

# Hand-hygiene practices in the operating theatre: an observational study

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## Editor's key points

- Hand hygiene is extremely important in preventing hospital-acquired infections.
- Operating theatre (OT) staff, in this study, interacted frequently with patients and OT implements.
- However, the uptake of opportunities for hand-hygiene application was very poor.
- This study exposes a wide-spread culture of non-adherence to hand hygiene among OT staff.

**Background.** The current prevalence of healthcare-associated infections (HAIs) is a major public health concern. Patient contact in the operating theatre (OT) can contribute to HAI via microbial contamination. The application of hand hygiene is effective in reducing infection rates. Limited data are available on adherence to hand-hygiene guidelines by OT staff.

**Methods.** Covert direct observations of OT staff at an academic medical centre were performed by a single, trained observer. The primary outcome was the frequency of hand-hygiene application by OT staff, including anaesthesiologists, anaesthesia nurses, surgeons, surgical nurses, and medical students. 'Sterile' scrubbed staff members were excluded. The following hand-hygiene opportunities were monitored: (i) entering or leaving the OT; and (ii) before patient contact. Furthermore, the frequency of 'potential contamination' was recorded (touching OT implements after contact with patient/patient body fluids without the subsequent application of hand hygiene). We recorded non-surgical glove usage for invasive procedures, for example, intubation or insertion of intravascular devices. Finally, we collected qualitative data on incentives for hand hygiene.

**Results.** A total of 28 operations were observed (60 h of observations). On average, 0.14 hand-hygiene applications per hour per staff member were witnessed. Upon entering or leaving the OT, hand hygiene was performed in 2% (7/363) and 8% (28/333) of opportunities.

**Conclusions.** Frequent interactions between patient, staff, and OT environment were observed. Adherence to hand-hygiene guidelines by OT staff was extremely low. This potentially exposes patients to microbial transmission, HAIs, and patient harm.

**Keywords:** cross infection; gloves, protective; guideline adherence; hygiene; observation

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Healthcare-associated infections (HAIs) are a major concern. In Europe, about 7% of hospitalized patients develop HAIs.<sup>1</sup> It is well known that intensive care units are sources of iatrogenic infections, but little has been reported about the operating theatre (OT) as a primary source of infection. Much effort is invested in maintaining sterility of the operating field, but less attention is paid to potential nosocomial infection sources through patient contact by 'non-scrubbed' staff.

The intraoperative environment serves as a risk factor for the development of hospital-acquired infections. First of all, anaesthetics are associated with immune suppression.<sup>2</sup> Furthermore, OT staff frequently touch the patient. Failure to apply hand hygiene before and afterwards can lead to contamination of OT implements, thus creating a reservoir for pathogens that can cross-infect the next patient. Such a route of microbial transmission has been well described for

healthcare workers on patient wards,<sup>3</sup> and also for anaesthesia providers in the OT.<sup>4</sup> Contamination of OT implements with pathogens has repeatedly been demonstrated, for example, telephones,<sup>5</sup> keyboards,<sup>6</sup> anaesthesia machines,<sup>7, 8</sup> and i.v. stopcock sets.<sup>7</sup> OT staff perform invasive procedures such as tracheal intubation, insertion of intravascular devices, and urinary catheters. This enables pathogens to bypass the normal patient defence barriers and can cause infections, for example, respiratory, urinary, and bloodstream. The overall incidence of anaesthesia-related infections within 72 h after operation has been reported as 3.4%.<sup>9</sup>

Hand hygiene is considered the single most cost-effective public health measure in preventing HAI.<sup>3</sup> Limited data are available on adherence to hand-hygiene guidelines by OT staff, and its role in preventing OT-borne HAI. In postal surveys among anaesthesiologists, ~50% (range of 36–58%) of respondents describe always washing their hands

between OT cases.<sup>10–13</sup> A total of 17% of anaesthesiologists report performing hand hygiene before anaesthesia, compared with 69% before lunch.<sup>6</sup> Compliance of gloving guidelines is also reportedly low, with compliance rates never exceeding 50%.<sup>10 11 13 14</sup> Observations on patient wards demonstrate that anaesthesiologists and surgeons have the lowest hand-hygiene compliance among physicians.<sup>15</sup> In a controlled before–after study, the incidence of HCAI 30 days after operation was reduced from 17.2% to 3.8% after the frequency of hand hygiene in the OT had increased from 0.15–0.38 to 7.1–8.7 hand-hygiene applications per hour.<sup>16</sup>

Clearly, patient contact by non-scrubbed OT staff does constitute a risk for HCAI, even though the exact mechanisms remain unclear. The aim of this study was to assess the frequency of hand-hygiene application and compliance to gloving guidelines by non-scrubbed staff in the OT. Both quantitative and qualitative methods are used to describe and interpret observed hand-hygiene behaviour.

## Methods

A trained observer conducted a prospective series of covert observations at the Utrecht University Medical Centre (UMCU), an academic hospital in the Netherlands. The study protocol was reviewed by the local ethics committee (METC Utrecht). In line with the Dutch Medical Research Involving Human Subjects Act (WMO), the study was given exemption from full ethical review as it did not expose study subjects to procedures or require them to follow new rules or protocols. Approval for the study was granted with no requirement for patient or provider consent.

The hospital has implemented several hand-hygiene protocols.<sup>17–20</sup> Staff are required by hospital protocol to clean their hands before and after each patient contact. Alcohol-based hand rub (propanol and mecetronium ethyl sulphate) is available inside and around the OT. Furthermore, a washing alcove is situated adjacent to each OT, comprising scrub sinks, soap dispensers, and alcohol-based hand rub dispensers. Members of staff are required to enter the OT via the washing alcove and clean their hands on entering and leaving. There are two other entrances: a large sliding door (used for transporting the patient in and out of the room) and a second door that leads to the sterile area where surgical instruments and supplies are kept. Non-sterile gloves are to be donned for the insertion of a tracheal tube, nasogastric tube, peripheral venous catheter, and peripheral arterial catheter. Sterile gloves are required for insertion of a central venous catheter and a urinary tract catheter.

## Observation technique

The observer, a senior medical student, was introduced to staff as a visiting medical student. The student underwent training to reliably observe hand-hygiene episodes. The observations were recorded in handwritten notes at frequent intervals. Members of staff were not informed about the nature of the study.

The observer kept the washing alcove (Figs 1 and 2) in view in order to observe the hand-hygiene practices of OT staff. A ‘hand-hygiene application’ was defined as any usage of alcohol-based hand rub, irrespective of duration and amount of cleaning product used. A ‘hand-hygiene opportunity’ was defined as a situation requiring hand-hygiene application. Sometimes, the observer was requested to stand at a position which did not allow continuous observation of the washing alcove. The observer then relied on the sound of running water or the squeaking sound of the alcohol dispenser to infer whether hand hygiene had occurred. When in doubt, the observation was marked as ‘missing’.

## Observational scoring tool

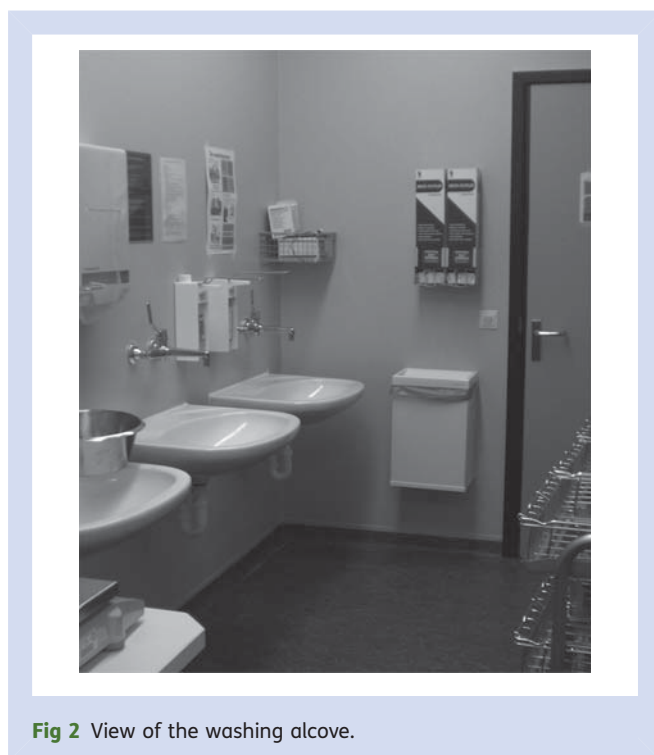
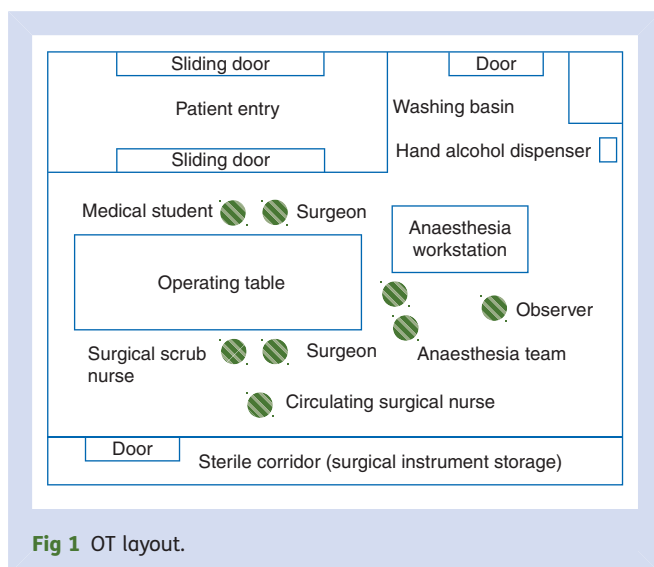
An observational scoring tool was developed based on an extensive literature review and pilot observations.<sup>21–23</sup> Using a single, covert observer meant that a strict selection in observation items had to be made, since measuring a comprehensive compliance rate for all hand-hygiene opportunities for several members of staff simultaneously would not be feasible. We chose clinically relevant items that could be scored accurately and unambiguously.

OT staff were categorized by profession as anaesthesiologists, anaesthesia nurses, surgeons, surgical nurses, and medical students. Staff who had performed a surgical scrub and donned sterile gown and gloves were excluded from observation. Surgeons were observed only before their surgical prep and after the surgical procedure was completed. The observational period for surgical nurses depended on their respective functions during the operation: scrub nurse (not observed while in sterile attire) or circulating nurse (non-sterile attire, continuously observed). Other staff members were observed continuously.

Application of hand hygiene was recorded every time an individual entered or exited the OT. When invasive procedures were performed, notes were made on whether gloves were donned as specified in the hospital guidelines.

We assessed the frequency with which the patient was touched by staff without prior hand hygiene, using the categories: >5 patient contacts, 1–5 patient contacts, and 0 patient contacts per surgical case. We did not continue the count beyond 5 contacts, since this would have exceeded the observer’s capacity to accurately monitor all members of staff at the same time and offered little additional insight.

After patient contact, hands need to be cleaned to prevent microbial contamination of OT implements. Since microbial contamination can also result from contact with patient body fluids (e.g. blood or saliva on dressing material), we monitored ‘potential contamination’ defined as touching objects in the room after having been in contact with the patient or the patient’s bodily fluids, without subsequent application of hand hygiene. We did not differentiate between touching the patient with bare ungloved hands or with gloves if the gloves were not discarded after previous patient contact and hand hygiene was not applied. The same scoring categories were used (i.e. >5, 1–5, 0 contacts).



The number of OT personnel wearing watches or jewellery was counted, since this is in violation of the hospital hand-hygiene protocol. Finally, detailed observations of incentives for the application of hand hygiene and glove usage were recorded using free text.

### Statistical analysis

We performed descriptive statistics using Open Office Calc (version 3.1.1, available at [www.openoffice.org](http://www.openoffice.org)). Data analysis resulted in counts of the number of operations, observation times, number of staff members, and number of gloves used. The performance of hand hygiene is expressed

as percentage (hand-hygiene applications/hand-hygiene opportunities) or as hand-hygiene applications per hour, per staff member. The categories used for analysis were 'before patient contact' and 'potential contamination'.

### Results

A total of 28 surgical procedures were observed, totalling over 60 h of observations. Patients underwent a variety of procedures, including general surgery (7), ophthalmology (4), otolaryngology (3), neurosurgery (3), vascular surgery (2), urology (2), gynaecology (2), and cardiothoracic surgery (2). The average number of personnel present in the OT at the same time was 8.4 (range: 5–11 people). The team typically included two to three members of the anaesthesia team, four to five members of the surgical team, and one medical student. Six out of 226 employees were observed to be wearing rings or watches (2.7%). A total of 69 applications of hand hygiene were observed during the entire study, an average of 0.14 hand-hygiene episodes per hour per individual.

Hand-hygiene application upon entering the OT was observed in seven of 363 opportunities (2%), and in 28 of 333 opportunities upon leaving the OT (8.4%). In 72 instances of leaving or entering the OT (10%), the observer was unable to determine with certainty whether hand hygiene had been applied.

The frequency of patient contact without prior hand hygiene varied among different groups of OT personnel (Table 1). This pattern was also observed for potential contamination.

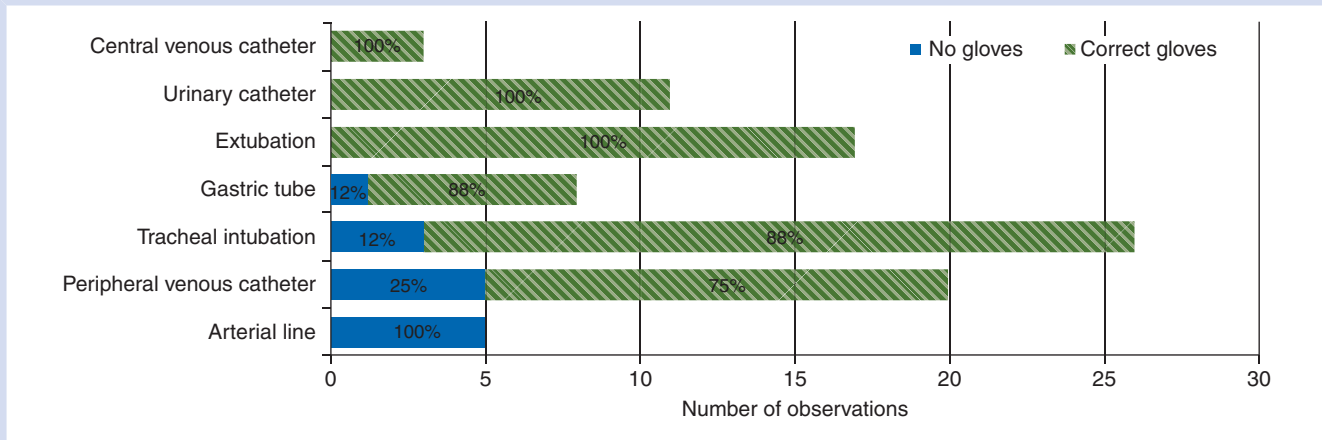
Compliance to gloving guidelines varied from 0% to 87% (Fig. 3).

The observer made an assessment of the number of gloves (sterile and non-sterile) donned during an operation and the apparent reasons inferred for wearing them. A total of 189 non-sterile and 24 sterile pairs of gloves were used. This constitutes six to seven pairs of non-sterile gloves, and zero to one pair of sterile gloves on average per operation, excluding sterile gloves donned by the operating team for the operation. The anaesthesia team used 106 pairs of non-sterile gloves. These were worn mainly during induction of anaesthesia (intubation, patient positioning), when touching objects visibly contaminated with body fluids and during emergence from anaesthesia (i.e. extubation, transporting patient into bed). Intubation and extubation together required the usage of 40 pairs of gloves (five missing observations for extubation). Surgeons used non-sterile gloves for palpation of organs and when positioning the patient (11 pairs). Surgical nurses used gloves mainly for handling objects contaminated with blood or secretions (e.g. gauzes, tubing, or tissue samples for pathology) and when cleaning up after the operation was completed (44 pairs).

Whenever hand hygiene was performed, the circumstances were noted. The main incentive to hand hygiene seemed to be contact with the patient's body fluids on

**Table 1** Interactions between members of staff and patients or OT (operating theatre) implements. Data are presented as *n* (%), per group

Perioperative staff	Patient contact without prior hand hygiene			Potential contamination of OR implements			Total
	>5 times	1–5 times	0 times	>5 times	1–5 times	0 times	
Anaesthesiologist	37 (95%)	2 (5%)	0 (0%)	35 (90%)	1 (3%)	0 (0%)	39
Anaesthesia nurse	33 (94%)	0 (0%)	0 (0%)	35 (100%)	0 (100%)	0 (0%)	35
Surgeon	19 (37%)	17 (32%)	14 (27%)	18 (35%)	27 (52%)	7 (13%)	52
Surgical nurse	1 (2%)	19 (29%)	45 (69%)	18 (28%)	22 (34%)	14 (22%)	65
Medical student	0 (0%)	17 (57%)	13 (43%)	0 (0%)	16 (53%)	14 (47%)	30

**Fig 3** Usage of gloves (sterile and non-sterile depending on the procedure) for each invasive procedure.

bare hands (e.g. blood on hands after insertion of intravascular device, saliva on laryngoscope). Members of the anaesthesia team sometimes washed their hands or applied alcohol-based hand rub after induction of anaesthesia, whereas surgeons sometimes did so after having completed the surgical procedure and removing their gloves.

## Discussion

Infection due to hospital-acquired microbes is an evolving problem worldwide, and horizontal transmission of bacterial organisms continues to cause a high nosocomial infection rate in acute care settings. In this study, we monitored hand-hygiene behaviour of 226 OT non-scrubbed team members and found that hand hygiene was applied no more than 0.14 times per individual per hour. Hand hygiene on entering or leaving the OT was rare (2% and 8%, respectively). A total of six to seven pairs of non-sterile gloves were used by the team per surgical procedure. Roughly three of four members of the surgical team touched the patient and OT implements repeatedly without intermittent application of hand hygiene. Almost invariably, members of the anaesthesia team came in contact with the patient or the patient's body fluids and objects in the OT without hand-hygiene application. These frequent interactions between patient, staff, and OT environment in the absence of hand-hygiene application are a risk for microbial transmission and HCAI.

Hand hygiene was mainly observed in three situations: when entering or leaving the OT, when hands were visibly soiled, or when a procedure (e.g. induction of anaesthesia, operation) was completed. Non-sterile gloves were used mainly for performing invasive procedures and when staff were in contact with patient body fluids, such as intubation/extubation of the trachea or handling objects contaminated with blood or secretions. Overall, there was a tendency to wear gloves for rather long periods of time. One individual wore the same pair of gloves for an entire operation (3 h).

Compliance with local hand-hygiene protocols during invasive procedures varied considerably. Nine of 10 OT staff wore non-sterile gloves when intubating the trachea or inserting a nasogastric tube. However, during insertion of peripheral venous catheters, less than one in four anaesthesia team members used gloves. Although the observed number of arterial cannulations was small, we never observed an anaesthesia team member wearing gloves during insertion of a radial artery catheter. We believe that this may be caused by the voiced concern, when wearing gloves, of reduced tactile perception leading to failure of cannulating the artery. Sterile gloves were always used for insertion of urinary tract catheters and central venous catheters.



The observer's obligation to remain covert posed some practical challenges. Since the observer pretended to be watching the operation as a student, it was not possible to keep the washing alcove continuously in view. The observer was sometimes asked to help with tasks such as lifting the patient from the operating table back to the hospital bed, which may have made it difficult to observe other staff members' actions at that moment. These constraints resulted in about 10% data loss in observations of entering or leaving the room. Nonetheless, hand washing or using alcohol-based hand rub is far more conspicuous than simply walking in or out of the OT and requires time to complete. Therefore, the data loss probably led to overestimation of compliance rates. In contrast, the data loss with glove counts probably led to an underestimation of the total number of gloves used.

We focused our study on the OT washing alcove as the designated location for OT hand hygiene. We thus may have missed hand hygiene performed elsewhere, for example, in the post-anaesthesia recovery room. However, the locations of alcohol dispensers beyond the washing alcove are limited at the study site. Hand washing is possible in the dressing room and toilet areas. Sinks and alcohol-based hand rub dispensers are present in the preoperative holding area and recovery rooms. The observer sometimes accompanied the anaesthesia team when transporting the patient and observed an occasional hand-hygiene action after patient handover. No alcohol-based hand rub dispensers are present in the OT corridors.

As all data were collected by the same observer, interobserver variation as a source of measurement error can be eliminated. The choice for covert observation meant that validation by a second observer was not possible, since the operating team does not allow more than one visitor at a time in the room. Covert observation effectively prevented a Hawthorne-like effect and the results likely reflect the actual behaviour of OT staff.

We made a selection of observation items based on relevance and feasibility. The items 'before patient contact' and 'potential contamination' were scored using categories (>5, 1–5, 0 times per surgical case). Although this is not as precise as an absolute number, it still conveys that many contacts take place without appropriate hand hygiene. Furthermore, the designated cut-off points (1 and 5 contacts) make a clear differentiation between groups of staff. 'Glove usage' and 'incentives for hand hygiene' are described mainly in a qualitative manner, which we found more suitable for illustrating actual behaviour.

All observations occurred at a single institution. However, there is reason to believe that the results of our study also reflect practices in many other hospitals. Similar hand-hygiene behaviour has been reported to the authors by staff from several hospitals in and outside the Netherlands (personal communication during the 2009 Annual Meeting of the American Society of Anesthesiologists and at several international presentations). Furthermore, our results are comparable with other studies and reports.

We measured an average of 0.14 hand-hygiene applications per hour per staff member, which is similar to 0.15–0.38 hand-hygiene applications per hour per staff member that were measured in another study as a baseline before intervention.<sup>16</sup> In our study, staff was unaware of the presence of an observer which may explain why the rate is slightly lower. In the post-anaesthesia care unit, an average of 19.6% adherence to hand-hygiene protocol was reported, with physicians complying less frequently (9.4%) than nurses (19.5%) or nurse assistants (32.1%).<sup>24</sup> Our findings are in agreement with a 2008 report on patient safety in the perioperative process published by the Netherlands Health Care Inspectorate which described shortcomings in the implementation of hand-hygiene guidelines.<sup>25</sup>

This study illustrates that adherence to hand-hygiene guidelines by OT staff is extremely low, which potentially exposes patients to microbial transmission and increases the risk of HCAs. An increase in hand-hygiene awareness is needed, coupled with organizational interventions that promote and facilitate the application of hand hygiene and reduced HCAI risk. The role of anaesthesia, surgical, and administrative leadership in creating the desired culture and holding providers accountable is essential.<sup>26</sup> We are aware that OT personnel work under considerable time pressures, which discourages changing gloves frequently or cleaning hands at every required instance of touching the patient. Additional measures to overcome hygiene challenges in the OT should be considered, including more thorough disinfection of objects and the entire room after each case and targeting specific high-risk procedures. Finally, it is necessary to closely monitor perioperative hand-hygiene practices over time to determine whether current intervention strategies are effective.

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## Conflict of interest

None declared.

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