

Validation of infectious diseases surveillance in nursing homes in the Netherlands

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Abstract

Objective – The aim of this study is to determine the validity within the basis data collection in the Surveillance Network of Infectious disease in Dutch nursing homes (SNIV).

Design – In a cross-sectional study the validity of the data collection is addressed.

Methods –For validation of the data collection, a validation team visited the nursing homes in May or June 2010 and assessed blinded, based on information of nurses, all residents of the participating nursing homes on having an infection (gastro-enteritis, influenza-like illness and probable pneumonia) according the SNIV definitions. Just before the visit, the local surveyors had to fill in the register form of SNIV, indicating specific infections of the residents. The outcome measures are the negative predictive value, positive predictive value and the inter-rater agreement using Cohen's kappa coefficient.

Results – Ten nursing homes participated in the validation study, the participating rate is 45% (10 out of 22). A total of 1429 residents were included in the study. The percentage of infections diagnosed by the validation team is 0.8% (n=12)(table 2,3,4). There where no discrepancies in five nursing homes. The positive predictive value and the negative predictive value where respectively 0.50 and 1.00. The inter-rater agreement (Cohen's kappa) was 0.99 (table 5).

Conclusion - Low prevalence provides unreliable estimates of the positive predictive value and the negative predictive value. The sample size should be adjusted to the prevalence of the infections in the target group. The best option would be to select positive cases retrospective, however this is not possible because of the anonymous registration and the absence of electronic patient records. Another possibility is the use of other measure methods, but the negative and positive predictive values approach the reality in practice the best. In the current setting validation is not feasible. The possibility of the use of arbitrary cases for validation studies should be considered.

Keywords- Validation study, infectious diseases, surveillance, nursing homes.

Introduction

Elderly, nursing homes and infectious diseases

The percentage of elderly, people over the age of 65, in the Netherlands is 15.3% in February 2010 (approximately 2.5 million) compared to 7.7% in 1950 (approximately 770 thousand). The percentage of people aged above 80 years had an even higher increase (1, 2). In the coming decades, the number of elderly will continue to grow. The main causes of the increase of aging are the decline of fertility rate

and the increase in life expectancy (3). After 2011, acceleration of the increase of the number of elderly is expected, from this year the first baby boomers of the postwar generation reaches the age of 65 in the Netherlands (4, 5). An estimated 25% of the population will be over the age of 65 in 2050 and four out of ten elderly aged above 65 years will be 80 years or older (6). Because of the change in population demographics that will occur in the next decennia and the changing population of nursing homes where patients are discharged sooner from hospitals, a need for increase in nursing home beds is expected (7-9).

The shorter stays in hospitals also increase the number of acts in nursing homes with an increased risk of infections, like infusions and urinary catheters (7, 9). Elderly are more susceptible to infections than the younger population, because of the physiological and pathologic changes that occur with ageing and the underlying chronic illnesses (5, 8, 10-12). In addition, infections are difficult to diagnose among elderly because of their subtle presentations, atypical symptoms and the presence of co-morbid illness. Elderly also frequently have cognitive disorders and are unable to communicate symptoms that can suggest the presence of an infection, hereby diagnoses are often delayed and treatments start late (5, 8, 11-14). Nursing homes are an environment with an increased risk for infections, residents share food, air and health care and residents as well as staff bring in infections from the hospital and the community (11).

SNIV nursing home network for surveillance of infectious Diseases

Because of the increasing number of nursing home beds that are needed, the increasing risk of infections and the difficulty to diagnose infections among elderly, endemic and epidemic infections occur relatively commonly in nursing homes (8). In addition, the morbidity and mortality from infections among elderly is higher than from infections among younger adults (14). These factors makes it important to monitor the occurrence of infectious diseases among elderly in nursing homes.

To understand the problem and to create handles for infection prevention and control in nursing homes in the Netherlands, the Center for Infectious Disease Control (CIb) of the National Institute Public Health and Environment (RIVM), started a nationwide network in 2009 in which surveillance of infectious disease in Dutch nursing homes occurs. In a weekly surveillance based on a diagnostic test, consisting of clinical definitions, the following infections are recorded: gastroenteritis, influenza-like illness and probable pneumonia. In addition, the total number of deaths in the nursing homes is recorded. The goal of the nationwide network, named Surveillance Network Infectious Disease Nursing homes (SNIV), is to form a network of nursing homes functioning as sentinels for a nationwide surveillance of infectious disease in nursing homes. In the beginning of 2009, 18 nursing homes participated in the nationwide network SNIV, this number has grown to 25 nursing homes at the beginning of 2010. In each nursing home an elderly care physician or nurse practitioner is responsible for registration of the health care associated infections and number of deaths by completing the weekly register form of SNIV in OSIRIS, a webbased-application. However it is possible that several local surveyors, mostly elderly care physicians, provide the information for this registration.

In recent years several studies has been performed on SNIV. In July 2008, they examined the process of collecting information by the elderly care physician to fill in the weekly register form. Key subject were the nurses, who noticed changes in behavior and well-being of the residents (15). In 2009, they examined if the clinical definitions match the criteria in which disease are diagnosed in practice by the surveyors (16). The definitions of infectious disease appeared to agree with the practice, but the question remains whether the local surveyors correctly use the clinical definitions for diagnosing the residents on having an infectious disease. The validity of the data within SNIV is not yet determined.

Validity surveillance system

One of the conditions for the quality of diagnostic tests, the clinical definitions, is that the results should be correct or valid. Are the surveyors in the nursing home uses the clinical definitions or are they guided by outside factors. In surveillance systems, validation studies are essential to ensure plausibility and reliability of the data. A validation study also offers the possibility to identify problems in the nursing homes regarding the surveillance system (17, 18).

Therefore the aim of this study is to determine the validity within the basis data collection in the Surveillance Network for Infectious disease in The Netherlands.

Methods

Population

The validation study of the surveillance system of infectious disease in the Netherlands was performed in nursing homes participating in the network SNIV in May and June 2010. The inclusion criterion for participating in SNIV is that nursing homes had to have at least 50 residents. The inclusion criteria for participating in the validation study were; participating more than three months in the network SNIV at the start of the validation study in May 2010. Twenty-two nursing homes were approached to participate in the validation study.

Initial recruitment took place via an item in the newsletter of the SNIV network. Next, the elderly care physician responsible for SNIV registration received an email with more and detailed information about the study. Then the SNIV team contacted the nursing homes by a phone call and asked for their cooperation and made an appointment. An informative letter was sent to the participating nursing homes, which exactly described the course of the study and what was expected from the nursing homes.

Study design

The study design of the validation method was cross-sectional, the assessment of the local surveyors and the SNIV-team occurred around the same time. The validation study is coupled to the HALT study, Healthcare Associated Infections and antimicrobial use in Long Term Care Facilities. More about this study in annex 1.

The validation team, consisting of two members of the SNIV team, planned one day visits to each nursing home that was willing to participate in the validation study. The surveyors of the nursing homes were asked to fill in the weekly register form (annex 2) of SNIV in the same way as they normally do, just before the day of the visit of the validation team. In addition, the surveyors were asked to record the name of the residents on the registration form. During the visit, the validation team made a pre-selection of residents with the possibility of an infection at the day of the visit, through questions to the nurses (table 1). These questions could simple be added to the ward questionnaire of HALT (annex 3). The knowledge of nurses was also used to score each definition of the SNIV protocol (table 2) for the residents left over after the pre-selection. The form in annex 4 was used for scoring the definitions. The validation team performed the assessment blinded.

At the end of the day, an evaluation meeting took place between the validation team and the elderly care physicians or nurse practitioner responsible for registration of SNIV. In a semi-structured interview the discrepancies between the validation team and the surveyors were discussed, through comparison of the form filled in by the validation team and the surveyors and through additional questions. After the interview and comparison of the infectious diseases assessed, all data were made anonymous. The assessment of the validation team was considered as the 'golden standard'

Table 1. Questions pre-selection

Gastroenteritis

Has the resident diarrhea?

Did the resident vomited?

If one of the above questions can be answered with yes, the resident has to be assessed following the SNIV-definitions.

Influenza-like illness

Has the resident acute, fast arising systemic or respiratory symptoms?

When answered yes, the resident has to be assessed following the SNIV-definitions.

Probable pneumonia

Has the resident an (on-sided) deviation during auscultation of the longs?

When answered yes, the resident has to be assessed following the SNIV-definitions.

Table 2. Definitions infectious diseases according to the SNIV protocol

Gastroenteritis¹

- **OR** three of more episodes of diarrhea in 24h deviating from is normal for the resident

- **OR** diarrhea **AND** two of the following symptoms:

fever, vomiting, nausea, stomach ache, abdominal cramps, blood or mucus in stool

- **OR** vomiting **AND** two of the following symptoms:

fever, nausea, stomach ache, abdominal cramps, blood or mucus in stool

- **OR** three episodes of vomiting within 24-hour period (without additional symptoms **AND** when vomiting is not related to the use of medication)

¹ non-infectious causes excluded

Influenza-like illness

- Acute¹ onset of the symptoms²
- **AND** at least one of the following systemic symptoms:
 - fever or febrile feeling, malaise, headache, myalgia
- **AND** at least one of the following three respiratory symptoms:
 - cough, sore throat, shortness of breath/dyspnoea

¹ Fast arising

² Other probability diagnoses excluded

Probable pneumonia

- Patients with at least one of the following symptoms are suspected of a low respiratory infection, probable pneumonia, if symptoms appear as changes from previous situations and other probability diagnoses excluded:
 - tachypnea, malaise, confusion, shortness of breath, cough (productive or unproductive), fever > 38 ° C or fever in the last 48 hours, pain in the chest (when breathing)
 - **AND** with new focal (one-sided) deviation during auscultation of the lungs
-

Analysis

The outcome measures were the negative predictive value, positive predictive value and the inter-rater agreement using Cohen's kappa coefficient. The negative and positive predictive values are used to calculate the probability that the diagnostic test will give the correct diagnose. The negative predictive value is the proportion of residents from whom the local surveyors diagnosed no specific infection and who truly had no specific infection according to the golden standard, the validation team. The positive predictive value is the proportion of residents from whom the local surveyors diagnosed a specific infection and who truly had that specific infection according to the golden standard, the validation team. (19).

The inter-rater agreement between the golden standard and the surveyors is expressed using Cohen's kappa coefficient. The interpretation of the Cohen's kappa values differ significantly in the literature (20). Baneerjee et al. (1999) indicate kappa values of less than 0.40 as a low degree of agreement and values of 0.75 and higher as an excellent degree of agreement (21).

Descriptive analyses were used to compare demographic and clinical characteristics between the nursing homes.

Results

Twenty-two nursing homes were approached for participation in the validation study, after recruitment ten nursing homes, geographically spread across the Netherlands, participated in the validation study (participation rate 45%). Reasons for not participating: problems with staff, participation in other research, other priorities and/or not interested in the study.

A total of 1429 residents were included in the validation study. The mean number of residents in a nursing home was 143, ranging from 71 to 210. The median of male resident was 33% (range 24%-36%). The median of disorientated residents in time and/of place was 58% (range 47%-93%).

Validation

Of the residents, 0.8% (n=12) were diagnosed with an infection by the validation team. Five of these infections were classified as gastroenteritis, two as influenza-like illness and five as probable pneumonia according to the SNIV definitions. There were no discrepancies between the local surveyors and the validation team at four nursing homes. In three nursing homes there were three deviations and in three nursing homes there was one deviation. Two out of the three homes which had the most deviations, were larger homes than the average. No remarkable difference for the characteristics, percentage men and percentage disoriented residents in time and of/place between the different nursing homes based on the number of discrepancies in the nursing homes were found. The most discrepancies were for probable pneumonia, namely seven discrepancies (table 1, 2, 3).

Table 2. Validation results for gastro-enteritis.

Gastroenteritis			
Diagnosis by surveyors	Diagnosis by validation team		Total
	yes	no	
Yes	4	2	6
No	1	1422	1423
Total	5	1424	1429

* Positive predictive value= 0.67
 * Negative predictive value=1.00

Table 3. Validation results for influenza-like illness.

Influenza-like illness			
Diagnosis by surveyors	Diagnosis by validation team		Total
	yes	no	
Yes	0	0	0
No	2	1427	1429
Total	2	1427	1429

* Negative predictive value= 1.00

Table 4. Validation results for probable pneumonia.

Probable pneumonia			
Diagnosis by surveyors	Diagnosis by validation team		Total
	yes	no	
Yes	1	3	4
No	4	1421	1425
Total	5	1424	1429

* Positive predictive value= 0.25
 * Negative predictive value= 1.00

Table 2 shows the validation results of the SNIV definition gastroenteritis. The positive predictive value was 0.67 and the negative predictive value was 1.00. The inter-rater agreement (Cohen's kappa) between the validation team and the surveyors was 1.00. Table 3 shows the validation results of the SNIV definition influenza-like illness. The positive predictive value can not be determined and the negative predictive value was 1.00. The inter-rater agreement (Cohen's kappa) between the validation team and the surveyors was 1.00. Table 4 shows the validation results of the SNIV definition probable pneumonia with a positive predictive value of 0.25 and a negative predictive value of 1.00. The inter-rater agreement (Cohen's kappa) between the validation team and the surveyors was 1.00.

Table 5. Overall table

Diagnosis by surveyors	Diagnosis by validation team		Total
	yes	no	
Yes	5	5	10
No	7	1412	1419
Total	12	1417	1429

* Positive predictive value= 0.50

* Negative predictive value= 1.00

The positive and negative predictive values for SNIV, all three infections together, were 0.50 and 1.00 respectively. The inter-rater agreement (Cohen's kappa) was 0.99 (table 5).

Discussion

In this study the validity of the data collection within the SNIV surveillance was addressed. A total of 1429 nursing home residents were assessed both by the SNIV validation team and the local surveyors on having an infection (gastro-enteritis, influenza like illness, probable pneumonia) according the SNIV definitions.

The characteristics of the nursing homes as described in the results, can possibly have an influence on the way of diagnosing by the surveyors (8, 28). Two out of the three houses with the most deviations, were larger houses than the average. The characteristics, percentage men and percentage disoriented residents in time and of/place seem to have no influence on the validation based on the number of discrepancies in the nursing homes. However, the number of discrepancies in this study was very small.

The prevalence of the three infections together was 0.8%, which is an excellent low prevalence of these infection diseases in nursing homes. The positive predictive value and the negative predictive value for these three infections were respectively 0.50 and 1.00. However, low prevalence provides unreliable estimates of the positive predictive value and negative predictive value. Predictive values are determined by the prevalence of the diseases, because this influences the relationship between the negative and positive results.

The inter-rater agreement (Cohen's kappa) was 0.99. A Cohen's kappa higher than 0.75 indicates an excellent degree of inter-rater agreement (21). However, the calculation of the Cohen's kappa is also related to the prevalence of the infectious diseases in nursing homes. Table 5 shows that the high inter-rater agreement which was achieved in this study, was due to mainly the true negatives.

In this study the validation team visited the nursing homes on a one day basis, in order to assess all residents on having an infection according the SNIV definitions. The local surveyors were unaware of this validation study since it was coupled to the HALT study. The blind assessment of the validation team and the surveyors as well as using the nurses to obtain the information for diagnosing the residents according the SNIV definitions are strong points of this study. A thesis of a student in 2009

has shown that nurses play a key role in the care of the elderly residents, they notice changes in behavior and the well-being of the residents (15). These points makes the chance on observer bias relatively small, because the local surveyors collect the data the same way they are used to do every week. Collecting the data on site is also a strong point.

A limitation of this study is that in advance the SNIV team asked the surveyors to fill in the register form just before the validation visit and add names tot the register form, unfortunately this was not done by the surveyors. Probably because they were unaware of the validation study and could not see the reason for doing this or a lack of time. This made it impossible to discuss the discrepancies with the elderly care responsible for SNIV registration. The weekly registration in OSIRIS is used to assess the discrepancies between the surveyors and the validation team, the advantage is that the data was collected exactly the same way as in the other weeks but the disadvantage is the time-delay between the two measurements and that it was impossible to prove whether the same patients were diagnosed with an infection by the validation team and the local surveyors. This however appeared to be only of limited effect due to the low prevalence of infection.

To our knowledge, this current study is the first in validation infectious disease surveillance in nursing homes in the Netherlands. Available literature on similar studies done in Europe is limited. The only countries in which a surveillance system of infectious diseases in nursing homes is found, are Germany and Norway (22, 23). However, none is reported about the validation of these surveillance systems. Several studies have established the validation of surveillance systems of nosocomial infections in hospitals, by reviewing medical records by a validation team containing trained people as golden standard. Most of these studies used a retrospective approach to assess the validity (17, 18, 24-27).

Validation studies in the future prefer a higher prevalence of infectious diseases in nursing homes to ensure plausibility and reliability of the data. The sample size should be adjusted to the prevalence of the infections in the target group. There are some possible solutions; the study can be conducted in the winter season, depending on outbreaks for a prevalence high enough. Another option is to repeat this study several weeks in a row, however the disadvantage is that this is very time consuming. The best option would be to select the positive cases retrospective, however this is not possible because of the anonymous registration of the infectious diseases in the nursing homes and the absence of electronic patient records.

Another possibility for validation studies in the future is the use of other measure alternatives. However, the predictive values give the probability that the elderly care physicians give the right diagnoses by using the clinical definition, which is what this validation study is all about. To our knowledge the the positive and negative predictive value are the best option because they determine the quality of the test and approach the reality in practice the most (19).

Concluding from this study; validation is not feasible in the current setting. The possibility of the use of arbitrary cases for validation study should be considered. This is certainly recommended when the main goal of the validation is to raise attention for the use of the definitions in practice. More research has to be done to determine possible factors that can influence the way of diagnosing by the local surveyors.

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Annex 1, HALT study

European Point Prevalence Survey on Healthcare Associated Infections and Antibiotic use in Long-Term Care Facilities.

USERGUIDE

FOREWORD

The aim of the HALT-project is to develop and implement a sustainable methodology to estimate the prevalence of healthcare associated infections, antimicrobial resistant micro-organism and antimicrobial use in Long Term Care facilities in Europe. Thus, future trends in European nursing homes could be monitored and the needs for intervention, training and/or additional infection control resources identified, to foster the safety of the residents in nursing homes and the ageing population in general.

The first action to reach these objectives is represented by the ‘European Point Prevalence Survey of Healthcare Associated Infections and Antibiotic use in Long-Term Care Facilities’.

WARD LIST, see appendix 3

The ward list is provided to facilitate the collection of denominator data in the participating nursing homes, required for the institutional questionnaire. It is not compulsory, but it can be help for adding up in each ward the aggregated data necessary for the institutional questionnaire.

RESIDENTS QUESTIONNAIRE

A resident questionnaire has to be completes only for residents with signs/symptoms of an infection and/ore for residents using an antibiotic on the day of the PPS.

INSTITUTIONAL QUESTIONNAIRE

Each participating nursing home has to complete the institutional questionnaire. This is essential for the study to collect important structural & functional characteristics, denominator data and information about antibiotic and infection control practices in the participating institution. This questionnaire contains the topics: general information, denominator data, medical care and co-coordinator, infection control practice in the facility and antibiotic policy.

Annex 2, Register form SNIV

Registratieformulier voor intern gebruik
SNIV (<http://www.sniv.nl>)



Code vph	Afdeling/Totaal vph *	Week

Leeftijdscategorie	Gastro-enteritis	Influenza-Achtig Ziektebeeld (IAZ)	Vermoedelijk Pneumonie	Sterfgevallen
< 60				
60-64				
65-74				
75-84				
≥ 85				
	Vermoedelijk sprake van een uitbraak? JA / NEE*	Vermoedelijk sprake van een uitbraak? JA / NEE*	Hoeveel monsters opgestuurd naar MML? AANTAL:	
		Hoeveel cliënten behandeld met Tamiflu/ anti-virale middelen? AANTAL:	Hoeveel cliënten doorverwezen naar het ziekenhuis? AANTAL:	
		Monsters opgestuurd naar MML? JA / NEE*		
		Monsters opgestuurd naar RIVM? JA / NEE*		

* Doorhalen wat niet van toepassing is.

Invoeren in Osiris : <http://osiris.rivm.nl/sniv>

Opmaakdatum d.d.:.....

Weeknummer :

Annex 4, SNIV-form

SNIV-formulier

Naam bewoner:.....

Welke infectieziekt(en) zijn bij de bewoner gediagnosticeerd:

- Gastro-enteritis
- Influenza-achtig ziektebeeld
- Vermoedelijk pneumonie

Graag aankruisen indien van toepassing

Gastro-enteritis (non-infectieuze oorzaak uitgesloten)						
OF 3 of meer malen per dag dunne ontlasting, afwijkend van normaal voor deze persoon						
OF dunne ontlasting en 2 van de volgende symptomen:	Koorts	braken	misselijkheid	buikpijn	buikkrampen	bloed of slijm bij de ontlasting
OF braken en 2 van de volgende symptomen:	Koorts	misselijkheid	buikpijn	buikkrampen	bloed of slijm bij de ontlasting	
OF 3 maal braken binnen 24 uur (zonder verder bijkomende klachten EN indien braken niet samenhangt met medicijngebruik)						

Influenza-achtig ziektebeeld					
Acuut begin van de symptomen					
EN tenminste één van de volgende systemische symptomen:	koorts	koortsachtig gevoel	malaise	hoofdpijn	myalgie
EN tenminste één van de volgende drie respiratoire symptomen:	Hoest	zere keel	Benauwdheid/ kortademigheid		

Vermoedelijk pneumonie							
minimaal één van de onderstaande symptomen, als deze optreden als verandering ten opzichte van de daarvoor bestaande situatie en andere waarschijnlijkheidsdiagnoses uitgesloten:	tachypnoe	malaise	verwardheid	Kortademigheid	hoesten (productief of niet productief)	koorts > 38°C of koorts in de afgelopen 48 uur	pijn in de borst (bij ademhaling)
EN met nieuwe focale (eenzijdige) afwijkingen bij auscultatie van de longen							