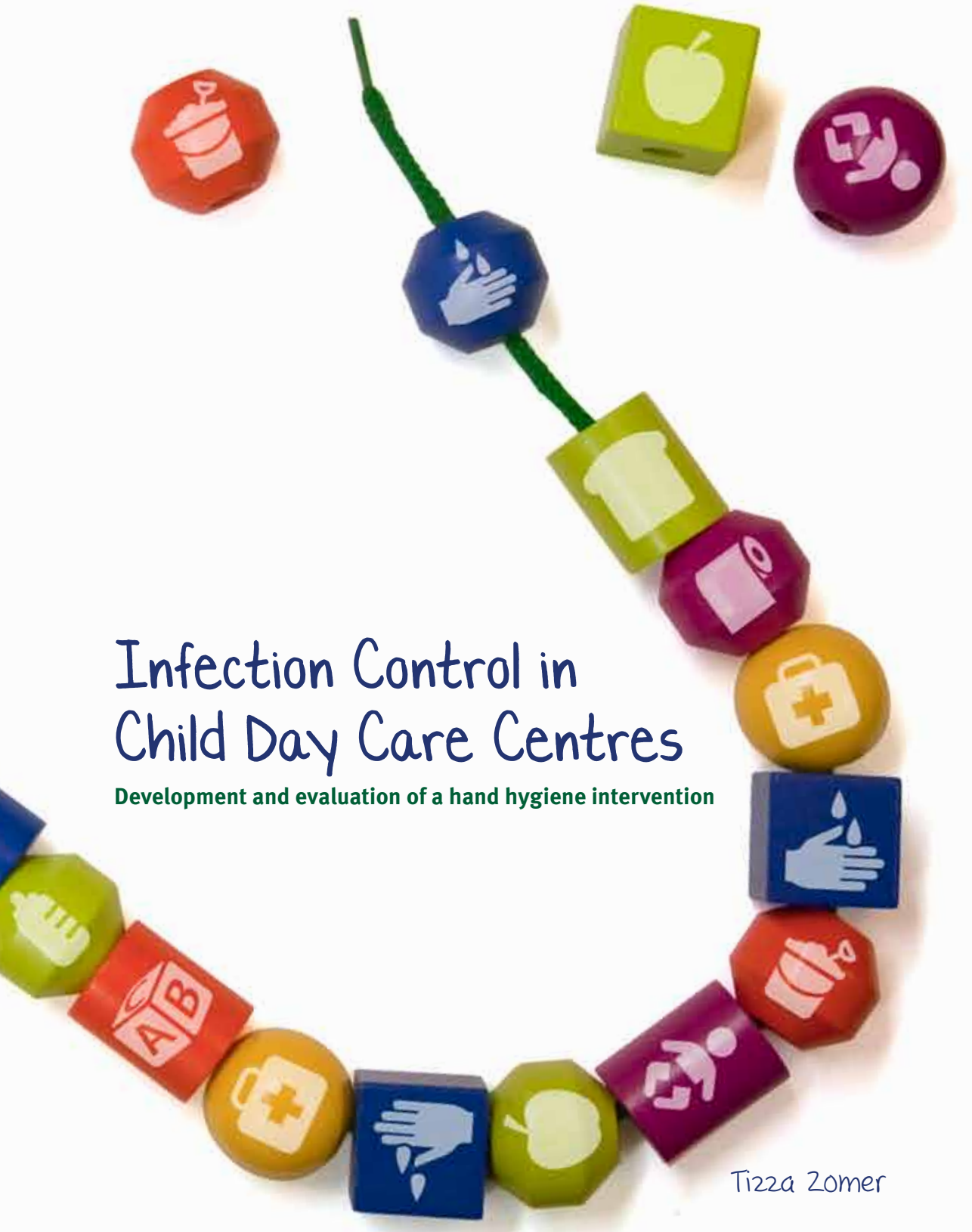
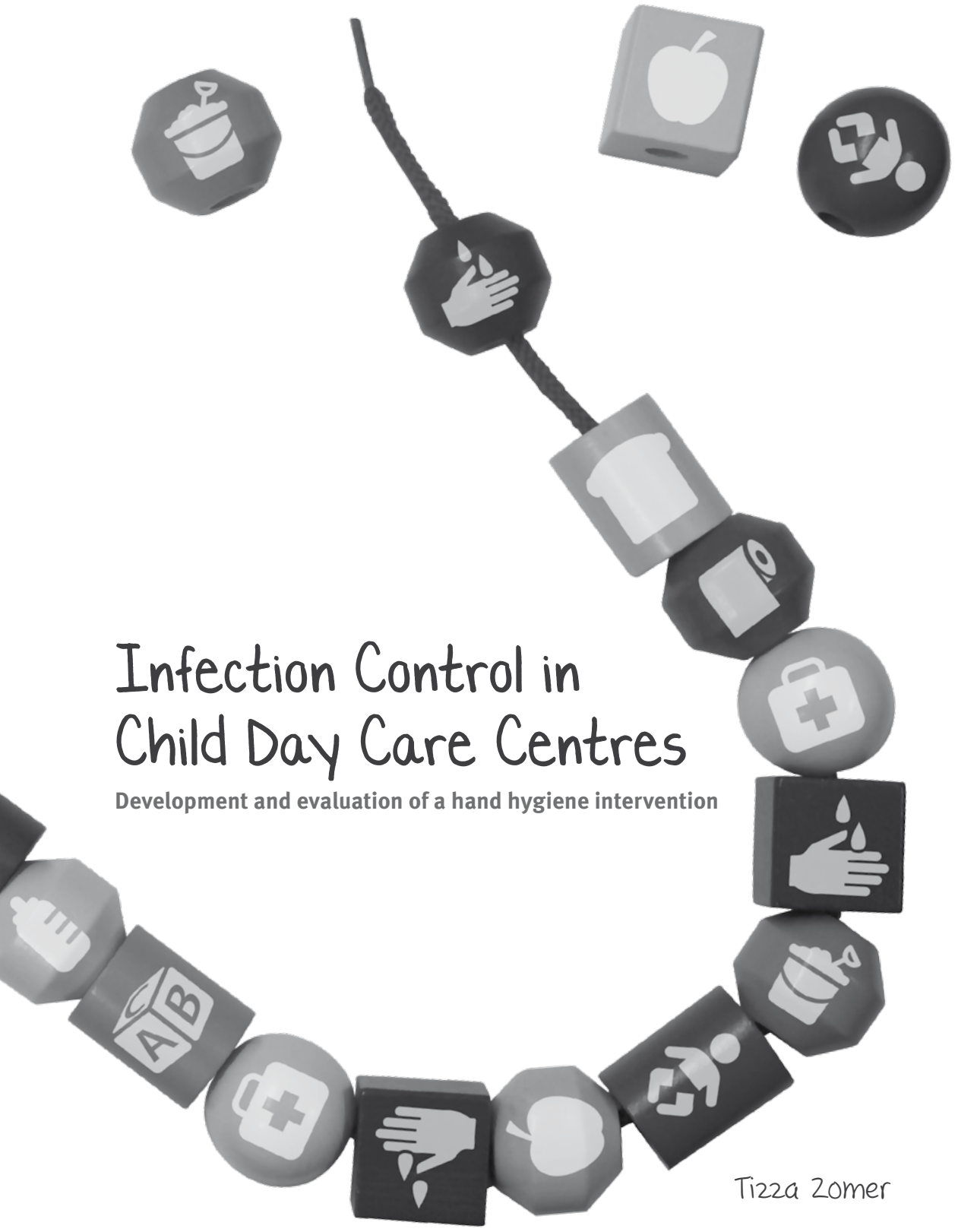


Infection Control in Child Day Care Centres

Development and evaluation of a hand hygiene intervention

Tizza Zomer



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Colofon

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Infection Control in Child Day Care Centres:

Development and evaluation of a hand hygiene intervention

Infectieziektebestrijding in kinderdagverblijven:

Ontwikkeling en evaluatie van een handhygiëne-interventie

Proefschrift

ter verkrijging van de graad van doctor aan de Erasmus Universiteit Rotterdam
op gezag van de rector magnificus

prof.dr. H.A.P. Pols

en volgens besluit van het College voor Promoties.
De openbare verdediging zal plaatsvinden op

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door

Tizza Petronella Zomer
geboren te Vlaardingen

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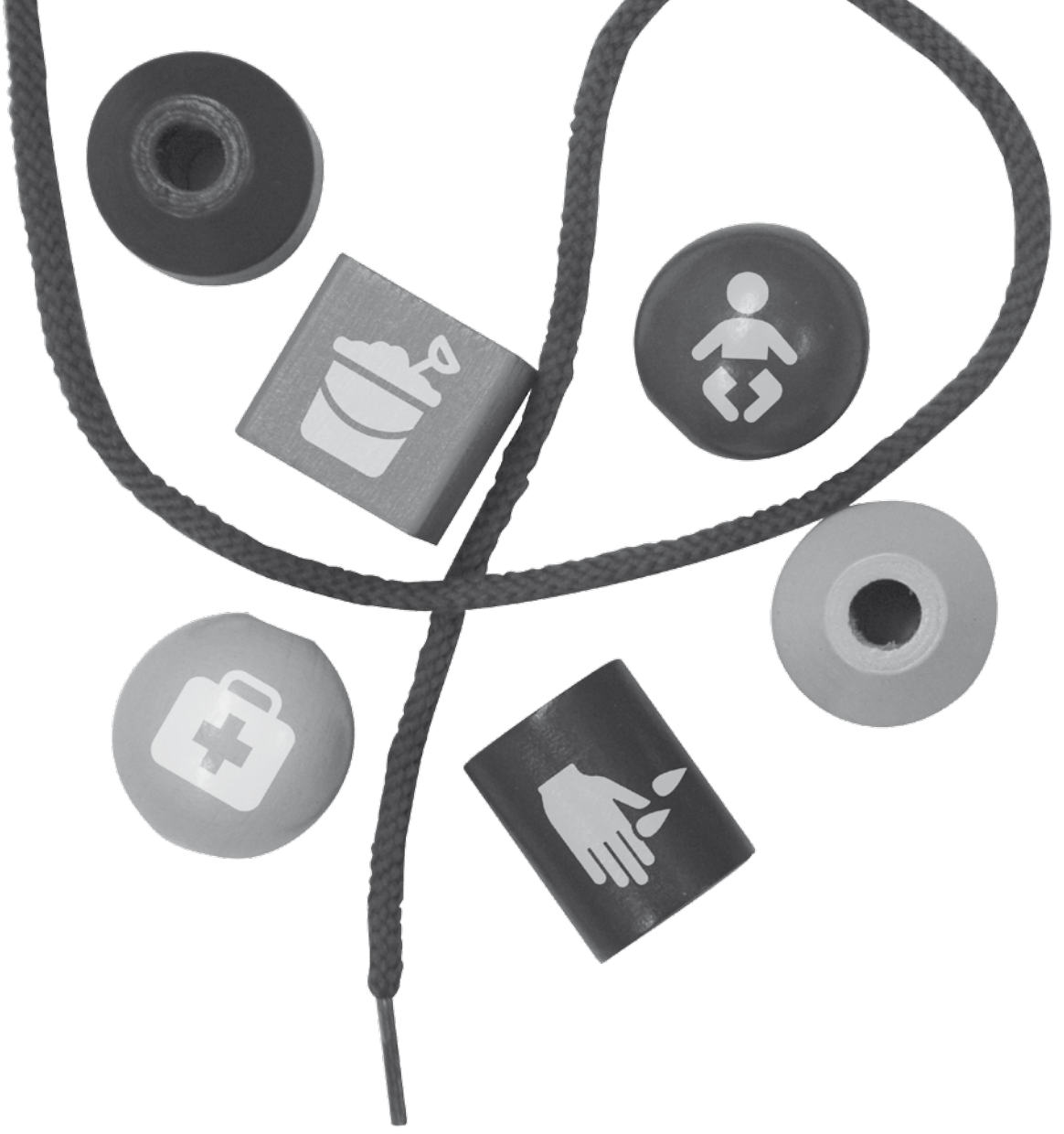
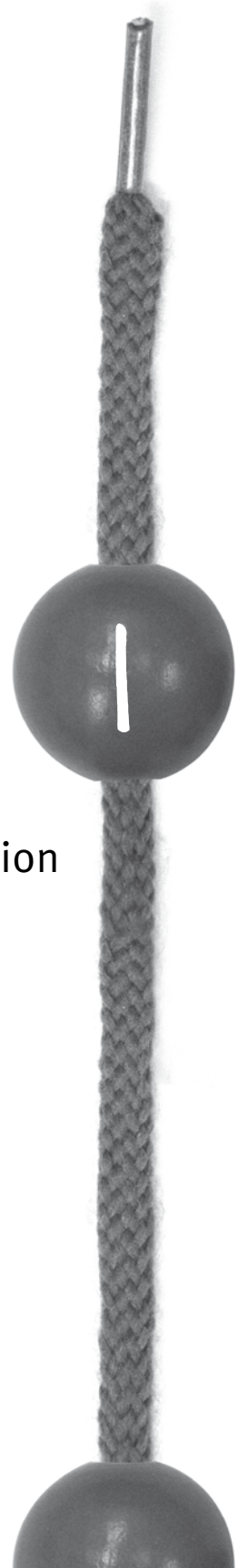
Contents





Chapter 1

General introduction

General introduction

Children attending child day care centres are at increased risk of acquiring gastrointestinal and respiratory infections compared to children cared for at home. Hand hygiene is known to be an effective measure to prevent infections. However, compliance with hand hygiene guidelines is generally low. In order to develop successful interventions to improve hand hygiene compliance and reduce gastrointestinal and respiratory infections among children attending day care, it is necessary to assess the key determinants that underlie hand hygiene behaviour. Interventions targeting these determinants can then be developed and evaluated.

This thesis focuses on infection control in child day care centres by improving caregivers' compliance with hand hygiene guidelines. It includes studies on caregivers' compliance with hand hygiene guidelines, determinants of caregivers' hand hygiene behaviour, the translation of these determinants into a hand hygiene intervention, and the evaluation of this intervention in a randomised controlled trial.

1.1 Infectious diseases and child day care

In 2013 there were 6200 day care centres in the Netherlands providing care for 39% of all Dutch children aged 0-4 years old (284.000/726.000).[1] During the study period this percentage was 44% in 2011 and 42% in 2012.[1] The decrease in percentage of children attending day care is probably caused by restrictions in governmental financial support to parents to reimburse them for the costs of day care. Also the number of day care centres slightly decreased, as in 2013 there were over 50 day care centres less than in 2012.[1] Nevertheless, in the Netherlands child day care attendance remains common.

Previous studies have shown that children attending child day care centres are at increased risk of acquiring gastrointestinal and respiratory infections compared to children cared for at home.[2, 3] In day care centres, transmission of infections is facilitated due to several reasons: 1) the immature immune system of the children makes them more susceptible for infections, and 2) there are relatively many children in a limited space which facilitates transmission of infections. In the Netherlands there is national surveillance of infectious diseases in child day care centres.[4] The results show that gastroenteritis and influenza-like illness are the most frequently reported infections, but also ear and eye infections are reported, as well as chickenpox, exanthema, and impetigo.[4] Children under the age of two years acquire gastrointestinal and influenza-like illness twice as often than children aged two to four years old.[4]

Pathogens commonly spread in day care centres that can cause respiratory infections among the children are e.g. rhinovirus, respiratory cyncytial virus, influenza virus, coronavirus, and adenovirus.[5] Pathogens associated with gastroenteritis among children attending day care are e.g. norovirus, rotavirus, astrovirus, enteric adenoviruses, and hepatitis A virus.[5, 6] The pathogens that circulate in child day care centres can result in children being infected at higher rates than caregivers and family members with also higher morbidity.[5] But also pathogens where young children experience less morbidity than adults, for example

hepatitis A, can spread from children attending day care centres to family members and possibly into the community.

These infections cause distress for the children and their parents. A previous study reported an association between childhood rotavirus gastroenteritis and changes in the child's behaviour, parental distress, parental worry, and impact on parents' daily activities.[7] Also another study on rotavirus gastroenteritis among children reported that parental stress levels were generally high (i.e. 5 or higher on a 10-point analogue scale).[8] Mean levels of stress were highest when children were admitted to hospital compared to treatment in the emergency department or primary care setting, and the mean level of stress reported by mothers was higher than that reported by fathers.[8] Besides stress, the infections also result in General Practitioner (GP) visits, medications and hospitalisation. In 29% of day care-related infections in the Netherlands a GP visit was required, in 6% antibiotic treatment was required and 2% of infections resulted in hospitalisation.[4] Furthermore, day care associated infections do not only affect the attending children, but can also result in secondary cases among caregivers and family members.[9]

For the Netherlands, it has been estimated that day care centre-related gastroenteritis and influenza-like illness result yearly in excess societal costs of respectively €24 million and €50 million.[10] These analyses included costs for General Practitioner (GP) consultations, prescription and over-the-counter medication, hospitalisation, laboratory testing, travelling to and from health services, and loss of productivity due to parental work absence for taking care of their ill child.[10] The mean costs per episode were twice as high for gastroenteritis (€255 per episode, range €168-€351) and three times as high for influenza-like illness (€204 per episode, range €155-€223) for children attending day care compared to children that do not.[10] The difference can be explained by the higher productivity losses induced by families with children attending day care.[10] A study on costs of paediatric community-acquired rotavirus gastroenteritis also reported parental work absence to be the major costs not reimbursed by national health care payers.[11] In this study, the number of workdays lost by parents varied between European countries. It was highest when the rotavirus infection was confirmed in primary care (ranging from 3.4 days in France to 7.5 days in the United Kingdom), followed by when the child was hospitalised (ranging from 2.3 days in France to 6.4 days in Germany), and lowest when the infection was confirmed in the emergency department (ranging from 2.5 days in France to 4.4 days in Spain).[11]

1.2 Hand hygiene compliance

Hand hygiene is known to be an effective measure to prevent gastrointestinal and respiratory infections.[12-14] A meta-analysis of hand hygiene interventions that besides child day care centres, also included schools, households, villages and communities, reported 31% reduction in gastrointestinal illness and 21% reduction in respiratory illness.[12] In addition, a Cochrane review reported that hand hygiene interventions resulted in 39% reduction in diarrheal episodes in children in institutions in high-income countries.[14] Another Cochrane review concluded that the spread of respiratory virus can be prevented by hand hygiene, especially around younger children.[13]

The Dutch National Centre for Hygiene and Safety developed hand hygiene guidelines for caregivers in child day care centres.[15] According to these guidelines, hand hygiene is mandatory for caregivers before touching/preparing food, before caregivers themselves eat or assist children with eating, and before wound care; and after diapering, after toilet use/wiping buttocks, after caregivers themselves cough/sneeze/wipe their own nose, after contact with body fluids (e.g. saliva, vomit, urine, blood, or mucus when wiping children's noses), after wound care, and after hands are visibly soiled.[15] In addition, the guidelines state that hands should be washed with water and soap followed by hand drying, or an alcohol-based hand sanitizer should be used (except when hands are visibly soiled).[15]

Compliance with hand hygiene guidelines is generally low; a review reported the median compliance in hospital care to be 40%.[16] Little is known regarding compliance with hand hygiene guidelines in child day care centres. In order to reduce infections among children, several hand hygiene interventions have been developed for child day care centres.[17-25] Most of these interventions not only focus on hand hygiene, but also include other hygiene practices such as e.g. aseptic nosewiping,[21] eliminating use of shared cups,[18] disinfecting toilet and diapering areas,[24] laundering of blankets,[24] and environmental cleaning (toys, furniture, doorknobs etc.).[17, 24] A review concluded that the nature and magnitude of the effect of these interventions varies between studies as well as subgroups within studies (younger versus older children).[5] However, comparison of the effect of these interventions is hampered by the use of different outcome measures, as some studies assessed incidence of gastrointestinal and/or respiratory infections[17, 20, 21, 24] whereas other studies assessed illness absenteeism.[18, 25] In addition, among studies with as outcome measure incidence of infections, the definitions for having diarrhoea and/or colds differed. Furthermore, only few studies corrected for clustering of the data,[17, 18, 20, 21, 23, 25] and even less reported baseline incidence of infections.[17-19, 23] Therefore, there is a need for well-designed studies to evaluate the effect of hand hygiene interventions in child day care centres.

1.3 A stepwise behavioural approach

No previous hand hygiene intervention for child day care centres reported to have been developed according to a stepwise behavioural approach. Interventions developed according to a stepwise behavioural approach address the key determinants that underlie the behaviour in question.[26] Interventions based on these determinants are more likely to be successful in changing behaviour, with long-term effects.[27] However, little is known on the key determinants that underlie hand hygiene behaviour of caregivers in child day care centres.

In order to study the determinants of caregivers' hand hygiene behaviour in child day care centres, theories and models from the behavioural sciences can be used, for example the Theory of Planned Behaviour[28] and the Health Belief Model.[26] The Theory of Planned Behaviour has previously been used in the hospital setting to explain hand hygiene behaviour of physicians and nurses.[29, 30] The theory is concerned with predicting an individuals' intention to perform a specific behaviour, in which intention is determined by the following three constructs: attitude (i.e. the degree to which an individual has a favorable or unfavorable evaluation of the behaviour), subjective norms (i.e. the perceived social

pressure to perform or not to perform the behaviour), and perceived behavioural control (i.e. the perceived ease or difficulty of performing the behaviour).[28] The Health Belief Model assumes that an individual's decision to engage in a health action is determined by his or her perception of personal susceptibility to a particular illness (i.e. perception of the risk of contracting that illness) and by perception of severity of a particular illness (i.e. feelings concerning the seriousness of that illness), balanced against the perceived benefits and barriers of the health action.[26]

Although the Theory of Planned Behaviour and the Health Belief Model have commonly been used to explain health behaviour, these models do not take into account habitual behaviour. Habits are a form of automaticity,[31, 32] which is seen among routine behaviours such as smoking, eating habits and hand hygiene. Habits have a history of repetition, may reflect an individuals' identity and can be characterized as efficient, executed without awareness, controllable to a limited extent, and intentional.[31] A behaviour might become habitual if it is triggered by a specific cue in the environment.[31] Therefore, environmental determinants, which can facilitate or hamper hand hygiene behaviour, can also be important, as well as knowledge. A review on compliance with hand hygiene guidelines in hospital care reported that improved accessibility of materials was associated with higher hand hygiene compliance, but remained inconclusive on the effect of knowledge on hand hygiene compliance.[16] In sum, cognitive determinants derived from the Theory of Planned Behaviour and the Health Belief Model may explain hand hygiene behaviour, as well as habits, knowledge and environmental determinants.

A discrepancy between self-reported and observed hand hygiene behaviour has previously been described in hospital care.[29, 33] Constructs of the Theory of Planned Behaviour predicted intention to perform hand hygiene among nurses and intention was related to self-reported hand hygiene.[29] However, observed hand hygiene behaviour was predicted by intensity of work activity in the nursing unit, rather than constructs of the Theory of Planned Behaviour.[29] Therefore, the Theory of Planned Behaviour might explain self-reported hand hygiene better than observed hand hygiene. To understand and explain potential differences in determinants of self-reported and observed hand hygiene behaviour, sociocognitive determinants should be assessed using both outcome measures.

1.4 Outline of this thesis

The aim of this thesis is to assess determinants of caregivers' hand hygiene compliance in child day care centres, to develop a hand hygiene intervention based on these determinants, and to evaluate the effect of this intervention. The research questions addressed are:

I. How compliant are caregivers with hand hygiene guidelines in child day care centres, and what are the environmental and sociocognitive determinants of caregivers' hand hygiene behaviour?

II. What intervention content is suited to target the identified environmental and sociocognitive determinants of hand hygiene behaviour?

III. How effective is the hand hygiene intervention developed according to a stepwise behavioural approach in improving caregivers' hand hygiene compliance and reducing gastrointestinal and respiratory infections in children attending child day care centres?

Chapter two describes an observational study in which hand hygiene compliance of caregivers in child day care centres was assessed, as well as the environmental determinants of caregivers' observed hand hygiene behaviour. Chapter three concerns a study on sociocognitive determinants of self-reported and observed hand hygiene behaviour of caregivers in child day care centres. In chapter four the environmental and sociocognitive determinants are translated into a hand hygiene intervention for caregivers in child day care centres. The chapter describes the intervention components and the design of a randomised controlled trial to evaluate the effect of this intervention. Chapter five concerns the results of the randomised controlled trial on the primary outcome measure, i.e. caregivers' compliance with hand hygiene guidelines. Chapter six describes the effect of the hand hygiene intervention on the secondary outcome measure, i.e. incidence of gastrointestinal and respiratory infections among children attending day care. Chapter seven is a general discussion where the research questions are answered and the main findings of this thesis are summarised. This thesis concludes with a summary in English and Dutch.

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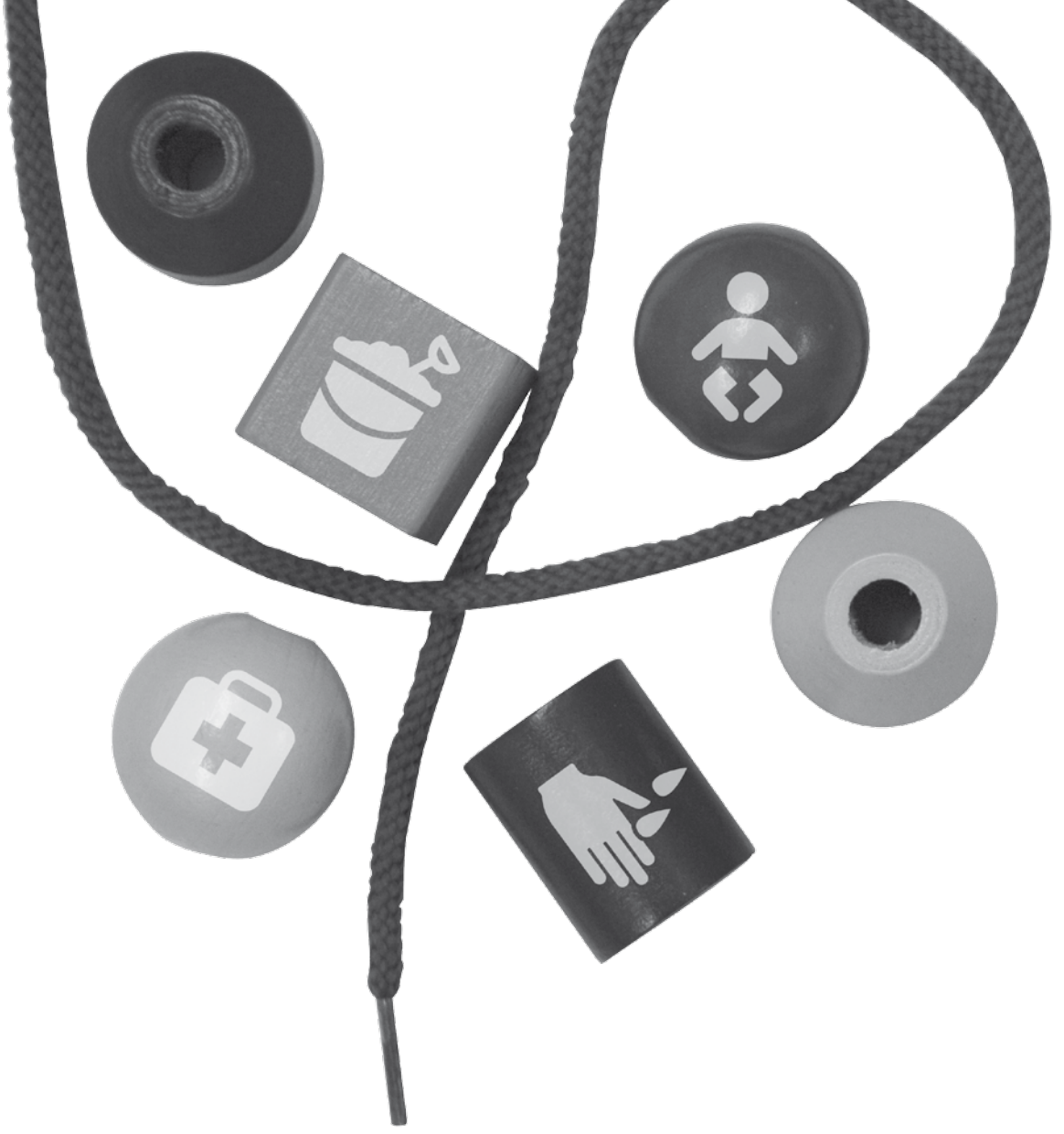

Chapter 2

Hand hygiene compliance and environmental determinants in child day care centers: An observational study

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Abstract

Background
Children attending day care centers (DCCs) are at high risk for contracting infections, for which hand hygiene (HH) is an effective prevention measure. The study objective was to assess caregivers' compliance to HH guidelines in DCCs, and to identify environmental determinants of HH behavior.

Methods
We observed caregivers' compliance to HH guidelines and collected data on environmental determinants (i.e. number of sinks, number and type of towel and soap facilities, availability of alcohol-based hand sanitizers). Using multilevel logistic regression analyses, odds ratios (OR) with 95% confidence intervals (CI) were obtained for environmental determinants of HH behavior.

Results
In 122 participating DCCs, 350 caregivers and 2003 HH opportunities were observed. The overall compliance was 42% (95% CI: 40%-44%). Compliance for different activities for which HH was indicated ranged from 20%-79%. In the multivariable model, the number of towel facilities per caregiver (OR 2.33; 95% CI: 1.40-3.88) and type of towel facilities were significantly associated with HH. Hands were most frequently washed when only paper towels were available compared to only fabric towels (OR 1.47; 95% CI: 1.00-2.16) or a combination of both paper and fabric towels (OR 2.13; 95% CI: 1.32-3.44).

Conclusions
HH compliance of caregivers in Dutch child DCCs can be improved. Interventions for this should take into account environmental determinants like the number and type of towel facilities.

Introduction

Children attending day care centers (DCCs) are at higher risk for contracting gastrointestinal and respiratory infections than children cared for at home.[1-4] The youngest children are at highest risk,[1, 2] and among children younger than one year of age DCC attendance has been associated with an increased risk for hospitalization for acute respiratory infections and gastroenteritis.[5, 6] DCC-related infections can cause distress for both children and their parents, but also incur costs because of visits to a physician, medication, hospitalization, and alternative care or parental work absence.[7]

Hand hygiene (HH) is known to be a simple and effective measure to prevent gastrointestinal and respiratory infections.[8-11] However, compliance with HH guidelines in child DCCs is generally low and little is known concerning the compliance for different types of activities for which HH is indicated. One study reported the observed compliance among caregivers after diapering to be 16%.[12] In other settings, compliance is also generally low. A systematic review reported the median compliance to HH guidelines of health care workers in hospitals to be 40%.[13]

Several interventions have been developed to increase HH in DCCs.[14-23] These interventions have shown varying effects, and little is known about the key determinants that underlie HH behavior of caregivers in DCCs. When developing interventions by a stepwise behavioral approach,[24] the first step is to assess the cognitive and environmental determinants of the behavior in question. The more is known about these determinants, the more likely it is that successful interventions with long-term effects can be developed to improve behavior.[25]

The objective of this study was to assess caregivers' compliance to HH guidelines in Dutch child DCCs, and to identify environmental determinants of HH behavior. This will help us to develop successful interventions to increase HH compliance, which ultimately can decrease infections among children attending DCCs.

Methods

An observational study was performed from August to October 2010 among DCCs in the regions of Rotterdam-Rijnmond, Leiden and Gouda, the Netherlands. This is a mixed urban-rural area with approximately 1.5 million inhabitants. Participating DCCs were recruited by stratified random sampling. Stratification criteria were: region (Rotterdam-Rijnmond vs. Leiden vs. Gouda); DCC size (small with a maximum capacity of ≤ 39 children vs. large with a maximum capacity of >39 children); geographic location (highly urban vs. urban vs. slightly/non-urban); and certification (certified vs. non-certified).

In each DCC, caregivers' compliance to the Dutch national guidelines for HH in DCCs,[26] was assessed with direct unobtrusive observation by a trained observer. Compliance was defined as the number of HH actions divided by the total number of opportunities for which HH was indicated according to the guidelines. According to the guidelines, that were based on expert opinion, HH was mandatory for caregivers before touching/preparing food, before caregivers themselves ate or assisted children with eating, and before wound care; and after diapering, toilet use/wiping buttocks, after caregivers themselves coughed/sneezed/wiped their own nose, and after contact with body fluids (e.g. saliva, vomit, urine, blood, mucus when wiping children's noses).[26] For these HH indications it was observed whether or not HH was performed. In addition to the HH indications outlined in the guidelines, HH after glove use was also observed. As observations did not take place in the caregivers' lavatory, HH after toilet use was only observed after assisting a child with toilet use and not after toilet use by caregivers themselves. HH was defined as washing hands with water and soap followed by hand drying, or use of an alcohol-based hand sanitizer. An alcohol-based hand sanitizer could not be used when hands were visibly soiled; in that case hands should have been washed with water and soap.

A total of seven observers were trained until the inter-rater reliability was above 75%. Our aim was to observe three caregivers per DCC, during a single day, and to observe each caregiver for two hours. One observer observed one caregiver at a time. Caregivers were informed that hygiene in general was being observed. Observations took place during routine care activities in common rooms including the diaper-changing room, kitchen and inside/outside playground. The observers collected data using personal digital assistants (PDAs) for electronic on-site data entry. Data were collected using an adaptation of the World Health Organization HH observation method.[27] After the observation, caregivers were asked to fill in a questionnaire to collect demographic data.

Besides observing HH behavior, the observers collected data on environmental determinants. In Dutch DCCs, children aged 0 to 4 years old are cared for in groups (i.e. classes). Each group of children has its own room where the daily activities take place (i.e. classrooms). For each caregiver, the following data were collected in the classroom they worked at: number of caregivers, number of children, age range of children, number of sinks for caregivers, number and type of towel facilities for caregivers, number and type of soap facilities for caregivers, availability of alcohol-based hand sanitizer, and whether a soap dispenser or pump was empty and not immediately refilled.

Data were analyzed using SPSS version 18 (SPSS Inc, Chicago, IL) and R version 2.12.2. We first calculated the overall compliance, as well as the compliance for specific activities for which HH was indicated, for environmental determinants, and for DCC characteristics. Next, multilevel analyses were performed to correct for clustering of the data within caregivers. The outcome measure was the observed HH compliance of caregivers in DCCs. Using multilevel univariate and multivariable logistic regression analyses,[28] odds ratios (OR) with 95% confidence intervals (CI) were obtained for different environmental determinants. A p-value ‹0.05 was considered significant. Only variables with a univariate P-value ‹0.2 were tested in multivariable analysis. The multivariable regression model was built using stepwise exclusion while correcting for type of activity for which HH was indicated.

Ethical approval was waived by the Medical Ethics Committee of the Erasmus University Medical Center in Rotterdam.

Results

A total of 122 DCCs participated in the study. From a list of 439 DCCs (the total number of DCCs in the three regions), a stratified random sample of 224 DCCs was drawn. Of these 224 DCCs, 98 participated and one DCC was used for training of observers (response rate 44%). In addition, 24 DCCs participated on their own request *(Figure 1)*. Of these 24 DCCs, 8 were not registered and identified at the start of the study. Therefore, these were not included in the list from which a stratified sample was drawn. Characteristics of participating DCCs are shown in *Table 1*. In all DCCs, children were cared for in classes. The median number of classes per DCC was three (range 1-11). The median number of children at the DCC on the day of the observation was 33 (range 3-116).

In the 122 participating DCCs, a total of 350 caregivers were observed. The inter-rater reliability of the observers was 79% and higher. The median number of caregivers observed per DCC was three (range 1-4). The median duration of the observations was two hours (range 1-3 hours). All caregivers were female, except one. The median age of the caregivers was 30 years old (range 19-57 years). The median number of years of work experience as caregiver at a DCC was six (range 0-30 years). Of the 350 observed caregivers, 25% worked at a DCC-class where children were aged 0 to 2 years old, 21% worked at a class where children were aged 2 to 4 years old, and 53% worked at a class where children were aged 0 to 4 years old.

The median number of children per DCC class was 9 (range 3-18) and the median number of caregivers was 2 (range 1-4). This resulted in a median of 4 children per caregiver (range 1.3-12.0). The median number of facilities for caregivers per classroom was 2 sinks (range 1-4), 2 towel facilities (range 0-4), and 2 soap facilities (range 0-4). Of 350 caregivers, 86% had gloves available in the classroom they worked at.

Figure 1: Flow-chart of the recruitment of day care centers (DCCs)

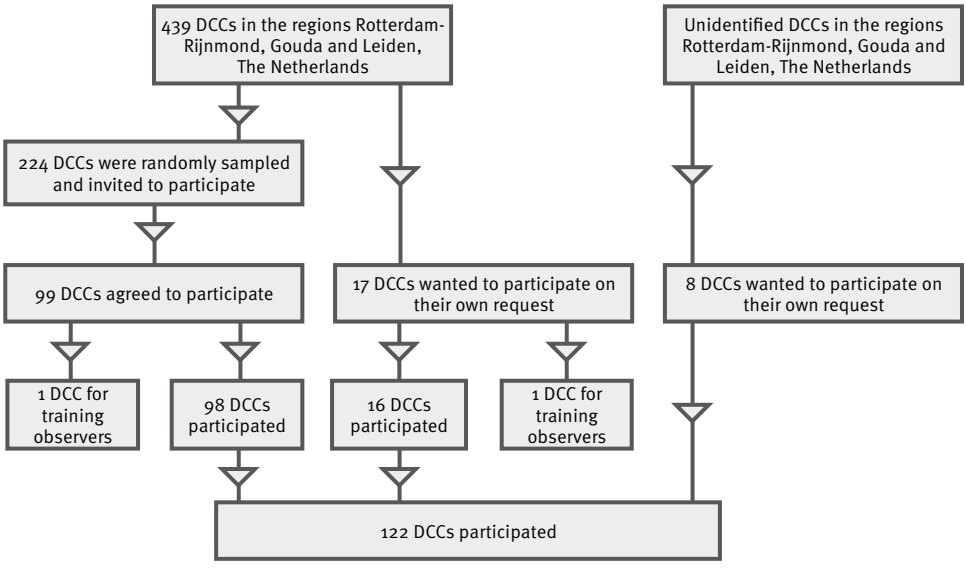

Table 1: Characteristics of participating child day care centers

	% (n) (N=122)
Region	
Rotterdam-Rijnmond	64 (78)
Leiden	22 (27)
Gouda	14 (17)
Size	
Small (≤ 33 children*)	52 (64)
Large (› 33 children*)	48 (58)
Degree of urbanicity	
Highly urban	57 (70)
Urban	21 (26)
Slightly/non-urban	21 (26)
Certification	
Certified	43 (53)
Non-certified	57 (69)
	Median (range)
Number of classes per DCC*	3 (1-11)
Number of children per DCC*	33 (3-116)
Number of caregivers per DCC*	8 (1-25)

**On the day of the observation. DCC, day care center.*

Compliance

A total of 2003 HH opportunities were observed. The overall compliance was 42% (841/2003) (95% CI: 40%-44%). Hands were most frequently washed after toilet/diapering activities (i.e. after changing a diaper with feces, after changing a wet diaper when the child was lying down, after changing a wet diaper when the child was standing, after caregivers assisted children with toilet use/wiping buttocks) (compliance 50%), and less frequently before eating/food handling activities (i.e. before food handling, before caregivers themselves ate, before caregivers assisted children with eating) (compliance 29%) and after contact with body fluids (i.e. after caregivers themselves coughed/sneezed/wiped their own nose, after contact with body fluids) (compliance 25%) *(Table 2)*. In addition to the 2003 observed HH opportunities, HH before wound care was observed twice, and on both these opportunities hands were not adequately washed (not included in the analysis as too few opportunities were observed). Concerning the specific HH indications outlined in the guidelines, HH compliance ranged from 20% before caregivers themselves ate to 79% after changing a diaper with feces. HH compliance was between 25%-50%: before food handling (compliance 31%), after caregivers themselves coughed/sneezed/wiped their own nose (compliance 29%), and before caregivers assisted children with eating (compliance 27%) *(Table 2)*. HH compliance was less than 25%: after changing a wet diaper when the child was standing (compliance 22%), after contact with body fluids (compliance 21%), and before caregivers themselves ate (compliance 20%) *(Table 2)*. In univariate and multivariable analyses, the type of activity for which HH was indicated was strongly associated with HH compliance ($p<0.001$). In addition to the 2003 observed opportunities for which HH was mandatory, 54 opportunities were observed for HH after using gloves. HH was performed on 67% of these 54 HH opportunities.

Table 2: Hand hygiene compliance per type of activity for which hand hygiene was indicated according to the Dutch guidelines for caregivers in child day care centers

Type of activity	Number of HH opportunities	Compliance (%) (95% CI)
Before eating/food handling activities	**588**	**29 (25-33)**
Before food handling	351	31 (27-36)
Before caregivers themselves ate	75	20 (12-30)
Before caregivers assisted children with eating	162	27 (31-34)
Before caregivers assisted children with eating	**1269**	**50 (47-53)**
After changing a diaper with faeces	239	79 (73-84)
After changing a wet diaper when the child was lying down	556	5 (49-57)
After changing a wet diaper when the child was standing	323	22 (18-27)
After caregivers assisted children with toilet use/wiping buttocks	151	55 (47-63)
After contact with body fluids	**146**	**25 (18-32)**
After caregivers themselves coughed/sneezed/wiped their own nose	62	29 (19-41)
After contact with body fluids	84	21 (14-31)
Overall	**2003**	**42 (40-44)**

Environmental determinants

Hand hygiene facilities

Concerning the environmental determinants, in 3% of 2003 HH opportunities there were no towel or soap facilities available for the caregivers in the classroom they worked at, although in all classrooms at least one sink was present. Univariate and multivariable analyses of environmental determinants demonstrated that both the number and type of towel facilities were significantly associated with HH *(Table 3)*. An increased number of towel facilities per caregiver was associated with increased HH compliance. In univariate analysis the OR for the number of towel facilities per caregiver was 1.37 (95% CI: 0.95-1.97). In the multivariable model, this OR was 2.33 (95% CI: 1.40-3.88) after correcting for the type of towel facilities, type of activity for which HH was indicated, DCC size, and number of children per caregiver. Concerning the type of towel facilities, HH compliance when only paper towels were available was 48% compared to 41% when only fabric towels were available, and 38% when both paper and fabric towels were available in the classroom the caregivers worked at. In 28% of 2003 HH opportunities only paper towels were available, in 45% only fabric towels and in 25% a combination of both paper and fabric towels. In univariate analysis, the OR for paper towels compared to a combination of both paper and fabric towels was 1.66 (95% CI: 1.13-2.43). The OR for paper towels compared to only fabric towels was 1.44 (95% CI: 1.03-2.02) (results not shown in *Table 3*). In the multivariable model, the type of towel facilities remained significantly associated with HH compliance after correcting for the number of towel facilities, type of activity for which HH was indicated, DCC size, and number of children per caregiver. In multivariable analysis, the OR for paper towels compared to a combination of both paper and fabric towels was 2.13 (95% CI:1.32-3.44). In addition, the OR for paper towels compared to only fabric towels was 1.47 (95% CI: 1.00-2.16) (results not shown in *Table 3*).

The number and type of soap facilities did not show to be associated with HH compliance *(Table 3)*. HH compliance when only soap pumps were available was 43%, compared to 35% when only dispensers were available, and 42% when both soap pumps and dispensers were available in the classroom the caregivers worked at. In 75% of 2003 HH opportunities only soap pumps were available, in 7% only dispensers and in 17% both soap pumps and dispensers. In addition, in 0.4% of 2003 HH opportunities there was also a soap bar available next to a soap pump. The availability of an alcohol-based hand sanitizer did not show to significantly increase HH compliance (OR 1.09; 95% CI: 0.81-1.47). This was available in 61% of 2003 HH opportunities for the caregivers in the classroom they worked at.

DCC characteristics

Univariate and multivariable analyses of DCC characteristics showed that an increased number of children per caregiver resulted in decreased HH compliance *(Table 3)*. Also large DCCs (i.e. more than 33 children present on the day of the observation) were associated with decreased HH compliance *(Table 3)*.

Table 3: Multilevel logistic regression analyses of environmental determinants of hand hygiene (HH) compliance in child day care centers (N=1957 HH opportunities)

Variables	Number of HH opportunities	Compliance (%) (95% CI)	
Environmental determinants			
Number of children per caregiver			
Age of children			
0-2 years old	552	44 (40-48)	
0-4 years old	1070	43 (40-46)	
2-4 years old	381	37 (32-42)	
Number of sinks per caregiver			
Number of towel facilities per caregiver			
Type of towel facility			
Paper towels	569	48 (44-52)	
Fabric towels	896	41 (38-45)	
Both	492	38 (34-42)	
Number of soap facilities per caregiver			
Type of soap facility			
Soap pump	1497	43 (40-45)	
Soap pump and soap bar	8	38 (11-72)	
Soap pump and dispenser	348	42 (37-47)	
Dispenser	133	35 (28-44)	
Alcohol-based hand sanitizer			
Available	1231	43 (40-46)	
Unavailable	770	41 (37-44)	
Empty soap dispenser/pump			
Yes	50	32 (20-46)	
No	1927	42 (40-45)	
DCC characteristics			
Certification			
Certified	847	45 (42-48)	
Non-certified	1156	40 (37-43)	
Degree of urbanicity			
Highly urban	1150	43 (40-46)	
Urban	428	39 (35-44)	
Slightly/non-urban	425	42 (37-47)	
Region			
Rotterdam-Rijnmond	2369	43 (41-46)	
Gouda	272	43 (37-49)	
Leiden	462	38 (34-42)	
DCC size			
›33 children present on the day of the observation	963	37 (34-40)	
≤ 33 children present on the day of the observation	1040	46 (43-39)	

***P‹0.01 *P‹0.05 †P‹0.2 #Corrected for type of activity for which HH was indicated. Ref. Reference*

	Univariate		Multivariable[#]	
	OR	95% CI	OR	95% CI
	0.94†	0.86-1.03	0.86**	0.77-0.96
	1.32	0.86-2.02		
	1.30	0.89-1.91		
	Ref.	Ref.		
	1.05	0.71-1.55		
	1.37†	0.95-1.97	2.33**	1.40-3.88
	*		**	
	1.66**	1.13-2.43	2.13**	1.32-3.44
	1.15	0.81-1.64	1.45	0.92-2.28
	Ref.	Ref.	Ref.	Ref.
	1.03	0.71-1.50		
	1.29	0.73-2.28		
	1.01	0.09-11.73		
	1.25	0.65-2.39		
	Ref.	Ref.		
	1.09	0.81-1.47		
	Ref.	Ref.		
	0.71	0.28-1.81		
	Ref.	Ref.		
	1.24†	0.93-1.65		
	Ref.	Ref.		
	1.16	0.80-1.67		
	Ref.	Ref.		
	1.16	0.75-1.80		
	1.33	0.93-1.90		
	1.32	0.80-2.15		
	Ref.	Ref.		
	0.69**	0.52-0.91	0.71*	0.51-0.98
	Ref.	Ref.		

Discussion

HH observations of caregivers in Dutch child DCCs demonstrated that hands were adequately washed in less than half of all HH opportunities. The type of activity for which HH was indicated and environmental determinants were associated with HH behavior of caregivers. Hands were washed most frequently after toilet/diapering activities and less frequently before eating/food handling activities and after contact with body fluids. Concerning the environmental determinants, HH compliance increased with an increasing number of towel facilities per caregiver. Furthermore, HH compliance increased when only disposable paper towels were available in the classroom compared to only fabric towels or a combination of both paper and fabric towels.

Few studies on HH in DCCs have reported the observed HH compliance to guidelines. One observational study in Brazil reported that caregivers washed their hands after diapering in 16% of occasions, and after assisting children to clean themselves after defecation in 16% to 19% of occasions [12]. We found higher frequencies of HH after diaper changing and assisting a child with toilet use/wiping buttocks (range 22%-79%). In other settings, handwashing frequencies are also low. An observational study in English households reported that caregivers of children washed their hands with soap after diaper changing in 42% of occasions.[29] In this study the presence of feces in the diaper did not increase the likelihood of handwashing,[29] which is contrary to what we found. Furthermore, a review reported that in several developing countries handwashing with soap by mothers or carers at key moments was rare, such as after toilet use, after cleaning a child, after cleaning up child stools, before feeding a child and before handling food (range 3%-25%).[30] Another review including studies on HH compliance in the hospital setting reported the overall compliance to be 40%,[13] which is similar to the 42% found in this study. Although in several different settings HH compliance has been assessed, for better comparison of our study results, more studies in DCCs on HH compliance are needed using similar definitions and observational methods.

Although it has previously been recognized that there is a need to identify and quantify the influence of environmental conditions on HH behavior,[31] this is to our knowledge the first study to assess environmental determinants of HH behavior of caregivers in DCCs. A previous intervention study concerning preschool children has shown that their HH behavior increased after improving environmental conditions including the supply of paper towels.[16,32] In the hospital setting, an improved accessibility of materials has been associated with a higher compliance to HH guidelines (in a review, four of seven studies reported a positive association).[13] An association between the number of sinks and compliance to HH guidelines was not found in the hospital setting (2 of 3 studies included in a review reported no association).[13] In our study, we also did not find such an association. Moreover, we also did not find an association between the number and/or type of soap facilities and HH compliance, nor did we find an association between the availability of alcohol-based hand sanitizer and HH compliance. That only paper towel facilities were significantly associated with HH compliance, might be explained by the fact that fabric towels can get wet and cold during the day if not replaced adequately. Caregivers might then skip handwashing to avoid having to touch the wet fabric towel. Concerning the DCC-characteristics, we found a negative association between HH compliance and the number of children per caregiver and between HH compliance and DCC size. A higher number of children per caregiver might well

be associated with a higher work intensity. This mirrors results from the hospital setting, in which a negative association between intensity of work activity and observed HH compliance has been reported.[31]

Our study had several strengths. Our outcome measure is observed HH compliance, as opposed to self-reported compliance which might not reflect actual practice.[33] Another strength of our study is the large sample size including 122 DCCs of which the majority was recruited by stratified random sampling. Furthermore, the high inter-rater reliability of the observers increases the reliability of the collected data.

Our study also had a number of limitations. A potential bias of observational studies is the Hawthorne effect, i.e. individuals might change their behavior when they know they are being observed.[27, 34, 35] We attempted to minimize this bias by informing caregivers that attention was paid to hygiene in general, without specifically mentioning HH. Nevertheless, the observed HH compliance, which was rather low, might be an overestimation. Another limitation of our study is the relatively low response rate among DCCs that were invited to participate (44%). No information could be obtained on DCCs not willing to participate. It might be that these DCCs have a lower interest in hygiene and therefore also less HH facilities and a lower HH compliance. Our findings concerning the HH compliance and facilities might then be an overestimation. Moreover, the inclusion of a small number of DCCs at their own request may have caused selection bias. However, comparison of these DCCs with the DDCs that were randomly sampled did not show a difference in HH compliance (41% versus 42%, respectively).

In conclusion, this study shows that the caregivers' compliance to HH guidelines in Dutch DCCs is rather low, especially before eating/food handling activities and after contact with body fluids. Children attending DCCs are therefore not optimally protected from infections, resulting in unnecessary distress and costs. Therefore, successful interventions with long-term effects to increase caregivers' HH compliance are needed. Interventions aiming to increase HH compliance of caregivers in DCCs, should ensure hands are washed when indicated in the guidelines. In addition, special attention should be given to those activities for which the compliance was lowest, such as before food handling, before caregivers themselves ate, before caregivers assisted children with eating, after caregivers themselves coughed/sneezed/wiped their own nose, after changing a wet diaper when the child was standing, and after contact with body fluids. Furthermore, interventions should also take into account environmental determinants such as the number and type of towel facilities. This study underlines the need to ensure that there are enough towel facilities per caregiver (i.e. at least one towel facility near every sink), and that only paper towels are available in the classroom instead of only fabric towels or a combination of both fabric and paper towels.

We have now assessed the environmental determinants of HH behavior of caregivers in DCCs. The next step is to assess the cognitive determinants of this behavior.[24] We have therefore also conducted a survey among caregivers in DCCs. Both studies on environmental and cognitive determinants have provided the basis for the development of an intervention, aiming to increase HH compliance of caregivers, with the ultimate goal to decrease infections among children attending DCCs.

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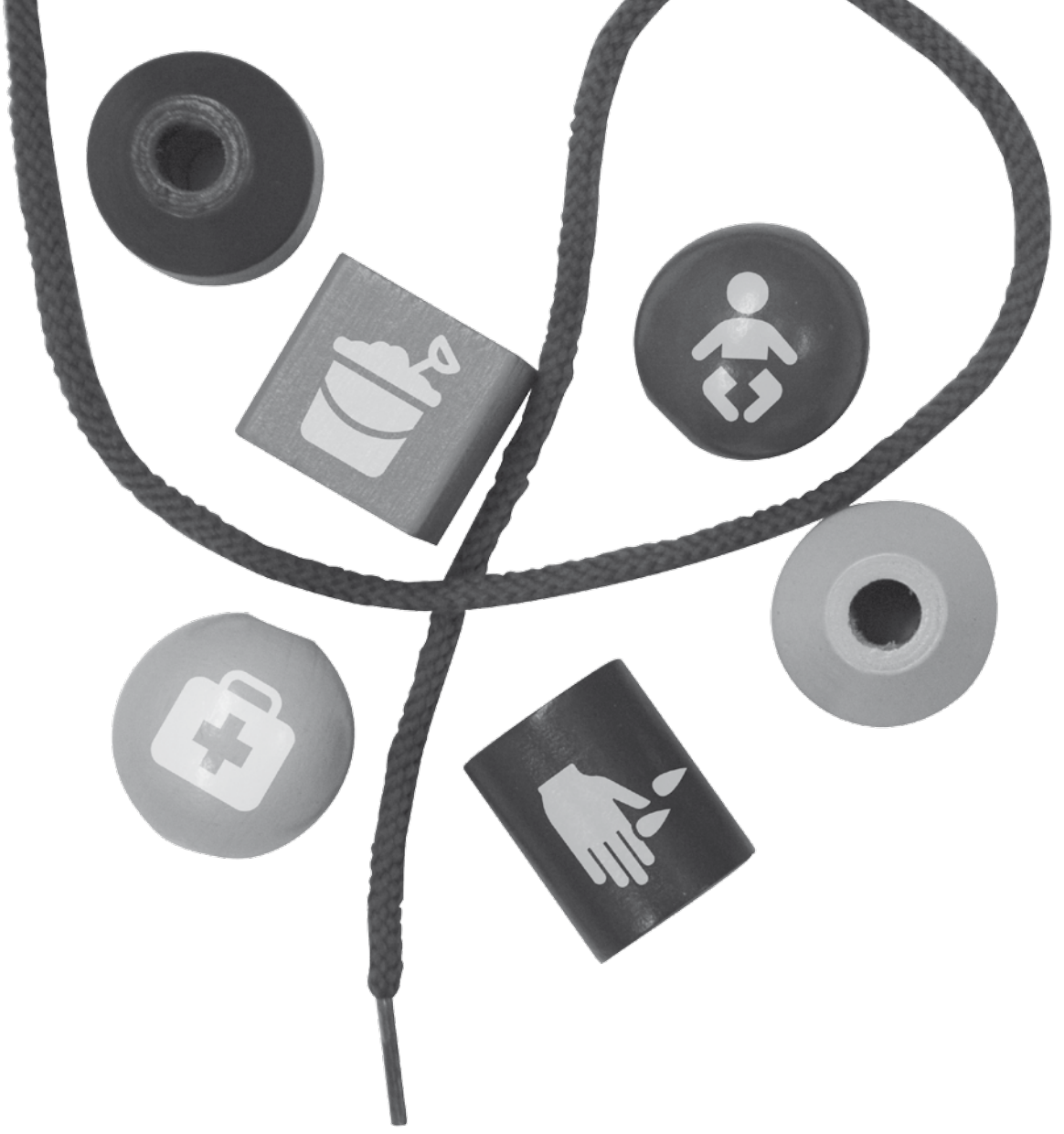

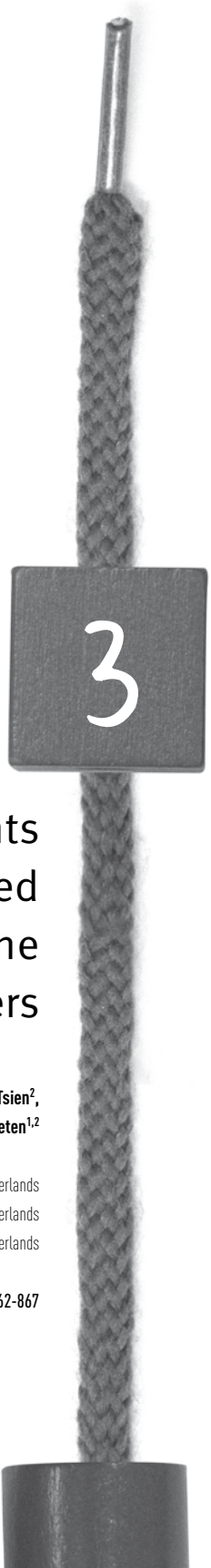

Chapter 3

Sociocognitive determinants of observed and self-reported compliance to hand hygiene guidelines in child day care centers

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Abstract

Background
Although hand hygiene (HH) has proven to be an effective measure to prevent infections, HH compliance is generally low. We assessed sociocognitive determinants of caregivers' HH behavior in child day care centers (DCCs) in order to develop an effective HH intervention.

Methods
Caregivers' compliance to HH guidelines was observed. Observed caregivers completed a questionnaire on self-reported HH compliance, sociocognitive determinants and socio-demographic data. To determine sociocognitive determinants of observed compliance, multilevel logistic regression analyses were performed. Self-reported compliance was analyzed using linear regression.

Results
In 122 participating DCCs, 350 caregivers and 2003 HH opportunities were observed. The response rate on the questionnaire was 100%. Overall observed HH compliance was 42% (841/2003). Overall mean self-reported HH compliance was 8.7 (scale 0-10). Guideline knowledge (OR=1.27; 95% CI: 1.03-1.56) and perceived disease severity (OR=0.93; 95% CI: 0.87-0.99) were associated with observed compliance. Guideline knowledge (β=0.31; P<0.001), guideline awareness (β=0.16; P<0.001), perceived importance (β=0.20; P=0.004), perceived behavioral control (β=0.24; P<0.001), habit (β=0.27; P<0.001), and children at home (β=0.30; P=0.002) were associated with self-reported compliance.

Conclusion
When developing HH interventions for caregivers in DCCs, improving guideline knowledge should be considered as this was associated with both observed and self-reported HH compliance. Furthermore, increasing guideline awareness, perceived importance and perceived behavioral control can contribute to better HH, as well as making HH a habitual behavior.

Introduction

Gastrointestinal and respiratory infections are common among children attending child day care centers (DCCs).[1, 2] These infections can result in unnecessary distress and costs,[3] and also in secondary transmission to other members of the child's household and outbreaks.[4, 5] Hand hygiene (HH) has shown to be a simple and effective measure to prevent gastrointestinal and respiratory infections.[6, 7] However, compliance to HH guidelines is generally low.[8, 9] Several interventions to increase HH in DCCs have shown varying effects.[10-15] Moreover, little is known about the key determinants that underlie HH behavior of caregivers in DCCs.

Interventions developed according to a stepwise behavioral approach address environmental and sociocognitive determinants of the behavior in question.[16] The more that is known about these determinants, the more likely it is that successful interventions with long term effects can be developed.[17] We previously assessed environmental determinants of HH behavior of caregivers in DCCs. It was demonstrated that HH behavior was associated with the type (i.e. paper or fabric) and number of towel facilities.[18] However, HH is a complex behavior and interventions that only address environmental determinants might not successfully increase HH compliance in the long-term.[19]

Little is known about sociocognitive determinants of HH behavior of caregivers in DCCs. As a starting point, we used concepts derived from the Theory of Planned Behavior [20] and the Health Belief Model.[16] Concepts from these models have previously been used to explain HH behavior in the health care setting.[21, 22] According to the Theory of Planned Behavior, an individuals' intention - which has been defined as an indication of how hard people are willing to try to perform a specific behavior - is determined by attitude (i.e. the degree to which an individual has a favorable or unfavorable evaluation of the behavior), subjective norms (i.e. the perceived social pressure, perceived behavior of others, and beliefs about how other people think about the behavior), and perceived behavioral control (i.e. the perceived ease or difficulty of performing the behavior).[20] According to the Health Belief Model, an individual's decision to engage in a health action is determined by his or her perceptions of personal susceptibility to a particular illness (i.e. perception of the risk of contracting that illness), and by perceptions of severity of a particular illness (i.e. feelings concerning the seriousness of that illness), balanced against perceived benefits and barriers.[16]

Although the Theory of Planned Behavior and the Health Belief Model have commonly been used to explain health behavior, these models do not take into account the automaticity of behavior, especially seen among routine behaviors such as HH.[23] Habits are a form of automaticity.[24] Habits develop over time and can be characterized as efficient, executed without awareness, controllable to a limited extent, and intentional.[24, 25] A behavior might become habitual if a specific response is spontaneously triggered by a specific cue in the environment.[24] Therefore, habits are more likely to be developed in a stimulating environment providing cues for action. In addition, it has been shown that environmental determinants can facilitate or hamper HH behavior.[18] In sum, cognitive determinants derived from the Theory of Planned Behavior and the Health Belief Model may explain intended HH behavior. Habits and environmental determinants might explain HH behavior, beyond the more cognitive route.

Previous studies have shown a discrepancy between self-reported and actual observed HH behavior.[21, 26] The Theory of Planned Behavior might explain self-reported behavior to a better extent than actual observed behavior, as has previously been shown for HH behavior in the health care setting.[21] It is therefore important to assess sociocognitive determinants using both self-reported and observed HH as outcome measures in order to understand and explain a potential difference.

The objective of this study was to assess sociocognitive determinants of HH behavior of caregivers in child DCCs using both observed and self-reported HH compliance as outcome measures. This will enable us to develop an intervention aiming to increase caregivers' compliance to HH guidelines, with the ultimate goal to decrease infections among children attending DCCs.

Methods

An observational study was performed from August to October 2010 among DCCs in the regions of Rotterdam-Rijnmond, Leiden and Gouda in The Netherlands. This is a mixed urban-rural area with about 1.5 million inhabitants (of the total of approximately 17 million inhabitants in The Netherlands). We recruited participating DCCs by stratified random sampling. Stratification criteria were: region (Rotterdam-Rijnmond vs. Leiden vs. Gouda); DCC size (small with a maximum capacity of ≤ 39 children vs. large with a maximum capacity of ›39 children); geographic location (highly urban vs. urban vs. slightly/non-urban); and certification (certified vs. non-certified).

Hand hygiene observations

In each DCC, caregivers' compliance to the Dutch national guidelines for HH in DCCs[27] was assessed with direct unobtrusive observation by a trained observer. Compliance was defined as the number of HH actions divided by the total number of opportunities for which HH was indicated according to the national guidelines. According to these guidelines, HH was mandatory for caregivers before touching/preparing food, before caregivers themselves ate or assisted children with eating, before wound care; and after diapering, toilet use/wiping buttocks, after caregivers themselves coughed/sneezed/wiped their own nose, and after contact with body fluids (e.g. saliva, vomit, urine, blood, or mucus when wiping children's noses).[27] For these HH indications it was observed whether or not HH was performed. As observations did not take place in the caregivers' lavatory, HH after toilet use was only observed after assisting a child with toilet use and not after toilet use by caregivers themselves. HH was defined as washing hands with water and soap followed by hand drying, or use of an alcohol-based hand sanitizer. An alcohol-based hand sanitizer could not be used when hands were visibly soiled; in that case handwashing with soap and water was required.

Seven observers were trained until the inter-rater reliability was above 75%. Our aim was to observe three caregivers per DCC, during a single day, and to observe each caregiver for two hours. One observer observed one caregiver at a time. Observations took place during routine care activities in common rooms including the diaper-changing room, the kitchen and the indoor/outdoor playgrounds. The observers collected data using personal digital assistants for electronic on-site data entry. Data were collected using an adaptation of the World Health Organization hand hygiene observation method.[28]

Questionnaire

After the observation, the observed caregivers were asked to complete a questionnaire on self-reported HH compliance and sociocognitive determinants of HH behavior. The questionnaire also included socio-demographic questions concerning age, gender, children living at home, and number of years of work experience. Caregivers returned completed questionnaires to the observers on the day of the observation.

The sociocognitive determinants assessed were derived from the Theory of Planned Behavior,[20] with additions from the Health Belief Model[16] and the Self-Report Habit Index,[24] and were identified by focus group discussions with caregivers and managers of DCCs.

Table 1: Example questions and answer options with means and Cronbach's alpha for assessment of sociocognitive determinants of hand hygiene (HH) behavior of caregivers in child day care centers (N=350 caregivers)

Sociocognitive determinant	Number of items	Example question	
Knowledge of the guidelines	5	Hands should be washed after each wet diaper change.	
Awareness of the guidelines	1	I know exactly what is stated in the HH guidelines.	
Susceptibility	3	What is the chance that a child in your class contracts an infection because you did not wash your hands?	
Perceived disease severity	2	How severe are the possible consequences for a child when it contracts an infection?	
Attitude	2	I think washing hands according to the guidelines is…	
Perceived importance	1	I think washing hands according to the guidelines is…	
Social norm	3	My manager believes I should always adhere to the HH guidelines.	
Social pressure	1	I feel pressure from my colleagues to adhere to the HH guidelines.	
Personal norm	1	HH is everyone's own responsibility.	
Perceived behavioral control	4	How sure are you that you will be able to wash your hands according to the guidelines when the workload is high?	
Outcome beliefs	2	Because I adhere to the HH guidelines the children in my class will contract less infections (like diarrhea, cold).	
Intention	2	In the future I plan to wash my hands according to the guidelines in all situations in which it is needed.	
Perceived physical environment	1	At my child day care centre all materials are available to wash my hands well.	
Habit	7	Adherence to the HH guidelines is something I do automatically.	

N.A., not applicable

The following sociocognitive determinants were assessed: knowledge of the guidelines, awareness of the guidelines, susceptibility (i.e. perception of the risk of contracting an infection), perceived disease severity (i.e. feelings concerning the seriousness of contracting an infection), attitude (i.e. the degree of a favorable or unfavorable evaluation of the behavior), perceived importance of performing HH, social norm (i.e. perceived behavior of others and beliefs about how other people think about the behavior), perceived behavioral control (i.e. perceived ease or difficulty of performing the behavior), outcome beliefs (i.e. expected outcomes of the behavior), perceived social pressure, personal norm (i.e. whether HH was perceived as everyone's own responsibility), intention (i.e. an indication of how hard people are willing to try to perform a specific behavior), perceived physical environment, and habit.

The questionnaire was based on a HH questionnaire for hospital staff,[22] adapted to the child day care setting, and pre-tested among three caregivers of DCCs. *Table 1* lists the sociocognitive determinants with example questions, answer options, and internal

	Answer option	Mean (SD)	Cronbach's alpha
	False, True	4.5 (0.7)	N.A.
	Certainly not (1) – Certainly yes (7)	5.4 (1.3)	N.A.
	Very small (0) – Very big (10)	5.1 (2.4)	0.83
	Not severe (0) – Very severe (10)	5.9 (2.2)	0.87
	Very pleasant (1) – Very unpleasant (7)	4.8 (1.8)	0.69
	Very unimportant (1) – Very important (7)	6.4 (0.8)	N.A.
	Strongly disagree (1) – Strongly agree (7)	5.9 (1.0)	0.71
	Strongly disagree (1) – Strongly agree (7)	2.5 (1.8)	N.A.
	Strongly disagree (1) – Strongly agree (7)	3.7 (2.3)	N.A.
	Completely unsure (1) – Completely sure (7)	5.4 (1.1)	0.82
	Strongly disagree (1) – Strongly agree (7)	5.5 (1.4)	0.90
	Strongly disagree (1) – Strongly agree (7)	6.2 (1.0)	0.90
	Strongly disagree (1) – Strongly agree (7)	6.3 (1.3)	N.A.
	Strongly disagree (1) – Strongly agree (7)	5.7 (0.9)	0.79

consistency measured with Cronbach's alpha. Constructs of sociocognitive determinants were revised until Cronbach's alpha was ≥0.7. In first instance, the construct importance was part of the construct attitude. As the Cronbach's alpha was <0.7, these two constructs were analyzed separately. For each sociocognitive determinant, the mean was calculated by summing the scores of each item and dividing this by the number of items *(Table 1)*. When needed, scales were reversed scored before calculating means, so that high scores reflect positive answers towards HH behavior. Guideline knowledge was measured with five true/false questions. All other sociocognitive determinants, except susceptibility and severity, were measured on a 7-point Likert scale. Susceptibility and severity were measured on a scale from 0 to 10 *(Table 1)*.

Self-reported HH compliance was assessed by calculating the mean of 13 questions, with the questions resembling the specific activities for which HH was indicated outlined in the guidelines. These 13 questions were answered on a scale from 0 to 10 (never-always).

Data were analyzed using SPSS version 18 (SPSS Inc, Chicago, IL) and R version 2.12.2. For both observed and self-reported outcome measures, the overall compliance was calculated, as well as the compliance for the specific activities for which HH was indicated. Calculation of a correlation between observed and self-reported HH compliance was not appropriate because, for most caregivers, only a few types of activities for which HH was indicated were observed, and not all of the HH indications encompassing the self-reported compliance. For both observed and self-reported HH behavior, compliance for the different HH indications was ranked and both rankings were compared. When analyzing the sociocognitive determinants, for the outcome measure observed HH compliance, multilevel analyses were performed to correct for clustering of the data within caregivers. Using multilevel univariate and multivariable logistic regression analyses,[29] odds ratios (OR) with 95% confidence intervals (CI) were obtained for different sociocognitive determinants. For the outcome measure self-reported HH compliance, it was checked whether the residuals were normally distributed. As this was the case for this outcome measure, univariate and multivariable linear regression analyses were performed to obtain regression coefficients for different sociocognitive determinants. A p-value <0.05 was considered significant. Only variables with a univariate p-value <0.2 were tested in multivariable analyses. The multivariable regression models were built using backward stepwise exclusion.

Ethical approval was waived by the Medical Ethics Committee of the Erasmus University Medical Center in Rotterdam (MEC-2009-417).

Results

A total of 122 DCCs participated in the study.[18] From a list of 439 DCCs (the total number of DCCs in the three regions), a stratified random sample of 224 DCCs was drawn. Of these 224 DCCs, 98 participated and one DCC was used for training of observers and not included in the data collection (response rate 44%). In addition, 24 DCCs participated at their own request.[18] Of 122 DCCs, 64% were located in the region of Rotterdam-Rijnmond, 22% in the region of Leiden and 14% in the region of Gouda. In all DCCs, children were cared for in classes. The median number of classes, children, and caregivers per DCC on the day of the observation was respectively three (range 1-11), 33 (range 3-116) and eight (range 1-25). The median number of children per DCC class was nine (range 3-18), and the median number of caregivers per class was two (range 1-4).

In the 122 participating DCCs, 350 caregivers were observed. All observed caregivers completed the questionnaire on sociocognitive determinants (response rate 100%). The inter-rater reliability of the observers who assessed HH compliance was 79% and higher. The median number of caregivers observed per DCC was three (range 1-4). The median duration of the observations was two hours (range 1-3 hours). All but one of the caregivers were female. The median age of the caregivers was 30 years old (range 19-57 years). The median number of years of work experience as caregiver at a DCC was six (range 0-30 years). Of 350 caregivers, 50% had children living at home.

Observed and self-reported hand hygiene compliance

A total of 2003 HH opportunities were observed. The overall observed HH compliance was 42% (841/2003) (95% CI: 40%-44%).[18] The observed HH compliance ranged from 20% before caregivers themselves ate to 79% after changing a diaper with feces *(Table 2)*. The overall mean self-reported compliance was 8.7 (scale 0-10). The mean self-reported compliance ranged from 7.8 after changing a wet diaper when the child was standing to 9.8 after changing a diaper with feces and after assisting children with toilet use/wiping buttocks *(Table 2)*. Ranking of the compliance for specific activities for which HH was indicated showed similar results for observed and self-reported HH compliance, except for HH after contact with body fluids and HH before caregivers themselves ate *(Table 2)*. These were ranked higher in self-reported compliance than in observed compliance.

Sociocognitive determinants

Table 1 shows the means and standard deviations of the sociocognitive determinants. Scores for susceptibility, social pressure and personal norm were around or below mid-scale, whereas the scores of the remaining sociocognitive determinants were above mid-scale. Concerning knowledge of the guidelines, the proportion of caregivers answering a knowledge question correctly ranged from 71% (true/false question "When washing hands it is not always necessary to use soap") to 99% (true/false question: "Before preparing lunch hands should be washed"). Of 350 caregivers, 62% answered all five knowledge questions correctly, 29% four questions, 8% three, 0.6% two, and 0.3% answered none of the questions correctly (results not shown).

Table 2: Observed and self-reported hand hygiene compliance per type of activity for which hand hygiene was indicated according to the Dutch guidelines for child day care centers

Type of activity	Observed compliance*	Self-reported compliance**
	% (number of HH opportunities)	Mean (range)
After changing a diaper with feces	79 (239)	9.8 (5-10)
After caregivers assisted children with toilet use/wiping buttocks	55 (151)	9.8 (5-10)
After changing a wet diaper when the child was lying down	53 (556)	8.6 (0-10)
Before food handling	31 (351)	8.5 (0.3-10)
After caregivers coughed/sneezed/wiped their own nose	29 (62)	8.2 (0-10)
Before caregivers assisted children with eating	27 (162)	8.2 (0-10)
After changing a wet diaper when the child was standing	22 (323)	7.8 (0-10)
After contact with body fluids	21 (84)	8.8 (3-10)
Before caregivers themselves ate	20 (75)	8.6 (0-10)
Overall	**42 (2003)**	**8.7 (4.5-10)**

**N=2003 hand hygiene opportunities **N=350 caregivers, scale 0 (never) to 10 (always)*

Univariate multilevel logistic regression analysis of sociocognitive determinants with outcome measure observed HH compliance demonstrated that guideline knowledge (OR 1.25; 95% CI: 1.01-1.53) and perceived behavioral control (OR 1.19; 95% CI: 1.04-1.36) were positively associated with HH compliance *(Table 3)*. For perceived disease severity, there was a negative association with HH compliance (OR 0.93; 95% CI: 0.87-0.996). In the multivariable model both guideline knowledge (OR 1.27; 95% CI: 1.03-1.56) and perceived disease severity (OR 0.93; 95% CI: 0.87-0.99) remained associated with HH compliance *(Table 3)*. Perceived behavioral control was no longer significantly associated with HH compliance.

Univariate linear regression analysis of sociocognitive determinants with outcome measure self-reported HH compliance also demonstrated a positive association between guideline knowledge and HH compliance (β=0.37, P<0.001) *(Table 3)*. There was also a positive association between HH compliance and the following variables: guideline awareness (β=0.29, P<0.001), perceived disease severity (β=0.07, P=0.009), attitude (β=0.10, P=0.004), perceived importance (β=0.44, P<0.001), social norm (β=0.33, P<0.001), perceived behavioral control (β=0.45, P<0.001), outcome beliefs (β=0.09, P=0.042), intention (β=0.38, P<0.001), perceived physical environment (β=0.12, P=0.014), habit (β=0.50, P<0.001), age (β=0.02, P=0.020), and children at home (β=0.30, P=0.012) *(Table 3)*. There was a negative association between HH compliance and susceptibility (β=-0.07, P=0.006). In the multivariable model, HH compliance remained significantly associated with guideline knowledge (β=0.31, P<0.001), guideline awareness (β=0.16, P<0.001), perceived importance (β=0.20, P=0.004), perceived behavioral control (β=0.24, P<0.001), habit (β=0.27, P<0.001) and having children living at home (β=0.30, P=0.002) *(Table 3)*. Perceived disease severity was excluded from the model in the last step of the backward stepwise selection with a p-value of 0.053. The final multivariable model explained 37.0% of the variance.

Table 3: Univariate and multivariable analyses of sociocognitive determinants of hand hygiene behavior of caregivers in child day care centers with as outcome measures observed hand hygiene compliance analyzed with multilevel logistic regression and self-reported hand hygiene compliance analyzed with linear regression

Variables	Observed compliance[#]		Self-reported compliance[##]	
	Univariate OR (95% CI)	Multivariable OR (95% CI)	Univariate ß	Multivariable ß
Sociocognitive determinants				
Guideline knowledge	1.25* (1.01-1.53)	1.27* (1.03-1.56)	0.37***	0.31***
Guideline awareness	0.96 (0.86-1.07)		0.29***	0.16***
Susceptibility	0.97 (0.91-1.03)		-0.07**	
Perceived disease severity	0.93* (0.87-0.996)	0.93* (0.87-0.99)	0.07**	
Attitude	1.01 (0.93-1.10)		0.10**	
Perceived importance	0.96 (0.81-1.14)		0.44***	0.20**
Social norm	1.10 (0.94-1.27)		0.33***	
Social pressure	0.99 (0.91-1.08)		-0.02	
Personal norm	1.05† (0.99-1.12)		0.03	
Perceived behavioral control	1.19** (1.04-1.36)		0.45***	0.24***
Outcome beliefs	1.05 (0.94-1.16)		0.09*	
Intention	1.14† (0.99-1.32)		0.38***	
Perceived physical environment	1.09† (0.97-1.22)		0.12*	
Habit	0.98 (0.84-1.15)		0.50***	0.27***
Personal characteristics				
Age	1.00 (0.99-1.02)		0.02*	
Number of years work experience	0.99 (0.97-1.02)		-0.00	
Children at home	1.18 (0.89-1.58)		0.30*	0.30**

[#]N=1946 hand hygiene opportunities [##]N=341 caregivers, scale 0 (never) to 10 (always)

*†P<0.2 *P<0.05 **P<0.01 ***P<0.001*

Discussion

This study demonstrates that HH behavior of caregivers in DCCs is positively associated with the following sociocognitive determinants: knowledge and awareness of HH guidelines, caregivers' own perceived ability to perform HH when needed (i.e. perceived behavioral control), perceived importance of performing HH, and habit. Furthermore, a personal characteristic, namely having children living at home, was also associated with HH compliance. Different sociocognitive determinants were associated with observed versus self-reported HH compliance; only knowledge of the guidelines was associated with both outcome measures. Furthermore, self-reported HH compliance was higher than actual observed compliance, demonstrating that self-reported compliance is overestimated. However, ranking the specific activities for which HH was indicated according to the guidelines did yield similar results. Hence, for those activities for which observed HH compliance was high, caregivers themselves also reported a high compliance, and vice versa.

To our knowledge, there are no other studies on sociocognitive determinants of HH behavior of caregivers in DCCs to which we can compare our results. One intervention study focusing on HH of children in DCCs reported knowledge scores to be higher among educators in intervention DCCs compared to educators in control DCCs.[30] In the hospital setting, knowledge has been associated in multivariate analysis with self-reported HH behavior.[22] However, the results of a systematic review on HH in hospitals remained inconclusive concerning the relationship between knowledge and HH behavior [9]. Previous studies have shown an association/correlation between perceived behavioral control and self-reported HH behavior of nurses,[22, 31] and between habit and self-reported HH behavior of physicians and nurses.[22] Habit has also been identified as a significant predictor of observed HH behavior in Kenyan households.[32] For better comparison of study results, more studies on sociocognitive determinants of caregivers' HH behavior in DCCs using a standardized questionnaire are needed.

To our knowledge, this study is the first to assess differences in sociocognitive determinants of self-reported versus observed HH behavior of caregivers in DCCs. A discrepancy between observed and self-reported HH behavior has previously been shown in the hospital setting, where variables of the Theory of Planned Behavior (i.e. intention, attitude, subjective norm, and perceived behavioral control) predicted self-reported, but not observed HH behavior.[21, 26] In studies concerning physical activity, it has also been shown that the Theory of Planned Behavior predicted self-reported behavior better than observed behavior.[33] Similarly in our study, we found perceived behavioral control in multivariable analysis to be associated with self-reported behavior and not with observed HH. Other determinants, such as awareness of the guidelines, perceived importance of performing HH, habit, and having children at home, were also only associated with self-reported HH behavior. Perceived severity of disease was only associated with observed HH behavior, and showed a weak and negative association. This negative association might be explained by the cross-sectional design, which does not imply a causal connection between the two constructs.[34] It might be that because of better compliance, caregivers therefore perceive the disease to be less severe. Only knowledge of the guidelines was associated in multivariable analysis with both self-reported and observed HH behavior.

That different sociocognitive determinants were associated with self-reported versus observed HH behavior demonstrates that it can be useful to assess determinants of both these outcome measures. Studies are needed to investigate the effect of interventions based on sociocognitive determinants of observed versus self-reported behavior, or on both. Interventions based solely on sociocognitive determinants of self-reported behavior might not have the desired effect, as we have shown, these determinants are not always related to actual observed behavior. The Theory of Planned Behavior at its core is concerned with predicting intentions.[35] Whether intentions predict behavior depends in part on factors beyond the individual's control.[35] Therefore, observed behavior not only depends on internal factors, but also on environmental factors. One study in the hospital setting demonstrated a negative association between intensity of work activity and observed HH.[21] Also other factors influencing actual behavioral control might be able to better explain observed HH.[21] Actual behavioral control of caregivers in DCCs might be influenced by, for example, the frequency of children in need for urgent help (e.g. when a child falls or when children fight). More studies are needed to assess the influence of such factors on observed HH behavior.

Our study has several strengths. We assessed both observed and self-reported HH compliance. Another strength of our study is the large sample size including 122 DCCs, of which the majority was recruited by stratified random sampling. Furthermore, all 350 observed caregivers returned the questionnaire (response rate 100%). In addition, the explained variance of the multivariable model of self-reported HH compliance was relatively high (R^2=0.37).

Our study also has a number of limitations. A potential bias of assessing observed HH compliance is the Hawthorne effect, i.e. individuals might change their behavior when they know they are being observed.[28, 36] We attempted to minimize this bias by informing caregivers during observations that the focus was on hygiene in general, without specifically mentioning HH. Another limitation of our study is the relatively low response rate among DCCs that were invited to participate (response rate 44%). No information could be obtained on DCCs not willing to participate. Moreover, the inclusion of a small number of DCCs at their own request may have caused selection bias. However, comparison of these DCCs with the DDCs that were randomly sampled did not show a difference in HH compliance (41% vs. 42%, respectively). Another limitation is the cross-sectional design, which does not imply causality. Furthermore, the questionnaire had not been validated. However, consistency among the items measuring the sociocognitive determinants was high, and the questionnaire was pre-tested among caregivers of DCCs to improve comprehensibility of the questions.

In conclusion, this study demonstrates that when developing interventions to increase HH compliance of caregivers in DCCs, the following sociocognitive determinants can be taken into account: improving knowledge and awareness of the guidelines, increasing perceived importance of HH, improving perceived behavioral control, and making HH an habitual behavior. Special attention should be given to improve knowledge of the guidelines, as this was associated with both observed and self-reported HH compliance. As this study showed self-reported HH compliance to be an overestimation of observed HH compliance, and that different sociocognitive determinants were associated with observed versus self-reported HH compliance, assessing determinants of both these outcome measures can be useful to explain HH behavior. This might potentially increase the effectiveness of HH interventions based on these determinants. More studies are needed to further assess and explain HH behavior of caregivers in DCCs.

Based on the sociocognitive and environmental determinants[18] of HH behavior of caregivers in Dutch DCCs, we will develop an intervention that will be evaluated in a cluster-randomized controlled trial. The aims of the intervention will be to increase HH compliance of caregivers and to decrease infections among children attending DCCs.

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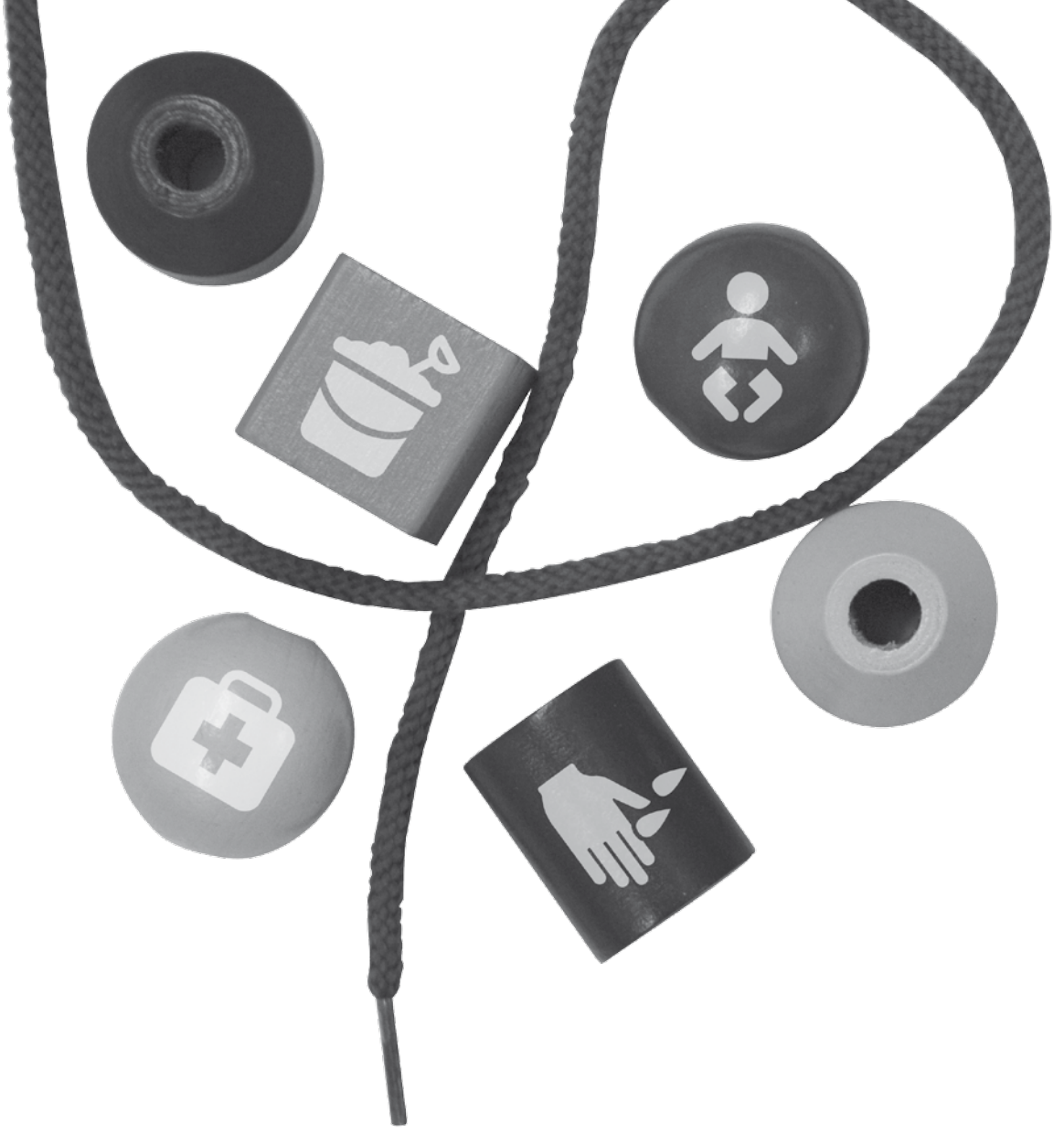

Chapter 4

A hand hygiene intervention to decrease infections among children attending day care centers: design of a cluster randomized controlled trial

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Abstract

Background
Day care center attendance has been recognized as a risk factor for acquiring gastrointestinal and respiratory infections, which can be prevented with adequate hand hygiene (HH). Based on previous studies on environmental and sociocognitive determinants of caregivers' compliance with HH guidelines in day care centers (DCCs), an intervention has been developed aiming to improve caregivers' and children's HH compliance and decrease infections among children attending DCCs. The aim of this paper is to describe the design of a cluster randomized controlled trial to evaluate the effectiveness of this intervention.

Methods/Design
The intervention will be evaluated in a two-arm cluster randomized controlled trial among 71 DCCs in the Netherlands. In total, 36 DCCs will receive the intervention consisting of four components: 1) HH products (dispensers and refills for paper towels, soap, alcohol-based hand sanitizer, and hand cream); 2) training to educate about the Dutch national HH guidelines; 3) two team training sessions aimed at goal setting and formulating specific HH improvement activities; and 4) reminders and cues to action (posters/stickers). Intervention DCCs will be compared to 35 control DCCs continuing usual practice. The primary outcome measure will be observed HH compliance of caregivers and children, measured at baseline and one, three, and six months after start of the intervention. The secondary outcome measure will be the incidence of gastrointestinal and respiratory infections in 600 children attending DCCs, monitored over six months by parents using a calendar to mark the days their child has diarrhea and/or a cold. Multilevel logistic regression will be performed to assess the effect of the intervention on HH compliance. Multilevel poisson regression will be performed to assess the incidence of gastrointestinal and respiratory infections in children attending DCCs.

Discussion
This is one of the first DCC intervention studies to assess HH compliance of both caregivers and children, as well as the incidence of gastrointestinal and respiratory infections in children, as outcome measures. When an effect of the intervention on improving HH compliance and/or reducing incidence of infections is shown, (inter)national dissemination of the intervention in other DCCs may be considered.

Trial registration
Netherlands trial registry: NTR3000

Background

Attendance at child day care centers (DCCs) has been recognized as a risk factor for acquiring gastrointestinal and respiratory infections.[1-3] These infections can cause distress for both the children and their parents, incur costs for health care and parental work absence, and result in secondary transmission.[4-6] Hand hygiene (HH) is a simple and effective measure to prevent infections.[7, 8] In the Dutch national HH guidelines for DCCs, the activities for which HH is indicated are outlined.[9] However, compliance with HH guidelines is generally low; hands are adequately washed in Dutch DCCs in less than half of all HH opportunities (compliance 42%).[10] Several HH interventions have been developed to decrease infections in DCCs.[11-17] However, these interventions show varying effects[18] and are not developed according to a stepwise behavioral approach taking into account the underlying determinants of HH behavior.[19] Interventions developed based on these determinants are more likely to be effective in the long term.[20] A study on HH in hospitals has shown that interventions have more effect when a combination of multiple determinants is addressed.[21]

We assessed environmental and sociocognitive determinants of caregivers' compliance with HH guidelines,[10, 22] and have used the results of our studies to develop a multi-component intervention aiming to improve caregivers' and children's HH compliance and decrease infections among children attending DCCs. The intervention consists of the following four components: 1) products necessary for HH (i.e. dispensers and refills for paper towels, soap, alcohol-based hand sanitizer, and hand cream); 2) training to educate about the Dutch national HH guidelines; 3) two team training sessions aimed at goal setting and formulating specific HH improvement activities; and 4) reminders and cues to action (i.e. posters and stickers). The four components of the intervention together could potentially result in better HH compliance and fewer gastrointestinal and respiratory infections among children attending DCCs. However, before (inter)national dissemination of the intervention in other DCCs can be considered, it is necessary to evaluate the effectiveness of the intervention. The objective of this paper is to describe the design of a cluster randomized controlled trial to evaluate the effectiveness of the HH intervention.

Methods/design

Objectives and hypotheses

The study objective is to evaluate the effectiveness of a HH intervention in DCCs. Our hypotheses are that HH compliance of caregivers and children in intervention DCCs will be significantly higher than in control DCCs, and that children attending intervention DCCs will have significantly less gastrointestinal and respiratory infections than children attending control DCCs.

Study design

The intervention will be tested in a two-arm cluster randomized controlled trial, to be conducted among 71 child DCCs; 36 intervention DCCs receive the intervention, while 35 control DCCs continue usual practice.

Setting

The study will be conducted among DCCs in the Netherlands in the regions of Rotterdam-Rijnmond, Leiden and Gouda. This is a mixed urban-rural area with about 1.5 million inhabitants (of the total of approximately 17 million inhabitants in the Netherlands). In this area around 25,000 children attend about 390 DCCs (unpublished data 2008).

Intervention development

Our previous studies concerning environmental and sociocognitive determinants of caregivers' compliance with HH guidelines in DCCs[10, 22] were used to develop a multi-component HH intervention for DCCs. The intervention targets caregivers' sociocognitive determinants such as guideline knowledge and awareness, perceived importance of performing HH, caregivers' own perceived ability to perform HH when needed (i.e. perceived behavioral control), and habit *(Table 1)*. In addition, with the provision of HH products the intervention targets environmental determinants *(Table 1)*.

Table 1: Intervention components and targeted determinants of hand hygiene (HH) behavior

Intervention component	Targeted determinants of HH behavior
1. Provision of HH products: dispensers and refills for paper towels, soap, alcohol-based hand sanitizer and hand cream	Environmental determinants, especially the availability of paper towels
2. Training to educate about the Dutch national HH guidelines; information booklet	Guideline knowledge and awareness, perceived HH importance
3. Two team training sessions aimed at goal setting and formulating specific HH improvement activities	Perceived HH importance, perceived behavioral control
4. Posters and stickers as reminders and cues to action	Guideline knowledge and awareness, habit

Our study on the environmental determinants of caregivers' HH compliance showed that hands are most frequently washed when only paper towels are available compared to only fabric towels or a combination of both paper and fabric towels.[10] Therefore, the intervention includes the provision of paper towel dispensers and refills. We also provide dispensers and refills for liquid soap, alcohol-based hand sanitizer, and hand cream to ensure that all necessary products for HH are available.

Our study on sociocognitive determinants demonstrated that the following determinants were related to HH compliance of caregivers: knowledge and awareness of the guidelines, perceived importance of performing HH, perceived behavioral control (i.e. caregivers' own perceived ability to perform HH when needed), and habit.[22] To improve knowledge and awareness of the HH guidelines and to increase perceived importance of HH, a one hour training session which incorporates the following topics was developed: transmission of infectious diseases, importance of HH at DCCs, the different activities outlined in the guidelines for which HH is indicated both for caregivers and children, and the techniques for performing HH using soap and water or alcohol-based hand sanitizer. The training session also includes an exercise using UV Glow Cream (Deb Benelux, Inc.) and a UV lamp to demonstrate the difference between quick and thorough hand washing. After the training session all participants, as well as caregivers who cannot attend, receive a booklet that outlines the content of the training about the HH guidelines.

To increase perceived behavioral control, two team training sessions were developed. The aim of these training sessions is to get team members to formulate team goals concerning HH and specific activities to improve HH of caregivers and children at their DCC. During the first training session, team members discuss current HH compliance, goal setting for future compliance, barriers and facilitators, and strengths of their team. During the second training session, which takes place about one month later, the interlaying period is reflected on and the following topics are discussed: rating of HH compliance of the team, improvements made so far, remaining difficulties and what is needed to address these, communication in case HH is not performed, and how to maintain the achieved results in the long term. The team training sessions are guided by trained coaches and are based on similar HH training sessions developed for Dutch hospitals.[23]
The intervention also includes reminders and cues to action to stimulate HH to become habitual behavior. For both caregivers and children a poster with the activities for which HH is indicated and a poster with the technique for adequate hand washing was developed, as well as reminder stickers. The posters and stickers were developed in collaboration with the department of Industrial Design of the Delft University of Technology in the Netherlands.

The intervention DCCs will be compared to control DCCs continuing usual practice. After data collection, the control DCCs will also be offered the intervention to motivate participation in the study.

Participants
Of 390 DCCs, 122 participated in our previous study on environmental and sociocognitive determinants of caregivers' compliance with HH guidelines.[10, 22] Of these 122 DCCs, 71 will participate in the trial to evaluate the effectiveness of the intervention. In Dutch DCCs, children aged three months to four years are cared for in groups or classes and each group of children has its own room where the daily activities take place (i.e. classrooms). In each participating DCC (both intervention and control), data will be collected in two of these groups, even if the DCC has more than two groups in total. Study participants will be caregivers (excluding interns) working in these two groups and children attending these groups. Inclusion criteria for the children are: aged at start of the trial between six months and 3.5 years; attending the DCC at least two days a week; intending to attend the DCC throughout the study period; and consenting Dutch speaking parents with access to email or regular post. Exclusion criteria for the children are: chronic illness or medication that would predispose them to infection; a sibling taking part in the trial (i.e. one child per family); and starting to attend the DCC after the start of the trial.

Randomization
Stratified randomization is performed by assigning each DCC to one of six strata based on size (i.e. small < 46 children per day versus large ≥ 46 children per day) and geographic location (i.e. highly urban versus urban versus slightly/non-urban). DCCs are assigned to either intervention or control group by means of computer generation with a 1:1 ratio in each of the strata.

Outcome measures
Primary outcome measure: observed HH compliance
The primary outcome measure is observed compliance of caregivers with HH guidelines. Compliance is defined as the number of HH actions divided by the total number of opportunities for which HH is indicated according to the Dutch national guidelines. According to these guidelines, HH is mandatory for caregivers before touching/preparing food, before caregivers themselves eat or assist children with eating, and before wound care; and after diapering, after toilet use/wiping buttocks, after caregivers themselves cough/sneeze/wipe their own nose, after contact with body fluids (e.g. saliva, vomit, urine, blood, or mucus when wiping children's noses), after wound care, and after visibly soiled hands.[9] For these HH indications it will be observed whether or not HH is performed. As observations cannot take place in the caregivers' lavatory, HH after toilet use will only be observed after assisting a child with toilet use and not after toilet use by caregivers themselves. HH is defined as washing hands with water and soap followed by hand drying, or use of an alcohol-based hand sanitizer. An alcohol-based hand sanitizer cannot be used when hands are visibly soiled; in this case, hand washing with soap and water is required.

Although the primary outcome measure is HH compliance of caregivers, it will also be observed whether caregivers supervise children to wash their hands, because the HH indications outlined in the guidelines also apply to children.[9] It will be observed whether caregivers supervise children to wash their hands before eating/preparing food, after toilet use, after playing outside, and after visibly soiled hands. Children should wash their hands with water and soap followed by hand drying. For babies and toddlers who cannot wash their hands themselves yet, caregivers can perform HH by using a wet cloth with soap on one side and only water on the other side.[9]

Compliance will be assessed with direct unobtrusive observation by trained observers before start of the intervention (To) and one (T1), three (T2), and six (T3) months after start of the intervention. At each measurement time point (i.e. To, T1, T2 and T3) the aim is to observe, during a single day in each DCC, three caregivers in the two groups participating in the study and to observe each caregiver for two hours. One observer will observe one caregiver at a time, as well as the children of which HH is supervised by that caregiver. Observations will take place during routine care activities in common rooms including the diaper-changing room, the kitchen and the indoor/outdoor playgrounds. The observers will collect data using personal digital assistants (PDAs) for electronic on-site data entry. Data will be collected using the World Health Organization HH observation method,[24] adapted for use in child DCCs.

Secondary outcome measure: incidence of gastrointestinal and respiratory infections in children

The secondary outcome measure is the incidence of gastrointestinal and respiratory infections in children attending DCCs. The aim is that 600 parents will monitor disease incidence in their child using strict definitions for diarrhea and a cold. Diarrhea is defined as at least two watery or unusually loose bowel motions in 24 hours.[15] A cold is defined as a blocked or runny nose with at least one of the following symptoms: coughing, sneezing, fever, sore throat, or earache.

Disease incidence will be assessed by parents using a paper calendar to mark the days their child has diarrhea and/or a cold. Each calendar page includes the definitions of illness. The paper calendar will facilitate record keeping and minimize recall bias. Parents will be contacted every two weeks by email and by regular post to enter the calendar page in an online version of the calendar or to send it in by regular post using a free-of-charge return envelop. The email will contain a link to the online calendar and parents will receive a password to ensure confidentiality. Parents who do not respond will receive a reminder email after one week, after two weeks they will receive a reminder letter, and after three weeks, if by then they still have not replied, they will be contacted by telephone. Monitoring of disease incidence by parents will last six months during which the intervention will be implemented in phases and baseline and follow-up data will be collected. In total, parents will be asked to return 14 calendar pages, with each page covering two weeks. To stimulate response parents will receive small incentives during the six months data collection (e.g. inflatable beach ball) and parents who return all calendar pages will receive a larger incentive at the end of the trial (i.e. tickets for the whole family for an amusement park for children).

Intervention implementation and data collection

The intervention will be implemented in the 36 intervention DCCs in phases over a period of six months. Timing of the intervention will be during the winter months, namely from mid-September until the end of March, when most gastrointestinal and respiratory infections occur. In all participating DCCs (both intervention and control), data will be collected in two groups. In each intervention DCC, due to budget restrictions, only the two groups where data are collected will receive the HH products and refills for six months. To facilitate support from the management and to stimulate cultural changes concerning HH, the training sessions and posters/stickers will be offered to the whole intervention DCC.

Figure 1: Timeline of data collection and phased implementation of a hand hygiene intervention at child day care centers (DCCs)

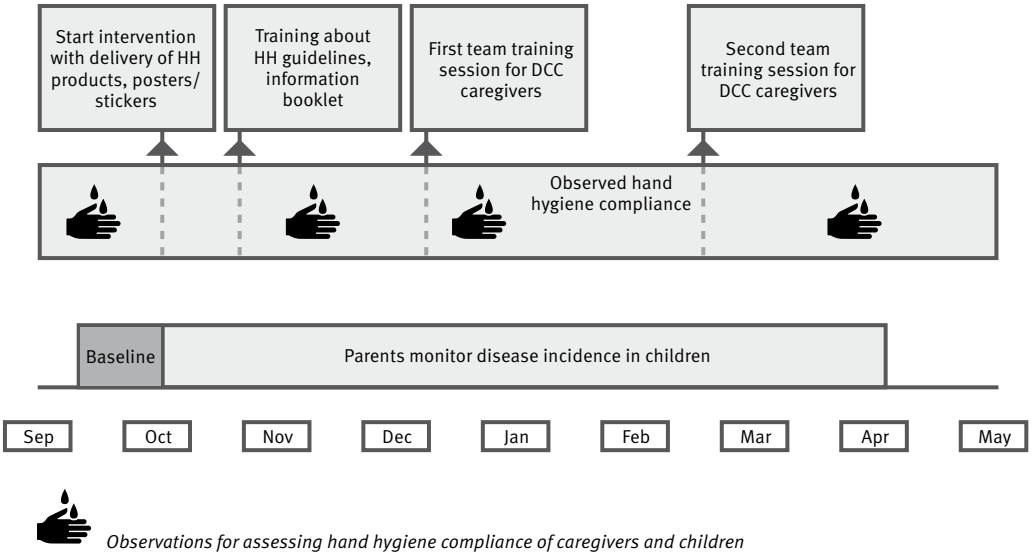

Figure 1 shows the timeline of phased implementation of the intervention and data collection. Baseline compliance (T0) and baseline incidence rates will be collected prior to start of the intervention. The intervention will start with the delivery of the dispensers with refills and posters/stickers. Shortly after that the training to educate about the national HH guidelines will be given. Compliance will be observed again one month after start of the intervention (T1) and this will be followed by the first team training session. Compliance will then be observed once more three months after start of the intervention (T2) after which the second team training session will be given. The final compliance observations will take place after the second team training session and six months after start of the intervention (T3).

Blinding

DCCs will not be blinded to treatment arms; the managers will be informed whether their DCC is allocated to the intervention or control group. Although the observers who collect compliance data and parents who monitor disease incidence will not be informed whether the DCC is in the intervention or control group, they will probably recognize the intervention materials.

Data analyses

First, descriptive analyses will be performed to assess the effect of the intervention on observed HH compliance and on incidence of gastrointestinal and respiratory infections in children. Compliance with HH guidelines will be calculated by dividing the number of HH actions by the total number of opportunities for which HH is indicated according to the Dutch national guidelines. Incidence of gastrointestinal and respiratory infections will be calculated by dividing the number of illness episodes by the total number of days at risk.

To account for clustering of the data within caregivers/children and within DCCs, multilevel analyses will be performed. The effect of the intervention on observed HH compliance will be analyzed using multilevel logistic regression. Multilevel poisson regression will be used to analyze the effect of the intervention on incidence of gastrointestinal and respiratory infections in children. If necessary, baseline differences between intervention and control DCCs will be corrected for, as well as for possible confounders at the level of the DCCs, caregivers or children.

Sample size calculation

Primary outcome measure: observed HH compliance

HH compliance is expected to increase due to the intervention from 30% at baseline to 60% six months after start of the intervention. To detect this increase we would need a sample size of 20 DCCs in a two-arm cluster randomized controlled trial (10 intervention and 10 control DCCs). This is based on 80% power with a two-sided alpha of 0.05, assuming 60 observed HH opportunities per DCC per measurement time point (i.e. To, T1, T2 and T3) and taking into account clustering of data within DCCs.

Secondary outcome measure: incidence of gastrointestinal and respiratory infections in children

To be able to detect 25% reduction in incidence of gastrointestinal infections of three per year and 15% reduction in incidence of respiratory infections of nine per year, we would need a sample size of 60 DCCs (30 intervention and 30 control DCCs) and disease monitoring of 600 children (10 children per DCC) for six months. This is based on 80% power with a two-sided alpha of 0.05, assuming 10 children per DCC and taking into account clustering of data within children and within DCCs. The assumed reduction in disease incidence seems to be realistic, given the pooled estimates of 39% and 31% reduction in gastrointestinal illness,[7, 25] and a pooled estimate of 21% reduction in respiratory illness.[25]

To be able to detect an effect of the intervention on both our primary and secondary outcome measure, it is necessary to include at least 60 DCCs in the cluster randomized controlled trial (30 intervention and 30 control DCCs) and include at least 600 children of which parents will monitor disease incidence for six months. However, some DCCs and some parents/children might withdraw from the trial due to unforeseen reasons. To allow for about 15% lost to follow-up, we aim to include five extra intervention DCCs and five extra control DCCs (in total 35 intervention and 35 control DCCs).

Process evaluation

A process evaluation will be conducted at the end of the trial (i.e. six months after start of the intervention) to identify strengths and weaknesses of the intervention, to be able to better interpret the results, and to provide recommendations for further intervention improvement. The process evaluation will include both qualitative and quantitative research. First, focus group discussions will be held with caregivers and managers of the intervention DCCs regarding their experience with the various components of the intervention. Second, a survey will be conducted to assess the extent to which caregivers and managers have been exposed to different intervention components, how workable and useful they found them, whether they liked them, and barriers or facilitators they experienced. Finally, another survey will be conducted to assess the effect of the intervention on sociocognitive determinants of caregivers' HH compliance.

Discussion

This paper outlines the study protocol for the evaluation of a DCC intervention aiming to increase caregivers' and children's HH compliance and decrease gastrointestinal and respiratory infections among children attending DCCs. Few DCC intervention studies have assessed, either caregivers' or children's HH compliance as outcome measure.[13, 15-17] To our knowledge, this will be the first study to assess HH compliance of both caregivers and children as primary outcome measure and to report, besides overall compliance, the compliance for each specific HH indication. In addition, this will also be the first HH intervention in DCCs developed according to a stepwise behavioral approach[19] targeting the key determinants that underlie caregivers' HH behavior. Although the intervention is based on determinants of HH compliance of caregivers, HH compliance of children will also be targeted and observed. Other strengths of the study are the randomized controlled design, the large number of participating DCCs and children/parents, and the long follow-up period. Furthermore, DCCs in the control group will also be offered the intervention after data collection, which probably will facilitate recruitment of participants and minimize dropout.[13]

A possible limitation of the study is the Hawthorne effect when observing HH compliance, i.e. individuals might change their behavior when they know they are being observed.[24, 26] However, during observations we will not inform caregivers that their HH is observed. If caregivers ask, they will be informed that the focus is on hygiene in general. Another possible limitation is that most caregivers will know, and parents and observers might recognize, the intervention status of the DCC. Data collection might be biased by this knowledge. In addition, illness will not be laboratory confirmed, which would be a more objective and specific outcome measure than monitoring of diarrhea and colds by parents. Furthermore, participating DCCs also participated in our previous study on determinants of caregivers' HH compliance and will have received feedback on their HH compliance six months before start of the trial. Baseline compliance might therefore be higher than in DCCs who did not participate in our determinants study. The effect size that we will measure might then be an underestimation of the true effect size of the intervention.

This study will demonstrate whether our intervention is effective in improving compliance with HH guidelines and/or reducing gastrointestinal and respiratory infections among children in DCCs. The study can also provide insight into transmission of infectious diseases in DCCs (i.e. caregiver-to-child versus child-to-child transmission) and into changeable determinants of HH behavior of caregivers in DCCs. When an effect of the intervention is shown, (inter)national dissemination of the intervention in other DCCs may be considered. The intervention might then also be used by DCCs to distinguish them from a quality perspective and to control ongoing infectious disease outbreaks.

Ethical Approval
Ethical approval was waived by the Medical Ethics Committee of the Erasmus University Medical Center in Rotterdam (MEC-2011-256).

Competing Interests
The authors declare that they have no competing interests. Dispensers and refills will be sponsored by SCA Hygiene Products, Sweden.

Authors' Contributions
All authors contributed to the design of the study and manuscript preparation. All authors have read and approved the final manuscript.

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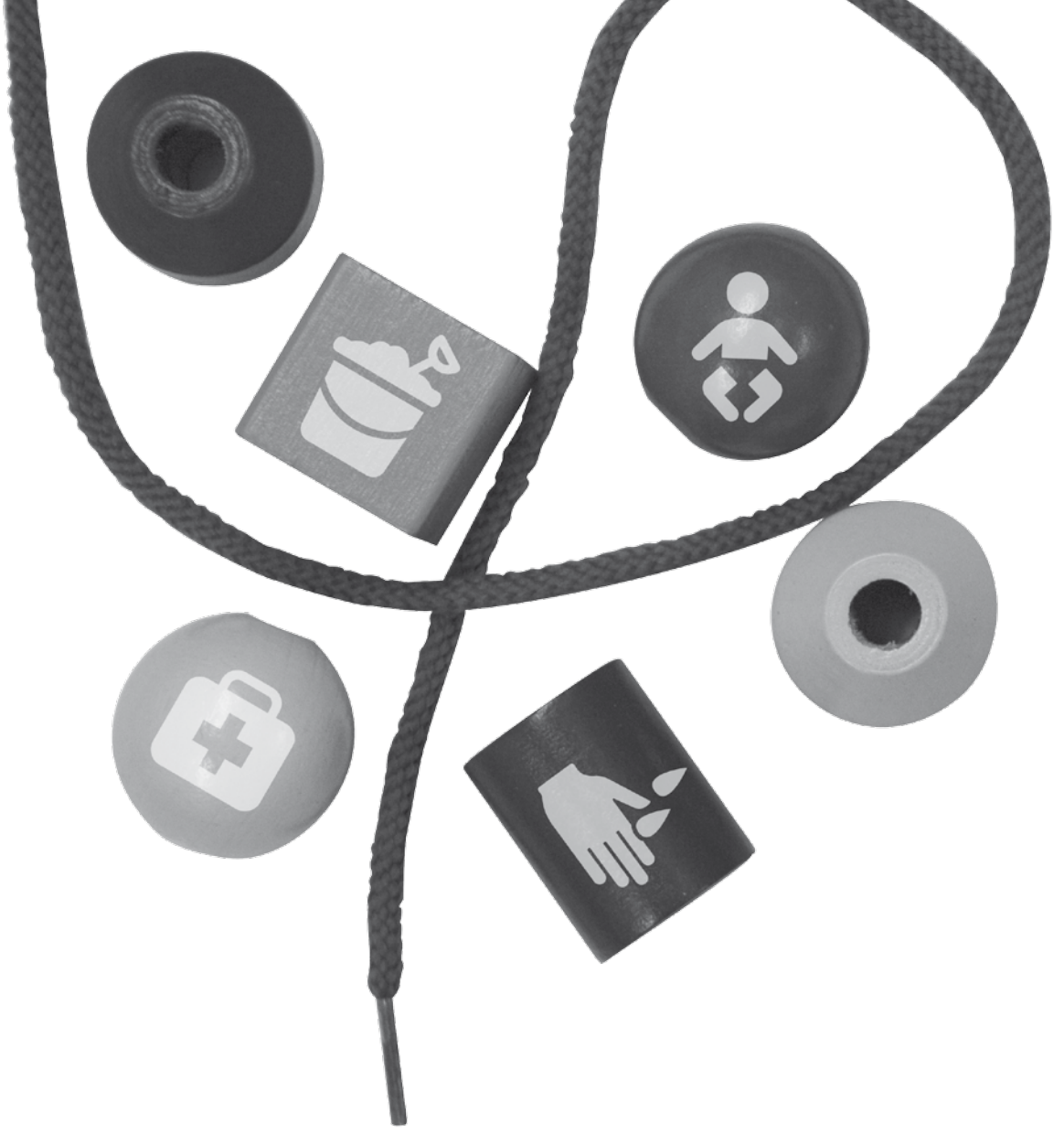

Chapter 5

Improving caregivers' hand hygiene compliance in child day care centres: a randomised controlled trial

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Abstract

Background
Gastrointestinal and respiratory infections among children attending day care centres (DCCs) are common and compliance with hand hygiene (HH) guidelines to prevent infections is low. With a stepwise behavioural approach, an intervention was developed to increase HH compliance and reduce infections in DCCs. The study objective was to evaluate the effect of this intervention on HH compliance.

Methods
The intervention was evaluated in a two-arm cluster randomised controlled trial in 71 DCCs in the Netherlands. 36 DCCs received the intervention including: 1) HH products; 2) training about HH guidelines; 3) two team training sessions aimed at goal setting and formulating HH improvement activities; and 4) posters/stickers as reminders and cues to action. Intervention DCCs were compared to 35 control DCCs that continued usual practice. Caregivers' HH compliance was observed at baseline and at one, three and six months follow-up. Using multilevel logistic regression, odds ratios (OR) with 95% confidence intervals (CI) were obtained for the intervention effect.

Results
In total, 795 caregivers were observed during 5042 HH opportunities. At baseline, caregivers' compliance in intervention DCCs was 53% versus 63% in control DCCs (OR 0.59; 95% CI 0.37-0.94). At one month follow-up, it was 66% in intervention DCCs versus 43% in control DCCs (baseline corrected OR 6.33; 95% CI 3.71-10.80), and at six months follow-up 59% versus 44% (baseline corrected OR 4.13; 95% CI 2.33-7.32).

Conclusions
The intervention, addressing determinants of caregivers' HH behaviour, leads to a significant increase in HH compliance in day care centres.

Introduction

Attending child day care centres (DCCs) has been associated with an increased risk of acquiring gastrointestinal and respiratory infections.[1-3] These infections can cause parental stress, secondary transmission, health care costs, and costs for parental work absence.[4-7] Hand hygiene (HH) is known to be an effective measure to prevent infections.[8, 9] However, compliance with HH guidelines in DCCs is generally low, as shown by our previous study which demonstrated that HH compliance in Dutch DCCs is 42%.[10] Although several HH interventions have been developed to reduce infections among children attending DCCs,[11-18] these interventions show varying results[19] and are not developed according to a stepwise behavioural approach taking into account the determinants that underlie HH behaviour.[20]

Our previous research showed that environmental determinants, such as the availability of paper towels, are associated with caregivers' HH compliance in DCCs.[10] In addition, we found that the following sociocognitive determinants are associated with caregivers' HH compliance in DCCs: knowledge and awareness of HH guidelines, perceived importance of performing HH, perceived behavioural control (i.e. perceived ease or difficulty of performing the behaviour) and habit.[21] We developed an intervention targeting these determinants aiming to increase caregivers'compliance with HH guidelines and reduce gastrointestinal and respiratory infections among children attending DCCs. We performed a cluster randomised controlled trial, with HH compliance by caregivers as primary outcome measure, and incidence of infections as secondary outcome measure. HH compliance as outcome measure provides insight into a more direct effect of the intervention and might explain the variation in effectiveness of previous HH intervention studies assessing disease incidence. In this paper we assess the effect of our intervention on improving HH compliance. The effect on disease incidence is reported separately.

Methods

A cluster randomised controlled trial was performed among DCCs in the regions of Rotterdam-Rijnmond, Gouda and Leiden in the Netherlands between September 2011 and April 2012. DCCs were randomised, stratified for DCC size and urbanicity.[22] In our previous study on determinants of caregivers' HH compliance, 122 DCCs participated.[10, 21] These DCCs were eligible and contacted to participate in the trial. Sample size calculation showed that 35 intervention DCCs and 35 control DCCs were needed.[22]

The intervention consisted of four components.[22] First, the following HH products were provided free of charge with refills for six months: dispensers for paper towels, soap, alcohol-based hand sanitizer and hand cream. Second, training was given to educate DCC caregivers about the Dutch national HH guidelines. This included a hand washing exercise using UV Glow Cream (Deb Benelux, Inc.) and an information booklet outlining the content of the training. Third, two team training sessions were given aimed at goal setting and formulating specific HH improvement activities. These were based on similar HH training sessions developed for Dutch hospitals.[23] Fourth, posters and stickers were provided for both caregivers and children as reminders and cues to action. Two groups in each DCC participated in the study. In intervention DCCs, these groups received the HH products. As caregivers rotated between groups, all caregivers received the training sessions.

Intervention DCCs were compared to control DCCs that continued usual practice. The primary outcome measure was observed HH compliance of caregivers. Compliance was defined as the number of HH actions divided by the total number of opportunities for which HH was indicated. According to the Dutch national guidelines, HH was mandatory for caregivers before touching/preparing food, before caregivers themselves ate or assisted children with eating, and before wound care; and after diapering, after toilet use/wiping buttocks, after caregivers themselves coughed/sneezed/wiped their own nose, after contact with body fluids (e.g. saliva, vomit, urine, blood, or mucus when wiping children's noses), after wound care, and after hands were visibly soiled.[24] For these HH indications it was observed whether or not HH was performed. As observations could not take place in the caregivers' lavatory, HH of caregivers after toilet use was not observed. HH was defined as washing hands with water and soap followed by hand drying, or using an alcohol-based hand sanitizer (which could only be used if hands were not visibly soiled).

Compliance was assessed with direct unobtrusive observation by trained observers before the start of the intervention (T0) and one (T1), three (T3), and six (T6) months after intervention start. In total, 13 observers were trained aiming for an inter-rater reliability above 75%. Observers were not blinded to the intervention status of the DCC, as they could easily recognise the intervention dispensers and posters/stickers. Data collection followed phased implementation of the intervention.[22] After observing baseline compliance (T0), intervention DCCs received the HH products, posters/stickers and training about the HH guidelines; after this HH compliance was observed again (T1), and once more after each of both team training sessions (T3 and T6). At each measurement, the aim was to observe three caregivers for two hours each in two participating groups per DCC. One observer observed one caregiver at a time. Data were collected using the World Health Organization HH observation method [25], adapted for use in child DCCs. At six months follow-up, it was also

observed whether the dispensers provided as part of the intervention were in use. After the last observations, a survey was conducted among caregivers in intervention DCCs concerning their exposure to the different intervention components.

Data were analysed using SPSS version 19 (SPSS Inc, Chicago, IL) and R version 2.12.2. Analyses were done including all intervention DCCs irrespective of whether they used the HH products, posters/stickers or obtained all training sessions (intention-to-treat analyses). First, baseline characteristics were compared using poisson regression for count variables, chi-squared test or Fisher's exact test for categorical variables, and independent t-test for continuous variables. Second, compliance at baseline and total follow-up (T1, T3 and T6 together) was calculated, as well as compliance for the separate follow-up measurements (T1, T3 and T6 separately). Additionally, for six months of follow-up (T6), compliance was calculated for each type of activity for which HH was indicated. Multilevel regression analyses were performed to correct for clustering of the data within DCCs and within caregivers. Using multilevel logistic regression analysis for total follow-up and for each separate follow-up measurement, odds ratios (ORs) with 95% confidence intervals (CI) were obtained for the intervention effect, corrected for confounders that showed significant differences at baseline between intervention and control DCCs. Because the type of activity for which HH was indicated previously showed to be an important determinant of caregivers' HH,[10] this was also included as a confounder.

Additional analyses were performed to correct for baseline compliance. For this we calculated the intervention effect as the interaction between intervention status of the DCC (i.e. intervention versus control) and follow-up measurement (i.e. baseline versus T1/T3/T6/ total follow-up). This resulted in an OR for the difference between baseline and follow-up measurement in intervention DCCs and an OR for the difference between baseline and follow-up in control DCCs. Comparison of these two ORs resulted in a baseline corrected OR.

Ethical approval was waived by the Medical Ethics Committee of the Erasmus University Medical Centre in Rotterdam (MEC-2011-256).

Results

71 DCCs participated in the trial. After randomisation, there were 36 intervention and 35 control DCCs. At baseline and one month after start of the intervention, all 71 DCCs participated. Three months after start of the intervention, one control DDC was lost to follow-up, and six months after start of the intervention two more control DCCs were lost to follow-up. None of the intervention DCCs were lost to follow-up. In total, 795 caregivers and 5042 HH opportunities were observed. It is noteworthy, that the same caregivers could have been observed multiple times. The inter-rater reliability of the observers was 74% and higher.

Comparison of baseline characteristics of intervention and control DCCs demonstrated that in intervention DCCs, the group type (0/1 year olds; 2/3 year olds; 0 to 4 year olds) significantly differed from control DCCs *(Table 1)*. This variable was therefore included in further analyses as a confounder. None of the other baseline characteristics were significantly different between intervention and control DCCs *(Table 1)*.

All 36 intervention DDCs received training on HH guidelines. Of 36 intervention DCCs, two DCCs did not use any of the provided HH products during the study period. Another two DCCs did not receive any of the team training sessions. At six months follow-up, 94% of intervention DCCs used the paper towel dispensers in at least one of the two groups, 89% used the soap dispensers, 86% used the dispensers with alcohol-based hand sanitizer, and 45% used the dispensers with hand cream (hand cream dispensers were delivered halfway through the trial and therefore were not installed everywhere). At six months follow-up, in 19% of intervention DCCs neither posters nor stickers of the intervention were used, in 83% the posters were used in at least one of two groups, and in 74% the stickers were used.

The response rate to the questionnaire on exposure to the intervention was 50% (274/546). Of 274 caregivers, 21% attended none of the training sessions, 25% attended one training session, 29% attended two training sessions, and 25% attended all three sessions; 77% received the information booklet of the training session on HH guidelines.

Figure 1 shows that caregivers' HH compliance at baseline was lower in intervention DCCs than in control DCCs. During follow-up, compliance in intervention DCCs was higher than in control DCCs, although the effect of the intervention seemed to wane slightly.

Figure 1: Effect of the intervention on caregivers' compliance with hand hygiene guidelines in child day care centres (DCCs) measured at baseline and one, three and six months after intervention start

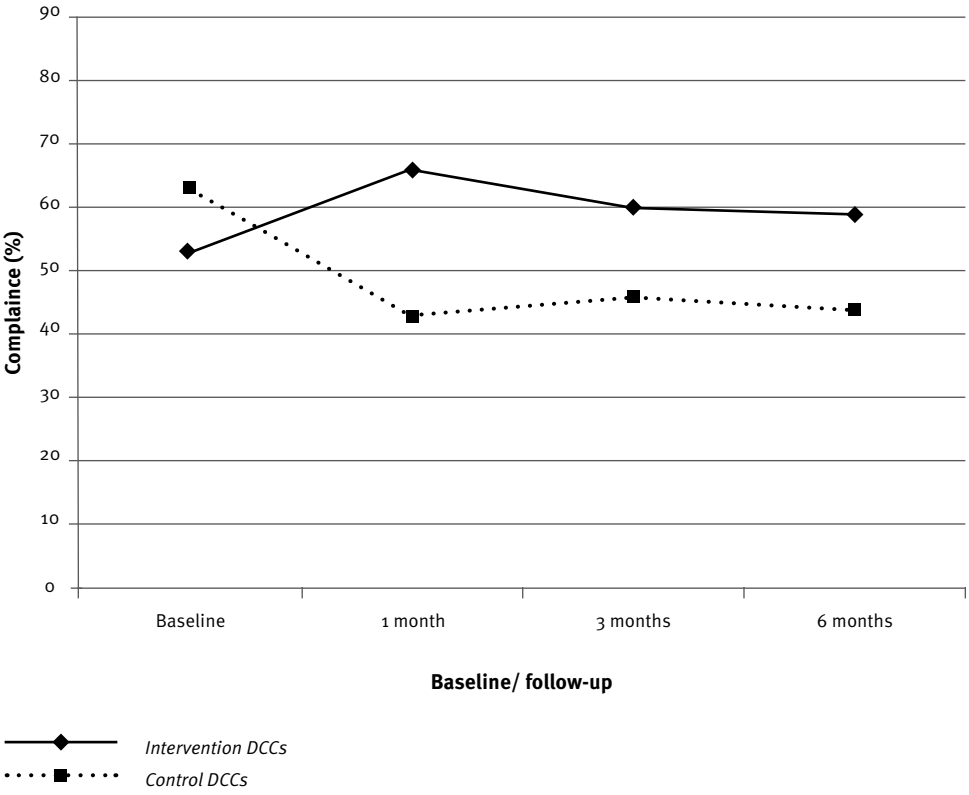

Table 1: Comparison of baseline characteristics of intervention and control day care centres (DCCs)

DCC characteristics	Intervention DCCs (N=36)	Control DCCs (N=35)	P-value[#]
Size (large, having ≥46 children per day)	53%	51%	0.91
Degree of urbanicity			0.84
Highly urban	58%	63%	
Urban	22%	23%	
Slightly/non-urban	19%	14%	
Region			0.47
Rotterdam-Rijnmond	67%	66%	
Gouda	14%	6%	
Leiden	19%	29%	
HKZ certification (certified)	44%	41%	0.83
Type of group*			0.03
0 and 1 year olds	21%	31%	
2 and 3 year olds	13%	24%	
0 to 4 year olds	67%	44%	
Number of towel facilities for caregivers per group*	1.63	1.54	0.68[##]
Type of towel facilities for caregivers on the group*			0.14
Only paper towels	25%	35%	
Only fabric towels	44%	48%	
Both fabric and paper towels	31%	17%	
Number of soap facilities for caregivers per group*	1.55	1.52	0.90[##]
Type of soap facilities for caregivers on the group*			0.66
Only soap dispensers	14%	11%	
Only soap pumps	70%	77%	
Soap dispensers combined with soap pumps	16%	12%	
Alcohol-based hand sanitizer for caregivers on the group (available)*	67%	59%	0.30
Number of towel facilities for children per group**	0.98	1.00	1.00
Type of towel facilities for children on the group**			1.00
Only paper towels	46%	46%	
Only fabric towels	44%	44%	
No towel facilities in reach of children	11%	10%	
Number of soap facilities for children per group**	0.84	0.75	0.62[##]
Type of soap facilities for children on the group**			0.20
Only soap dispensers	42%	25%	
Only soap pumps	35%	48%	
No soap facilities in reach of children	23%	27%	
Number of children per caregiver***	5.2	5.1	0.63[###]

** N=72 intervention groups and 70 control groups. ** N=57 intervention groups and 48 control groups (groups with children aged 0-2 years were excluded). *** N=105 intervention caregivers and 102 control caregivers. [#] Estimated with Chi squared test or Fisher's exact test. [##] Estimated with poisson regression. [###] Estimated with independent T-test*

Table 2: Effect of the intervention on compliance with hand hygiene (HH) guidelines in child day care centres (DCCs) during total follow-up and at one, three and six months after intervention start

Compliance*	Intervention DCCs		Control DCCs		OR** (95% CI)	Baseline-corrected OR** (95% CI)
Baseline	53%	(331/623)	63%	(353/564)	0.59 (0.37-0.94)	
Total follow-up	62%	(1243/2005)	44%	(812/1850)	2.73 (1.92-3.87)	
OR** (95% CI)	2.03	(1.49-2.76)	0.44	(0.32-0.60)		4.65 (2.99-7.25)
Baseline	53%	(331/623)	63%	(353/564)	0.60 (0.38-0.95)	
1 month follow-up	66%	(459/692)	43%	(273/640)	3.79 (2.41-5.95)	
OR** (95% CI)	2.57	(1.77-3.73)	0.41	(0.28-0.60)		6.33 (3.71-10.80)
Baseline	53%	(331/623)	63%	(353/564)	0.61 (0.38-0.97)	
3 months follow-up	60%	(392/649)	46%	(273/600)	2.48 (1.56-3.94)	
OR** (95% CI)	1.80	(1.23-2.62)	0.44	(0.30-0.65)		4.08 (2.37-7.02)
Baseline	53%	(331/623)	63%	(353/564)	0.60 (0.36-1.00)	
6 months follow-up	59%	(392/664)	44%	(266/610)	2.48 (1.48-4.15)	
OR** (95% CI)	1.77	(1.19-2.63)	0.43	(0.28-0.65)		4.13 (2.33-7.32)

** Calculated by dividing the number of HH actions by HH opportunities*

*** All ORs are corrected for the type of activities for which HH was indicated, clustering of the data within DCCs and within caregivers, and group type (i.e. 0/1, 2/3 and 0 to 4 years old)*

Compliance at baseline was significantly different between intervention and control DCCs (respectively 53% versus 63%; OR 0.59; 95% CI 0.37-0.94) *(Table 2)*. In intervention DDCs, compliance increased from 53% during baseline to 62% during total follow-up *(Table 2)*. Correcting for type of activity for which HH was indicated, group type, and clustering of the data within caregivers and within DCCs, the OR was 2.03 (95% CI 1.49-2.76). In control DCCs, compliance decreased from 63% during baseline to 44% during total follow up (OR 0.44; 95% CI 0.32-0.60). Comparison of these two ORs resulted in a baseline corrected OR of 4.65 (95% CI 2.99-7.25). One month after the start of the intervention, the baseline corrected OR was 6.33 (95% CI 3.71-10.80). Three months after the start of the intervention, this was 4.08 (95% CI 2.37-7.02). Six months after the intervention start, this was 4.13 (95% CI 2.33-7.32).

Table 3: Effect of the intervention on caregivers' compliance with each of the specific activities for which hand hygiene (HH) was indicated outlined in the Dutch national guidelines for child day care centres (DCCs), at six months after intervention start

	Intervention DCCs		
	Compliance (%)	Number of HH opportunities (n)	
Overall compliance caregivers	**59**	**(664)**	
Eating/food handling	39	(196)	
Before food handling	51	(111)	
Before caregivers themselves ate	19	(26)	
Before caregivers assisted children with eating	25	(59)	
Toilet/diapering	73	(322)	
After changing a diaper with faeces	94	(77)	
After changing a wet diaper when child was lying down	69	(144)	
After changing a wet diaper when child was standing	56	(79)	
After wiping buttocks when assisting children with toilet use	82	(22)	
Contact with body fluids	55	(105)	
After caregivers coughed/sneezed/wiped their own nose	42	(24)	
After contact with body fluids	60	(75)	
Before wound care	33	(3)	
After wound care	67	(3)	
After visibly soiled hands	59	(41)	

** Difference between intervention and control DCCs at six months follow-up minus the difference at baseline*

*** Interaction effect of intervention status of the DCC and baseline/follow-up measurement corrected for group type (i.e. 0/1, 2/3 and 0 to 4 years old), and clustering of the data within caregivers and within DCCs*

N.A., Not applicable (numbers are too small to give a reliable estimate as activities occurred ≤ 5 times)

Comparison of the different types of activities for which HH was indicated showed that at six months follow-up there was a significant increase in HH compliance (taking into account baseline) after toilet and diapering activities (OR 4.49; 95% CI 2.23-9.05) and after contact with body fluids (OR 4.88; 95% CI 1.77-13.44) *(Table 3)*. Among toilet and diapering activities, the largest baseline-corrected difference in HH compliance between intervention and control DCCs was 46%, after changing a wet diaper when a child was standing. Among activities with body fluid contact, the largest baseline-corrected difference was 47%, after caregivers coughed/sneezed/wiped their own nose *(Table 3)*. The increases in caregivers' HH compliance before eating and food handling activities and after visibly soiled hands were not significant *(Table 3)*.

Control DCCs						
	Compliance (%)	Number of HH opportunities (n)	Difference	Baseline corrected difference*	Baseline corrected OR**	
			%	%	OR	95% CI
44	**(610)**	**15**	**25**	**4.13**	**2.33-7.32**	
24	(164)	15	14	1.95	0.76-5.00	
29	(83)	22	25			
20	(35)	-1	8			
20	(46)	5	-19			
57	(272)	16	28	4.49	2.23-9.05	
80	(71)	14	20			
56	(127)	13	26			
31	(65)	25	46			
78	(9)	4	-6			
38	(127)	17	35	4.88	1.77-13.44	
23	(22)	19	47			
39	(99)	21	39			
33	(3)	N.A.	N.A.			
100	(3)	N.A.	N.A.			
49	(47)	10	11	2.11	0.13-34.22	

Discussion

This is the first HH intervention in DCCs developed according to a stepwise behavioural approach targeting the underlying determinants of caregivers' compliance with HH guidelines. To our knowledge, this is also the first study to assess HH compliance of caregivers as primary outcome measure. This study demonstrates that our HH intervention for DCCs is effective in improving caregivers' compliance with HH guidelines. In addition, the intervention was well implemented with high exposure to the different intervention components.

Most HH intervention studies in DCCs report as outcome measure the incidence of gastrointestinal and/or respiratory infections in children, or absences of caregivers/children due to illness.[11-18] A review showed that the effect of these interventions on incidence/absence varies.[19] HH compliance is a more proximal outcome measure to evaluate the effect of a HH intervention. Incidence of infections can be influenced by many other factors besides caregivers' HH, such as cleaning activities and hygiene at home.

There are few studies to compare our results with. One other DCC intervention study assessed observed HH compliance of caregivers as outcome measure, although no comparison with control DCCs was reported.[16] The study reports that after training, caregivers' HH improved after diapering and after contact with mucus, saliva, vomit etc. of children.[16] In our study, HH also improved after toilet and diapering activities and after contact with body fluids. No effect was found on HH compliance before eating and food handling activities. Therefore, intervention studies for improving HH compliance in DCCs should pay special attention to these activities.

Another intervention study assessed children's HH behaviour.[12] At six months follow-up, the adjusted RR for HH before lunch was 2.93 (95% CI 1.86-6.97) and after bathroom use it was 3.30 (95% CI 1.83-16.67).[12] In two other studies, only compliance of children in intervention DCCs or at follow-up was reported, and no information was given on compliance in control DCCs or at baseline.[14, 15, 18] Our intervention primarily focused on caregivers and was developed based on determinants of caregivers' HH behaviour and not children's HH behaviour. Besides the posters and stickers, our intervention did not include components specifically targeting children (e.g. hand washing songs). Because determinants of children's HH might be different from determinants of caregivers' HH, studies are needed to assess these in order to develop effective interventions aiming to increase children's HH.

Despite randomisation, caregivers' HH compliance at baseline was significantly higher in control DCCs compared to intervention DCCs. At baseline the incidence of gastrointestinal infections was also higher in control DCCs versus intervention DCCs, but decreased during follow-up (paper in print Epidemiology and Infection). This might explain the difference in HH compliance at baseline, as our previous qualitative study showed that caregivers usually increase their HH when observing diarrhoea among the children (unpublished data). Because of the baseline difference, we report results uncorrected as well as corrected for baseline compliance. Compliance during follow-up in intervention DCCs was significantly higher than in control DCCs, both corrected and uncorrected for baseline. One year prior to the intervention start, we assessed caregivers' HH compliance in DCCs and showed that the overall compliance was 42%.[10] Although compliance was higher at baseline in both

intervention and control DCCs (respectively 53% and 63%), compliance in control DCCs during follow-up was similar, with little variation over time (43% at T1, 46% at T3 and 44% at T6). Baseline measurement thus seems to be an outlier, which might be explained by the mentioned high incidence of gastrointestinal infections or by the fact that participating DCCs received information regarding their HH compliance six months prior to intervention start.

A strength of our study is that besides overall compliance, the compliance for each of the specific HH indications is also reported. Furthermore, our intervention had multiple components, addressing environmental and sociocognitive determinants of HH. Moreover, exposure to the different intervention components was high, except for the hand cream dispensers that were delivered halfway through the intervention period. Other strengths of the study are the randomised controlled design, the high inter-rater reliability among observers, and the large sample size of 71 participating DCCs and 795 observed caregivers. In addition, control DCCs also received the intervention after data collection, which probably facilitated DCC recruitment and minimised loss to follow-up.[12]

A possible limitation of our study is the Hawthorne effect; caregivers might change their behaviour when they know they are being observed.[26] Although this bias could not be entirely prevented, it was minimised by informing caregivers that the focus of the study was on hygiene in general, not specifically mentioning HH. Furthermore, repeated exposure to observations could make caregivers less sensitive to adapting their behaviour during observations.[25] Nevertheless, we would expect the Hawthorne effect to be more pronounced in intervention DCCs than in control DCCs, as being exposed to the intervention made it more likely for caregivers to know the purpose of the observations. The intervention effect might then be an overestimation of the true effect size. The incidence of gastrointestinal and respiratory infections in children attending DCCs (which we report separately) would then be a more objective outcome measure. Another possible limitation is that observers might have recognised the intervention status of the DCC, which could have biased data collection. Furthermore, the participating DCCs also participated in our previous study on determinants of HH behaviour, for which they received information regarding their HH compliance six months prior to intervention start. Therefore, the intervention effect might be an underestimation of the true effect size.

In conclusion, this study shows that our intervention addressing determinants that underlie caregivers' HH behaviour is effective in improving caregivers' HH compliance in DCCs. Therefore, dissemination of the intervention in other DCCs can be considered (especially when determinants of HH behaviour are similar). DCCs can then implement the intervention to distinguish themselves from a quality perspective from other DCCs. More studies are needed to assess the duration of the intervention effect beyond six months and to assess which components of the intervention are most effective in order to recommend on e.g. yearly repetition of certain intervention components.

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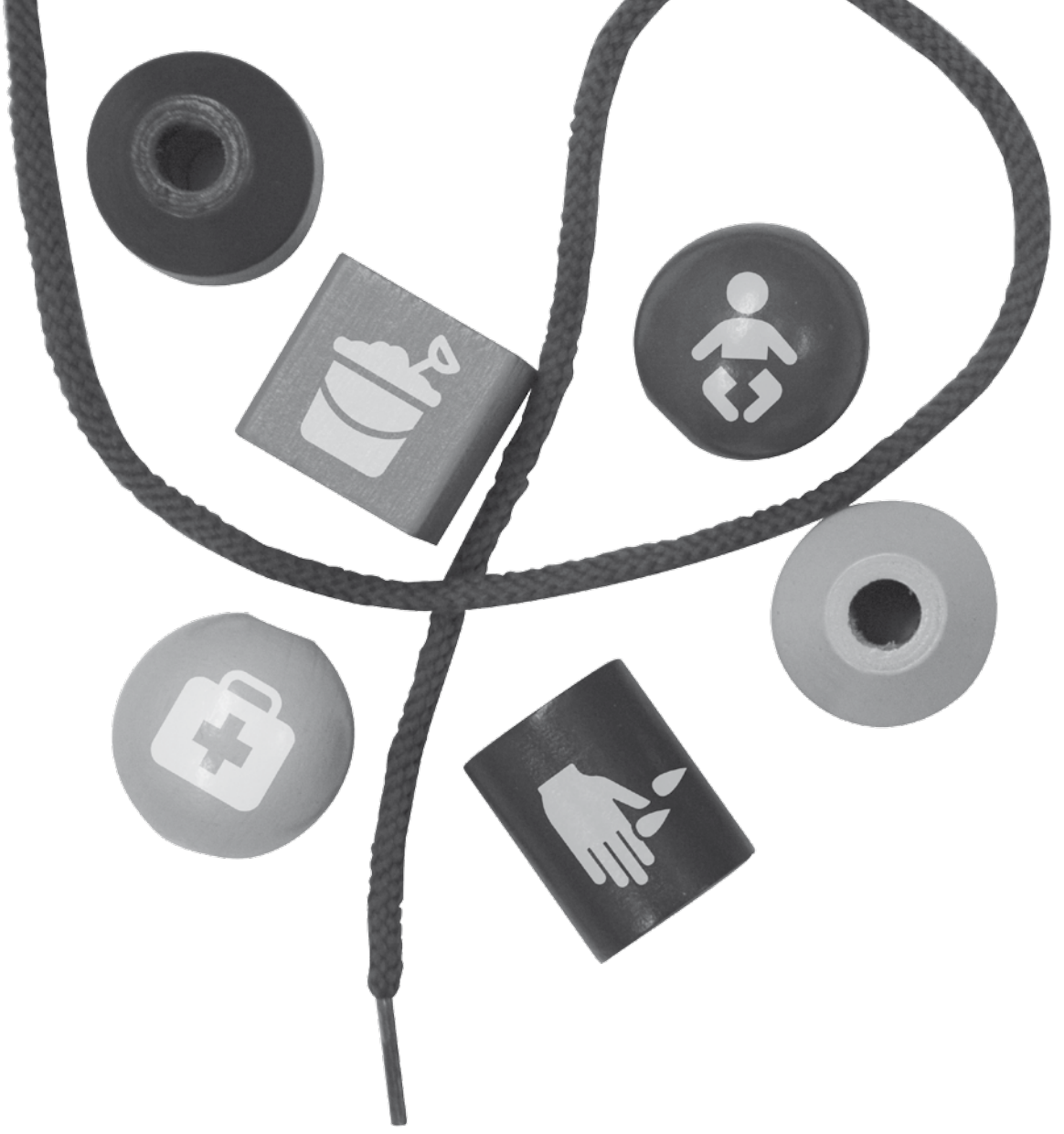

Chapter 6

A hand hygiene intervention to reduce infections in child day care: a randomized controlled trial

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Abstract

Infections are common among children attending day care centres (DCCs). We evaluated the effect of a hand hygiene (HH) intervention for caregivers on the incidence of gastrointestinal and respiratory infections in children. The intervention was evaluated in a two-arm cluster randomized controlled trial. Thirty-six DCCs received the intervention including HH products, training sessions, and posters/stickers. Thirty-five control DCCs continued usual practice. Incidence of episodes of diarrhoea and the common cold in children was monitored by parents during six months. Using multilevel Poisson regression, incidence rate ratio's (IRR) with 95% confidence intervals (CI) were obtained. Diarrhoeal incidence was monitored in 545 children among 91937 days. During follow-up, the incidence was 3.0 episodes per child-year in intervention DCCs versus 3.4 in control DCCs (IRR 0.90; 95%CI 0.73-1.11). Incidence of the common cold was monitored in 541 children among 91373 days. During follow-up, the incidence was 8.2 episodes per child-year in intervention DCCs versus 7.4 in control DCCs (IRR 1.07 95%CI 0.97-1.19). In this study, no evidence for an effect of the intervention was demonstrated on the incidence of episodes of diarrhoea and the common cold.

Introduction

Children attending day care centres (DCCs) acquire gastrointestinal and respiratory infections more often than children cared for at home.[1, 2] Hand hygiene (HH) is considered to be a simple and effective measure to prevent infections.[3, 4] However, in DCCs caregivers' compliance with HH guidelines is low.[5]

Although several HH interventions have been developed to reduce DCC-related infections,[6-14] inconsistent results on their effectiveness have been reported.[15] Moreover, these interventions did not report to be developed according to a stepwise behavioural approach using models and theories from the behavioural sciences to understand the determinants that underlie HH behaviour.[16] Our previous research showed that environmental determinants, such as the availability of paper towels, are associated with caregivers' HH compliance in DCCs.[5] In addition, we found that the following sociocognitive determinants are associated with HH compliance of DCC caregivers: knowledge and awareness of HH guidelines, perceived importance of performing HH, perceived behavioural control (i.e. perceived ease or difficulty of performing the behaviour), and habit.[17] Interventions aiming to improve caregivers' HH compliance in DCCs are more likely to be successful when addressing these determinants. We therefore developed an intervention based on these sociocognitive and environmental determinants of caregivers' HH behaviour. The aim of the intervention was to increase caregivers' compliance with HH guidelines (primary outcome measure) and reduce infections in children (secondary outcome measure). Due to the intervention, caregivers' compliance with HH guidelines improved. Compliance was defined as the number of HH actions divided by the total number of opportunities for which HH was indicated. According to the Dutch national guidelines, HH was mandatory for caregivers before touching/preparing food, before caregivers themselves ate or assisted children with eating, and before wound care; and after diapering, after toilet use/wiping buttocks, after caregivers themselves coughed/sneezed/wiped their own nose, after contact with body fluids (e.g. saliva, vomit, urine, blood, or mucus when wiping children's noses), after wound care, and after hands were visibly soiled.[18] HH compliance was observed at one, three and six months follow-up. At six months follow-up, caregivers' HH compliance in intervention DCCs was 59% versus 44% in control DCCs (baseline corrected OR 4.13; 95% CI 2.33-7.32).[19]
The effect of our intervention on HH compliance is described elsewhere.[19] In this paper we assess the effect of our intervention on incidence of gastrointestinal and respiratory infections in children attending DCCs.

Methods

A cluster randomized controlled trial of a HH intervention was performed among DCCs in the regions of Rotterdam-Rijnmond, Gouda and Leiden in the Netherlands between September 2011 and April 2012. DCCs were randomized, stratified for size and urbanicity.[20] DCCs which participated in our previous study on HH determinants[5, 17], were contacted to participate in the trial.

The intervention consisted of four components.[20] First, the following HH products were provided free of charge: dispensers for paper towels, soap, alcohol-based hand sanitizer and hand cream, with refills for six months. Second, training about the Dutch national HH guidelines was given and a booklet outlining the content of the training was distributed. Third, two team training sessions were given aimed at goal setting and formulating specific HH improvement activities. The team training sessions were based on similar HH training sessions developed for Dutch hospitals.[21, 22] Fourth, posters and stickers for both caregivers and children were provided as reminders and cues to action. Two groups in each DCC participated in the study. In intervention DCCs, these groups received the HH products. As caregivers rotated between groups, all caregivers received the training sessions. The intervention was implemented in four phases (HH products at start, three training sessions with one month interval). Intervention DCCs were compared to control DCCs which continued usual practice.

The outcome measure was incidence of gastrointestinal and respiratory infections in children monitored by parents. Parents were enrolled in the trial between 1st of August 2011 and 1st of November 2011. Baseline measurement was collected between mid-September 2011 until 1st of November 2011; starting when parents were enrolled and ending when the intervention started. Follow-up measurement was from the 1st of November 2011 until the end of March 2012. Children were recruited from two groups of the DCC, even if the DCC had more than two groups in total. In that case, in both intervention and control DCCs the researchers in collaboration with the managers of the DCCs randomly selected two groups. Parents were recruited from 142 groups, of a total of 297 groups (48%). Children were eligible to participate if they: attended the DCC at least two days a week; were between six months and 3.5 years of age at start of the trial; intended to attend the DCC throughout the study period; and if their parents consented, were Dutch speaking, and had access to email or regular post. Children were excluded if they had a chronic illness or medication that predisposed them to infection, a sibling taking part in the trial (i.e. one child per family could be included), or if they started attending the DCC after start of the trial.

Parents were asked to monitor disease incidence in their child using an infection calendar to mark the days their child had diarrhoea and/or a common cold. Diarrhoea was defined as at least two watery or unusually loose stools in 24 hours. The common cold was defined as a blocked or runny nose with at least one of the following symptoms: coughing, sneezing, fever, sore throat, or earache. Every two weeks, parents were contacted by email and regular post to enter the calendar page in an online version of the calendar or to send it in using a free-of-charge return envelope. Parents who did not respond were reminded after one week (email), two weeks (letter), and three weeks (telephone). Sample size calculation showed that to be able to detect 25% reduction in incidence of gastrointestinal infections of three per

year and 15% reduction in incidence of respiratory infections of nine per year, we would need disease monitoring of 600 children for six months (80% power, two-sided alpha of 0.05).[20]

In order to interpret results we assessed exposure to the intervention. We observed whether the intervention dispensers and posters/stickers were in use at six months follow-up. In addition, a survey was conducted among caregivers.

Data were analysed using SPSS version 19 (SPSS Inc, Chicago, IL) and R version 2.12.2. Analyses were performed according to the intention-to-treat principle, i.e. including all intervention DCCs irrespective of whether they used the HH products, posters/stickers or obtained all training sessions. First, baseline characteristics were compared using chi-squared test or Fisher's exact test for categorical variables and independent t-test for continuous variables. Second, the incidence of diarrhoea and the common cold was calculated during baseline and follow-up in intervention and control DCCs. Incidence was defined as the number of disease episodes per child-year. A new disease episode was defined after seven symptom-free days and in additional analyses after three symptom-free days.[9] Episodes of illness which started on the first day parents started monitoring disease incidence were excluded.

Multilevel Poisson regression analyses were performed to correct for clustering of the data within DCCs. Incidence risk ratio's (IRR) with 95% confidence intervals (CI) were obtained for the intervention effect, corrected for DCC group type (0 and 1 year olds, 2 and 3 year olds, 0 to 4 year olds), as this was the only possible confounder that showed to be significantly different between intervention and control DCCs/children at baseline. Besides overall incidence, incidence was calculated stratified for children aged 0/1 years old and 2/3 years old. Tests for overdispersion were performed, but no corrections were necessary.

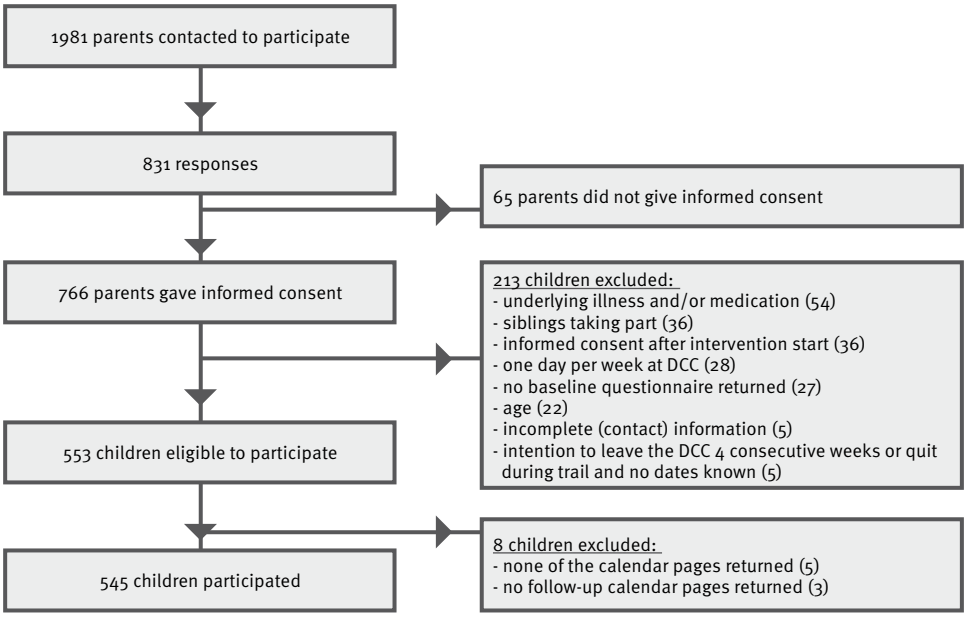
Additional analyses were performed to correct for baseline measurement. For this we calculated the interaction between intervention status of the DCC (i.e. intervention versus control) and follow-up measurement (i.e. baseline versus follow-up). This resulted in an IRR for the difference between baseline and follow-up measurement in intervention DCCs and an IRR for the difference between baseline and follow-up in control DCCs. Comparison of these two IRRs resulted in a baseline corrected IRR.

Ethical approval was waived by the Medical Ethics Committee of the Erasmus University Medical Centre in Rotterdam (MEC-2011-256).

Results

In the trial 71 DCCs participated. After randomisation, there were 36 intervention DCCs and 35 control DCCs. Of 1981 parents which were invited to participate, 766 gave informed consent for their child (response rate 39%) *(Figure 1)*. Of 766 children, 553 were eligible for inclusion. Of 553 children, five parents did not return any of the calendar pages with incidence data and three parents did not return any pages during follow-up, therefore 545 children were included in the analyses. For 19 of 545 children, baseline incidence data were missing.

Figure 1: Flow diagram of the recruitment of children in 71 child day care centres (DCCs)



Of 545 children, 278 (51%) were in 34 intervention DCCs and 267 (49%) in 35 control DCCs. The median number of participating children per DCC was seven (range 1-18). Of 545 parents, 94% returned 12 or more of 14 calendar pages. Comparison of baseline characteristics demonstrated that the group type significantly differed between intervention and control DCCs *(Table 1)*. This variable was therefore included in further analyses as a possible confounder. None of the other baseline characteristics were significantly different between intervention and control DCCs and children *(Table 1)*.

Intervention exposure

All 36 intervention DDCs received the training on HH guidelines and all, but two, received at least one of the team training sessions. Another two intervention DCCs did not use any of the provided HH products. The response rate to the questionnaire on intervention exposure was 50% (274/546). Of 274 caregivers, 79% attended at least one of the training sessions.

Table 1: Comparison of baseline characteristics of intervention and control day care centres (DCCs) and children

DCC characteristics	Intervention DCCs (N=36)	Control DCCs (N=35)	p-value
Size (large, having ≥46 children per day)	53%	51%	0.91
Degree of urbanicity			0.84
Highly urban	58%	63%	
Urban	22%	23%	
Slightly/non-urban	19%	14%	
Region			0.47
Rotterdam-Rijnmond	67%	66%	
Gouda	14%	6%	
Leiden	19%	29%	
Hygiene and quality certification (certified)	44%	41%	0.83

Child characteristics	Intervention children (N=278)	Control children (N=267)	p-value
Gender (boys)	51%	54%	0.43
Age at start of trial (mean)	1.5 years	1.6 years	0.53
Children eating solid foods	98%	97%	0.74
Children solely breastfed at start of trial	0%	2%	0.056
Children ever breastfed	76%	79%	0.32
Number of days per week at the DCC (mean)	2.7 days	2.7 days	0.70
Children with siblings	56%	63%	0.09
Children with siblings at the DCC	25%	26%	0.65
Children that started attending the DCC in the three months before trial start	3%	3%	0.96
Children in a single parent household	7%	9%	0.43
DCC group type			<0.001
0 and 1 year olds	16%	18%	
2 and 3 year olds	14%	32%	
0 to 4 year olds	70%	50%	

The information booklet on HH guidelines was received by 77% of caregivers. At six months follow-up, the dispensers for paper towels, soap, alcohol-based hand sanitizer and hand cream were used in at least one of two groups in respectively 94%, 89%, 86%, and 45% of intervention DCCs. Moreover, in 86% the posters were used and in 74% the stickers.

Incidence of episodes of diarrhoea and the common cold

Incidence of episodes of diarrhoea was monitored in 545 children during 91937 days. Incidence of episodes of the common cold was monitored in 541 children during 91373 days. Of 545 children, four children were excluded from analyses because they had the common cold every day during the trial. *Figure 2* shows the incidence of episodes of diarrhoea and the common cold in intervention and control DCCs over time; the crude incidence of diarrhoeal episodes differed between intervention and control DCCs at baseline, while during follow-up it was similar. Concerning the crude incidence of episodes of the common cold, at baseline as well as follow-up this was similar for intervention and control DCCs (except for November).

When defining a new episode of diarrhoea after seven symptom-free days, the incidence in intervention DCCs at baseline was 3.0 diarrhoeal episodes per child-year versus 5.1 in control DCCs *(Table 2)*. Corrected for group type and clustering of the data within DCCs, this difference was statistically significant (IRR 0.57, 95% CI 0.38-0.85). During follow-up there were 3.0 diarrhoeal episodes per child-year in intervention DCCs versus 3.4 in control DCCs (IRR 0.90, 95% CI 0.73-1.11). The baseline corrected IRR was 1.58 (95% CI 1.05-2.36). Additional analyses stratified by age, showed similar results during follow-up for children aged 0/1 year old (IRR 0.97, 95% CI 0.75-1.26; baseline corrected IRR 1.82, 95% CI 1.08-3.08) and children aged 2/3 years old (IRR 0.83, 95% CI 0.63-1.09; baseline corrected IRR 1.29, 95% CI 0.68-2.43) (results not shown in table). Analyses with a new disease episode defined after three symptom-free days, showed that uncorrected for baseline incidence there were slightly fewer episodes of diarrhoea in intervention versus control DCCs (IRR 0.81, 95% CI 0.63-1.05; p=0.07) *(Table 2)*.

When defining a new episode of the common cold after seven symptom-free days, the incidence in intervention DCCs at baseline was 9.8 episodes of the common cold per child-year versus 9.2 in control DCCs (IRR 1.06, 95% CI 0.85-1.34) *(Table 3)*. During follow-up there were 8.2 episodes of the common cold in intervention DCCs versus 7.4 in control DCCs (IRR 1.07, 95% CI 0.97-1.19; baseline corrected IRR 1.01, 0.79-1.29). Additional analyses stratified by age, showed similar results during follow-up for children aged zero or one year old (IRR 1.07, 95% CI 0.93-1.22; baseline corrected IRR 1.13, 95% CI 0.80-1.61) and children aged two or three years old (IRR 1.10, 95% CI 0.95-1.27; baseline corrected IRR 0.90, 95% CI 0.63-1.28) (results not shown in table). Analyses with a new disease episode defined after three symptom-free days, showed similar results as analyses with a new disease episode after seven symptom-free days (IRR 1.04, 95% CI 0.95-1.13; baseline corrected IRR 1.05, 95% CI 0.84-1.33) *(Table 3)*.

Figure 2: Effect of a hand hygiene intervention on incidence of episodes of diarrhoea and the common cold among children attending day care centres (DCCs)

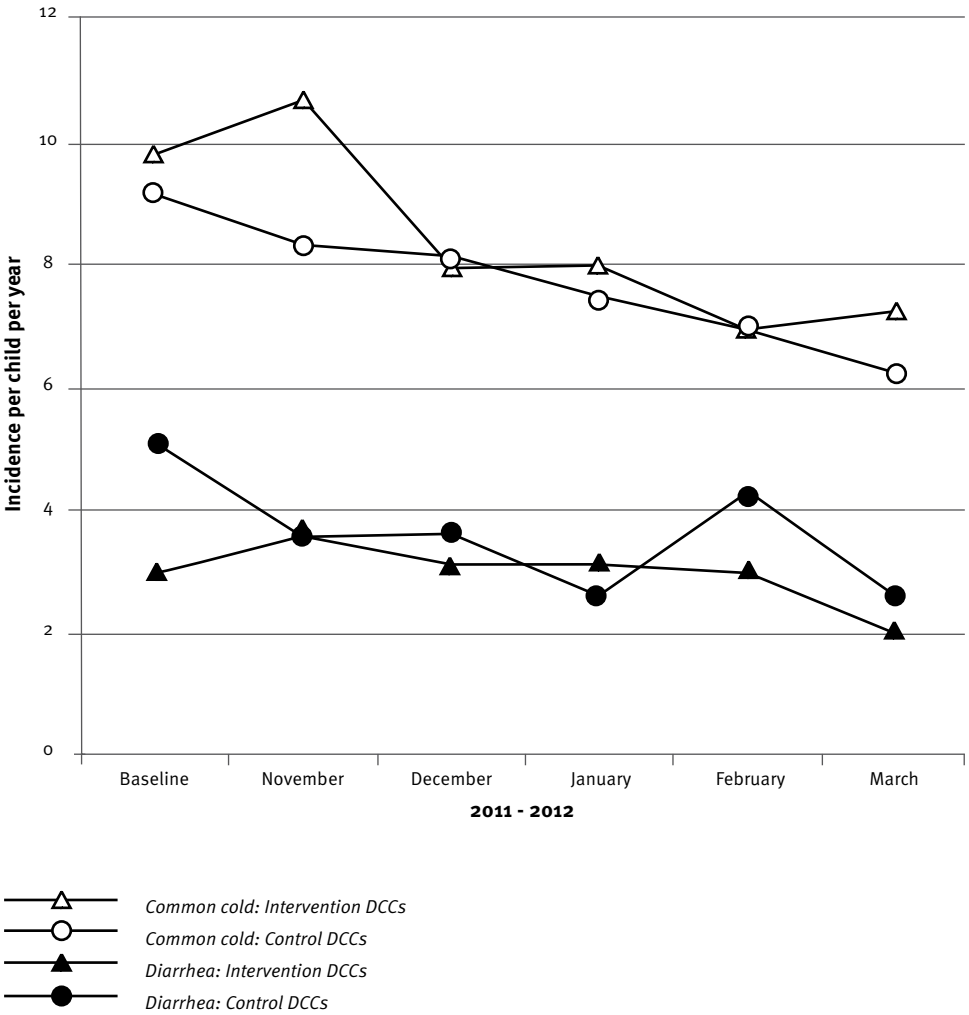


Table 2: Effect of a hand hygiene intervention on incidence of episodes of diarrhoea among children attending day care centres (DDCs) (N=545)

		Intervention DCCs
7 symptom-free days between episodes	Baseline incidence**	3.0 (42/5042)
	Follow-up incidence**	3.0 (336/40564)
	IRR* (95% CI)	1.06 (0.76-1.48)
3 symptom-free days between episodes	Baseline incidence**	3.2 (44/ 5042)
	Follow-up incidence**	3.3 (370/ 40564)
	IRR* (95% CI)	1.11 (0.77-1.60)

IRR = incidence risk ratio

**Also corrected for clustering of the data within DCCs and group type*

***Incidence of episodes per year (i.e. no. of episodes/no. of days at risk)*

Table 3: Effect of a hand hygiene intervention on incidence of episodes of the common cold among children attending day care centres (DDCs) (N=541)

		Intervention DCCs
7 symptom-free days between episodes	Baseline incidence**	9.8 (132/ 4914)
	Follow-up incidence**	8.2 (904/ 40354)
	IRR* (95% CI)	0.83 (0.69-1.00)
3 symptom-free days between episodes	Baseline incidence**	11.1 (194/ 4914)
	Follow-up incidence**	9.5 (1048/ 40354)
	IRR* (95% CI)	0.86 (0.72-1.02)

IRR = incidence risk ratio

**Also corrected for clustering of the data within DCCs and group type*

***Incidence of episodes per year (i.e. no. of episodes/no. of days at risk)*

	Control DCCs	IRR* (95% CI)	p-value
	5.1 (100/7170)	0.57 (0.38-0.85)	0.006
	3.4 (361/39161)	0.90 (0.73-1.11)	0.32
	0.67 (0.54-0.84)	1.58 (1.05-2.36)	0.03
	5.7 (112/ 7170)	0.53 (0.34-0.83)	0.002
	4.1 (435/ 39161)	0.81 (0.63-1.05)	0.07
	0.72 (0.57-0.92)	1.53 (1.00-2.36)	0.03

	Control DCCs	IRR* (95% CI)	p-value
	9.2 (178/ 7096)	1.06 (0.85-1.34)	0.60
	7.4 (794/ 39009)	1.07 (0.97-1.19)	0.15
	0.82 (0.70-0.97)	1.01 (0.79-1.29)	0.94
	11.1 (216/ 7096)	0.98 (0.80-1.21)	0.87
	8.9 (955/ 39009)	1.04 (0.95-1.13)	0.44
	0.81 (0.70-0.94)	1.05 (0.84-1.33)	0.65

Discussion

This is the first HH intervention in DCCs developed according to a stepwise behavioural approach targeting the underlying determinants of caregivers' compliance with HH guidelines. The study objective was to evaluate the effect of the intervention on the incidence of episodes of diarrhoea and the common cold in children attending DCCs. During follow-up, there were less episodes of diarrhoea in intervention DCCs versus control DCCs. However, this difference was not statistically significant and corrected for baseline the effect changed direction, with significantly more diarrhoeal episodes in intervention DCCs. This was primarily influenced by an unexplainable high baseline incidence in control DCCs. No effect of the intervention was shown on the incidence of episodes of the common cold.

Our study has several strengths. This is the first HH intervention in DCCs which was developed based on the underlying determinants of HH behaviour. In addition, this is one of few DCC intervention studies correcting for baseline incidence in multilevel analyses. Other strengths of the study are the randomized controlled design, a large sample size of 71 DCCs, high exposure to intervention components, and a high percentage of calendar pages returned among parents with few children lost to follow-up. In addition, control DCCs received the intervention after data collection, which probably facilitated DCC recruitment and also minimized loss to follow-up.[7]

Our study has several limitations. First, as the response of parents was initially limited, there were not enough children included when starting baseline measurement. Therefore, recruitment of parents continued during baseline measurement. As a result, the number of days that parents filled in the infection calendar during baseline varies. For four children, no baseline data were provided by the parents. Moreover, also the exact weeks that baseline data were collected vary between the children, which might lead to incomparable results due to different circulating pathogens. An additional complicating factor is that half of intervention DCCs, due to practical reasons, already received the training on HH guidelines while baseline measurement was still ongoing. For children of these DCCs, we censored the calendar days from the day of the training until official intervention start on the 1st of November 2011. As a result, more baseline data were collected in control DCCs versus intervention DCCs. The above mentioned limitations of the baseline measurement might partly explain the baseline difference between intervention and control DCCs in incidence of episodes of diarrhoea. Another limitation is that our study is under-powered. According to sample size calculations, we would have needed disease monitoring among 600 children for six months (109,200 child-days).[20] We monitored 545 children during five months follow-up, resulting in data on 79,725 child-days, which is 73% of the anticipated 109,200 child-days. Furthermore, the possible effect size of the intervention is probably smaller than what we assumed during sample size calculation. Other limitations are that the method to assess disease incidence was not validated and the relatively low response rate among parents of 39%. No information was obtained on parents not willing to participate. It might be that these parents have less interest in hygiene which could have influenced disease incidence at child DCCs and possibly also the intervention effect.

In the same trial we also assessed caregivers' HH compliance at baseline and follow-up, and found that HH compliance increased significantly in intervention versus control DCCs.[19] At baseline, compliance in intervention DCCs was 53% versus 63% in control DCCs (OR 0.59; 95% CI 0.37-0.94). At six months follow-up, compliance was 59% versus 44% (baseline corrected OR 4.13; 95% CI 2.33-7.32). Nevertheless, we could not demonstrate an effect of the intervention on incidence of episodes of diarrhoea and the common cold. This might partly be explained by the fact that on average the children attended the DCCs 2.7 days a week and children can also become infected outside the DCC. In the Netherlands it is common that at least one of the parents works part-time and therefore it is not surprising that the children only attend the DCC part-time. Another explanation could be that within DCCs other hygiene activities are also important for the prevention of disease transmission (i.e. cleaning toys, floors, furniture, toilets etc.). Furthermore, in our study the main focus was on caregivers' HH; besides posters and stickers for children, there were no other techniques to encourage children's HH, even though their HH might also be important to reduce infections in DCCs. Another possible explanation is that HH compliance did not improve enough in intervention DCCs to result in a reduction in infections, or that the difference in HH compliance between intervention and control DCCs was not large enough to detect differences in disease incidence. Possibly there is a critical threshold for HH compliance to result in a lower incidence of infections. A Dutch study on DCC-related disease burden, during the same time period as our intervention showed a peak in incidence of gastroenteritis in February 2012.[23] In our control DCCs there was the same increase in incidence, while this was not the case in intervention DCCs. Therefore, it might be that with an increase of infections, the intervention becomes more effective.

Our study shows the importance of baseline measurements in intervention studies, as baseline incidence of diarrhoeal episodes differed between intervention and control DCCs. There are few other DCC intervention studies which performed a baseline measurement.[6-8, 13] One of these studies performed analyses to assess whether the difference between baseline and follow-up was different for intervention versus control DCCs.[8] As we found a significant difference between intervention and control DCCs in diarrhoeal baseline incidence, we corrected the effect of the intervention for baseline incidence. This was done by adding an interaction term to assess whether the difference between baseline and follow-up was different for intervention versus control DCCs. By adding this interaction term, we were still able to also correct for group type and clustering of the data within DCCs. To our knowledge, this is the first study to perform this type of analysis. More DCC intervention studies are needed with baseline measurement.

Previous HH intervention studies in DCCs have shown varying effects on incidence of gastrointestinal and/or respiratory infections and/or illness absenteeism[15]. We found three randomized controlled trials with as outcome measure incidence of gastrointestinal and/or respiratory infections that corrected for clustering of the data.[6, 9, 10, 13] Gudnason et al. also reported a baseline measurement and similar to our study, did not demonstrate an effect of their intervention on incidence of diarrhoea and colds.[6] Roberts et al. reported a reduction in episodes of colds only among children aged 24 months and younger and a reduction in episodes of diarrhoea only among children aged over 24 months.[9, 10] However, in this study

no baseline incidence was reported. Therefore, it is possible that the difference between intervention and control DCCs was already present before start of the intervention. Carabin et al. report that their intervention reduced the incidence of upper respiratory tract infections.[13] However, similar to our study, they also report a reduction in incidence in control DCCs. Therefore, it is less likely that the incidence reduction in intervention DCCs is caused by the intervention. This indicates that there is limited evidence available that improved HH in DCCs is associated with fewer gastrointestinal and respiratory infections. More evidence is needed to understand the importance of hand hygiene in reducing gastrointestinal and respiratory infections in children attending DCCs.

In conclusion, this study shows that there is no evidence that our HH intervention - addressing determinants that underlie caregivers' HH behaviour - is effective in reducing gastrointestinal and respiratory infections among children attending DCCs. An explanation might be that HH compliance did not increase enough to result in fewer infections and/or that other transmission routes are also important, such as other hygiene/cleaning activities within the DCC as well as children's HH. Future intervention studies should target several transmission routes and be evaluated in robust studies including baseline measurement.

Acknowledgments

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Trail registration
Dutch trial registry: NTR3000.

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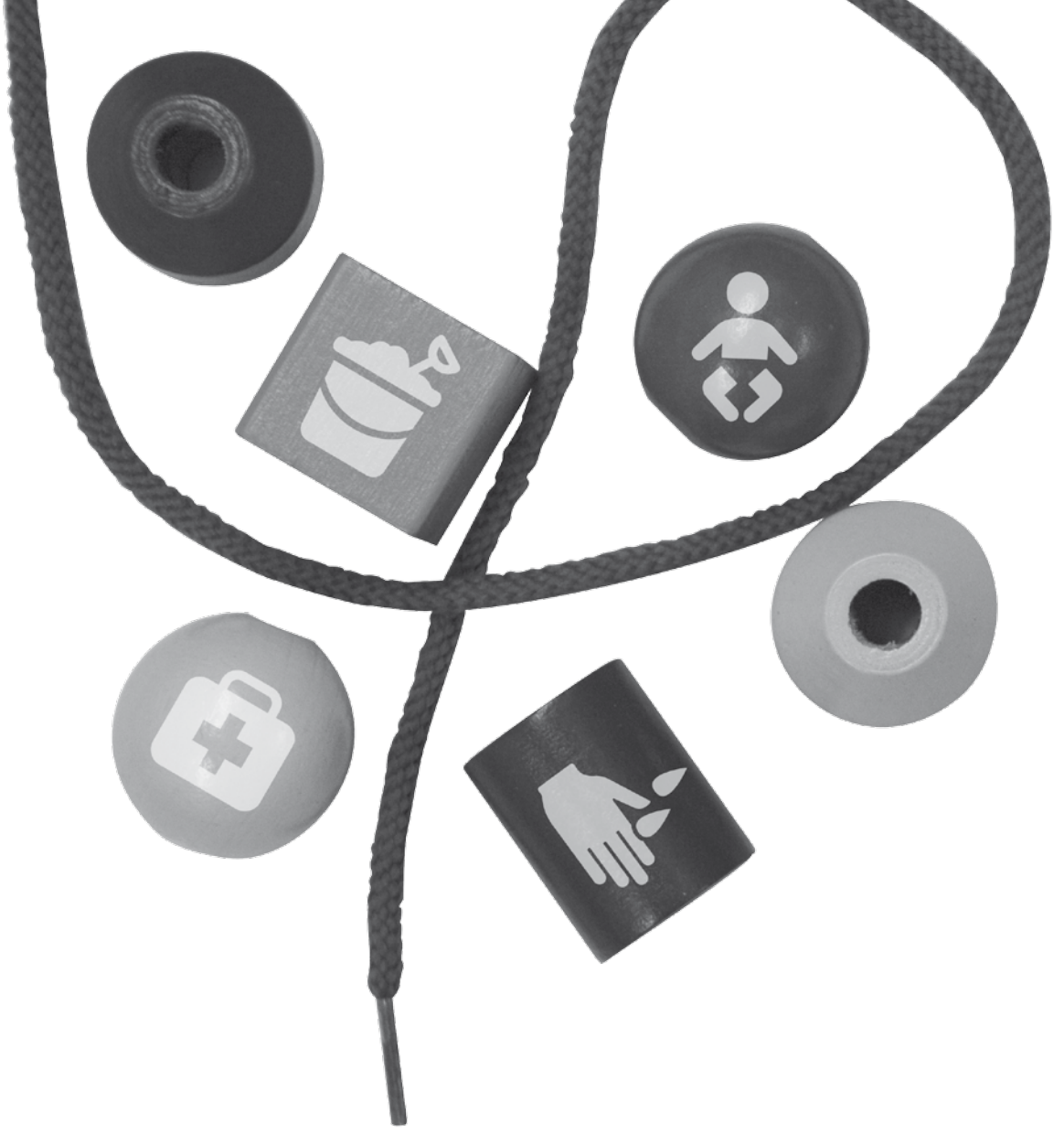

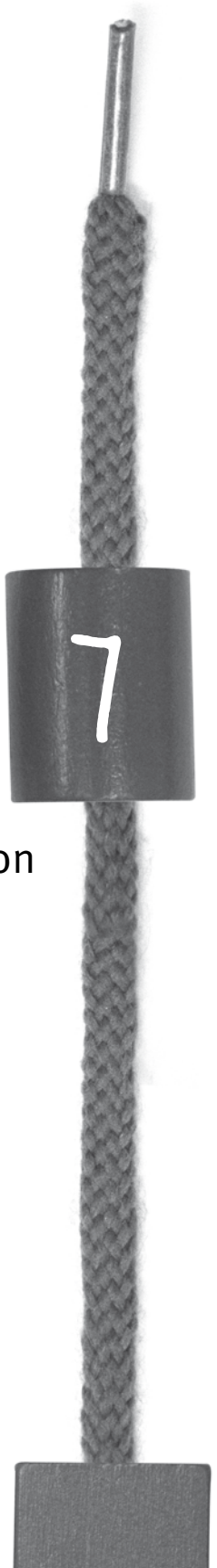

Chapter 7

General discussion

General discussion

The overall aim of this thesis is to develop and evaluate a hand hygiene intervention for infection control in child day care centres. In this final chapter, the research questions stated in the introduction are addressed using the results of the studies described in this thesis. This chapter concludes with implications for further research and recommendations for infection control in child day care centres.

7.1 Hand hygiene compliance and its determinants

How compliant are caregivers with hand hygiene guidelines in child day care centres, and what are the environmental and sociocognitive determinants of caregivers' hand hygiene behaviour?

7.1.1 Hand hygiene compliance

Overall observed hand hygiene compliance was 42%, indicating that in less than half of all hand hygiene opportunities hands were washed. Mean self-reported hand hygiene compliance was 8.7 on a scale from 0 (never) tot 10 (always).

Our study showed that there is room to improve hand hygiene compliance of caregivers in child day care centres and that self-reported hand hygiene compliance is an overestimation of observed compliance, i.e. caregivers think their hand hygiene is better than it actually is. When developing interventions this should be taken into account, to ensure caregivers do not think the intervention is unnecessary for them. A difference between observed and self-reported hand hygiene has also been seen in studies in the hospital setting[1, 2] and might be explained by response bias due to socially desirable responding. Another explanation might be that it is difficult for caregivers to estimate their own hand hygiene compliance, especially since they were filling in the questionnaire when they were on a break and relaxed, whereas they were observed during hectic busy times.[3]

A limitation of observational studies is observer bias or the Hawthorne effect, i.e. individuals might change their behaviour because of being observed.[4] Because the observers informed the caregivers that hygiene in general was observed without specifically mentioning hand hygiene, it is unlikely that caregivers changed their hand hygiene behaviour during the observations (some caregivers even voluntarily demonstrated their cleaning products). Moreover, because caregivers did not know precisely when hand hygiene was indicated, it is unlikely that compliance with hand hygiene guidelines increased during the observations, as hand hygiene actions not indicated according to the guidelines were not taken into account. Nevertheless, due to the Hawthorne effect the observed compliance with hand hygiene guidelines might be biased, possibly an overestimation of the true compliance.

The response rate among participating child day care centres was rather low (44%). Although no information was obtained on child day care centres that did not want to participate, it might be that these centres had less interest in hygiene and therefore possibly had a lower compliance with hand hygiene guidelines. Our observed hand hygiene compliance might then also be an overestimation. The true compliance rate in Dutch day care centres might thus be even lower than what we found in our study.

Although hand hygiene compliance has been assessed in several settings, this is one of the first studies to assess hand hygiene compliance of caregivers in child day care centres. An observational study in Brazil reported that caregivers washed their hands after diapering in 16% of occasions and after assisting children to clean themselves after defecation in 16% to 19% of occasions.[5] We found higher frequencies of hand hygiene after diapering (range 22-79%) and assisting a child with toilet use/wiping buttocks (55%). The difference might be explained by different definitions of correct hand hygiene and observational methods, and by the fact that the studies took place in different countries with ten years time difference. A review concerning studies on hand hygiene compliance in the hospital setting reported the overall compliance to be 40%,[6] which is similar to the 42% we found in our study.

7.1.2 Environmental determinants

Observed hand hygiene compliance increased with an increasing number of towel facilities per caregiver and when only disposable paper towels were available in the classroom, compared to only fabric towels or a combination of both paper and fabric towels. In addition, we found that observed hand hygiene compliance decreased as the number of children per caregiver increased.

Our study is the first to assess environmental determinants of caregivers' compliance with hand hygiene guidelines in child day care. However, improvement of environmental conditions has previously been part of hygiene interventions. A previous intervention study concerning preschool children has shown that their hand hygiene behaviour increased after improving environmental conditions including the supply of paper towels.[7, 8] In another study hand washing, diapering and food-preparation equipment specifically designed to reduce the spread of infectious agents significantly reduced diarrheal illness among the children.[9] In the hospital setting improved accessibility of materials has also been associated with better compliance with hand hygiene guidelines.[6] In our study we did not find an association between the number of sinks and hand hygiene compliance, the number and/or type of soap facilities and hand hygiene compliance, nor between the availability of alcohol-based hand sanitizer and hand hygiene compliance. That only paper towel facilities were significantly associated with observed hand hygiene compliance, might be explained by the fact that fabric towels can get wet during the day if not replaced adequately. Caregivers indicated sometimes skipping hand drying to avoid having to touch the wet fabric towel, which in our study was registered as inadequate hand hygiene, as our definition of hand hygiene included hand drying.

We found a negative association between observed hand hygiene compliance and the number of children per caregiver. A higher number of children per caregiver is associated with a higher work load. In the hospital setting it has been shown that intensity of work activity was negatively associated with observed hand hygiene compliance.[2]

7.1.3 Sociocognitive determinants

The following sociocognitive determinants were positively associated with self-reported hand hygiene behaviour: knowledge and awareness of hand hygiene guidelines, perceived behavioural control, perceived importance of performing hand hygiene, and habit. Only knowledge of the guidelines was directly associated with observed hand hygiene compliance.

The sociocognitive determinants assessed were derived mainly from the Theory of Planned Behaviour[10], with additions from the Health Belief Model[11] and the Self-Report Habit Index[12]. In addition, we performed qualitative research to identify possible hand hygiene determinants not mentioned in the literature. We conducted ten focus group discussions: two with managers of child day care centres, seven with caregivers at child day care centres, and one with parents of children attending child day care centres. The focus group discussions were based on semi-structured interviews previously used in the hospital setting.[13] The questions included the advantages and disadvantages of performing hand hygiene, the facilitating and hampering factors, but also the most and least important activities that require hand hygiene. Based on the results of these discussions, we added items in the questionnaire about sore and dry hands following hand hygiene and about when hand hygiene is indicated (e.g. after every diaper change, before preparing fruit). Based on our literature review and focus group discussions, we assessed the following sociocognitive determinants: knowledge of the guidelines, awareness of the guidelines, perceived susceptibility (i.e. perception of the risk of contracting an infection), perceived disease severity (i.e. feelings concerning the seriousness of contracting an infection), attitude (i.e. the degree of a favourable or unfavourable evaluation of the behaviour), perceived importance of performing hand hygiene, social norm (i.e. perceived behaviour of others and beliefs about how other people think about the behaviour), perceived behavioural control (i.e. perceived ease or difficulty of performing the behaviour), outcome beliefs (i.e. expected outcomes of the behaviour), perceived social pressure, personal norm (i.e. whether hand hygiene was perceived as everyone's own responsibility), intention (i.e. an indication of how hard people are willing to try to perform a specific behaviour), perceived physical environment, and habit.

There may well be other important hand hygiene determinants that we have not assessed. Our model can be seen as a starting point for explaining hand hygiene behaviour of caregivers in child day care centres. Although in multivariate analysis the explained variance of self-reported hand hygiene of 37% was relatively high, this shows that our model can still be improved. New insights could be provided by adding constructs from other theoretical models. For example, we did not assess the influence of culture on hand hygiene, which is a construct in the Model of Culture and Behaviour[14] and PEN3 model[15]. These models do not only focus on individuality, but also take into account the cultural context of behaviour. Our model can also be improved by mediation analyses to assess how the sociocognitive determinants are associated with each other. Although we constructed a correlation matrix and performed hierarchical regression analyses, this did not yield any clear-cut notifiable results and there is room for more analyses in this regard.

Concerning the sociocognitive determinants of observed hand hygiene behaviour, we only found an association with knowledge of the guidelines. The fact that the variables of the Theory of Planned Behaviour did not predict observed hand hygiene behaviour, shows

this might not be the best model to predict routine-like/habitual behaviour, that might be better explained by models of automaticity. These models propose that our behaviour is influenced less by conscious rationalisations and more by subconscious reactions, e.g. to environmental cues or emotions.[16, 17] Although we included habit into our model, which is a form of automaticity,[12] we did not find an association between habit and observed hand hygiene behaviour. However, in our study on environmental determinants we demonstrated a negative association between observed hand hygiene compliance and the number of children per caregiver. It might be that observed hand hygiene behaviour is influenced more by external factors, such as (peaks in) workload.

A previous study among nurses in the hospital reported that the variables of the Theory of Planned Behaviour were not associated with observed hand hygiene compliance.[2] However, they found a negative association between observed hand hygiene and intensity of work activity.[2] Five indicators were used to construct an index reflecting intensity of activity in the nursing units (type of nursing unit; time of day; amount of time elapsed for 10 hand washing indications; nursing unit census (i.e. the number of patients); and patient-to-nurse ratio). Intensity of work activity is a factor that influences actual behavioural control.[2] Factors directly influencing behavioural control of caregivers in child day care centres should be explored further. In child day care, behavioural control of caregivers might also be influenced by, for example, the number of hand hygiene opportunities per time unit or the number of children in need for urgent help during a specific time (e.g. when a child falls or when children fight).

Our questionnaire on sociocognitive determinants was not fully validated. Therefore, choosing different questions/phrasings to assess the sociocognitive determinants could possibly yield different results. However, internal consistency among the items measuring each sociocognitive determinant was high (most determinants were measured by 2 to 7 items), and we pretested the questionnaire among caregivers of day care centres to assess face validity and improve comprehensibility of the questions.

Our study is the first on sociocognitive determinants of hand hygiene behaviour of caregivers in child day care centres. Although knowledge has been associated with self-reported hand hygiene behaviour of nurses and physicians,[18] the results of a systematic review on hand hygiene in hospitals remained inconclusive concerning the relationship between knowledge and hand hygiene behaviour.[6] Previous studies have shown an association/correlation between perceived behavioural control and self-reported hand hygiene behaviour of nurses[18] and between habit and self-reported hand hygiene behaviour of physicians and nurses.[18] Habit has also been identified as a significant predictor of observed hand hygiene behaviour in Kenyan households.[19]

The determinants of caregivers' hand hygiene compliance that we identified, can be used for intervention development. Because we found different determinants for self-reported and observed hand hygiene behaviour, research is needed to learn/understand whether interventions are more effective based on determinants of self-reported versus observed behaviour, or on both.

7.2 Development and evaluation of the hand hygiene intervention

What intervention content is suited to target the identified environmental and sociocognitive determinants of hand hygiene behaviour?

Our intervention consisted of four components: 1) hand hygiene products; 2) training about hand hygiene guidelines; 3) two team training sessions aimed at goal setting and formulating hand hygiene improvement activities; and 4) reminders and cues to action (posters/stickers).

The environmental and sociocognitive determinants of caregivers' hand hygiene behaviour were translated into the intervention in three ways. First, four parallel workshops were organised with about 20 participants each, consisting mainly of caregivers and managers from child day care centres. Participants were asked to think of ways how to translate the found determinants into intervention components. Following the workshops, the ideas were presented to all participants and their feasibility was discussed. Second, a creative session was organised in collaboration with the Delft University of Technology. Using creative facilitation techniques,[20] eight participants, consisting of caregivers of child day care centres but also behavioural experts and intervention developers, developed concrete ideas for the intervention. In addition to the workshops and creative session, we reviewed the literature for suitable methods and strategies to address the specific determinants.

The intervention we developed consisted of four components. First, as we have shown that paper towels are an important determinant of caregivers' hand hygiene behaviour, paper towel dispensers and refills were provided free of charge for six months (the duration of the intervention), as well as dispensers and refills for soap, alcohol-based hand sanitizer and hand cream. Second, to increase knowledge and awareness of the guidelines and to increase perceived importance of hand hygiene, a training session about hand hygiene guidelines and technique and infection transmission routes was given and a booklet outlining the content of the training was distributed. Third, to increase perceived behavioural control, two team training sessions were given aimed at goal setting and formulating specific hand hygiene improvement activities. The team training sessions were based on similar hand hygiene training sessions developed for Dutch hospitals.[21, 22] Fourth, posters and stickers for both caregivers and children were provided as reminders and cues to action to stimulate hand hygiene to become an habitual behaviour.

Our intervention was evaluated in a cluster randomised controlled trial including 36 intervention day care centres which were compared to 35 control day care centres continuing usual practice. The primary outcome measure was caregivers' observed hand hygiene compliance. The secondary outcome measure was incidence of gastrointestinal and respiratory infections among children attending day care. Two groups in each child day care centre participated in the study. In intervention day care centres, these groups received the hand hygiene products. As caregivers rotated between groups, all caregivers received the training sessions. The intervention was implemented in four phases. Hand hygiene products and the training on hand hygiene guidelines were provided at intervention start, followed by two team training sessions at one month interval each. At baseline and after

each training session, hand hygiene compliance was observed. During the six months study period, parents of participating children completed an infection calendar to assess incidence of infections. Methodological issues of the intervention evaluation will be discussed in the following paragraph.

7.3 Effect of the hand hygiene intervention

How effective is the developed hand hygiene intervention in improving caregivers' hand hygiene compliance and reducing gastrointestinal and respiratory infections in children attending child day care centres?

7.3.1 Effect of the intervention on caregivers' hand hygiene compliance

The intervention was effective at one, three and six months in improving caregivers' hand hygiene compliance in child day care centres, with and without taking into account baseline compliance.

Comparison of the different types of activities for which hand hygiene was indicated showed that at six months follow-up there was a significant increase in hand hygiene compliance after toilet and diapering activities and after contact with body fluids (taking into account differences in baseline compliance). There was no significant increase in caregivers' hand hygiene compliance before food-related activities (including food handling, eating, and assisting children with eating). Looking more specifically at these activities, we see that caregivers' hand hygiene increased before food handling and before caregivers themselves ate. However, it decreased before caregivers assisted children with eating. This might be explained by the fact that our observation method for this hand hygiene indication was very strict, as caregivers might have washed their hands before assisting a child with eating, but then the phone rang or they had to leave the table and touch a cupboard to get something for another child, and according to our observation method they would have to wash hands again before they continued to assist a child with eating. Our strict observation method probably made it more difficult for caregivers to improve hand hygiene before assisting a child with eating.

There is only one study to compare our results with, because most hand hygiene intervention studies in child day care centres report as outcome measure the incidence of gastrointestinal and/or respiratory infections in children, or absences of caregivers/children due to illness.[8, 23-29] One other intervention study assessed observed hand hygiene compliance of caregivers in child day care centres as outcome measure, although no comparison with control centres was reported.[27] The study showed that after training, caregivers' hand hygiene improved after diapering and after contact with mucus, saliva, vomit etc. of children.[27] In our study, hand hygiene also improved after toilet and diapering activities and after contact with body fluids.

7.3.2 Effect of the intervention on incidence of infections in children

We found no evidence for an effect of the intervention on the incidence of episodes of diarrhoea and the common cold.

The fact that our intervention showed to be effective in improving caregivers' hand hygiene compliance, but not in reducing the incidence of gastrointestinal infections in children, might be explained by three different scenario's. First, the scenario that hand hygiene compliance truly improved with no effect on the incidence of infections. Second, although we found an effect on hand hygiene compliance, that this is biased. Third, that hygiene compliance improved with an effect on incidence of infections, even though we could not demonstrate this.

The first scenario (that hand hygiene compliance truly improved with no effect on the incidence of infections) could be explained by the fact that the children in our study on average attended the day care centre 2.7 days a week (which is rather typical for the Netherlands) and they could also become infected outside the day care centre where they spent the majority of the time. Another explanation could be that within day care centres, other hygiene activities are also important for the prevention of disease transmission (i.e. cleaning toys, floors, furniture, toilets etc.). Furthermore, the main focus in our study was on caregivers' hand hygiene. Besides posters and stickers for children, there were no other techniques to encourage children's hand hygiene, even though this might also be important to reduce infections in day care centres. Another possible explanation is that hand hygiene compliance did not improve enough in intervention centres to result in a reduction in infections, or that the difference in hand hygiene compliance between intervention and control day care centres was not large enough to detect differences in disease incidence. Possibly there is a critical threshold for hand hygiene compliance to result in a lower incidence of infections.

The second scenario, that the effect of the intervention on hand hygiene compliance was biased, could be explained by the Hawthorne effect. It might be that the Hawthorne effect was more prominent during the evaluation of the intervention than during our first observation study (which took place six months earlier). In addition, the Hawthorne effect was possibly more prominent in intervention centres than in control centres, because caregivers in intervention centres had received the training on hand hygiene guidelines. This made them more aware that specifically hand hygiene was observed and more knowledgeable about specific hand hygiene indications outlined in the guidelines. Moreover, the same day care centres participated in both studies and after the first observation study, they received a report including the results of their hand hygiene compliance. We tried to minimize the Hawthorne effect by communicating that hygiene in general was observed, not specifically mentioning hand hygiene. In addition, the observations took place unobtrusively. A previous study reported caregivers becoming less sensitive to the Hawthorne effect by repeated observations.[4] Nevertheless, in the focus group discussions that we performed as part of our process evaluation, some caregivers said they were more aware of their hand hygiene during the observations and they tried to do better. Others however mentioned that their hand hygiene had really improved because of the intervention.

The third scenario - that hand hygiene compliance improved with an effect on incidence of infections, although we could not demonstrate this - might be explained by the fact that our study was under-powered to evaluate the intervention effect on disease incidence. During follow-up we monitored 545 children during five months and not 600 children for six months, as was calculated with sample size calculations. Therefore, we only obtained data on 73% of the anticipated 109,200 child-days. The lack of power can be explained by the fact that, due to time constraints, we checked whether the children met the inclusion criteria only after data collection. Although 766 parents gave informed consent, only 545 children could be included in the analyses, which was much less than we expected. In addition, recruitment of parents took more time than we had foreseen and therefore we had to extend the baseline measurement with as consequence a shorter follow-up period. Another explanation for the third scenario is that the possible intervention effect size is smaller than what we assumed during sample size calculation (15% reduction for respiratory infections and 25% reduction for gastrointestinal infections). Hence, we could not demonstrate an effect of the intervention on disease incidence. Furthermore, the baseline measurement of the incidence of gastrointestinal and respiratory infections among the children was hampered due to several methodological issues and therefore less reliable. First, recruitment of parents took more time than we had foreseen and therefore continued after baseline measurement had started. Therefore, the number of days and the exact calendar weeks included in baseline measurement differs among the children. Second, because many parents were enrolled after the official start of the baseline measurement, we had to continue the baseline measurement until November. But the intervention start was already planned for most day care centres, and therefore half of the intervention day care centres received the training on hand hygiene guidelines while baseline measurement was still ongoing. For these children, we censored the calendar days from the day of the training until intervention start, resulting in more baseline data for children in control day care centres than intervention centres. Another limitation of the baseline measurement was that it took place during September and October 2011, while the intervention was implemented from November 2011 until the end of March 2012. It is likely that the number and possibly the type of infections going around in these months differ. An alternative is to conduct the baseline measurement one year before, in exactly the same calendar months as the intervention.[23] However, it is known that younger children are at higher risk of contracting infections.[30, 31] Comparison of baseline and follow-up measurement is then hampered by the fact that the children do not have the same age. Furthermore, it is practically very difficult to have parents/children participate in a study that lasts such a long time and it is likely that the number of children lost to follow-up will increase. It is noteworthy that uncorrected for baseline, there was borderline significantly less diarrhoea (19%) in intervention centres than in control centres during follow-up and this difference increased during the peak of the rotavirus season. This suggests that we might have shown that the intervention is effective in reducing diarrhoea if we had had more power. In addition, the intervention was evaluated in day care centres willing to participate. It might be that these centres are more focussed on hygiene and therefore have a better hygiene and already fewer infections among children. The effect of the intervention on hand hygiene compliance and incidence of infections might then be an underestimation.

Previous hand hygiene intervention studies in child day care centres have shown varying effects on incidence of gastrointestinal and/or respiratory infections and/or illness absenteeism.[32] We found three randomised controlled trials with as outcome measure incidence of gastrointestinal and/or respiratory infections that corrected for clustering of the data.[23, 25, 26, 29] Gudnason et al. also reported a baseline measurement and similar to our study, did not demonstrate an effect of their intervention on incidence of diarrhoea and colds.[23] Roberts et al. reported a reduction in episodes of colds only among children aged 24 months and younger and a reduction in episodes of diarrhoea only among children aged over 24 months.[25, 26] However, in this study no baseline incidence was reported. Therefore, it is possible that the difference between intervention and control centres was already present before start of the intervention. Carabin et al. conclude that their intervention reduced the incidence of upper respiratory tract infections, because they found a reduction in incidence in intervention day care centres.[29] However, similar to our study, they also report a reduction in incidence in control day care centres. Therefore, it is less likely that the incidence reduction in intervention centres is caused by the intervention. Although these studies indicate that there is limited evidence that hand hygiene in child day care centres is associated with fewer gastrointestinal and respiratory infections, a meta-analysis to quantify the effect of hand hygiene interventions - including studies with and without multilevel analyses and/or baseline measurement - demonstrated 31% reduction in gastrointestinal illness and 21% reduction in respiratory illness.[33]

In conclusion, this is the first hand hygiene intervention to significantly increase hand hygiene compliance of caregivers in child day care centres. We could not demonstrate an effect of our intervention on incidence of gastrointestinal and respiratory infections, as our study was underpowered and the baseline measurement was hampered. However, uncorrected for baseline there was less diarrhoea in intervention centres than in control centres, and this difference increased during the peak of the rotavirus season, showing that possibly the intervention is more effective when the number of infections increase. In addition, the intervention was evaluated in day care centres willing to participate, which may have better hygiene and already fewer infections among children, leading to an underestimation of the true effect size. We therefore conclude that it is plausible that the intervention has a positive (though not very large) effect on reducing gastrointestinal infections, and that it is worthwhile to implement and further develop and evaluate it in child day care centres in the Netherlands.

7.3.3 Strengths and limitations

Unfortunately we did not quantitatively assess the effect of our intervention on each of the determinants which the intervention addressed. However, we did perform a process evaluation which consisted of six focus group discussions with caregivers and two with managers of intervention centres. Concerning the different sociocognitive determinants addressed in the intervention, it is likely that knowledge and awareness of the guidelines improved. During the observations, caregivers in intervention centres demonstrated to know when hand hygiene was indicated. Furthermore, in the focus group discussions it was mentioned that the knowledge training was an eye-opener and useful. Also the soap and paper towel dispensers used in the intervention were received positively and were seen as an improvement compared to the products used prior to the intervention. Caregivers indicated the posters and stickers helped hand hygiene to become habitual behaviour.

However, they were considered most effective in the beginning of the intervention and were less noticed towards the end of the intervention. A suggestion was to renew them during the intervention period or change the location. In the team training sessions we discussed what is necessary to make hand hygiene become a habit and to increase perceived behavioural control. As the usefulness of the trainings was very dependent on the input and active participation of the caregivers themselves, and this was not achieved in all sessions, the reactions were divided. It was suggested to better motivate and communicate what is expected of the caregivers beforehand in order to avoid that caregivers attend the team trainings with wrong expectations. Furthermore, possibly peer education might be more successful for the team training sessions, because it might be easier for peers to motivate caregivers as they know all the daily situations caregivers can run into.

Despite randomisation, caregivers' hand hygiene compliance in control day care centres was significantly higher at baseline than in intervention centres. At baseline, the incidence of gastrointestinal infections was also higher in control day care centres versus intervention centres. This might explain the difference in hand hygiene compliance at baseline, as our previous focus group discussions showed that caregivers increase their hand hygiene when observing diarrhoea among the children. We checked whether some day care centres were outliers with high incidence of infections and whether they were clustered geographically, but this was not the case. Because of the baseline differences in both compliance and disease incidence, we reported the results both uncorrected as well as corrected for baseline.

Concerning the infection calendar, we had a relatively low response rate of 39% of parents who were willing to participate. No information was obtained on nonresponders. It might be that these parents have less personal interest in hygiene, which could have influenced disease incidence and possibly also the intervention effect. Among the parents who did participate, a high percentage of calendar pages were returned with few children lost to follow-up. It is a strength of our study that parents monitored disease incidence in their children and not personnel of the day care centres, although the infection calendar used to assess disease incidence was not validated. To assess the use of the infection calendar, parents were asked to fill in a survey after the data collection period. The results of the survey showed that the definitions were quite clear and parents did not encounter much problems/hesitations filling in the infection calendar. Furthermore, the case definitions for diarrhoea and the common cold were quite sensitive. As we also obtained information on whether or not children with diarrhoea experienced fever, the analyses were also performed with a more specific definition (i.e. diarrhoea with fever). This did not influence the results of the effect of the intervention. However, it might be that inclusion of other symptoms in our case definitions would influence the intervention effect, e.g. vomiting, nausea, headache. Furthermore, as the outcome measure was not laboratory-confirmed, it might be that also non-infectious diarrhoea was included. More specific laboratory-confirmed outcome measures could also influence the intervention effect.

Control centres were offered the intervention (after the data collection period), which probably facilitated recruitment of child day care centres and minimized loss to follow-up.[8] It is noteworthy that not all control centres eventually received the intervention. There had been a decrease in percentage of children attending day care between 2011 (44%) and 2013 (39%),[34] which was probably caused by restrictions in governmental financial support to parents to reimburse them for the costs of day care. As a result also the number of day care centres slightly decreased. Therefore, by the time the control centres were to receive the intervention, which was halfway 2012, some control centres no longer existed and for some others, losing children and having to make staff redundant, hand hygiene was not the highest priority.

7.4 Recommendations

The studies presented in this thesis contribute to the literature on infection control in child day care centres. The most important recommendations for further research and for practice are discussed in this paragraph.

7.4.1 Recommendations for further research

- Future studies should assess observed hand hygiene compliance as outcome measure, and not (only) self-reported compliance.

- Studies are needed to investigate the effect of interventions based on sociocognitive determinants of observed versus self-reported behaviour, or on both.

- More studies are needed to comprehensively assess determinants of observed hand hygiene behaviour. Possibly factors influencing behavioural control, such as intensity of work activity, play a role.

- Further research is necessary to optimise the intervention, because it might be that other transmission routes are more important than caregivers' hand hygiene compliance:
    - The intervention could be optimised by including environmental hygiene practices (e.g. cleaning toys or the diaper changing pad).
    - Studies are needed on children's hand hygiene compliance and determinants of their hand hygiene, and/or determinants of caregivers to encourage children to wash their hands. Including children's hand hygiene in the intervention will provide insights whether transmission is mainly from chid-to-child or caregiver-to-child.
    - Children can also acquire infections outside the day care centre. Including hand hygiene at home might therefore also be a valuable addition to the intervention.
    - Once the intervention is optimised and shows to be effective in reducing incidence of infections among children, the next step will be to evaluate whether the intervention is cost-effective. This will enable policy makers to make decisions on whether or not to allocate budget for implementation of the intervention on the national level.

7.4.2 Recommendations for practice

- In Dutch day care centres caregivers wash their hands in less than half of all recommended hand hygiene opportunities. Therefore, it is necessary to implement interventions to improve caregivers' compliance with hand hygiene guidelines.

- Caregivers overestimate their compliance with hand hygiene guidelines. This can be addressed by setting team goals when starting training sessions to improve hand hygiene, to avoid that the caregivers underestimate their problem.

- We identified several environmental and sociocognitive determinants that are associated with caregivers' hand hygiene behaviour in child day care. Hand hygiene interventions should target these determinants.

- Although we could not demonstrate a clear effect of our intervention on the incidence of gastrointestinal and respiratory infections among children attending Dutch day care centres in our study, it is plausible that the intervention is effective in outbreak situations with a higher number of infections. Therefore we recommend to implement and further develop and evaluate our hand hygiene intervention in child day care centres in the Netherlands.

- It is plausible that our intervention is effective in low income countries where gastrointestinal infections are more prominent and form a greater public health problem. In that case we recommend that the intervention effect is re-evaluated, as the determinants of caregivers' hand hygiene behaviour might differ between low and high income countries and our intervention was developed based on determinants of hand hygiene of Dutch caregivers.

- Parts of the intervention can also be used in other settings:
  1. the posters and stickers are suitable for the youngest children in primary schools;
  2. the knowledge and team training sessions can easily be adapted to improve hand hygiene in other settings, for example in nursing homes;
  3. the knowledge training can be included in the curriculum of schools and colleges for caregivers in child day care centres, especially because during focus group discussions it became clear that this now is missing.

7.4.3 Further intervention implementation

The Netherlands Organization for Health Research and Development (ZonMw) provided funds for further implementation of the intervention in other day care centres in the Netherlands. Therefore, we have sent all registered child day care centres in the Netherlands an information booklet on the intervention and how to implement it themselves. For this, we developed protocols on how to give the training on hand hygiene guidelines and the two team training sessions. These can be found on the website *www.heelgewoonhandenschoon.nl*. Furthermore, to support caregivers in giving the team training sessions, we gave train-the-trainer sessions on three locations throughout the Netherlands in which caregivers from various day care centres participated free of charge. In addition, train-the-trainer sessions were held at four day care centres, with caregivers from various locations. To complete implementation of the intervention, the posters and stickers can be downloaded from the website, as well as a code to obtain the hand hygiene products with a discount.

We also informed the Dutch regional public health offices of the intervention by an information booklet. When child day care centres experience outbreaks of infectious diseases, they report this to their regional public health office. To control the outbreak, public health physicians and nurses often advise to increase hygiene in general, also including hand hygiene. Now they can point out the website *www.heelgewoonhandenschoon.nl* where child day care centres find the tools to actively increase their hand hygiene.

In collaboration with the Dutch National Centre for Hygiene and Safety (LCHV), the Dutch national guidelines for hand hygiene in child day care centres have been adapted following the results of our studies. Hand hygiene after using gloves has been added to the guidelines. Furthermore, the guidelines have become more specific, for example by adding that hands should be washed specifically after each wet diaper change and not only once after changing all wet diapers.

7.4.4 Conclusion

This thesis focuses on infection control in child day care centres by improving caregivers' compliance with hand hygiene guidelines. The results of the studies presented show that there is room to improve caregivers' hand hygiene compliance in Dutch day care centres. Furthermore, a combination of environmental and sociocognitive determinants are associated with caregivers' hand hygiene behaviour. We developed an intervention targeting these determinants, which was evaluated in a randomised controlled trial. Our intervention is effective in improving caregivers' compliance with hand hygiene guidelines. Although, due to several methodological issues we could not demonstrate an effect of our intervention on disease incidence, it is plausible that the intervention has a positive (though not very large) effect on reducing gastrointestinal infections, and that it is worthwhile to implement and further develop and evaluate it in child day care centres in the Netherlands.

7.5 References

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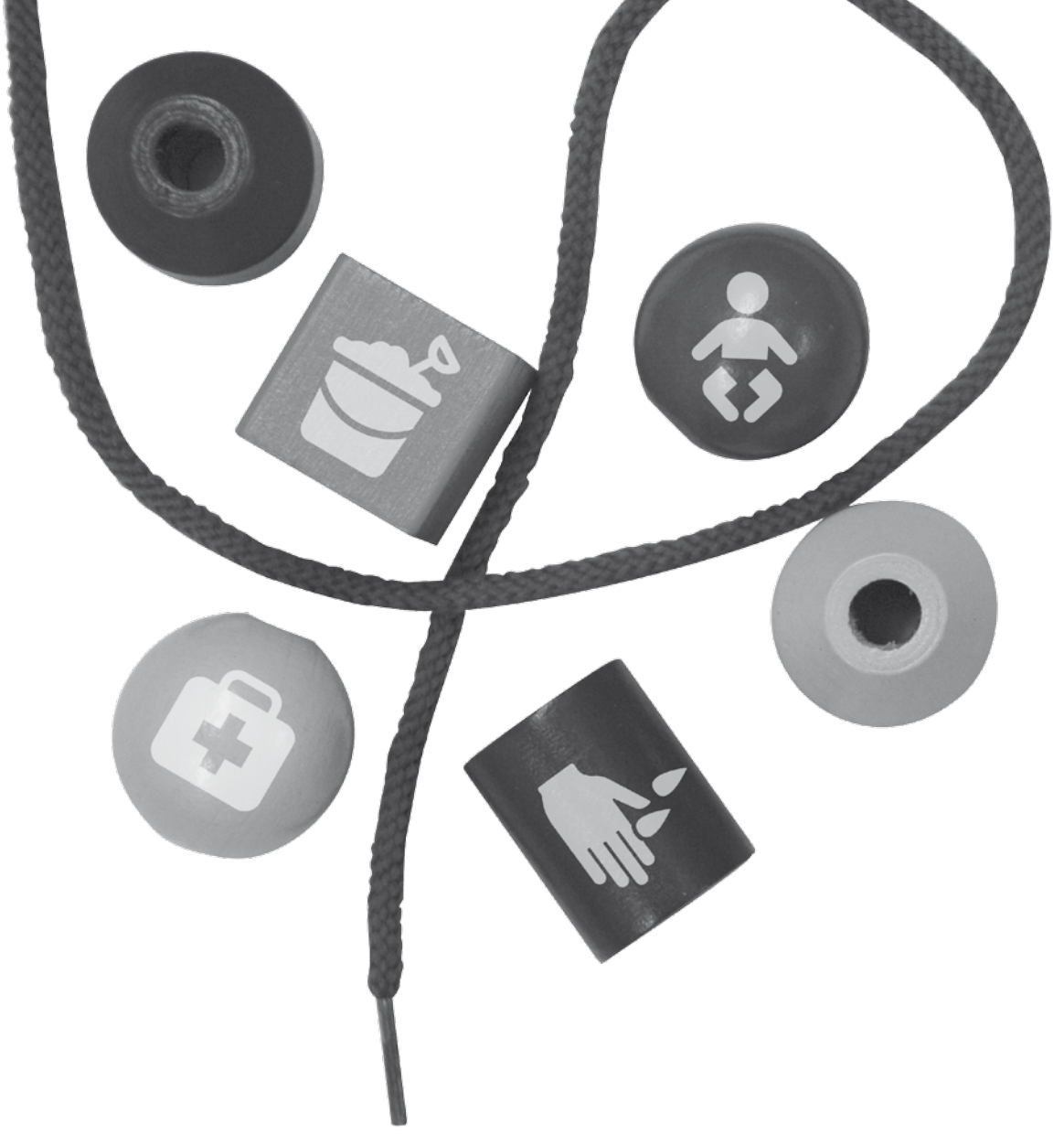

Summary

This thesis focuses on infection control in child day care centres by improving caregivers' compliance with hand hygiene guidelines. Children attending child day care centres are at increased risk of acquiring gastrointestinal and respiratory infections, compared to children cared for at home. Hand hygiene is known to be an effective measure to prevent infections. However, compliance with hand hygiene guidelines is generally low. In order to develop successful interventions to improve hand hygiene compliance and reduce gastrointestinal and respiratory infections among children attending day care, it is necessary to assess the key determinants that underlie hand hygiene behaviour. Interventions targeting these determinants can then be developed and evaluated.

An observational study was conducted including 122 child day care centres and 350 caregivers in the regions of Rotterdam-Rijnmond, Leiden and Gouda in the Netherlands *(Chapter 2 and 3)*. Both observed *(Chapter 2)* and self-reported *(Chapter 3)* hand hygiene compliance were assessed. Overall observed compliance was 42%; indicating hands were washed in less than half of all hand hygiene opportunities. Overall mean self-reported hand hygiene compliance was 8.7 on a scale from 0 (never) to 10 (always). The results show that there is room to improve caregivers' compliance with hand hygiene guidelines in day care. Furthermore, self-reported compliance is an overestimation of observed compliance, i.e. caregivers think their hand hygiene is better than it actually is.

Chapter 2 describes the environmental determinants of caregivers' hand hygiene behaviour. The results show a negative association between caregivers' hand hygiene compliance and the number of children per caregiver. Furthermore, our study showed that observed hand hygiene compliance increased with an increasing number of towel facilities per caregiver. In addition, hand hygiene compliance increased when only disposable paper towels were available in the classroom compared to only fabric towels or a combination of both paper and fabric towels.

Chapter 3 describes sociocognitive determinants of caregivers' hand hygiene compliance. The sociocognitive determinants assessed were derived from the Theory of Planned Behaviour, with additions from the Health Belief Model and the Self-Report Habit Index, and from focus group discussions with caregivers and managers of child day care centres. The results show that the following sociocognitive determinants were positively associated with self-reported hand hygiene behaviour of caregivers in day care centres: knowledge and awareness of hand hygiene guidelines, perceived behavioural control (i.e. perceived ease or difficulty of performing the behaviour), perceived importance of performing hand hygiene, and habit. Only knowledge of the guidelines was also associated with observed hand hygiene behaviour.

Chapter 4 describes the development and evaluation of the hand hygiene intervention. The intervention consisted of four components. First, as paper towels are an important determinant of caregivers' hand hygiene behaviour, paper towel dispensers and refills for six months were provided free of charge, as well as dispensers and refills for soap, alcohol-based hand sanitizer and hand cream. Second, to increase knowledge and awareness of

the guidelines and to increase perceived importance of hand hygiene, training about the Dutch national hand hygiene guidelines was given and a booklet outlining the content of the training was distributed. Third, to increase perceived behavioural control, two team training sessions were given aimed at goal setting and formulating specific hand hygiene improvement activities. Fourth, posters and stickers for both caregivers and children were provided as reminders and cues to action to stimulate hand hygiene to become an habitual behaviour.

The intervention was evaluated in a cluster randomised controlled trial including 36 intervention day care centres which were compared to 35 control day care centres continuing usual practice. The primary outcome measure was caregivers' observed compliance with hand hygiene guidelines. The secondary outcome measure was incidence of gastrointestinal and respiratory infections in children attending day care. The intervention was implemented in four phases: hand hygiene products and posters/stickers were provided at intervention start, followed by the training session on hand hygiene guidelines and two team training sessions at one month interval each. At baseline and after each training session, hand hygiene compliance was observed in both intervention and control centres. During the six months study period, parents filled in an infection calendar to assess incidence of gastrointestinal and respiratory infections in their children.

Chapter 5 describes the effect of the intervention on caregivers' compliance with hand hygiene guidelines. The intervention was effective at one, three and six months follow-up in improving caregivers' hand hygiene compliance, with and without taking into account baseline compliance.

Chapter 6 describes the effect of the intervention on incidence of gastrointestinal and respiratory infections in children attending day care centres. We found no evidence for an effect of the intervention on the incidence of episodes of diarrhoea and the common cold, although the intervention did increase hand hygiene of caregivers. This could be explained by the fact that our incidence study was underpowered and the baseline measurement was hampered. However, uncorrected for baseline, there was less diarrhoea in intervention centres than in control centres, and this difference increased during the peak of the rotavirus season, showing that possibly the intervention is effective in reducing diarrhoea, especially when the number of infections increase. In addition, the intervention was evaluated in day care centres willing to participate, which may already have had a better hygiene and fewer infections among children before intervention start, leading to an underestimation of the true effect size. We therefore conclude that it is plausible that the intervention has a positive effect on reducing gastrointestinal infections, and that it is worthwhile to implement and further develop and evaluate it in child day care centres in the Netherlands.

Samenvatting

Dit proefschrift beschrijft de preventie van infectieziekten in kinderdagverblijven door het bevorderen van de handhygiëne van pedagogisch medewerkers. Kinderen op kinderdagverblijven hebben een verhoogd risico op het krijgen van maagdarm- en luchtweginfecties vergeleken met kinderen die thuis worden opgevangen. Handhygiëne is een effectieve manier om infecties te voorkomen, maar over het algemeen worden de handen onvoldoende gewassen. Voor het ontwikkelen van een succesvolle interventie voor het verbeteren van handhygiëne en het verminderen van maagdarm- en luchtweginfecties bij kinderen op kinderdagverblijven, moet in kaart worden gebracht welke determinanten geassocieerd zijn met het handhygiënegedrag van pedagogisch medewerkers. Interventies gericht op deze determinanten kunnen dan worden ontwikkeld en geëvalueerd.

We hebben bij 122 kinderdagverblijven en 350 pedagogisch medewerkers observationeel onderzoek uitgevoerd in de regio's Rotterdam-Rijnmond, Leiden en Gouda *(Hoofdstuk 2 en 3)*. Zowel de geobserveerde *(Hoofdstuk 2)* als zelfgerapporteerde *(Hoofdstuk 3)* naleving van de handhygiënerichtlijn is in kaart gebracht. De geobserveerde naleving van de handhygiënerichtlijn was gemiddeld 42%; de handen worden dus in minder dan de helft van de handhygiënemomenten ook daadwerkelijk gewassen. Zelfgerapporteerde handhygiëne was gemiddeld 8.7 op een schaal van 0 (nooit) tot 10 (altijd). De resultaten laten zien dat er ruimte is om de handhygiëne van pedagogisch medewerkers in kinderdagverblijven te verbeteren. Daarnaast is de zelfgerapporteerde handhygiëne een overschatting van de geobserveerde handhygiëne; pedagogisch medewerkers denken dat ze de handen beter wassen dan dat ze in werkelijkheid doen.

Hoofdstuk 2 beschrijft de omgevingsdeterminanten van handhygiëne van pedagogisch medewerkers in kinderdagverblijven. De resultaten laten een negatieve associatie zien tussen handhygiëne en het aantal kinderen per pedagogisch medeweker. Daarnaast zien we dat de handhygiëne toeneemt bij een toenemend aantal handdoekfaciliteiten per pedagogisch medewerker. Ook neemt de handhygiëne toe als er alleen papieren handdoekjes aanwezig zijn op een groep vergeleken met alleen stoffen handdoeken of een combinatie van stoffen en papieren handdoeken.

Hoofdstuk 3 beschrijft de sociaal-cognitieve determinanten van handhygiëne van pedagogisch medewerkers op kinderdagverblijven. De sociaal-cognitieve determinanten die zijn onderzocht zijn constructen uit de Theory of Plannend Behaviour, het Health Belief Model en de Self-Report Habit Index. Daarnaast zijn mogelijke determinanten geïdentificeerd in focus groep discussies met pedagogisch medewerkers en managers van kinderdagverblijven. De resultaten laten zien dat de volgende sociaal-cognitieve determinanten positief geassocieerd zijn met zelfgerapporteerde handhygiëne: kennis van de handhygiënerichtlijn, het op de hoogte zijn van de handhygiënerichtlijn, het belang inzien van een goede handhygiëne, de ervaren gedragscontrole (het gevoel dat pedagogisch medewerkers de handen kunnen wassen, ook als de werkdruk hoog is) en gewoonte. Alleen kennis van de richtlijn was geassocieerd met geobserveerd gedrag.

Hoofdstuk 4 beschrijft de ontwikkeling en evaluatie van de handhygiëne-interventie. De interventie bestond uit vier onderdelen. Ten eerste, aangezien papieren handdoekjes geassocieerd waren met handhygiëne, zijn er papieren handdoekdispensers met navullingen voor zes maanden gratis geleverd. Daarnaast zijn ook dispensers met zeep, handalcohol en handcrème geleverd. Ten tweede is er een kennistraining over de handhygiënerichtlijn gegeven om er voor te zorgen dat de kennis werd vergroot en pedagogisch medewerkers op de hoogte waren van de richtlijn en het belang van handhygiëne inzagen. Na afloop van de kennistraining kregen alle deelnemers een informatieboekje als naslagwerk. Als derde onderdeel van de interventie zijn er, voor het vergroten van de ervaren gedragscontrole, twee teamtrainingen gegeven waarbij het team doelen opstelde en tot concrete oplossingen kwam om de handhygiëne te verbeteren. Ten slotte zijn er als vierde onderdeel van de interventie posters en stickers geleverd voor zowel pedagogisch medewerkers als kinderen. De posters en stickers herinnerden pedagogisch medewerkers eraan dat zij hun handen moesten wassen en bevorderden op die manier dat handhygiëne een gewoonte werd.

De interventie is geëvalueerd in een cluster randomised controlled trial waarbij 36 kinderdagverblijven met interventie zijn vergeleken met 35 controlekinderdagverblijven zonder interventie. De primaire uitkomstmaat was de geobserveerde naleving van de handhygiënerichtlijn door pedagogisch medewerkers. De secundaire uitkomstmaat was de incidentie van maagdarm- en luchtweginfecties bij kinderen op kinderdagverblijven. De interventie is in vier fasen geïmplementeerd: de handhygiënematerialen en posters/stickers zijn bij aanvang van de interventie gegeven, gevolgd door de kennistraining en twee teamtrainingen met elk een tussenperiode van één maand. Voor start van de interventie en na elk van de drie trainingen is de handhygiëne geobserveerd in zowel interventie- als controlekinderdagverblijven. Gedurende zes maanden hebben ouders van kinderen op kinderdagverblijven een infectiekalender bijgehouden om de incidentie van maagdarm- en luchtweginfecties in kaart te brengen.

Hoofdstuk 5 beschrijft het effect van de interventie op de geobserveerde handhygiëne. Na één, drie en zes maanden follow-up was de interventie effectief in het verbeteren van handhygiëne van pedagogisch medewerkers, met en zonder correctie voor baseline meting.

Hoofdstuk 6 beschrijft het effect van de interventie op de incidentie van maagdarm- en luchtweginfecties bij kinderen op kinderdagverblijven. Wij hebben geen bewijs gevonden voor een effect van de interventie op de incidentie van maagdarm- en luchtweginfecties, hoewel de interventie wel effectief was in het verbeteren van de handhygiëne van pedagogisch medewerkers. Dit kan worden verklaard door het feit dat onze incidentiestudie onvoldoende power had en de baseline meting niet optimaal was. Echter, ongecorrigeerd voor baseline meting was er minder diarree in interventiekinderdagverblijven vergeleken met controlekinderdagverblijven, en dit verschil nam toe gedurende de piek van het rotavirusseizoen. Dit laat zien dat de interventie mogelijk effectief is in het verminderen van diarree als het aantal infecties toeneemt. Daarnaast is de interventie geëvalueerd in kinderdagverblijven die mee wilden doen met het onderzoek. Het kan zijn dat deze kinderdagverblijven al een betere hygiëne en minder infecties hadden voor de start van de interventie, waardoor er een onderschatting is van het interventie-effect. Wij concluderen dan ook dat het plausibel is dat de interventie een positief effect heeft op het verminderen van maagdarminfecties, en dat de interventie verder geïmplementeerd, ontwikkeld en geëvalueerd kan worden in Nederlandse kinderdagverblijven.

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Dit onderzoek had niet kunnen plaatsvinden zonder de deelname van kinderdagverblijfmedewerkers en ouders van kinderen op kinderdagverblijven. Ik wil jullie enorm bedanken voor jullie openheid en inzet.

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Amersfoort, Oktober 2014

Curriculum Vitae

Tizza Zomer werd in 1980 geboren te Vlaardingen. Na het behalen van haar HAVO diploma aan het Zernike College te Haren volgde zij de opleiding Oefentherapie Cesar aan de Hogeschool Utrecht waar zij in 2003 afstudeerde. In datzelfde jaar ging zij Gezondheidswetenschappen studeren aan de Vrije Universiteit te Amsterdam. In 2007 rondde zij deze studie af met een tweejarige onderzoeksmaster op het gebied van Internationale Volksgezondheid en Infectieziekten. In het kader van haar onderzoeksmaster heeft zij stage gelopen bij de European Centre for Disease Prevention and Control waar zij heeft gewerkt aan een evaluatie van de Epidemic Intelligence activiteiten. Daarnaast heeft zij bij het Rijksinstituut voor Volksgezondheid en Milieu gewerkt aan een review betreffende de introductie van rotavirus vaccinatie in Nederland. Na het afronden van haar onderzoeksmaster heeft zij van 2007 tot 2009 het EPIET (European Programme for Intervention Epidemiology Training) programma gedaan bij het Zweeds Nationaal Instituut voor Infectieziektebestrijding te Stockholm. Daar heeft zij gewerkt aan verschillende onderzoeken op het gebied van infectieziekten epidemiologie, zoals onderzoek van een norovirusuitbraak en risicofactoronderzoek naar moxifloxacin-resistente *Clostridium difficile*. In 2009 begon zij aan haar promotieonderzoek bij de GGD Rotterdam-Rijnmond en het Erasmus Medisch Centrum, wat resulteerde in dit proefschrift. Tijdens haar promotieonderzoek heeft zij een MSc. Epidemiologie behaald. Sinds maart 2014 werkt zij als onderzoeker op het gebied van zoönosen bij het Rijksinstituut voor Volksgezondheid en Milieu.

Curriculum Vitae

Tizza Zomer was born in 1980 in Vlaardingen. After completing her secondary education at the Zernike College in Haren, she started to study Remedial Therapy Cesar at the University for Applied Sciences in Utrecht (Hogeschool Utrecht) where she graduated in 2003. In that same year she started to study Health Sciences at the Free University in Amsterdam. In 2007 she completed a two-year research master's programme with a specialisation in International Public Health and Infectious Diseases. As part of her master's degree she worked as a trainee at the European Centre for Disease Prevention and Control on the evaluation of the Epidemic Intelligence activities. She also was an intern at the Dutch National Institute for Public Health and the Environment where she worked on a review concerning the introduction of rotavirus vaccination in the Netherlands. After graduating she was an EPIET (European Programme for Intervention Epidemiology Training) fellow at the Swedish National Institute for Infectious Disease Control in Stockholm from 2007 to 2009. Here she worked on different research projects in infectious disease epidemiology, e.g. an investigation of a norovirus outbreak and a risk factor study for moxifloxacin-resistant *Clostridium difficile*. In 2009 she started her PhD at the Municipal Public Health Service Rotterdam-Rijnmond and the Erasmus University Medical Centre, resulting in this thesis. As part of her PhD, she completed a MSc. in Epidemiology. Since March 2014, she works as a researcher on zoonoses at the Dutch National Institute for Public Health and the Environment.

Publications

Zomer TP, Erasmus V, Looman CW, Tjon-A-Tsien A, van Beeck EF, de Graaf JM, van Beeck AHE, Richaruds JH, Voeten HACM. A hand hygiene intervention to reduce infections in child day care: a randomized controlled trial. Epidemiol Infect. In print.

Zomer TP, Erasmus V, Looman CW, van Beeck EF, Tjon-A-Tsien A, Richaruds JH, Voeten HACM. Improving hand hygiene compliance in child day care centres: a randomised controlled trial. Submitted for publication.

Nugroho A, Erasmus V, ***Zomer TP,*** Wu Q, Richardus JH. Behavioral interventions for MSM and transgender in Southeast Asia and Asian countries with Muslim population groups: A Systematic Review. Submitted for publication.

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Zomert TP, Erasmus V, Richardus JH, Voeten HACM. Heel gewoon, Handen schoon: verbetering handhygiëne op kinderdagverblijven. Infectieziekten Bulletin. 2013;24(8):227-228.

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PhD portfolio

Summary of PhD training and teaching activities

ERASMUS UNIVERSITEIT ROTTERDAM

Name PhD student:	Tizza Zomer	***PhD period:***	2009 – 2014
Erasmus MC Department:	Public Health	***Promotor(s):***	Prof.dr. J.H. Richardus
		Supervisors:	dr. H.A.C.M. Voeten dr. V. Erasmus

1. PhD training	Year	Workload (Hours/ECTS)
Research skills and in-depth courses		
Master in Epidemiology (Nihes)	2010-2013	30 ECTS
Presentations		
Dutch Conference Public Health, Rotterdam,8-9 April 2010; poster presentation "Hand hygiene in child day care centres: what are the environmental determinants?"	2010	1 ECTS
Symposium on hand hygiene in child day care centres, 8 February 2011; organisation and oral presentation "Observed hand hygiene in child day care centres"	2011	4 ECTS
Municipal Public Health Service Rotterdam-Rijnmond, lunch meeting, 25 November 2011; oral presentation "Research on hand hygiene in child day care centres"	2011	1 ECTS
SCA Hygiene Products, Gothenburg, 27 February 2012; oral presentation "Hand hygiene in child day care centres"	2012	1 ECTS
Dutch Conference Public Health, Rotterdam,10-11 April 2012; poster presentation "Hand hygiene in child day care centres: environmental determinants"	2012	1 ECTS
National Institute for Public Health and the Environment (RIVM); 6th Conference for public health nurses on infectious disease control, Bilthoven, 11 May 2012; oral presentation "Research on hand hygiene in child day care centres"	2012	1 ECTS
Conference of the Netherlands Epidemiology Society (WEON), Rotterdam, 14-15 June 2012; oral presentation "Hand hygiene compliance and environmental determinants in child day care centres"	2012	1 ECTS
Symposium on hand hygiene in child day care centres, 9 October 2012; organisation and oral presentation "Effect evaluation of a hand hygiene intervention"	2012	4 ECTS
National Institute for Public Health and the Environment (RIVM); 7th Conference for public health nurses on infectious disease control, Bilthoven, 17 May 2013; oral presentation "Research on hand hygiene in child day care centres"	2013	1 ECTS

1. PhD training	Year	Workload (Hours/ECTS)
Municipal Public Health Service Rotterdam-Rijnmond, Department of Environment and Hygiene, 13 June 2013; oral presentation "Design and evaluation of a hand hygiene intervention"	2013	1 ECTS
European Scientific Conference on Applied Infectious Disease Epidemiology (ESCAIDE), Stockholm, 5-7 November 2013; oral presentation "Improving hand hygiene compliance to reduce infections in child day care"	2013	1 ECTS
Seminars and workshops		
Research seminar, Erasmus University Medical Centre Rotterdam, Department of Public Health, 14 March 2011; oral presentation "Hand hygiene in child day care centres"	2011	1 ECTS
Training of day care personnel	2011-2012	4 ECTS
Workshop at symposium on hand hygiene in child day care centres, 8 February 2011; "Intervention measures targeting determinants of hand hygiene in child day care centers"	2011	1 ECTS
Workshop at symposium on hand hygiene in child day care centres, 9 October 2012; "Further implementation of the intervention components"	2012	1 ECTS
2. Teaching activities		
Supervising two master students Technical University Delft	2011	4 ECTS
Supervising medical students Erasmus University Medical Centre Rotterdam	2011	3 ECTS
Supervising master student Free University Amsterdam	2012	2 ECTS
Supervising research assistants	2010-2013	12 ECTS
Reviewer American Journal of Infection control, Plos One, Tijdschrift voor Gezondheidswetenschappen	2012-2013	3 ECTS
Advisor on development of a hygiene toolkit by the National Institute for Public Health and the Environment (RIVM)	2013	2 ECTS


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