Applying human factors and ergonomics to the misuse of nonsterile clinical gloves in acute care

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Background: Health care workers (HCWs) are recommended to wear nonsterile clinical gloves (NSCG) for direct contact with blood and body fluids. However, there is evidence of extensive inappropriate NSCG use.

Methods: A mixed-methods study comprising observation of NSCG use in 2 acute hospitals and semistructured HCW interviews. Qualitative data were categorized using thematic analysis. Findings were mapped to the Systems Engineering Initiative for Patient Safety model and used to develop a strategy for improving NSCG use.

Results: Two hundred seventy-eight procedures performed in 178 episodes of care involved the use of NSCG. NSCG were inappropriate for 59% of procedures (165 out of 278). Risk of cross-contamination occurred in 49% (87 out of 178) episodes. Twenty-six HCWs were interviewed; emotion and socialization were key factors influencing decisions to use NSCG. Data from observation and thematic analysis were mapped to 6 interacting components of the Systems Engineering Initiative for Patient Safety work system. Interventions targeting each component informed quality improvement strategies.

Conclusions: Despite intense promotion of hand hygiene as the key measure to protect patients from health care-associated infection, NSCG dominate routine clinical practice and potential cross-contamination occurs in 50% of care episodes. Such practice is associated with significant environmental and financial costs and adversely affects patient safety. The application of human factors and ergonomics to the complex drivers of inappropriate NSCG behavior may be more effective than conventional approaches of education and policy in achieving the goal of preventing health care-associated infection and improving patient safety.

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Patient Safety (SEIPS) model provides a framework for exploring the work system and its influence on processes and outcomes for both patients and HCWs.\(^1\)\(^,\)\(^3\)\(^,\)\(^1\)\(^3\)

Research focused on strategies to improve hand hygiene (HH) behavior fails to adequately account for the increasing and inappropriate use of NSCG.\(^1\)\(^,\)\(^1\)\(^5\) Recent studies have identified that staff wear NSCG for procedures not involving exposure to BBF and frequently do not remove them at the points in care where HH is indicated and do not decontaminate hands following their removal.\(^1\)\(^,\)\(^2\)\(^,\)\(^6\)

These studies suggest that the factors influencing NSCG use behavior are complex and, like many HFE work processes, unlikely to be modified by education interventions.\(^1\)\(^7\) Disgust is an important trigger for HH and glove use. Qualitative research also suggests that despite policy and guidance, emotion, and socialization are key drivers for HCWs’ inappropriate use of NSCG.\(^3\)\(^,\)\(^1\)\(^8\) Although the World Health Organization My 5 Moments for Hand Hygiene is based on human factors principles, there is limited applied HFE research on use of the SEIPS 2.0 model in infection prevention and control (IPC). Applying HFE to the use of NSCG may provide a framework for preventing the transmission of infection and promoting appropriate glove use.\(^1\)\(^,\)\(^5\)\(^,\)\(^2\)\(^0\)

Our study builds on previous research\(^1\)\(^1\) to confirm if similar behavior and attitudes are apparent in other hospitals and apply SEIPS 2.0 to identify the interacting work systems and processes that influence NSCG use behavior, informing strategies for reducing inappropriate NSCG use and improving patient safety.

**METHODS**

We undertook a mixed-methods approach using observation and qualitative interviews.

**Observational audit of glove use**

A validated audit tool was used in 2 acute care hospitals to record the sequence of donning and removing NSCG, HH, and items touched during episodes of care.\(^2\)\(^1\) Observation periods began when a HCW donned gloves for an episode of care and ended when the episode was completed. Omission of HH before donning NSCG was not considered as a risk of cross-contamination; HH following NSCG removal was considered adequate if local protocol was adhered to; and NSCG use was considered appropriate if the procedure involved potential or actual contact with BBF, mucous membranes, situations required by local policy (eg, patient under isolation precautions), or contact with substances hazardous to health.\(^7\)\(^,\)\(^1\)\(^1\)\(^9\) Observations were conducted by a member of the IPC team during January-June 2014 in different types of wards. Staff were unaware of the purpose of the audits to minimize the Hawthorne effect.

Data were analyzed using SPSS version 19 (IBM-SPSS Inc, Armonk, NY); Pearson’s \(\chi^2\) (or Fisher exact test for small samples) was used to assess the statistical significance of the variables.

**Interviews with HCWs**

HCWs were recruited through an advert in the trust staff e-newsletter. To encourage openness, a member of the university research team conducted semistructured interviews with staff who responded. Written consent was obtained from participants before conducting each interview. The interview schedule explored factors that influenced decisions to wear NSCG and to challenge their use by other HCWs.

Interviews were digitally recorded and transcribed verbatim; transcripts were analyzed using a 6-step thematic analysis described previously.\(^2\)\(^2\) Following initial familiarization, the data were manually coded, preliminary themes and categories identified, refined, and checked to confirm they captured the essence of the data. Saturation was reached when no further meanings or perceptions could be found within the data set. Finally, 2 researchers integrated the themes with the framework developed in the previous study; descriptors for the themes were agreed upon and a refined framework incorporating the new data was generated.

**Application of SEIPS 2.0**

To describe the use of NSCG-use in the context of a work system, the SEIPS 2.0 model was used to map the refined thematic framework to the 6 work-system components.\(^1\)\(^1\) This analysis was used to consider strategies that could be applied to improve processes and outcomes and reduce high-risk NSCG use behavior.

**Ethical approval**

Observations of NSCG use formed part of routine clinical audit undertaken by the IPC team and did not require ethical approval. Ethical approval for interviews with HCWs was granted by the college’s Research Scrutiny and Ethics Committee and access agreed by the trust’s Research and Development Department.

**RESULTS**

**Observational audit of the NSCG use**

A total of 194 episodes of care were observed with 178 (91.8%) involving the NSCG use; 278 procedures were performed and NSCG use was inappropriate for 59% (165 out of 278), but varied between hospital A (37 out of 88; 42%) and B (128 out of 190; 67.4%) (\(P < .001\)). The procedures for which NSCG were most commonly worn are shown in Table 1; few involved a risk of BBF contact and in 5% of episodes HCW wore NSCG for a prolonged period without performing any procedure.

The overall rate of cross-contamination associated with episodes of care where NSCG were used was 49% (87 out of 178); the rate of cross-contamination varied from 58% (40 out of 69) at hospital A to 42% (47 out of 109) at hospital B (\(P = .065\)) and there was no significant difference between staff groups. The moments of HH where cross-contamination occurred are shown in Table 2.

In 62% of episodes (54 out of 87), cross-contamination occurred at more than 1 moment of HH because NSCG were not removed after or between procedures. Moment 1 cross-contamination occurred when NSCG were donned at a dispenser

**Table 1**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Frequency observed</th>
<th>% of all procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning</td>
<td>37</td>
<td>13.3</td>
</tr>
<tr>
<td>Mobilization of patient</td>
<td>36</td>
<td>12.9</td>
</tr>
<tr>
<td>Handling linen/bed making</td>
<td>35</td>
<td>12.6</td>
</tr>
<tr>
<td>Intravenous device manipulation</td>
<td>28</td>
<td>10.1</td>
</tr>
<tr>
<td>Personal hygiene</td>
<td>21</td>
<td>7.6</td>
</tr>
<tr>
<td>Toileting (including contact with commodes/urinals)</td>
<td>20</td>
<td>7.2</td>
</tr>
<tr>
<td>Handling equipment</td>
<td>20</td>
<td>7.2</td>
</tr>
<tr>
<td>Manipulation of invasive device (not intravenous)</td>
<td>16</td>
<td>5.8</td>
</tr>
<tr>
<td>Attention to patient</td>
<td>16</td>
<td>5.8</td>
</tr>
<tr>
<td>No particular task</td>
<td>14</td>
<td>5.0</td>
</tr>
</tbody>
</table>
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