

**Improving adherence to hand hygiene practice in a neonatal unit:  
The effectiveness of an intervention**

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## Abstract

**Introduction:** The most effective strategy in the prevention of nosocomial infections is hand hygiene. Multidisciplinary strategies have showed to have positive results on the adherence to hand hygiene.

**Aim:** To measure (i) adherence to hand hygiene and (ii) the effect of an intervention on hand hygiene practices of nurses and physicians working on a level II neonatal unit of a children's hospital in the Netherlands.

**Research questions:** What is the effect of an intervention promoting hand hygiene on the adherence of nurses and physicians working on a level II neonatal unit of a children's hospital in the Netherlands? What is the influence of the awareness of being observed on the adherence?

**Methods:** Before and after the intervention 39 nurses and three physicians were observed on the adherence to hand hygiene. The intervention included (i) a questionnaire, (ii) posters promoting hand hygiene and (iii) a lesson including theory and practice. Data were collected using an observation list and a questionnaire. Data analysis was performed with descriptive statistics, odds ratio, Wilcoxon signed-rank test, Mann Whitney test, Spearman's rank correlation coefficient and Chi square.

**Results:** The adherence to hand hygiene changed from 34,8% to 36,2% ( $p=0,78$ ). The adherence of healthcare workers who were aware of being observed was in both observation periods higher than those who were not aware. After the intervention this difference was significant ( $p=0,03$ ).

**Conclusion:** The intervention had no significant effect on the adherence to hand hygiene. Awareness of being observed by a colleague outside the care team resulted in a higher adherence.

**Recommendation:** The influence of the kind of observer on the awareness and adherence should be taken into account when designing future research.

## Keywords

Hand hygiene, intervention, observation, neonatal intensive care unit.

## Samenvatting

**Introductie:** De meest effectieve strategie om nosocomiale infecties te voorkomen is handhygiëne. Multidisciplinaire strategieën hebben een positief resultaat aangetoond op de toepassing van handhygiëne.

**Doel:** Het meten (i) van de toepassing van handhygiëne en (ii) het effect van een interventie op de handhygiëne door verpleegkundigen en artsen, werkend op een level II neonatale unit van een kinderziekenhuis in Nederland.

**Onderzoeksvragen:** Wat is het effect van een interventie die handhygiëne promoot op de toepassing van handhygiëne door verpleegkundigen en artsen werkend op een level II neonatale unit van een kinderziekenhuis in Nederland? Wat is de invloed van het bewustzijn van observaties op de handhygiëne?

**Methode:** Voor en na de interventie zijn 39 verpleegkundigen en drie artsen geobserveerd op de toepassing van handhygiëne. De interventie omvatte (i) een vragenlijst, (ii) posters die de handhygiëne promoten en (iii) een les met theorie en praktijk. Data werden middels een observatie- en vragenlijst verzameld. Voor de data-analyse zijn beschrijvende statistiek, een odds ratio, de Wilcoxon signed-rank toets, de Mann Whitney toets, Spearman's rank correlation coefficient en Chi kwadraat gebruikt.

**Resultaten:** De toepassing van handhygiëne veranderde van 34,8% naar 36,2% ( $p=0,78$ ). In beide observatieperiodes was de toepassing van handhygiëne hoger bij medewerkers die zich bewust waren van de observaties. Na de interventie was dit significant ( $p=0,03$ ).

**Conclusie:** De interventie had geen significant effect op de toepassing van handhygiëne. Bewustzijn van de observatie door een collega van buiten het zorgteam resulteerde in een hogere toepassing van handhygiëne.

**Aanbeveling:** In het design van een toekomstig onderzoek zou men rekening moeten houden met de invloed van het type observeerder op het bewustzijn en de handhygiëne.

## Trefwoorden

Handhygiëne, interventie, observatie, neonatale intensive care unit.



## Introduction

Nosocomial infections (NIs) are the primary cause of morbidity and mortality among infants admitted to neonatal intensive care units (NICUs)<sup>1-6</sup>. NIs are infections acquired during hospitalization and usually occur 72 hours after birth<sup>5</sup>. The incidence of NIs among healthy term infants is <1% compared to 20-25% among preterm infants. Rates of NIs among preterm infants increase with decreasing gestational age and birth weight<sup>4,7,8</sup>. Several risk factors for NIs in preterm infants have been described like the immature immune system, indwelling vascular or urinary catheters, multiple invasive procedures, parenteral nutrition, endotracheal tubes, antibiotics and prolonged hospital stay<sup>4,7,8</sup>. Organisms that cause NIs in NICUs are usually transmitted by the hands of physicians, nurses and other health care workers (HCWs)<sup>9-12</sup>.

The most effective strategy in the prevention of NIs is hand hygiene<sup>13-17</sup>. Transmission of infection decreases as hand hygiene adherence increases<sup>13-15,18-29</sup>. Hand hygiene adherence is actual applied hand hygiene in relation to moments that hand hygiene is required<sup>15</sup>. The World Health Organization (WHO) describes five key moments when hand hygiene should be applied<sup>30</sup>: (i) before touching a patient, (ii) before clean/aseptic procedures, (iii) after body fluid exposure/risk, (iv) after touching a patient, and (v) after touching patient surroundings. Since 2002, the Centers for Disease Control and Prevention (CDC) recommends hand rubbing with alcohol as the standard of care<sup>31</sup>.

Studies conducted in NICUs have reported that the adherence of HCWs to hand hygiene is low, generally less than 50%<sup>13-15,32</sup>. HCWs are unaware of their poor adherence since self-reported and observed rates differ greatly<sup>33</sup>. Promotion of hand hygiene adherence is a complex issue (15). Several factors negatively influence actual adherence of HCWs such as insufficient awareness of personal and group performance, high work load or insufficient knowledge of guidelines<sup>28,32,34,35</sup>.

Several interventions have been studied to improve hand hygiene adherence<sup>14,20,26,28,32,38</sup>. These studies demonstrated that education to improve the knowledge of guidelines and observation sessions with performance feedback increased hand hygiene adherence of HCWs from on average 38% to 61%. Other interventions are distributing hand hygiene posters, promoting hand hygiene supplies and presenting the number of health-care associated infections (HAI)<sup>26,39</sup>. Because of the complexity of the process of change, single interventions often failed, but multidimensional, multidisciplinary strategies have showed positive results<sup>32,40</sup>.

The three most reported methods of measuring adherence are direct observation, self-report of HCWs and indirect calculation based on hand hygiene product usage<sup>41</sup>. Direct observation is the only method that can assess hand hygiene technique and is noted by the WHO as the golden

standard<sup>30</sup>. A disadvantage is the possible Hawthorne effect, ie. the knowledge of being included in the study appears to affect people's behavior<sup>42</sup>.

Self-report improves the awareness of HCWs of their own behavior, but shows a poor validity in several studies<sup>28,38,40,41</sup> as self-reported hand hygiene rates differ greatly from observed rates<sup>33</sup>.

Indirect calculation promotes individual responsibility, but does not provide information about the individual adherence to hand hygiene<sup>41</sup>.

Studies use different designs to research adherence to hand hygiene before and after an intervention<sup>43</sup>. They differ in the number of observation moments (interrupted time-series design), the number of intervention moments (uncontrolled before-after design with sequential data collection) and the use of a control group (controlled before-after design). The most commonly used design is the uncontrolled before-after design<sup>43</sup>.

### **Problem statement**

Hand hygiene is a simple and effective strategy in the prevention of NIs. Nevertheless, the adherence to hand hygiene on NICUs, is often less than 50%<sup>13-15,32</sup>. The expectation is that this rate is not different on level II neonatal units. However, this assumption is not supported by data.

### **Aim**

The aim of this study was to measure (i) adherence to hand hygiene and (ii) the effect of an intervention on hand hygiene practices of nurses and physicians working on a level II neonatal unit of a children's hospital in the Netherlands. The intervention included a questionnaire, posters and a lesson including theory and practice.

### **Research questions**

“What is (i) the adherence to hand hygiene of nurses and physicians working on the level II neonatal unit of a children's hospital in the Netherlands and what is (ii) the effect of an intervention promoting hand hygiene on this adherence?”

In this study, observation (by two types of observers) was used to assess adherence to hand hygiene. Since the adherence can be influenced by the awareness of being observed and the knowledge of guidelines<sup>14,20,26,28,32,38</sup>, the following subquestion was formulated. “Is the adherence influenced by the: (i) awareness of being observed, (ii) kind of observer, (iii) knowledge of guidelines?”

## Methods

### Setting

The study was conducted from January to April 2011 at a level II neonatal unit of a children's hospital in the Netherlands. In the Netherlands these units treat patients with serious illnesses, but do not perform prolonged intensive care treatment of specific patients with very complicated diseases<sup>44</sup>. Annually, approximately 500 children are admitted. The neonatal unit consists of one unit with 20 beds. There are four washing sinks with sensor taps, alcohol and soap dispensers and paper towels. There is an alcohol dispenser at each bed. At both unit entrances is also a washing sink. A sign requests personnel and visitors to wash the hands before entering the unit, but there is no instruction how to perform hand hygiene.

### Sampling

The target population consisted of nurses and physicians working on a level II neonatal unit in the Netherlands. The research population included all 45 nurses and seven physicians working on the neonatal unit where the study was conducted. These nurses and physicians formed the sample and were considered as representative<sup>42</sup>.

To estimate the sample size a power analysis was performed. The effect size was based on an average increase of adherence of 23% after the intervention<sup>14,20,26,38</sup>. Based on a power of 0,80, a beta of 0,20 and an alpha of 0,05 the sample size was estimated on 70 in the pre- and post intervention group. The calculated sample size exceeded the available sample of 45 nurses and seven physicians.

### Procedure

#### *Study design*

To measure the effect of an intervention, we conducted a quasi experimental, one group pretest-post test study design. This means that only one group was the subject of study without a control group. Randomization was impossible since all HCWs under study worked on the same unit. During the first observation period of one month, a baseline assessment of hand hygiene practices was performed. This period was directly followed by the intervention. After the intervention hand hygiene practices were observed for the second time during a period of one month. Given the length of the study period it was not possible to conduct a third observation period to see if a possible effect sustained.

#### *Approval and ethics*

The sector manager and medical manager of the children's hospital were asked for permission to conduct this study. The nurses and physicians were informed that they were going to be observed. However, the topic of the observation was not disclosed to them since this might effect their behavior and thereby obscure the effect of the variable of interest<sup>42</sup>.

Privacy of the observed HCWs was guaranteed by giving only the researcher and observers access to the study results.

## **Data collection**

To conduct the observations as discrete as possible, the Institute for Healthcare Improvement (IHI) recommends to use observers who have responsibilities on the unit under study, but who are not part of the care team. Therefore two hospital hygienists observed the HCWs. However, the short study period required the addition of two nurses to the observation team. These two nurses were excluded from the study. The observers and the researcher discussed and practiced how to score hand hygiene practice. The intention was to observe a HCW approximately 30 minutes, based on an average duration mentioned in other studies<sup>38,45,46</sup>. Subsequently a Cohen's Kappa was determined between the researcher and each observer to ensure the inter-observer reliability. For this study the Kappa was 0,85, where '0' means no agreement and '1' means complete agreement<sup>42</sup>.

The observations took place on moments with intensive patient contact such as washing, feeding or giving medication. The observers recorded their status (hygienist or nurse) and the time and duration of the observation. To minimize the Hawthorne effect the observers kept some distance from the HCWs and usually sat behind the monitor counter in the center of the unit. Each HCW was scheduled to be observed once per observation period. Since the research population consisted of 43 nurses and seven doctors 50 observations could theoretically be performed before the intervention and 50 after the intervention.

HCWs knowledge of hand hygiene guidelines and the awareness of being observed were collected by self-report. Characteristics of HCWs were collected to describe the sample.

Data were collected anonymously, because the researcher is also the manager of the unit.

Numbers were used instead of names.

## **Instruments and variables**

### *Observation list*

The observers used the observation list that was made and validated by Pittet<sup>15</sup> and translated into Dutch and proven to be practicable in the study of Van den Hoogen<sup>38</sup>. This list was chosen, because it is based on the earlier mentioned five moments for hand hygiene of the WHO which are also included in the hospital protocol for hand hygiene. The five moments are designed to be easy to learn, logical and applicable in a wide range of settings<sup>30</sup>. The observation list is also short, clear and easy to use. During the previous discussions with the observers, it occurred that before/after touching patient surroundings often was directly followed by before/after touching a patient. To enhance the inter-rater reliability, these moments were not scored separately.

For this study the term hand hygiene included hand washing (washing hands with water and non-antimicrobial soap), antiseptic hand rub (rubbing hands with alcohol) and hand drying.

According to the observation list hand hygiene was categorized in three categories:

- (1) sufficient (applied at the right moment and complete, ie. washing the hands and the arms and letting hands dry before handling);
- (2) insufficient (applied at the right moment, but incompletely);
- (3) no hand hygiene.

Although the categories 'sufficient' and 'insufficient' vary in the applied technique, they indicate adherence at the right moment. Therefore these two categories were put together and were considered as 'adherence' throughout this paper.

### *Questionnaire*

Immediately after the first and second observation, a questionnaire was handed over to the observed HCWs. This self-report questionnaire has been made by Pittet<sup>15</sup> and has been translated into Dutch and proven to be reliable and practicable in the study of Van den Hoogen<sup>38</sup>. It included nine questions about hand hygiene such as the intention to adhere to hand hygiene, perception of knowledge of hand hygiene indications and perception of difficulty of adhering to hand hygiene<sup>15</sup>. In addition the awareness of being observed was asked. For categorizing the answers, a 2-3-point scale was used.

### **Intervention**

#### *Questionnaire*

The questionnaire above was simultaneously used as part of the intervention, because it gave the HCWs insight in their own knowledge, thoughts and actions regarding hand hygiene.

#### *Posters*

To promote hand hygiene eight different posters were chosen. Some posters focused on hand hygiene technique. These messages alone are unlikely to improve adherence<sup>47</sup>. Therefore, more effective posters with gain framed messages with a minimal fear appeal were added<sup>48</sup>. The posters were distributed at places where the HCWs work every day or walk by, e.g. on doors, in the coffee room and above wash sinks. To promote the topic and keep the HCWs alert, the posters were replaced weekly by two new ones<sup>39</sup>.

#### *Theoretical and practical lesson*

A theoretical and practical lesson about hand hygiene was developed by the researcher and the observers. It was expected that this lesson would help the HCWs memorize the importance and the technique of hand hygiene.

The theory included: (i) rationale, indications and techniques for hand hygiene, (ii) methods to maintain hand skin health and (iii) indications for and limitations of glove use. These elements were based on an overview of educational and motivational programs for HCWs<sup>28</sup>. Furthermore, the observers gave feedback on the findings of the first observation period.

Information about the hand hygiene technique included films about the hand rub technique using alcohol (Hygiène des mains Hôpitaux Universitaires de Genève) and about the hand washing method (WHO). The washing method was practiced and tested by rubbing the hands with a special powder before washing them. A special blue light showed the spots that had not been cleaned.

## **Data analysis**

To analyze the effect of the intervention, the HCWs who completed both observation periods and the full intervention were taken into account. These HCWs were considered as the effect group. Their demographic data were compared with HCWs who were observed once, performing an odds ratio and a Mann Whitney test.

To compare the effect group's adherence before and after the intervention a Wilcoxon signed-rank test was used.

For the whole sample, the difference in adherence in relation to (i) the awareness, (ii) the kind of observer and (iii) knowledge of hand hygiene guidelines was tested by a Mann Whitney test. Spearman's rank correlation coefficient was used to test the relation between observer and awareness on the adherence.

A Chi-square test was used to test the relationship between the awareness and kind of observer. All tests were two-tailed and a p-value less than 0,05 was considered as statistically significant. Data analysis was conducted in SPSS version 17.0 (SPSS Inc., Chicago, IL, USA).

## **Results**

### **Sample**

Of the 45 nurses, two were excluded because they were observers. Four nurses and four physicians were missed by the observers. Eventually, thirty-nine nurses and three physicians were observed in the first and/or second observation period. The study covered a sample of 42 HCWs. Twenty six HCWs were observed in both periods. Sixteen HCWs were observed once, eight only in the first period, eight only in the second period. This made a total of 34 HCWs in both periods. The duration of the observations averaged 27 minutes (range 15-45) in the first period versus 29 minutes (range 20-45) in the second. The observations were carried out during day shifts (88,2%) and during evening shifts (11,8%). Thirty seven HCWs (88,1%) attended the lesson.

### **Effect group**

Twenty five of the 42 HCWs completed both observation periods and the full intervention and were considered as the effect group. One HCW was observed in the first and second observation period, but did not attend the lesson. However, she had completed the questionnaire, probably saw the posters and was therefore added to the effect group making a total of 26.

There was no significant difference in characteristics between the effect group and the other 16 HCWs who were only observed before or after the intervention.

<Insert table 1>

### **Adherence**

Table 2 shows the adherence for the effect group. Before the intervention 250 opportunities for hand hygiene were observed, after the intervention 210. In the effect group the percentage of sufficient hand hygiene did not change whereas the percentage for insufficient hand hygiene slightly increased. The adherence (sufficient plus insufficient) for hand hygiene changed from 34,8% to 36,2% ( $p=0,78$ ).

In the whole study group the adherence showed the same pattern as in the effect group.

<Insert table 2>

### **Adherence and influencing factors**

Table 3,4 and 5 show the adherence of the 34 HCWs in both periods in relation to awareness of being observed and the kind of observer. In period one, 346 expected hand hygiene moments were observed, 274 in period two.

#### *Adherence and awareness*

In both periods 32,4% of the HCWs were aware of being observed. Hereby the number of opportunities for hand hygiene for aware HCWs is higher than for not aware HCW's. The adherence of HCWs who were aware was in both periods higher than those who were not aware. In period two this difference was significant ( $p=0,03$ ; table 3).

In period one the adherence of aware HCWs was significant higher when the hygienists observed than when the nurses observed.

<Insert table 3>

#### *Awareness and observer*

The hospital hygienists performed 38,3% of all observations, the nurses 61,7%. The HCWs were in both periods significantly more aware of the observations when the hygienists observed than when the nurses observed. In period one this rate was 53,3% vs 21,1% ( $p=0,05$ ), in period two 90,0% vs 4,3% ( $p=0,000$ ).

<Insert table 4>

#### *Adherence and observer*

In both periods, the adherence observed by the hygienists was significantly higher than the adherence observed by the nurses ( $p=0,005$  and  $p=0,004$ ). Because adherence was both influenced by awareness (table 2) and the kind of observer (table 5), it was investigated if there was a relation between the awareness and the kind of observer on the adherence. In the first

period, the awareness of being observed by a hygienist resulted in a higher adherence. Awareness of being observed by a nurse did not result in difference in adherence. Analysis with Spearman's rank correlation coefficient showed in both periods no significant relation between the awareness and the kind of observer on the adherence.

<Insert table 5>

### *Knowledge and adherence*

The knowledge about hand hygiene guidelines among all observed HCW's was scored 100% 'yes' in both periods, whether the HCWs did or did not attend the intervention. Regarding the effect group, the answer to the question whether correct hand hygiene have been applied, was 84,6% 'yes' and 15,4% 'no' before the intervention and 76,9% 'yes' and 11,5% 'no' after the intervention (11,5% did not answer this question). However, the adherence was 32,6% in period one and 37,9% in period two. In both periods the majority of the observed HCWs found it difficult to apply proper hand hygiene (resp 65,4% and 61,5%).

## **Discussion**

The purpose of this study was to collect data about adherence to hand hygiene by HCWs on a level II neonatal unit and to measure the effect of an intervention on the adherence. The adherence did not change after the intervention. A slightly increase in insufficiently applied hand hygiene was observed, whereas sufficiently applied hand hygiene did not change.

About one in three HCWs were aware of being observed. The HCWs were more aware when the hospital hygienists observed them then when nurses observed them.

The awareness of being observed resulted in a higher adherence. The hospital hygienists observed a significantly higher adherence than the nurses. Given the kind of observer, there was no significant relation between awareness and adherence.

In both periods, all HCWs indicated that they knew the hand hygiene guidelines.

Furthermore, the HCWs' self-assessment of hand hygiene adherence did not match the observed adherence.

### **Intervention**

The adherence at baseline in our study was in line with what is described in the literature about hand hygiene on NICUs<sup>14,20,26,28,32,38</sup>. Although we used the same intervention we did not measure an improvement of hand hygiene practices in our study in contrast to other studies that measured an increase of adherence of 18 to 23%<sup>14,32,38,46</sup>. One explanation might be that the sample of our study was not sufficient thus resulting in insufficient power to measure an effect of the intervention. Another difference with other studies is that the posters were chosen by the researcher and observers. It has been suggested that a higher effect could be achieved when the target population is involved in this process<sup>39</sup>. In other studies it is not described how posters were chosen. Finally, in

our study performance feedback was given to the whole group during the lesson instead of individual feedback right after the observation<sup>38,46</sup>.

We observed no change in overall adherence but we did find a slight increase in insufficient hand hygiene. We suggest that the intervention slightly increased adherence, but that one does not take the sufficient time to perform correct hand hygiene. "Being too busy" is often cited as an explanation for non-adherence or insufficient adherence in other studies<sup>49,50</sup>.

### **Awareness and observer**

Like Pittet<sup>15</sup>, our study showed that awareness of being observed resulted in a higher adherence (Hawthorne effect). We have investigated the relation between the kind of observer and the adherence, whereas most studies do not pay attention to this subject<sup>14,45,46</sup>. Our study showed that the hospital hygienists observed a significantly higher adherence than the nurses. We assume that awareness of observation by a familiar colleague (the nurse) did not influence HCWs adherence as much as awareness of observation by a colleague from outside the care team (the hygienist). This can indicate that the group culture did not reinforce adherence although other studies show the opposite<sup>28, 32,35</sup>

We investigated the relation between the kind of observer and awareness of being observed. When the hospital hygienist observed, the awareness among HCW's of being observed was higher than when nurses observed. Therefore this study cannot subscribe the IHI's statement that observations should be performed by someone not part of the team. We presume that in our study observations by a hospital hygienist was more often noticed, because both hygienists were not part of the nursing team whereas observations by a nurse being part of the team is less striking. Subsequently, we investigated the relation between awareness, kind of observer and adherence. We found two important points. First, both kind of observers measured no difference in adherence between aware and not aware HCWs. However, the adherence observed by the hygienists is higher than when the nurses observed, even when the HCW was not aware of being observed. A possible explanation is that even though the HCWs were not aware of being observed, they were aware of the hospital hygienists being present, which might cause in itself a higher adherence. Second, when the HCW was aware, the adherence was significantly higher (in period one) when the hygienists observed than when the nurse observed.

It seems that there was no direct relationship between kind of observer and adherence. Adherence was more likely to be influenced by awareness, whereas awareness was higher when the hygienists observed than when the nurses observed.

### **Knowledge**

In both periods, all HCWs indicated that they knew the hand hygiene guidelines whether the HCWs did or did not attend the intervention. Other studies report 35% of the HCWs<sup>15</sup> and an improvement of 81% to 93% after an intervention. In retrospect, in our study the question about the knowledge was not distinctive enough. On one hand, the observations show that hand hygiene is not optimal,

which partly could be explained by overestimated knowledge of hand hygiene guidelines. On the other hand, a general question about hand hygiene is more likely to provoke a desirable answer than specific questions testing knowledge. Huang<sup>46</sup> used the HCWs' Knowledge of Hand-Hygiene Questionnaire which includes concrete questions about the moments, the duration, technique of hand hygiene. This could have given more insight in our study. Observations could test the application of this knowledge. In addition, some questions were scored on a 2-point scale where for example a 5-point scale would have given more gradation.

The finding that the HCWs' more positive self-assessment of hand hygiene adherence did not match the observed adherence is consistent with Haas and Larson<sup>41</sup> who concluded that an objective assessment of hand hygiene only can be achieved by observation and not by self report. Individual feedback on hand hygiene adherence could enhance insight.

### **Limitations**

First, randomization was not feasible since the intervention was performed on one unit. Second, due to the small sample size it is likely that no effect could be shown. Other studies, with a larger sample show a larger effect<sup>14,20,26,28,32,38</sup>. Third, although the infection rate is seen as an important outcome parameter with regard to hand hygiene adherence<sup>43</sup>, this study has not investigated the infection rate in infants admitted to the neonatal unit due to the short study period. It is acknowledged that a longer period of infection rate surveillance is necessary before the impact of improved hand hygiene can be measured<sup>14</sup>.

The study was conducted at a single neonatal unit, which may limit general application of our findings as the organization of work and the specific environmental factors may influence behavior.

### **Conclusion**

The adherence to hand hygiene at baseline in our study was in line with other studies.

The intervention in this study had no significant effect on the adherence. After the intervention, more HCWs applied hand hygiene at the right moment, but not always with adequate techniques. In both periods, all HCW's indicated that they had knowledge about hand hygiene guidelines. This shows a mismatch between self-assessed knowledge and application of adequate techniques. Awareness of being observed by a colleague outside the care team resulted in a higher adherence. This effect was not found when a colleague from the care unit performed the observation.

## **Recommendations**

To measure a possible higher effect of the intervention, a larger sample is recommended. The questions about the guidelines seemed not distinctive enough. Concrete questions testing the knowledge could have given more insight.

In future research the influence of group culture and peer pressure could be analyzed. Awareness and hand hygiene adherence is influenced by the fact whether the observer is from outside the care unit or not. This effect should be taken into account when designing future research.

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## APPENDIX Tables

**Table 1.** Characteristics of HCW's of the Effect Group and HCW's outside the Effect Group <sup>a</sup>.

Characteristics of observed HCW's	Effect group (n=26)	Outside the effect group (n=16)	P value
<b>Gender</b>			
Male	0 (0%)	0 (0%)	n/a
female	26 (100%)	16 (100%)	
<b>Age (years)</b>	38,7 (23-54)	37,0 (22-49)	0,57 <sup>b</sup>
<b>Profession</b>			0,813 (0,642 - 1,028) <sup>c</sup>
Nurse	26 (100%)	13 (81,2%)	
Physician	0 (0%)	3 (18,8%)	
<b>Experience care (years)</b>	19,3 (5-36)	16,7 (3-33)	0,467 <sup>b</sup>
<b>Experience at the neonatal unit (years)</b>	7,9 (0,5-21)	7,0 (0,2-20)	0,520 <sup>b</sup>

<sup>a</sup> Data showed as number (%) or mean (range)

<sup>b</sup> Mann Whitney test

<sup>c</sup> Odds ratio (CI 95%)

**Table 2.** Application of Hand Hygiene in Relation to the expected Hand Hygiene Moments before and after the Intervention in the Effect Group <sup>a</sup>

Adherence effect group (n=26)	First observation	Second observation	P value <sup>f</sup>
no <sup>b</sup>	163/250 (65,2%)	134/210 (63,8%)	0,78
sufficient <sup>c</sup>	63/250 (25,2%)	43/210 (20,5%)	0,73
insufficient <sup>d</sup>	24/250 (9,6%)	33/210 (15,7%)	0,07
adherence <sup>e</sup>	87/250 (34,8%)	76/210 (36,2%)	0,78

<sup>a</sup> Data showed as number (%); actual applied hand hygiene in relation to moments that hand hygiene is required

<sup>b</sup> No hand hygiene when the opportunity required hand hygiene.

<sup>c</sup> Sufficient (hand hygiene applied at the right moment, completely).

<sup>d</sup> Insufficient (hand hygiene applied at the right moment, but incompletely).

<sup>e</sup> Adherence (sufficient and insufficient together, ie. at the right moment, but not necessarily the right technique).

<sup>f</sup> Wilcoxon signed-rank test for two dependent samples.

**Table 3.** Adherence in Relation to Awareness<sup>a</sup>.

Factor	Period 1 (n=34)		Period 2 (n=34)	
	Adherence	Difference (P value)	Adherence	Difference (P value)
<b>Awareness</b>				
yes	45/97 (46,39%)	0,11 <sup>b</sup>	39/65 (60,00%)	0,03 <sup>b</sup>
no	68/249 (27,30%)		65/209 (31,10%)	
yes - observer hygienist	37/63 (58,73%)	0,04 <sup>c</sup>	37/58 (63,79%)	0,22 <sup>c</sup>
yes - observer nurse	8/34 (23,53%)		2/7 (28,57%)	
no - observer hygienist	26/66 (39,39%)	0,11 <sup>c</sup>	3/3 (100,0%)	0,11 <sup>c</sup>
no - observer nurse	42/183 (22,95%)		62/206 (30,10%)	

<sup>a</sup> Data showed as number (%); actual applied hand hygiene in relation to moments that hand hygiene is required

<sup>b</sup> Mann Whitney test

<sup>c</sup> Spearman's rank correlation coefficient

**Table 4.** Awareness in Relation to Observer<sup>a</sup>

Observer	Period 1 (n=34)		Period 2 (n=34)	
	Number of aware HCWs	Difference (P value)	Number of aware HCWs	Difference (P value)
Hygienist	53,3%	0,05 <sup>b</sup>	90,0%	0,000 <sup>b</sup>
Nurse	21,1%		4,34%	

<sup>a</sup> Data showed as number (%)

<sup>b</sup> Chi square

**Table 5.** Adherence in Relation to Awareness and Observer<sup>a</sup>

Factor	Period 1 (n=34)		Period 2 (n=34)	
	Adherence		Adherence	Difference (P value)
hygienist	63/129 (48,84%)	0,005 <sup>b</sup>	40/61 (65,57%)	0,004 <sup>b</sup>
nurse	50/217 (23,04%)		64/213 (30,05%)	
hygienist - HCW aware	37/63 (58,73%)	0,236 <sup>c</sup>	37/58 (63,79%)	0,279 <sup>c</sup>
hygienist - HCW not aware	26/66 (39,39%)		3/3 (100,0%)	
nurse - HCW aware	8/34 (23,53%)	0,847 <sup>c</sup>	2/7 (28,57%)	0,302 <sup>c</sup>
nurse - HCW not aware	42/183 (22,95%)		62/206 (30,10%)	

<sup>a</sup> Data showed as number (%); actual applied hand hygiene in relation to moments that hand hygiene is required

<sup>b</sup> Mann Whitney test

<sup>c</sup> Spearman's rank correlation coefficient