based on the findings of the two case studies and their recommendations, the following evaluation method is proposed for crisis responses.

1. Characterize the crisis response organization in general.
   a. Describe the response organization and the standard work procedures based on documentation. The description of the response organization should be done before the crisis occurs.
   b. Organize a meeting with experts with two objectives:
      i To verify the description of the response organization and the standard work procedures;
      ii To determine the critical control points (CCPs) for that crisis response organization.
2. Evaluate the response to a specific crisis.
   a. Reconstruct the facts in a simple timeline[9] based on documentation. Use the CCPs as guidance to make sure the relevant facts are recorded in the timeline.
   b. Interview the experts involved with the following objectives:
      i To verify the timeline[10];
      ii To determine how the timeline developed through the CCPs in the specific case;
      iii To determine whether other CCPs were critical in the case.
   c. Select a limited set of CCPs for evaluation.
   d. Organize a workshop for the experts involved with the objectives:
      i To establish the root causes of the undesirable events, using the 5 Whys method supplemented by the work control categories of 3CA where appropriate;
      ii To identify actions to eliminate or mitigate the root causes and improve the response on the CCPs.

[9] The use of ECFA+ was regarded as too time-consuming with too few additional benefits. It is therefore omitted from the proposed method.
[10] During the crisis response it is recommended to keep in mind that a timeline might be needed at some stage to facilitate communications and improve the overview of the status of the crisis. A standard reporting format from the start of the crisis will facilitate the drafting of a timeline.

iii To strengthen understanding of possible difficulties experienced by other parts of the response organization.

3. Improve the crisis response organization.
   a. Make an implementation plan for the actions identified and monitor the implementation (Plan, Do, Check, Act cycle).
   b. Consider improvements in the standard reporting format to facilitate future evaluations.

7 Case study 3 – Zika virus

In phase IV, the recommended evaluation method as described in Section 1.1 is applied to a new case, the Zika virus outbreak in 2015–2016 (see Figure 6).

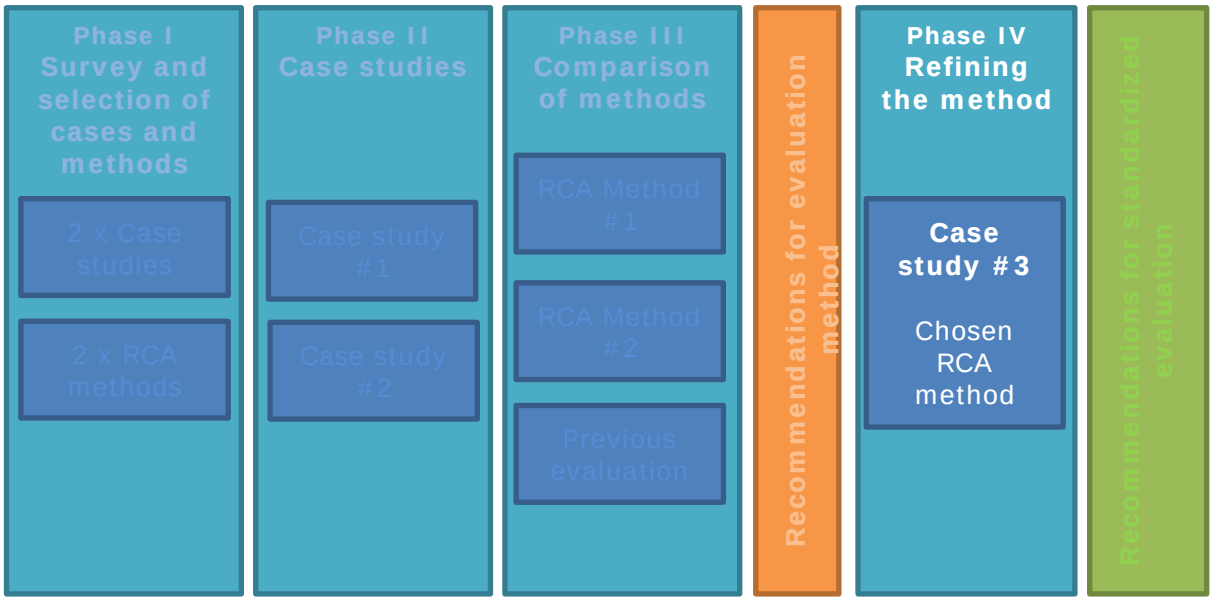


Figure 6: Schematic overview of the study design – phase IV

7.1 Case description

The Zika virus is an endemic virus in large parts of South-East Asia. It belongs to the family of flaviviruses. In 2015, the Zika virus also emerged in parts of South America, where the virus was new. Not surprisingly, Zika caused panic as the virus was suspected of being the causative agent of microcephaly in human embryos. Only in February 2016, when it became clear that the Zika virus was indeed the causative agent, did the WHO call Zika a Public Health Emergency of International Concern (PHEIC).

For two reasons, the Netherlands was also concerned about the Zika virus. Part of the Kingdom of the Netherlands is situated in the Caribbean close to South America and the 2016 Olympic and Paralympic Games, which many Dutch athletes were participating in and Dutch supporters attending, were being held in Brazil.

Zika is a vector-borne disease with a mosquito (*Aedes aegypti*) as vector. This mosquito is common in warmer regions like South America but not in Europe. This mosquito is also a vector for other (flavi-) viruses. At the beginning of the outbreak it was unclear whether or not the Zika virus could also be sexually transmitted.

7.1.1 Methods

Following the recommendations from the Moerdijk case and the Salmonella thompson case, the evaluation method consists of the following steps:

1. Characterize the response organization in general:
   - Collect standard protocols.
   - Identify critical control points (CCPs) for that organization.
2. Make a factual reconstruction of the Zika case:
   - Gather preliminary information, i.e. all relevant documentation:
     i. Written reports;
     ii. Logs of past events;
     iii. Relevant policies and procedures.
   - Collect and organize the facts surrounding the event to understand what happened:
     i. Optional: fill gaps via interviews with those involved.
   - Construct a factual timeline.
3. Review CCPs:
   - Discuss pre-selected CCPs with interviewees.
   - Prioritize undesirable events to be evaluated with RCA.
4. Identify root causes:
   - Use 5 Whys method, supplemented by elements of 3CA where useful.
5. Design and implement changes to eliminate the root causes:
   - Determine how to change processes and systems to reduce the likelihood of occurrence of the root causes.

Steps 1 and 2 were executed by the evaluator, based on written documents (see Annex XIV). At the same time, reported numbers of Zika-infected people in different parts of the Kingdom of the Netherlands were collected. This was followed by individual interviews with three members of the response team, in which the constructed timeline and identified CCPs were discussed and, as necessary, supplemented. Next, a set of CCPs was selected for collective evaluation. In a workshop with three members of the response team, the 5 Whys approach was used to determine the root causes.

7.2 Results

7.2.1 Step 1: Description of the response organization

The Zika outbreak was an international outbreak. Relevant signals from the International Health Security Council of the World Health Organization, from the ECDC (Round Table Reports) and from national institutions are discussed at the RIVM in weekly signalling meetings (Signaleringsoverleg, SO). Depending on the severity of the signal (expert opinion), a coordinating meeting (afstemmingsoverleg, AO) between experts of the Landelijke Coördinatie Infectieziektebestrijding (LCI) is organized. The next step in the response process is the organization of a response team (RT). It is the decision of the members of the AO to organize a formal RT. The process of upscaling (signal » AO » RT) follows a protocol, but criteria for upscaling are not standardized, as every outbreak is unique. The organization of an RT is protocoled, with a standard agenda for meetings (see Annex XV). This standard agenda can be seen as a list of general CCPs, as shown in Table 7.

Table 7: Critical control point categories for a response to an endemic virus (vector-borne disease) epidemic

1	Data collection and evaluation (epidemiologic and diagnostic information)
2	Risk analysis[11] (including communication to professionals and to the public)
3	Remedial actions
4	Monitoring and evaluation

The frequency with which the RT meets depends on the available epidemiological information. If specific expertise is required, external experts are invited.

For this emergency response evaluation the CCPs were not assessed in a workshop, but from documents only, due to time constraints. The crisis management for the Zika virus epidemic was organized in a similar way to the response to the Salmonella thompson outbreak. If we compare these CCPs with the CCPs of the S. thompson case, however, we see that the CCPs for the latter are more oriented towards process factors such as capacity, cooperation and communication.

It should be noted that during the evaluation process it became clear that it is important to make a distinction between critical points and critical control points. Critical points are also important in relation to a successful crisis response. However, not all critical points are within the control of the crisis response organization. For example, the control of mosquitos is critical for the response to the Zika virus. However, this is outside the control of the RIVM response organization and is therefore not considered to be a critical control point for this response function.

7.2.2 Step 2: Factual reconstruction

Factual reconstruction was performed to reveal the chain of events in the crisis and response and to offer respondents a tool for recollecting critical events. The starting point for the timeline was determined to be the moment when the WHO called Zika a PHEIC. There is no endpoint, as the outbreak had not ended at the time of writing this report. The reconstructed timeline is given in Annex XIII. The timeline was initially based on situation reports of the Ministry of Health and RT reports. During subsequent the interviews, the timeline was checked and, as necessary, supplemented, CCPs were identified and discussed and the roles of the RIVM and the RT were evaluated.

The first signals of the Zika epidemic in non-endemic South America emerged in the second half of 2015. These signals were discussed at the RIVM's next signalling meeting. Yet, at the LCI, there was controversy about the potential severity of a Zika infection, as the relation between Zika and a specific symptom, microencephaly in human embryos, remained unclear until February 2016. The controversy hampered the

[11] Risk analysis can have different meanings depending on the phase in the safety chain: in the first phases of prevention and pro-action (cold phase) it is used for identifying risks and analysing what preparedness is needed in case of an outbreak. In the response and repression phases, as it is used here, it focusses on the analysis of the expected severity of the outbreak and the interventions and actions that might be needed.

formation of a coordinating meeting (AO). In this period, people from the LCI were also busy with other public health issues, like Ebola and the health situation in asylum seeker centres in the Netherlands. As soon as the relation between Zika infection and microencephaly became clear and the WHO called Zika a PHEIC, however, the RT was formed, without any preceding formal AO.

With respect to the Netherlands, the Zika virus threatened inhabitants of the overseas Kingdom of the Netherlands (oKNL: Bonaire, St Eustasius, Saba, Aruba, Curacao and St Maarten). Women from the European Kingdom of the Netherlands (eKNL) who were pregnant or intending to become pregnant and were returning from epidemic regions were also at risk. Shortly afterwards it became clear that Zika was not only vector-borne, but also sexually transmissible. Thus, Zika was also identified as a risk for men returning from epidemic regions that wanted to have children on a short term.

Countries of the oKNL are fully responsible for dealing with local public health issues. Therefore, the role of the RIVM in oKNL was limited to giving advice on vector control and to offering diagnostic tools. Unfortunately, vector control is a long-term issue. There was no diagnostic tool for it and Zika was not seen as a big issue by people from oKNL, as vector-borne diseases are regarded as ‘part of life’. Additionally, serological detection techniques for Zika cross-react with other endemic flaviviruses like Dengue, hampering the identification of Zika-positive persons. This in turn hampers developing a serological test as bloodserum samples from Zika-positive persons are crucial for that.

In the eKNL, the focus was initially on women – either pregnant or intending to become pregnant – returning from epidemic regions. Here, too, a lack of tools (diagnostic, treatment) limited the role of the RT. Zika was not a notifiable disease and it was not clear how many infected women had returned from epidemic regions. The LCI developed a guideline for women travelling to epidemic regions. When there was evidence that the Zika virus was also sexually transmissible, the guideline was adjusted and generalized to women and men.

A timeline of facts is given in Annex XIII.

From February 2016 on, in the eKNL, the outbreak continued, with a gradually increasing number of infected people returning from epidemic regions. By the end of June, 65 Zika cases had been reported. Overseas, the number of infected people reached 266 at that time.

7.2.3 Step 3: Identifying critical control points

In the interviews with involved actors, they were first shown the timeline of events. This was based on situation reports and RT reports. Actors were asked to complete this timeline if necessary and they were asked to point to critical issues in the development of the outbreak. In general, actors mentioned that the Zika outbreak was beyond the control of the RT because the Zika virus is vector-borne and newly emerged in an overseas area.

Discussion on CCPs and undesirable events with actor 1:
The development of a guideline for eKNL travellers was discussed. According to this actor, the guideline was correct and in time and thus did not lead to a CPP identified.

Both in eKNL and in oKNL it was difficult to get a good picture of the epidemiological status and this affected the development of the outbreak, especially in oKNL. This is linked partly with the CCP of a timely organization of an RT.

Actor 1 noted that a reliable diagnostic tool was lacking. Furthermore, in eKNL the focus was on travellers, whereas most infected people were locals in oKNL. A difference in opinion between experts from oKNL and experts from eKNL about the severity of the situation in oKNL complicated the situation. This difference in opinion was partly caused by the facts that vector-borne diseases are accepted as part of life in oKNL and that prior to the Zika outbreak, oKNL had suffered a Chikungunya outbreak with a large impact on the local population. During the emergency response actor 1 was the only expert and he did not always feel comfortable with respect to advice to be given as he had no counterpart to discuss with.

Discussion on CCPs and undesirable events with actor 2:
It was difficult to get a good understanding of the development of the outbreak, because it was not possible to get a good picture of the epidemiologic situation.

Actor 2 mentioned the initial lack of a diagnostic tool and the fact that Zika is not a notifiable disease as underlying causes for not getting a good picture of the epidemiological situation. It was also mentioned that during the outbreak many people from the LCI were involved and that experts had to spend a lot of time introducing new fellow workers in the Zika case.

A guideline for pregnant women was critical to prevent additional cases, the CCP identified form this discussion was the guideline for (pregnant) travellers.

Discussion on CCPs and undesirable events with actor 3:
Actor 3 also mentioned as underlying causes the initial lack of a diagnostic tool and a poor surveillance system in combination with a laborious exchange of epidemiological data. Also poor vector control hampered the crisis control. On the other hand, the good relationship with expert colleagues overseas was a benefit. From the discussion also the CCP of an adequate guideline for (pregnant) travellers emerged.

Although all three RT members interviewed mentioned that the RT had little influence on the outbreak, they all also mentioned that the RT could have started earlier than February 2016.

CCPs selected for evaluation

From the factual reconstruction and from the interviews, three CCPs[12] were selected, for which undesirable events were chosen to evaluate with the 5 Whys method. The CCPs were:

1. *Organization*: timely organization of the RT;
2. *Communication*: adequate communication with pregnant women in oKNL;
3. *Diagnostics*: Adequate diagnostics of the epidemiological situation.

7.2.4 Step 4: Root cause analysis

CCP1: Timely organization of the RT

Usually, an RT results from an AO, for instance when external expertise is required to better respond to a public health emergency. Already in 2015, starting from July, experts from oKNL and eKNL were informing each other about Zika. In November 2015, the LCI discussed the need for a diagnostic tool with the department of IDS within the RIVM. Initially, experts differed in their opinions of the severity of Zika infections, as it was not clear that microencephaly in human embryos was caused by the Zika virus. Involved experts were also busy with other public health problems like Ebola and issues related to asylum seekers. Moreover, mosquito control is an ongoing matter requiring a long-term strategy that is outside the RIVM's control. In February 2016, the RT was organized without a formal, preceding AO, after the WHO had called the Zika outbreak a PHEIC. The RCA session focussed on the undesirable event of a late organization of the RT.

Table 8: 5 Whys analysis for late organization of the RT

Why 1	Why was the RT not organized at an earlier stage of the outbreak? • The first step in upscaling in case of a public health emergency, the organization of a formal AO, was not taken.
Why 2	Why was an AO not organized? • There was scientific uncertainty about the Zika virus. Within the RIVM, there was discussion about the severity of a Zika infection and thus about the urgency to organize an AO. • Experts were busy with other public health matters.
Why 3	Why was there uncertainty? • Zika infections were new for the Netherlands and information from countries where Zika was epidemic at that time was doubtful and of little use for the local situation.

[12] Other factors mentioned in the crisis response were the many changes of LCI personnel involved in the Zika RT, the fact that the position of the mosquito expert was soloitary (he had no counterpart to review possible advices), poor collaboration with colleagues in oKNL and limited capacity of the health organization in oKNL.

CCP2: Adequate communication with pregnant women in oKNL
The RCA session focussed on the undesirable event of a limited potential to advise pregnant women in oKNL:

Table 9: 5 Whys for limited potential to advise pregnant women in oKNL

Why 1	Why were the possibilities to advise pregnant women limited? • There was no algorithm for monitoring pregnant women. • Initially, Zika was thought to be transmitted only via a vector, i.e. mosquitos, which are a fact of life in oKNL. The local population therefore did not have a great sense of the importance of the outbreak. • Little attention was paid to Zika, as only a few people were infected and the oKNL was recovering from a large Chikungunya outbreak. • When it became clear that Zika was also sexually transmissible, interventions useful in eKNL (use of condoms) to minimize the risk of infection were of little help in oKNL, as the virus is also transmissible via endemic mosquitos. • In the oKNL only a limited number of people are active in public health care.
Why 2	Why was it initially not known that Zika was also sexually transmissible? • Zika was new in the eKNL. Consequently, little was known about the route of transmission.
Why 3	Why was little known about the route of transmission of Zika? • Vector-borne diseases are a fact of life in oKNL and shortly before the Zika outbreak, the oKNL had suffered a large Chikunguya outbreak.

CCP3: Adequate diagnostics of the epidemiological situation
This point was discussed only briefly during the 5 Whys exercise, as the undesirable event of a lack of a good picture of the epidemiological situation. The main cause identified was the lack of a diagnostic tool for pregnant women. In the early stages of the Zika outbreak, pregnant women were diagnosed with an echoscopic technique. After the WHO called Zika a PHEIC, effort was put into the development of a better, serological technique. A PCR technique (a molecular technique able to detect specific genetic material from dead or living organisms) is of limited value, as it detects only acute infections.

Table 10: 5 Whys for lack of a good picture of the epidemiological situation

Why 1	Why was a serological test not available at the start of the outbreak? • Although Zika was not new, it was not considered relevant to the Netherlands.
Why 2	Why did it take so long to develop a new serological diagnostic technique? • It was difficult to obtain positive control samples to validate any new technique.

7.3 Discussion

The evaluation of the Zika case revealed many critical points that hampered a good crisis response. However, a number of them were outside the control of the RIVM, and were therefore not considered as CCPs for improvement of the response function of the RIVM. Within the possibilities of control of the RT, only its (late) organization was a Ctrue CP. This was caused by the absence of a formal AO, preceding the organization of an RT.

7.4 Conclusions and recommendations

The evaluation of the Zika case revealed that there is a need for clear communication on the distinction between critical points and critical control points. Critical points are essential to a good crisis response, but are outside the control of the response organization, whereas critical control points (CCPs) are within its control. An evaluation may address both CCPs and critical points, or only CCPs. Since participants may have different expectations of the outcome of an evaluation, it is important to set the scope of the evaluation at the beginning: do we evaluate only CCPs, or do we evaluate critical points as well?

8 Conclusions and recommendations

Evaluation method

We recommend using the following evaluation method:

1. *Characterize the crisis response organization in general*
    a. Describe the response organization and the standard work procedures based on documentation that describes the response organization and its procedures. The description of the response organization is done before the crisis occurs.
    b. Organize a meeting with experts with two objectives:
        i To verify the description of the response organization and the standard work procedures;
        ii To determine the critical control points (CCPs). Distinguish between CCPs, which are within the control of the response organization, and critical points, which are outside its span of control. Make clear which actions or interventions are to be evaluated before starting the evaluation process.
2. *Evaluate the response to a specific crisis*
    a. Reconstruct the facts in a simple timeline based on documentation. Use the CCPs as guidance to make sure the relevant facts are recorded in the timeline.
    b. Interview the experts involved with the following objectives:
        i To verify the timeline;
        ii To determine how the CCPs developed in the specific case;
        iii To determine whether other CCPs were critical in the case.
    c. Select a limited set of CCPs for evaluation.
    d. Organize a workshop for the experts involved with the objectives:
        i To establish the root causes of the undesirable events, using the 5 Whys method supplemented by the work control categories of 3CA where appropriate;
        ii To identify actions to remedy the root causes and improve the response to the CCPs;
        iii To strengthen understanding of possible difficulties of other parts of the response organization.
3. *Improve the crisis response organization*
    a. Make an implementation plan for the actions identified and monitor the implementation (Plan, Do, Check, Act cycle).
    b. Consider improvements in the standard reporting format to facilitate the evaluations.

Critical control points (CCPs)

Identifying the CCPs is a valuable step in the improvement of the evaluation process. First, the CCPs express which are the most important aspects within a response organization to be controlled and used in evaluations. Second, the CCPs can be used to guide minutes of meetings: they can be used as the headings in a meeting agenda and later on facilitate the construction of a timeline. CCPs to be included in

all response situations are related to action lists, bottlenecks, communication and evaluation.

We therefore recommend that response organizations determine the CCPs early on and re-evaluate them regularly, to help them guide the evaluation process.

Timeline

Constructing a timeline was found to be essential in all cases. It gives an overview of the progress of the crisis and response in time and the distribution of actions that took place and can show quantitative information simultaneously (such as the number of afflicted persons in the S. thompson case). The ECFA+ timeline has the added benefit of identifying the different actors, which makes the case more recognizable for these actors. A drawback of the ECFA+ method is that it is very time-consuming to construct a timeline a long time after an event. Thus, we recommend drafting a timeline right away, or making sure that the CCPs are to be used as items on the agenda during response meetings and as headings in incident logbooks. Thus it will be much easier to track their development over time later on When a proper timeline is made.

In general the response evaluation should be done as soon as possible, preferably starting during the crisis.

RCA tools

A root cause is the underlying cause of symptoms or findings that will recur in new evaluations if the root cause is not identified and eliminated. We demonstrated in a number of example cases that RCA tools can be used to improve the evaluation process of response organizations at the RIVM, by finding root causes that were not explicitly identified in earlier evaluations.

The S. thompson case is a good example. If there is another incident involving salmonellosis, it will likely again cost a lot of time to gather data on patients, because of the root cause – that the RIVM has no legal mandate to do so – remains unresolved. Salmonellosis is notifiable, but only in the event of an outbreak (two or more related cases). If the response organization is to improve the speed with which it identifies an outbreak of salmonellosis, it must first deal with this underlying problem.

The Moerdijk case is another example. Previous evaluations led to recommendations for several technical improvements in the response to such incidents, but the RCA method revealed the underlying cause of the response organization's failure to learn from its actions, namely the lack of a feeling of ownership of information sharing. Here again, the organization should tackle this first if it wants to improve its response function.

There is an added beneficial effect when using the RCA method in a meeting with all parties involved. Discussing the causes and hearing the arguments from other team members gives more insight into the problems that other parts of the organization experience. Thus, it encourages collective ownership of the emergency response system.

Though this effect is not solely attributable to the use of an RCA method, we recommend always convening a group meeting at the end of any evaluation cycle so that this effect can be felt.

As described in the preceding chapters, the exact evaluation method that should be used by the various response organizations at the RIVM may vary according to the incident at hand and the teams deployed to respond to it. In a session with LCI both RCA methods were tried. That session converged quite naturally on the root cause for the undesirable event by just using the 5 Whys method and avoided putting the blame on persons instead of on organizational elements. The session with the MOD, however, benefitted from the use of 3CA methods and we recommend using elements from 3CA to strengthen the 5 Whys method into a converging root cause, where needed.

9 References

Aneziris O, de Baedts E, Baksteen J et al, The quantification of occupational risk, The development of a risk assessment model and software, RIVM Report (620801001)Bilthoven, The Netherlands, 2008

ESReDA, Barriers to learning from incidents and accidents, ESReDA guidelines, www.esreda.org, 2015

Jackson BA, Faith KS, Willis HH, Evaluating the Reliability of Emergency Response Systems for Large-Scale Incident Operations, Santa Monica, CA: RAND Corporation, 2010

Jayswal A, Li X, Zanwara A, Loua H et al, A sustainability root cause analysis methodology and its application, Computers and Chemical Engineering 35 (2011) 2786–98

Koornneef F, Hale AR, Organizational learning and theories of action, In: Andriessen JH, Fahlbruch B, editors, How to manage experience sharing – from organizational surprises to organizational knowledge, Amsterdam: Elsevier Science, 2004

Krumkamp R, Ahmad A, Kassen A, Hjarnoe L, Syed AM, Aro AR, et al, Evaluation of national pandemic management policies – A hazard analysis of critical control points approach, Health policy, 92 (2009) 21–26

Nicolini D, Waring J & Mengis J, Policy and practice in the use of root cause analysis to investigate clinical adverse events: Mind the gap, Social Science & Medicine 73 (2011) 217-225

Noordwijk Risk Initiative Foundation, ECFA+ Manual, 2007

Pranger J, Selection of Incident Investigation Methods, Loss Prevention Bulletin 209 (2009) 1-12

RIVM, National guidance for infectious disease threats and crises, 2012

Rooney JJ, Vanden Heuvel LN, Root cause analysis for beginners, Quality Progress 37 (2004) 45–53

Stoto M, Measuring and assessing public health emergency preparedness, J Public Health Management Practice, 19 (2013) 16–21

Van Alphen WJT, Gort J, Stavast KIJ, Zwaard AW, Leren van Ongevallen, Een overzicht van Analysemethodieken (in Dutch),The Hague: SDU Uitgevers, 2009

Van Ouwerkerk IMS, Isken LD, Haij Vandi M, Timen A, Een kader voor het evalueren van infectieziekteuitbraken (in Dutch), Infectieziekten Bulletin 20 (2009) 95–98

Wu AW, Lipshutz AKM, Pronovost PJ, Effectiveness and efficiency of root cause analysis in medicine, JAMA, 299 (2008) 685–87

Yabba A, Comparative case study on outbreak management: VU University, 2012

Zhu W, Building a safety management system for infectious disease outbreak control in the Netherlands – an exploratory study, Delft University of Technology, 2012

Annex I Selection of emergency response cases

To determine possible cases for re-evaluation, a survey of past incidents and past large-scale exercises was carried out. Data were collected through interviews with the coordinators of the crisis response organizations of the RIVM, the communications department of the RIVM, and a search in Icaweb[13] in all available cases. This resulted in a list of 36 cases (Table 11).

The following criteria were used for the selection of two emergency response cases:

Knock-out criteria (KO)

- The cases do not relate to an appointed response function of the RIVM (**R**).
- The cases are not recent enough to evaluate the current response functions and to have access to documents; therefore, the cases should not be more than 5 years old (**Y**).
- Previous evaluations were not conducted and available for review (**E**).

Preference criteria

- The two cases must relate to different appointed response functions; Chemicals, Nuclear, Vaccines, Bacteria in Food, Infectious disease (**RF**).
- The cases must involve cooperation with multiple partners such as local authorities, local relief workers and partner institutes in order to identify weaknesses in the cooperation (**Cp**).
- A real case (**R**) is preferred over an exercise (**E**).
- A recent case is preferred over an older case (**Y**).

Table 11: List of incidents and exercises

#	Incident	Year	KO	RF	Cp	E/R	Y
1	Twente: *Salmonella Typhimurium* ft 560 outbreak	2006	Y				
2	Hoogeveen: dead crocodile causes sickness in pet shop	2007	Y				
3	Q-fever	2007/2008					
4	Uganda: Marburg virus infection via a bat	2008	Y				
5	Botulism	2008	Y				
6	Widespread concern over HPV vaccination	2009	Y				
7	Swine flu outbreak	2009	Y				
8	New influenza A (H1N1) outbreak	2009	Y				
9	*Salmonella Typhimurium* outbreak	2010	Y				
10	Hepatitis A outbreak	2010	Y				

[13] Icaweb is the information system of the Crisis Expert Team for Environment and Drinking Water.

#	Incident	Year	KO	RF	Cp	E/R	Y
11	Fukushima, Japan: nuclear power plant accident	2011	E				
12	Moerdijk: Chemie-pack explosion and fire	2011		C	●●●	R	*
13	Lith: fire	2011		C	●●	R	*
14	Germany: Contamination of food with Ehec	2012		F		R	*
15	Contamination of salmon with *Salmonella Thompson*	2012		F	●●	R	*
16	Legal proceedings against a member of the board of directors of the RIVM	2012	R				
17	Recall of batches of vaccines (Infanrix-IPV)	2012		V	●●	R	*
18	Nijkerk: fire at plastics store	2012		C	●●	R	*
19	Promens Zevenaar: fire	2013		C	●●	R	**
20	Measles epidemic	2013		I		R	**
21	Moerdijk: Shell plant explosion	2013		C	●●	R	**
22	MERS-CoV	2013					
23	Zevenaar: fire at plastics factory	2013		C	●●	R	**
24	Poeldijk: fire in horticulture	2014		C	●●	R	***
25	Moerdijk: Shell plant explosion	2014		C	●●	R	***
26	Vlijmen: fire	2014		C	●●	R	***
27	Nijmegen: leakage of unknown chemical substance	2014		C	●	R	***
28	Unknown chemical substance in house	2014		C	●	R	***
29	Africa: Ebola outbreak (and possibility of patients in the Netherlands)	2014		...	●●	R	***
30	Criticism of screening test for colorectal cancer	2014		...	●●	R	***
31	Doel: EPA-n exercise	2014		N	●●●	E	***
32	Defective needles used for vaccines	2015		...	●●	R	***
33	Legal proceedings against the RIVM for European tender HPV tests	2015	R				
34	Schelde: poliovirus	2014		C/I	●●●	R	***
35	Borssele: EPA-n exercise	2015		N	●●●	E	****
36	Styrene leakage from ship collision	2015		C	●●	R	****

Notes: Cp is qualitatively scored with bullets: the more bullets, the more partners involved;
Y is scored with stars: * = 2010–2012, ** = 2013, *** = 2014, **** = 2015.

Annex II Literature search on evaluation strategies

A systematic literature search was conducted in order to explore whether defined evaluation strategies existed for crisis response and, if so, which were the most established. The search was conducted in both Medline and Scopus, and yielded a total of 114 (Medline) and 213 (Scopus) articles. After an initial selection based on title and abstract, 25 (Medline) and 32 (Scopus) articles remained. These articles were read in full and examined, after which 4 (Medline) and 7 (Scopus) articles were considered relevant to this study.

Medline

The details of the Medline search are shown in Table 12.

Table 12: Medline search

#	Searches	Results
1	(root adj cause adj analysis).ti.	130
2	exp Evaluation Studies as Topic/	1045220
3	exp Program Evaluation/	57269
4	exp Root Cause Analysis/	106
5	exp Disease Outbreaks/	69098
6	exp Disasters/	60188
7	exp Accidents/	143260
8	4 and 5	0
9	4 and 6	0
10	exp * Root Cause Analysis / and exp *Accidents/	18
11	exp *Program Evaluation/ and exp *Disease Outbreaks/	23
12	exp *Program Evaluation/ and exp *Disasters/	66
13	exp *Program Evaluation/ and exp *Accidents/	222
14	limit 13 to ‘review articles’	25
15	exp *Evaluation Studies as Topic/ and exp *Disease Outbreaks/	105
16	limit 15 to ‘review articles’	7
17	exp *Evaluation Studies as Topic/ and exp *Disasters/	92
18	limit 17 to ‘review articles’	7
19	exp *Evaluation Studies as Topic/ and exp *Accidents/	426
20	limit 19 to ‘review articles’	57
21	1 and 5	1
22	1 and 6	0
23	1 and 7	45
24	10 or 11 or 12 or 14 or 16 or 18 or 20 or 23	210
25	remove duplicates from 24	209
26	from 25 keep 1,8,20-21,33,44,65,67, 74,78,85,101, 123, 131-132,135-136,142,152,156,158,167,180,185,188,197	26
27	exp *Disaster Planning/	8510
28	exp Disaster Planning/og [Organization & Administration]	3598
29	exp Disaster Planning/mt [Methods]	1548
30	exp Disaster Planning/st [Standards]	656
31	exp *Program Evaluation/	11663
32	exp Program Evaluation/mt [Methods]	4738

#	Searches	Results
33	exp Program Evaluation/sn [Statistics & Numerical Data]	978
34	exp Emergency Responders/	8750
35	exp Program Development/	23121
36	exp Evaluation Studies as Topic/	1045220
37	exp *Disasters/pc [Prevention & Control]	232
38	27 and (31 or 32 or 33)	59
39	28 and (31 or 32 or 33)	32
40	29 and (31 or 32 or 33)	13
41	30 and (31 or 32 or 33)	10
42	38 or 39 or 40 or 41	64
43	27 or 28 or 29 or 30	9083
44	43 and 34	150
45	43 and exp *Evaluation Studies as Topic/	50
46	43 and 37	72
47	36 and 37	8
48	37 and (31 or 32 or 33)	1
49	42 or 44 or 45 or 46 or 47 or 48	291
50	49 not 24	241
51	from 50 keep 2–8, 11, 13–17, 19–27, 30, 35–36, 40–41, 45, 49, 53, 55, 57, 59, 61–62, 70–71, 75–76, 79, 82, 85–87, 89, 96, 100–101, 105, 108–109, 112, 114, 116, 119–120, 122, 124, 129–130, 135, 137–138, 140–141, 145–148, 151, 153, 155, 157, 159, 162, 164–166, 184, 188–189, 195–196, 208, 217–218, 238–239	88
52	26 or 51	114

Scopus

This strategy for Scopus appeared too complex, where some combinations of words resulted in a large number of (mostly irrelevant) hits. Finally, the following set was used:

(((TITLE (strateg* OR management* OR respons* OR action* OR coordination* OR reaction* OR decontamination* OR operation*)) AND (((TITLE (evaluation* OR investigation* OR audit* OR reflexion* OR analyses OR identification*)) AND (TITLE (disaster* OR catastroph* OR hazard* OR accident* OR crisis* OR emergenc* OR event* OR impact* OR outbreak* OR contaminat*))) AND (TITLE (evaluation*)))) OR ((TITLE (strateg* OR management* OR respons* OR action* OR coordination* OR reaction* OR decontamination* OR operation*)) AND (((TITLE (evaluation* OR investigation* OR audit* OR reflexion* OR analyses OR identification*)) AND (TITLE (disaster* OR catastroph* OR hazard* OR accident* OR crisis* OR emergenc* OR event* OR impact* OR outbreak* OR contaminat*))) AND (TITLE (investigation*)))) OR ((TITLE (strateg* OR management* OR respons* OR action* OR coordination* OR reaction* OR decontamination* OR operation*)) AND (((TITLE (evaluation* OR investigation* OR audit* OR reflexion* OR analyses OR identification*)) AND (TITLE (disaster* OR catastroph* OR hazard* OR accident* OR crisis* OR emergenc* OR event* OR impact* OR outbreak* OR contaminat*))) AND (TITLE (audit*)))) OR ((TITLE (strateg* OR management* OR respons* OR action* OR coordination* OR reaction* OR decontamination* OR operation*)) AND (((TITLE (evaluation* OR investigation* OR audit* OR reflexion* OR analyses OR

identification*)) AND (TITLE (disaster* OR catastroph* OR hazard* OR accident* OR crisis* OR emergenc* OR event* OR impact* OR outbreak* OR contaminat*))) AND (TITLE (reflexion*)))) OR ((TITLE (strateg* OR management* OR respons* OR action* OR coordination* OR reaction* OR decontamination* OR operation*)) AND (((TITLE (evaluation* OR investigation* OR audit* OR reflexion* OR analyses OR identification*)) AND (TITLE (disaster* OR catastroph* OR hazard* OR accident* OR crisis* OR emergenc* OR event* OR impact* OR outbreak* OR contaminat*))) AND (TITLE (identification*))))) AND (infect*) AND (EXCLUDE (DOCTYPE , 'cp') OR EXCLUDE (DOCTYPE , 'no') OR EXCLUDE (DOCTYPE , 'ip') OR EXCLUDE (DOCTYPE , 'cr') OR EXCLUDE (DOCTYPE , 'Undefined')) AND (LIMIT-TO (SUBJAREA , 'MEDI') OR LIMIT-TO (SUBJAREA , 'ENVI') OR LIMIT-TO (SUBJAREA , 'BIOC') OR LIMIT-TO (SUBJAREA , 'IMMU') OR LIMIT-TO (SUBJAREA , 'PHAR') OR LIMIT-TO (SUBJAREA , 'HEAL') OR LIMIT-TO (SUBJAREA , 'VETE')) AND (EXCLUDE (LANGUAGE , 'Chinese') OR EXCLUDE (LANGUAGE , 'Japanese') OR EXCLUDE (LANGUAGE , 'Russian') OR EXCLUDE (LANGUAGE , 'Italian') OR EXCLUDE (LANGUAGE , 'Portuguese') OR EXCLUDE (LANGUAGE , 'Czech'))

Annotated bibliography of most useful articles

Yuniarto HA. The shortcomings of existing root cause analysis tools. Proceedings of the World Congress on Engineering. 2012, 4–6 July; Vol III.

This article operates under the Six Sigma's 'Define-Measure-Analyse-Improve-Control' (DMAIC) methodology. RCA is considered a vital tool for the Analyse phase. The author contends that the effective use of RCA tools is limited due to their reductionism and lack of attention to 'soft' factors. This makes RCA less suitable for complex systems. The article offers an insightful criticism of the use of RCA.

Stoto M. Measuring and assessing public health emergency preparedness. J Public Health Manag Pract. 2013, Sep–Oct;19 Suppl 2:S16–21.

The author present the current ways to measure preparedness. Organizations often make use of after action reports (AAR), but these do not determine root causes nor describe why something was successful or failed. The article does not go into depth on RCA, but rather the possibility of measuring preparedness.

Schuh RG, Eichelberger TR, Stebbins S, Pomer B, Duran L, Mahoney JF, Keane C, Lin CJ, Potter MA. Developing a measure of local agency adaptation to emergencies: a metric. Eval Program Plann. 2012, Nov;35(4):473–80.

This article describes the burden of different tasks and functions during a crisis. It makes use of an Adaptive Response Metric (ARM).

Torner N, Carnicer-Pont D, Castilla J, Cayla J, Godoy P, Dominguez A. Auditing the management of vaccine-preventable disease outbreaks: the need for a tool. PLoS One. 2011, Jan;6(1):e15699.

This pilot study explores the use of quality indicators as critical points for evaluation. The article does not address RCA but may be a helpful source for the identification of critical evaluation points.

Krumkamp R, Ahmad A, Kassen A, Hjarnoe L, Syed AM, Aro AR, Reintjes R. Evaluation of national pandemic management policies – a hazard analysis of critical control points approach. Health Policy. 2009, Sep;92(1):21–26.
This article describes the application of HACCP to the evaluation of national pandemic prevention and control systems. This is a helpful example of applying methods other than RCA to the evaluation of pandemic preparedness.

Carroll JS, Rudolph JW, Hatakenaka S. Lessons learned from non-medical industries: root cause analysis as culture change at a chemical plant. Qual Saf Health Care. 2002;11:266–69.
This article describes the benefits of RCA for the health care and other sectors. One major benefit is the cultural change brought about by RCA, as employees develop a critical attitude and openness to learning. This article draws attention to the possible importance of ownership during the implementation of RCA.

Sundnes KO. Health disaster management: guidelines for evaluation and research in the Utstein style: Executive summary. Prehosp Disaster Med. 1999, Apr–Jun;14(2):43–52.
The author emphasizes the importance of a structural framework for the evaluation process and describes a template for the design, implementation and reporting of evaluations. Although this article mentions disaster response evaluation, it may be too general a description to benefit our project specifically.

Annex III Literature search on root cause analysis

A systematic literature search was conducted in order to explore whether defined evaluation strategies existed for crisis response and, if so, which were the most established. The search was conducted in both Medline and Scopus, and yielded a total of 227 (Medline) and 171 (Scopus) articles. After an initial selection based on title and abstract, 60 (Medline) and 28 (Scopus) articles remained. These articles were read in full and examined, after which 11 (Medline) and 4 (Scopus) articles were considered relevant to this study.

Medline

Table 13: Medline searches

#	Searches	Results
1	exp 'Root Cause Analysis'/	109
2	(root adj cause adj analy$).ti.	164
3	rca.ti. and (root adj cause$).ti,ab.	8
4	1 or 2 or 3	231
5	remove duplicates from 4	227

Scopus

TITLE (tool* OR method* OR standard* OR checklist* OR approach* OR framework* OR design* OR system* OR model* OR strateg*) AND TITLE-ABS-KEY-AUTH ('root cause analy*') AND (EXCLUDE (SUBJAREA , 'MEDI')) AND (EXCLUDE (DOCTYPE , 'cp') OR EXCLUDE (DOCTYPE , 'cr') OR EXCLUDE (DOCTYPE , 'no'))

Annotated bibliography of most useful articles

Shaqdan K, Aran S, Daftari Besheli L, Abujudeh H. Root cause analysis and health failure mode and effect analysis: two leading techniques in health care quality assessment. J Am Coll Radiol. 2014, Jun;11(6):572–79.

The article describes 11 steps in the execution of RCA, and 5 steps in the execution of Healthcare Failure Mode and Effect Analysis (HFMEA). According to the authors, RCA and HFMEA can be used in conjunction: RCA to obtain the root cause for a single incident, and HFMEA to detect weaknesses in the whole process.

Lehtinen TOA, Mäntylä MV, Vanhanen J. Development and evaluation of a lightweight root cause analysis method(ARCA method) – Field studies at four software companies. Inform. Softw. Technol. 2011;1045-61.

The article describes the development and evaluation of a 'lightweight' RCA method (based on literature and other RCA methods). The method is applied in the software industry, which makes it difficult to draw comparisons with the crisis response field. However, the article offers useful insights into what may be essential components of RCA.

Pham JC, Kim GR, Natterman JP, Cover RM, Goeschel CA, Wu AW, Pronovost PJ. ReCASTing the RCA: an improved model for performing root cause analyses. Am J Med Qua. 2010 May-Jun;25(3): 186-91.

The authors claim that RCA is effective in the identification of hazards, but does not pay enough attention to possible methods of risk reduction.

The article describes an improved RCA method based on the CAST model. This offers additional insights into the role of RCA as an evaluation method.

Wu AW, Lipshutz AKM, Pronovost PJ. Effectiveness and efficiency of root cause analysis in medicine. JAMA. 2008;299(6):685–87.
This article describes the effectiveness and efficiency of the application of RCA in health care. It also mentions barriers to the implementation of RCA.

Iedema R, Jorm C, Braithwaite J. Managing the scope and impact of root cause analysis recommendations. J Health Organ Manag. 2008;22(6):569–85.
This article describes the added value of recommendations generated by RCA, via interviews with 9 senior health managers. The authors adopt a critical attitude towards RCA. However, despite limitations, RCA is considered to contribute to improved understanding and discussion between professionals. The article offers insights into the human factor of RCA.

Middleton S, Chapman B, Griffiths R, Chester R. Reviewing recommendations of root cause analyses. Aust Health Rev. 2007, May;31(2):288–95.
This article describes opinions of health care professionals regarding previously implemented RCAs and the recommendations that followed. They conclude that the quality of the RCA results is dependent on the relationships within the team that performs the RCA (e.g. mutual trust, liberty to speak). The article offers insights into the human factor of RCA.

Braithwaite J. Westbrook MT, Mallock NA, Travaglia JF, Iedema RA. Experiences of health professionals who conducted root cause analyses after undergoing a safety improvement programme. Qual Saf Health Care. 2006, Dec;15(6):393–99.
A study of a cohort of health professionals who have taken part in a Safety Improvement Program (SIP). RCA is one of the components of the SIP. The article describes (i) 8 barriers experienced during RCA by the health professionals, (ii) opinions about the implementation and benefits of RCA. The article offers useful insights for the implementation phase of RCA.

Annex IV Selection of RCA methods

Introduction

A root cause analysis (RCA) is a tool for investigating the underlying cause of problems or accidents. RCA methods are widely used in accident investigations to reveal the underlying causes of an accident and weaknesses in the safety management system.

It is important to know when you have found a root cause. Root causes can be identified by 4 characteristics:

1. They are specific.
2. They can reasonably be identified.
3. They are those over which management has control.
4. They are those for which effective recommendations can be generated.

Many RCA methods are available, and choice depends on the goal and depth of the analysis, the resources available and the expertise of the analysts. An overview of RCA methods by Van Alphen et al. (2009) describes 20 RCA methods extensively, and lists even more. The selection of an appropriate RCA method is therefore not straightforward.

A personal communication with Van Alphen concluded that the choice of a specific method is less important than the way in which it is used. A systematic approach is essential. This statement is supported by literature. Indeed, many similarities were found between the different RCA methods.

- All RCA methods generally speak of ‘incidents’. Although an incident can refer to a specific event, for example during accident investigations, it can also be defined as a ‘deviation from the desired process’ or an ‘undesirable change’ ’in the situation. This definition is more appropriate to response analysis.
- The consensus is that RCA is an organizational tool, as most RCA methods identify organizational factors as root causes. This supports the claim that RCA is a suitable method for response analysis, because it contributes to organizational learning.

Pre-selection of RCA methods

A pre-selection of RCA methods was made on the basis of a literature search and personal communication with Van Alphen. This resulted in five potentially suitable approaches:

1. Combination of fishbone diagram and 5 Whys
2. Combination of fishbone diagram and pareto analysis
3. 3CA
4. PRISMA
5. Tripod

Combination of fishbone diagram and 5 Whys

A fishbone diagram is also called a ‘cause and effect’ diagram. It is a visualization tool to categorize causes of a problem or incident. By organizing the causes and underlying causes a fishbone structure emerges, which gives this technique its name. This tool is often used in

combination with 5 Whys or pareto analysis, and provides a way of categorizing the identified causes.

5 Whys is the most basic method of RCA. The process of this method can be seen in . It can be performed as a team exercise, where a teamleader guides the discussion.

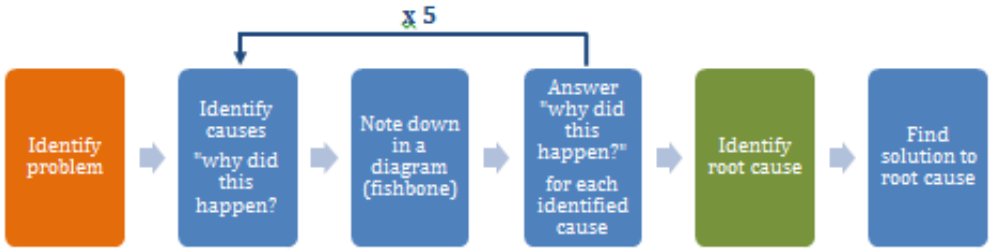


Figure 7: Process of the 5 Whys method

Due to its simple framework, there is room for flexibility per crisis response evaluation. However, there is a significant risk that the researcher might become lost among multiple causes, as the 5 Whys method offers little guidance as to prioritizing or weighting causes. (A common strategy is to pick one possible route and stick with it. If the problem persists, a different route is chosen …) The 5 Whys method has received a lot of criticism, because it 'limits' 'the research to a linear perspective, whereas some issues might have more than one root cause. It is therefore doubtful whether this framework is suitable for elaborate evaluations; businesses traditionally use this method as a quick and easy way to find potential corrective actions for recurring problems. Finally, it may be more difficult to do a comparison between consecutive evaluations, because the differences between each evaluation may be too great.

Combination of fishbone diagram and pareto analysis

For fishbone diagram, see above.

Pareto analysis is a tool often used as an alternative to the 5 Whys method. The basis of the pareto analysis is the 80/20 rule; the idea that 80% of the problems arise from 20% of the causes. This tool helps to focus attention on the most important causes. This method is useful when there are many possible competing courses of action. It requires a large set of problems as input. However, the intended result of the factual reconstruction is not a large set of problems, but rather specific critical points that will be further investigated. The method is therefore not suitable for crisis response analysis.

3CA

The 3CA approach defines 'incidents' 'as 'undesirable changes' 'in a chain of events. The result of this method is a core description of incidents in terms of changes and limitations in prevention controls. Furthermore, this method can be classified as 'barrier analysis' 'because it focuses on the absence or failure of barriers and prevention controls. According to Van Alphen (2009), this approach also helps non-experts to

structure the problem. Some projects using the combined ECFA+/3CA method were carried out successfully (Yabba, 2012; Zhu, 2012).

PRISMA
PRISMA is a method used to analyse aggregated data from a large number of small or near incidents. It produces large amounts of data on organizational, technical and human factors, thereby identifying systemic problems. Thus, this method can be characterized as a monitoring system rather than an RCA method. The result of this method is a database of the most common problems. However, the aim of this research is to find the root cause of previously identified problems, thus eliminating the need for a database. Furthermore, the aim of the PRISMA method is to collect data from many incidents, and it is therefore less suitable for single incident analysis.

Tripod
The Tripod approach assumes that human actions are often a direct cause of incident occurrence. However, human actions arise from a certain context or work environment. In turn, this work environment is a consequence of latent causes, i.e. structural organizational problems. These problems can be solved by decisions at management level. The relation between context and human action is regarded as probabilistic: context does not directly cause specific events, but rather increases the likelihood of these events happening.

This approach seems to be quite similar to the 3CA method, as it also focuses on the absence or failure of barriers and prevention controls. One significant difference was found in the literature (Van Alphen et al., 2009), namely that 3CA is indicated as being suitable for non-experts, whereas the Tripod approach requires a significant amount of expertise.

Combining methods
Tripod does appear to have extra elements, such as the categorization of underlying factors (Basis risico factoren, BRF)(Table 14). Nicolini (2011) states that there is also broad consensus that RCA is a toolbox of approaches rather than a single method. This statement suggests that elements of different RCA methods may be combined to yield better results. It is worth investigating whether combining 3CA with Tripod or other methods may have some benefit.

Table 14: Categorization of underlying factors in Tripod

1	Organization
2	Incompatible goals
3	Communication
4	Procedures
5	Training
6	Design
7	Hardware
8	Maintenance management
9	Housekeeping
10	Error-enforcing conditions
11	Defences

Criteria for selection of the RCA methods

First, the question arises whether the RCA framework is in fact suitable for response analysis.

This is assessed according to two criteria:

1. ***Construct validity***: the degree to which a test measures what it claims, or purports, to be measuring.
2. ***External validity***: the extent to which the results of a study can be generalized to other situations and to other people. (Can the same method be applied in similar situations and produce similar results?)

Both construct validity and external validity were assessed by examining whether previous scientific studies had successfully used RCA to answer their research question in similar settings.

Construct validity and external validity are likely to be sufficient for most RCA methods, because they are established methods in incident analysis. However, whether this method can be transferred to response analysis has not been well proven in the scientific literature. Nevertheless, other tools from system analysis have successfully been used for emergency response evaluation, such as Fault Tree Analysis and HACCP, so the use of RCA in response analysis is a logical notion.

The second question is which specific RCA method produces the desired information? There are many varieties of RCA methods, all with varied results and focal points, and their suitability was assessed according to the following criteria:

1. ***Internal validity***: Is the method able to sufficiently underpin a causal relation between factors?
2. ***Content validity***: Does the instrument in fact produce results that answer the research question? (Is the focus of the method on technical, organizational or human causes? Because the purpose of this study is to improve organizational learning capacity, the RCA method should at least be able to identify potential organizational factors)

Because the secondary aim of the project is to develop a standardized evaluation method, the following criteria were also included in the selection of RCA methods:

1. ***Simplicity***: for example, whether an expert is needed to lead the evaluation team. (Ideally, the selected RCA method would adopt a convergent approach, which helps to narrow down the causes to the most predominant ones. This saves time and reduces the expertise required)
2. ***Feasibility***: the amount of time and human resources that are required to execute the evaluation.

Scoring of the RCA methods
An overview of the criteria scoring can be found in Table 15.

Table 15: Overview of RCA methods and scoring

	Internal validity	Content validity	Construct / External validity	Simplicity	Feasibility
Combination: Fishbone diagram & 5 Whys					
Fishbone diagram Result: causal diagram of 6 factors: equipment, process, people, materials, environment, management Illustrates cause–effect relationships (Jayswal, 2011)	Only identifies causes, does not offer solutions Does not prioritize causes, therefore low suitability for complex cases	Structures cause–effect using 6 generic headings: Methods, Machines (equipment), People (manpower), Materials, Measurement, Environment		Fast, efficient, easy to under-stand Easy to lose track of priorities/to ask the wrong question	Heavily dependent on researcher's decisions/ questions
5 Whys Result: a diagram or 'Why tree' showing levels of failure causes	Not sure if it identifies single root cause or multiple root causes	Combined with fishbone diagram		Fast, efficient, easy to under-stand Easy to lose track of priorities/to ask the wrong question	Not very stressful on participants Heavily dependent on researcher's decisions/ questions
Pareto Analysis Result: identification of major causes (Jayswal, 2011) 80/20 rule (80% of problems arise from 20% of causes) Helps focus attention on most important causes	Useful where many possible courses of action are competing for attention (wiki)	Simple technique for prioritizing problem-solving work Does not identify major cause (uses 5 Whys or RCA for that)		Not sure if useful, because critical points have already been identified via expert meetings Maybe useful for determining critical points in case study	
Combination: ECFA+ & 3CA					

	Internal validity	Content validity	Construct / External validity	Simplicity	Feasibility
3CA Result: core description of incident in terms of changes and limitations in prevention controls	Focuses on undesirable changes		Previous research: Yabba, 2012 Zhu, 2012	Demands a critical attitude, and ability to prioritize causes Structured method, uses matrix as a tool	Helps non-experts to bring structure to a problem
ECFA+ Result: sequential description of incident, ECF diagram: actor – action – object Graphic representation of factual reconstruc-tion	Method of structuring data in support of further cause analysis	Possible to compare different actors Also suitable for complex cases	Previous research: Yabba, 2012 Zhu, 2012	Emphasis on creating structure	Recommen-ded as a team exercise No software needed, but uses a physical wall + sticky notes
Tripod					
Result: clear insight into organizational flaws ● Tripod Beta-diagram ● Report (generated by Tripod Beta Tree-software) ● Trio: Hazard, Event, Target	Highly suitable for complex situations	Strong organizational focus and structural flaws Both short-term and long-term recommenda-tions		Much effort required. Suitable for complex situations	Expert study leader required Much brainpower needed

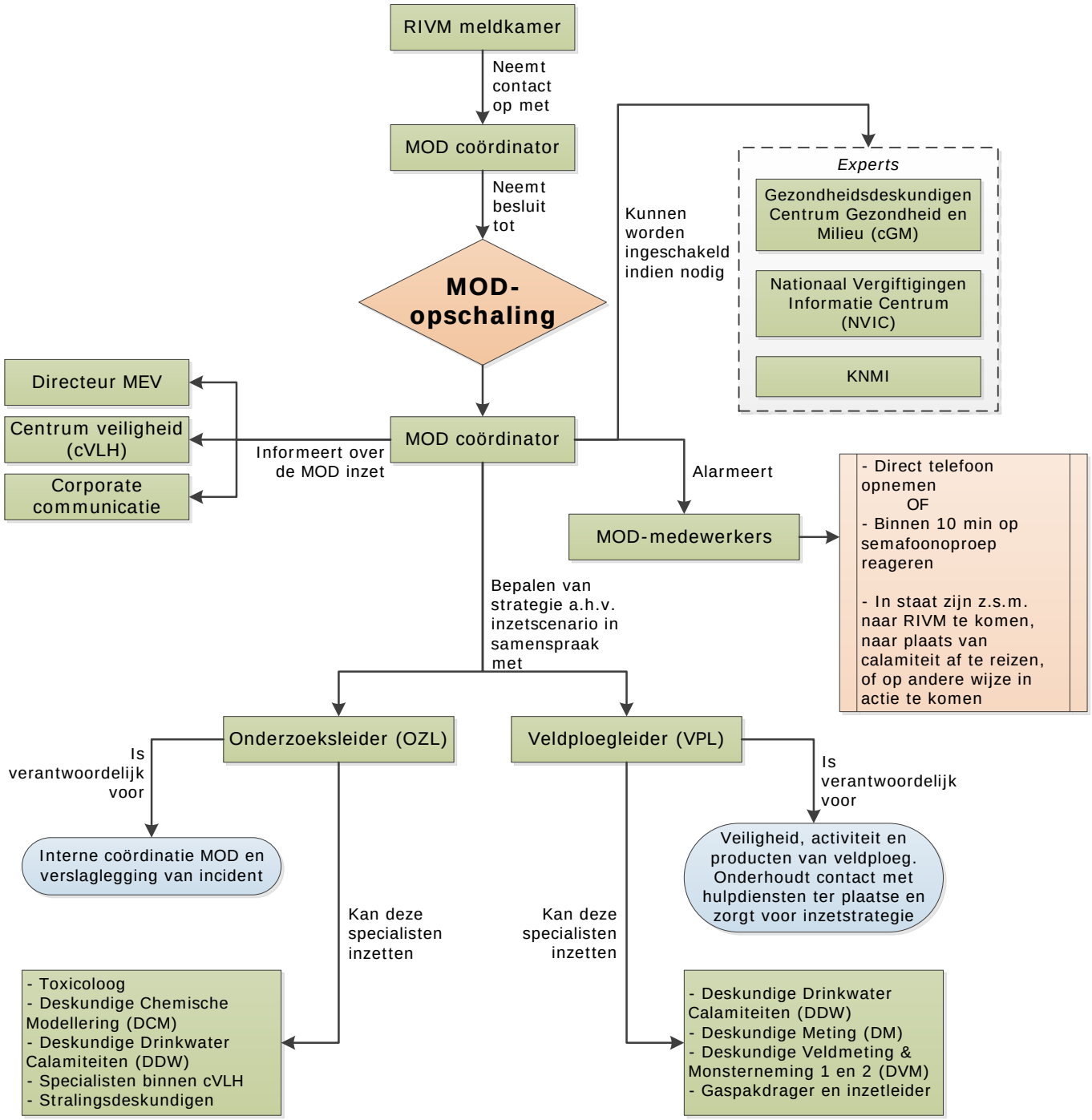
RCA selection

Based on the scoring, it was decided to select two (combinations of) methods:

- Simple factual reconstruction: *timeline* and simple RCA method: *5 Whys*;
- Elaborate factual reconstruction: *ECFA+* and elaborate RCA Method: *3CA*.

The 3CA method may be combined with elements from Tripod.

Annex V Organogram of the emergency response to chemical accidents (MOD)



Annex VI Questionnaire case study 1 – Shell Moerdijk

Tijdlijn

- Komt deze overeen met de werkelijke gang van zaken?
- Missen er eventueel belangrijke momenten?
- Evaluatie: is zoiets een handige geheugensteun/manier om overzicht te creëren?
- Handig om ook in de toekomst te gebruiken?

Het start-moment

- Wat voor cijfer zou je geven aan het opstarten van de MOD geven?
- Waarom dat cijfer?
  - Hoe zat het met *bereikbaarheid* van de MOD?
  - Hoe zat het met de *opschaling* van MOD naar BOTmi ?
  - Hoe verliep het contact met de *vraagsteller*?

Snelheid van proces

- Wat voor cijfer zou je geven aan de snelheid waarmee de MOD response verliep?
- Waarom dat cijfer?
  - Was de MOD snel genoeg gealarmeerd?
  - Hoe zat het met het tijdig *uitrukken van de veldteams*?
  - Hoe zat het met het *verloop van de analyse*?
  - Hoe zat het met het *aanleveren van advies*?
  - Hoe verliep de *communicatie* tussen de MOD teams?

Materieel

- Wat voor cijfer zou je geven aan de beschikbaarheid van het materiaal tijdens metingen?
- Waarom dat cijfer?
- Wat waren specifieke punten die mis gingen of waarmee je ontevreden was?
  - Hoe verliep de *monstername*?
  - Hoe zat het met de *technische ondersteuning* (bijvoorbeeld ICAWEB?)

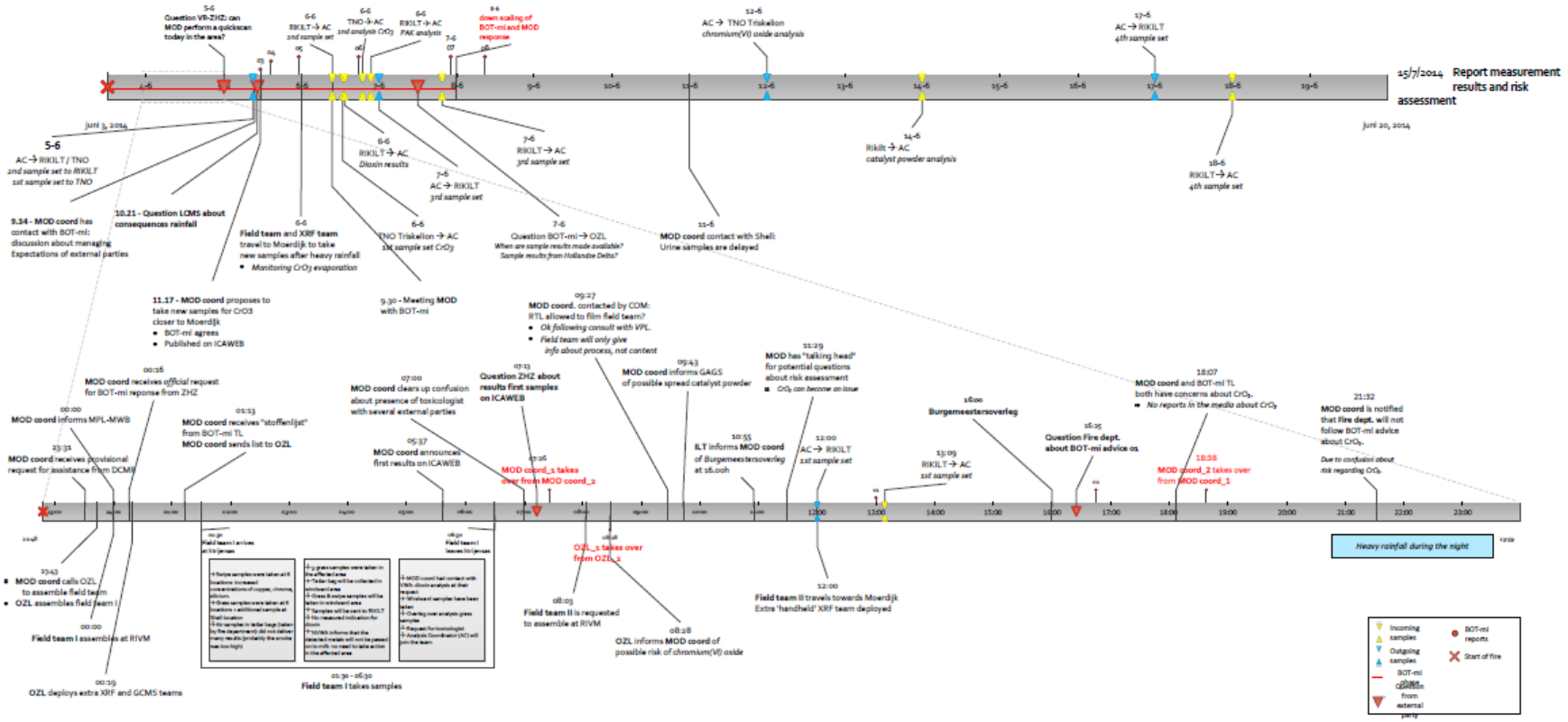
Overig

- Op welke momenten was je in het bijzonder tevreden over hoe het proces verliep?
- Heb je nog punten die niet aan bod zijn gekomen, maar wel waardevol zijn om te vernoemen?

Evaluatie

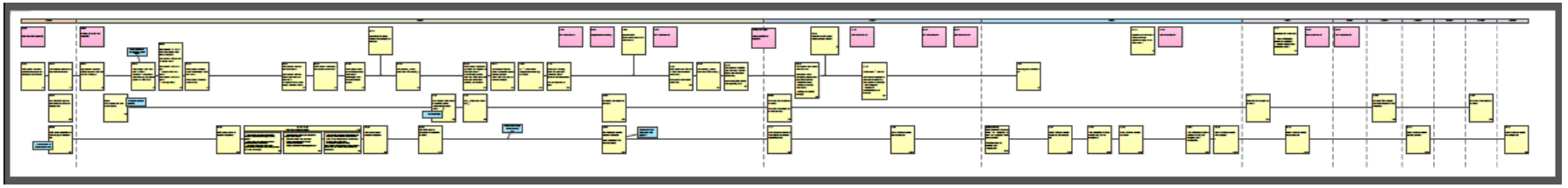
- Wat vond je van de vragen?
- Handig om ook in de toekomst te gebruiken?
- Wat vond je van de categorieen?
- Had je het gevoel dat deze manier van vragen + categorieën een goed beeld geven van de response?

Annex VII Timeline case study 1 – Shell Moerdijk



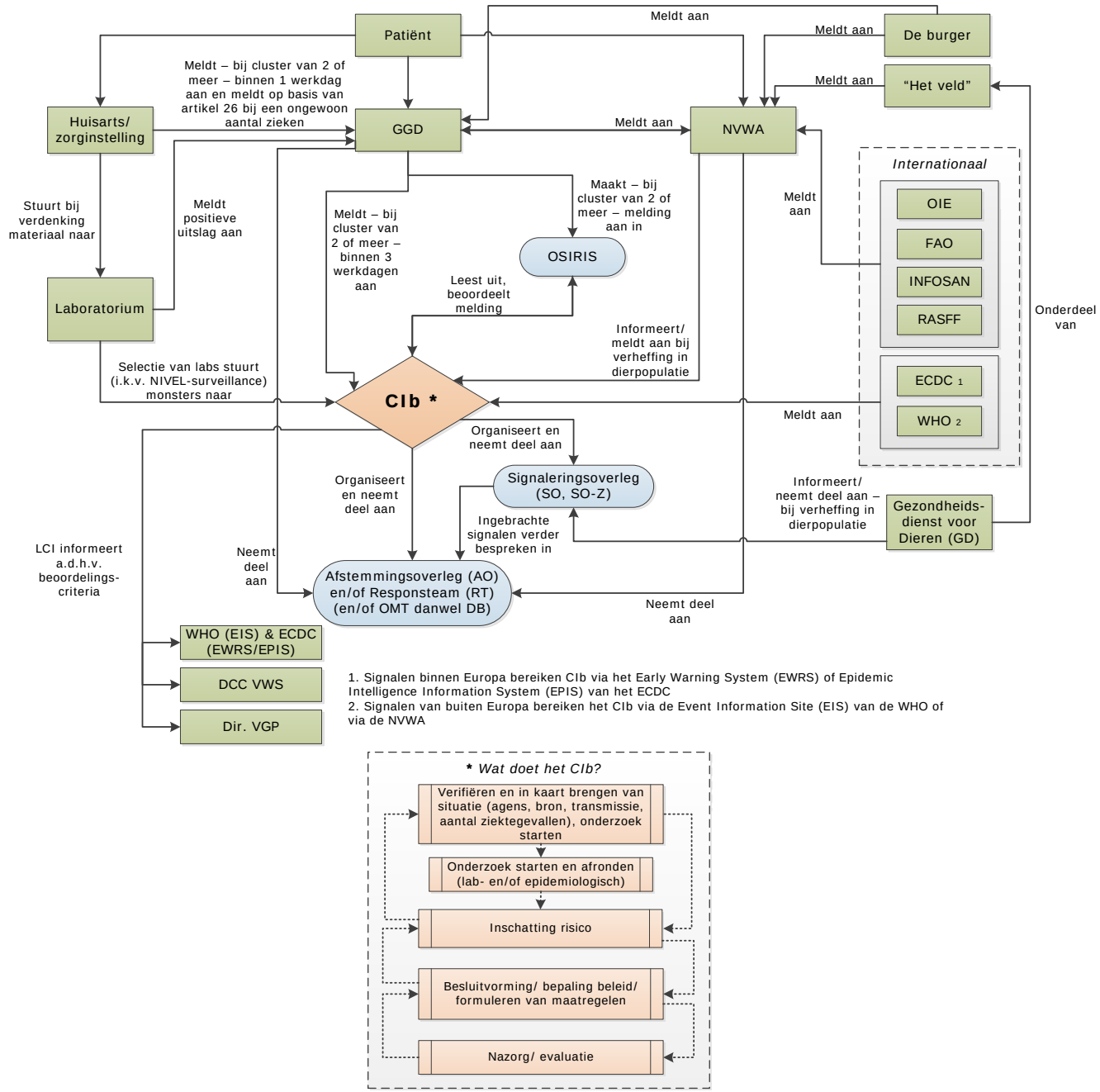
See Annex VII tijdlijn MOD Shell Moerdijk.pdf

Annex VIII ECFA+ chart case study 1 – Shell Moerdijk



See Annex VIII ECFA+ MOD Shell Moerdijk.pdf

Annex IX Organogram of the emergency response to food-related incidents (CIb)



1. Signalen binnen Europa bereiken CIb via het Early Warning System (EWRS) of Epidemic Intelligence Information System (EPIS) van het ECDC
2. Signalen van buiten Europa bereiken het CIb via de Event Information Site (EIS) van de WHO of via de NVWA

Annex X Questionnaire case study 2 – *S. Thompson*

Tijdlijn

- Komt deze overeen met de werkelijke gang van zaken?
- Missen er eventueel belangrijke momenten?
- Evaluatie: is zoiets een handige geheugensteun/manier om overzicht te creëren?
- Handig om ook in de toekomst te gebruiken?

Samenwerking

- Wat voor cijfer zou je geven aan de samenwerking tussen de verschillende partijen?
- Waarom dat cijfer?
- Kun je voorbeelden noemen van momenten die beter hadden kunnen verlopen?

Informatievoorziening

- Wat voor cijfer zou je geven aan het contact met de media?
- Waarom dat cijfer?
- Kun je voorbeelden noemen van momenten die beter hadden kunnen verlopen?
- Wat voor cijfer zou je geven aan de informatievoorziening van het RIVM naar het publiek?
- Waarom dat cijfer?
- Kun je voorbeelden noemen van momenten die beter hadden kunnen verlopen?

Patiënten controle onderzoek

- Wat voor cijfer zou je geven aan hoe het patiënt-controle onderzoek is verlopen?
- Waarom dat cijfer?
- Kun je voorbeelden noemen van momenten die beter hadden kunnen verlopen?
- Wat voor cijfer zou je geven aan de typering?
- Wat voor cijfer zou je geven aan het vinden van de bron?

Capaciteit van CIb

- Wat voor cijfer zou je geven aan de hoeveelheid mankracht die beschikbaar was tijdens de response?
- Waarom dit cijfer?
- Kun je voorbeelden noemen van momenten waarbij mankracht een kritiek punt was?
- Hoe ervoer je de rol van de vergaderingen en overleggen, zoals het Signaleringsoverleg (SO)
    - Wat vond je van de opbrengst van de vergaderingen in relatie tot de tijd en inspanning?
        - Kosten-baten analyse
    - Specifiek, Hoe ervoer je de grenzen van het mandaat?

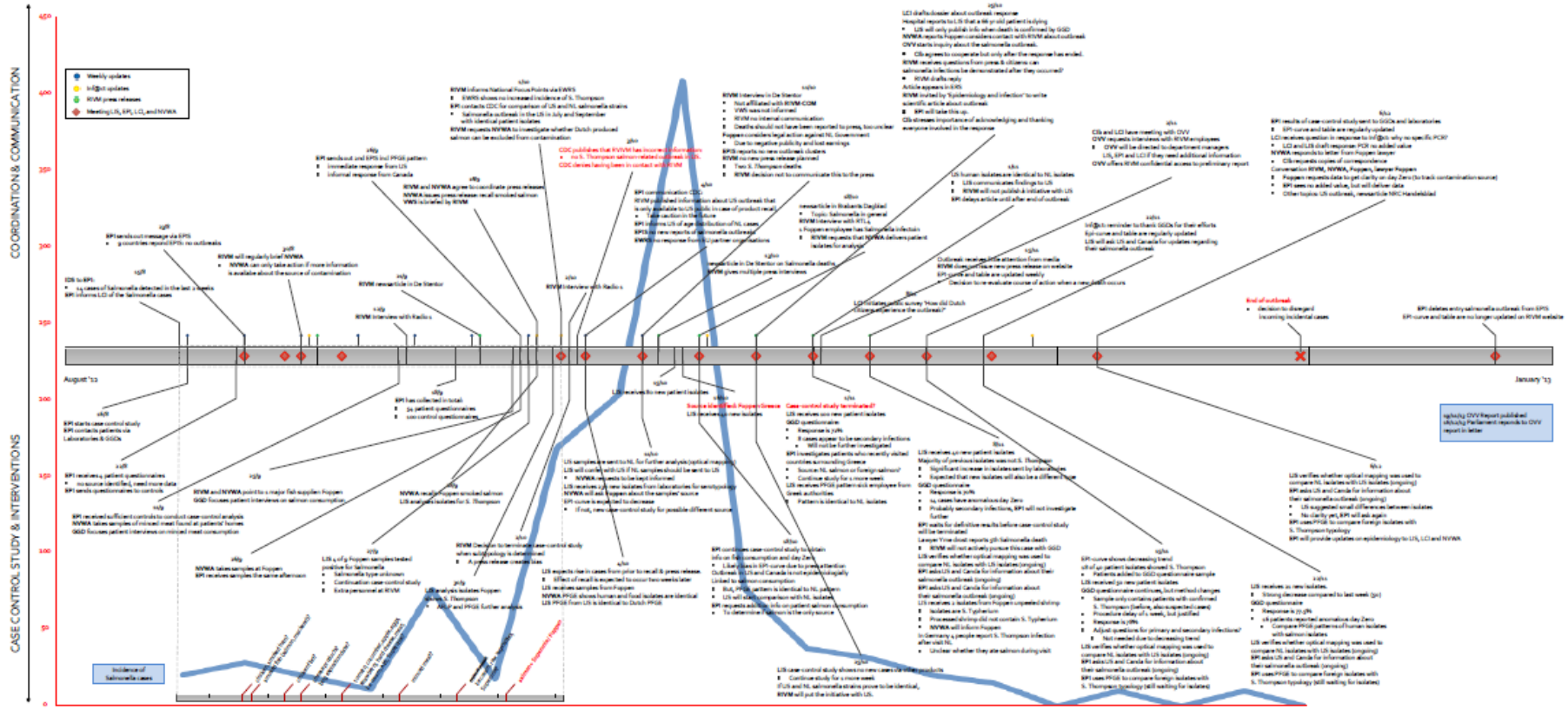
Overig

- Op welke momenten was je in het bijzonder tevreden over hoe het proces verliep?
- Heb je nog punten die niet aan bod zijn gekomen, maar wel waardevol zijn om te vernoemen?

Evaluatie

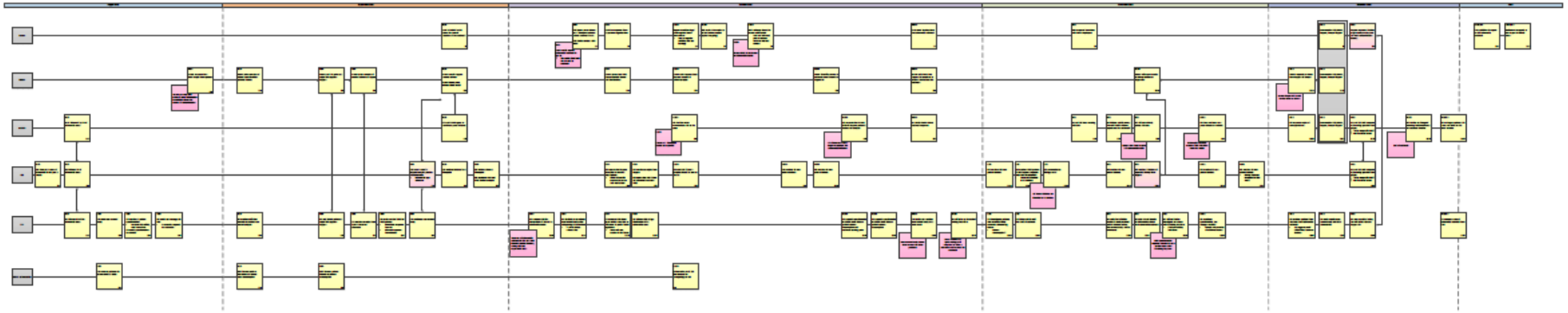
- Wat vond je van de vragen?
- Handig om ook in de toekomst te gebruiken?
- Wat vond je van de categorieën?
- Had je het gevoel dat deze manier van vragen + categorieën een goed beeld geven van de response?

Annex XI Timeline case study 2 – S. Thompson



See Annex XI tijdlijn Salmonella Thompson.pdf

Annex XII ECFA+ chart case study 2 – S. Thompson



See Annex XII ECFA+ Salmonella Thompson.pdf.

Annex XIII ECFA+ chart case study 3 – Zika

date	actor	fact	eKNL	Aruba	Curacao	St Maarten	Bonaire	St Eustasius	Saba	oKNL
1-2-2016	WHO	PHEIC								
8-2-2016	VWS	Dutch offer to oKNL: advice and support in vector control	20				0	0	0	0
8-2-2016	RIVM	guideline for travelers								
8-2-2016	RIVM	start of a guideline for pregnat women								
8-2-2016	EMC en RIVM	start of the development of a diagnostic test								
9-2-2016		guideline for professionals	23				0	0	0	0
9-2-2016	Intravacc	start development of a vaccin								
10-2-2016	LUMC	start development of a vaccin	23	1	4	0	0	0	0	5
10-2-2016	RIVM	Risk Assessment for athletes and public to Olympic games								
11-2-2016		advice to use condoms	23	4	4	0	0	0	0	8
12-2-2016	RIVM	initiative to make Zika a notifiable disease	23	4	4	0	0	0	0	8
15-2-2016			24	4	4	0	1	0	0	9
16-2-2016			24	6	4	0	1	0	0	11
17-2-2016			24	6	4	0	1	0	0	11
18-2-2016	St Eustasius	request for financial support	24	10	36	1	1	0	0	48
19-2-2016	Responsteam Zika	Zika not considered notifiable	24	10	36	1	1	0	0	48
25-2-2016	NOC/NSF	request for a meeting with VWS and RIVM	30	10	36	2	1	0	0	49
25-2-2016	Saba	request for support in vector control								
25-2-2016	VWS	meeting with oKNL about communication								
3-3-2016	St Eustasius	request to VWS for support in vector control	32	14	36	2	1	0	0	53
3-3-2016	BES	request to VWS for support in vector control								
3-3-2016		Case of sexually transmitted Zika in France								
10-3-2016	WHO	statement based on IHR-Emergency committee	32	14	36	2	1	0	0	53

date	actor	fact	eKNL	Aruba	Curacao	St Maarten	Bonaire	St Eustasius	Saba	oKNL
10-3-2016	RIVM	adjustment of guidelines for pregnant women								
10-3-2016	COGEM	advice for working with GM- Zika virus								
10-3-2016	WHO	roadmap with research priorities								
17-3-2016	RIVM	advice to VWS about notification	40	15	40	4	4	0	0	63
17-3-2016	EMC	final validation of a serological test								
24-3-2016			40	15	40	4	4	0	0	63
31-3-2016	RIVM	serological test is available	40	15	70	4	4	0	0	93
7-4-2016	IGZ	surveillance of vector control on St Eustasius is not optimal	45	20	70	10	4	0	0	104
21-4-2016		Proposal for integrated vector control	45	20	70	10	4	0	0	104
19-5-2016	VWS	Zika is notifiable	50	20	75	10	10	0	0	115
19-5-2016		St Eustasius reacts positively to proposal for integrated vector control								
2-6-2016	RIVM/NVWA/WUR	Risk assessment Zika in oKNL: low risk	50	20	200	10	10	0	0	240
16-6-2016	RIVM	adjustment advice use of condoms	65	20	200	10	10	0	0	240
30-6-2016	NVWA	three dead Aedes aegypti found on Schiphol airport	65	20	210	25	10	0	1	266
14-7-2016		start registration of pregnant women with zika	75	20	210	25	15	4	1	275

Annex XIV Protocols

Draaiboek AO, RT of RT-z
Stap 1: Verantwoordelijkheden benoemen, datum vaststellen, leden definiëren
De kosten die gemaakt worden voor een DB of OMT kunnen geboekt worden op het projectnummer van Respons regulier (óf op een bepaald crisisnummer)

Nr.	Taak	Voort gang	Datum & naam uitvoerder
1	**Bespreek welke personen verantwoordelijk zijn voor het organiseren van AO of RT of RT-z** - Beleidsadviseur(s) - Arts(en) - Bureaumedewerker(s) (evt, vooral bij de meer formele RT-z of als er veel buitenlandse deelnemers bij zijn betrokken) Informeer je collega's voor de continuïteit!		
2	**Kies een datum**		
3	**Bespreek wie verantwoordelijk is voor het opstellen van de notulen (beleidsadviseur)**		
4	**Indien over een onderwerp al eerder een bijeenkomst heeft plaatsgevonden, kijk dan hoe dit is verlopen** -Wat is er eerder gedaan? -Wie waren daarbij aanwezig? -Werken we consequent? -Zijn er nog punten besproken die in een volgende bijeenkomst aan de orde moeten komen?		
5	**Definieer welke sleutelfiguren/ deelnemers er aanwezig moeten zijn** Maak hierin onderscheid tussen deelnemers die onmisbaar zijn (sleutelfiguren) en de andere deelnemers. Bedenk ook of er veterinaire partners uitgenodigd moeten worden wanneer het een zoönose betreft (RT-z). Bij RT's gebeurt het uitnodigen van CIb collega's via de CENTRUMHOOFDEN!!! Uitnodigen kan door centrumhoofd telefonisch te bellen: toelichten doel Responsteam en vragen wie het centrum wil afvaardigen, alleen als telefonisch niet lukt, per mail. (sjabloon vooraankondiging) Informeer ook de centra die niet aansluiten bij het overleg!		
6	**Bel de sleutelfiguren op om te vragen of zij beschikbaar zijn op de gekozen datum** Anders moet een andere datum overwogen worden.		
7	**Registreer in het registratiesysteem wanneer dit overleg plaatsvindt**		
8	**Informeer het secretariaat over de bijeenkomst en schrijf op het bord wie verantwoordelijk is**		

Nr.	Taak	Voortgang	Datum & naam uitvoerder
9	**Wanneer het verzoek voor een AO of RT-z komt uit het SO-z, informeer het SO-Z dan wanneer het besluit is genomen** Voorbeeld-e-mail		
10	**Maak een map aan op de R-schijf onder Casuïstiek (betreffende jaartal)** Kopieer voor de standaardindeling en basisdocumenten de map Draaiboek en sjablonen AO en RT en pas deze vervolgens aan (verwijder niet-relevante documenten of voeg mappen toe) Kant-en-klaar mappenstructuur met sjablonen		
11	**Reserveer de gekozen datum en het tijdstip in de agenda's van de betrokken RIVM-medewerkers**		
19	**Informeer communicatie** Informeer hen telefonisch. Registreer in kolom voortgang welke persoon wanneer geïnformeerd is.		
20	**Informeer VWS** **Spreef af wie VWS informeert en leg dit vast in Crios.**		

Stap 2. Uitnodiging, agenda en deelnemerslijst opstellen

Nr.	Taak	Voortgang	Datum & naam uitvoerder
1	**Maak bij een RT-z of een meer officiële RT een lijst van alle deelnemers die uitgenodigd worden** **Bij een gewone RT of AO volstaat een lijst namen op het verslag.**		
4	**Stel een agenda op** (voorbeeldagenda) Bepaal i.o.m. de voorzitter de duur van het overleg. Voor RT volstaat meestal een uur.		
5	**Vraag deskundigen om een presentatie voor te bereiden** Benoem hoe lang de presentatie mag duren, vermeld dit ook op de agenda.		
5	**Verzamel relevante literatuur of documenten die met de definitieve agenda moeten worden meegestuurd**		
7	**Stuur definitieve uitnodiging, inclusief agenda en alle bijlagen** **Bij RT-z ook** - Deelnemerslijst (zonder telefoonnummers en e-mailadressen) - Eventuele routebeschrijving (in verband met meer externen)		
8	**Maak naambordjes (optioneel)** Dit alleen als er veel externen zijn die elkaar niet kennen, bijvoorbeeld een RT-z. Naambordjes kunnen gedrukt worden bij de repro. Vul alle namen in in het sjabloon en stuur deze per email naar de repro (zo tijdig mogelijk). Vraag ook een paar lege reservekaarten. Vermeld de titels, eerste voorletter, achternaam en organisatie (gebruik een afkorting indien te lang). Zonder		

Nr.	Taak	Voort gang	Datum & naam uitvoerder
	Mw, Dhr en zonder functie.		
9	**Indien op het RIVM: meld externe bezoekers aan bij de receptie en reserveer parkeerplaatsen**		

Stap 3. Ruimte reserveren

Nr.	Taak	Voort gang	Datum & naam uitvoerder
1	**Bespreek of het overleg plaatsvindt op het RIVM of op een externe locatie** In principe op het RIVM tenzij er een reden is om dit buiten het RIVM te beleggen.		
2	**Boek een geschikte overlegruimte** In de rolodex zijn diverse overlegruimtes (buiten het RIVM) te vinden. Tot ca 8-10 deelnemers kan U.103 ook. Wanneer het overleg op het RIVM plaatsvindt, reserveer dan een zaal in de T-gang (is representatief en er is voldoende ruimte).		
3	**Indien eigen laptop wordt meegenomen, controleer of deze werkt** Voordat op een RIVM laptop offline gewerkt kan worden moet je eenmalig de laptop aan het RIVM netwerk hangen en inloggen.		
4	**Wanneer gekozen wordt voor videoconferencing of telefonische vergadering op het RIVM, regel en test dit dan tijdig (houd rekening met eventueel tijdsverschil)** **GEBRUIK INSTRUCTIE!!** R:\LCI\5. Preventie en Bestrijding\5.4 Advies bij crisis\Procedures en sjablonen\Instructies videoconferencing viadesk etc		

Stap 4. De dag van het overleg

Nr.	Taak	Voort gang	Datum & naam uit-voerder
1	**Zorg voor een laatste versie van de agenda en deelnemerslijst** Neem deze documenten uitgeprint mee. Bedenk of andere stukken ook op papier aanwezig moeten zijn.		
4	**Zorg ervoor dat je op tijd bent!**		
5	**Zet aan het einde van het overleg alle presentaties op je eigen memory stick en verwijder deze van de computer**		

Stap 5. Uitwerking

Let op: bij meer formele RT's, waaruit bijv een advies naar VWS of EZ volgt, zul je bepaalde voorbeeldbreven van de OMT's/DB's moeten gebruiken.

Verslaglegging

Nr.	Taak	Voortgang	Datum & naam uitvoerder
1	**Na het RT of RT-z meteen VWS (en bij RT-z ook EZ) telefonisch informeren**		
2	**Stel een verslag op en maak daarin een korte samenvatting dat 'WOB-baar' is** Gebruik het sjabloon in deze map		
3	**Laat het verslag lezen door de voorzitter van het overleg voor akkoord en correcties.**		
4	**Stuur VWS (en evt. EZ) een korte samenvatting van (WOB-bare gedeelte) van verslag.** **(Soms gaat er een brief naar VWS)**		
5	**Stuur het conceptverslag naar de deelnemers (als de tijd het toelaat kan dat evt. na een redactieslag door de redacteuren)**		
6	**Verwerk de binnengekomen opmerkingen op het verslag** Inhoudelijke opmerkingen worden met de secretaris afgestemd. De laatste versie wordt goedgekeurd door de voorzitter. Als essentiële opmerkingen niet worden overgenomen, wordt de betreffende afzender geïnformeerd over de reden van afwijzing.		
7	**Laat de definitieve versie van het verslag controleren op taalfouten** Als al het commentaar is verwerkt worden de brief en het verslag nog eenmaal gelezen door een bureaumedewerker om typefouten eruit te halen. Controleer ook de automatische velden op alle pagina's (datum, behandeld door, emailadres etc)		
8	**Stuur het definitieve verslag naar de deelnemers** Benoem in de e-mail ook het eventuele vervolgtraject		

Communicatie

Nr.	Taak	Voortgang	Datum & naam uitvoerder
1	**Overweeg een Inf@ctbericht** Denk ook aan een labinf@ct, vetinf@ct, arboinf@ct		
2	**Handel overige communicatie richting professionals verder af** Denk hierbij aan: -EWRS-bericht		
3	**Bespreek met de communicatiemedewerkers welke informatie kan of moet worden gecommuniceerd** Denk bij communicatie aan: -Nieuwsbericht op RIVM-site -Q&A's -Twitter Denk ook aan de Engelstalige website van het RIVM		
4	**Informeer de centrumhoofden en andere geïnteresseerden (vergeet directe collega's niet) over de uitkomsten van het overleg**		

Stap 6. Afronding

Nr.	Taak	Verant-woordelijke	Voort gang	Datum & naam uitvoerder
1	**Bewaak de actiepunten** Gebruik hiervoor het vaste format. Neem alle actiepunten op in de lijst en houd na het overleg de stand van zaken bij. Geef met grijs afgeronde actiepunten weer. Meld in kolom voortgang regelmatig hoe het ervoor staat en meld de datum dat het actiepunt is afgerond.	Beleids-adviseur		
2	**Zorg ervoor dat de R-schijf opgeruimd is**	Bureau-medewerker		

Annex XV Standard agenda for response meeting

Onderwerp	**Afstemmingsoverleg/ responsteam XXX**
Datum en tijd	
Locatie	
Voorzitter	XXX, LCI
Aanwezig	XXX, XX (LCI, notulist)

1. **Opening en voorstelronde/ rolverdeling**
   Agenda conform BOB-C-structuur (beeldvorming, oordeelvorming, besluitvorming, communicatie)
   Doel van het overleg

2. **Actiepuntenlijst**
   Voorbeeldtabel:

No	actiepunt	Verantwoor-delijke	einddatum	Status
1 110714				

3. **Stand van zaken nationaal/ internationaal (beeldvorming)**

   3b. Epidemiologie
   Tijd, plaats, persoon
   Bespreken eventuele studies (bv. case control)

   3a. Diagnostiek
   Tijd, plaats, persoon

4. **Risicovorming/ knelpunten (oordeelvorming)**

5. **Maatregelen en acties (besluitvorming)**
   Benoemen van te nemen maatregelen en acties (opnemen in actiepuntenlijst)

6. **Casusregister R-schijf** (tijdens 1e overleg bespreken, verantwoordelijken voor aanwijzen)

7. **Communicatie**
   Professionals: bv. signaleringsoverleg/ Inf@ct
   Publiek: bv. persbericht, website RIVM
   Ministeries

8. **Evaluatie** (tijdens laatste overleg)

9. **Rondvraag en vervolgoverleg**

Annex XVI Workshop results

On 5 July 2017 we organized a workshop to generate feedback on our proposed method of evaluating the RIVM's response to incidents. We invited 17 people to take part in this workshop: 6 from external parties and 11 from the RIVM (including 3 attendees from the response functions that we had involved in our study). Two external parties – the NVWA and Berenschot – were asked to give a brief introductory overview of how they evaluate their responses to incidents. An important point raised during these presentations was the need to make a distinction between lessons identified and lessons learned. It should be ensured that a lesson has been internalized before it is taken off the list of lessons identified. After a short discussion on the methods used by the NVWA and Berenschot we briefly explained our approach by going through the Shell Moerdijk case, explaining the different methods we used in our evaluation. Afterwards we invited the attendees to give their feedback in the form of a SWOT (strengths, weaknesses, opportunities and threats) analysis. We discussed the comments made, especially those under 'weaknesses', to look for possible ways of improving our proposed method. The table at the end of this appendix lists in detail the comments on each analysis sheet. A summary of the main points made by the attendees is given below:

1. Light vs full version
   Many attendees saw potential in the method, but commented that it would be too time-consuming to use it for every response. It was suggested that a 'light' version be developed for smaller responses and the full method used for larger incidents. The light version would certainly benefit from the recommendation to structure the reporting in such a way that a quick timeline can be constructed and that the CCPs are known from the start.
2. External party involvement
   The workshop attendees recommended involving external parties in the development of the method. At the start of the project we discussed this and decided not to involve them at this stage because we wanted to focus specifically on RIVM response functions in order to determine the relevant CCPs. However, some CCPs are related to external parties (such as communications) and the evaluation of the method can certainly benefit from the involvement of external parties, which could provide an objective assessment of our work.
3. Outsider review
   In relation to the second bullet point, the attendees also suggested avoiding 'marking your own papers' by letting outsiders conduct the evaluation. This can be done by asking evaluators from one RIVM unit to assess another unit.
4. Training and competence
   Some concern was expressed over the fact that a certain competence in RCA methods is required for our proposed evaluation method. The question then arises as to how such competence is acquired and maintained. During the workshop it became apparent that the 5 Whys method is being used by at least one RIVM unit (DVP/VPZ) on a routine basis. This unit should therefore be involved in follow-up projects.

Table 10: SWOT analysis for the workshop on "Improving evaluations of response functions at RIVM"

S	**W**	**O**	**T**
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Via RCA goede kijk op werkelijke oorzaken van de crisis.	Zorg voor een goed borgingssysteem.	Tijdslijn ter plekke opstellen.	Evaluatie moeheid – intern – extern.
Door RCA 5 x Why of 3CA wordt gefaciliteerd om breed te blijven denken.	Doen van RCA is een vak, er moet aandacht zijn voor training. Jim: Leren en uitwisselen binnen RIVM.	Makkelijker en sneller op de inhoud van de evaluatie, want iedereen wet en kent het evaluatieproces.	Evaluatie moeheid.
Evaluatie methode uitventen als redelijk simpel en snel uit te voeren.	Aanbevelingen al direct in stap 3. Voorstel in losse stap pas aanbevelingen formuleren om te voorkomen dat je daar teveel naar toe gaat redeneren. Jim: Aanbevolen als losse laatste stap	Zorg in de implementatie/evaluerstap dat je lessons identified van lessons learned scheidt/volgt.	Ieder van crisisorganisatie niet expliciet betrokken bij evaluatie. Hierdoor risico dat evaluatie en aanbevelingen niet gedragen worden.
Systematische aanpak van evaluaties.	Tijdsbeslag! Criteria voor wanneer je wel een uitgebreide RCA analyse doet en wanneer niet. Jim: 1 “Hot wash” per x jaar, maak verder een “light versie” voor “snelle plof” incidenten.	Betrekken externen (expert organisaties, org betrokken bij de case, opdrachtgevers etc.): benutten lerend vermogen + kennis van andere organisaties.	Bij een standaard methode altijd oppassen dat het middel niet het doel wordt. Evalueren omdat het moet/kan niet om “echt” te evalueren en ervan te leren.
Simpel en handig om als je wil/moet evalueren je een basis daarvoor klaar hebt liggen.	Kan heel omvangrijk worden als alles wordt uitgediept. Als meerdere organisaties betrokken zijn is vaststellen van CCPs complex. Jim: intern: implementatie. Beter interne audit dienst. Onafhankelijke internen?	- duidelijke leerpunten - uniforme manier van evalueren maakt vergelijken makkelijker (bijv tussen incidenten of met soortgelijk geval in verleden).	- niet ver genoeg doorvragen - te veel evalueren -> te veel acties + te weinig draagkracht - borging van acties is van belang, anders verdwijnt rapport in een la.

S	W	O	T
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Blijven doorvragen net zolang tot de basis oorzaak is gevonden.	Focus op eigen handelen, eigen organisatie. Visie externe partners niet direct duidelijk, terwijl dit een meerwaarde voor een lerende organisatie kan zijn. Jim: beperking van dit project. in rapport anders(?)	Meer generieke benadering van crisisevaluatie.	Bias: teveel intern gericht, onvoldoende breed gezichtsveld.
- Overzichtelijk, geeft structuur - to the point - sluit al aan op ons kwaliteitssysteem (RIVM-DVP).	T veel focus op afwijkingen. Denk ook bewust aan wat ging er goed.	Bouwsteen/methode voor onderdeel van gehele evaluatie.	Gevaar dat uitkomst minder serieus wordt genomen als je jezelf evalueert
- Doorvragen met why. - implementeren met pdca. - kwetsbaar opstellen door de openheid over de evaluatiemethode.	Slager keurt zijn eigen vlees (doordat het een interen evaluatie is). Minder gericht op samenwerkingspartners die ook het proces bepalen. NB: MOD moet ook reclame maken (?)	Navolgbaar in heel RIVM en darbuiten (hept evaluatie NL verder).	Te weinig tijd/geld om dit echt te doen.
Vooraf helder hebben wat standaard ccps zijn.	Tijdsbeslag: benodigde tijd voor uitvoeren methode. Onduidelijk wanneer methode uitgevoerd wordt, met kans dat betrokkenen feiten zijn vergeten.	Relatief eenvoudige methode die daardoor goed te leren, overdraagbaar is aan andere evaluatoren. ook helder welke stappen gevolgd zijn.	Vaste CCPs -> mogelijk andere case specifieke ccps over het hoofd gezien.
Simpele tijdlijn (anders teveel werk om bruikbaar te zijn).	Tijdslijn maken kost veel tijd, heb je die tijd? Jim (?): Criterium (?) – ”Hotwash”. Als iets -> Dan dit…	Ontwikkelen van een systeem om kleine en grote evaluatiepunten te borgen in de zin dat ze ook uitgevoerd worden en niet alleen opgeschreven worden.	Tijdrovend -> werkt als iemand vrijgesteld is voor evaluatiewerkzaamheden.

S	W	O	T
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Systematisch en goed omschreven (navolgbaar, zorgt voor herkenbaarheid) .	Wie bepaalt waarop een root cause analysis te hebben. Jim: periodiek extern laten beoordelen.	Systematisch en goed omschreven. – Gevaar van bureaucratie (het blijft mensenwerk).	Buitenwereld ziet dit als navelstaarderij. (Tenzij je gelijk duidelijk maakt wat je er mee verbetert of borgt).
Implementatie van leerpunten vast onderdeel.	->stap 4 van implementeren en evalueren. Ervaring is dat er geen tijd en aandacht is voor de evaluatiepunten -> Geen lerende organisatie.	Kan er ook een uitgekleed model worden bedacht – voor “kleinere” incidenten.	Analyse richt zich op problemen. Hoe krijg je volledig beeld van “hoe het gegaan is”?
CCPs beoordelen voor zowel goed gegaan als verbeteren.	Ontbreken van moment van samenkomen. Jim(?) debriefen psychosociaal.	Mogelijkheid om diep er op in te gaan (kan ook spanningsveld geven met manager (?) politiek).	
CCPs aan de voorkant definiëren geeft richting aan evaluatie en transparantie.	Niet overal toepasbaar. Afhankelijk van incident. Jim: altijd hotwash, dan kiezen(?)	Geeft aanknopingspunten voor inrichting crisisorganisaties -> CCP, functies etc.	
Plan voor implementatie.	Jim?: AAR Hotwash -> direct -> papier enquête -> standaard vragen -> samen zitten 3 dgn wachten met AAR (sociale aspect laten bezinken)	Mogelijkheid double/triple logslesen (?)-> structurele verbetering crisisresponse.	
Onderbouwd/overwogen keuze mogelijk voor bepaalde methode.			

RIVM
Committed to *health and sustainability* -