Health Care Workers' Hand Decontamination Practices : An Irish Study

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Clin Nurs Res 2006 15: 6
DOI: 10.1177/1054773805282445

Clinical Nursing Research
Volume 15 Number 1
February 2006 6-26

10.1177/1054773805282445
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Health Care Workers' Hand Decontamination Practices

An Irish Study

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The primary purpose of this quasi-experimental research is to observe health care workers' compliance with hand-hygiene guidelines during patient care in an intensive care unit in Ireland before (pretest) and after (posttest) implementation of a multifaceted hand-hygiene program. Health care workers' attitudes, beliefs, and knowledge in relation to compliance with handwashing guidelines were also investigated. A convenience sample of nurses, doctors, physiotherapists, and care assistants (n = 73 observational participants, n = 62 questionnaire respondents) was used. Data (N = 314 observations, 62 questionnaires) were analyzed descriptively and cross-tabulated using chi-square (Pearson's) and Mann-Whitney statistical tests. Results revealed that a significant shift (32%) occurred in health care workers' compliance with handwashing guidelines (pretest 51%, posttest 83%, $p < .001$) following the interventional hand-hygiene program. Significant changes were also found in relation to health care workers' attitudes, beliefs, and knowledge ($p < .05$).

Keywords: *hand hygiene; infection control; nurse; PRECEDE; compliance*

Hospital-acquired infection poses a very real and serious threat to all people who are admitted to hospital. Pathogens are readily transmitted on health care workers' hands, and hand hygiene substantially reduces this transmission. Evidence-based guidelines for health care workers' hand-hygiene practices exist; however, compliance with these guidelines is in-

Author's Note: I wish to acknowledge the Health Research Board, Ireland, who provided funding for this study through a Nursing and Midwifery Clinical Research Fellowship. I also wish to acknowledge Professor Geraldine McCarthy, University College Cork, who supervised the study and provided valuable guidance and support throughout. Finally, I wish to acknowledge the nurses, doctors, physiotherapists, and care assistants who, despite many demands on their time, willingly participated in this study. Please address correspondence to Ms. Sile A. Creedon, School of Nursing & Midwifery, University College Cork, Ireland; e-mail address: sile.creedon@ucc.ie.

ternationally low. The current study reveals that a multifaceted behavioral intervention may positively affect compliance rates and health care workers' attitudes, beliefs, and knowledge about compliance with hand-hygiene guidelines.

Hospital-Acquired Infection and Health Care Workers' Compliance With Hand-Hygiene Guidelines

Cross infection has been a problem since hospitals were established to provide care for the sick. Pioneering individuals such as Semmelweiss, Nightingale, and Lister demonstrated that a direct relationship existed between the rate people acquired infection while in hospital and infection control practices—especially handwashing of health care workers (Bryan, Cohran, & Larson, 1994; Jarvis, 1994). Nowadays, 6% to 10% of patients admitted to hospital and up to 26% of patients who are cared for in intensive care units (ICUs) acquire an infection (Emmerson, Enstone, Griffin, Kelsey, & Smyth, 1996; Glynn et al., 1997; Haley et al., 1985; Vincent et al., 1995). Acquisition of infection is costly particularly to the patient, and in general to the health systems (Coello et al., 1993; Kim, Oh, & Simor, 2001; Plowman et al., 1999). Researchers have suggested that the rate of hospital-acquired infection can be reduced by up to 33% if health care workers comply with handwashing guidelines (Haley et al., 1985; Pittet et al., 2000). Compliance with guidelines rarely exceeds 45% (Creedon, 2004; Graham, 1990; Larson et al., 1992; Moongtui, Gauthier, & Turner, 2000; Pittet, Mourouga, & Perneger, 1999; Sproat & Inglis, 1994; Zimakoff, Kjelsberg, Larsen, & Holstein, 1992). Health care workers have revealed that "busyness" (Gould & Ream, 1994), lack of time (Bridger, 1997; Larson & Killien, 1982; Voss & Widmer, 1997), inaccessible equipment (Gould & Ream, 1994; Harris et al., 2000; Kaplan & McGuckin, 1986), and skin irritation (Zimakoff et al., 1992) contributed to poor compliance rates.

Several unifaceted interventions, such as provision of educational programs (Conly, Hill, Ross, Leitzman, & Louise, 1989; Dubbert, Dolce, Richter, Miller, & Chapman, 1990; Gould & Chamberlain, 1995), motivational programs (Simmons, Bryant, Neiman, Spence, & Arheart, 1990), automated equipment (Broughall, Marshman, & Jackson, 1984), an alcohol rub (Bischoff, Reynolds, Sessler, Edmond, & Wenzel, 2000; Graham, 1990; Maury et al., 2000; Muto, Sistrom, & Farr, 2000; Pittet et al., 2000), and use of role models (Seto, Ching, Yeuen, Chu, & Seto, 1991), have had little success in improving compliance rates. Others concluded that any single innovation or intervention to influence behavior change (e.g., handwashing) would be ineffective unless it was part of a program recognizing the complex

nature of behavior and the profound difficulties of change (Green & Kreuter, 1999; Larson, Bryan, Adler, & Blane, 1997; Leventhal & Cameron, 1987; Naikoba & Hayward, 2001; Seto, 1995).

The current research provides data on health care workers' compliance with handwashing guidelines in an Irish health care setting and factors that influence their behavioral compliance. The current research also provides information on the effects of an interventional hand-hygiene program aimed at behavioral change. The current study is presented against a background of a paucity of published research investigating health care workers' hand-hygiene practices in Ireland.

Purpose

The main purpose of the current study was to observe health care workers' compliance with hand-hygiene guidelines during patient care in an ICU in Ireland before and after implementation of a multifaceted hand-hygiene program. A secondary purpose was to investigate health care workers' attitudes, beliefs, and knowledge in relation to handwashing behavior prior to and following implementation of a hand-hygiene program. Two main research questions were posited.

Does a multifaceted interventional hand-hygiene program positively affect health care workers' compliance with handwashing guidelines in an ICU?

Does a multifaceted interventional hand-hygiene program positively affect health care workers' attitudes, beliefs, and knowledge about handwashing guidelines?

Design

The current study design was quasi-experimental and theoretically underpinned by a modified form of the predisposing reinforcing and enabling constructs in educational diagnosis and evaluation (PRECEDE) health education theory (Green & Kreuter, 1999). Health care workers' compliance with handwashing guidelines was measured before (pretest) and after (posttest) delivery of an interventional hand-hygiene program and an expectation existed that an improvement would occur in compliance rates following the hand-hygiene program. Attitudes, beliefs, and knowledge related to compliance with handwashing guidelines were also investigated in the pretest and posttest phases. The interventional hand-hygiene program aimed at enabling, reinforcing, and predisposing health care workers to comply with handwashing guidelines.

Theoretical Framework

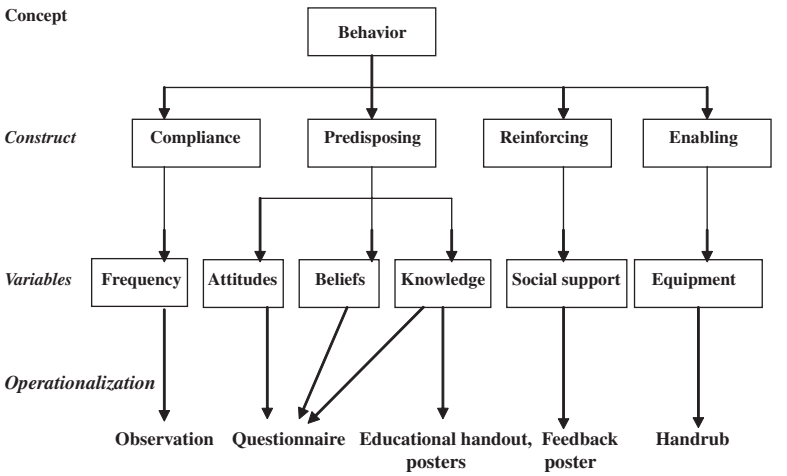
The PRECEDE health education theory was developed in the 1970s to enhance the quality of health interventions by offering health professionals a systematic planning process and has been used to plan behavioral change in relation to giving health educational advice (Green, Erickson, & Schor, 1988), infection control (Goldrick & Larson, 1997), risky behaviors (Frauenknecht, Brylinsky, & Zimmer, 1998) and health care workers' compliance with handwashing guidelines (Larson et al., 1997). It is a four-phase process: social, epidemiological, behavioral, and educational assessment. The process of social assessment is concerned with investigating issues deemed problematic to particular groups of people (e.g., acquisition of an infection while hospitalized). The frequency or rate of these particular problems is examined by investigating its epidemiology, which in turn may be affected by human behavior and environment. The concept of behavior is dependent on factors that predispose (attitudes, beliefs, knowledge), enable (access), and reinforce (feedback) an individual to engage in a particular behavior. Any behavior exhibited as a response or wish of an influencing source may be defined as compliance (Rungapadiachy, 1999). As the researcher was particularly interested in attempting to change behavioral compliance, use of a modified version of the model (behavioral and educational assessments only) was believed a good option.

The interventional program aimed to predispose, enable, and reinforce health care workers' compliance with hand-hygiene guidelines. Health care workers were predisposed to comply with hand-hygiene guidelines by provision of an educational handout and a poster campaign designed specifically to act as knowledge transmitters and behavioral prompts. An alcohol hand rub was the enabler for hand decontamination. Hand-hygiene behavior was reinforced by providing feedback of results from the pretest phase. This feedback was provided in poster format displayed only in the nurses' station to avoid possible misunderstandings from either patients or visitors (see Figure 1).

Sample

Convenience sampling was used, and sample size was determined by reviewing other studies in the area and also by consultation with a statistician in National University of Ireland, Cork, Ireland. A total sample size (pretest and posttest) of 200 observations and 50 questionnaires was required to show a 5% level of significance and 80% power in a two-tailed test. The study was

Figure 1
Theoretical Framework



conducted in the medical-surgical ICU (8 beds) of a large urban teaching hospital in Ireland (344 beds). Ethical approval was sought and granted. Justification for choosing this hospital was its size, and the fact that it provided an "on-call" service for emergency cases and, therefore, was more representative of acute hospitals than one that did not accept admission to hospital of trauma patients. While drawing study participants from the same site and not using a control group weakens generalizability of the findings, Burns and Grove (1993) confirmed that "this is one of the most frequently used designs in nursing research" (p. 307), and its choice was guided by other studies related to the area (Bischoff et al., 2000; Larson et al., 1997; Maury et al., 2000; Pittet et al., 2000).

Theoretical underpinnings of the study necessitated two samples be drawn: one from health care workers' handwashing practices (the behavior) and the other from health care workers themselves, that is, nurses, doctors, physiotherapists, and care assistants, so that their predisposition (attitudes, beliefs, knowledge) to compliance with handwashing guidelines could be measured. In the hospital where the main study was carried out, all nurses, doctors, care assistants, and physiotherapists were invited to participate provided they met the following inclusion criteria: (a) willing to be involved in the study, (b) working full-time in the ICU, (c) involved in delivering direct

patient care, (d) willing to complete the questionnaire, and (e) willing to be observed.

Method

Instruments

Two research instruments were used in this study:

- structured observational schedule designed to capture observational data on health care workers' compliance with handwashing guidelines
- self-report questionnaire designed to elicit information in the form of written responses in relation to attitudes, beliefs, and knowledge regarding compliance with handwashing guidelines

The Observational Schedule

The observational schedule was originally devised by Elaine Larson (Larson et al., 1997) and modified for use in the current study. It was based on Centers for Disease Control and Prevention (CDC; 1988) hand-hygiene guidelines and consisted of seven items: (a) beginning and/or resuming care; (b) between contact with patients; (c) before invasive procedures; (d) after touching inanimate objects likely to be contaminated followed by a patient care activity; (e) before and after touching wounds; (f) after direct contact with body substance; and (g) after taking care of an infected patient or one who is likely to be colonized.

The Self-Report Questionnaire

The questionnaire was originally devised by Carol O'Boyle (1999) and modified for use in the current study. It comprised six subscales (A to F), two of which were related to attitudes (11 items), three to beliefs (20 items), and one to knowledge (8 items). Participants were asked to respond to semantic differential rating scales (1 to 7) anchored with bipolar adjectives, to describe attitudes and beliefs. Scores 1 to 3 represented negative beliefs and/or attitudes, 4 neutral, and scores 5 to 7 represented positive beliefs and/or attitudes. *Attitudes* were described as "consistent and enduring thoughts, beliefs and feelings that people have about . . . issues people or events" (Edelmann, in Cormack, 2000, p. 277) and operationalized in two different ways. For example, "Handwashing on my unit (or after every patient contact, or however it was stated) is convenient." Other adjectives include *frustrating*, *practical*, *irritating*, *necessary*, *harmful* (evaluative attitudes). Participants were

asked to rate agreement with what they thought others would want them to do. These items were worded as "My coworkers strongly think I should adhere to the handwashing guidelines." Other referents were nurse manager, doctors, patients I care for, and others. *Beliefs* were defined as a conviction that a phenomenon or object is true or real (Green & Kreuter, 1999) and were operationalized as expressions of outcomes (e.g., "I believe my patients will have fewer nosocomial infections") or personal beliefs (e.g., "My knowledge about the hospital's handwashing guidelines is excellent"). Beliefs about skin condition (e.g., "I believe my skin is extremely dry") were also investigated. *Knowledge* was defined as specific information about a subject or an intended behavior (Green & Kreuter, 1999) and was operationalized as when handwashing should be carried out. Questions asked related to a specific handwashing guideline and had three possible responses (yes—the respondent agreed that the item was a guideline; no—the respondent did not agree that the item was a guideline; and don't know—the respondent did not know if the item was a guideline). Data on health care workers' knowledge was considered nominal. Each stem used directly represented a guideline.

Validity and Reliability

Interrater reliability is a concern particularly when a number of researchers use an observational rating scale to collect data. This was not a concern in the current study as one researcher collected all data. Prior researchers had reported Cronbach's alpha on reliability on both instruments at .76 for the observational schedule and .87 for the handwashing assessment tool. In the current study, Cronbach's alpha was reported at .78 for the observational tool and .87 for the personal evaluation tool.

Content validity of both instruments was established by a thorough review of the literature, consulting expert opinion, and conducting a pilot study. In relation to consulting expert opinion, a group of 13 nurses was recruited to examine both instruments. This group consisted of 2 infection control nurses, 1 nurse manager, 4 clinical nurses, 3 nurse researchers, and their research supervisors. On their advice, small changes were made to the questionnaire but not the observational schedule. These changes included using the same lead-in comments to each section and changing some wording (e.g., "tick one" instead of "check one"). Previous versions of the questionnaire had asked study participants to supply their names. This request was omitted as it was felt that this information was not a requirement for the study.

A pilot study was carried out by the researcher in a similar setting to where the main study was conducted (ICU of a university hospital). Permission was

sought, and 11 health care workers (doctors, nurses, care assistants, and physiotherapists) involved in direct patient care volunteered to participate. An observational period of 3 hours was conducted by the researcher. No difficulties were found on completing the questionnaire, and the average length of time taken was 3 to 4 minutes. While observing handwashing practices, the researcher was conscious of the Hawthorne effect, that is, the potential that her presence might have affected health care workers' handwashing behavior. Partial obscurement of the researcher by positioning herself in a corner decreased this effect. Feedback was positive in relation to the posters and the educational handout. The use of foot dispensers for the alcohol rub (envisaged for use in the main study) was found to be inappropriate as each foot dispenser required screwing onto the wall. This resulted in the manufacturer's 50-ml bottle with plunge head being used. A major amendment was made to the observational schedule as one item was removed. This item pertained to the necessity for handwashing "before and after touching wounds." The researcher found that with the advent of keyhole surgery and advances in types of wound dressing scarcely any surgical wounds were actually touched.

Data Collection

Observation occurred both at pretest and posttest stages, using a pen to fill out a structured observational schedule (checklist). In an attempt to overcome the Hawthorne effect of observation, the researcher spent some time in the unit prior to data collection and positioned herself unobtrusively in the unit during observational periods. The pretest phase involved daily visits to the clinical area to observe health care workers. Observational periods were of approximately 2 hours duration at a given time and took place either during the morning (8:00 a.m. to 2:00 p.m.) or evening shifts (2:00 p.m. to 10:00 p.m.). Depending on the level of patient care delivery, the researcher observed handwashing practices of health care workers' attending either two or three beds at a given time. Beds and health care workers were randomly chosen. A separate checklist was used for each health care worker, and in the first part of the checklist, an *X* was placed beside the relevant discipline, that is, nurse, doctor, care assistant, or therapist. If an indication for handwashing was noted, the researcher placed a tick on the checklist next to the relevant guideline, under the column Indication. If handwashing occurred, another tick was inserted in the column Conventional (sink and soap). If handwashing did not occur, no tick was made. If the screens were pulled around the bed to ensure patient privacy, the researcher did not go behind the screens but, if possible, did ascertain what procedure was to be carried out (by obser-

vation of the equipment being used, e.g., dressing, IV canula, etc.) and if handwashing was carried out. This was easier to do in the pretest phase, as the beds do not have sinks adjacent to them, as is the case in 40% of ICUs in Europe (O'Connell & Humphreys, 2001). During the pretest phase, a target of 150 observations was fulfilled to meet statistical requirements. The same observational checklist format was used with an additional column titled Alcohol Hand Rub. If handwashing was indicated, a tick was inserted in the Indication column; if handwashing occurred, a tick was inserted in either the Conventional or Alcohol Hand Rub column. As in the pretest phase, one checklist was used per health care worker, and a target of approximately 150 observations was met to fulfill statistical requirements.

A total of 76 questionnaires were distributed, and 62 were returned for analysis—34 from the pretest and 28 from the posttest. Health care workers completed the questionnaire in 3 to 4 minutes and returned it to the researcher during the same shift of duty that they received it. When the researcher was not present, a supply of questionnaires was left on the unit in the care of the nurse manager who took responsibility for distribution. A period of 1 month was allowed for the pretest phase and also for the interventional hand-hygiene program. Data for the posttest phase was collected 7 weeks after the intervention for a period of 1 month (4 weeks). Justification for time frames came from other similar studies and also from time constraints placed on study completion.

Introduction of the Intervention

In the interventional program, health care workers were predisposed to comply with hand-hygiene guidelines by provision of knowledge (an educational handout and poster campaign), enabled by provision of an alcohol rub, and their hand-hygiene behavior was reinforced by feedback of pretest observations of posters. All instruments (handout and posters) were developed exclusively for use in the current study.

The educational handout concentrated on the rationale for handwashing and presented information on rates of hospital-acquired infections, reasons for infection acquisition, and cost of infection acquisition. The handout also gave information on handwashing technique, and the CDC guidelines were presented in easy-to-read format. Copies were placed in the nurses' station, and health care workers were encouraged to take a copy. A copy was also placed in a clear plastic envelope at each individual nurse's workstation (by each bed).

To provide knowledge and feedback of observations, five different posters were developed for use in the current study. In an attempt to represent a multidisciplinary approach, no one group of health care professionals was overtly displayed. All figures were depicted in cartoon format, and male and female genders were represented. The ward manager and the researcher, using the criteria of maximum visibility and being located close to where handwashing normally occurred, determined poster location jointly. Posters 1 and 2 were placed on both entrances to the nurses' station. These posters targeted "who" should handwash and depicted a male and a female health care worker. Poster 3 was placed close to the sink in the area used to draw up medications and prepare for invasive procedures. It attempted to emphasize when handwashing should be carried out, that is, prior to a patient care activity. A female health care professional prior to carrying out patient care was presented. Size of the hands was exaggerated to emphasize their importance, and the caption read "Hands Washed??" Poster 4 was placed on a wall directly opposite the nurses' station and was designed to draw attention to the use of an alcohol hand rub. An illustration of a health care professional being "followed" by evil-looking micro-organisms was drawn up. The health care professional is seen pursued by micro-organisms, and the caption reads "Saved by the alcohol rub." Poster 5—feedback poster—was displayed in the nurses' station only, to prevent any misunderstandings if viewed by visitors or patients. Results of health care workers' handwashing practices from the pretest phase and from another similar study (Maury et al., 2000) were displayed in two panels on this poster.

The enabling factor, an alcohol hand rub (pH 6.5, specific gravity 0.9@ 25C, alcohol content is 60% ethyl alcohol and contained skin emollients), was provided by each patient's bedside, and the researcher gave instructions for use.

Data Analysis

Observational and self-report data were analyzed using Statistical Package for Social Sciences (SPSS, Version 9). Pairing of data collected from study participants was not possible as generally study participants in the posttest differed from those in the pretest because of shifts (part-time, job sharing, flexible hours), annual, and study leave. Both sets of data were regarded as independent—individually and collectively.

To provide descriptive statistics for handwashing compliance rates, indications for handwashing and observations of actual handwashing behavior

were tabulated. Compliance rates were expressed as percentages (number of indications that occurred taken as full compliance, i.e., 100%) and were examined by chi-square test (Pearson's) to determine the existence of a relationship between the pretest and posttest phases. Exact procedures were incorporated. Differences between rates and their 95% confidence intervals (CIs) were calculated in MATLAB statistical package.

Data obtained from the questionnaire were analyzed by subscale, that is, attitudes, beliefs, and knowledge. Data related to attitudes and beliefs were considered ordinal as a 7-point rating scale (semantic differential) was used. Results from each attitude or belief within their respective sections were averaged to obtain a mean score. Means and standard deviations from the pretest and posttest phases are presented, with their differences and 95% CIs. The main statistical test used to analyze data in the current study was the nonpaired *t* test. Results from data derived from the questionnaire were confirmed using nonparametric Mann-Whitney *U* tests to enhance the robustness of the findings. In relation to data derived from health care workers' knowledge of handwashing guidelines, responses were split into yes or no/don't know and analyzed using chi-square test. CIs (95%) for differences in response rates are presented.

Findings

Two main research questions were posed in the current study. The first question related to the effect a multifaceted interventional hand-hygiene program might have on health care workers' compliance with handwashing guidelines. The second question related to the effect a multifaceted interventional hand-hygiene program might have on health care workers' attitudes, beliefs, and knowledge of handwashing guidelines.

Compliance With Handwashing

Results revealed that the overall group of health care workers' baseline compliance with handwashing guidelines was 51%. This increased by 32% ($p < .001$) in the posttest phase to 83% (see Table 1). Nurses' and others' handwashing compliance rates significantly increased by more than 30% (pretest 56% to posttest 89%, $p < .001$) and (pretest 66% to posttest 96%, $p > .05$) respectively, whereas doctors' compliance rates increased by more than 20% (pretest 31% to posttest 55%, $p = .066$). Results from the current study revealed that a multifaceted interventional hand-hygiene program positively affects health care workers' handwashing practices.

Table 1
Overall Group Compliance Rates With Handwashing Guidelines and Compliance Rates by Discipline

	Overall Group Compliance Rate			
	Pretest	Posttest	Posttest Minus Pretest Difference (95% CI)	*p*
All disciplines	77/152 (51%)	135/162 (83%)	32% (23%, 42%)	< .001*
Compliance rate by discipline				
Nurses	57/101 (56%)	94/106 (89%)	33% (21%, 44%)	< .001*
Doctors	12/39 (31%)	12/22 (55%)	24% (2%, 49%)	.066
Others (physiotherapist and/or care assistants)	8/12 (66%)	29/30 (96%)	30% (3%, 57%)	.032

*$p < .05$.

Health Care Workers' Attitudes and Beliefs Toward Compliance With Handwashing Guidelines

All pretest and posttest mean attitude and belief subscale scores ranged from 4.75 to 6.60, reflecting an overall positive attitude toward complying with guidelines (see Table 2). Mean scores were not statistically different at postintervention except in relation to beliefs about skin condition ($p < .001$). Results from the current study revealed that a multifaceted interventional program positively affects health care workers' beliefs about skin condition.

Health Care Workers' Knowledge Related to Compliance With Handwashing Guidelines

Overall knowledge of handwashing guidelines was good as 79% to 91% of health care workers' in the pretest, and 96% to 100% in the posttest correctly identified each guideline (see Table 2). Analysis of data revealed that knowledge had significantly increased in relation to identifying that handwashing is necessary (a) beginning or resuming patient care ($p = .033$); (b) if patient care is interrupted ($p = .010$); (c) between patient contact ($p = .033$), before performing an invasive procedure ($p = .032$); and (d) after contact with equipment and/or objects likely to be contaminated ($p = .032$). Results

Table 2
Health Care Workers' Attitudes and/or Beliefs Toward Compliance With Handwashing Guidelines and Identification of Specific Handwashing Guidelines

	Health Care Workers' Attitudes and/or Beliefs Toward Compliance With Handwashing Guidelines			
Attitude or Belief Being Addressed	Pretest *M* (*SD*)	Posttest *M* (*SD*)	Posttest Minus Pretest Difference (CI 95%)	*p* value: Mann-Whitney *U*
Evaluative attitudes	5.49 (1.58)	5.73 (1.41)	.24 (–.5, 1.0)	.582
Other peoples' attitudes	5.92 (1.22)	5.34 (1.92)	.58 (–1, 0.3)	.905
Outcome beliefs	5.16 (.71)	5.08 (.83)	.08 (–.5, 0.3)	.638
Personal beliefs about compliance with guidelines	5.30 (1.4)	5.66 (1.1)	.36 (–.3, 1.0)	.477
Skin condition	4.75 (1.8)	6.60 (.79)	0.15 (1.0, 3.0)	< .001*
	Health Care Workers' Knowledge and/or Identification of Specific Handwashing Guidelines			
Stem item: Handwashing guidelines state that I should wash my hands:	Pretest % Correct	Posttest % Correct	Pretest Minus Posttest Difference Rates Correct (CI 95%)	*p* Value
1. Beginning or resuming patient care	29/33 (88%)	28/28 (100%)	12% (–23%, –1.0%)	.033
2. If my patient care is interrupted	26/33 (79%)	28/28 (100%)	21% (–35%, –7%)	.010*
3. Between patient contact	29/33 (88%)	28/28 (100%)	12% (–23%, –1.0%)	.033*
4. Before performing an invasive procedure	28/32 (88%)	28/28 (100%)	12% (–24%, –1%)	.032*
5. After contact with equipment and/or objects likely to be contaminated followed by a patient care activity	28/32 (88%)	28/28 (100%)	12% (–24%, –1%)	.032*
6. After direct contact with patient body fluids	30/33 (91%)	28/28 (100%)	9% (–19%, 1%)	.069*

Note: CI = confidence intervals.
*$p < .05$.

from the current study revealed that a multifaceted interventional hand-hygiene program positively affected health care workers' knowledge of handwashing guidelines.

Discussion

Baseline compliance (N = 314 observations) with handwashing guidelines was found to be 51%. Even though this rate is only marginally more than one half what it should be, that is, full compliance, it is an improvement on rates found in other similar studies such as 13% (Gould & Chamberlain, 1995), 19% (Conly et al., 1989), 22% (Simmons et al., 1990), 23% (Bischoff et al., 2000), 25% (Sproat & Inglis, 1994), 29% (Larson, 1989), 32% (Graham, 1990), 33% (Moongtui et al., 2000), and 34% (Zimakoff et al., 1992). It is similar to findings such as 47% (Pittet et al., 2000), and less than 60% (Maury et al., 2000), 65% (Larson et al., 1997), or 81% (Dubbert et al., 1990). Comparisons are relevant as all studies were set in ICUs with the exception of Larson (1989), which was conducted in a pediatric unit, and Pittet et al. (2000), which was a hospital-wide study. Studies (Dubbert et al., 1990; Larson et al., 1997; Maury et al., 2000) that revealed a compliance rate greater than 51% found in the current study included only nurses in their sample. Nurses generally have a higher handwashing compliance rate than other health care workers such as doctors or technicians (Bischoff et al., 2000; Pittet et al., 2000; Zimakoff et al., 1992). Although it was encouraging to establish that health care workers in an Irish health care setting had a higher baseline compliance rate than more than one half the studies reviewed, a note of caution must be sounded. Health care workers might have altered their practices as a result of being observed (Hawthorne effect); however, this limitation also applied to other observational studies (Bischoff et al., 2000; Graham, 1990; Larson, 1989; Larson et al., 1997; Maury et al., 2000; Pittet et al., 2000; Zimakoff et al., 1992). Self-reporting on handwashing practices as carried out by the sample in Sproat and Inglis (1994) and Broughall et al. (1984) affected results as health care workers were found to overestimate their compliance rate.

As previously stated, health care workers' baseline compliance rate was found to be 51%. This rate increased to 83% following the hand-hygiene program, which focused on provision of an alcohol hand rub, an educational handout, a poster campaign, and feedback of results. This significant ($p <$ .001) compliance shift of 32% compared favorably to compliance shifts in other interventional and/or observational studies such as an increase of 1% (Gould & Chamberlain, 1997), 3% (Larson et al., 1997), 7% (Simmons et al.,

1990), 11% (Dubbert et al., 1990), 13% (Graham, 1990), 16% (Pittet et al., 2000), 20% (Bischoff et al., 2000), and 25% (Conly et al., 1989), There appeared to be no other factor (such as an outbreak of pathogenic micro-organisms or increase in patients nursed in isolation) that contributed to the major compliance shift that occurred in the current study than the hand-hygiene program.

Prior to the intervention, health care workers had a positive attitude to complying with guidelines, which became more positive following the intervention (rating 1 to 7, group mean score: pretest 5.49 and posttest 5.73), although not statistically significant. Health care workers also had a positive attitude toward how others viewed compliance with guidelines prior to the intervention that then decreased somewhat (rating 1 to 7, group mean score: pretest 5.92 and posttest 5.34). Larson et al. (1997) also found that health care workers had a positive attitude toward complying with handwashing guidelines before and after the intervention whereas Zimakoff et al. (1992) found that health care workers' attitudes toward complying with handwashing guidelines was affected by others' (peers, 'patients') opinions. When health care workers' compliance rates increased in the current study following the intervention, attitudes were not correspondingly more positive that supports findings by Larson et al. (1997) and Zimakoff et al. This type of observation concurs with Green and Kreuter (1999) who stated that behavior is affected by a "tangled web of causal factors" (p. 153), that is, attitudes, beliefs, knowledge, enablement, and reinforcement, rather than any specific factor.

Health care workers believed that compliance with handwashing guidelines had a positive outcome in terms of reduced rates of hospital-acquired infection and transmission of micro-organisms. These beliefs were not affected ($p = .638$) by the intervention as their pretest score (group mean 5.16) was marginally higher than the posttest score (group mean 5.08), as also found by Larson et al. (1997). Health care workers believed that they had adequate time to comply with handwashing guidelines prior to and after the intervention, even though their compliance was barely more than 50% prior to the intervention. This finding directly contravened findings by Bridger (1997), Pittet et al. (1999), and Voss and Widmer (1997), who all found that health care workers believed that lack of time contributed to poor handwashing practices. Pittet et al. (2000) confirmed that workloads were an independent predictor of poor handwashing compliance. Health care workers in the current study did not appear to attach any importance to "time" needed to comply with guidelines, as opposed to their beliefs about their skin condition.

Health care workers believed that the condition of their skin improved significantly ($p < .001$) following the intervention, which confirmed findings by Boyce (1999), Larson (1989), and Larson, Eke, & Laughon (1986). Prior to the introduction of the alcohol gel with emollients (which was part of the intervention in the current study), the choices of handwashing agents were nonmedicated soap or chlorhexidine 4%. Washing with either soap and water or chlorhexidine and water removes moisture (fats) from the skin, which are only replaced at the rate of 20% after 1 hour and 50% after 3 hours (Scheuplein & Blank, 1971). The presence of "fats" or fatty acids in the skin have a fungicidal and bactericidal function important in maintaining skin flora (Marples, 1965), and conditions such as dermatitis occur when fats or fatty acids are decreased or absent. Dermatitis resulting from frequent handwashing is one of the most common occupational risks for health care professionals, occurring at a rate of 10% to 45% (Holness, Tarlo, Sussman, & Nethercott, 1995; Munksgaard, Hansen, Engen, & Holm, 1996; Sproat & Uveges, 1995). Damaged skin harbors increased numbers of potential pathogens (Newman & Seitz, 1990; Rotter, Koller, & Neumann, 1991). Numerous studies have shown that alcohol-based formulations with added emollients are equivalent or superior to antiseptic agents for microbial killing (Newman & Seitz, 1990; Rotter et al., 1991), and as alcohol rubs require no washing or drying, skin damage is reduced resulting in fewer reports of skin irritation and redness (Larson et al., 1986; Zimakoff et al., 1992). In the current study, health care workers believed that the condition of their skin improved in terms of appearance, intactness, moisture content, and sensation (itching, etc.) after the interventional program. The only factor in this program that could have affected their skin condition was provision of an alcohol hand rub. No other variable was evident during the study period that might have caused this improvement (e.g., provision of hand cream or decrease in bed occupancy). Alcohol rubs should be considered as a viable alternative to soap or chlorhexidine and water, to improve compliance and reduce skin irritation in ICUs.

While provision of an educational handout affected health care workers' level of knowledge in this study, baseline knowledge level was already good as more than 70% of health care workers correctly identified handwashing guidelines. Reasons for this might be attributed to a heavy emphasis on infection control practices and handwashing particularly during nursing preregistration and postregistration programs. A high knowledge level does not correlate with a baseline compliance rate of 51%, even though when knowledge levels increased to 96% (posttest), compliance rates increased to 83%. In other studies, lack of knowledge did not explain low compliance levels.

McKeown and Williamson (1992) reported that there was no difference evident in practice between staff in a psychiatric hospital who had read infection control guidelines and those who had not. This type of finding is consistent with the recommendation that single-stranded interventions are not effective in behavioral change, and that attention must be paid to all factors that predispose an individual to behave in a certain fashion, that is, attitudes, beliefs, and knowledge (Green & Kreuter, 1999).

Limitations

The researcher identified a number of limitations in the current study and attempted to minimize their effect. In relation to study design, previous studies have shown that interventions have a short-term influence on the behavior of health care workers (Conly et al., 1989; Doebbeling, Pfaller, Houston, & Wenzel, 1988; Donowitz, 1987; Dubbert et al., 1990; Simmons et al., 1990). A limitation for the current study, therefore, was the lack of a long-term observational follow-up period after the intervention, such as 12 months. The time frame chosen for the current study was influenced by other studies (Bischoff et al., 2000; Sproat & Inglis, 1994) and also by a time limit (1 year) placed on thesis development. Findings are valuable in that the current study was well planned, based on a thorough literature review, and findings are presented to a population where (to the knowledge of the researcher) comparable findings are not published. In any event, a follow-up observational study is planned.

Another limitation related to design was the lack of a control group, that is, one-group pretest-posttest design. Weaknesses of this design are that participants in many studies using this design are selected based on high or low scores on the pretest (Polit & Hungler, 1999). This limitation was offset by including all health care workers who met the inclusion criteria (not based on any type of scoring system) in both the pretest and posttest phases of the study. Another limitation of this design is that administration of the pretest may affect posttest results (Burns & Grove, 1993) presumably because of familiarity gained from being involved in the pretest. This limitation was offset in the current study, as many health care workers who were involved in the pretest were not necessarily the same individuals as those involved in the posttest because of shift changes, annual leave, job sharing, and so on.

In relation to data collection strategies, although observations were as unobtrusive as possible, the Hawthorne effect must be considered. Maintaining a presence on the unit prior to data collection and being positioned unobtrusively in a corner of the unit served to decrease this limitation. In any case, all

observational studies are prone to the Hawthorne effect, and the only way to avoid this is not to inform study participants of the purpose of the study. This carries ethical implications as study participants are not in a position to give informed consent (Knapp, 1998). Even if this bias were present and inflated the pretest and posttest findings, the ratio of improvement, that is, 32% would possibly remain. No such bias could have affected secondary findings on attitudes, beliefs, and knowledge.

Application and Recommendations

As the baseline handwashing rate in the current study (51%) leaves room for improvement, an immediate recommendation from the current study might be provision of an alcohol hand rub by each patient's bedside. Findings from this and other studies leave no room for doubt that easy access to hand hygiene in a timely fashion appears to be a necessary prerequisite for appropriate hand-hygiene behavior. Access to an alcohol-based hand rub in high-demand situations, such as most critical care units, or in high-stress working conditions, at times of overcrowding or understaffing, appears to be a critical factor in promoting adherence. Health care workers also need to be positively predisposed to engage in hand hygiene by virtue of their education, and by provision of relevant, up-to-date knowledge in an easy-to-remember manner. As with all behavior, some form of reinforcement needs to occur, whether by performance feedback or some other form of positive reinforcement. Equal attention needs to be paid to all disciplines providing patient care, thus a multimodal, multidisciplinary strategy is necessary.

Further research is required to establish if health care workers' compliance rates remain at 83%. Health care workers' attitudes, beliefs, and knowledge in relation to hand hygiene also require further investigation to determine appropriate interventions to address hand-hygiene behavioral change. Investigation of health care workers' skin condition urgently deserves further attention as an issue that affects compliance with handwashing guidelines, and one that has the potential to cause an increase in transmission of pathogenic micro-organisms.

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