Individual differences in judgments of hand hygiene risk by health care workers

Anne Collins McLaughlin, PhD, and Fran Walsh, PhD
Raleigh, North Carolina; and Atlanta, Georgia

Background: The hand hygiene practices of health care workers (HCWs) have long been the main vector for nosocomial infection in hospitals. The purpose of this study was to examine influences on risk judgment from the individual differences in knowledge levels and health beliefs among US HCWs.

Methods: Knowledge levels were assessed by questions taken from published questionnaires. The health locus of control scale was used to characterize internal health beliefs. HCWs assessed the risks of pathogen transfer in situations that varied according to the surface touched and the person doing the touching.

Results: HCWs reported lower risk assessments for touching surfaces compared with touching skin. Risk assessment was influenced by individual differences, including in knowledge level and internal health locus of control.

Conclusion: Our data describe the individual differences of HCWs related to hand hygiene in ways that can be used to create targeted interventions and products to improve hand hygiene.

Key Words: Nosocomial infection; fomite; nurse; infection control; education; knowledge; locus of control; environmental service.

The individual differences in attitudes and knowledge level among health care workers (HCWs) have been identified as an important research area by the Centers for Disease Control and Prevention, specifically in the areas of education level and motivation. The importance of these areas lies in the effects of individual differences on intentions and behavior, as demonstrated in the theory of planned behavior. However, despite previous findings indicating that knowledge level and other individual differences (e.g., viewing oneself as a role model) affect compliance rates, individual differences among HCWs have not been widely studied.

Interventions to improve hand hygiene have been implemented at group levels, typically via educational programs, punishment-and-reward systems, and the introduction of hand hygiene products. But despite this high level of organizational support, hand hygiene compliance rates have been unacceptably low, and the prevalence of nosocomial infections has been unacceptably high. Although various interventions have shown promising results in improving hand hygiene rates, to date no intervention has produced 100% compliance. Individual differences may explain the remaining noncompliance of HCWs and offer clues for new avenues aimed at improving hand hygiene practices.

DIFFERENCES IN KNOWLEDGE

In educational interventions, HCWs are typically presented with information and training on correct hand hygiene methods rather than on changing beliefs. It is possible that someone who does not believe that he or she can control his or her health would be less receptive to an educational intervention. However, one study that measured belief change found that an educational intervention could alter such beliefs as “I believe my patients will have fewer nosocomial infections.” It is also possible that a person with a perceived high level of control over his or her health would perceive his or her own hand hygiene as effectively stopping the spread of disease. However, no previous study has focused on the roles of individual differences (such as in beliefs) in hand hygiene.

Specific knowledge of fomites

Contact with contaminated inanimate objects (fomites) creates a vector for pathogens. Touching a single contaminated surface can transfer pathogens to up to the
next 7 touched surfaces.7,8 Although patients’ skin contains resident flora, there are also high concentrations of microorganisms on surfaces that contact patients, HCWs, and the health care environment. These surfaces include bed rails, keyboards, and remote controls, which when touched by a HCW’s hands may transfer microorganisms to other surfaces and to patients.7,9-11 Despite the dangers that fomites present, this knowledge may not be sufficiently widespread among HCWs to ensure their understanding of the level of risk when touching surfaces and then touching patients.

DIFFERENCES IN BELIEFS

The actor-observer bias

Another reason for noncompliance with hand hygiene might be a belief that one’s hands are not as dangerous as another person’s hands. This hypothesis comes from a type of error known in the social psychology literature as actor-observer bias.12 Actor-observer bias occurs when a person is more likely to attribute negative events to the internal state of others and to an external state when considering the self. That is, an error committed by another person is viewed as being due to some failing within that person, such as carelessness, whereas an error committed by oneself is viewed as being caused by situational variables, such as having too many things to do at once. It is possible that an HCW judges his or her hands to be cleaner than other people’s hands and thus not as dangerous to patients. Support for this hypothesis is provided by a study that compared self-perception of hand hygiene with the perception of others, in which both nurses and doctors were found to believe that their own hand hygiene surpassed that of their peers.13 To date, no study has examined the role of the self compared with others in judgment of risk.

Internal health locus of control

Scores on internal health locus of control (HLC) scales provide an indication of how much control persons believe they have over their health.14 Individual differences, such as locus of control, may explain the effectiveness of educational campaigns and other interventions. Questions about control beliefs were included in a previous study of HCWs and form part of the theory of planned behavior.15 The questions in that study were not from the traditional scale used to measure locus of control, however.14 Further, the responses to those questions were not examined as to whether those beliefs affected HCWs’ judgments of risk associated with a behavior.

Persons with greater feelings of internal control over health are more proactive about pursuing health behaviors.14 It has been suggested that persons with differing loci of control be administered different treatments in health care situations.14 Thus, it might be beneficial to design different hand hygiene interventions based on HCWs’ differing loci of control. For example, those with an internal control orientation might benefit most from self-regulated educational materials, whereas those with low internal control might benefit more from materials that emphasize compliance and involve social support from others.16 It also may be possible to improve internality of control by encouraging internal beliefs, which can translate to more proactive health behaviors.14 However, how HCWs vary in their internal HLC and whether they differ from the general adult population remain unknown.

In summary, we hypothesized that individual differences in knowledge and beliefs might explain the differences in understanding of risk among HCWs. Individual differences also might explain the variable effectiveness of hand hygiene interventions in HCWs and suggest new avenues for future interventions.

FACTORIAL SURVEYS

Factorial surveys are typically used to measure judgment, decision making, and attribution, usually of a specified group.17 These judgments are often made on visual analog scales with the ends labeled but no marks shown on the interior of the scale. These surveys combine the control of an experiment with the external validity of self-reports. A factorial survey is a standardized vignette with specific story aspects that can be varied systematically; for example, a vignette could describe a hand hygiene scenario in the same words each time, but with the surface touched by the person changed. This allows measurement of a participant’s estimate of risk for different surfaces with all other variables held constant.

Factorial surveys also combine the control of an experimental design with the richness of survey research, which allows for high internal and external validity.18 Each variable can be manipulated, and its individual and interactive effects with other independent variables can be determined. These surveys also reduce multicollinearity, a problem with many surveys.17,18 Finally, factorial surveys offer “concrete, detailed situations on which to make judgments rather than the demand for abstract generalizations.”17

OVERVIEW OF THE STUDY

An online survey was conducted with 3 groups of HCWs: nurses, infection preventionists (IPs), and environmental services (ES) managers. IPs are generally in
charge of creating the infection control program for a facility and receive formal training in infection control practices. ES managers coordinate housekeeping staff and choose and control the cleaning products available to cleaning staff and HCWs. Their interaction with patients is low but does occur. These 3 groups completed a 45-minute-long survey detailing their HLC beliefs, hand hygiene knowledge, reported hand hygiene behaviors in different locations, and assessment of risks in different scenarios. These scenarios varied by the person performing the action, the kind of surface touched by that person, and the degree of contamination risk.

METHODS

Participants

A total of 71 participants were recruited from nurses, IPs, and ES managers. Many of the IPs also self-identified as nurses, resulting in 31 self-identified registered nurses, 17 nurses with various other titles, 1 physician’s assistant, and 1 medical assistant. Given their extra education and duties (spending at least 50% of their time in infection prevention activities), IPs were considered a separate group. Most of the IPs worked in acute care (n = 53), with the rest scattered across school, clinic, home, rehabilitation, and long-term care settings. The nurses and IPs worked across many departments from pediatrics to intensive care units, whereas all of the ES managers worked in the Environmental Services Department. The participants were contacted through a survey company and were paid $50 for their time. Participants were recruited nationally and represented 29 different US states.

Demographic information included age, years in the profession, sex, and hand hygiene training within the previous 3 years (Table 1). The 3 groups differed significantly in terms of age and sex; the ES managers were older and had more male participants compared with the nurses and IPs.

One question related to general individual differences examined whether the 3 groups included in this study have different internal HLC scores compared with the general population. It is possible that persons who choose a health-related career might have higher scores, or that health care training might increase feelings of internal control over their health. This was true in part; the internal HLC scores of the nurses and ES managers were not significantly different from healthy adult norms (P > .05), but those of the IPs were significantly higher [t (81) = 2.45; P = .017]. The 3 groups did not differ significantly from one another. The 3 groups also did not differ in terms of knowledge scores.

Survey components

Knowledge test. The knowledge test comprised 29 questions taken from previously published questionnaires. Many of the questions were specific to HCWs who interact with patients, for example: “Which type of hand hygiene method is required before palpation of the abdomen?: (a) Hand rubbing; (b) Handwashing; (c) None; (d) Unsure.” Others were more general, such as: “What is the minimum time needed for alcohol-based hand rub to kill most pathogens on your hands?: (a) 3 seconds; (b) 10 seconds; (c) 20 seconds; (d) 60 seconds.” One point was given for each correct answer.

Health locus of control. The internal HLC scale contained 6 questions and was scored from 6 to 36. The internal HLC score quantifies an individual’s perceived amount of control over his or her health. Persons scoring low on this scale tend to believe that outside forces affect their health, whereas those scoring high on this scale believe that they have control over their own health.

Risk assessment scenarios. A factorial survey was developed to investigate the effects of specific variables on HCW’s risk assessment judgment. Factorial levels included the actor in the scenario and the potentially contaminated surface touched by that actor. The first manipulation was the actor in the scenario, manipulated by changing the actor from “you touch...” to “Barbara touches...” This variable was included to investigate whether risk assessment varied according to the actor-observer bias. The type of surface touched was manipulated by having the actor in the scenario touch a patient’s skin or an object that had been previously touched by the patient. This variable was included to examine whether or not HCWs’ perceived surfaces as being less risky to touch than patients.

The final manipulation was the hand hygiene behavior of the actor in each scenario. The actor either performed or did not perform hand hygiene before interacting with a patient. When an actor performed correct hand hygiene, the scenario was considered very low risk (for simplicity, termed “no risk” herein). When the actor did not perform hand hygiene, the scenarios varied in risk based on the likelihood of contamination. These “no-hygiene” scenarios manipulated risk on an ordinal scale; that is, one scenario was at an objectively higher risk than another, although the difference between risk levels did not need to be the same. Thus, level 2 scenarios were higher risk than level 1, but lower risk than level 3. These scenarios were developed with the assistance of an infection control expert to ensure that they represented an increase in actual risk level. An example scenario with full hand hygiene compliance is as follows:
During the course of the day, you enter the room of a patient and adjust her leg at her request. Before and after touching the patient, you vigorously wash your hands for 30 seconds with soap and warm water before continuing with your day. Mark your assessment of the risk of pathogen transfer to the next patient you touch.

An example noncompliance scenario is as follows: Barbara touches the bedside table of a patient during flu season and then moves to another patient without performing hand hygiene in between visits. Mark your assessment of the risk of pathogen transfer between patients.

In the survey, each actor was paired with each surface under each of the the 4 risk levels, for a total of 16 scenarios. Each participant rated all 16 scenarios.

**Design and procedure**

Independent variables included the actor in the scenario (self vs other) and the surface touched (patient vs inanimate object). Each of these variables was considered in the context of a HCW performing or failing to perform hand hygiene in between visits. Mark your assessment of the risk of pathogen transfer between patients.

In the survey, each actor was paired with each surface under each of the the 4 risk levels, for a total of 16 scenarios. Each participant rated all 16 scenarios.

**RESULTS**

Multiple linear regression was used to determine the individual contributions of each predictor variable to the risk rating assigned to a particular scenario. Predictors included actor, surface, internal HLC, knowledge score, the interaction of internal HLC and knowledge score, and profession group (dummy-coded with nurses as the reference group). Predictor variables were entered into the regression in the order of their predicted importance in uniquely explaining the variance using the “Enter” method. Predictor variables were uncorrelated, indicating no problems with multicollinearity (all $P$s < .05).

**Risk level 0 scenario results**

In the level 0 (no-risk) scenario, the HCW followed all hand hygiene recommendations. It was predicted that the HCWs’ knowledge of hand hygiene as well as their internal HLC would explain any differences in risk ratings for these scenarios. Knowledge score alone also affected risk ratings, with participants with high knowledge rating the scenarios as lower in risk compared with those with low knowledge (Table 2). Contrary to our hypothesis, internal HLC alone was not a
significant predictor. However, internal HLC interacted with knowledge score such that persons high in internal control beliefs and high in knowledge rated the no-risk scenario even lower in risk compared with those with high knowledge alone (Fig 2). Professional group, surface, and actor did not affect risk ratings.

Risk level 1-3 scenario results

All scenarios with risk (ie, the actor in the scenario did not perform hand hygiene) were hypothesized to be predicted by actor, surface, knowledge of hand hygiene, and internal HLC. Specifically, scenarios in which the actor was the self would be rated as less risky than scenarios involving others, all persons were predicted to rate inanimate surfaces as less risky than patient contact, and participants with high knowledge and/or low internal HLC were predicted to rate all scenarios as more risky compared with those low in knowledge.

Significant predictors were internal HLC and the type of surface touched (Table 2). Neither knowledge score nor actor was a significant predictor when risk was present in a scenario. No interaction terms were significant. Compared with nurses, ES managers rated risk as lower at risk levels 1 and 3, controlling for all other variables in the equation. No other differences were seen among the 3 professional groups.

DISCUSSION

In scenarios in which the actor fully complied with hand hygiene rules, knowledge level played a role in whether or not the participant recognized the lack of risk in the scenario. Participants with high knowledge scores rated the scenarios as lower in risk compared with those with lower knowledge scores, especially when the former also had high internal HLC scores. Interestingly, those low in knowledge but high in internal HLC demonstrated the opposite response, rating no-risk scenarios as higher in risk than any other group. This is an interesting finding, because it implies that internal HLC can be either beneficial or harmful, depending on the participant’s knowledge level. In contrast, scenarios in which the actor did not comply with hand hygiene rules showed that HCWs repeatedly estimated contact with surfaces as being less risky than contact with a patient’s skin. This finding was observed for all scenarios containing risk and did not vary according to knowledge level or internal HLC. Internal HLC score also predicted risk assessment, with participants with low internal HLC tending to rate the risk as lower compared with those with high internal HLC.

The influence of knowledge level on the no-risk scenarios was surprising, given that most participants scored high on the test of hand hygiene knowledge. Yet even within this restricted range, there were differences in risk assessment in those participants with the highest knowledge scores. Internal HLC affected risk ratings for every type of scenario. In no-risk scenarios, internal HLC interacted with knowledge score to drive the risk ratings of high-knowledge participants even lower compared with knowledge score alone. However, in participants with lower knowledge scores, a high level of internal HLC resulted in the highest risk ratings. When risk was present in a scenario, internal HLC was linked
The table below provides a summary of hierarchical regression analysis for variables predicting HCWs’ perceptions of risk (n = 71).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Level 0 risk</th>
<th>Level 1 risk</th>
<th>Level 2 risk</th>
<th>Level 3 risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B SE B β</td>
<td>B SE B β</td>
<td>B SE B β</td>
<td>B SE B β</td>
</tr>
<tr>
<td>Step 1 (constant)</td>
<td>21.8 2.5</td>
<td>89.72 1.86</td>
<td>93.93 2.1</td>
<td>92.8 1.45</td>
</tr>
<tr>
<td>Actor</td>
<td>-2.61 0.78</td>
<td>0.51 1.5 0.01</td>
<td>-3.81 2.41</td>
<td>2.63 1.67</td>
</tr>
<tr>
<td>Surface</td>
<td>-3.19 1.47</td>
<td>-5.87 1.23</td>
<td>-9.12 2.41</td>
<td>-5.74 1.67</td>
</tr>
<tr>
<td>Knowledge score</td>
<td>-1.95 0.43</td>
<td>-9.09 0.32</td>
<td>0.54 0.36</td>
<td>0.28 0.25</td>
</tr>
<tr>
<td>Internal HLC</td>
<td>0.06 0.38 0.19</td>
<td>0.92 0.28 0.19</td>
<td>0.87 0.32 0.16</td>
<td>0.10 0.22 0.26</td>
</tr>
<tr>
<td>Step 2 (constant)</td>
<td>21.67 2.40</td>
<td>89.73 1.86</td>
<td>93.93 2.10</td>
<td>92.78 1.45</td>
</tr>
<tr>
<td>Actor</td>
<td>-2.61 0.77</td>
<td>0.51 1.41 0.01</td>
<td>-3.81 2.42</td>
<td>2.63 1.67</td>
</tr>
<tr>
<td>Surface</td>
<td>-3.19 1.76</td>
<td>-8.57 1.23</td>
<td>-9.12 1.20</td>
<td>-5.74 1.67</td>
</tr>
<tr>
<td>Knowledge score</td>
<td>-2.08 0.47</td>
<td>-8.08 0.32</td>
<td>0.54 0.36</td>
<td>0.25 0.25</td>
</tr>
<tr>
<td>Internal HLC</td>
<td>0.29 0.37 0.18</td>
<td>0.90 0.28 0.18</td>
<td>0.85 0.32 0.15</td>
<td>0.10 0.22 0.27</td>
</tr>
<tr>
<td>Internal HLC × Knowledge score</td>
<td>-0.56 0.12 -0.28</td>
<td>0.03 0.09 0.02</td>
<td>0.03 0.10 0.02</td>
<td>-0.11 0.07 -0.09</td>
</tr>
<tr>
<td>Step 3 (constant)</td>
<td>23.85 3.07</td>
<td>91.30 2.37</td>
<td>95.35 2.70</td>
<td>94.25 1.84</td>
</tr>
<tr>
<td>Actor</td>
<td>-2.61 0.77</td>
<td>0.51 1.41 0.01</td>
<td>-3.81 2.42</td>
<td>2.63 1.66</td>
</tr>
<tr>
<td>Surface</td>
<td>-3.19 1.76</td>
<td>-8.57 1.23</td>
<td>-9.12 1.20</td>
<td>-5.74 1.66</td>
</tr>
<tr>
<td>Knowledge score</td>
<td>-2.19 0.42 -0.29</td>
<td>-0.17 0.33 -0.03</td>
<td>0.48 0.37 0.08</td>
<td>0.18 0.25</td>
</tr>
<tr>
<td>Internal HLC</td>
<td>0.27 0.37 0.18</td>
<td>0.87 0.29 0.18</td>
<td>0.85 0.32 0.15</td>
<td>0.10 0.22</td>
</tr>
<tr>
<td>Internal HLC × Knowledge score</td>
<td>-0.56 0.12 -0.27</td>
<td>0.03 0.09 0.02</td>
<td>0.03 0.10 0.02</td>
<td>-0.11 0.07 -0.09</td>
</tr>
<tr>
<td>IPs vs other professions</td>
<td>-1.27 3.37 -0.02</td>
<td>-0.19 2.60 -0.01</td>
<td>-1.68 2.94 -0.04</td>
<td>-0.35 2.01 -0.10</td>
</tr>
<tr>
<td>ES managers vs other professions</td>
<td>-5.85 3.51 -0.11</td>
<td>-5.08 2.71 -0.124</td>
<td>-2.81 3.07 -0.06</td>
<td>-4.57 2.1 -0.14</td>
</tr>
</tbody>
</table>

NOTE: Level 0 risk: \( R^2 = 0.076 \) for step 1, \( \Delta R^2 = 0.072 \) for step 2, and \( \Delta R^2 = 0.009 \) for step 3 (P < .001); level 1 risk: \( R^2 = 0.087 \) for step 1, \( \Delta R^2 = 0.000 \) for step 2 (P = .734), and \( \Delta R^2 = 0.014 \) for step 3 (P = .110); level 2 risk: \( R^2 = 0.086 \) for step 1, \( \Delta R^2 = 0.000 \) for step 2 (P = .754), and \( \Delta R^2 = 0.003 \) for step 3 (P = .651); level 3 risk: \( R^2 = 0.341 \) for step 1, \( \Delta R^2 = 0.008 \) for step 2 (P = .118), and \( \Delta R^2 = 0.018 \) for step 3 (P = .057). B, standardized coefficient; SE, standard error.

\*P < .05. Significant findings are highlighted to show the pattern of results that differed between no-risk scenarios and scenarios with risk.

Fig 2. Three-dimensional mesh plot showing the interaction of the continuous variables of knowledge score and internal HLC on risk assessment for the no-risk (level 0) scenarios. Those with low knowledge and high internal HLC were least able to recognize the lack of risk, whereas those with high internal HLC and high knowledge rated the scenarios as least risky.

to higher ratings for risk. It is possible that providing information about the direct effects of hygiene might encourage persons who feel a lack of control over health to develop more feelings of control, but this should be paired with education about hand hygiene.

Limitations

Risk assessments might not necessarily translate to behavior. For example, in a low-risk scenario, HCWs may take the same precautions as in a high-risk scenario despite rating the risk as low. If this were the case, then their ratings of risk would be unrelated to behavior. Although it seems likely that risk beliefs correspond to action, this cannot be verified based on the present survey results.

Except for the type of surface touched, many of the significant predictors had small, but significant and consistent, effects on risk assessment. When considering compliance on a global scale, it is possible that even tiny effects can account for many lives if behavior is affected by risk assessment.

CONCLUSION

Our findings indicate that individual differences in knowledge and beliefs affected the risk that HCWs
assigned to different scenarios. These risk assessments were also affected by the surface touched in the scenario, with patient skin believed to be riskier than objects. In general, the participants with the most knowledge and highest internal HLC were the least susceptible to the skin-object differentiation and the most likely to recognize when proper hygiene indicated a low-risk scenario. Based on these findings, future interventions should focus on knowledge, fomites, and beliefs.

**Knowledge**

All of the HCWs in this study were knowledgeable, but those with the highest knowledge scores demonstrated a greater understanding of how good hygiene affects risk. Recommendations based on our findings include frequent evaluation to ensure maintenance of a high knowledge level and continuing education regarding the potential for pathogen transfer from various surfaces.

**Fomites**

Given that HCWs and patients consistently misjudge the danger of surfaces, possible strategies could include reducing the need for contact with surfaces by using products that are single-use or do not require human adjustment; increasing the cleaning and disinfection of high-touch surfaces; raising awareness of the risk of transfer of pathogens from fomites; reviewing current cleaning and disinfection protocols, tools, and chemistries to ensure that they adequately meet the facility’s needs; and keeping HCWs informed of emerging cleaning and disinfecting technologies, such as antimicrobial surfaces and coatings, new chemistries, and cleaning and disinfecting systems.

**Beliefs**

The focus here should be on increasing feelings of control in HCWs with low internal HLC. Although there is no guaranteed method for changing HLC beliefs, the following are some possible avenues: (1) understanding individual differences in risk assessment by locus of control; (2) using cognitive behavior therapy, with the idea of changing behaviors to change HLC beliefs; (3) providing positive reinforcement and feedback on hand hygiene actions to help change HLC beliefs; (4) and providing information on the direct effects of actions, to help convince HCWs who perceive a lack of control that their actions do in fact affect outcomes.

In conclusion, it is evident that more needs to be done to educate HCWs about pathogens on surfaces. To enhance the success of hand hygiene education and training concerning surfaces, individual differences in HCWs’ current knowledge level and internal HLC beliefs should be taken into account. The ultimate goal is to increase compliance with effective hand hygiene programs, and documenting individual differences in hygiene knowledge among HCWs can help guide the design of future interventions.

This work was supported in part by the Kimberly-Clark Corporation. Portions of these data were presented at the 2010 Annual Meeting of the Human Factors and Ergonomics Society, San Francisco, CA.

**References**