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# Preventing nosocomial infections: improving compliance with standard precautions in an Indonesian teaching hospital

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**Summary** Standard precautions can prevent transmission of micro-organisms. This study investigated hand hygiene, handling of needles and use of personal protective equipment in an Indonesian teaching hospital, and performed a multi-faceted intervention study to improve compliance. An intervention was performed in an internal medicine ward and a paediatric ward, consisting of development of a protocol for standard precautions, installation of washstands, educational activities and performance feedback. Before, during and after the intervention, observers monitored compliance with hand hygiene, safe handling of needles and use of gloves, gowns and masks. A gynaecology ward served as the control. Unobtrusive observations were performed to check for an influence of the observers on the overt observations. In total, 7160 activities were observed. Compliance with hand hygiene increased from 46% to 77% in the internal medicine ward and from 22% to 62% in the paediatric ward. Before the intervention, no safe recapping of needles was recorded in either ward. After the intervention, 20% of needles were recapped safely. Inappropriate gown use decreased in the internal medicine ward.

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There were no significant changes in use of gloves and masks. There may have been an effect of the overt observations in the paediatric ward, but there was no effect in the internal medicine ward. There were no significant changes in the control ward, except for a decrease in the use of gloves. In conclusion, compliance with hand hygiene procedures improved significantly due to an intervention project focused on education and improved facilities. Compliance with safe handling of needles improved slightly due to introduction of the one-handed method for safe recapping of used needles.


## Introduction

Prevention of pathogen transmission in hospitals is based primarily on standard precautions. According to the principle that every patient is a potential source of pathogens, precautions should be taken whenever contact with a patient or patient's materials may result in transmission. Standard precautions combine measures to prevent nosocomial infections in patients and job-related infections in healthcare workers (HCWs). Among the standard precautions are hand hygiene, personal hygiene of HCWs and patients, safe handling of sharp objects, and the use of personal protective equipment (PPE) such as gloves, gowns and masks.[1]

Improving adherence to standard precautions has been the aim of many intervention studies published in recent years.[2–16] Most of these studies focused on changing the behaviour of HCWs towards stricter observance of hand hygiene protocols.

Low adherence to guidelines is considered to be an attitudinal and behavioural problem. However, in developing countries, HCWs face other problems in compliance with standard precautions.[17,18] In Indonesia, many public hospitals have limited facilities for infection control. Clinical wards often have few handwashing facilities, sometimes without soap or towels. Sufficient water pressure to assure a continuous supply of water is not always guaranteed. Sometimes there is no running water, and washbasins filled with cleaning solutions (chlorhexidine/cetrimide) are used instead. Alcohol-based hand rubs are not widely available, and there is often a shortage of gloves, gowns and masks. In many hospitals, single-use gloves are sterilized and re-used, and containers for safe disposal of sharp objects are often absent.

Given the essential role of standard precautions, an intervention study was performed in the Dr. Kariadi Hospital, Semarang, Indonesia, taking into account the problems described above and behavioural aspects to improve adherence to hand hygiene, safe handling of needles and the use of PPE.

## Methods

### Setting

The study was conducted in a paediatric ward and an internal medicine ward at Dr. Kariadi Hospital. A gynaecology ward served as the control. The internal medicine ward is a 66-bed unit with eight large rooms and four two-bed rooms, three of which are used for isolation. The paediatric ward is a 45-bed unit with nine rooms, one of which is used for protective isolation and two are used for source isolation. The gynaecology ward is a 66-bed unit with seven large rooms.

At the start of the study, there were two washstands with running water, soap and either a cotton towel or no towel in the internal medicine ward. In the paediatric ward, there were three trolleys with two bowls, one filled with a chlorhexidine/cetrimide solution and one filled with water.

Empty plastic bottles were used as needle containers in both study wards. Needles were usually resheathed first and then discarded into these bottles. There was a shortage of gloves in both wards, and disposable latex gloves were sterilized and re-used. Cotton gowns and masks were in limited supply.

### Design

The study consisted of several periods.

1. Pre-intervention baseline observation period. HCWs were not informed about the actual goal of the observations.
2. Consensus period. Observations were continued and members of the local infection control committee, researchers and representatives of medical and nursing personnel developed ward protocols for hand hygiene, use of PPE and safe

handling of needles during a series of consensus discussions.
3. Intervention period. Intervention activities were performed and observations were continued.
4. Post-measurement and feedback period. Observations were continued and feedback was given once or several times.

## Intervention

At the start of the intervention period, three more washstands were installed in the internal medicine ward. In the paediatric ward, the washbasins were replaced by three washstands.

One month after installation of the washstands, a three-week campaign was commenced, consisting of a lecture on standard precautions, practical sessions in small groups and written information. The practical sessions were run frequently to ensure that all medical and nursing personnel and students could attend. HCWs learned and practised correct handwashing techniques and use of hand rub in the first week, safe handling of needles in the second week, and use of PPE in the third week. As no budget was available for designated needle containers, recapping was taught with the one-handed method as the only correct way of handling used needles.[19,20] Each attendant received a summary of the protocol and a small bottle of alcohol-based hand rub. Hand rub was also placed in all rooms in the wards. Alcohol-based hand rub was produced locally by the hospital pharmacy (one pocket bottle contained 100 mL ethanol 70% plus 2 mL glycerin). Feedback on compliance with hand hygiene during baseline and consensus periods was given orally and on charts hung near washstands. Those attending the practical sessions on safe recapping received a pocket calculator with statements on infection control as a small gift. Brightly coloured posters depicting the procedures were hung in nurses' rooms.

After the campaign, feedback on compliance with hand hygiene protocols was given once in the paediatric ward and three times in the internal medicine ward.

## Measurements

Adherence to guidelines was measured by overt observations of HCWs by the researchers (HF and DOD) and trained observers. Observations were also made unobtrusively by trained ward personnel whilst doing their work in order to check whether compliance was influenced by the presence of the observers. An observation schedule ensured that all rooms were observed equally. Half of the patient rooms were studied per observation. Overt observations were made from 7.00 to 8.30 a.m., and unobtrusive observations were made between 7.30 and 8.30 a.m.

All activities that, according to the protocol, required hand hygiene or use of PPE were recorded. Simultaneously, other observers counted the number of handwashings. As there were only two to four handwashing facilities per ward, all handwashings in the ward were recorded. Use of hand rub was only counted in the rooms under observation.

It was recorded each time a HCW carried out any activity while wearing gloves, a gown or a mask, or handled needles. Handling of needles was classified as unsafe when used needles were either not recapped by the one-handed method or were taken from the room without resheathing.

## Outcome measures

Compliance with hand hygiene: observed hand hygiene as percentage of maximum hand hygiene indicated by the ward protocol.
Compliance with PPE: observed use of gloves, masks and gowns as percentage of maximal use indicated by the ward protocol.
Safe handling of needles: percentage of cases of handling needles followed by recapping by the one-handed method.

## Calculations and statistical analysis

Compliance with hand hygiene was calculated as follows:

$$\frac{a+(b(c/d))}{((e_tf_t)+(e_2f_2)\cdots+(e_nf_n))(c/d)}\times 100$$

in which $a$ represents the number of times that handwashing is observed for the whole ward, $b$ is the number of times that use of alcohol-based hand rub is observed in the observed rooms, $c$ is the number of patients present in the ward, $d$ is the number of patients present in the observed rooms, $e$ is an activity carried out by a HCW in an observed room, and $f$ is the number of times that hand hygiene should be applied for activity $e$ according to the consensus protocol.

Population characteristics and compliance were analysed using SPSS. First, compliance was calculated per observation period. Regression lines and ANOVA were used to detect significant changes in compliance within observation periods. When there were no significant changes in compliance

per observation period, mean compliance for these periods was calculated. Next, significant differences between all periods were analysed with ANOVA and post-hoc tests. Significant differences between overt and unobtrusive observations were determined with the independent samples *t*-test.

For statistical analysis, the post-measurement period was divided into several periods because feedback was given repeatedly in the internal medicine ward. The post-measurement data for the paediatric ward were divided into periods paralleling the periods in the internal medicine ward, so the difference between measurements alone and feedback plus measurements could be analysed.

## Results

Observations were performed from 21 July 2003 to 26 June 2004. During 81 overt observations per ward, 3126 and 1879 activities were observed in the internal medicine ward and the paediatric ward, respectively (Table I).

### Hand hygiene

There were no significant trends in compliance within periods in either of the wards. Therefore, mean compliance in the baseline period was compared with mean compliance in the other periods.

In the internal medicine ward (Figure 1a and Table I), compliance increased significantly from baseline to the intervention period [difference 38%, 95% confidence interval (CI) 13—64] and remained increased until the end of the study. Overall, there was a 67% increase from baseline to the last observation period (difference 31%, 95% CI 1—62).

In the paediatric ward (Figure 1b and Table I), there was a significant increase in compliance from baseline to the intervention period (difference 74%, CI 95 41—108). In the last period, after six weeks without any activities, there was a non-significant decrease in compliance (difference 34%, 95% CI -73—4). The difference calculated is the difference from the intervention period to the last observation period. Overall, there was a 182% increase from baseline to the last observation period (difference 40%, 95% CI 4—76).

### Handling of needles

In the internal medicine ward, handling of needles was recorded 693 times, with hardly any safe handling in the baseline and consensus periods and a non-significant increase in the intervention period (Table I). Compliance was highest in the last observation period (difference 53%, 95% CI 39—74).

In the paediatric ward, handling of needles was observed 158 times. The majority of needles were handled unsafely in all periods (Table I).

### Use of PPE

Neither ward exhibited significant differences in compliance with PPE use (Table I).

In the internal medicine ward, use of gloves was observed 45 times in the baseline period, while there were 103 indications for use. After the intervention period, use of gloves was observed 113 times, while there were 197 indications for use. Compliance did not change significantly throughout the study. Indications for use of gowns were observed 20 times in the baseline period, while gown use was observed 418 times. After the intervention period, use of gowns was observed 216 times, while there were three indications for use. Overuse of gowns decreased significantly from 27 gowns per observation in the baseline period to two gowns per observation in the last observation period (difference 25, 95% CI -18 to -31). Mask use was observed 59 times throughout the study period, while there were two indications for use. Compliance with the use of gowns and masks could not be calculated because there were very few indications.

In the paediatric ward, use of gloves was observed three times in the baseline period, and there were 20 indications for use. After the intervention period, use of gloves was observed 14 times and there were 37 indications for use. In total, mask use was observed 15 times, while there were six indications for use, and gown use was observed 12 times, with five indications for use according to standard precautions. Due to these small numbers, compliance with the use of gloves, gowns and masks could not be calculated.

### Unobtrusive observations

Unobtrusive observations were performed 21 times in the internal medicine ward and 16 times in the paediatric ward from the intervention period to the last observation period (Figure 1a,b).

There was no significant difference between the two types of observations. However, inspection of the boxplots suggests that there may have been a difference for the paediatric ward, at least during the intervention period, which failed to reach significance due to the small sample size.

**Table I** Demographic data

| | Baseline | Consensus | Intervention | Post 1 | Post 2 | Post 3 | Post 4 |
|---|---|---|---|---|---|---|---|
| Internal medicine | | | | | | | |
| Number of overt observations | 15 | 14 | 12 | 11 | 8 | 14 | 7 |
| Patients on ward[a] | 27 (5) | 35 (7) | 40 (10) | 46 (6) | 45 (8) | 32 (9) | 25 (5) |
| Patients observed[b] | 49 (11) | 52 (11) | 50 (12) | 47 (11) | 46 (14) | 52 (14) | 51 (17) |
| Number of activities[c] | 42 (14) | 42 (17) | 41 (21) | 45 (14) | 44 (15) | 29 (15) | 23 (9) |
| Handwashing[d] | 44 (8) | 52 (12) | 61 (21) | 55 (13) | 58 (16) | 44 (14) | 35 (14) |
| Use of hand rub[e] | 11 (7) | 9 (9) | 9 (11) | 27 (13) | 27 (13) | 17 (10) | 14 (13) |
| Compliance hand hygiene[f] | 37, 46 (23) | 55, 61 (27) | 68, 84 (63) | 58, 63 (24) | 67, 63 (11) | 80, 79 (30) | 65, 77 (27) |
| Safe recapping | 1 (3) | 0 (0) | 8 (16) | 18 (21) | 33 (26) | 13 (18) | 57 (42) |
| Compliance glove use | 44 (31) | 57 (32) | 47 (34) | 49 (39) | 64 (39) | 52 (41) | 77 (32) |
| Compliance gown use | 100 | 100 | — | 100 | — | — | 100 |
| Compliance mask use | — | 0 | — | — | — | 0 | — |
| Paediatrics | | | | | | | |
| Number of overt observations | 15 | 14 | 10 | 11 | 12 | 11 | 8 |
| Patients on ward[a] | 22 (4) | 25 (6) | 23 (6) | 28 (6) | 23 (5) | 26 (3) | 19 (4) |
| Patients observed[b] | 54 (21) | 57 (20) | 54 (9) | 57 (10) | 48 (11) | 50 (19) | 53 (20) |
| Number of activities[c] | 22 (10) | 33 (16) | 21 (9) | 32 (14) | 18 (7) | 17 (10) | 17 (6) |
| Handwashing[d] | 13 (5) | 19 (7) | 33 (11) | 34 (12) | 31 (16) | 28 (7) | 25 (9) |
| Use of hand rub[e] | 1 (5) | 12 (15) | 8 (14) | 14 (10) | 19 (28) | 8 (9) | 10 (9) |
| Compliance hand hygiene[f] | 24, 22 (10) | 41, 40 (19) | 77, 96 (70) | 68, 88 (63) | 95, 85 (35) | 78, 84 (44) | 55, 62 (18) |
| Safe recapping | 0 (0) | 2 (6) | 13 (35) | 22 (37) | 0 (0) | 25 (46) | 0 (0) |
| Compliance glove use | 18 (41) | 4 (12) | 17 (37) | 17 (41) | 8 (17) | 0 (0) | 45 (37) |
| Compliance gown use | 33 (58) | — | 0 | — | — | — | — |
| Compliance mask use | 33 (58) | — | 100 | — | 0 | — | — |
| Gynaecology | | | | | | | |
| Number of overt observations | | 19 | 12 | 9 | | | |
| Patients on ward[a] | | 57 (4) | 53 (6) | 47 (5) | | | |
| Patients observed[b] | | 52 (6) | 50 (6) | 47 (10) | | | |
| Number of activities[c] | | 60 (10) | 55 (14) | 40 (9) | | | |
| Handwashing[d] | | 17 (7) | 19 (8) | 16 (8) | | | |
| Use of hand rub[e] | | 0 0 | 0 0 | 0 0 | | | |
| Compliance hand hygiene[f] | | 14, 14 (5) | 17, 17 (8) | 17, 17 (6) | | | |
| Safe recapping | | 0 0 | 0 0 | 0 0 | | | |
| Compliance glove use | | 85 (31) | 64 (48) | 25 (20) | | | |
| Compliance gown use | | — | — | — | | | |

The numbers given are mean percentages (standard deviation), unless otherwise indicated.
[a] Number of patients present in the ward at the start of 90-min observation period.
[b] Percentage of patients observed (number of patients present in observed rooms/number of patients present in ward) during 90-min observation period.
[c] Number of observed activities carried out by ward personnel per 90-min observation period.
[d] Number of times that handwashing was observed in the ward per 90-min observation period.
[e] Use of hand rub as percentage of total hand hygiene (handwashing + use of hand rub) per 90-min observation period.
[f] Median, mean (standard deviation).

## Control ward

In the gynaecology ward, 2155 activities were observed during the consensus, intervention and post-intervention periods.

There was no significant change in compliance with hand hygiene during the observation period, either within or between periods. Use of alcohol-based hand rub was never observed. All needles were handled unsafely in all periods.

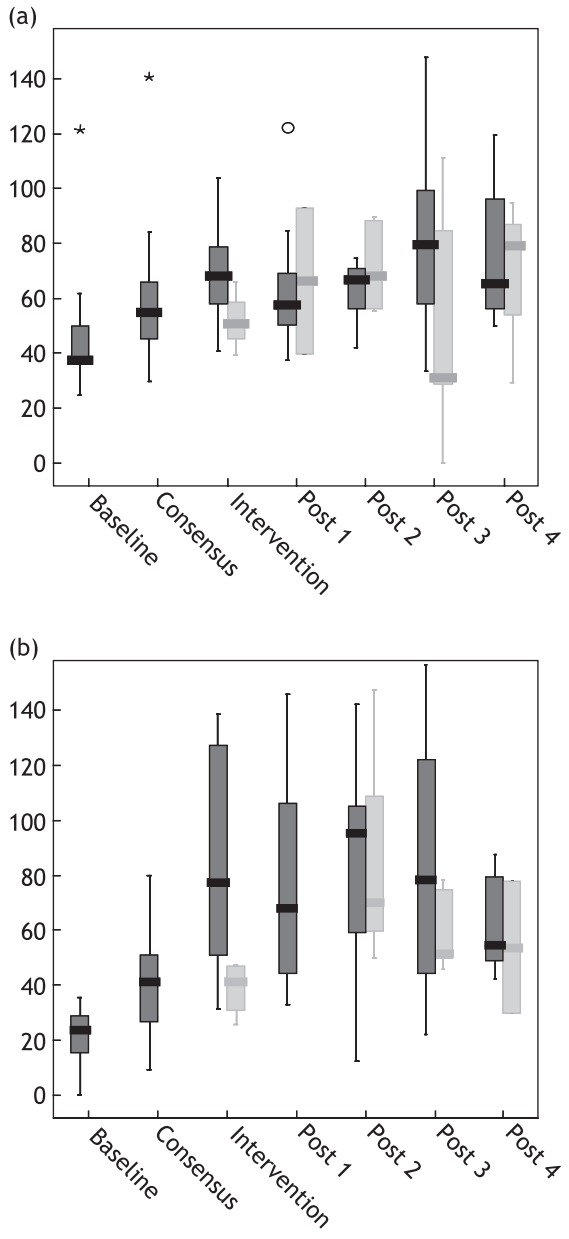


**Figure 1** Compliance with hand hygiene protocols (%) in (a) an internal medicine ward and (b) a paediatric ward. In these boxplots, the dark grey bars represent compliance with hand hygiene protocols (interquartile range) measured by overt observations, while the light grey bars represent compliance measured by unobtrusive observations. The horizontal lines represent median compliance per period, and ∗ and ○ represent outliers.

Compliance with use of gloves decreased significantly from the consensus period to the post-intervention period. Use of gloves was observed 121 times and there were 84 indications for use. Compliance with the use of gowns and masks could not be calculated because, although gowns were worn 40 times and masks were worn 25 times, there were no indications according to standard precautions. Gowns were worn while handling cytostatic drugs.

## Discussion

The intervention procedure, combining installation of washstands, teaching activities and feedback on performance, resulted in a significant and sustainable improvement in hand hygiene. Safe handling of needles by applying the one-handed method for resheathing used needles was introduced with some success in the internal medicine ward but failed in the paediatric ward. With the exception of a strong decrease in overuse of gowns in the internal medicine ward, the use of gloves, masks and gowns did not change despite instruction to HCWs and consensus about indications for use.

For the assessment of compliance with the hand hygiene protocol, observations of handwashing and care activities were performed separately. The advantage of this method was that the observers did not need to follow the HCWs closely. The disadvantage was that compliance had to be calculated with the assumption that the number and type of activities in the observed rooms were the same as in the whole ward, because observations of handwashing at washstands concerned the whole ward whereas activities could be measured for a small part of the ward. By calculating mean adherence per period, individual variations were levelled out and reliable estimations of adherence were possible.

The fact that HCWs were observed from a distance decreased observer bias. The hypothesis that people improve their behaviour when they know they are being observed could not be confirmed by comparing compliance measured with overt and unobtrusive observations. In the paediatric ward, there may have been a temporary influence of observation on HCWs' compliance during the intervention period. At this point in the study, HCWs were aware of the goal of the observations as they received feedback on their compliance in the baseline and consensus periods. Indeed, on several occasions, HCWs started washing their hands 'en masse' when they spotted the observers. This effect appeared to dissipate after a few weeks.

The hand hygiene intervention was the most successful. During and shortly after the intervention period, there was an enthusiastic response of personnel, especially in the paediatric ward. In this ward, before the intervention, there were no washstands with running water. Several senior nurses in the paediatric ward felt frustrated by the lack of facilities in their ward, and saw the study as an opportunity to tackle the problems of hand hygiene. During the study, they regularly reminded the HCWs of the importance of hand hygiene. The initial response in the internal medicine ward was

weaker, but compliance was still significantly higher six months after the intervention than at baseline. After the newly appointed head nurse of this ward was settled into her new job, she also regularly reminded HCWs of the importance of hand hygiene during educational meetings.

Although overall compliance with hand hygiene improved significantly, alcohol-based hand rub did not become an accepted alternative to handwashing. Acceptance of hand rub could facilitate compliance greatly.[5,8,12,21] One pocket-sized bottle with 100 mL of locally produced alcohol-based hand rub currently costs Rp 1375 (Euro 0.14), consisting of Rp 325 for the bottle and Rp 1050 for the contents. In practice, the price of a bottle is slightly lower because the bottles are re-used.

Introduction of hand rub may have failed for several reasons. During the consensus discussions and practical sessions, it was noticed that there were misconceptions regarding indications, effectiveness, unfavourable effects and correct use of hand rub. Fear that hand rub would dry the skin played a role, which was an understandable concern given the fact that alcohol-based solutions, often without skin protection, were present in the wards before the study and were occasionally used for hand hygiene. Many HCWs questioned the effectiveness of hand rub alone, which may be due to a common perception that water is the only effective means of hand hygiene. In a predominantly Muslim society, people learn to wash their hands frequently with water from early childhood. For Muslims, drinking of alcohol is forbidden (*haram*). Islam permits use of alcohol as a medicinal agent, and most HCWs did not object to using alcohol-based hand rubs. However, HCWs occasionally remarked that alcohol was not a desirable agent for them to use.

With regard to handling of needles, disposal of unsheathed needles in designated needle containers is superior to resheathing, even by a safe method. Unfortunately, containers were not available so HCWs were taught to recap needles using the one-handed method. In the current low-budget situation, this method could make HCWs' work much safer.

Although this intervention had some effect, unsafe handling of needles was still observed at the end of the study. If the hospital management gave proper attention to bloodborne diseases by creating facilities for correct disposal of sharp objects, this might enhance HCWs' awareness of and compliance with safe handling of needles. A system for vaccination of HCWs and post-exposure prophylaxis should also become part of the hospital infection control system.

Compliance with use of gloves was reasonable, although many HCWs did not know that hand hygiene should be carried out after removing gloves. Due to a shortage of gloves, used gloves were washed and re-used. The authors decided not to prioritize an adequate supply of gloves, gowns and masks, given the few indications for use and a limited budget. However, a marked improvement in the quantity and quality of PPE use might require improvements in facilities. The overuse of gowns in the internal medicine ward can be explained by the habit of several nurses of wearing gowns as part of their daily dress, which they discontinued after learning the indications for use of gowns.

Compliance was measured up to six months after the end of the campaign. Continuing observations, repeated feedback and further improvements in facilities may help to sustain the effects of the intervention. In many hospitals in Western countries, teaching and reminding HCWs about the importance of infection control measures are tasks of the infection control personnel. In Dr. Kariadi Hospital, there are no infection control professionals; instead, one or two nurses in each ward are responsible for infection control in addition to patient care. In this study, they proved to be enthusiastic and authoritative opinion leaders. Appointment and training of infection control professionals may help to maintain the effects of intervention projects, such as that presented here.

Influencing HCWs' behaviour with respect to infection control is difficult, but is best achieved by intervention procedures that combine several methods, such as educational activities and feedback.[5,12,22–25] In countries with limited healthcare resources, such as Indonesia, such interventions are only likely to be successful when they incorporate improvements in facilities.

Further studies are needed to determine whether appointing dedicated, trained infection control personnel will support adherence to hand hygiene protocols and improve compliance with PPE and safe handling of needles. Better facilities, such as designated needle containers, may also stimulate better compliance. In the current low-budget situation, priority should be given to hand hygiene and safe handling of needles. Reasons for limited concern regarding bloodborne diseases and acceptance of alcohol-based hand rub should be explored further.

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