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# Why Healthcare Workers Don't Wash Their Hands: A Behavioral Explanation

Michael Whitby, MD; Mary-Louise McLaws, PhD; Michael W. Ross, PhD

**OBJECTIVE.** To elucidate behavioral determinants of handwashing among nurses.

**DESIGN.** Statistical modeling using the Theory of Planned Behavior and relevant components to handwashing behavior by nurses that were derived from focus-group discussions and literature review.

**SETTING.** The community and 3 tertiary care hospitals.

**PARTICIPANTS.** Children aged 9-10 years, mothers, and nurses.

**RESULTS.** Responses from 754 nurses were analyzed using backward linear regression for handwashing intention. We reasoned that handwashing results in 2 distinct behavioral practices—inherent handwashing and elective handwashing—with our model explaining 64% and 76%, respectively, of the variance in behavioral intention. Translation of community handwashing behavior to healthcare settings is the predominant driver of all handwashing, both inherent (weighted  $\beta = 2.92$ ) and elective (weighted  $\beta = 4.1$ ). Intended elective in-hospital handwashing behavior is further significantly predicted by nurses' beliefs in the benefits of the activity (weighted  $\beta = 3.12$ ), peer pressure of senior physicians (weighted  $\beta = 3.0$ ) and administrators (weighted  $\beta = 2.2$ ), and role modeling (weighted  $\beta = 3.0$ ) but only to a minimal extent by reduction in effort (weighted  $\beta = 1.13$ ). Inherent community behavior (weighted  $\beta = 2.92$ ), attitudes (weighted  $\beta = 0.84$ ), and peer behavior (weighted  $\beta = 1.08$ ) were strongly predictive of inherent handwashing intent.

**CONCLUSIONS.** A small increase in handwashing adherence may be seen after implementing the use of alcoholic hand rubs, to decrease the effort required to wash hands. However, the facilitation of compliance is not simply related to effort but is highly dependent on altering behavioral perceptions. Thus, introduction of hand rub alone without an associated behavioral modification program is unlikely to induce a sustained increase in hand hygiene compliance.

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Although healthcare worker (HCW) compliance with handwashing guidelines is a cornerstone of ideal infection control practice, the rate of such compliance has proved to be abysmal.<sup>1</sup> A variety of interventions have been investigated with the intent of improving knowledge of and compliance with handwashing guidelines and then reinforcing these practices<sup>2-6</sup>; however, until recently, none have engendered evidence of sustained improvement during a protracted period.<sup>7,8</sup>

In 2000, two groups published findings that provided hope to those concerned about improving handwashing practice. Pittet et al.<sup>7</sup> demonstrated that handwashing compliance among nurses at the University of Geneva hospitals increased to a maximum of 66% during a 48-month period. This improvement was associated with concomitant decreases in healthcare-acquired infection rates and cross-transmission of methicillin-resistant *Staphylococcus aureus*. The Geneva program was multilevel and multifactorial, with a number of

interventions likely to affect HCW behavior. However, the particular focus of this program was the provision of an alcohol-based hand rub designed to reduce the time taken and the inconvenience associated with handwashing. Subsequently, Larson et al.<sup>8</sup> described a significant increase in handwashing compliance that was sustained for a 14-month period in a Washington, DC, teaching hospital. Their program attempted to induce organizational cultural change toward optimal hand hygiene, with senior administrative and clinical staff overtly supporting and promoting the handwashing program.

After publication of the Geneva study,<sup>7</sup> commercially produced alcohol-based hand rubs became widely marketed and introduced into hospitals, with the expectation that a sustained increase in compliance with handwashing guidelines would follow. The usefulness of such products has been reinforced on the basis of recommendations in internationally well-respected guidelines.<sup>9</sup> Some reports of short-term im-

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improvements in compliance that occurred after the introduction of alcohol-based hand rubs, often recorded from overt observation, have been published.<sup>10-13</sup>

Although the benefits of the interventions reported by Pitet et al.<sup>7</sup> and Larson et al.<sup>8</sup> are undoubted and the cost-effectiveness of the programs has been justified,<sup>14</sup> we must now identify why these interventions were successful. Handwashing as a practice is a globally recognized phenomenon; however, the inability to motivate HCW compliance with handwashing guidelines suggests that handwashing behavior is complex. Human behavior is the result of multiple influences from our biological characteristics, environment, education, and culture. Although these influences (hereafter referred to as “components”) are usually interdependent, some have more force than others.

Many theories have been developed to define the nature and relationship of multiple factors that affect a range of health-related behaviors. Use of these theoretical behavior models has widely occurred in a number of areas of health education and health promotion, sometimes with considerable success.<sup>15</sup> The Theory of Planned Behavior (TPB)<sup>16</sup> is appropriately used when examining behaviors considered to be determined by a person’s intention. With regard to handwashing, the model is predicated on a person’s acceptance that the immediate cause of handwashing is their antecedent intention to wash their hands. The intention to perform a given behavior is predicted directly, although to differing degrees, by 3 intermediate variables: attitude (a feeling that the behavior is associated with certain attributes or outcomes that may or may not be beneficial to the individual), subjective norms (a person’s perception of pressure from peers and other social groups), and perceived behavioral control (a person’s perception of the ease or difficulty in performing the behavior). These intermediate variables are predicted by the strength of the person’s beliefs about the outcomes of the behavior, normative beliefs (which are based on a person’s evaluation of the expectations of peers and other social groups), and control beliefs (which are based on a person’s perception of their ability to overcome obstacles or to enhance resources that facilitate or obstruct their undertaking of the behavior). For each behavior, qualitative assessments, which usually take the form of focus-group discussions, are initially used to best determine the content of each influencing component. This often means that predictive components described by other behavioral models can also be included in the final paradigm to best explain the behavior of interest. Our investigations focus on elucidating and determining the origin of the behavioral determinants of handwashing in nurses in the health-care setting.

Ethical approval for both parts of this study within all 3 environments (hospital, schools, and the community) was provided by the ethics committees of Princess Alexandra Hospital, Brisbane, and of the University of New South Wales, Sydney, Australia.

## FOCUS-GROUP DISCUSSIONS

### Methods

Focus-group discussions involving the following 3 cohorts were held: children, mothers, and nurses. Children aged 9-10 years were chosen on the basis of their ability to articulate their beliefs and practices and those of their family unit. This cohort comprised 4 groups of 16 children each (8 boys and 8 girls). The groups were selected from the following 4 schools: 1 private school for girls, 1 private school for boys, and 2 coeducational public schools in high and low socioeconomic catchment areas. Mothers were chosen on the supposition that they played a major role in the promotion of health within the family unit. This cohort comprised 4 groups each of 16 mothers of other children aged 9-10 years, selected from volunteers from 4 different schools with demographic characteristics described above. Nurses were chosen because they constitute the largest professional group of HCWs employed in healthcare facilities and have the most patient contact and, therefore, handwashing opportunities.<sup>17</sup> The nurse cohort was composed of 4 groups of 16 female nurses each from the following 4 wards of 2 large tertiary care referral hospitals: infectious diseases, internal medicine, intensive care, and general surgical.

The same experienced female professional market researcher moderated each session by use of a semistructured interview technique with open-ended statements and questions based on results of literature review or unpublished pilot observations. Each focus-group discussion was recorded and transcribed verbatim. Data were analyzed for recurrent themes and concepts, and grounded-theory methodology was used to investigate handwashing practices. Data expressing attitudes, beliefs, and practices were also used as the content of a questionnaire developed on a modified TPB format.<sup>16</sup>

### Results

*Views on the purpose of handwashing.* Handwashing was perceived foremost as a mechanism of self protection against harmful organisms. Children understood the concept of microbes and agreed that, although water can get rid of surface dirt on hands, it is necessary to use soap to ensure that “germs” are killed. Handwashing behavior was also influenced by the appearance of their hands. Mothers, although recognizing that handwashing played an integral role in both the removal of microbes and the prevention of their transfer, described the practice as a habitual rather than as a thoughtful action associated with particular occasions. Handwashing was perceived as an act that not only physically but also psychologically “cleaned” their hands of microorganisms and “dirt,” which may be either visible or otherwise emotionally sensed. Nurses described their handwashing behavior in similar terms, as an unconscious practice (Table 1).

TABLE 1. Drivers of Handwashing

Purpose	<p>“[Handwashing] makes sure you don’t get sick.” (child)</p> <p>“You are at risk all the time, which is probably why you wash your hands all the time.” (nurse)</p>
Indication	<p>“Color of skin, how dirty they are.” (child)</p> <p>“[You wash your hands] when they feel grossy.” (mother)</p> <p>“[You wash your hands] to get rid of the smell.” (mother)</p>
Motivation	<p>“I think you just subconsciously do it, you have done it for such a long time. You don’t think about why you are doing it.” (mother)</p> <p>“It [handwashing] is almost like a ritual. I have even reached the point where you do it whether you realize you have done it or not.” (nurse)</p>

Teaching children about handwashing commences when a child begins eating semisolid foods and coincides with toilet training. Mothers and nurses agreed that handwashing in the home is of lesser importance; thus, the decision by children to wash hands was strongly influenced by situation. A risk assessment based on the perceived likelihood that harmful microorganisms are present is made before deciding whether to wash hands in public areas (eg, shopping centers and playgrounds) considered more likely than homes to harbor harmful “germs” (Table 2).

*Attitudes toward handwashing in the community.* More-specific scenarios were introduced to elicit attitudes with regard to handwashing after a variety of activities, such as playing on a swing, playing with a handheld computerized game, reading a book, or using the toilet (Table 3). Mothers’ and nurses’ evaluation of the importance of children washing their hands after playing on a swing were mixed, with responses qualified by the context of the situation. A similar attitude was elicited in regard to playing with a handheld computerized game and reading at home as opposed to in a public library. All children expressed the view that it was mandatory to wash hands after going to the toilet. The emphasis was on “the germs that you could get” from contact with various things, including their own body. The need to wash hands after using the toilet was even more important if the toilet was for public use, because children perceived a public toilet as having the potential to harbor “more germs” than their toilet at home. This attitude was unanimously supported by both mothers and nurses, who held public toilets in very

poor regard because they are “grossy” and a “haven for germs.” Some mothers and nurses reported that they physically avoid touching doorknobs or using soap cakes in such environments.

*Nurses’ attitudes toward handwashing at work.* Although nurses appeared to believe that they habitually washed their hands without thinking about it, a number of factors appeared to affect the importance that they placed on handwashing in the healthcare setting (Table 4), including the condition of their patients, the extent of patient contact, their assessment of the task involving a patient, and workload. Nurses believed that patients are a potential reservoir of infection because patients have little understanding of infection transmission. Nurses assessed the risk of infection due to contact with individual patients on the basis of several criteria, including the patient’s diagnosis, physical appearance, and perceived general cleanliness; visibility of the patient’s body fluids; and the patient’s age. An assessment was made in terms of the degree of “dirtiness” or the lack of “cleanliness” of a patient.

Handwashing was not always considered to be essential for certain types of physical contact with patients. Tasks that require nonintimate touching of a patient (eg, measuring the heart rate or blood pressure) or use of inanimate objects (either hospital or patient related, including clothing, medication, and clean linen) were less likely to be considered important motivating factors for handwashing, compared with tasks involving more-prolonged physical contact.

TABLE 2. General Community Attitudes Toward Handwashing

Influence of situation	<p>“You need to wash your hands if you are in an area where germs might be, like a shopping center.” (child)</p> <p>“You don’t have to be completely over the top, just with other people’s germs.” (mother)</p> <p>“I am perfectly happy with my germs at home, but not with anyone else’s germs.” (nurse)</p>
Commencement of teaching	<p>“The emphasis is [on handwashing] straight away when you become a parent.” (mother)</p> <p>“Sitting in their highchair, the first thing you do is get a cloth and wash their hands.” (mother)</p>

TABLE 3. Specific Community Attitudes Toward Handwashing

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Swings and handheld computerized game	
	“Where is the swing—in a public playground or in your backyard?” (mother)
	“My kids would never wash their hands after Playstation [Sony], but when you think about it, it would carry so many germs because there are different kids over.” (mother)
Toilets	
	“You get germs on your hands.” (child)
	“You get germs from wiping yourself.” (child)
	“[You get] germs from the flush button.” (child)
	“[Handwashing before] going to the toilet goes without saying.” (nurse)

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In parallel with the nurse’s assessment of the task involving a patient, nurses judged the level of “dirtiness” of the actual task. This assessment resulted in nursing staff feeling compelled to wash their hands if their hands were visibly contaminated, moist or gritty, or touched axillae, genitals, or the groin.

Nurses reported that, when under time constraints, they used physical and task assessments to determine the necessity of handwashing. However, nurses always felt compelled to wash hands after performing tasks they considered to be “dirty.”

*Components of handwashing.* Discussions identified that handwashing was practiced as 2 separate behaviors, one we term “inherent” and the other we term “elective.” Inherent handwashing applies to behavior that is undertaken when hands are physically dirty or feel sticky or when hands have been somewhere considered to be “emotionally dirty” (eg, nurses described axillae, groins, and genitals as “dirty”). All groups described a belief that handwashing with soap and water is required after this type of contact. Elective handwashing applies to behavior that encompasses all other potential handwashing opportunities. The term refers only to an individual’s perception that handwashing may not need to be undertaken in a particular circumstance and is not

intended to imply that, in the healthcare setting, handwashing is a matter of choice.

#### THEORETICAL BEHAVIORAL MODEL

##### Methods

*Development of the questionnaire.* Questions were developed after assessment of international handwashing guidelines, after review of literature to ascertain reported barriers to handwashing, and, predominantly, from our analysis of the responses from the focus-group cohort. Original components of the TPB included the effect of role modeling (perceived peer behavior), the effect of an individual’s perception of the positive and negative effects of handwashing (attitudes), and the effort required to undertake handwashing and the role of peer pressure (subjective norms). During the focus group discussions, 4 separate peer groups were identified: senior physicians, senior administrators, non-infection control nurses, and infection control nurses. Although TPB usually has one outcome component, we modeled for the 2 separate handwashing practices that were identified, termed “elective in-hospital handwashing” and “inherent in-hospital handwashing.” The questionnaire is available from the authors upon request.

TABLE 4. Nurses’ Attitudes Toward Handwashing

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Patient assessment	
	“I find it off putting when a patient says ‘can you fill my water jug up’ and at the same time, they hand you their [urine] bottle.”
	“[The decision to wash hands depends on]...basically the patient themselves and watching their personal hygiene and how they wash themselves and their hands.”
	“With a lot of older patients, their basic hygiene tends to fall down a lot.”
Degree of physical contact	
	“I would be more inclined to wash my hands if I were touching a patient rather than objects.”
Task assessment	
	“When you see that film of stuff, if body fluid is there, it is more real whereas bed clothes with nothing on it, you tend to strip it, make it, and get on with the next one.”
	“If there is anything you can visually see that is ‘dirty,’ you definitely wash your hands then, things like making beds, you’d probably would not be so inclined.”
Workload	
	“If you are not washing your hands enough it is because you are so busy...you should be washing, but there is no way in the world...even experienced staff would do that because they have to get their medications out, make beds, get their patients off to showers, etc, and have doctors coming in and giving orders—it’s just not going to happen.”

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TABLE 5. Components of the Model

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<p>In-hospital elective handwashing (<math>r = 0.87</math>)</p> <p>After touching autoclaved materials; after touching the hospital's telephone; after touching a patient's furniture; after arranging flowers at work; after rubbing a patient's back; after taking a patient's temperature; after sponging a patient; after shaking hands with a patient; after touching a patient's feet; after blowing my nose; after taking a patient's pulse; after touching a patient's breast; after using someone else's computer</p> <p>In-hospital inherent handwashing (<math>r = 0.84</math>)</p> <p>After performing a wound dressing; after making an incontinent patient's bed; after performing a mouth toilet; after changing a urine bag; after dressing an infected wound; after touching a patient's groin; after defecating; after emptying a soiled bed pan; after touching a patient's armpit</p> <p>Community inherent handwashing (<math>r = 0.52</math>)</p> <p>After urinating; after cleaning my toilet at home; after gardening</p> <p>Community elective handwashing (<math>r = 0.90</math>)</p> <p>Before leaving work for home; before making coffee or tea at home; after cleaning my kitchen at home; before I eat a meal at home; after taking out the garbage at home; after vacuuming at home; before preparing a meal at home; after using my own computer at home; after patting my dog; after blowing my nose; after cleaning my shower; after reading a newspaper; after stroking my cat; after sexual intercourse; after using someone else's computer</p> <p>Subjective norms for nurses (<math>r = 0.90</math>)</p> <p>It is important that my nurse colleagues should wash their hands in accordance with the hospital policy; it is important to please my nurse colleagues and wash my hands after contact with a physically "dirty" patient; the physicians/surgeons think I should wash my hands after contact with a physically "dirty" patient; it is important to please the physician/surgeons and wash my hands after contact with a physically "dirty" patient</p> <p>Subjective norms for infection control practitioners (<math>r = 0.90</math>)</p> <p>My infection control practitioner thinks I should wash my hands after contact with a physically "dirty" patient; my infection control practitioner thinks I should wash my hands after contact with a physically "clean" patient; my infection control practitioner wants me to comply with the handwashing protocol</p> <p>Subjective norms for physicians and surgeons (<math>r = 0.77</math>)</p> <p>The physicians/surgeons think I should wash my hands after contact with a physically "dirty" patient; the physicians/surgeons think I should wash my hands after contact with a physically "clean" patient</p> <p>Subjective norms for administrators (<math>r = 0.84</math>)</p> <p>My hospital administration thinks I should wash my hands after contact with a physically "dirty" patient; my hospital administration thinks I should wash my hands after contact with a physically "clean" patient</p> <p>Attitudes (<math>r = 0.80</math>)</p> <p>I know the hospital's handwashing protocol; the hospital's handwashing protocol reduces cross-infection; following the handwashing protocol will protect me from serious infection; if I follow the handwashing protocol I will protect my patients from serious infection; if I follow the handwashing protocol I will protect my family from serious infection; I am responsible for reducing risk of cross-infection in my patients; it is my role to influence hand hygiene behavior in my colleagues; patients have a right to expect high hand hygiene standards; offensive odor/material is removed from my hands if I wash them; by following the handwashing protocol, I will be viewed as a responsible nurse; the availability of antibiotics to treat infection means that I don't need to wash my hands as much; I don't believe handwashing is necessary after minimal contact with a physically clean patient</p> <p>Perceived peer behavior (<math>r = 0.91</math>)</p> <p>I believe my charge-nurse washes his/her hands in accordance with the hospital policy; I believe physicians/surgeons wash their hands in accordance with the hospital policy; I believe my nurse colleagues wash their hands in accordance with the hospital policy</p> <p>Effort required (<math>r = 0.80</math>)</p> <p>When I'm pushed for time I don't wash after minor patient contact; I don't wash my hands for minor patient contact because the hand basins are not conveniently placed; I don't wash my hands as often as I should because hand washing solution irritates my hands; handwashing procedures are too time-consuming to be strictly adhered to; if I follow the handwashing protocol, my hands will become dry, cracked, and irritated; when I am busy, I don't wash my hands after minor patient contact.</p>
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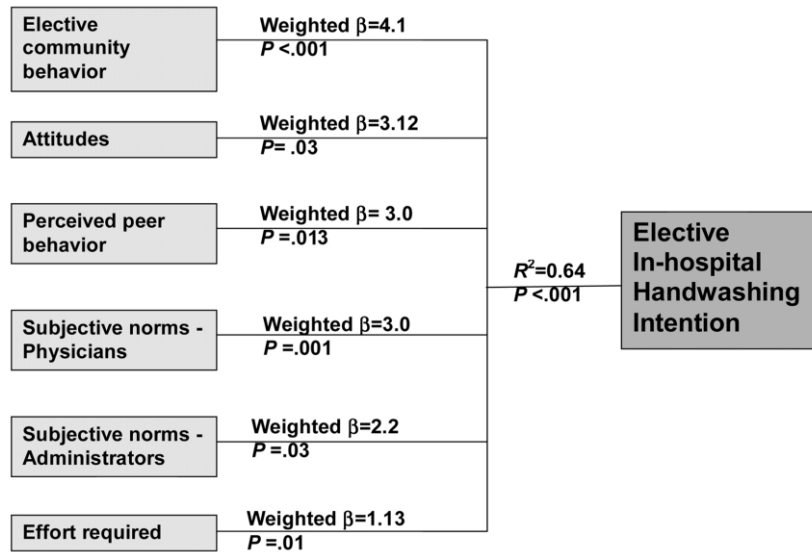


FIGURE 1. Modeling of elective hospital handwashing intention

*Measurement of the responses.* Responses to questions about elective in-hospital handwashing and inherent in-hospital handwashing were measured on a 5-point scale (always, mostly, sometimes, occasionally, and never), whereas the predictive components were measured on a 7-point Likert-type scale (ranging from strongly agree to strongly disagree). The scores were reversed for questions worded in the negative. All items within each component were summed. There were 56 questions about attitudes, 4 about subjective normative components, and 4 that controlled for perceived behavior. A total of 22 questions addressed each of the outcome components (ie, in-hospital elective handwashing and in-hospital inherent handwashing).

*Assessment of construct validity of the components and model development.* All components were tested for internal consistency using the Cronbach  $\alpha$  coefficient, with both the final items for each component and the Cronbach  $\alpha$  results listed

in Table 5. The newly modified model now consists of 9 components tested for predictiveness of 2 outcomes (elective in-hospital handwashing and inherent in-hospital handwashing) by use of backwards linear regression. The  $\beta$  coefficient for each predictive component was calculated and represents a measure of the influence of each component on the intention to wash hands. For significant predictors,  $\beta$  values were statistically standardized (weighted  $\beta$ ) by use of interquartile ranges, to allow for direct comparisons of the positive or negative effect of each component on the intention to undertake the behavior.

## Results

The questionnaire on handwashing behavior was completed by 754 (61%) of 1,238 nurses surveyed from 3 large teaching hospitals. Modeling of the intention to undertake in-hospital

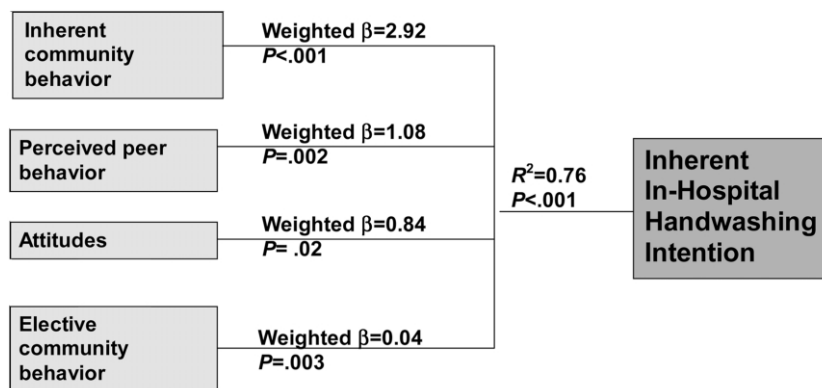


FIGURE 2. Modeling of inherent hospital handwashing intention

elective handwashing is illustrated in Figure 1. This model explains 64% of the variance for the intended behavior. Six components were shown to have a significant impact on the intention to wash hands, with no significant first-order interaction terms or colinearity. Internal consistency within each component was high, with coefficients exceeding 0.77 in all components except inherent community behavior ( $r = 0.52$ ).

Elective community behavior was shown to have a major impact (weighted  $\beta = 4.1$ ;  $P < .001$ ) on the intention to perform elective in-hospital handwashing. Attitude toward handwashing (weighted  $\beta = 3.12$ ;  $P = .03$ ) was also important, because with every single-unit improvement in the attitude toward handwashing, a 3-fold increase in the intent to undertake the behavior is predicted. Perceived peer behavior (role modeling) (weighted  $\beta = 3.0$ ;  $P = .013$ ) is of equal predictive importance. The effect of peer pressure from physicians (weighted  $\beta = 3.0$ ;  $P = .001$ ) and administrators (weighted  $\beta = 2.2$ ;  $P = .03$ ) was also significant, unlike the impact of peer pressure from nurses, including infection control nurses, which was eliminated from the model. Effort required had a significant ( $P = .01$ ) impact; however, the model predicted that a single-unit decrease in the effort required would result in only a minimal increase in the intention (weighted  $\beta = 1.13$  units) to undertake the behavior.

Modeling of the intention to undertake inherent in-hospital handwashing explained 76% of variance of this practice and effectively showed that only 3 components had a substantial impact. Weighted  $\beta$  values ranged from 0.82 to 2.92 (Figure 2).

## DISCUSSION

Our choice of cohorts may be a potential limitation of our study, because the attitudes of the cohort may not be representative of the entire nursing community, of male nurses, or of all occupational groups of HCWs.<sup>18</sup> The handwashing practices discussed by all respondents involved a ritualized behavior performed mainly for self-protection against infection with harmful microorganisms, despite differences in age and employment experience and the potential influence of scientific training. That all 3 groups expressed nearly identical ideas about handwashing supports the impression that the development of handwashing beliefs and practices first occurs during early childhood and continues thereafter with little modification.

Belief in a potential risk for infection was clearly modified by the source of microorganisms: the risk from a family source was considered to be much less harmful than the risk from nonfamily and public sources. The handwashing ritual was adjusted by all 3 groups accordingly. There was no modification to the toileting ritual, however. Mothers and nurses described toilets as a "haven for germs," and this belief was reiterated by children. The belief that fecal material, including ones' own, is harmful is consistent with a hypothesis developed by Curtis and Biran,<sup>19</sup> who argue that the human emo-

tion of "disgust" is an evolutionary protective response to environmental factors that may pose a risk of infection. This response may be mirrored in the way that nurses make judgments about the potential risk for infection that contact with a patient may pose. Their assessment of the need to wash hands was strongly influenced by the emotional concepts of "dirtiness" and "cleanliness."

Our data suggest that an individual's handwashing behavior is not a homogenous practice but falls into 2 broad categories. The first category we have denoted as "inherent handwashing practice," which drives the majority of community handwashing behavior and occurs when hands are visibly soiled or feel sticky or gritty. This practice appears to require hand cleansing with water. A similar concept has previously been described after observations in developing countries where handwashing was identified as motivated by a need to "to remove dirt, to rinse off food after eating, [and] to make hands look and smell good."<sup>20</sup> Consistent findings were also recorded after observations of mothers and of British child care professionals, in whom a need to wash hands after changing diapers was promoted by a desire to remove offensive smells and to eliminate stickiness.<sup>21</sup> For nurses, we have added a further component to this category: nurses also wash their hands when they have been in contact with areas that we interpreted, on the basis of the focus-group discussions, as "emotionally dirty places," such as axillae or genitals, or a patient who is regarded as "unhygienic" because of appearance, age, or demeanor. Types of activities that induce intrinsic handwashing behavior in both the community and the healthcare setting are, therefore, those perceived as posing a risk to oneself.

We termed the other component to handwashing practice as "elective handwashing behavior." For older children, for example, this can be represented in that behavior that mothers find the most need to reinforce (eg, washing hands before a meal when the child feels that his or her hands are neither visibly soiled or feel sticky). For nurses at work, this component of handwashing behavior includes noninvasive, impersonal touching of a patient (eg, taking a pulse or touching inanimate objects in a patient's environment). Because this social type of contact is not perceived to pose a threat, it does not trigger an intrinsic response with an immediate desire to wash hands; it represents to the nurse an elective opportunity for handwashing. However, handwashing after such a contact in the healthcare environment is mandatory, because it may lead to microbial contamination of the hands, with the potential for cross-infection.

Nurses who completed the questionnaire clearly believed that they did not have time to wash their hands on all occasions; this finding is common to many studies.<sup>22-23</sup> Because of perceived time constraints, nurses seem to act through a self-developed "hierarchy of risk" to determine when handwashing was necessary. By this, we mean that they rank their opportunities for handwashing; when very busy, they give lower priority to washing their hands than they do to other



more pressing tasks. This hierarchy is based on the risk of infection an individual nurse perceives to be associated with an activity. Behavior that we have defined as intrinsic handwashing remains mandatory and impelling regardless of time constraints and will be performed regardless of obstacles. In contrast, other activities that should be followed by handwashing, such as bed changing and pulse taking, are not perceived to pose a risk of infection to the nurse and are thus given a lower priority. Therefore, such elective handwashing opportunities, although mandatory in the healthcare setting to reduce risk of cross-infection, are often omitted by busy nurses. This finding may also explain why increased accessibility to sinks does not lead to improved handwashing compliance.<sup>17,24,25</sup>

Our findings suggest that patterns of handwashing behavior develop in early childhood. Thus, nurses who began their careers before they were 25 years of age have, for the past 2 decades, continually reinforced an established model of inherent and elective handwashing practice through their community behavior. These patterns of handwashing translate into the healthcare setting. The fact that sustained alteration to this ritualized behavior is difficult to achieve should, therefore, not surprise us.

Modeling handwashing behavior among nurses on the basis of the TPB has been previously attempted without success. That TPB study treated handwashing as a homogenous practice.<sup>26</sup> Our conclusions are limited in that our behavior model predicts only the intention to wash hands and is not supported by an observational study confirming its predictions. Such a confirmation would require linkage of each individual's reported intention to his or her covertly observed handwashing behavior. Nevertheless, our data provide significant insights into HCW hand hygiene behavior. Because human behavior is so complex, models that explain 30%-40% of the variance in the behavior being investigated are considered to be acceptable. Our models of elective and inherent in-hospital handwashing intentions explained 64% and 76% of the variance in behavior, respectively.

Our modeling of elective in-hospital handwashing intention demonstrates the need for nurses to believe that handwashing in a particular situation results in a benefit to them (weighted  $\beta = 3.12$ ). It also shows an equally important effect of role modeling of senior physicians (weighted  $\beta = 3.0$ ) and senior administrators (weighted  $\beta = 2.2$ ) but, interestingly, not of other nurses, including infection control practitioners. This latter finding is supported by the successful outcomes of the studies by Pittet et al.<sup>7</sup> and Larson et al.,<sup>8</sup> in which overt support by senior administrators and senior physicians for handwashing compliance was promoted. It is also in keeping with the results of Lankford et al.,<sup>25</sup> who demonstrated a higher likelihood of handwashing by HCWs when senior members of staff were present.

Alcoholic hand rub may act as a cue to memory and may be more cosmetically acceptable. It certainly reduces the time required to cleanse hands,<sup>27</sup> overcoming one of the most com-

monly reported compliance barriers; it is thus represented in our modeling by the component "effort reduction." The components of our elective handwashing model have been demonstrated to act independently on outcome, and the effect of reduction of effort in our model is relatively small, compared with that of the behavioral components, particularly peer pressure and senior peer behavior.

We argue that inherent community handwashing practice is the most significant predictor of inherent in-hospital handwashing behavior; the perceived protective nature of this component of handwashing behavior means that it will be performed with water whenever nurses believe, on the basis of physical or emotional grounds, that their hands are soiled. It is a plausible explanation of the finding from the Geneva study<sup>7</sup> that, despite the promotion and ready accessibility of alcoholic hand rub, handwashing with water was performed during one third of all hand hygiene opportunities at all time points over the 48-month observation period. The intent to undertake inherent in-hospital handwashing was unaffected by a nurse's perception of expectations of any HCW and was also unaffected by effort reduction. One could anticipate that handwashing that occurs in a hospital with no structured handwashing behavioral modification program will be predominantly composed of inherent practices.

Our modeling demonstrates that, for inherent in-hospital handwashing intent, effort reduction has no impact. Similarly, for elective handwashing intent, the effect of effort reduction is small. Because all components of both models act independently on outcome, the apparently minimal effect of effort reduction strongly implies that the sustained increase in compliance demonstrated in the Geneva hospitals' program<sup>7</sup> is a consequence not of the introduction of alcoholic gel but of behavioral modification through peer pressure and role modeling that acted mainly on elective in-hospital handwashing behavioral intent. Thus, without an associated behavioral modification program, the provision of hand rub alone is unlikely to induce a sustained increase in hand hygiene compliance among nurses to the extent that a decrease in nosocomial infection or cross-transmission of marker multiresistant organisms will eventuate.

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