Improving hand hygiene compliance rates in the haemodialysis setting: more than just more hand rubs

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Abstract

Background. Haemodialysis patients are at high risk for developing healthcare-associated infections as well as acquiring multidrug-resistant microorganisms. Hand hygiene is considered to be the single most effective tool to prevent healthcare-associated infections. The number of indications and the extent of indication-specific compliance with hand rubs in the haemodialysis setting are currently unknown.

Methods. We conducted a prospective, three-phase, observational intervention study on hand hygiene during haemodialysis treatments. Optimized hand hygiene standard operating procedures (SOPs) for dialysis connections (Intervention I) and disconnections (Intervention II) were compiled and implemented during two predefined intervention periods.

Results. A total of 8897 indications for hand rubs were observed throughout this study. In the course of the study, we identified an increase in the number of hand rubs performed (6–9, mean number per dialysis procedure), paralleled by a decrease in the indications for hand rubs (21–15), resulting in a significant increase of overall hand rub compliance (30–62%).

The greatest improvement was seen before aseptic tasks (21–52%), the indication with the greatest impact on preventing healthcare-associated infections. There was no difference between haemodialysis via central venous catheter access or arterio-venous (AV) fistulas.

Conclusions. This study provides the first detailed data on the number of and indications for hand rubs during dialysis. An >100% increase in overall hand hygiene compliance could be achieved by a comparably moderate increase in hand rubs performed in combination with optimized hand hygiene SOPs.

Haemodialysis units represent a hotspot of such infections due to patient characteristics [4–7]. The use of invasive devices (i.e. the punctures of AV fistula or the connections of central venous dialysis catheters) is one of the most important risk factors for acquiring healthcare-associated infections [1, 2, 7]. Additionally, haemodialysis patients are particularly prone to infections caused by blood-borne viruses like hepatitis B and C. Moreover, colonization with multidrug-resistant microorganisms like methicillin-resistant Staphylococcus aureus (MRSA) and extended broad-spectrum beta-lactamase (ESBL)-producing enterobacteria is an additional risk [8].

Hand hygiene is considered to be the single most effective tool to prevent healthcare-associated infections including those caused by MRSA and ESBL-producing enterobacteria [9–11]. The WHO defined ‘five moments’ for hand hygiene (Table 1) and highlighted the need for new strategies to improve everyday hand hygiene practices on the basis of the current low compliance [1, 12, 13]. Data on hand hygiene in haemodialysis units are scarce [14]. We conducted a prospective observational intervention study to determine the number of overall and indication-specific hand rubs (HR) performed, indications for HR and the calculated compliance rates during haemodialysis treatments. The interventions were aimed at increasing compliance primarily by optimizing standard operating procedures (SOPs) for dialysis connections and disconnections.

Materials and methods

Study design

We performed a prospective interventional study at the haemodialysis unit of a tertiary care centre at the RWTH Aachen University Hospital (Division of Nephrology) between March 2010 and September 2010. Primary goals of this study were (i) a precise analysis of dialysis-associated hand hygiene and (ii) the optimization of hand hygiene compliance. The haemodialysis unit consists of 12 dialysis sites and performs about 5000 individual treatments per year (75% inpatients). Twenty-two dialysis nurses (12 full time, 10 part-time) and 3 physicians (1 full time, 1 part-time and 1 consultant) belong to the staff. Treatments are performed in two shifts on 3 days per week and one shift on another 3 days per week. The

Introduction

Healthcare-associated infections have a great impact on morbidity, length of hospital stay and treatment costs [1–4].
equal variance testing, otherwise the Wilcoxon rank-sum test was performed. 3.1.1 (Systat); the unpaired the WHO definitions. Statistical analyses were performed using SigmaStat number of HR divided by the number of hand hygiene indications according to Indications not directly related to connections or disconnections were docu-
mented and analysed separately. The compliance rate (%) was calculated as the
Calculation and statistics

Table 1. ‘Five moments’ for hand hygiene according to the WHO guideline [12] and examples within the dialysis setting

<table>
<thead>
<tr>
<th>Indication for hand hygiene</th>
<th>Definition/situation</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication 1</td>
<td>Before touching a patient</td>
<td>Before measuring blood pressure Before examining the AV-fistula</td>
</tr>
<tr>
<td>Indication 2</td>
<td>Before clean/aseptic procedure</td>
<td>Immediately before puncture of the AV-fistula Immediately before connecting the central venous catheter</td>
</tr>
<tr>
<td>Indication 3</td>
<td>After body fluid exposure risk</td>
<td>Immediately before opening the syringes wrapped in sterile packages</td>
</tr>
<tr>
<td>Indication 4</td>
<td>After touching a patient</td>
<td>After performing a blood gas analysis</td>
</tr>
<tr>
<td>Indication 5</td>
<td>After touching patient surroundings</td>
<td>After connecting the venous access with the dialysis machine</td>
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</table>

Hand hygiene in haemodialysis

Predefined interventions were directed at problems observed during the preceding observation period and were performed by the infection control staff in collaboration with the haemodialysis team. Interventions consisted of individual and group courses on hand hygiene, direct observations with feedback and the compiling and implementation of SOPs. In addition, in order to reduce recontaminations, and consequently unnecessary HR, optim-
ization of the dispenser positions, use of disinfectant bottles for the gown pockets and finally the presentation of interim results as a training and motivational tool were initiated. Intervention I mainly addressed the con-
nection process by generating SOPs (one each for AV fistula and central venous catheter). Intervention II mainly addressed the disconnection procedure by generating SOPs and further improved the distribution and the practical implementation of the SOP for the connections as well (Figure 1).

Interventions

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Calculation and statistics

One haemodialysis procedure was defined as connection plus disconnection. Indications not directly related to connections or disconnections were documented and analysed separately. The compliance rate (%) was calculated as the number of HR divided by the number of hand hygiene indications according to the WHO definitions. Statistical analyses were performed using SigmaStat 3.1.1 (Systat); the unpaired t-test was applied after successful normality and equal variance testing, otherwise the Wilcoxon rank-sum test was performed.

Results

Throughout the study, a total of 8897 indications for hand hygiene were identified (Phase I: 2376, Phase II: 3413, Phase III: 3108), 4520 HR (Phase I: 875, Phase II: 1684, Phase III: 1961) were performed. Analysing the observed HR indications during Phase I, we identified a recurrent number of avoidable HR indications and ‘systematic mistakes’ in the workflow (e.g. recontaminations after HR, not performing the HR immediately before an aseptic task). We subsequently implemented and trained hand hygiene-optimized SOPs (Table 2).

The mean number of observed HR indications during one haemodialysis procedure decreased by 29% with a significant reduction, from both Phase I to Phase II and from Phase II to Phase III (both $P < 0.001$; Figure 2). In parallel, hand hygiene compliance significantly improved by 107% (Figure 2). This effect was achieved both by reducing the number of indications and by a significant increase in performed HR, from 6 to 9, for an individual haemodialysis procedure ($P < 0.001$; Figure 2). Immediately following the implementation of the SOPs, the greatest increase in compliance rates was observed for connections after the first intervention and for disconnections after the second intervention (Figure 3). The number of recontaminations due to a non-optimized workflow significantly decreased during the study in parallel with the implementation of SOPs. Compliance with hand hygiene beyond connections and disconnections improved from 47 (460/977), 56 (770/1380) and finally to 65% (745/1144) during the three observation phases.

By analysing the hand hygiene compliance with respect to the different indications (Indications 1–5, before and after patients contact, Table 1), we identified indication-specific differences in baseline compliance and improvements. During the baseline Phase I, the lowest compliance was observed before aseptic tasks (170/826) and the highest after having contact with the patient (156/256) (Figure 4). Comparing compliance before patient contact and aseptic tasks with that after contact with the patients, their body fluids and the surroundings revealed a significantly lower compliance before (28%) than after (43%) contact, during Phase I ($P = 0.002$). During Phases II and III, we no longer observed significant differences between the hand hygiene compliance rates before and after contact (41 and 60% versus 51 and 62%; $P = 0.652$ and $P = 0.185$).
Considering all three observation periods, the highest compliance rate was achieved before patient contact with a significant increase ultimately reaching 88% (Figure 4). The greatest improvement, however, was seen before aseptic tasks with an increase of 148% during the study period (Figure 4). There was little difference between haemodialysis via central venous catheter access or AV fistulas. In addition, there was no difference between the early and late shift or between days with two shifts versus days with one shift (data not shown).

**Table 2. Examples of changes in our hand hygiene-optimized SOPs that resulted in major improvements of hand hygiene compliance**

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
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<tbody>
<tr>
<td>One disinfectant dispenser per two patients</td>
<td>One disinfectant dispenser for each patient</td>
</tr>
<tr>
<td>Recontaminations due to non-optimized dispenser positions</td>
<td>Omitting recontaminations during the process by optimization of the dispenser positions</td>
</tr>
<tr>
<td>No use of disinfectant bottles carried in the gown pockets</td>
<td>Disinfectant bottles for the gown pockets routinely used in the context of the preparation of the (dis)connection setting</td>
</tr>
<tr>
<td>Frequent recontaminations due to regular interruptions in order to retrieve missing instruments during the connection/disconnection process</td>
<td>Preparation of the equipment used during the connection/disconnection before starting the process on a side table, thereby avoiding recontaminations</td>
</tr>
<tr>
<td>Performing hand rubs when not indicated but not always performing hand rubs when indicated</td>
<td>Defining the right time points for hand rubs within the standardized workflow</td>
</tr>
<tr>
<td>More than the necessary indications for hand rubs due to not perfectly optimized workflow</td>
<td>Facilitating the workflow by SOPs</td>
</tr>
<tr>
<td>Recontaminations due to the use of manually operated waste bins</td>
<td>Exchange of waste bins by pedal bins</td>
</tr>
</tbody>
</table>

**Fig. 2.** Indications for hand rubs (A), number of performed hand rubs (B) and compliance (C) for one haemodialysis treatment. A significant decrease in the number of indications paralleled by a significant increase in the performed hand rubs resulted in a significant increase in hand hygiene compliance. Individual significance between groups is indicated.

**Fig. 3.** Hand hygiene compliance for the haemodialysis connection process (A) and the disconnection process (B) in correlation to the implementation of the corresponding SOP. Individual significance between groups is indicated.

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**Discussion**

Our study offers the first detailed data regarding haemodialysis-associated indication-specific hand hygiene. The key finding of our study is that a comparably moderate increase in HR performed, in combination with hand hygiene-optimized SOPs, resulted in a major increase of HR compliance.

Data on hand hygiene in the haemodialysis setting are very limited. Our observed baseline hand hygiene compliance rate
of 30% for a haemodialysis procedure was within the expected broad range (5–98%, average 40%) of published data in the general healthcare field [12–14]. One single study previously reported dialysis-associated hand hygiene compliance rates between 14 and 36% [14]. However, the study by Arenas et al. [14] suffered from certain limitations: hand hygiene definitions differed from the commonly used WHO definitions, hand washing rather than hand disinfection was documented, data were not provided for the entire haemodialysis procedure and no interventions were performed.

Why is it so hard to reach 100% hand hygiene compliance in highly trained medical staff? One reason for hand hygiene non-compliance is the limited amount of available time of the medical staff [9, 15–20]. Another reason might be that a lack of SOPs leads to frequent recontaminations. Simply increasing the number of HR performed increases the workload, and although this might result in increased short-term compliance, it will unlikely have long-term success. In our own study, following two interventions and training phases, we observed a very acceptable overall compliance rate of 62%. This was achieved by a combination of reducing the number of indications and increasing the number of HR performed. The overall benefit was mainly due to an implementation of SOPs, indicating that optimizing the workflow is essential to increasing compliance with infection control practices. To summarize, this is the first study, demonstrating an improved compliance due to workflow optimization.

Several interventions mainly addressing selected barriers for compliance led to a transient increase in compliance, while others failed [9, 11–13, 19, 21]. In the future, interventions will need a multifaceted approach as previously demonstrated by the first multidimensional, and a hospital-wide campaign to achieve sustained hand hygiene improvements [9, 13, 21]. Ongoing audits and feedback with positive reinforcement have been shown to result in a sustained effect [22]. The authors conducted direct observations including feedback at a low level but over a very long time period of 6 years. It is of note that the improvement of compliance was due to a behavioural change as in our investigation. Therefore, it seems reasonable to expect a sustained effect in our clinic by ongoing feedback observations on an annual basis.

Hand hygiene before patient contact (WHO Indications 1 and 2, Table 1) plays a major role in controlling healthcare-associated infections. Compliance with WHO Indication 1 is a cornerstone in preventing cross-transmission of multidrug-resistant bacteria [9, 21]. Compliance with WHO Indication 2 has the highest potential for preventing healthcare-associated infections, especially due to blood-borne viruses in the haemodialysis setting, thus improving patient safety. During our baseline observation period, compliance was lowest (21%) before aseptic tasks (WHO Indication 2) and highest (61%) after patient contact (WHO Indications 3, 4, 5). In other words, the higher the demand is for hand hygiene, in order to prevent healthcare-associated infections, the lower the adherence to recommendations. The same low compliance before patient contact has been previously reported for other healthcare settings and once for haemodialysis [9, 12–14, 22–26]. However, most of these studies did not perform a detailed indication-specific analysis according to the WHO definition and methodology [9, 12–14, 22, 25, 26]. These findings would indicate that healthcare workers in general do not pay the same amount of attention to infection control measures before patient contact and aseptic tasks as after contact with the patients or their body fluids. Interestingly, Whitby et al. suggested that, in these situations, medical staff exhibit self-triggered activity as a self-protection mechanism [27]. In contrast, our intervention study resulted in the greatest increases of hand hygiene compliance before patient contact and aseptic tasks (WHO Indications 1 and 2), indicating a significant improvement in reducing healthcare-associated infections.

Limitations of the study: we cannot exclude an observer bias (Hawthorne effect). Due to the knowledge of being under observation, compliance may have increased. We tried to partially overcome this problem by implementing a pilot observation phase and by performing the
observation by a medical student rather than an infection control professional. Evaluation of the effectiveness of appropriate hand hygiene behaviour on the ultimate outcome, i.e. the infection rate, would certainly represent the best way to define the impact of improved hand hygiene. Since these infections are complex events and do not occur in the same setting as originated especially for haemodialysis, reduction is rather difficult to show. It was not in the scope of our study to document reduction of infections in patients and staff. However, it is generally accepted that an increase in hand hygiene compliance is a major player in decreasing both transmission of (multiresistant) microorganisms and infection rates [9, 12]. Failure in appropriate hand hygiene is considered the leading cause of healthcare-associated infections (HCAI) and spread of multi-resistant organisms from the WHO and the Centers for Disease Control and Prevention perspective, and has been recognized to contribute significantly to outbreaks [12]. Because there is substantial evidence for the correlation between good hand hygiene practices and low HCAI rates, hand hygiene is an important indicator of safety and quality of care. Therefore, it is embedded in the HCAI planks of the 5 Million ‘Lives’ Campaign (http://www.who.int/hi/Programs/Campaign/) and is emphasized in the WHO Collaborating Centre on Patient Safety Solutions as one of the highest priority solutions to improve patient safety (www.who.int/patientsafety/solutions/patientsafety/en/) [12].

In conclusion, our study is the first to present detailed hand hygiene indicators, HR activities and compliance for individual haemodialysis procedures, including a two-phase interventional approach. It is the first study demonstrating that implementing and optimizing the haemodialysis connection and disconnection protocols significantly improved hand hygiene compliance by both decreasing the number of hand hygiene indications and increasing HR when indicated. Although our data show that surveillance enhances compliance to hand hygiene, it remains to be proven that this will also impact on outcomes in terms of infection rates and mortality.

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Conflict of interest statement. None declared.

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