Compliance to Hand Hygiene Guidelines in Hospital Care

A stepwise behavioural approach

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Compliance to Hand Hygiene Guidelines in Hospital Care

A stepwise behavioural approach

Handhygiëne Compliance in het Ziekenhuis
Een stapsgewijze gedragswetenschappelijke benadering

Proefschrift

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op gezag van de rector magnificus

Prof.dr. H.G. Schmidt

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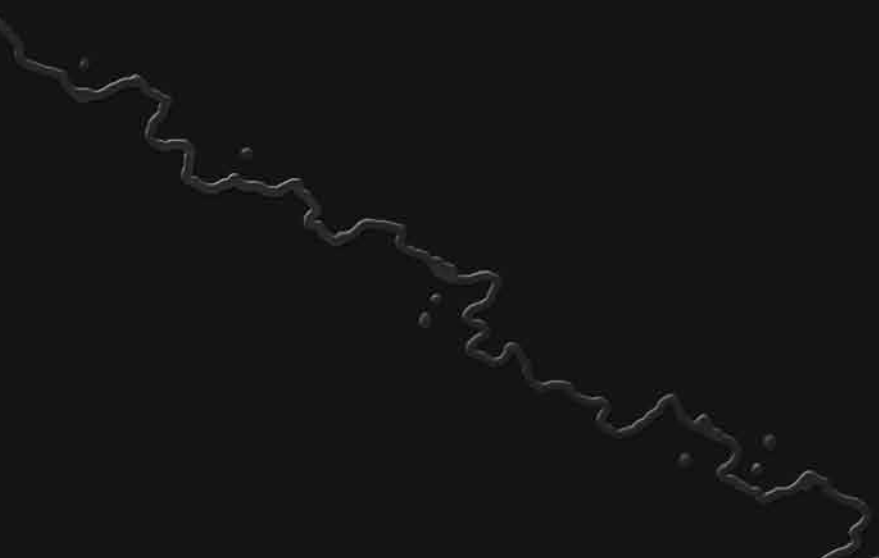
General introduction



INTRODUCTION

Healthcare associated infections (HAI) are a threat to the health of people requiring acute or chronic care. Since HAI can often be avoided by taking preventative measures, including proper application of hand hygiene principles, the prevention of these infections has received growing attention over the past decades. However, the application of preventive measures in clinical practice remains problematic and the observed compliance with such measures is often poor. Hand hygiene is one such area where compliance needs to be improved. To be able to develop successful interventions for the improvement of hand hygiene, it is essential to identify the factors influencing hand hygiene behaviour, and to investigate which interventions best target these factors.

This thesis reports on a number of studies on the identification of behavioural and environmental correlates of hand hygiene behaviour among healthcare workers, and the translation of these determinants into an intervention. This chapter describes the background, aims and theoretical framework used, and presents an introduction to the individual studies that are part of this thesis.

Adverse events and healthcare associated infections

In modern health care systems, adverse events have been recognized as an important but largely avoidable threat to patients.[1] In the United States it is estimated that adverse events result in 44,000-98,000 deaths each year.[1] A Dutch report published in 2007, showed that of the 1.3 million patients admitted to Dutch hospitals in the year 2004, 2.3% were the victim of one or more preventable adverse events, resulting in 1,735 potentially avoidable deaths.[2] Over the last decades, this recognition has led to the launch of several national and international projects aimed at improving patient safety.[3-5] One of the areas receiving much attention is the prevention of HAI, one of the most common types of adverse events.[6] At any time, over 1.4 million people worldwide develop infectious complications associated with healthcare.[7] HAI occur across the globe, with an estimated pooled prevalence of 7.6% in mixed patient populations in high-income countries. Only few data are available from developing countries, but generally the reported HAI rates in low resource settings are higher (estimated pooled prevalence of 20.1%) than in high-income countries. The risk of acquiring HAI is significantly higher than in other health care settings.[8] This leads to a considerable burden of disease and mortality. It has been estimated that HAI are responsible for 80,000 deaths in the United States and 5,000 deaths in the United Kingdom.[9] Although global estimates of the burden of HAI are not yet available, there is clear evidence by extrapolating the results from published studies that yearly hundreds of millions of people are affected by HAI and that the burden of disease due to HAI is much higher in low- to middle-income countries.

The current societal burden in the Netherlands remains very large, since about 1.5 million hospital admissions annually occur and national surveillance has shown a prevalence rate of HAI of 8%.[10] This means that each year about 120,000 persons in The Netherlands are affected by an HAI. According to recent estimates, this leads to 1,000 cases of excess mortality in The Netherlands each year.[11]

Hand hygiene and infection prevention

Over the past two decades, improving patient safety has received growing attention, and one of the first goals of the World Health Organization's World Alliance for Patient Safety is the substantial reduction of HAI. To reach this goal, significant improvement in the compliance of healthcare workers (HCWs) with hand hygiene guidelines is considered to be crucial.[7] Observed compliance rates among HCWs have been regarded by health authorities as unacceptably poor.[12] Hand hygiene (i.e. washing hands with soap and water, or disinfection using an alcohol-based hand rub) is considered one of the most important measures to prevent HAI infections and to limit the spread of antimicrobial-resistant pathogens and subsequent HAI.[13] Adequate hand hygiene can substantially avoid HAI, in particular those that are exogenous in nature, i.e. the consequence of the transmission of pathogens from patient to patient or from the environment to patients.[14] Internationally, between 15 and 30% of HAI are considered preventable by improved hand hygiene.[15] Application of this figure to the Dutch context indicates that improved hand hygiene has the potential to annually avoid 18,000-36,000 HAI in the Netherlands. However, more recent evidence suggests that even a higher proportion of HAI, 50% or more, are preventable.[8] This increases the potential to avoid HAI in the Netherlands to 60,000 each year.

The need for significantly improving hand hygiene is further stressed when considering the fight against the emergence of multiple antibiotic-resistant bacteria. Prominent examples are *Pseudomonas aeruginosa* and members of the *Acinetobacter spp*, which during the past three decades has emerged from an organisms of limited pathogenicity to infectious agents of importance to hospitals worldwide.[16] Since the new millennium multi-hospital outbreaks in temperate climates are increasingly reported, including several outbreaks in the Netherlands. In order to avoid a further increase of this type of resistant bacteria in hospitals and to avert increasing numbers of unnecessary victims, improved hand hygiene is of paramount importance.

In order to facilitate adequate hand hygiene, international guidelines have been developed stating when hand hygiene is required, the so-called five moments for hand hygiene.[17,18] These guidelines state that hand hygiene is required before and after patient care, after possible contact with bodily fluids, after contact with the direct patient environment and just prior to executing aseptic tasks.[18] The preferred method for performing hand hygiene

is alcohol based hand rub, rather than soap and water, since it is easier and quicker to use.[17]

However, compliance with these guidelines remains low, with observed rates often falling below 50%.[19] To address the problem of low compliance, many interventions have been designed and evaluated, but the effects of these interventions are often moderate and short lived.[20,21] Grol and Grimshaw made an inventory of the most common interventions used to improve hand hygiene practices and described that educational interventions have only short term effects, reminders have a sustained but only modest effect, and performance feedback may be effective, but only so long as feedback is continued.[15] They concluded that a comprehensive plan, targeting problems and barriers to change with strategies at different levels (professional, team, patient, and organisation) is needed to achieve lasting changes in hand hygiene routines.

Adherence to medical guidelines in general is a similar problem, and several studies have investigated the reasons for non-adherence to often evidence based measures and guidelines.[22-24] Adherence to many guidelines is low, even though it is essential to improve health outcomes.[25] Weingarten *et al.* found that although physicians were positive about the added value of guidelines, this did not result in them applying the guidelines in practice. However the feeling that a guideline had changed the way you work in practice (i.e. shaped a new habit) was positively associated with guideline adherence.[24] These results indicate that intention alone is not sufficient to apply guidelines in practice, and there was a need to further investigate the mechanisms at play. Ham *et al*. later divided the factors that influence guideline adherence into three groups: patient, physician and system factors.[23] More recently, Cabana *et al.* conducted a systematic literature review and classified barriers for adherence into factor influencing knowledge (i.e. lack of familiarity or awareness), attitudes (lack of agreement, outcome expectancy, self-efficacy, motivation) and behaviour (patient, guideline and environmental factors, such as time and resources) and suggested that a theoretical framework including factors from these three dimensions could best be used to improve adherence.[22] Based on their review of 76 studies on factors influencing guideline adherence, this model was considered best suited to explain the mechanisms at work. This call for insights from the behavioural sciences in understanding guideline adherence in general, can be applied in the same way in order to understand adherence to hand hygiene guidelines.[26]

Hand hygiene improvement from a behavioural perspective

To be able to effectively improve compliance rates, it is important to follow a planned and stepwise approach to the development of interventions,[27] using insights from the behavioural sciences.[26,28] Compliance with hand hygiene guidelines in health care is considered

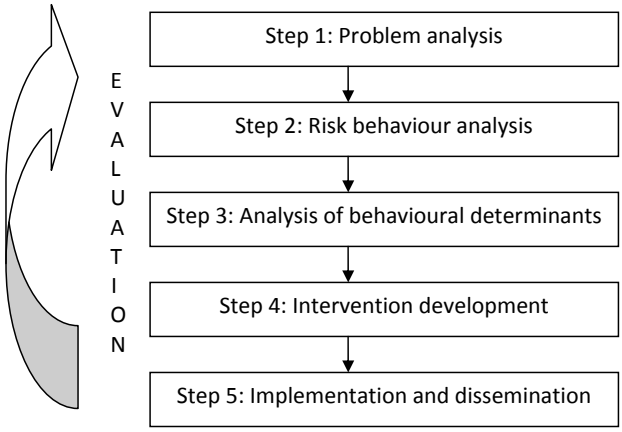


Figure 1.1. Model of planned health education and promotion[30]

preventive behaviour and should be approached as such.[29] In order to make optimal use of the limited resources available, interventions should be planned according to a stepwise behavioural approach using planning models (figure 1.1).[27,30] The first step in this model is identifying prevalent health problems. Subsequently the prevalence of the risk behaviour (i.e. non-compliance), the differences in risk behaviour between target populations (i.e. physicians, nurses, as well as other healthcare workers who have contact with patients) associated with this health problem should be identified. The third step involves identifying the determinants of the risk behaviour. In the fourth step these determinants are translated into interventions, which are implemented in the fifth step. During the entire process each step should be evaluated. This thesis will focus on steps 2, 3 and 4 of the model.

Theoretical model

In order to study the determinants of hand hygiene behaviour (Step 3) an explanatory theory of behaviour was used, the Theory of Planned Behaviour. The Theory of Planned Behaviour (TPB)[31] is an adaptation of the Theory of Reasoned Action,[32] and describes that observed behaviour is predicted by the intention to perform the behaviour, which is in turn influenced by behavioural attitudes (i.e. perceptions of different positive and negative consequences of hand hygiene compliance), subjective norms (i.e. the perceived opinion of others concerning hand hygiene compliance) and perceived behavioural control (the conviction that you could execute the behaviour required to produce the outcome). Perceived behavioural control can influence both the intention to perform the behaviour as directly influence the behaviour itself, as can be seen in figure 1.2.

The TPB has previously been used by O'Boyle *et al*. to study hand hygiene behaviour.[33] So far, the determinants of the two professional groups working in healthcare (i.e. physicians

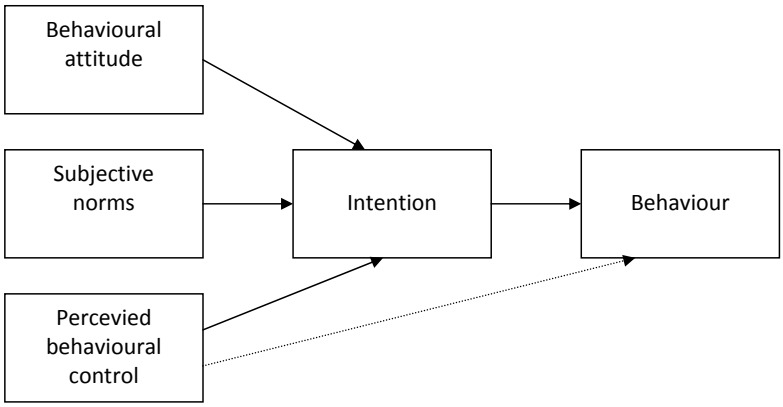


Figure 1.2. Theory of Planned behaviour[31]

and nurses) have not yet been investigated separately, even though a number of studies have shown that results for these two groups are not equal, with interventions being more successful for nurses.[34-36] This thesis therefore focuses on three groups of healthcare workers: physicians, nurses and medical students. Furthermore, the amount of variance explained by the model has rarely been reported, and it therefore remains unclear how effective this theory is in predicting hand hygiene behaviour. The factors included in the TPB are all rational and conscious decision-making factors, whereas some behaviours might be automatic and not the result of the conscious evaluation of possible outcomes.[37] Furthermore, behaviour can be influence by environmental factors, not included in the TPB. In order to develop successful interventions other factors possibly influencing hand hygiene behaviour would also have to be explored.

Outline of the thesis

The aim of this thesis is to contribute to systematic evidence based research of individual and environmental correlates of hand hygiene behaviour of healthcare workers, and develop an intervention based on the associations found. The work described in this thesis focussed on the determinants of hand hygiene behaviour and the development of interventions targeting the factors that influence it (steps 2, 3, and 4 of figure 1). The central research questions addressed are:

I. To what extent are the hand hygiene guidelines currently adhered to and what are the important individual and environmental correlates of this behaviour?

II. How can effective interventions be designed to improve hand hygiene behaviour in practice?

The thesis is divided into two parts. In part one the risk behaviour itself and the behavioural and environmental correlates of hand hygiene are explored (Steps 2 and 3 of the planned model). **Chapter two** describes a systematic review of the literature on hand hygiene compliance studies. In the study described in **chapter three** a qualitative exploration of the correlates of hand hygiene behaviour was conducted. **Chapter four** describes an investigation of the observed and self-reported correlates of hand hygiene behaviour. **Chapter five** investigated these correlates for a cohort of final year medical students, in order to identify how best to target this group.

In part two, knowledge of the behavioural correlates is applied in a number of studies exploring possible interventions to improve this hand hygiene behaviour in practice (Step 4). **Chapter six** deals with a Delphi study aimed at identify the most important and most changeable determinants of hand hygiene from an expert perspective. **Chapters seven and eight** focus on interventions aimed at improving hand hygiene behaviour. **Chapter seven** describes an experiment to explore the effectiveness of action planning in influencing the hand hygiene behaviour of nurses. **Chapter eight** describes the design and development of a novel alcohol based hand rub dispenser to facilitate and induce hand hygiene behaviour. Finally, a multi model intervention package was developed and a study set up to investigate its effectiveness, as described in **chapter nine**.

In the general discussion a summary of the main findings of this thesis and recommendations for further research and practice are provided.

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Chapter 2

Systematic review of studies on complianceto hand hygiene guidelines in hospital care

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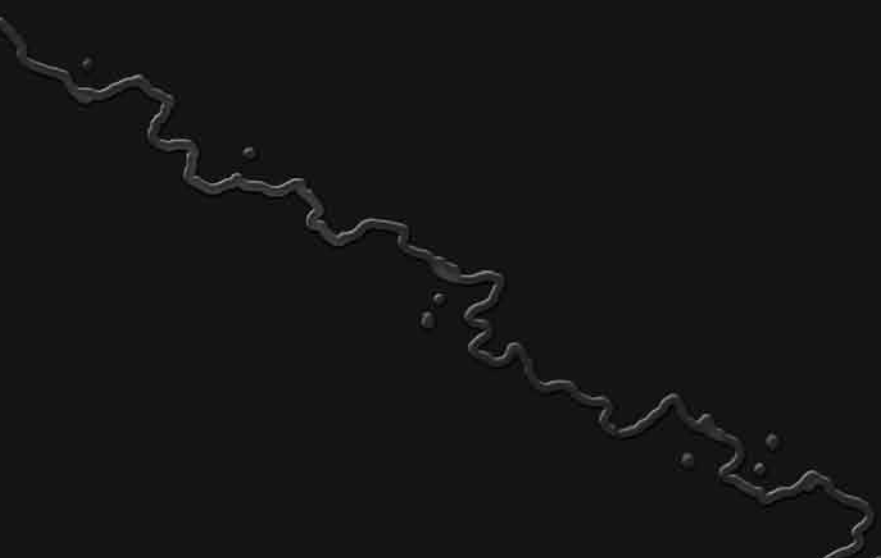

ABSTRACT

The objective of this study was to assess the prevalence and correlates of (non)compliance to hand hygiene guidelines in hospital care. A systematic review of studies published before 1st January 2009 on observed or self-reported compliance rates was conducted. Articles were included on empirical studies written in English, conducted on general patient populations in industrialized countries. The results were grouped by type of health care worker before and after patient contact. Correlates contributing to compliance were grouped and listed. We included 96 empirical studies, the majority (n= 65) in the intensive care unit. In general, the study methods were not very robust and often ill reported. We found an overall median compliance rate of 40%. Unadjusted compliance rates were lower in the ICU (30-40%) compared to other settings (50-60%), among physicians (32%) compared to nurses (48%), and before (21%) compared to after (47%) patient contact. Situations with a high activity level and physicians (lower compliance) and dirty tasks, introduction of hand alcohol, performance feedback and accessibility of materials (higher compliance) were (in majority) associated with compliance rates. A minority of studies (n=12) have investigated the behavioral determinants of hand hygiene, of which only seven report the use of a theoretical framework with inconclusive results. Non-compliance to hand hygiene guidelines is a universal problem, which calls for standardized measures for research and monitoring. Theoretical models from the behavioral sciences should be internationally used and adapted to better explain the complexities of hand hygiene.

INTRODUCTION

Hospital-acquired, or nosocomial, infections are a major threat to patients. At any time, over 1.4 million people worldwide develop infectious complications associated with healthcare.[1] Universally across the globe, 5-10% of patients acquire nosocomial infections, with prevalence rates of 20-30% for patients admitted to an Intensive Care Unit (ICU). This leads to a considerable burden of disease and mortality. It has been estimated that hospital- acquired infections are responsible for 80,000 deaths in the United States and 5,000 deaths the United Kingdom.[2]

Over the past two decades, improving patient safety has received growing attention, and one of the first goals of the World Health Organization's World Alliance for Patient Safety is the substantial reduction of hospital-acquired infections. To reach this goal, improvement in compliance with hand hygiene guidelines is needed. Observed compliance rates among healthcare workers (HCWs) have been regarded by public health authorities as unacceptably poor.[3] Hand hygiene (i.e. washing hands with soap and water, or disinfection using alcohol-based hand rub) is considered the most important measure to prevent nosocomial infections and the spread of antimicrobial-resistant pathogens and subsequent nosocomial infections.[4] Over the past several decades, various campaigns promoting hand hygiene have been launched, but substantial and lasting effects on compliance rates have hardly been reported.[5]

To be able to effectively improve compliance rates, it is important to follow a planned and stepwise approach to the development of interventions, using insights from the behavioural sciences.[6] Compliance with hand hygiene guidelines in healthcare is considered a preventive behaviour and should be approached as such.[7] A first step toward the development of interventions should be to identify the prevalence of the risk behaviour (i.e. non-compliance), the differences in risk behaviours between target populations (i.e. physicians, nurses as well as other HCWs who have contact with patients), as well as the determinants of the risk behaviour.[6] General overviews of hand hygiene compliance rates have been reported in previous reviews,[8-12] but compliance across studies has not yet been quantified for specific settings (e.g. ICU versus non-ICU ward) or for specific parts of the guidelines (e.g. before and after patient contact). Moreover, the relative importance of factors influencing compliance and noncompliance has not yet been documented in a systematic review.

We conducted a systematic literature review of observed and self-reported compliance rates with hand hygiene guidelines in healthcare. We focused our review on hospitals, because the risk for acquiring and spreading infection is most substantial in this setting.

We addressed the following research questions:

1. Which settings have been studied and which methods have been used to measure hand hygiene compliance rates in hospital care?
2. What hand hygiene compliance rates have been reported in general and for different HCWs, settings and situations?
3. Which correlates of compliance and noncompliance with hand hygiene guidelines have been identified?

METHODS

Data sources and search strategy

Searches for eligible studies were conducted using the Medline (PubMed), PsycINFO and Web of Science databases. All articles published prior to January 1, 2009 were included in the searches. The search terms used were: "hand hygiene, hand washing, guideline adherence, compliance, standard precaution, general precaution, nosocomial infection, hospital acquired, and infection control". Keywords were matched to database-specific indexing terms. The search strategy was verified by hand searches, by checking whether three key articles[13-15] from our personal database (which should be selected by use of the search strategy) were actually retrieved during the search. In Medline (PubMed) the "related articles" of these key papers were retrieved and added to the search database.

Selection criteria

Studies included in the review met the following criteria: the subjects of study were HCWs caring for patients from the general hospital population; compliance to hand hygiene guidelines was measured, either by self-reporting or observation; empirical studies were included; the samples were taken from countries with established market economies, as defined by the World Bank; and the articles were published in English.

Selection procedure

Relevant papers were selected by screening the titles (first step), abstracts (second step) and entire articles (third step) retrieved during the database searches. During each respective step respectively the title, abstract or entire article was screened to ensure that it met the selection criteria listed above. This screening was conducted independently by two researchers (V.E. and E.F.v.B.). Disagreement between the reviewers about eligibility was resolved through discussion.

Data extraction and management

Data were extracted from the included studies by the two researchers (V.E. and E.F.v.B) and entered into a Microsoft Access database. The findings (i.e. the compliance rates and their underlying factors) and methodological details of each study (e.g. design, setting, sample size, type of HCWs included in the sample, type of compliance measurement (i.e. observed or self-report), characteristics of the measurement instrument, data analysis and country) are listed in tables 1-4. All the characteristics of the studies that were reviewed are shown in table 2.1.

Summarizing study findings

The compliance rates measured were grouped into intervals and listed in table 2.2 and 2.3. Furthermore, information of the setting (i.e. ICU or general ward) and sample (i.e. type of HCWs studied) is given. Specific distinctions were made between compliance rates measured by means of observation and compliance rates measured by means of self-reporting; between three groups of HCWs (i.e. physicians, nurses and other HCW), and between before and after patient-contact situations. These results are also presented in graphic form in figure 2.1. The underlying factors for hand hygiene performance that were found in the studies were grouped and listed separately (table 2.4).

RESULTS

Selected papers

The database search identified 3,264 titles: (Medline (PubMed) 2,543 titles; PsycINFO 13 titles; Web of Science 708 titles). Searching in PubMed for articles related to three key papers[13-15] added an additional 548 titles. This resulted in 2,727 unique titles of articles of potential relevance to the review. Screening of the titles and abstracts resulted in a selection of 215 articles that appeared to meet all the selection criteria. One hundred and fifteen of these articles did not meet the inclusion criteria after they had been fully read, resulting in final inclusion of 96 articles.

Included studies

Studies were included if they met the five selection criteria mentioned in the methods section. Each step of the selection process resulted in the following: 2727 titles screened, 667 titles included; 667 abstracts screened, 215 abstracts included; and 215 papers screened, 96 papers included.

Study characteristics

Hospital settings and HCWs studied

In the majority of studies (n=65), hand hygiene compliance was studied in the ICU setting (table 2.1). Compliance rates and their determinants have been studied less frequently in both general (n=32) and surgical wards (n=22). Information on compliance rates for three

Table 2.1. Characteristics of studies included in the review[1]

	References	*Samples (n)*
Setting		
ICU	[2, 15-79]	65
General ward	[15, 26, 27, 29, 33, 45, 50, 51, 60-62, 69, 70, 72-75, 78-83]	23
Surgical ward	[15, 29, 32, 33, 35, 45, 50, 51, 60-62, 69, 70, 72-75, 78-81, 84]	22
Other	[15, 25, 40, 45, 49-51, 55, 57, 58, 60, 62, 69, 70, 72-75, 78-80, 85-100]	37
Unknown	[14, 101-109]	10
Sample type (HCW)		
Nursing staff only	[14, 21, 29, 39, 49, 62, 82]	7
Physicians only	[15, 73, 79, 85, 91, 97]	4
Other HCW only	[86, 92, 103, 106]	4
Nursing staff + physicians	[41, 42, 44, 48, 63, 65, 66, 71, 83, 87, 94, 98, 108]	10
Nursing staff + physicians + other	[16-20, 22, 23, 25-28, 30-34, 36-38, 45-47, 50-54, 57, 58, 60, 61, 64, 67-70, 72, 75, 76, 78, 80, 81, 84, 90, 93, 95, 100-102, 104, 105, 107]	46
Physicians + other		
Nursing staff + other	[43, 88, 89, 96]	4
Unknown	[24, 35, 40, 55, 56, 59, 74, 77, 99, 109]	7
Sample size (HCW)		
<20	[82, 98, 109]	3
20-40	[20, 43, 73, 86, 88, 94]	6
40-60	[21, 36, 53, 56]	4
>60	[14, 15, 25, 27-29, 33, 45, 48-50, 57, 64, 65, 70, 72, 78, 81, 87, 91, 92, 95, 96, 101-103, 106]	27
Unknown	[16-19, 22-24, 26, 30-32, 34, 35, 37-42, 44, 46, 47, 51, 52, 54, 55, 58-63, 66-69, 71, 74-77, 79, 80, 83-85, 89, 90, 93, 97, 99, 100, 104, 105, 107, 108]	56
Sample size (observations)		
<100	[21, 63, 86, 98, 109]	5
100-500	[19, 20, 36, 43, 45, 46, 54, 58, 79, 82, 84, 85, 90-94, 97, 101, 103, 104, 107]	22

Table 2.1. (*continued*)

	References	*Samples (n)*
500-1500	[15, 18, 23, 25, 27, 30, 37, 38, 47, 49, 52, 56, 60, 61, 65, 67, 68, 71, 81, 83, 88, 100, 102, 105, 106]	25
1500-2500	[17, 22, 26, 28, 41, 64, 75, 108]	8
2500-5000	[24, 31, 34, 39, 50, 76, 78, 80, 89, 95]	10
> 5000	[32, 40, 51, 66, 69, 99]	6
Unknown	[16, 29, 35, 42, 44, 53, 55, 57, 59, 62, 72-74, 77]	14
Not applicable (self-report)	[14, 33, 48, 70, 87, 96]	6
Study design		
Cross-sectional	[14, 15, 18, 24, 27, 29, 33, 36-38, 44, 45, 47-50, 56, 58, 60, 61, 64, 68, 70, 73, 78, 79, 81, 82, 85-89, 91, 93-96, 98, 101, 103, 104, 107-109]	45
Before-after study	[16, 17, 19, 20, 23, 25, 26, 30, 34, 35, 39, 41-43, 46, 51-55, 57, 59, 62, 63, 65-67, 69, 72, 74, 75, 77, 80, 84, 90, 92, 97, 99, 100, 102, 105]	41
Other	[21, 22, 28, 31, 32, 40, 71, 76, 83, 106]	10
Assessment of compliance		
Observed	[15-19, 21-25, 27-32, 34-38, 40-44, 46, 47, 50-53, 80, 82, 84-86, 88-90, 92-95, 101, 102, 104-10626, 55-69, 71-79, 81, 83, 97-100, 108, 109]	82
Self-report	[14, 33, 48, 70, 87, 91, 96]	7
Observed + self report	[20, 39, 45, 49, 54, 103, 107]	7
Reliability instrument		
Unknown/not reported	[14-17, 19, 21, 24-30, 33-38, 41, 42, 44-48, 52-54, 82, 84-96, 101-10755-65, 67, 68, 70-76, 78, 79, 83, 97-100, 108, 109]	79
>0,7	[18, 20, 22, 23, 31, 32, 39, 40, 43, 49-51, 66, 69, 77, 80, 81]	17
Data analysis		
Univariate	[16-18, 20, 21, 23-25, 29, 30, 33, 35-37, 40, 43-45, 47, 51, 53, 57, 58, 62, 65, 77-79, 81-83, 88, 90, 91, 94, 96, 99, 102-104, 107, 108]	42
Multivariate	[14, 15, 22, 27, 28, 31, 32, 34, 38, 39, 48-50, 66-70, 73, 75, 76, 80, 87, 89, 93, 95, 100, 106]	28
Frequencies	[19, 26, 41, 42, 46, 52, 54-56, 59-61, 63, 64, 71, 72, 74, 84-86, 92, 97, 98, 101, 105, 109]	26
Country		
Europe	[15, 20, 24-27, 29, 34, 41, 42, 44, 45, 48, 50, 51, 56, 64, 66, 67, 70, 78, 81, 83, 84, 86, 88, 89, 91, 92, 95, 98, 102, 105, 107, 108]	35
USA + Canada	[14, 16-19, 21-23, 28, 31-33, 36-40, 43, 46, 49, 52-55, 60, 61, 63, 65, 68, 69, 72, 75-77, 80, 82, 85, 87, 90, 93, 94, 96, 97, 99-101, 103, 104, 106, 109]	50
Australia	[30, 35, 57-59, 62, 71, 73, 74]	9
Asia	[47, 79]	2

[1] The number of samples does not always add up to 96 in those categories where more than one option is possible i.e. a study that takes place in both the ICU and surgical ward appears in both rows.

types of HCWs has been collected in the available studies, (i.e. for physicians, registered nurses and other HCWs), although a number of studies do not specifically mention which HCWs were studied. The majority of studies (n=46) have taken combined samples of the three types of HCWs.

Sample sizes and study designs

With respect to the sizes of the samples studied, a very large variation was present in both the number of HCWs included in the study (7–1,050), and the number of observations (19–20,082) included in the study. The majority of studies (n=56) refrained from mentioning the number of HCWs included. Most studies (n=76) reported the number of observations, showing a tendency towards samples between 500-1,500 observations. Cross-sectional studies (n=45) and before-after intervention studies (n=41) were roughly equally represented. All compliance rates derived from before-after studies in the present review are based on data collected prior to the intervention.

Measurement of compliance rates

Compliance was measured using direct observation by a trained observer, and/or self-reporting by an HCW. In all studies, compliance was defined as the percentage of opportunities for which HCWs adhered to hand hygiene guidelines, in other words a compliance rate of 50% means hand hygiene was performed in one-half of the opportunities for hand hygiene according to guidelines. All observational studies used some type of self-developed scoring form to directly observe hand hygiene compliance. A few studies (n=9) also assessed compliance by means of self-reporting, using self-developed questionnaires. Only a minority of studies (n=17) mention any form of reliability testing, all studies reporting reliability testing showed good results (Cronbach α, >0.7). Compliance was reported in different ways (i.e. before patient contact, after patient contact, as an average of possible events or a combination of these).

Compliance rates

Overall compliance rates (i.e. the sum of all events in which hand hygiene was performed divided by the sum of all possible hand hygiene events) measured in the included studies ranged from 4-100%; whenever possible, this rate was calculated per type of HCW, otherwise the results are designated as "Type of HCW unknown". Table 2.2 provides an overview of overall compliance rates by type of HCW. This table shows that compliance rates higher than 50% were found among 41% of samples of nurses, 20% of physicians, 47% of other HCWs and 25% of HCWs of unreported profession.

Across all professions, 25% of studies reported overall compliance rates higher than 50%. The majority of studies used direct observation (see figure 2.1), providing a median overall

Table 2.2. Observed baseline overall compliance rates by profession[1]

	Nurses			*Physicians*			*Other HCWs*			**HCW type unknown All HCWs**		
	References	**(n)**		**References**	**(n)**		**References**			**References**	**(n)**	
Compliance rate		Samples	%		Samples	%		Samples	%		Samples	%
<20%	95	1	3%	71 73 78 93 95 97 110 111	8	18%	37 57 61 67 78 104 111	7	16%	26 78 102 109	4	11%
20-30	21 29-32 37 78	7	17%	23 37 38 57 64 67 76 105	8	18%	57 69 76	3	7%	18 24 26 35 52 54 55 63 74	9	25%
30-40	60 61 67 71 76 83 104	7	17%	20 31 32 41 50 53 57 60 69 76 83 90 91 104	14	31%	57 58 68 71 76 83 95	7	15%	16 24 26 34 40 93 99 101	8	22%
40-50	23 27 41 53 64 68 69 76 105	9	22%	30 42 57 61 65 68	6	14%	30 50 57 58 64 105 106	7	16%	16 22 24 26 66 100	6	16%
50-60	20 38 39 42 50 65 90 93 110	9	22%	15 58 79	3	7%	23 27 31 46 53 57 58	8	18%	56 59 77 108	5	14%
60-70	25 46	2	5%	58 72	2	4%	20 25 32 57 58 90	6	13%	43 52	2	6%
70-80	49 57 111	3	7%	58 75	2	4%	57 58 72 75 98	5	11%	45 47	2	6%
>80%	58 72 75	3	7%	46 58	2	4%	57 58	2	4%		0	

[1] Calculated by dividing the sum of all moments hand hygiene was performed by the sum of all possible hand hygiene moments. Whenever possible this was calculated per type of HCW, otherwise the results can be found in the column "HCW unknown". With intervention studies only baseline data was used.

baseline compliance rate across all settings, situations and HCWs of 40%. With respect to the study design, 45 studies were cross-sectional and 41 had a before-after intervention design (table 2.1). The median compliance rate reported in cross-sectional studies was somewhere in the range of 30-40%. For before-after intervention studies the median baseline compliance was somewhere in the range of 40-50%.

Sixty-five studies measured and reported observed compliance rates for the ICU, with a median compliance rate somewhere in the range of 40-50%. Of these studies, 28% reported compliance rates higher than 50%. In comparison, the median compliance rate measured in the non-ICU wards was somewhere in the range of 50-60%.

The studies reviewed showed lower compliance among physicians than among nurses and other HCWs; 9 studies reported compliance rates of greater than 50% (median 32%) among physicians. In comparison, 17 studies reported compliance rates of greater than 50% (median 48%) among nurses. The group designated 'Other HCWs' had an overall median compliance of 40-50% (table 2.2).

In 35 studies, compliance rates were measured both before and after patient contact. There were large differences, with hand hygiene compliance by all HCWs before patient contact showing a median of 21%, whereas compliance after patient contact was higher,

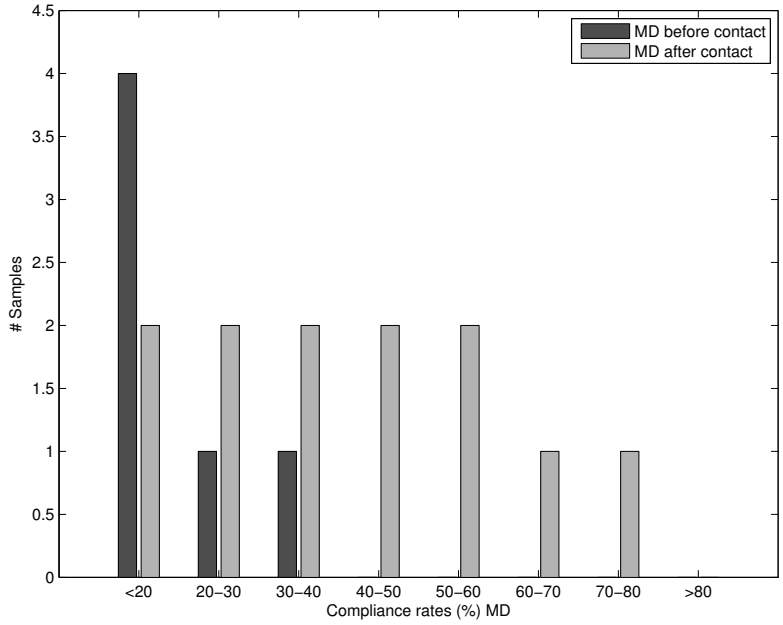

Figure 2.1. Observed baseline compliance rates among physicians (MDs) before and after patient contact.

Table 2.3. Observed baseline compliance rates before and after patient contact by profession[1]

	Nurses			*Physicians*			*Other HCWs*			**HCW type unknown**		
	References	**(n)**		**References**	**(n)**		**References**	**(n)**		**References**	**(n)**	
*Compliance rate **before** patient contact*												
<20%	19 28	2	29%	19 28 81 107	4	67%	19 28	2	40%	17 38 88 89	4	67%
20-30	81	1	14%	80	1	17%	80 81	2	40%	107	1	17%
30-40				52	1	17%				84	1	17%
40-50	62 80	2	29%				52	1	20%			
50-60	52	1	14%									
60-70	49	1	14%									
70-80												
>80%												
*Compliance rate **after** patient contact*												
<20%				36 44	2		92	1		17	1	
20-30	44	1		44 107	2		19 28 36	3				
30-40	19 28 44	3		28 44	2					38 88 89 107	4	

1 Calculated by dividing the sum of all moments hand hygiene was performed by the sum of all possible hand hygiene moments. Whenever possible this was calculated per type of health care worker, otherwise the results can be found in the column "HCW unknown". With intervention studies only baseline data was used.

with a median compliance rate of 47%. Fifteen studies reported compliance rates before or after patient contact by profession.[14,19,28,33,36,44,49,52,62,80-82,85,107,109] Table 2.3 shows that compliance rates lower than 20% before patient contact were found in 29%, 67%, 40%, and 67% of studies among nurses, physicians, other HCWs and HCWs of unknown profession, respectively. Compliance rates lower than 20% after patient contact were not found for nurses but were found in 18%, 13% and 14% of studies on physicians, other HCW and HCW of unknown profession, respectively. Nurses showed quite similar median compliance rates before (46%) and after (53%) patient contact. Among physicians large differences in compliance were present before and after patient contact, with a tendency toward low compliance rates before contact (median 13%) and higher compliance after contact (median 43%) (figure 2.1).

Correlates of noncompliance to hand hygiene guidelines

Table 2.4 shows the studies that investigated to a greater or lesser extent which factors might be underlying compliance behaviour, with the associations found. The factors studied most frequently are profession, workload, attitude, time of day, patient's risk of infection, feedback, knowledge and the effects of different materials (e.g. alcohol-based hand rub) on compliance.

Table 2.4. Correlates of compliance to hand hygiene guidelines in healthcare

Correlate	Reference	Association	Number of samples	Summary		
				+	-	0
Profession (MD vs RN)	[18, 23, 25, 27, 30-34, 36-38, 46, 50-52, 57, 58, 60, 61, 64, 65, 67, 68, 71, 72, 75, 76, 78, 80, 81, 85, 90, 93, 95, 96, 98, 100-102, 104, 107, 108, 110]	+, –, 0	44	2	25	17
Activity level	[15, 29, 31, 34, 49-51, 67, 76, 89, 93, 95, 101]	+, –, 0	13	1	9	3
Attitude	[15, 20, 33, 48, 49, 70, 81, 103, 106, 107]	+, 0	10	4		6
Time of day (day vs night)	[23, 50, 61, 67, 75, 84, 93, 99, 101, 104]	+, –, 0	10	3	1	6
Patient risk	[15, 18, 25, 34, 51, 70, 81, 82, 93, 104]	+, –, 0	10	4	5	1
Feedback	[16, 17, 39, 43, 57, 66, 72, 84, 105]	+, 0	9	6		3
Alcohol	[22, 26, 32, 34, 41, 51, 67, 76]	+	8	8		
Glove use	[27, 37, 38, 62, 104, 106]	+, –, 0	6	4	1	1
Knowledge	[20, 29, 48, 89, 103]	+, –, 0	5	2	1	2
Accessibility of materials	[15, 30, 62, 65, 67, 83, 100]	+, 0, –	7	4	1	2
Gender of HCWer (M vs F)	[48, 58, 70, 85, 106]	–, 0	5		4	1
Experience of HCWer	[70, 91, 102, 106, 110]	–, 0	5		2	3
Task type (dirty vs clean)	[31, 38, 71, 82, 110]	+	5	5		
Number of sinks	[36, 38, 60]	+, 0	3	1		2
Positive role model	[38, 46, 106]	+, 0	3	2		1

The effect of profession (i.e. physician or nurse) was studied most frequently (n=44). Physicians are generally associated with lower compliance rates than nurses (25 of 44 samples). In 17 samples, no effect of profession was found; in 2 samples the reverse association was found. Activity level (an indicator for workload) was studied in 13 samples, and was frequently associated with a lower compliance (9 of 13 studies). The effect of the time of day (daytime shifts vs. evening, night or weekend shifts) was studied in 10 articles, with 6 studies showing no effect for time of day. Patient's risk of infection, which was studied in 10 articles, was frequently associated with lower compliance (5 of 10 studies). Feedback was often associated with higher compliance (6 of 9 studies), as was glove use (8 of 8 studies) and accessibility of materials (4 of 7 studies). However, the only factor consistently associated with higher compliance was type of task (dirty vs clean) with 5 of 5 studies showing higher compliance with dirty tasks.

Eight studies examined the effects of the introduction of alcohol based hand rub or gel on the hand hygiene compliance of HCWs, and all found a positive association with hand hygiene compliance irrespective of whether a promotional campaign was launched or not (8 of 8 studies). An alcohol based liquid or gel solution was made available by either wall-mounted dispensers,[17,76] or wall-mounted dispensers in combination with carrying individual bottles.[26,32,34,41,51,67] Furthermore, a number of studies also launched some form of promotional campaign together with the introduction of alcohol based disinfectant.[17,32,34,51,76] Only one study looked at the effect of carrying an individual bottle[67] and found a positive significant effect on hand hygiene compliance.

Behavioural factors in relation to compliance were studied by 13 studies.[15,20,33,38,46,48,49,70,81,96,103,106,107] Ten studies analysed some form of attitude in relation to compliance, but the results remain inconclusive with 4 studies showing a positive effect, and 6 studies showing no effect.[15,20,33,48,49,70,81,103,106,107] The same applies to the effects of positive role models, which were analysed in three studies.[38,46,106] With respect to the theoretical framework used in these studies, 7 studies report applying a theory from the behavioural sciences. The Theory of Planned Behaviour was used in 4 studies[14,49,70,81], the PRECEEDE (Predisposing, Reinforcing, Enabling Constructs in Educational Diagnosis and Evaluation) model in 2 studies[20,39] and one study applied a theory of thinking styles to their hand hygiene research.[73]

DISCUSSION

We assessed the methodological characteristics of 96 empirical studies on compliance with hand hygiene guidelines in industrialized countries. Most studies included the ICU. In general, the study methods were not very robust and often ill reported. We produced a quantitative summary of compliance rates, showing a large variation (4-100%) with an overall median compliance rate across all settings, situations and HCWs of 40%. Compliance rates were lower in the ICUs (with a median rate somewhere in the range of 30-40%) compared to other settings (with a median rate somewhere in the range of 50-60%), were lower among physicians (32%) than among nurses (48%), and were lower before patient contact (21%) than after patient contact (47%). To date, we have found that type of HCW and workload have been studied most extensively as potential determinants of non-compliance. The majority of the time, the situations that were associated with a lower compliance rate were those with a higher activity level and/or those in which a physician was involved. The majority of the time, the situations that were associated with a higher compliance rate were those having to do with dirty tasks, the introduction of alcohol-based hand rub or gel, performance feedback, and accessibility of materials.

Of the studies investigating the behavioural determinants of hand hygiene only seven reported the use of a theoretical framework. Results from this field of research are still scarce and inconclusive.

On the basis of this systematic review, it can be concluded that direct observation is considered the norm when it comes to measuring compliance, because this method is applied in approximately 90% of the studies reviewed. However, it still remains unclear how valid this method is as an indicator for the extent to which the international hand hygiene guidelines are adhered to. First, there are the problems arising from the Hawthorne effect, which states that people will change their behaviour if they are aware of being observed.[42] Solutions for this phenomenon are not always practical, but the implications for the data collected cannot be ignored. Second, although there are international guidelines describing specific situations when hand hygiene is required, their application in measuring compliance remains limited. Some studies only observed hand hygiene behaviour before contact with the patient,[52,96] and some only after contact.[36,44,82,85,92,103,109] Some studies only observed hand hygiene after a specific task, (i.e. after disconnection from a haemodialysis machine),[88,89] or only laboratory workers at the end of a shift.[86] Furthermore, many studies merely report "observing compliance", and in these cases it is completely unclear which moments were observed and what the reported compliance rates actually mean.

Almost all studies used a self-developed tool to measure the compliance level, causing further problems in the comparability of studies and their results. So far, only a few studies have used previously developed and tested instruments, such as the Hand Hygiene Observation Tool, (either the original tool or and adapted form of it).[49]

Apart from observation and self-reporting, there are a number of other methods which may be employed as indicators of hand hygiene compliance, such as the amount of alcohol or soap used (i.e. 2 L per day),[112,113] electronic monitoring (i.e. counter in alcohol dispenser)[40] or the number of hospital-acquired infections.[10] Each of these indirect measures has some advantages over direct observation by a trained observer -because some are much cheaper and easier to use- but they do not provide valid information on compliance.[114] One study made a new step in this direction, however, by monitoring entrance and exit of people from a patient's room, and linking this to electronic monitoring of the alcohol-based hand rub dispenser.[99] When someone enters without using the dispenser, this is registered as noncompliance. However, this method also has limitations, however, because only hand hygiene behaviour when entering and exiting can be monitored, and it can only be applied in single patient rooms.

Our systematic review has confirmed that compliance rates are universally low and has quantified variation depending on situational factors. We found that median compliance rates were 16% lower among physicians than among nurses and that they were lower in

the ICU compared to other settings. In addition, we were the first to make a distinction in our quantifications between compliance before and compliance after patient contact. Compliance before patient contact (median < 20%) appeared lower than after patient contact (median 30-40%). This could indicate that factors related to the HCWs benefit are understudied as potential determinants of compliance to hand hygiene in hospitals, as has been found in qualitative research,[7,115] and is consistent with the positive association found between dirty tasks and hand hygiene performance.

What influences hand hygiene?

Many factors underlying compliance have been studied, and although the results remain far from conclusive, a number of factors appear to play a role in affecting compliance. Studied most often by far are the differences in compliance rates between physicians and nurses. Physicians are associated with lower compliance rates, both in general and in the specific situations before patient contact. Furthermore, a higher activity level correlates with lower compliance, which could at least partly explain the lower compliance measured in the ICUs, compared to other settings. The only factors consistently associated with higher compliance is type of task (dirty vs clean) and the introduction of an alcohol-based hand rub or gel. This last factor always led to higher compliance (in comparison with when only hand washing was possible) in the studies reviewed here. It remains somewhat unclear, however, whether it is the product itself, the often-improved availability of the product and distribution method (i.e. individual bottles or wall mounted dispensers), or the promotional aspects involved which trigger better hand hygiene, although it would appear that the use of individual bottles does have an effect on hand hygiene compliance. This is not unexpected, because these bottles could improve self-efficacy, which was previously shown to influence hand hygiene compliance.[49] Other factors associated with higher compliance are the use of performance feedback and improved accessibility of materials. These two factors could be used in interventions to improve compliance. It has also been shown that glove use is a predictor of compliance with hand hygiene guidelines.[106]

So far, only a limited number of studies have focussed on behavioural factors, and although some have identified some aspects influencing this behaviour, the effects remain unclear and understudied. The theoretical models used so far have not been able to predict hand hygiene behaviour very successfully, and these models will have to be adapted to better explain the complexities of this behaviour. This can be supported by qualitative research, providing some initial insight into the factors influencing this behaviour, which can later be investigated quantitatively. Few studies have as yet adopted this approach, but of late qualitative studies are appearing in the literature.[115-117] Qualitative studies have,

for example, shown the importance of positive role-models, particularly for nursing and medical students,[115,116] a factor only studied by three quantitative studies so far.

Our review has some limitations, particularly due to the lack of homogeneity between the studies included. We were not able to perform any type of meta-analysis due to the large methodological differences. The studies included in our review were of varying methodological quality, with some studies reporting neither their sample type, size or any form of reliability testing. Furthermore, a great deal of studies fail to report on the type of instrument used for obtaining the data or on how observers were trained. This makes comparison and interpretation of the results difficult, not only in this review but in general for researchers interested in hand hygiene studies.

How to proceed?

From this review, it has become clear that, although there is a great deal of research available on the topic of hand hygiene compliance, few firm conclusions can yet be drawn. To facilitate comparison and learning in the future, there is a great need for a standardized measuring instrument and standardized reporting. More recently the WHO has taken steps to enable more standardized guidelines and measurement, and the effects of these efforts will hopefully become visible in future studies. Many more recent studies have adopted stronger designs (i.e. larger samples sizes, better controlled conditions, use of behavioral theories) than did older studies, and it would appear that hand hygiene compliance research has matured. However, much remains unclear, and that which is clear is not always easy to implement in practice. In order to develop successful interventions more research into the behavioral determinants is needed[13,15] and in particular how these determinants can be applied to improve hand hygiene. Process indicators are of paramount importance here, as in any intervention, and a systematic understanding of why some interventions succeed and others fail is needed. This information could then be applied to those situations identified by this review as being at high risk for noncompliance (e.g. before patient contact), leading to improved patient safety.

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Chapter 3

A qualitative exploration of reasons for poor hand hygiene among hospital workers: lack of positive role models and of convincing evidence that hand hygiene prevents cross-infection

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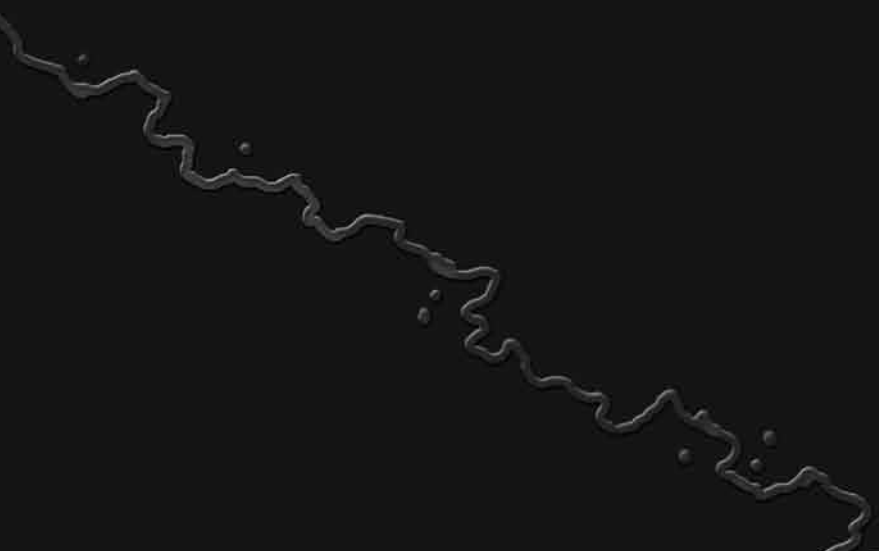

ABSTRACT

The objective of this study was to investigate potential determinants of hand hygiene compliance among health care workers in a hospital setting. A qualitative study was conducted based on structured interview guidelines, consisting of nine focus group interviews (n=58) and seven individual interviews (n=7). Interview transcriptions were subjected to content analysis. Healthcare workers of intensive care units and surgical departments of five hospitals of varying size in the Netherlands participated in this study, namely nurses, attending physicians, medical residents, and medical students (n=65).

Nurses and medical students expressed the importance of hand hygiene for the prevention of cross-infections for both the patient and themselves. Physicians expressed the importance of hand hygiene for self-protection, but perceived a lack of evidence for the prevention of cross-infections. All participants pronounced that personal beliefs about efficacy of hand hygiene and examples and norms provided by senior staff within a hospital are of major importance for hand hygiene compliance. They further reported that hand hygiene was most often performed after tasks perceived as dirty, and personal protection appeared to be more important for compliance that patient safety. Medical students explicitly mention copying the behaviour of their superiors, often leading to non-compliance in clinical practice. Physicians mentioned that their non-compliance was because they believed that hand hygiene efficacy in the prevention of hospital acquired infections was not supported by a strong evidence base. The results indicate that beliefs about the importance of hand hygiene for self-protection are the main reason for performing hand hygiene. Lack of positive role models and social norms may hinder compliance.

INTRODUCTION

Healthcare associated infections are a major threat to patients and place a great burden on national healthcare services.[1,2] This problem must be combated with an adequate level of hand hygiene compliance since this is of crucial importance in preventing cross-transmission[3-5] and has been identified as a health policy priority.[1,6] However, the level of hand hygiene compliance remains low worldwide and has been termed "unacceptably poor" by a public health authority in London, United Kingdom.[7] Interventions aimed at improving hand hygiene compliance have been implemented, but the effects of these interventions remain modest and/or of short duration.[8,9] To develop interventions with more pronounced and sustainable effects, information is needed on the behavioural determinants of hand hygiene compliance.[10] This topic has only recently started receiving attention by investigators involved in hand hygiene research.[11,12] Qualitative research can provide valuable insight into possible behavioural determinants,[13,14] and is often the first step in a stepwise approach to intervention development.[15] Qualitative methods have, however rarely been used to evaluate hand hygiene compliance among healthcare workers. Compliance with hand hygiene behaviour among different groups of hospital workers may be influenced by beliefs and norms that vary across the groups. Review of the international literature reveals that the hand hygiene behaviour of nurses has been studied most extensively.[16,17] Physician compliance is often found to be lower than that of nurses[18,19] although the reason for this is not always clear. Medical students' hand washing behaviour has rarely been studied,[20] although research into their behaviour could provide essential knowledge on how tomorrow's physicians could be stimulated to comply with hand hygiene guidelines in order to break the cycle of poor physician hand hygiene.[2] The present study is a qualitative exploration of reasons for poor hand hygiene among nurses, medical students and physicians in the hospital setting in the Netherlands.

METHODS

Participants

A total of nine focus groups and seven individual interviews were conducted with healthcare professionals. Participants were recruited from five Dutch hospitals. The hospitals included were one small general hospital (<400 beds), one large general hospital (> 400 beds), one top clinical teaching hospital and two university teaching hospitals. Participants worked either in the Intensive Care Unit (ICU) or surgical ward of these hospitals, and worked as nurses (n=24), ICU nurses (N=23), attending physicians (n=4), residents (n=3) or medical students (n=11). All groups were homogenous with respect to profession and hospital. In order to ensure maximum participation levels, the focus groups and individual

interviews were held on location. The individual interviews were conducted with physicians, since their schedules did not allow group interviews.

Focus group interviews

Each focus group interview (n=9) took between 30 and 60 minutes, and included between four and ten participants. All interviews were led by a moderator (V.E.) and supported by an assistant. At the start of the interview, it was emphasized that the interview was not a test (i.e. there were no good or bad answers) and that all opinions were respected. Furthermore, the participants were encouraged to discuss their opinions openly to retrieve as many as possible opinions. All focus groups were recorded with a voice recorder and fully transcribed.

Face to face interviews

Each individual interview (n=7) took 20 to 50 minutes. The interviews were led by an interviewer (V.E.). Again, it was expressed in the introduction that the interview was not a test, and that all answers and information was useful. All these interviews were also recorded with a voice recorder and fully transcribed.

The interview guide

All interviews were conducted following a structured interview-guide (table 3.1) to ensure that all topics were covered during the interview. The interview- guide was developed a priori based on the constructs included in an established behavioural determinants model, the Theory of Planned Behaviour (TPB).[21] Therefore, the interview-guide aimed at exploring attitudes (i.e. perceptions of different positive and negative consequences of hand hygiene compliance), subjective norm (the perceived opinion of others concerning hand hygiene compliance) and perceived behavioural control concerning compliance to hand hygiene standards. According to TPB, these constructs predict the intention for engagement in the behaviour under study, and readiness to change hand hygiene behaviour was also explored. The TPB had previously been used in studies explaining hand

Table 3.1. Topics covered to lead focus group discussions and interviews

Topics	Discussion points
Attitudes	– What are reasons for (non)compliance – What are (dis)advantages of hand hygiene? – Who benefits from hand hygiene? – How important is hand hygiene? – When do you like to perform hand hygiene?
Subjective norms	– How do other HCWs influence hand hygiene behaviour?
Perceived behavioural control	– Does anything prevent HCWs from performing hand hygiene? – How could hand hygiene be stimulated?

hygiene behaviour.[12,16] Earlier studies have indicated that other perceived social influences than subjective norms may be important for a range of behaviours,[15] such as example behaviour of others (i.e. modelling) and direct social support, and these potential social influences were also included.

Analysis

The transcripts were systematically content analyzed using Nvivo software (version 7) for analysis of qualitative data. The program was used for coding the data and facilitating analysis by generating code-specific reports from the data that were content analyzed for the existence of common themes and key points, by two independent researchers (V.E. and W.B.). Disagreements were resolved by a third researcher (J.B.).

RESULTS

All participants admitted that non-compliance to the hand hygiene guidelines occurred frequently.

Attitudes

The pros of hand hygiene compliance

Participants mentioned the prevention of cross-infections as the main advantage of hand hygiene. Participants in all three groups distinguished between preventing cross-infections among patients and protecting themselves. Physicians mainly mentioned the protection of the patient on both individual and ward level, while nurses and medical students also mentioned self-protection as an important advantage of hand hygiene. Furthermore, physicians and nurses mentioned the advantages of uniformity in procedure for the hospital as a whole.

If asked directly, the most frequently given reasons for performing hand hygiene were the protection of oneself from cross-infection ("*Yes I think that most people do it for themselves, otherwise you wouldn't feel the urge to wash your hands so quickly after that diabetic foot*" – a medical student) and the need to feel clean and fresh after performing tasks perceived as dirty. For example after contact with body fluids, or after contact with patients or body parts perceived as unclean ("*I think than when you've touched a patient who was a bit sticky, you want to get rid of it*" – a physician). All participants mentioned performing hand hygiene especially when they felt that their hands were dirty, before eating and at the end of shift.

The cons of hand hygiene compliance

The disadvantages that were mentioned were similar among all three groups, and concerned mainly dry and sore hands as a result of hand hygiene practices. Furthermore physicians and nurses mentioned the amount of time necessary for adequate hand hygiene.

Subjective norm

Social control

All participants mentioned a lack of social control with regard to compliance to hand hygiene guidelines and all groups reported difficulties in addressing others about their hand hygiene behaviour ("*I think lots of people see It (= lack of hand hygiene), but don't say anything*" – a medical student).

Role models

Nurses and particularly medical students mentioned the presence of negative role models, i.e. experienced nurses or physicians who were noncompliant, as reasons for their own non-compliance. Medical students explicitly mentioned that they were unable to comply if the rest of the group fails to comply. They would otherwise fall behind during rounds, and they report a strong influence from negative role models to abstain from compliance with the hand hygiene guidelines ("*To a great extent I copy the behaviour of the physicians and staff members*" – a medical student). Furthermore, both medical students and nurses reported that they adjust their behaviour to what they witness in practice ("*If you arrive here and no-one washes their hands…. yes I think you copy that behaviour. You think that's what they do so that must be right*" – a nurse). Physicians also reported the need for positive role models.

Norms

In all groups a discussion arose around 'the culture' in the hospital, in which it is accepted that particularly senior physician staff members deviate from the set of rules and guidelines, and is an important reason for non-compliance ("*Those at the bottom of the ladder make sure that everything is done correctly and then a (physician)staff member walks in without washing his hands and everything is wasted*" – a physician). All participants agreed that creating a stronger social norm and more explicit social control would be important for improving hand hygiene compliance.

Perceived behavioural control

Barriers to hand hygiene compliance mentioned by participants were the occurrence of emergent situations, the lack of availability of and easy access to hand hygiene materials, lack of time and forgetfulness. Furthermore, improving the availability and accessibility of

materials and non-irritating hand alcohol rubs were mentioned as important facilitators to improve compliance. Physicians reported that the scarcity of evidence-based research supporting the role of hand hygiene in the prevention of healthcare associated infections is a barrier for compliance ("*...there should be data (about hand hygiene), real data, presentations and reports. So that people can read about it*" – a physician).

DISCUSSION

With the help of a qualitative study design, we analyzed the behavioural determinants of hand hygiene compliance among different hospital healthcare workers, including physicians, nurses and medical students. The hand hygiene behaviour of healthcare workers appears to be motivated by self-protection and a desire to clean oneself after a task that is perceived as dirty. Nurses and medical students expressed the importance of hand hygiene for preventing cross-infections among patients and themselves, whereas physicians expressed the importance of hand hygiene for self-protection, but also perceived a lack of evidence for the importance of hand hygiene in preventing cross-infections.

Personal beliefs about the efficacy of hand hygiene and examples set and norms established by senior staff within a hospital are of major importance for hand hygiene compliance. Medical students tend to copy the hand hygiene behaviour of their superiors, leading to non-compliance when they observe non-compliance by others. Physicians mentioned that their non-compliance was associated with a perceived lack of evidence that hand hygiene is effective in the prevention of healthcare associated infections, which could be an explanation for the inverse correlation found between the level of education and the rate of hand washing compliance.[22]

Behavioural research into hand hygiene compliance is highly needed because it is essential for developing successful multifaceted interventions.[8,11] Previously, one qualitative study into hand hygiene was performed by Whitby *et al.*, although this study focused more on hand washing in the community setting, and included a different group of participants (children, mothers and nurses) compared to our study (physicians, nurses and medical students).[12] Despite the differences, one striking similarity can be found in the data about nurse's attitudes towards hand washing at work. The nurses in a study by Whitby *et al*. reported that their level of compliance is influenced by their own assessment of the degree of 'dirtiness' or the 'lack of cleanliness' of a patient, which was also found in our study. This assessment results in performance of hand hygiene mainly after direct contact with the patient. This is indicative of a lack of information about the presence of pathogens in the vicinity of the patient, and on such items as door handles, telephones etc. Increased

knowledge about such pathogens, combined with the desire to feel clean could lead to better hand hygiene after contact with these inanimate objects. That hand hygiene is mainly performed after patient contact is not only supported by the results from the study by Whitby *et al.,*[12] but also by numerous studies measuring hand hygiene performance in practice.[16,23-27] In general, these studies find much higher rates of hand hygiene after patient contact than before patient contact. This provides another indication that the motivation for performing hand hygiene is perhaps influenced more by the inherent desire to clean oneself when feeling dirty than by and interest in protecting the patient, as previously suggested by Whitby *et al.*[12]

In the same study Whitby *et al*. further found that "elective in-hospital hand washing behaviour" was significantly influenced by nurses' beliefs about the benefits of the activity, by peer pressure from senior physicians and administrators and by role modelling.[12] Pittet *et al*. performed a quantitative study among physicians and found that observed physician adherence was mainly predicted by variables related to the environmental context, to social pressure and the perceived risk of cross-transmission and to a positive individual attitude towards hand hygiene.[28] The results presented in both these studies confirm our own results and underline the importance of social norms and culture for compliance with hand hygiene guidelines. Physicians mentioned a need for more social control in order to improve their hand hygiene behaviour, although it remains unclear who should provide this control. Most physicians do not feel inclined to comment on the hand hygiene behaviour of their colleagues, and some feel nurses should perform this task. However, only a few nurses (mostly older, more experienced nurses) mentioned ever having commented on the hand hygiene behaviour of physicians. Furthermore, medical students appear to copy the hand hygiene behaviour of the physicians they see at work, often resulting in poor hand hygiene habits which will later be copied by new students. Positive role models are essential in breaking the cycle,[2] however most physicians do not see themselves as role models and many appear to not feel inclined to change their behaviour. Authorities responsible for medical training of physicians in all career phases should be involved in promoting better hand hygiene compliance, because doing may improve compliance across the hierarchy of healthcare professionals. Since not all physicians are convinced that sound rationale supports the effectiveness of hand hygiene compliance, an independent synthesis of the available evidence from controlled (quasi) experimental studies on the role of hand hygiene in the prevention of cross-infection should also be conducted.

When interpreting the aforementioned results, a number of study limitations have to be taken into account. Different groups of healthcare workers participated in this study. However, number of physicians was relatively small due to the impracticality of focus group interviews for this profession. This, in effect, resulted in two types of qualitative data

in this study, i.e. from group discussions and individual interviews. On the other hand, the quality of the data is strengthened by the participation of different types of healthcare workers and by the inclusion of healthcare workers from different institutions. This, in combination with the considerable degree of consistency in the answers given, enhances the generalizability of the results. It is furthermore important to consider that the value of the findings presented here lies in their qualitative nature; that is, they are useful in the preliminary identification of possible factors influencing hand hygiene compliance. These factors can then be investigated further in quantitative and experimental research.

CONCLUSION

The results of this qualitative study indicate that beliefs about the importance of self-protection are the main reasons for performing hand hygiene. Lack of positive role models among and social norms established by senior physicians may hinder compliance.

The results from this study should inform methods for stimulating hand hygiene compliance in healthcare settings. If hand hygiene is indeed mainly influenced by the desire to clean oneself and by the behaviour of other healthcare professionals, then workshops and courses that focus on patient protection may have little effect. The best methods for improving hand hygiene compliance may involve encouraging senior healthcare workers to be compliant and creating a supportive environment with readily available and easily accessible hand hygiene facilities.

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Chapter 4

Hand hygiene of physicians and nurses: equally low compliance rates, but other determinants

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Chapter 5

Hand hygiene during patient care: factors that influence the behaviour of our next generation physicians

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Chapter 6

Measures to improve hand hygiene tailored to determinants of (non)compliance and field experiences: a Delphi study

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Chapter 7

Improving hand hygiene behaviour of nurses using action planning: a pilot study in the intensive care unit and surgical ward

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ABSTRACT

Compliance with hand hygiene guidelines by hospital physicians and nurses is universally low and there is a need to apply powerful intervention methods from social sciences in order to improve compliance. One method is the formation of implementation intentions (or action planning) in which concrete 'if then' plans are formulated to link an environmental cue with performance of an intended behavioural action. This pilot study explored the practicality and effects of action planning on the hand hygiene behaviour of nurses in an intensive care unit (ICU) and surgical ward of a university teaching hospital. A pre-post test design was used, and 17 nurses were invited to participate. A trained researcher observed the hand hygiene behaviour of nurses before and three weeks after the intervention in which action plans were formulated. Frequencies were calculated and logistic regression analysis was performed to assess changes in hand hygiene behaviour. Of the 17 participants, 10 (seven in surgical ward, three in ICU) had complete data and were included in the analyses. In total, 283 potential moments for hand hygiene were identified, 142 in the surgical ward and 141 in the ICU. Hand hygiene behaviour increased from 9.3% at baseline to 25.4% post intervention (OR: 3.3; 95% CI: 1.7-6.5; P <0.001). Although this was a small scale study, the results show promise for the application of action planning to improve the hand hygiene behaviour of nurses in the short term. Action planning has shown success in closing the intention-behaviour gap in other fields, and its use for improving hand hygiene behaviour in healthcare should be further investigated.

INTRODUCTION

Compliance with hand hygiene guidelines by hospital physicians and nurses is universally low, even though hand hygiene is considered the most important measure in the prevention of healthcare-associated infections.[1-5] Over the past decades various campaigns promoting hand hygiene among caregivers have been launched, but substantial and lasting effects on compliance rates have hardly been reported.[6] To improve this situation, the need to apply research and intervention methods from the social sciences is increasingly recognised.[7-9] One of the reasons for low hand hygiene compliance is not that caregivers do not have the intention to perform hand hygiene, but that they often fail to act according to this intention. One type of intervention developed in social psychological research, specifically for addressing this discrepancy between intention and behaviour, is the application of action planning (or implementation intentions), often used in behaviours where there is little congruity between intended and performed behaviour.[10] This applies to hand hygiene behaviour (HHB) since several studies have shown that most healthcare workers have positive intentions towards hand hygiene, even though their compliance in practice is usually low.[11,12]

Implementation intentions are specific action plans, defining where and when to perform a particular behavioural action in order to achieve an intended goal.[13] Action plans take the form of 'if-then' plans (if situation X occurs, I will perform behaviour Z in order to achieve goal Y) and thus link situational cues (i.e. wound care) with a behavioural response (i.e. perform hand hygiene) that suits the desired outcome (prevent infection). These 'if-then' plans assist in translating intentions into actions and have shown promising results in promoting health behaviours such as physical activity, dietary intake and participation in screening activities.[10,14] Action planning can also be applied to other settings and behaviours; it can help healthcare workers to plan how and when they will perform hand hygiene in agreement with protocols, and how they could overcome barriers they might encounter in everyday practice.[15] This could help to overcome the intention-behaviour gap, leading to proper hand hygiene in practice. It has, however, never been tested whether action plans could be effectively applied to stimulate HHB in a healthcare setting. This pilot study sought to explore the usability and indications for efficacy of using action plans among nurses in the intensive care unit (ICU) and surgical ward in order to improve HHB.

METHODS

A before-and-after study was conducted from March to August 2008 in an ICU and a surgical-ward of a university teaching hospital to explore the practicality of action planning among nurses as an intervention to improve hand hygiene compliance.

Participants, procedure and measurement

Study participants were recruited from nurses working on the days on which data collection was planned in each ward. A trained observer randomly selected nine nurses from the surgical ward and eight from the ICU for observation. The study was introduced as a general patient safety study and nurses were not aware that hand hygiene was the focus of study. All observations were collected between 08:00 and 11:00 and each nurse was observed for a period of 30 minutes. The HHB of the selected nurses was measured unobtrusively before and three weeks after the intervention, using a previously developed Personal Digital Assistant (PDA)-based observation tool. This tool, adapted from the Hand Hygiene Observation Instrument, scores HHB according to World Health Organization guidelines on healthcare indications for hand hygiene.[12,16] One week after the first observations, each nurse who had been observed was invited to participate in an interview (the intervention) with one of the researchers who was not involved in any observational data collection (M.N.K.). All nurses who were interviewed were included in the second observation round, conducted at least three weeks after the intervention. See figure 7.1 for a schematic overview of the study design.

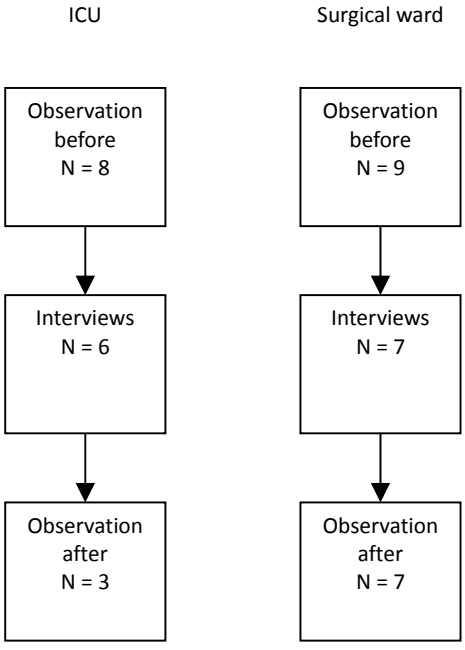

Figure 7.1. Study design and participant flow for the ICU and surgical ward, wherby N is the number of nurses participating during each phase of the study.

Box 7.1. Formulating action plans (implementation intentions)

1. Choose a specific situation (i.e. wound care) and describe how you go about this task.
2. During this task:
(a) When will you perform hand hygiene?
Before you touch the patient, after removing dirty bandages and after you have cleared everything up.
(b) Where will you do this?
In the patient room.
(c) How will you do it?
I always use alcohol-based hand rub, I don't like to wash my hands with soap and water.
(d) Who will be involved?
Me.

Formulated action plan:
- Enter patient room - use alcohol - gloves on - remove bandages - gloves off - clean gloves on - - new bandages - gloves off - alcohol.
I will pay extra attention to making sure that I have everything I need before I put on my gloves, so that I don't have to leave the patient after I have already touched the wound.

Intervention

The intervention consisted of a structured interview on the importance of hand hygiene, rated self-compliance, preferred method of hand hygiene and possible barriers encountered in daily practice, after which action plans (implementation intentions) for performing hand hygiene were made. Each interview lasted about 30 minutes. For the action planning component, participants were free to choose a specific healthcare situation, for example wound care, and were then encouraged to form action plans for this situation (see box 7.1 for an example). Participants were first asked to make a step-by-step plan of how they usually work in the specific situation. They were then instructed to make a more specific plan defining when, where and how they would perform specific actions conducive to appropriate hand hygiene. In addition to action planning, they also had to anticipate and plan alternatives for moments when things are likely to go wrong (coping planning). However, no feedback was given as to the correctness and quality of the formulated action plans.

Data analysis

Hand hygiene compliance rates (frequencies) were calculated. One-way analysis of variance and logistic regression analysis was performed using SPSS 17, to test for differences in HHB between baseline and follow-up.

RESULTS

During the intervention period, interviews in which action plans were formed were held with seven nurses from the surgical ward, and six from the ICU (see figure 7.1). In total,

Table 7.1. Pre- and post-intervention compliance rates for the ICU, surgical ward and overall.

	Pre-intervention compliance % (95% CI)	**Post-intervention compliance** % (95% CI)
ICU	10,7% (4-17)	15,8% (6-26) *
Surgical ward	7,8% (2-14)	33,8% (22-46) ***
Overall	9,3% (5-14)	25,4% (18-33)***

*** Increase is statistically significant with p<0.001
* Increase is statistically significant with p<0.05

seven nurses were lost to follow-up due to holidays, pregnancy leave and lengthy absence due to illness. It was possible to observe 10 participants post intervention: seven from the surgical ward and three from the ICU.

Action planning

The topics chosen during the action planning interviews were wound care (eight nurses), after glove removal (one nurse) and after leaving the patient's room (one nurse).

Observations

Only the pre- and post-intervention data collected from nurses who participated in the intervention were included in the analysis (N=10). During the study we collected 142 observations for potential hand hygiene opportunities in the surgical ward, and 141 in the ICU. Hand hygiene compliance rates increased from 9.3% at baseline to 25.4% post intervention (P <0.001). Hand hygiene compliance in the surgical ward improved from 7.8% to 33.8% (P < 0.001), and in the ICU from 10.7% to 15.8% (P <0.05) (Table 7.1). Logistic regression analysis showed that nurses were 3.3 times more likely to perform hand hygiene (OR: 3.3; 95%CI: 1.7-6.5) after the intervention. There were no significant effects for unit type on compliance (OR: 0.48; 95%CI: 0.8-3.1).

DISCUSSION

The results of this pilot study indicate that interviews including action planning could be useful in improving the HHB of individual nurses. The nurses were able to plan how they would fit proper hand hygiene into their routine, and post-intervention results indicate some success in implementing these plans. This is promising, because although most healthcare workers have positive intentions to comply with hand hygiene guidelines, in practice they often fail to do so.[1]

One of the limitations of our study was the small number of participants and short time span between intervention and follow-up (three weeks). Furthermore, baseline compliance in participating wards was extremely low, and it is not inconceivable that any kind

of attention to hand hygiene could have yielded an effect, although other studies have shown similarly low levels of compliance.[17-19] Our study was conducted in one university hospital, limiting generalisation of our results. Further research in different hospital types, more participants and a longer follow-up period are needed to justify large scale application of the intervention. Finally, action plans were formulated within a broader interview setting with other topics, and so effects may be due to the combined intervention and not to action planning only. Research is needed where action plans are formulated without other topics to exclude possible confounding. The simple pre-post test design does not allow us to ascribe the effects of the intervention with great certainty.

This study showed that it is feasible to use action planning as a behaviour change strategy, and that this approach may be effective. However, the application of action planning using the individual interview method is difficult in healthcare settings due to shifts. Individual face-to-face interviews are time-consuming and expensive as well as difficult to plan. Alternative applications of action plans through group sessions or web-based programmes should therefore be further investigated, as should their use with physicians, as it is still unclear how effective action planning might be with them. Action planning can potentially help bridge the intention-behaviour gap, leading to improved compliance in practice. Furthermore, formulation of action plans helps to identify possible barriers and how one might deal with them.[14] This process, also referred to as coping planning, may be particularly important for planning behaviour in difficult situations. Studies have shown that healthcare workers often have positive intentions to comply with hand hygiene guidelines, although this may not translate into actual compliance. Action planning may therefore be an essential addition to existing tools for compliance improvement. It must be noted, however, that action planning is only likely to work when people have positive intentions, indicating that it may have to be combined with other motivational interventions.[10,15]

In our study we saw a shift in compliance from 10% to 25%, but this is still far too low. Although action planning is likely to improve compliance with hand hygiene protocols, it is unlikely to have sufficient effect as a single intervention; multiple component interventions addressing individual, social, environmental and planning variables are needed to substantially improve hand hygiene. Studies have shown that attention should be paid to changes in the social and physical environment, training and education.[1,16,20] Action planning can be a useful and unique component in this package, since it specifically aims to overcome the intention- behaviour gap and to lead to greater hand hygiene compliance in practice.

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Chapter 8

Improving hand hygiene compliance in hospitals by design

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Chapter 9

The ACCOMPLISH study. A cluster randomised trial on the cost-effectiveness of a multicomponent intervention to improve hand hygiene compliance and reduce healthcare associated infections

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ABSTRACT

Public health authorities have recognized lack of hand hygiene in hospitals as one of the important causes of preventable mortality and morbidity at population level. The implementation strategy ACCOMPLISH (Actively Creating COMPLIance Saving Health) targets both individual and environmental determinants of hand hygiene. This study aims to evaluate the cost-effectiveness of a multicomponent implementation strategy aimed at the reduction of healthcare associated infections in Dutch hospital care, by promotion of hand hygiene. The ACCOMPLISH package will be evaluated in a two-arm cluster randomised trial in 16 hospitals in the Netherlands, in one intensive care unit and one surgical ward per hospital. A multicomponent package, including e-learning, team training, introduction of electronic alcohol based hand rub dispensers and performance feedback. The primary outcome measure will be the observed hand hygiene compliance rate, measured at baseline and after 6, 12 and 18 months; as a secondary outcome measure the prevalence of healthcare associated infections will be measured at the same time points. Process indicators of the intervention will be collected pre and post intervention. An ex-post economic evaluation of the ACCOMPLISH package from a healthcare perspective will be performed. Multilevel analysis, using mixed linear modelling techniques will be conducted to assess the effect of the intervention strategy on the overall compliance rate among healthcare workers and on prevalence of healthcare associated infections. Questionnaires on process indicators will be analysed with multivariable linear regression, and will include both behavioural determinants and determinants of innovation. Cost-effectiveness will be assessed by calculating the incremental cost-effectiveness ratio, defined here as the costs for the intervention divided by the difference in prevalence of healthcare associated infections between the intervention and control group. This study is the first RCT to investigate the effects of a hand hygiene intervention programme on the number of healthcare associated infections, and the first to investigate the cost-effectiveness of such an intervention. In addition, if the ACCOMPLISH package proves successful in improving hand hygiene compliance and lowering the prevalence of healthcare associated infections, the package could be disseminated at (inter)national level.
Trial registration: NTR2448

INTRODUCTION

Public health authorities have recognized lack of hand hygiene (HH) as one of the important causes of preventable mortality and morbidity at population level.[1-3] Both at national (i.e. UK, USA, The Netherlands) and international levels (World Health Organisation) poor HH has been identified as a threat to public health. HH compliance rates are universally low, leading to unacceptably high rates of healthcare associated infections (HAI), and resulting in unnecessary excess mortality and morbidity in the population and increased healthcare costs due to increased length of hospital stay and more complex care.[4]

Guidelines stipulating when HH is required have been in place for many years, but are often not adhered to. Two thirds of the studies included in a systematic review reported compliance rates below 50%.[5] To address the problem of low compliance, many interventions have been designed and evaluated, but the effects are often short lasting or moderate.[6] Grol and Grimshaw made an inventory of the most common interventions used to improve HH practices and described that educational interventions have only short term effects, reminders have a sustained but only modest effect, and performance feedback may be effective, but only if feedback is continued.[7] They concluded that a comprehensive plan, targeting different problems and barriers to change with strategies at different levels (professional, team, patient, and organisation) is needed to achieve lasting changes in HH routines.

It is increasingly recognized that the observed failure to achieve large and sustained effects is due to the absence of well-designed implementation strategies using insights from the behavioural sciences.[8,9] Such strategies are based on a good understanding of factors that contribute to compliance at both the individual and environmental level. Therefore we previously conducted a study that investigated the behavioural correlates of hand hygiene behaviour. This study revealed that the hand hygiene behaviour of physicians and nurses is influenced by different factors.[10] Contrary to previous interventions, this knowledge should be used in the design of new strategies to improve compliance. But in accordance with the conclusions of Grol and Grimshaw, the study also revealed that factors at other levels than the individual healthcare worker (HCW), including specific barriers for change, should be targeted as well. Even though HCW know they should perform HH in order to protect both themselves and their patients, negative role models, poor accessibility of materials and a poor social culture can hamper good HH.[11] This so-called intention-behaviour gap has been targeted successfully in other fields by using implementation intentions and recently this method has also been applied to hand hygiene improvement.[12,13]

The knowledge gained from our previous behavioural research has therefore been used to develop ACCOMPLISH (Actively Creating COMPLIance Saving Health): a multicomponent implementation strategy to improve the hand hygiene behaviour of physicians and nurses. ACCOMPLISH has the potential to substantially increase compliance and reduce HAI in Dutch hospitals, but experimental implementation and evaluation of this package is necessary before large-scale dissemination in healthcare practice can be advised.

Objectives

This study aims to evaluate the cost-effectiveness of the ACCOMPLISH package and will test the effects of this implementation strategy on HH compliance and prevalence of HAI. Furthermore, an economic evaluation will investigate the cost-effectiveness of this strategy from a healthcare perspective.

Research questions:

1. What is the effect of the multicomponent implementation strategy ACCOMPLISH on HH compliance rates?
2. Which process indicators contribute most substantially to observed changes in HH compliance?
3. What is the effect of the multicomponent implementation strategy ACCOMPLISH on the prevalence of HAI?
4. What is the balance between costs and health effects (costs per prevented HAI) of the ACCOMPLISH package?

METHODS/DESIGN

Study design

The ACCOMPLISH package will be tested in a two-arm cluster randomized trial in 16 hospitals in the Netherlands (eight intervention and eight control) in one intensive care unit (ICU) and one surgical ward per hospital. In eight hospitals ACCOMPLISH will be introduced, while eight control hospitals will maintain normal HH practices. All infection prevention activities as well as any large outbreaks or other major events which might influence HH behaviour will be documented in a process evaluation. The primary outcome measure will be the observed hand hygiene compliance rate, measured at baseline (T1) and after 6 (T2), 12 (T3) and 18 (T4) months. As a secondary outcome measure the prevalence of HAI will be measured at the same time points. At each time point data identifying process indicators will be collected. The process evaluation will also include determinants of implementation, namely the social-political context, the organization,

the adopting person (i.e. the HCW), the innovation itself and the facilities needed for implementation.[14] See figure 9.1 for an overview of the data collection activities.

Area of study

A multicenter study of 16 hospitals in the Netherlands.

Sample for study

The sample of 16 hospitals will include university teaching hospitals, large general hospitals, small general hospitals and non-academic teaching hospitals and will de randomised at hospital level. Target population: nurses and physicians with direct patient contact working in the ICU or surgical ward at the participating hospitals in the Netherlands.

The Intervention

Intervention program: theoretical background

ACCOMPLISH is evidence and theory based, by following a planned stepwise behavioural research approach to intervention development.[15] It focuses on individual level factors, increasing personal and normative feedback, and is embedded in self-regulation theory, which suggests that behaviour-change is a dynamic process, in which specific, achievable goals need to be set, discrepancies between desired goals and goal progress need to be fed back to an individual, and finally (social) reinforcement is an important element to promote behavioural sustainability and ongoing goal pursuit.[12,16] Among others, it addresses these elements by means of increasing planning, performance feedback, increasing knowledge of HH guidelines on an individual level and on environmental factors creating an increased availability of alcohol based hand rub and increasing the visibility of HH guideline support. These factors were identified as major determinants of non-compliance in a previous study.[10]

The ACCOMPLISH package includes changes to the physical and social environment, performance feedback & goal setting, training and action planning (see table 9.1):

1. The physical environment will be adapted by improving the availability of alcohol based hand rub by electronic dispensers with an electronic feedback system. These dispensers will enable easy access and also remind HCW to perform HH at the point of care. The dispensers register each use with a time stamp, which will be used for periodic feedback.
2. The social environment will be targeted with training at group and individual level based on the Helping Hands team training package, to improve social and descriptive norms.[17] The unique contribution of this part of the intervention is built upon the Social Learning Theory,[18] the Social Influence Theory,[19] the Theory on Team Effectiveness,[20]

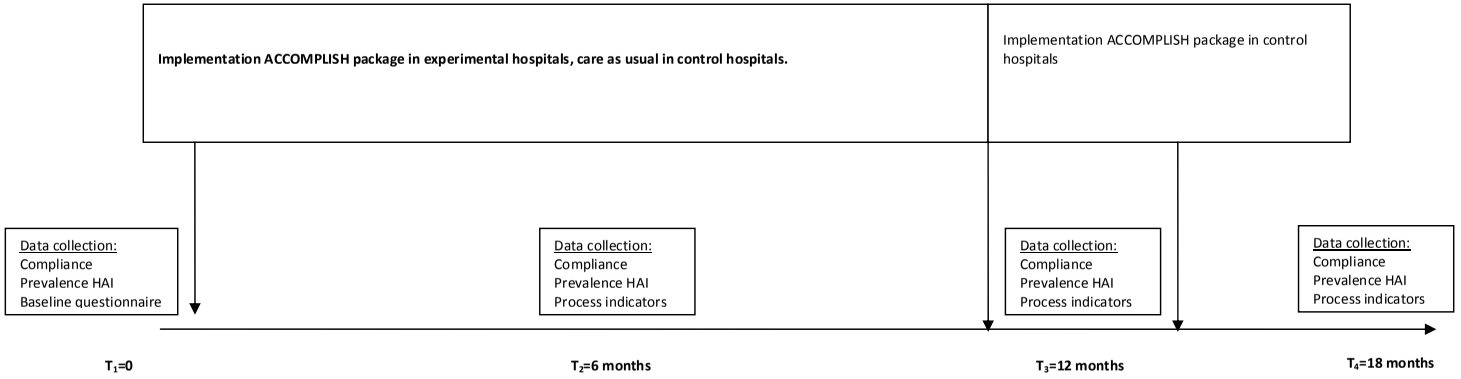

Figure 9.1. Study design ACCOMPLISH trial

and the Leadership Theory.[21] The key elements of the training are: gaining active commitment and initiative of ward management and team members, modelling by informal leaders at the ward, setting norms and targets within the team, identifying barriers and formulating activities to improve. This team training will be delivered to nurses and physicians separately. The physician teams will receive one interactive group session, and a web-based session for individual completion a month later. The nurse teams will receive three interactive team sessions during a period of 3-4 months. The interactive sessions will be led by a specially trained coach. During the intervention period the ward manager actively supports the team.

3. Performance feedback is an effective tool to increase awareness, and has often been effective in improving HH for short periods.[22] Through periodical performance feedback of HH frequencies, as measured by the novel dispenser mentioned above, a sustained positive effect on hand hygiene behaviour could be accomplished. Different mediums will be used for communicating the feedback (i.e. newsletters, electronic feedback) and will be imbedded into pre-existing work routines. A reward programme will be linked to the performance feedback in order to provide positive reinforcement of the desired behaviour (i.e. ward with highest increase in compliance).
4. An e-learning module will be used for education purposes, focussing on increasing factual knowledge, risk perception and the formulation of action plans. The module will be used for both physicians and nurses, but tailored to their specific behavioural correlates. Planning will be increased by making action plans (implementation intentions), as part of the training in which HCW will be assisted in making concrete plans and formulating solutions to the everyday problems they encounter concerning HH, using if-then plans. Concretely, it will involve formulating plans how and when they intend to perform hand hygiene (i.e. if I am about to examine a patient in the ICU, then I first walk past the alcohol based hand rub dispenser), as has been successfully used in other areas of public health[23] and more specifically for improving hand hygiene.[13]

Implementation

In order to increase the chances of successful implementation, an extensive communication strategy will be put in place prior to the start of the intervention period.

In each hospital contact persons will be appointed: the Infection Control Practioner (ICP), who will act as a coordinator for all activities, and also as the primary contact between the researchers and hospital. Other contacts will include medical staff, nurses and managers form each hospital, to stimulate active participation in the study by all groups.

At the start of the intervention a festive kick-off meeting will be planned in the participating units, in which HCW will be informed about the intervention activities. Special attention will be paid to the reasons for a process evaluation during the study. HCW will

Table 9.1. Content of the intervention, including operationalisation and targeted behavioural correlate.

Content of intervention	Operationalised as	Target behavioural correlate
Physical environment	Electronic alcohol based hand rub dispenser	Habit, availability of materials
	Posters and reminders in workplace	Raise awareness
Social environment	Interactive team training sessions	Social and descriptive norms, goal setting, role models
Education	E-learning modules	Factual knowledge, risk perception, action plans, planning
Performance feedback	Feedback of frequency data: monthly reports with reward	Social norms, self-regulation

be instructed as to how they can signal when a component of the intervention is interfering with their work activities, so that effective measures to solve these problems can be set in motion swiftly. Twelve months after the start of the intervention post intervention measurements will commence.

After the post-intervention measurements, the ACCOMPLISH package will be adjusted for all process evaluation information gathered and will be offered to the control hospitals. Based on experience gained from the study, they will receive instructions on how to implement the package.

OUTCOME MEASURES

Primary outcome measure: observed compliance rate

The compliance rate is operationalised as the number of HH practices divided by the number of opportunities for HH according to the international guidelines of the WHO,[24] which state that HH must be performed before and after patient contact, after contact with patient surroundings, after body fluid exposure risk, and before aseptic tasks. Compliance will be assessed covertly by direct observation at T1(baseline), T2 (6 months post-intervention), T3 (12 months post intervention) and T4 (18 months post intervention) at the individual level by a trained observer with the electronic Dutch version of the Hand hygiene Observation Instrument.[25] All observations will be collected between 07:30 and 13:00. Each observation session will last 4-5 hours, during which time at least three different nurses will be followed in their duties. Furthermore, any physicians caring for the same patient as the nurse being followed will also be observed.

Although some HCW may be aware of the true nature of the study, most will revert to their routine quickly, reducing the Hawthorne effect.[26] In addition, the frequency of HH per

ward will be collected continuously by the novel electronic dispensers. Furthermore, data on environmental factors influencing HH will be collected (such as patient to nurse ratio and the number of patients on the ward).

Secondary outcome measure: prevalence of HAI

The prevalence rate is operationalised as the number of HAI per 100 patients. This will be assessed with the PREZIES module of the national surveillance system of HAI during the 18 month intervention period (www.prezies.nl). This module is comparable to CDC surveillance methods (www.cdc.gov/HAI/surveillance/monitorHAI.html). Point-prevalence will be measured at T1, T2, T3 and T4 in all experimental and control units, in a given time slot (two week period). All prevalence data will be collected by a qualified ICP, who will be trained before commencement of the study. At each data collection point two point-prevalence measurements will collected, and the data of the two measurements averaged to adjust for fluctuations.

PROCESS INDICATORS

In order to identify barriers and facilitators of the implementation of ACCOMPLISH, information on process indicators will be collected at T1, T2, T3 and T4. Special attention will be paid to the different types of determinants of innovation in healthcare, which can be divided into 5 groups, namely the socio-political context, the organization, the adopting person or HCW, the innovation and the facilities needed to implement the innovation.[14] Information will be collected on HCW experiences with components of the intervention, on self-reported compliance rates and behavioural and environmental determinants of non-compliance using a questionnaire based on the Theory of Planned Behaviour in addition to constructs identified in qualitative research.[11,27] It will provide information about dissemination requirements, needed for large scale application. Other process indicators identifying possible infection prevention activities outside the intervention package will be collected during the entire intervention.

Economic evaluation

An ex-post economic evaluation of the ACCOMPLISH package to improve compliance to hand hygiene guidelines compared to a control group, from a healthcare perspective will be performed in accordance with the Dutch guidelines.[28]

A cost-effectiveness analysis will assess the balance between costs of the intervention and effects of improved HH, from a healthcare perspective. Costs for all separate actions and time used by all individual healthcare professionals, the training program, costs for the

electronic alcohol based hand rub dispensers and all other materials will be measured from a healthcare perspective for the intervention package. Table 9.2 gives an overview of the costs which will be calculated.

For the calculation of the saving due to reduced healthcare use of patients without HAI total intramural medical costs of comparable patients with HAI will be calculated. For the most important cost items, unit prices will be determined by following the micro-costing method,[29] which is based on a detailed inventory and measurement of all resources used. Resource costs arise within the hospital and consist of outpatient visits, inpatient days, use of the operation room, radiology examinations, blood tests, etc. Real medical costs will be calculated by multiplying the volumes of healthcare use with the corresponding unit prices. For instance, the calculation of the costs of complications and prolonged hospital stay will consist of detailed measurement of investments in manpower, equipment, materials, housing and overhead. The salary schemes of hospitals and other healthcare suppliers will be used to estimate costs per hour for each healthcare professional. Taxes, social securities and vacations will be included.

Data on effects (reduction of HAI), costs (time costs of extra HH and material and development costs) and savings (reduced healthcare use of patients without HAI vs. comparable patients with HAI) will all be collected in this study. Data on treatment (hospitalisation) and follow-up consultations will be collected retrospectively from (electronic) patient charts and hospital administrations in a case-control study (60 cases, 60 controls). From each of the 4 strata (university teaching, non-academic teaching, large general, small general) 1 hospital will be selected for the case control study, and from this hospital 15 cases will be selected by the local ICP. Fifteen controls will be matched by characteristics such as age, sex and diagnosis on admittance. Since cost data per patient (but not per day care) are typically highly skewed, nonparametric bootstrap techniques will be used for calculating the differences in distributions of the direct medical costs. The data will be extracted from the patient files by a researcher using an anonymous data-collection form. Information will be collected on, among others, length of hospital stay, length of ICU stay, number of days on artificial ventilation, number of intravasal or urinary catheters placed and on antibiotic use.

To measure the economic impact of improved hand hygiene cost-effectiveness will be assessed by calculating the incremental cost-effectiveness ratio, defined here as the costs for the intervention (minus savings) divided by the difference in prevalence of HAI between the intervention and control group. Costs and effects will both be discounted with a 3% ratio. A sensitivity analysis will be performed to demonstrate the sensitivity of the results to changes in improved compliance under influence of process indicators (barriers and

Table 9.2. Costs to be calculated for cost-effectiveness analysis

Intervention component	Costs to be calculated
Alcohol dispensers	1. costs of alcohol rub dispenser (purchase + maintenance)
	2. costs of placement (staffing costs)
	3. costs of more frequent refilling due to increased use of alcohol hand rub (compared to control unit)
	4. costs of alcohol hand rub due to increased use (compared to control unit)
	5. extra staffing time needed to perform HH compared to control unit (# times HH is performed extra X average time needed for HH as measured by new dispenser)
Feedback component	1. promotional materials for feedback element (posters, newsletters)
	2. costs for rewards
	3. extra time needed to incorporate feedback into daily work activities (i.e. during existing staff meetings)
Training component	1. production costs social and web based training
	2. maintenance costs web based training
	3. staffing costs for staff time needed to participate in training sessions
Overall	1. staffing costs continuous maintenance intervention components by infection control nurse
	2. training infection control nurse prior to intervention

facilitators). Prognostic modelling will be used for a limited set of predictors of outcome (e.g. attendance of training sessions, alcohol hand rub availability, and frequency of feedback sessions by ICP).

Sample size calculations

Compliance: Compliance rates are expected to increase from 20% at baseline to 50% twelve months after the intervention. Assuming 120 observed opportunities for compliance per ward per measurement moment and a 10% heterogeneity between wards, a power of 93% was calculated with two-sided alpha=0.05 for this design. In each hospital one ICU and one surgical ward will be included in the study.

Prevalence of HAI: 8568 patients are expected to be included in this study. Based on PREZIES data a baseline prevalence of HAI of 12% in the surgical ward and of 25% in the ICU is estimated.[30] Approximately 30% of these infections are exogenous and based on international literature a reduction of 40% of the exogenous part of these HAI can be expected in the intervention hospitals.[31] This will lead to a reduction in HAI in the surgical ward from 12-> 10%, and in the ICU from 25->22%. Based on an average reduction of 16-> 14% (when pooling the data) a power of 73% with a two-sided alpha = 0.05 was calculated. Since baseline measurements will be collected in all units this will enable comparison within units, substantially increasing the power.

Selection of the sample

Randomisation will take place at hospital level by means of computer generation. Therefore in each hospital both wards will be included in the same arm of the trial.

Data analysis

Process indicator questionnaires: These will be analysed with multivariable linear regression analysis, with self-reported compliance (never-always on a 10-point scale) as primary outcome variable. The determinants included in the questionnaire will include the socio-political context, the organization, the adopting person or HCW, the innovation and the facilities needed to implement the innovation.[14] Furthermore behavioural determinants will be included in the questionnaire, including attitudes, social norms, perceived behavioural control, intention, habit, knowledge of the guidelines and patient safety culture (as measured by the ComPaz questionnaire).[32]

Randomized controlled trial: The effect of the intervention strategy on the overall compliance rate among HCW (logistic regression analysis), and on prevalence of HAI will be assessed. Multilevel analysis will be performed to compensate for the clustered nature of the data (HCW are clustered within wards), using mixed linear modelling techniques.

DISCUSSION

In this paper the ACCOMPLISH intervention study has been outlined. This study is the first RCT to investigate the effects of a HH intervention programme on the number of HAI, and the first to investigate the cost-effectiveness of such an intervention. Furthermore, this is one of the first interventions tailored to the different behavioural determinants of physicians and nurses.

Strengths of the study are number of participating centres, the cluster randomized controlled trial design and the length of follow-up (6, 12 and 18 months). Furthermore, the inclusion of not only a process measure (compliance) as outcome, but also the number of HAI and the cost-effectiveness study add to the strength of the study design. The limitations of the study are the use of prevalence rather than incidence data and the fact that that not all process evaluation instruments have been validated.

The results of the study will contribute to the body of evidence on influencing HH and shed light on the cost-effectiveness of such measures from a societal perspective. In addition, if the ACCOMPLISH package proves success in improving HH compliance and lowering the prevalence of HAI the package could be disseminated at national and international level.

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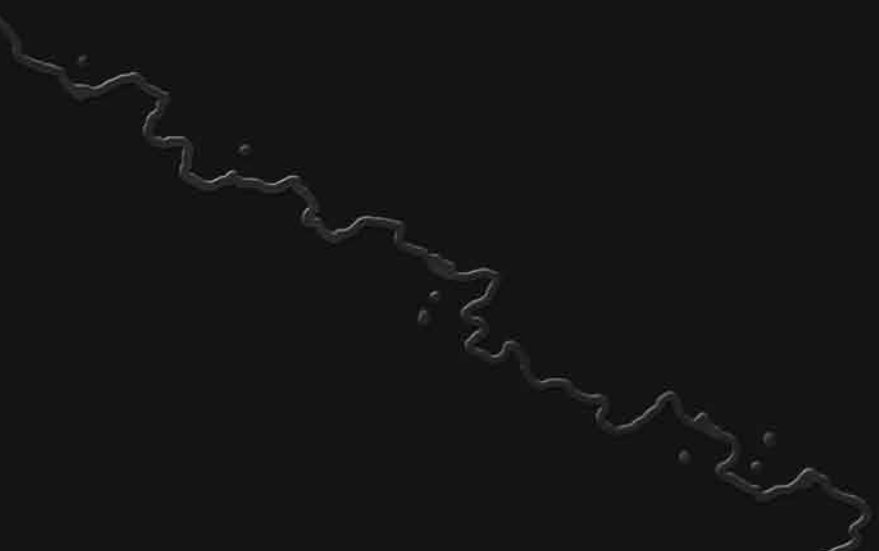
Chapter 10

General discussion



INTRODUCTION

This thesis describes a number of studies on the identification of behavioural and environmental correlates of hand hygiene behaviour among health care workers, and the translation of these determinants into an intervention, following a planned stepwise approach to behaviour change.[1] The following research questions were addressed:

I. To what extent are the hand hygiene guidelines currently adhered to and what are the important individual and environmental correlates of this behaviour?
II. How can effective interventions be designed to improve hand hygiene behaviour in clinical practice?

Main findings

i. Guideline adherence

Two studies were conducted to investigate the level of guideline adherence (**chapter two and four**). In a systematic review (**chapter two**) we reviewed the guideline adherence reported in 96 studies on hand hygiene compliance, and found a median level of compliance of 40%. Compliance rates were lower in the ICU's than in other settings, were lower among physicians than among nurses, and were lower before patient contact than after patient contact. **Chapter four** described an observational study in a representative sample of 24 Dutch hospitals with participation of one ICU and one surgical ward from each hospital. This study showed a 20% overall compliance to the hand hygiene guidelines, compliance rates being lowest in teaching facilities. The level of compliance in this multicentre study was lower than the median level of compliance reported in the 96 studies included in our systematic review, presented in **chapter two**. The difference in compliance rates is possibly due to the relatively strict WHO guidelines used in the observation of compliance in this study, which were not used in all studies included in the systematic review.[2] Our observational study also found compliance to be lower in ICUs than in other hospital settings, and lower prior to patient contact compared to after patient contact. However, unlike the systematic review, this study did not yield significant differences in the hand hygiene compliance of physicians when compared to that of nurses.

ii. Individual en environmental correlates of hand hygiene behaviour

Four studies investigated the individual and environmental factors influencing hand hygiene behaviour (**chapters two to five**). In **chapter two** we reviewed the available literature to investigate behavioural correlates of hand hygiene compliance, and found that the behavioural correlates of hand hygiene compliance had been studied only sporadically, and the results of these studies remained inconclusive. The results of our qualitative study (**chapter three**) showed that the hand hygiene behaviour of healthcare workers

Table 10.1. Determinants with a statistically significant association with the hand hygiene compliance of physicians, nurses and medical students

Determinant	Physicians	Nurses	Medical students
Knowledge of guidelines	X		
Risk perception	X	X	
Attitudes			X
Social norm		X	
Perceived behavioural control		X	X
Habit	X	X	X

appeared to be influenced by the factors described in the Theory of Planned Behaviour,[3] i.e. attitudes, social norm and perceived behavioural control. In addition, risk perception, knowledge of the guidelines and habit were found to be factors influencing hand hygiene behaviour. Further quantitative research (**chapters four and five**) showed that the factors that influence the hand hygiene behaviour of physicians differ from those affecting nurses' behaviour, and also from those affecting medical students behaviour (see table 10.1), indicating that these groups should be addressed differently in order to improve their hand hygiene compliance.

The results presented above indicate that the hand hygiene behaviour of healthcare workers is influenced by a combination of environmental and behavioural factors. Working in an ICU and in a university teaching hospital was associated with poor hand hygiene. These findings are a cause for concern, since patients in the ICU are at a particular risk for developing infections, and university teaching hospitals are the environment where the healthcare workers of tomorrow are trained. The results described in **chapter five** further indicated that habit was strongly associated with the hand hygiene behaviour of all groups of healthcare workers. Shaping good habits is therefore essential. It is thus an unfortunate paradox that university teaching hospitals do not seem the best environments to shape the hand hygiene habits of the students and fellows in their training programs. Comparing the behavioural correlates of nurses and physicians yielded the important finding that physicians are less influenced by their social environment than nurses are, reflecting their more autonomous working style. On the other hand, physicians, compared to nurses, are more influenced by knowledge of the guidelines.

iii. Designing effective interventions to improve hand hygiene compliance

Four studies investigated translating these behavioural correlates into interventions. **Chapter six** described a Delphi study in which a panel of healthcare workers, managers and infection prevention experts reached consensus on the determinants of non-compliance to hand hygiene guidelines among nurses, whereas only limited agreement was reached about what is important among physicians. Consensus could be reached on two major

changeable determinants of non-compliance in both professional groups: knowledge of the healthcare worker and social culture of the hospital or unit. For nurses, experts also agreed on the importance of the physical environment, in terms of accessible materials and the feasibility to perform hand hygiene under all circumstances. We identified strong consensus about a restricted package of effective and feasible measures to improve hand hygiene. This bundle of interventions included education, performance feedback, reminders in the work environment and the improved accessibility of materials. We found strong consensus about the importance to change social culture, but many doubts were expressed about the feasibility to change social culture in clinical practice. The panellists also disagreed with each other about the role of stimulating active patient participation and about the application of sanctions or penalties as possible elements of an intervention package to improve hand hygiene behaviour.

Since habit had been identified in both qualitative and quantitative research as being an important determinant for physicians, nurses and medical students, we investigated a possible intervention to influence it. In other fields the use of action planning (or implementation intentions) had been investigated and found successful in influencing habitual or automatic behaviour.[4] Implementation intentions are specific action plans, defining when and where to perform a particular behavioural action in order to achieve an intended goal.[5] Action plans take the form of 'if then' plans (if situation X occurs, I will perform behaviour Z in order to achieve goal Y) and thus link situational cues (i.e. placing a urinary catheter) with a behavioural response (i.e. perform hand hygiene) that suits the desired outcome (prevent infection). These 'if then' plans assist in translating intentions into actions and have shown promising results in promoting health behaviours such as physical activity, dietary intake and participation in screening activities.[4,6]

However, this method had not yet been applied as an intervention to influence hand hygiene behaviour. In the study described in **chapter seven** a pilot was therefore conducted to this end. The results of this pilot study indicated that interviews including action planning could be useful in improving the hand hygiene behaviour of individual nurses. The nurses were able to plan how they would fit proper hand hygiene into their routine, and post-intervention results indicate some success in implementing these plans, since hand hygiene compliance increased from 9.3% at baseline to 25.4% post intervention (OR: 3.3; IC: 1.7-6.5; P <0.001). The baseline compliance of 9.3% was lower than the average in the national sample (i.e. 20%), although this was to be expected since the pilot was conducted in a teaching hospital, and these facilities showed a significantly lower compliance compared to other hospital types in the national study.

Both the literature review (**chapter two**) and the Delphi study (**chapter seven**) indicated that accessibility of materials and performance feedback are important in the promotion of hand hygiene compliance. A study was therefore conducted in collaboration with industrial design engineers as to which functions the ideal hand hygiene dispenser should have in order to facilitate promotion of use, as described in **chapter eight**. A participatory design approach investigated which functions were considered most useful and important by healthcare workers.[7] Overall, the participants reacted positively to the concept chosen. Most important features for the participants are the universal placement (i.e. not limited to sink locations) of the device and the spray function. Participants indicated that they felt the dispenser had a professional look and enabled ease and more frequent use during patient care. However, participants were neutral as to whether the feedback provided by the device would promote social control.

Finally, both the results from the literature review and the studies described in this thesis suggest that successful hand hygiene promotion interventions should be multifaceted. Therefore, based on the determinants we identified (**chapter two to six**) and intervention approaches from our own group (**chapter seven and eight**) and other Dutch researchers within this field,[8] we developed an intervention package. This package (ACCOMPLISH) is tailored to the determinants of hand hygiene compliance of physicians and of nurses. The intervention package focuses on individual level factors, increasing personal and normative feedback, and is embedded in self-regulation theory, which suggests that behaviour-change is a dynamic process, in which specific, achievable goals need to be set, discrepancies between desired goals and goal progress need to be fed back to an individual, and finally that (social) reinforcement is an important element to promote behavioural sustainability and ongoing goal pursuit.[9,10] Among others, it addresses these elements by means of increasing planning, performance feedback, increasing knowledge of hand hygiene guidelines on an individual level and on environmental factors creating an increased availability of alcohol based hand rub and increasing the visibility of hand hygiene guideline support (table 10.2).

We designed a study to investigate the cost-effectiveness of this intervention package (**chapter nine**). In this cluster randomized controlled design we can investigate the effects of the novel hand hygiene compliance intervention on compliance and on the prevalence of HAI at middle-term follow-up (12 months). Furthermore, a case-control study will investigate the influence of HAI on healthcare costs, and an analysis of the cost-effectiveness of the intervention will be conducted from a societal perspective.

Table 10.2. Content of the intervention, including operationalization and targeted behavioural correlate.

Content of intervention	Operationalized as	Target behavioural correlate
Physical environment	Electronic alcohol based hand rub dispenser	Habit, availability of materials
	Posters and reminders in working place	Raise awareness
Social environment	Interactive team training sessions	Social and descriptive norms, goal setting, role models
Education	E learning modules	Factual knowledge, risk perception, action plans, planning
Performance feedback	Feedback of frequency data: monthly reports with reward	Social norms, self-regulation

Methodological issues

The studies presented in this thesis used a variety of different methodologies from qualitative exploratory research, through a systematic review to original quantitative cross-sectional and quasi-experimental research. These studies have several limitations and the results should be interpreted in light of these limitations. In this section considerations regarding the theoretical framework, study designs, sampling and participants and measures are discussed.

The theoretical framework

The model used in the studies described here, an extended version of the Theory of Planned Behaviour (TPB),[3] is not the end point, and much could still be done to further investigate the mechanisms of the model, the direction of the associations but also possible other constructs which are yet to be added. The model described in this thesis was able to explain the variance in behaviour well, although there is still room for improvement. First, the construct culture mainly focussed on the element of institutional and departmental commitment due to practical limits in the length of the questionnaire. However, studies have shown that the concept of safety culture consists of more dimensions.[11,12] Ideally, the influence of these other dimensions on hand hygiene compliance should be investigated further.

Second, the work described in this thesis is based on the TPB, however other theoretical frameworks could also have been considered, including the Health Belief Model or Social Cognitive Theory.[13,14] However, a recent study investigating the best model for explaining hand hygiene behaviour, suggests that a TPB with additional components regarding the environment,[15] as we were able to do in our model (see figure 10.1) using TPB[3] with additions from SEM[16] and habit.[17] Furthermore, these constructs were significantly associated with hand hygiene compliance, indicating that the model suggested by Nicol *et al*. (2009)

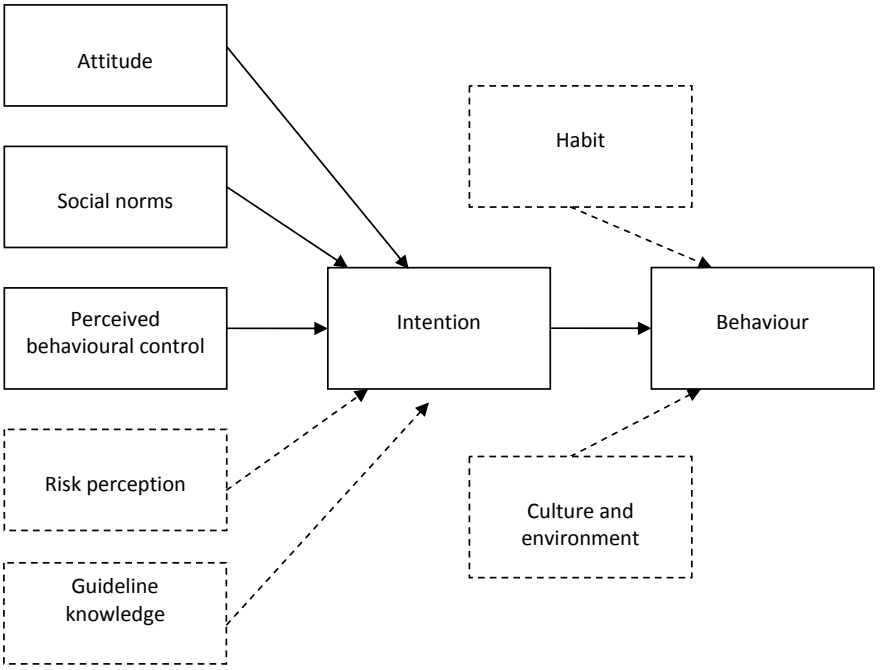


Figure 10.1. Extended Theory of Planned Behaviour model. The solid boxes represent constructs from the TPB.[3] Constructs in dashed boxes have been added based on our own study results.[2,18]

is indeed better at explaining this type of behaviour. New studies should, therefore, include investigations into these constructs, as they might prove valuable additions in promoting hand hygiene compliance.

Qualitative studies

Three qualitative studies were conducted, namely a focus group study (**chapter three**), a Delphi study (**chapter six**) and a participatory design approach study (**chapter eight**). These qualitative studies were exploratory in nature and were important as input for the cross-sectional survey studies and the intervention development that followed.

The strength of focus group studies (**chapter three**) is the richness and breadth of the data that can be collected, making it an ideal tool for the initial exploratory phase of research.[19] Furthermore the inclusion of different study populations (nurses and physicians) was a further strength of the study. Similar techniques are applied in the participatory design approach (**chapter eight**). These techniques however have the limitations that they are labour intensive, that the sample size is often relatively small, and that samples might not be representative of the target population. Moreover, it proved rather difficult to plan group

discussions with physicians due to their different individual work schedules. Instead, we chose to conduct individual interviews with a relatively small number of them. When conducting qualitative research in a clinical setting where patient care is always an overriding priority a certain degree of flexibility is essential, also in participatory design techniques.[20]

The qualitative work described above yielded insights which were investigated quantitatively in **chapters four and five**. In accordance with the qualitative results, quantitative research showed that habit indeed plays an important role in influencing the hand hygiene behaviour of all major groups of healthcare workers. Furthermore, knowledge of the guidelines has a strong positive association with hand hygiene compliance, although only for physicians and medical students, whereas qualitatively it was suggested this would also be true for nurses. On the other hand, social norms were found quantitatively to only be associated with hand hygiene compliance for nurses but not for physicians, as was suggested qualitatively. Risk perception was associated with hand hygiene compliance in both qualitative and quantitative studies. Lastly, outcome beliefs were positively associated with hand hygiene compliance for nurses and medical students, as was suggested qualitatively. However, the lack of a scientific evidence base for efficacy of hand hygiene in preventing infection, which was considered an important barrier for physicians' compliance, was not found in the qualitative research. However, this aspect may not have received enough attention in the questionnaire.

One of the strengths of the Delphi technique (**chapter six**) is that it allows for including the viewpoints of different stakeholders or experts, no matter what their geographical location, since the study is conducted electronically. Furthermore, the technique guarantees anonymity and results are not skewed by otherwise dominant opinion leaders. Therefore, it is possible not only to gain insight into consensus but also in the level of dissensus. The Delphi technique focuses on exploring agreement of consensus between respondents on the topics included in the study.[21] The results are dependent on the participants included in the study, and we particularly saw that the highest drop-out during the 3 rounds was among managers (overall response 67%), compared to infection prevention experts (79%). Therefore, the viewpoints of managers might be have become somewhat underrepresented in the final outcomes. Furthermore, as in other Delphi studies,[22,23] the procedure of panel selection may have introduced some bias. Experts with a positive attitude towards hand hygiene interventions may have been over represented, since they were primarily recruited from hospitals willing to participate in a national study on this topic. It should be considered that estimations of the expected effectiveness and feasibility of measures could have been different in the panel had been selected by a truly random sampling of the available pools of reference groups.

Systematic review

The study reported in **chapter two** is a systematic review to examine the prevalence and correlates of compliance and non-compliance with hand hygiene guidelines in hospital care. The strength of this review is that it is one of the first to systemically review studies on hand hygiene compliance. However, the review had some limitations, particularly due to the lack of homogeneity among the studies included. We were not able to perform any type of meta-analysis because of the large methodological differences in the studies included in the review. The studies included were of varying methodological quality, with some studies not even reporting their sample type, size, or any form of reliability testing. Furthermore, a fair number of the studies failed to report on the type of instrument used for obtaining the data or on how observers were trained. For these reasons previous reviews[24,25] chose to exclude most studies on hand hygiene compliance. However, in order to give an overview of the existing literature we chose to include the studies despite these methodological issues. This could have resulted in an overestimation of compliance, since the compliance levels reported in the more robust studies tended to be lower,[25] in agreement with our finding of a compliance of 20% in a national sample. More consistent descriptions and greater consistency in presentation of outcome measures in scientific papers is essential to improve the quality of data that can be analysed in systematic reviews, as well as increase the usability of the results in practice.

Quantitative studies

Chapters four, five and seven describe three quantitative studies. **Chapters four and five** describe two observational cross-sectional studies to investigate the behavioural correlates of hand hygiene behaviour among physicians, nurses and medical students quantitatively. These studies had a number of limitations. Firstly, the outcome measure of the questionnaires was self-reported behaviour and not observed (or actual) behaviour. Secondly, the questionnaire was not validated before this application. Thus, it is not certain that the separate constructs were measured correctly. However, all these constructs did have a high internal consistency. Lastly, the response among physicians and nurses was acceptable at 60%, but we could not collect and analyse information about the non-responders. Therefore, response bias in our questionnaire data cannot be excluded and it could have resulted in a higher self-reported compliance (selection on compliance). Furthermore, a response bias might have resulted in an underestimation of the effects of some constructs. For example, possibly the nurses and physicians who completed the questionnaire had more knowledge of the guidelines than those who did not.

Chapter seven describes a quasi-experimental pilot study on the use of action planning to improve the hand hygiene compliance of nurses. One of the limitations of this study was the small number of participants and short time span between intervention and follow-up

(three weeks). Furthermore, baseline compliance in participating wards was very low, <10%, and it is not inconceivable that any kind of attention to hand hygiene in such wards could have yielded a positive effect. Other studies have shown similarly low levels of compliance, indicating that this level of compliance is not unique to this cohort. Our study was conducted in one university hospital, limiting generalisation of its results. Further research in different hospital types, more participants and a longer follow-up period are needed to justify large scale application of the intervention. Finally, action plans were formulated within a broader interview setting with other topics, and so effects may be due to the combined intervention and not to action planning alone. Research is needed in which action plans are formulated without other topics to exclude possible confounding. The simple pre-post test design does not allow us to ascribe the effects of the intervention with great certainty.

Design of the study ACCOMPLISH (Actively Creating COMPLiance Saving Health)

Chapter nine describes the ACCOMPLISH intervention package and the design of a study evaluating the effects of this package on hand hygiene compliance and healthcare associated infections. Strengths of the study are the number of participating centres, the cluster randomized controlled trial design and the length of follow-up (6, 12 and 18 months). Furthermore, the inclusion of not only a process measure (compliance) as outcome, but also the occurrence of HAI and the addition of a cost-effectiveness analysis add to the strength of the study design. The limitations of the study are the use of prevalence rather than incidence data and the fact that that not all process evaluation instruments have been validated.

Participants

The participants in the work described here have always included healthcare workers, in particular nurses and physicians from the ICU and surgical wards. This often meant having to fit data-collection activities into already busy shifts. As a result, interviews and focus groups always had to be kept as short as possible, never exceeding one hour. Furthermore, it sometimes proved extremely difficult to find physicians with the time and willingness to participate in interviews (e.g. in **chapter eight**), resulting in a very small sample size from this group and in an over-representation of the views of nurses in this study. On the other hand, the large overall numbers of healthcare workers willing to participate in the various data-collection activities (e.g. **chapters three, four and five**) have resulted in sound datasets enabling the insights found in this thesis.

Self-reported compliance as outcome measure

Due to practical reasons the main outcome measure for the questionnaires used in **chapters four and five** was self-reported compliance, and not observed behaviour. Although com-

pliance was observed in the study described in **chapter four**, these results were collected anonymously and could therefore not be linked to questionnaire data. The implications for this are that it remains unclear how our model would explain actual behaviour in practice.

Implications of the study findings

The studies presented in this thesis were among the first to explore improving hand hygiene compliance through a stepwise behavioural approach. A number of implications for future research and use in practice arise from these results.

Implications for future research

The studies in this thesis generated both qualitative and quantitative evidence on the behavioural determinants of hand hygiene compliance and how they could be influenced. The next step in this process would be testing the effectiveness of interventions based on these finding in practice. This thesis includes a paper on the design of such a study; however this trial is currently on going.

One finding in the studies reported here, is that healthcare workers require feedback on the effects of their behaviour, for example the occurrence of infections in their ward. From a research perspective it is also essential that studies show the effects of hand hygiene compliance on the occurrence of healthcare associated infections. Although the baseline evidence for the necessity of hand hygiene in healthcare is old and stems from the time of Semmelweis, healthcare workers, and in particular physicians require a strong and more recent evidence base for this procedure. Although many aspects can influence the occurrence of HAI making detection difficult, the necessity for this type of publication remains. Furthermore, the economic aspects should also be weighed alongside the benefits, in order to enable decisions at a public health level. This means a shift from the moral stigma of hand hygiene (something you do because you should) and to it becoming the proper thing to do because it has been proven effective. Furthermore, studies need to investigate until which point hand hygiene promotion is still effective. Perhaps a compliance level of e.g. 70% is sufficient to prevent the large majority of HAI events preventable through hand hygiene, and promotion after that point no longer cost-effective.

The development of successful interventions is but a first step and implementation is an important although often underestimated aspect of behavioural interventions. Practice would benefit greatly from systematic research into the best practices for the implementation of interventions.

The findings of the research discussed in this thesis suggest that the environment is important in stimulating good hand hygiene behaviour. In the ACCOMPLISH package the work

environment is therefore also targeted through the placing of a newly designed alcohol based hand rub dispensers. Research from the social sciences suggests that the environment is important in influencing norm adherence and norm-directed behaviour, like rules and guidelines.[26] This effect of *cue power*, which involves the automatic activation of mental concepts[27] can strongly influence behaviour.[26] Several and sometimes conflicting mental concepts, such as attitudes, goals, norms, and expectations, exist at the same time but not all are activated simultaneously. Only the mental concepts which are salient will actually influence the behaviour at any specific point in time. This activation can be caused by an internal stimulus or an external cue from the environment. For example, observing that others did not conform to a specific norm, weakens the normative goal in general, thereby inhibiting the influence of this norm but also other norms (a process called the cross-norm inhibition effect) on one's behaviour. Deactivation of one social norm (e.g. you should not litter) can lead to the further deactivation of socially desirable norms[28] in favour of hedonic goals, which could be totally unrelated to littering.[26] This spreading effect can have extensive effects on behaviour,[29] also in a healthcare setting built on norms and protocols. Research into the effects of environmental cues on adherence could prove a valuable addition to patient safety interventions.

The hand hygiene behaviour of physicians, nurses and medical students is influenced by different factors and further research should focus on these specific professional groups. Research into influencing the hand hygiene behaviour of physicians is especially needed since classical interventions are least effective with this group.[30] The classical approach to improving hand hygiene, i.e. education based interventions, is not the best way to improve the hand hygiene behaviour of nurses and medical students, but is essential in interventions targeting physicians, although in itself not enough. The next step would be to investigate how education based interventions should target this difficult to reach and teach group. For nurses and medical students, it is essential to target their level of self-efficacy rather than their level of factual knowledge. All groups can benefit from hand hygiene as a habitual behaviour and future research should focus on how this can best be achieved. Other fields have found changes and cues in the physical environment to be instrumental in breaking old habit and forming new ones.[17] The application of this knowledge into the healthcare system should be investigated.

Implications for practice

The World Health Organization (WHO) considers five key features crucial for implementing successful multimodal hand hygiene interventions: (1) engineering controls to improve accessibility of hand alcohol, (2) education and training, (3) observation of compliance and data feedback, (4) reminders in the work environment, and (5) creation of an institutional safety climate.[31] Different combinations of these elements have been included

in the few hand hygiene interventions in Europe (the Geneva initiative) and the US (the Washington initiative) with sustained positive effects on compliance.[32]

The ACCOMPLISH intervention package contains all these elements, but has additionally identified the need for tailoring the interventions to the separate needs of physicians and nurses, based on the results of a planned stepwise behavioural approach for intervention development.[1] The differences found in the determinants indicate that successful interventions should target specific groups of health care workers differently in order to be successful for all groups. The data from **chapter four** revealed that compliance to hand hygiene guidelines of physicians and nurses is influenced by different factors, and that the addition of elements targeting habit are essential.[2] Experts from hospital practice further confirmed that specific interventions -added to a common core- should contain specific elements and approaches for both professional groups. Amongst others, the experts expressed the opinion that changes in the physical environment, such as improved accessibility of hand alcohol, will be effective for nurses, but not for physicians. This is compatible with findings from the Geneva initiative, which found a sustained positive effect of this measure (combined with promotional materials and institutional commitment) on the hand hygiene behaviour of nurses, whereas compliance of physicians remained poor. This led to the conclusion that the best way to improve hand hygiene among doctors remained to be determined.[30] Based on our results, we hypothesize that for physicians, improvements of knowledge and social culture are key to increase hand hygiene compliance rates. This hypothesis will be investigated in the ACCOMPLISH study described in **chapter nine**. Should this ACCOMPLISH package prove to be cost effective in improving hand hygiene compliance and, thus to significantly lower the prevalence of HAI, the package could be disseminated at national and international level.

At a national level, the results will be disseminated to organisations such as PREZIES (the national surveillance network for hospital infections), the WIP (Dutch working party on infection prevention) and the IGZ (Dutch health inspectorate). These organisations are involved in the national policy and guidelines, and could enable structural implementation of these research findings into practice. On the other hand, bottom-up dissemination is also essential. Dissemination of the tools from this intervention (such as the e-learning and team training modules, but also measurement instruments such as the questionnaire and observational protocol) can be achieved through professional organisations such as the VHIG (Dutch Society for Hygiene and Infection Prevention in Healthcare), the VIZ (Society of Infectious Diseases) and the NVMM (Dutch Society of Medical Microbiology). In addition web based instruments of dissemination can be applied at relatively low additional costs. Ultimately, those working in the hospitals themselves can most effectively help to bring the results from research into practice. Teaching hospitals in particular, where

future physicians are trained, must be targeted. Furthermore, since guideline knowledge was found to be an important correlate for physicians, they (e.g. physicians in fellowship programs) should receive training on basic hygiene and infection prevention practices at the time they enter clinical practice. E-learning has practical advantages, and should it prove effective in the aforementioned intervention study, dissemination of the e-learning module should be considered for physicians in particular.

The stepwise behavioural approach to intervention development[1], as described in this thesis, could easily be applied to other patient safety areas and in particular for guideline/protocol adherence in healthcare. The methodology enables the development of effective interventions targeting the crucial points of non-compliance. Applying these behavioural insights to the healthcare setting can help improve patient safety and further improve healthcare.

CONCLUSIONS

This thesis has added insight into the behavioural correlates of hand hygiene compliance in healthcare and how interventions could target these correlates. The research presented suggests that a combination of individual and environmental correlates influence this behaviour, and that these correlates differ for physicians, nurses and medical students. Interventions should therefore be tailored to the target professional group in order to be successful.

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Summary

Healthcare associated infections (HAI) are a threat to public health. Since a portion of HAI can be prevented by preventative measures including hand hygiene, the prevention of these infections has received growing attention over the past decades. To be able to develop successful intervention for the improvement of hand hygiene, it is essential to identify the factors influencing this behaviour, and investigate which interventions can be developed targeting these factors.

The aim of this thesis was to contribute to systematic evidence based research of individual and environmental correlates of hand hygiene behaviour of healthcare workers, and develop an intervention based on the associations found. The work described in this thesis focussed on the determinants of hand hygiene behaviour and the development of interventions targeting the factors that influence it. The central research questions addressed are:

I. To what extent are the hand hygiene guidelines currently adhered to and what are the important individual and environmental correlates of this behaviour?
II. How can effective interventions be designed to improve hand hygiene behaviour in practice?

Two studies were conducted to investigate the level of guideline adherence. In a systematic review (**chapter two**) we reviewed the guideline adherence reported in 96 studies on hand hygiene compliance, and found a median compliance of 40%. Compliance rates were lower in the ICU's (with a median rate somewhere in the range of 30%–40%) than in other settings (with a median rate somewhere in the range of 50%–60%), were lower among physicians (32%) than among nurses (48%), and were lower before patient contact (21%) than after patient contact (47%). In general, the study methods were not very robust and often ill reported. Furthermore, only a limited number of studies (n=7) investigated behavioural correlates using a theoretical framework, and the results from these studies were inconclusive.

The results of qualitative study (**chapter three**) showed that the hand hygiene behaviour of healthcare workers appeared to be influenced by the factors described in the Theory of Planned Behaviour, i.e. attitudes, social norm and perceived behavioural control. In addition, risk perception, knowledge of the guidelines and habit were mentioned as factors influencing hand hygiene behaviour. Nurses and medical students expressed the importance of hand hygiene for preventing cross-infections among patients and themselves. Physicians expressed the importance of hand hygiene for self-protection, but they perceived that there is a lack of evidence that hand hygiene is effective in preventing cross-infections. All participants stated that personal beliefs about the efficacy of hand

hygiene and examples and norms provided by senior hospital staff are of major importance for hand hygiene compliance. They further reported that hand hygiene is most often performed after tasks that they perceive as dirty, and personal protection appeared to be more important for compliance that patient safety. Medical students explicitly mentioned that they copy the behaviour of their superiors, which often leads to non-compliance during clinical practice. Physicians mentioned that their non-compliance arises from their belief that the evidence supporting the effectiveness of hand hygiene for prevention of healthcare associated infections is not strong.

Chapter four described an observational study in a representative sample of 24 Dutch hospitals with participation of the ICU and surgical ward. This study showed a 20% overall compliance to the hand hygiene guidelines, and was found to be lowest in teaching facilities. In ICU's and before patient contact hand hygiene compliance was lower, although no significant difference was found in the hand hygiene compliance of physicians compared to nurses. **Chapter four** also showed that physicians were strongly influenced by a lack of knowledge of the guidelines and perceived severity of infection for them self. Nurses on the other hand were influenced more by what important other persons think about hand hygiene (descriptive norm), and their own perceived ability to perform hand hygiene when needed (perceived behavioural control). Both physician's and nurses' hand hygiene behaviour is strongly influenced by habit.

Chapter five reported the results for final year medical students, and showed that their hand hygiene behaviour was most strongly influenced by habit, perceived outcomes of hand hygiene and whether students feel to have the ability to perform hand hygiene in practice. Knowledge and risk perception were not associated with hand hygiene compliance.

Chapter six described a Delphi study in which a panel of health care workers, managers and infection prevention experts reached broad consensus on the determinants of non-compliance to hand hygiene guidelines among nurses, but where less consensus could be reached about what is important among physicians. Consensus could be reached on two major changeable determinants of non-compliance in both professional groups: knowledge of the healthcare worker and social culture of the hospital or unit. For nurses, experts also agreed on the importance of the physical environment, in terms of accessible materials and the feasibility to perform hand hygiene in all circumstances. We identified strong consensus about a restricted package of effective and feasible measures to improve hand hygiene, consisting of: education, performance feedback, reminders in the work environment and the improved accessibility of materials. We found strong consensus about the importance to change social culture, but doubts were expressed about its feasibility

in practice. The panellists disagreed with each other about patient participation and sanctions as possible elements of an intervention package.

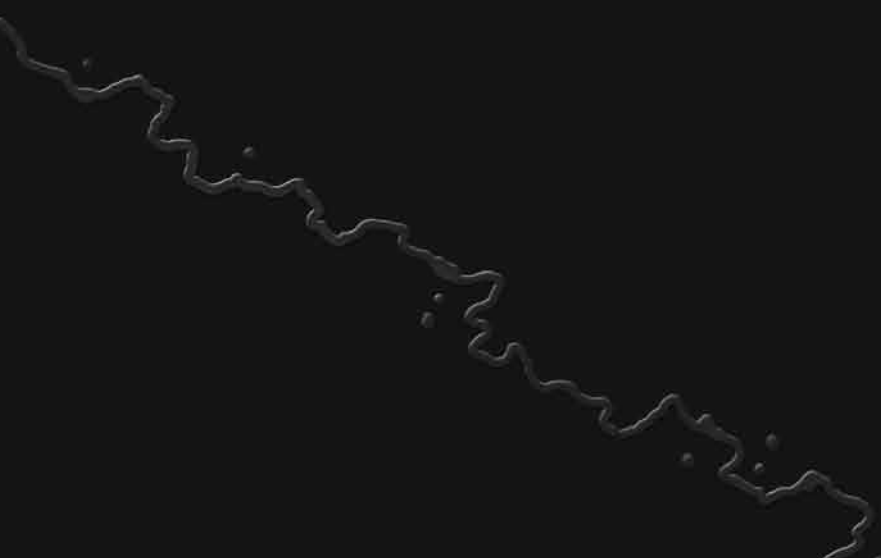
In the study described in **chapter seven** a pilot was conducted to assess the effects of application of implementation intentions to improve hand hygiene. The results of this pilot study indicated that interviews including action planning could be useful in improving the hand hygiene behaviour of individual nurses. The nurses were able to plan how they would fit proper hand hygiene into their routine, and post-intervention results indicate some success in implementing these plans, since hand hygiene compliance increased from 9.3% at baseline to 25.4% post intervention (OR: 3.3; IC: 1.7-6.5; P <0.001).

Both the literature review (**chapter two**) and the Delphi study (**chapter seven**) indicated that accessibility of materials and performance feedback were important in the promotion of hand hygiene compliance. A study was therefore conducted in collaboration with industrial design engineers as to which functions the ideal hand hygiene dispenser should have in order to facilitate promotion of use, as described in **chapter eight**. A participatory design approach investigated which functions were considered most useful and important by healthcare workers. Overall, the participants reacted positively to the concept. Most important features for the participants are the universal placement of the device and the spray function. Participants indicated that they felt the dispenser had a professional look and enabled ease and more frequent use during patient care.

Finally, both the results from the literature review and the studies described in this thesis suggest that successful hand hygiene promotion interventions should be multifaceted. Therefore, based on the determinants we identified (**chapter two to six**) and intervention approaches from our own group (**chapter seven and eight**) and other Dutch researchers within this field,[8] we developed an intervention package. This package (ACCOMPLISH) is tailored to the determinants of hand hygiene compliance of physicians and of nurses. The intervention package focuses on individual level factors, increasing personal and normative feedback, and is embedded in self-regulation theory, which suggests that behaviour-change is a dynamic process, in which specific, achievable goals need to be set, discrepancies between desired goals and goal progress need to be fed back to an individual, and finally (social) reinforcement is an important element to promote behavioural sustainability and ongoing goal pursuit. Among others, it addresses these elements by means of increasing planning, performance feedback, increasing knowledge of hand hygiene guidelines on an individual level and on environmental factors creating an increased availability of alcohol based hand rub and increasing the visibility of hand hygiene guideline support.

We designed a study to investigate the cost-effectiveness of this intervention package (**chapter nine**). In this cluster randomized controlled design we can investigate the effects of the novel hand hygiene compliance intervention on compliance and the prevalence of HAI at middle-term follow-up (12 months). Furthermore, a case-control study will investigate the influence of HAI on healthcare costs, and an analysis of the cost-effectiveness of the intervention will be conducted from a societal perspective.

Samenvatting



Zorg-gerelateerde infecties (ZGI) vormen een bedreiging voor de gezondheid van de maatschappij. Aangezien een deel van de ZGI voorkomen kan worden met preventieve maatregelen zoals handhygiëne, heeft het voorkomen van deze infecties de afgelopen jaren steeds meer aandacht gekregen. Voor het ontwikkelen van succesvolle interventies ter bevordering van handhygiëne is het essentieel om de factoren die dit gedrag beïnvloeden te identificeren. Daarnaast is het nodig te onderzoeken welke interventies er ontwikkeld kunnen worden die gericht zijn op deze factoren.

Dit proefschrift beoogt twee doelen na te streven. Ten eerste het bijdragen aan systematisch onderzoek naar de individuele – en omgevingscorrelaten van het handhygiëne gedrag van zorgverleners. Ten tweede om een interventie te ontwikkelen op basis van de gevonden associaties. Het werk dat in dit proefschrift wordt beschreven richtte zich op de determinanten van handhygiëne gedrag en het ontwikkelen van interventies die gericht zijn op de factoren die dit gedrag beïnvloeden. De centrale onderzoeksvragen zijn:

I. In hoeverre worden de handhygiëne richtlijnen nageleefd en wat zijn de belangrijke individuele en omgevingscorrelaten van dit gedrag?
II. Hoe kunnen effectieve interventies worden ontworpen om handhygiëne in de dagelijkse praktijk te bevorderen?

Er werden twee studies uitgevoerd om de compliance (mate van naleving) te onderzoeken. In een systematische review (**hoofdstuk twee**) hebben we de compliance onderzocht van 96 studies over handhygiëne compliance, waarbij de mediaan van de in deze studies gerapporteerde compliance 40% was. Op de Intensive Care (IC) was de compliance lager (mediaan tussen 30-40%) dan op andere afdelingen (mediaan tussen 50-60%). De compliance was lager onder artsen (32%) dan onder verpleegkundigen (48%), en was daarnaast lager vóór contact met de patiënt (21%) dan na contact met de patiënt (47%). Over het algemeen waren de gebruikte onderzoeksmethoden van de onderzochte studies niet erg robuust en vaak slecht gerapporteerd. Hiernaast heeft slechts een klein aantal studies (n=7) de gedragscorrelaten onderzocht aan de hand van een theoretisch model. De resultaten hiervan zijn niet overtuigend.

De resultaten van een kwalitatief onderzoek (**hoofdstuk drie**) lieten zien dat het handhygiëne gedrag van zorgverleners beïnvloed werd door factoren die beschreven worden in de Theorie van Gepland Gedrag, dat wil zeggen: attitude, sociale norm en ervaren gedragscontrole. Hiernaast werden risicoperceptie, kennis van de richtlijnen en gewoonte genoemd als factoren die handhygiëne gedrag beïnvloedden. Verpleegkundigen en geneeskundestudenten noemden het belang van handhygiëne in het voorkomen van kruisinfecties voor patiënten en henzelf. Artsen noemden het belang van handhygiëne voor zelf-

bescherming, maar ervaren een tekort aan bewijs voor de effectiviteit van handhygiëne in het voorkomen van kruisinfecties. Alle deelnemers noemden persoonlijke ideeën over de effectiviteit van handhygiëne en voorbeelden en normen zoals weergegeven door senior zorgpersoneel als heel belangrijk voor handhygiëne compliance. Hiernaast meldden ze dat handhygiëne voornamelijk wordt uitgevoerd na taken die als vies worden ervaren. Persoonlijke bescherming leek belangrijker te zijn voor compliance dan patiëntveiligheid. Geneeskundestudenten rapporteerden expliciet dat zij het gedrag van hun senioren kopiëren, vaak met non-compliance tot gevolg. Artsen meldden dat hun non-compliance vooral voortkomt uit de vooronderstelling dat het bewijs voor de effectiviteit van handhygiëne ter voorkoming van ZGI zwak is.

Hoofdstuk vier beschrijft een observationele studie die bestond uit een representatieve steekproef van 24 Nederlandse ziekenhuizen, met deelname van de IC en chirurgische verpleegafdeling. Deze studie liet zien dat de gemiddelde compliance 20% was, waarbij de laagste compliance in opleidingsziekenhuizen werd gemeten. Handhygiëne was lager op de IC en vóór contact met de patiënt, maar er werd geen significant verschil in de handhygiëne compliance van artsen en verpleegkundigen gevonden. **Hoofdstuk vier** laat verder ook zien dat artsen sterk worden beïnvloed door kennis van de richtlijnen en de ervaren ernst van een infectie voor zichzelf. Verpleegkundigen werden echter meer beïnvloed door de mening van andere belangrijke personen t.a.v. handhygiëne (descriptieve norm) en hun eigen ervaren vermogen om handhygiëne uit te oefenen wanneer dat nodig is (ervaren gedragscontrole). Zowel bij artsen als verpleegkundigen werd het handhygiëne gedrag sterk beïnvloed door gewoonte.

Hoofdstuk vijf beschrijft de resultaten voor laatstejaars geneeskundestudenten. Het laat zien dat hun handhygiëne gedrag werd beïnvloed door gewoonte, ervaren gevolgen van handhygiëne en of zij het gevoel hadden dat ze handhygiëne in de praktijk zouden kunnen uitoefenen (ervaren gedragscontrole). Kennis en risicoperceptie zijn niet geassocieerd met handhygiëne compliance.

In **hoofdstuk zes** wordt een Delphi studie beschreven waarin een expertpanel van zorgverleners, managers en experts op het gebied van (infectie)preventie in brede zin, consensus hebben bereikt over de factoren die het handhygiëne gedrag van verpleegkundigen beïnvloeden en in mindere mate over de factoren die dit gedrag van artsen beïnvloeden. Consensus werd bereikt over twee belangrijke veranderbare determinanten van non-compliance voor beide beroepsgroepen, namelijk kennis van de richtlijnen en de sociale cultuur van het ziekenhuis of de afdeling. Voor verpleegkundigen waren de experts het ook eens over het belang van de fysieke omgeving wat betreft de bereikbaarheid van materialen en de haalbaarheid om handhygiëne in alle situaties uit te oefenen.

Wij hebben sterke consensus geïdentificeerd voor een beperkt pakket aan effectieve en haalbare maatregelen om handhygiëne te bevorderen. Dit pakket bestaat uit: educatie, het geven van feedback, herinneringen in de werkomgeving en de verbeterde bereikbaarheid van materialen. Wij vonden sterke consensus over het belang van het veranderen van de sociale cultuur, maar experts waren niet zeker over de haalbaarheid hiervan in de praktijk. De leden van het expertpanel waren het niet eens over patiëntparticipatie en sancties als mogelijke elementen van een interventie.

In **hoofdstuk zeven** wordt een pilot studie beschreven die is uitgevoerd om de haalbaarheid van het gebruik van implementatie-intenties te onderzoeken. De resultaten van deze pilot lieten zien dat het houden van interviews, met als onderdeel het formuleren van actieplannen, nuttig kan zijn in het bevorderen van het handhygiëne gedrag van individuele verpleegkundigen. De verpleegkundigen konden hiermee plannen hoe zij goede handhygiëne in hun dagelijkse routine zouden passen. Postinterventie resultaten lieten zien dat het implementeren van deze plannen redelijk succesvol is geweest aangezien handhygiëne compliance steeg van 9.3% voor de interventie tot 25.4% na de interventie (OR: 3.3; IC: 1.7-6.5; P <0.001).

Zowel het literatuuronderzoek (**hoofdstuk twee**) als de Delphi studie (**hoofdstuk zeven**) lieten zien dat de bereikbaarheid van materialen en het geven van feedback belangrijk zijn om handhygiëne compliance te bevorderen. Daarom is een studie uitgevoerd in samenwerking met industriële ontwerpers om de functies van de ideale handhygiëne dispenser te onderzoeken (**hoofdstuk acht**). Een participatieve ontwerpmethode heeft onderzocht welke functies als nuttigst en belangrijkst werden ervaren door zorgverleners. Over het algemeen waren deelnemers positief over het concept. Volgens hen zijn de belangrijkste eigenschappen de mogelijkheden tot universele plaatsing van de dispenser en de spray functie. De deelnemers gaven aan dat zij van mening zijn dat de dispenser een professionele uitstraling had en makkelijker en frequenter gebruik stimuleerde.

De resultaten uit de studies die beschreven zijn in dit proefschrift suggereren dat succesvolle handhygiëne interventies multimodaal zouden moeten zijn. Daarom hebben wij een interventiepakket ontwikkeld op basis van de determinanten die door ons geïdentificeerd zijn (**hoofdstuk twee tot zes**), interventie benaderingen uit onze eigen groep (**hoofdstuk zeven en acht**) en andere Nederlandse onderzoekers op dit gebied. Dit interventiepakket (ACCOMPLISH) is toegesneden op de determinanten van handhygiëne compliance van artsen en verpleegkundigen. Het interventiepakket richt zich op individuele factoren en op het stimuleren van persoonlijke en normatieve feedback en is ingebed in de zelfregulatie theorie. Deze theorie suggereert dat gedragsverandering een dynamisch proces is waarin specifieke, haalbare doelen moeten worden geformuleerd, dat discrepanties tussen

doelen en gedrag moeten worden teruggekoppeld aan het individu en dat sociale bevestiging een belangrijk element is om duurzame gedragsverandering te bevorderen. Deze elementen worden gericht aangepakt wanneer planning wordt bevorderd, feedback wordt gegeven, kennis van de handhygiëne richtlijnen op individueel niveau wordt vergroot en omgevingsfactoren (die zorgen voor een verhoogde bereikbaarheid van handhygiëne voorzieningen) worden verbeterd.

Er is een studie ontworpen om de kosteneffectiviteit van dit interventiepakket te onderzoeken (**hoofdstuk negen**). In dit cluster-gerandomiseerde, gecontroleerde design kunnen we de effecten meten van deze nieuwe handhygiëne interventie op het voorkomen van ZGI op de middellange termijn (12 maanden). Hiernaast zal een case-controle studie de effecten van ZGI op zorgkosten onderzoeken en zal een analyse van de kosteneffectiviteit van de interventie vanuit een maatschappelijk perspectief worden uitgevoerd.

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CURRICULUM VITAE

Vicki Erasmus was born in Pietermaritzburg, South Africa, on the 17th of May 1980. After completing primary school at the Longmarket Girls' School she immigrated to the Netherlands. There she completed secondary school at the Farel College in 1998, and started studying Psychology at Leiden University. During her studies she was involved in several research projects in the fields of experimental cognitive psychology and safety science, and in 2003 the completed the Honors Research Programme. In 2005 she obtained her MSc in cognitive psychology with a thesis on Human Error in the Operating Theatre. Subsequently, she worked as a patient safety advisor at the OR department at Leiden University Medical Centre in Leiden, the Netherlands. In 2006 she started a PhD at the Department of Public Health in Rotterdam, the Netherlands, resulting in this thesis.

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PhD PORTFOLIO

Summary of PhD training and teaching activities
Name PhD student: Vicki Erasmus
PhD period: 2006-2012
Promotors: Prof. dr. E.W. Steyerberg and prof. dr. H.A. Verbrugh
Supervisors: Dr. E.F. van Beeck and dr. M.C. Vos

	Year	Workload (ECTS)
1. Courses		
Dutch writing skills for non-native speakers	2007	5
Erasmus Summer Programme	2009	6
Teach the teacher didactic training Erasmus MC	2010	1
2. Teaching activities		
Supervision of MSc students EUR and TU Delft	2008-2012	12
Supervisor curriculum medical students theme 4.2 and 3C	2008-2011	5
Lectures TU Delft Medisign	2009-2010	1
Primary prevention practical, curriculum medical students 4th year training	2011	1
3. Conferences and presentations		
National activities:		
Presentations within Erasmus MC	2007-2012	4
Presentations within Dutch hospitals	2007-2012	6
Organisation of and presentation at national symposium Hand hygiene in Dutch hospitals	2008	4
Organisation of and presentation at national symposium Hand hygiene in Child Day Care centres	2010	4
Keynote speech and workshop IGZ patient safety symposium	2010	1
International conferences:		
European Patient Safety Conference Porto, Portugal	2007	1

Lancet conference on Hospital Associated Infections, London, UK	2008	1
ISQUA conference, Dublin, Ireland	2009	1
BAPCOC European Expert meeting New strategies to monitor and control infections, antibiotic use and resistance in health care facilities in the EU Member States	2010	1
International forum on quality and safety in health care, Amsterdam, the Netherlands	2011	1
Bode Hand hygiene days, Staatsburg, France	2011	1
HEPS Patient safety conference, Oviedo, Spain	2011	2
Hospital hygiene day, University Hospital Ghent, Belgium	2011	1