Determinants of hand hygiene compliance among nurses in US hospitals: A formative research study

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Abstract

Hand hygiene is the simplest and most effective measure for preventing healthcare-associated infections. Despite the simplicity of this procedure and advances made in infection control, hospital health care workers’ compliance to hand hygiene recommendations is generally low. Nurses have the most frequent patient care interactions, and thus more opportunities to practice hand hygiene. As such, it is important to identify and understand determinants of nurses’ reported compliance. Formative research was undertaken to assess the potential impact of several unexamined factors that could influence HH among nurses: professional role and status, social affiliation, social norms, and physical modifications to the work environment (as well as institutional factors like safety climate). A survey questionnaire was developed primarily to inform the creation of a behaviour change intervention. The survey looked at how these factors influence HH among nurses and sought to identify barriers and levers to reported hand hygiene. It was administered to a survey panel of acute care nurses, working in US hospitals, with a year or more of experience. Multivariate regression modelling suggested that reported hand hygiene compliance was most likely to be a function of a hospital management’s communication openness, perceived performance by peers, increased interactions with patients and staff, and the reduction in stress, busyness, and cognitive load associated with role performance. A powerful, effective intervention on HH among nurses therefore could be directed at improving communication openness, consider the impact of perceived performance by peers, increase interactions with patients and staff, and determine how to reduce the stress and cognitive load associated with role performance.

Introduction

Hand hygiene (HH) is the simplest and most effective measure for preventing healthcare-associated infections (HAIs).[1] Despite the simplicity of this procedure and advances made in infection control, hospital health care workers’ compliance to HH recommendations is generally low.[2] Nurses have the most frequent patient care interactions, and thus more...
opportunities to practice HH.[3] As such, it is important to identify and understand determinants of nurses’ reported compliance. Hand hygiene is a complex behaviour with a myriad of motivators and barriers.[1, 4] While the basic behavioural aspects surrounding HH practices in hospital settings have been widely researched, there remain gaps in the literature regarding effective psychological promotion of hand hygiene compliance (HHC).[4] Psychological frameworks have been shown to lead to behaviour change in a wide variety of contexts, especially in the behaviour of healthcare workers (HCWs).[5] Therefore, focusing on determinants of behaviour change and employing psychological behaviour change models can better inform HH improvement strategies.

Behaviour Centred Design (BCD) is a general approach to behaviour change that offers both a Theory of Change for behaviours in addition to a practical process for designing and evaluating interventions.[6] The BCD’s Theory of Change incorporates concepts such as reinforcement learning theory,[7] the evolution of behavioural control,[8] the evolved structure of human motivation,[9] and behaviour settings theory.[10,6] The behaviour settings theory explains the relationship between individuals and the environment—both physical and social.[10] Behaviour is a function of the setting within which it takes place. As such, behaviour settings are situations where people have learned what to expect from the environment and from other people’s behaviours. Each setting has a purpose, a designated place, a set of objects, and a prescribed set of behaviours. Therefore, each person entering a setting expects others, who are also participants, to perform their designated roles.

BCD is associated with a checklist of factors that determine human behaviour, which can be used to direct empirical investigations prior to the design of public health interventions. This checklist includes environmental determinants such as the props and infrastructure that support performance of the behaviour, as well as the psychological characteristics and personal traits required.

The aim of this study is to use the BCD approach to identify determinants that impact the HHC of nurses in intensive and acute care hospital units. A combination of literature review and formative research are used to identify prospective strategies for a behaviour change intervention. Recognizing what motivates and hinders a nurse from practicing HH should aid in the development of successful strategies seeking to improve nurses’ HHC.

Background

Given the complexity of institutional settings for behaviour change, our data gathering strategy focussed on potentially important factors that have not yet been found to be significant. The literature search began with a background search to develop an understanding for the breadth of the body of literature. The iterative search process became more refined and developed as the review progressed. Once the volume and general scope of the HH field had been determined, parameters were set and search strings were developed [S1 File]. Search strings were developed for concepts encompassing behaviour change, hand hygiene compliance, healthcare workers, healthcare-associated infections, hand hygiene, and interventions. Medline, Web of Science, CINAHL, and Google Scholar databases were electronically searched selecting only for papers written in English. A total of 187 publications were identified this way; after filtering for papers published from January 2002- January 2015, there were 89 papers left to be reviewed. Additional papers and grey literature were identified by searching the references lists of the retrieved papers. We used the WHO’s tables of factors (WHO Table I.2.1) as well as hand hygiene improvement interventions (WHO Table I.2.2) as a framework.[1]
Categorizing and identifying modifiable factors using BCD

The BCD Checklist itemises all the types of behavioural determinants identified by the BCD approach. Placing the factors from the literature known to influence HHC (Table 1) into the BCD Checklist enables us to see what categories of factors have potential for deeper investigation and could serve as the foundation for further research into HHC (see Table 2). This analysis shows that only a few of these categories have been investigated by intervention-based studies in the literature, and it is apparent that whole categories of factors have not yet been examined by the public health community. Types of potential factors that have been completely ignored thus far are listed without entries in Table 1. It should be noted that even some categories with entries below have not been fully investigated; additional factors could be identified and explored. If we restrict our attention to categories—either with or without entries—which
Table 2. Characteristics of survey participants.

| Variable                        | N Response (out of 540) | Percent (%) |
|---------------------------------|-------------------------|-------------|
| **Gender**                      |                         |             |
| Female                          | 490                     | 90.74       |
| Male                            | 50                      | 9.26        |
| **Geographic Location in the United States** |                     |             |
| New England                     | 27                      | 5.00        |
| Middle Atlantic                 | 75                      | 13.89       |
| East North Central              | 102                     | 18.89       |
| West North Central              | 43                      | 7.96        |
| South Atlantic                  | 88                      | 16.29       |
| East South Central              | 24                      | 4.44        |
| West South Central              | 44                      | 8.15        |
| Mountain                        | 54                      | 10.0        |
| Pacific                         | 83                      | 15.37       |
| **Age**                         |                         |             |
| 20–29 y                         | 46                      | 8.52        |
| 30–39 y                         | 124                     | 22.96       |
| 40–49 y                         | 104                     | 19.26       |
| 50–59 y                         | 183                     | 33.89       |
| ≥ 60–69 y                       | 83                      | 15.37       |
| **Professional Status**         |                         |             |
| Staff nurse                     | 467                     | 86.48       |
| Nurse manager                   | 10                      | 1.85        |
| Assistant nurse manager         | 13                      | 2.41        |
| Nursing director                | 3                       | 0.56        |
| Advanced practice nurse         | 28                      | 5.19        |
| Other                           | 19                      | 3.52        |
| **Medical Specialty**           |                         |             |
| Medical/surgical unit (Med/surg) | 129                     | 23.89       |
| Intensive care unit (ICU)       | 108                     | 20.00       |
| Cardiac unit                    | 51                      | 9.44        |
| Emergency                       | 105                     | 19.44       |
| Other (NICU, PACU, Radiology, Oncology, Obstetric) | 147 | 27.22 |
| **Hospital Type**               |                         |             |
| Teaching                        | 305                     | 56.48       |
| Non-Teaching                    | 235                     | 43.52       |
| Urban                           | 407                     | 75.37       |
| Rural                           | 133                     | 24.63       |
| System-affiliated               | 425                     | 78.70       |
| Independent                     | 115                     | 21.30       |
| **Hours Worked Per Week**       |                         |             |
| 30–35 h                         | 62                      | 11.48       |
| 36–40 h                         | 411                     | 76.11       |
| 41–45 h                         | 22                      | 4.07        |
| 46–50 h                         | 35                      | 6.48        |
| ≥ 51–65 h                       | 10                      | 1.85        |

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can be readily changed by the types of mechanisms that are both acceptable and within the budget of an average hospital administration, we arrive at the following list of five categories: (1) **motivational psychology**, (2) **reactive psychology** (i.e. habit formation), (3) **modification of the relevant behaviour setting stage**, (4) **role change**, and (5) **social norm manipulation**. These categories will be the focus of this formative research.

**Importance of this formative research**

Formative research is a critical step in the development of health behaviour change interventions.[6, 11] The purpose of formative research is to assess individuals’ beliefs, perceptions, behaviours, and the structure of the environment itself that may help or hinder program effectiveness. Typically, such research involves significant fieldwork in the relevant context. In the case of this study, the ability of the research team to obtain a comprehensive view of the factors associated with HHC was limited by the logistics of access to hospitals. It was neither possible to take nurses from the floor during their shift nor to engage in substantial observation of their practices without introducing bias into the data collection. Further, there is considerable variation and organization-specific intricacies when it comes to the institutional contexts of HHC, which needs to be understood and considered when creating interventions intended to be widely used. Thus, the decision was made to administer a survey to a large number of nurses with a range variety of experiences across the United States, gaining in breadth what was lacking in terms of depth in the investigation. This survey sought to assess the behavioural change potential of the factors identified by the analysis above.

**Methods**

Ethics approval was attained from the London School of Hygiene and Tropical Medicine’s Observational and Interventions Research Ethics Committee (reference number is 14411).

**Sampling procedure**

An anonymous internet-based cross-sectional survey was administered between November to December 2015 by a global online sampling and digital data collection company called Dynata—formerly known as Research Now—to a survey panel of acute care nurses, working in various types of hospitals that are geographically distributed across the US, with at least a year or more of experience. There were 19,969 hospital nurses available to take the survey. With a confidence interval of 95% and a margin of error 5%, we calculated that we need a minimum of 377 completed surveys. Dynata screened and recruited participants, and it used an incentive scale based on set time increments. Incentive options allowed panellists to redeem from a range of gift cards, charitable contributions, and other products or services upon completing the survey.

**Survey design**

The survey concentrates on the five unexamined but modifiable factors that are potential determinants of HHC: (1) motivation, (2) habit, (3) roles, (4) behaviour setting stage, and (5) norms. The survey questions, which draw upon various concepts and measurement tools from fields such as sociology and psychology, are designed to measure the degree to which these factors influence reported HHC [S2 File]. In doing so, a novel questionnaire was developed using techniques—such as vignettes and the self-reported habit index (SRHI)[12]—that have not been commonly or consistently used in HH questionnaires before. The movement of the
The role of the nurses was explored through professional identity. Identities are the traits and characteristics, social relations, roles, and social group memberships that define an individual.\[13\] A professional identity is the sense of self that is associated with the enactment of a professional role.\[14, 15\] This identity gives members of a profession a definition of self-in-role and the goals, values, norms, and interaction patterns that are associated with their job.\[16\] This definition of identity is critical to how professionals interpret and behave in various work situations, with identity being both a product of situations and a determinant of behaviour within situations.\[13,17\] Identity is (a) predicted to influence what individuals are motivated to do, (b) encompasses how individuals think and makes sense of themselves and others, (c) the actions the individuals take, and (d) the individuals' feelings and abilities to control or regulate themselves.\[18, 19\]

By learning what qualities, skills, and traits nurses value, the perceived responsibilities of the professional role can be modified to include the responsibility of practicing HH. There is potential for hand hygiene to be integrated into the qualities that nurses perceive to be what a "good" or "ideal" nurse possesses. Respondents are therefore asked to choose five qualities or traits they wish they had exhibited more of during their most recent shift. The following

![Fig 1. Known hand hygiene compliance factors.](https://doi.org/10.1371/journal.pone.0230573.g001)
qualities and traits were identified from the literature:[20–27]

| Empathy          | Reliability     |
|------------------|-----------------|
| Respect          | Awareness       |
| Confidence       | Critical Thinking|
| Technical Competence | Stress Management |
| Leadership       | Flexibility     |
| Good Communication Skills | Physical Endurance |
| Mental Endurance | Patient Advocate |
| Friendliness     | Resourcefulness |
| Patience         | Responsiveness  |
| Good judgment    | Cooperativeness |

Respondents were then asked to choose five statements they would least like to hear said about them as a nurse. The statements address undesirable qualities and traits or unfavourable working conditions identified in the literature.[20–27]

“I do not provide emotional support to my patients.”
“I am unsure of myself as a nurse.”
“I do not handle stress well.”
“I am not as technically skilled as I should be.”
“I am curt and short with the patients.”
“I do not show leadership qualities.”
“I do not communicate well with others.”
“I neglected a patient.”
“I am not dependable.”
“I am not always aware of what is going on around me.”
“I hurt a patient.”
“I neglected a patient.”
“I do not know my patient’s wants or needs.”
“I am not flexible and able to adapt.”
“I am not a team player.”

Norms. A social norm is a rule of behaviour that individuals conform to conditionally based on the beliefs that (a) most people in their relevant network conform to this behaviour (this is referred to as an empirical expectation), (b) they themselves believe that they should perform the behaviour (normative personal belief), and (c) that most people in their relevant network believe they ought to conform to this behaviour as deviations from the norm could result in potential punishment (referred to as a normative expectation).[28] Social norms direct human action, however, norms are situationally contingent, meaning that a norm’s
salience and one’s compliance to this norm are conditional upon the situation.[29] To understand and predict behaviour, it is important to know which social norms individuals find salient in particular contexts—that is, which norms are likely to be dependent on particular settings.[30, 31]

The normative system of nursing with respect to HH behaviour can be measured through learning about (a) individual’s preferences for ‘proper’ HH action, (b) expectations of others’ HH behaviour, and (c) beliefs about the expectations others have of them in this regard. We sought to identify nurses’ social norms regarding hand hygiene and whether the social norms have a causal influence on behaviour. Bicchieri (2014) devised a series of questions that diagnose, explain, and predict collective patterns of behaviour, which were adapted for the research purposes here.[28] This involves ascertaining several aspects of a normative system, including empirical expectations, normative beliefs, and normative expectations. To test empirical expectations, respondents were asked about their own beliefs regarding the prevalence of HH behaviour among their peers; respondents were asked to disclose how many nurses out of a group of ten would always practice HH at the various indications.

To test normative personal beliefs, respondents were also asked if they think they should practice HH at six various moments: (1) before entering a patient’s room, (2) when exiting a patient’s room, (3) after taking a patient’s vitals, (4) after cleaning a patient’s wound, (5) before charting in the nurse station, and (6) after talking with fellow nurses in the break room. Responses along a Likert scale from Never to Always were offered. To test normative expectations, respondents were asked if they believed that other nurses thought that they should use hand sanitizer or soap at the same moments provided above. Once again, the same Likert scale offered five response options.

**Habit.** Habits are defined as psychological tendencies to respond automatically to environmental stimuli, acquired through repeated practice in particular contexts.[32, 33] Habitual actions are triggered in response to contextual cues associated with their performance: for example, automatically putting on a seatbelt (action) after getting into the car (contextual cue) or washing hands (action) after using the toilet (contextual cue).[34] Habit strength is a continuum. Habits that are considered to be of weak or moderate strength are performed with less frequency than strong habits.[35]

Participants were asked about the strength of their HH habits using the Self-Report Habit Index (SRHI) developed by Vernplanken et al. (1994).[36] The SRHI is a tool used either as a dependent variable, or to determine or monitor habit strength without measuring behavioural frequency. It discriminates between behaviours varying in frequency and between daily vs. weekly habits. The index is based on features of habit: a history of repetition, automaticity, and expressing one’s identity. Respondents answer the degree to which they felt the statement affected them using a 5-point Likert scale (from Strongly Disagree to Strongly Agree). There is evidence that the SRHI can solicit accurate answers comparable to real behaviours.[37] The index in this case is phrased to ask respondents about practicing HH before entering and after exiting a patient’s room.

**Motivation.** Motives are evolved psychological mechanisms that help individuals choose the appropriate goal-directed behavioural strategy in response to a situation.[38] An appropriate strategy would most likely lead to a satisfactory outcome in terms of the benefits accruing from that interaction with the environment.[9] A satisfactory outcome involves an experience that is rewarding—be it a sensory pleasure, a metabolic benefit for the body, or a change to one’s place in the social world.

This research sought to identify what motivates people to practice HH. Thus, the objective of the motive questions was to determine if a person of higher status—such as a nurse manager or direct supervisor—or someone who is dependent on the nurse—such as patient—is a likely
motivator of HH. The BCD’s motive mapping technique is used.[6] Motive mapping attempts to reduce psychological ‘distance’ by simulating the behavioural context using a narrative, and attempts to minimize the participant’s reflection by focusing directly on the rewards from performance.

Participants responded to three scenarios asking about how feedback is likely to influence their own HH behaviour. In each of the scenarios, participants were told that they had taken a patient’s vitals and immediately practiced HH upon exiting the room. At the end of each scenario, positive feedback regarding the practicing of HH was shared with the nurse by the nurse manager, a fellow nurse, and the patient. Respondents answered to what degree they feel this feedback makes them more likely to use hand sanitizer in the future as compared to normal usage. A five-point Likert scale measured responses.

Situational constraints: Vignettes. Participants were asked to judge their likely compliance to HH in varying situations known as vignettes. Vignettes are closer to real-life judgment-making situations than relatively abstract questions that are typical of most surveys. Respondents were asked to reflect on whether they would practice HH in the following situations: (1) exiting a patient’s room after taking the patient’s vitals, (2) entering a patient’s room before taking vitals, (3) exiting a patient’s room after cleaning and bandaging the patient’s diabetic foot wound, and (4) entering a patient’s room before cleaning and bandaging the patient’s foot wound. These situations were altered slightly for each follow-up question by introducing either a facilitator or a barrier to practicing HH, such as:

- Large patient load, which measures busyness
- Already wearing gloves, which measures the nurse’s inclination to practice HH when wearing protective equipment
- Being observed by the infection prevention manager, which measures higher status social influence
- Being observed by a fellow nurse, which measures peer influence
- Trying to practice hand hygiene but the dispenser is empty, which measures perception of ease
- An interruption during patient care requiring the immediate assistance of the nurse, which measures interruption
- An emergency requiring CPR, which measures reaction to emergency

Through vignettes, we sought to determine the extent to which these factors impact HH behaviour. Responses were presented on a five-point Likert scale based on the likelihoods of behavioural response.

Institutional factors: Safety culture and familiarity with hand hygiene. Nurse behaviour takes place within the context of hospital life. Hospitals can be considered institutions, which have an impact on the settings that occur within them. Therefore, this research sought to assess the culture of safety within the respondents’ institutions. It has been widely accepted that the safety culture of one’s hospital affects HHC rates.[1, 39–41] To measure the safety culture of the hospitals where the respondents work, the research team selected and modified questions from the hospital survey on patient safety culture developed by the US Agency for Healthcare Research and Quality.[42] Questions were grouped according to the safety culture dimensions they are intended to measure. Groups included: rating overall perceptions of safety, frequency of event reporting, supervisor/manager expectations and actions, teamwork within units, closeness, communication openness, feedback and
communication about error, non-punitive response to error, staffing, and hospital management support. Five point Likert scales asking for agreement/disagreement and frequency were used.

Participants were also asked about their engagement and participation in past HH training and interventions, both as nursing students and as practicing professionals. In addition, participants were asked about their hospital’s own HH programs. Questions were all phrased so that a yes/no response was appropriate.

**Modification to physical setting.** Finally, the research aimed to investigate various ways to disrupt a behaviour setting, specifically by identifying how the stage and arrangement of props of the setting surrounding the act of HH serve as constraints or opportunities to practicing HH. Respondents are presented with two photos—one of a hallway in a non-descript hospital and one of a patient’s room—and then asked how both the hallway and the room could be altered to better facilitate HH. These questions allowed for open-ended responses.

**Formatting the survey**

The survey was a self-administered online task. Each question was presented on its own webpage. Respondents were first asked a series of screener questions to determine if they were eligible: they had to be an acute care nurse, working in a US hospital, with a year or more of experience.

Those who are eligible were then presented with a series of photos related to the modification of the physical setting. These questions were asked first because the research team wanted responses that were not influenced by other questions in the survey. In addition, the photos served to ground the respondents in the survey by providing visual context. The vignettes immediately followed; the research team reasoned that the vignettes would likely solicit the most accurate responses about HH performance. As such, the vignettes were placed early in the survey so that the respondents were not biased or primed by subsequent specific queries. The professional identity questions were asked next as these questions tapped into values. Questions about norms followed and were followed by questions on habit and motivation. The final questions focused on the safety culture of the hospital as well as the respondents’ history with HH interventions and programs. A diagram of the survey questions and flow are provided in Fig 2.

**Analysis of the survey**

Descriptive statistics were first used to characterize the sample. Univariate analyses were therefore first conducted to determine which variables were associated with reported levels of HHC. Next, a multivariate regression of the variable of interest—reported HH on exiting a patient room after taking vitals—was conducted on demographic, role, safety culture, and norm variables. This variable of interest was chosen as it was asked in the form of a vignette, which is closer to real-life judgment-making situations and thus provided a better sense of compliance than asking respondents directly about their HHC. In addition, this specific vignette question was used as nurses are more likely to practice HH upon exiting a room, but less likely to practice HH after conducting a low-risk procedure. As an ordinary least squares regression of outcome on predictors was inappropriate for a model with this number of predictors but only 500 observations, we performed a bidirectional stepwise procedure to build the model, using the Akaike Information Criterion (AIC) as the model-building criterion for adding or removing variables; any variable that, when removed, changed the model AIC by $\leq 1$ was discarded by the procedure.
Results

Study population

A total of 540 surveys were completed. Table 2 summarizes selected characteristics of the participants. The median age was 49 (range: 24–70). In a typical workday, more than two-thirds of the respondents (68%) reported spending 80% or more of their time performing direct patient care. Familiarity with HH practices was indicated by 459 (85%) of respondents, who reported that HH was emphasized during professional training to be a nurse. Furthermore, the clear majority of respondents (456, or 84%) had participated in a hospital-led hand hygiene initiative before.

Summary variables were standardized before analysis. Variables included habit, safety culture, norms, motivation, role, hand hygiene familiarity, and demographics. Means were taken across Likert scale questions per the prescribed groupings. Sums were calculated across yes/no variables and demographic variables were encoded with a binary number system.

Univariate analysis

The results for each of the five main potential determinants of HHC have been provided in their respective tables and figures enumerated below. Major findings have been summarized for norms, habit, and motives.

Vignettes. The results for every question in this section of the survey are included in Table 3. The most salient findings were that nurses were more likely to practice HH upon exiting a patient’s room than entering, and that when the procedure was perceived as being high-risk—such as cleaning and bandaging a wound—there was an increased likelihood of...
Table 3. Responses to vignettes.

**Vitals-Vignette–Exit**
You are a nurse in Normal Hospital. You need to take the vitals for Mrs. Jones in room 2. You enter the room, say hello, explain the procedure, take Mrs. Jones' vitals, ask if she needs anything else, and then you head towards the door to leave.

| Question                                                                 | Response                      | N responses | Percent (%) | Corresponding figure in S1 Fig |
|--------------------------------------------------------------------------|-------------------------------|-------------|-------------|--------------------------------|
| **Base Vignette Exiting**                                               |                               |             |             |                                |
| Practicing HH upon exiting the patient’s room.                           | Not at all likely             | 2           | 0.37        | Fig A                          |
|                                                                          | Slightly likely               | 7           | 1.30        |                                |
|                                                                          | Moderately likely             | 32          | 5.93        |                                |
|                                                                          | Very likely                   | 124         | 22.96       |                                |
|                                                                          | Extremely likely              | 375         | 69.44       |                                |
| **Busyness**                                                             |                               |             |             |                                |
| Practicing HH when leaving the patient’s room with other demanding tasks on the mind | Much less likely             | 11          | 2.04        | Fig B                          |
|                                                                          | Somewhat less likely          | 71          | 13.15       |                                |
|                                                                          | No difference                 | 357         | 66.11       |                                |
|                                                                          | Somewhat more likely          | 33          | 6.11        |                                |
|                                                                          | Much more likely              | 68          | 12.59       |                                |
| **Gloves**                                                               |                               |             |             |                                |
| Practicing HH after taking off gloves                                    | Much less likely              | 8           | 1.48        | Fig B                          |
|                                                                          | Somewhat less likely          | 53          | 9.81        |                                |
|                                                                          | No difference                 | 354         | 65.56       |                                |
|                                                                          | Somewhat more likely          | 44          | 8.15        |                                |
|                                                                          | Much more likely              | 81          | 15.00       |                                |
| **Peer Influence**                                                      |                               |             |             |                                |
| Practicing HH when seeing a fellow nurse outside the patient’s room      | Much less likely              | 0           | 0           | Fig B                          |
|                                                                          | Somewhat less likely          | 11          | 2.04        |                                |
|                                                                          | No difference                 | 365         | 67.59       |                                |
|                                                                          | Somewhat more likely          | 86          | 15.93       |                                |
|                                                                          | Much more likely              | 78          | 14.44       |                                |
| **Higher Status Social Influence**                                      |                               |             |             |                                |
| Practicing HH when seeing the hospital’s Infection Prevention Director outside the patient’s room | Much less likely              | 0           | 0           | Fig B                          |
|                                                                          | Somewhat less likely          | 0           | 0           |                                |
|                                                                          | No difference                 | 257         | 47.59       |                                |
|                                                                          | Somewhat more likely          | 70          | 12.96       |                                |
|                                                                          | Much more likely              | 213         | 39.44       |                                |
| **Higher Status Modelling**                                             |                               |             |             |                                |
| Practicing HH when leaving the patient’s room even though the Nurse Manager did not practice HH | Much less likely              | 2           | 0.37        | Fig B                          |
|                                                                          | Somewhat less likely          | 9           | 1.67        |                                |
|                                                                          | No difference                 | 351         | 65.00       |                                |
|                                                                          | Somewhat more likely          | 69          | 12.78       |                                |
|                                                                          | Much more likely              | 109         | 20.19       |                                |
| **Empty Dispenser**                                                     |                               |             |             |                                |
| Practicing HH when there is an empty ABHR dispenser                      | Much less likely              | 38          | 7.04        | Fig B                          |
|                                                                          | Somewhat less likely          | 162         | 30.00       |                                |
|                                                                          | No difference                 | 248         | 45.93       |                                |
|                                                                          | Somewhat more likely          | 37          | 6.85        |                                |
|                                                                          | Much more likely              | 55          | 10.19       |                                |

(Continued)
Table 3. (Continued)

| Question                                                                 | Response          | N responses | Percent (%) | Corresponding figure |
|--------------------------------------------------------------------------|-------------------|-------------|-------------|----------------------|
| **Interruption**                                                          |                   |             |             |                      |
| Practicing HH when interrupted upon leaving a patient’s room              | Much less likely | 30          | 5.56        | Fig B                |
|                                                                          | Somewhat less likely | 117        | 21.67       |                      |
|                                                                          | No difference     | 296         | 54.81       |                      |
|                                                                          | Somewhat more likely | 35          | 6.48        |                      |
|                                                                          | Much more likely  | 62          | 11.48       |                      |
| **Emergency**                                                            |                   |             |             |                      |
| Practicing HH when exiting the patient’s room to attend to an emergency  | Much less likely | 118         | 21.85       | Fig B                |
|                                                                          | Somewhat less likely | 162        | 30.00       |                      |
|                                                                          | No difference     | 188         | 34.81       |                      |
|                                                                          | Somewhat more likely | 30          | 5.56        |                      |
|                                                                          | Much more likely  | 42          | 7.78        |                      |
| **Vitals-Vignette–Entry**                                                |                   |             |             |                      |
| Now instead of exiting Mrs. Jones’s room, you are entering her room to   |                   |             |             |                      |
| take her vitals.                                                         |                   |             |             |                      |
| Question                                                                 | Response          | N responses | Percent (%) | Corresponding figure |
| Base Vignette Entry                                                      |                   |             |             |                      |
| Practicing HH before entering patient’s room                             | Not at all likely | 6           | 1.11        | Fig A                |
|                                                                          | Slightly likely   | 30          | 5.56        |                      |
|                                                                          | Moderately likely | 64          | 11.85       |                      |
|                                                                          | Very likely       | 132         | 24.44       |                      |
|                                                                          | Extremely likely  | 308         | 57.04       |                      |
| Patient’s request                                                        |                   |             |             |                      |
| Practicing HH upon patient’s request                                     | Much less likely | 1           | 0.19        | Fig C                |
|                                                                          | Somewhat less likely | 0         | 0           |                      |
|                                                                          | No difference     | 230         | 42.59       |                      |
|                                                                          | Somewhat more likely | 37          | 6.85        |                      |
|                                                                          | Much more likely  | 272         | 50.37       |                      |
| Empty Dispenser                                                          |                   |             |             |                      |
| Practicing HH when there is an empty ABHR dispenser                      | Much less likely | 37          | 6.85        | Fig C                |
|                                                                          | Somewhat less likely | 145        | 26.85       |                      |
|                                                                          | No difference     | 270         | 50.00       |                      |
|                                                                          | Somewhat more likely | 34          | 6.30        |                      |
|                                                                          | Much more likely  | 54          | 10.00       |                      |
| Gloves                                                                   |                   |             |             |                      |
| Practicing HH before putting on gloves                                   | Much less likely | 47          | 8.70        | Fig C                |
|                                                                          | Somewhat less likely | 134        | 24.81       |                      |
|                                                                          | No difference     | 285         | 52.78       |                      |
|                                                                          | Somewhat more likely | 27          | 5.00        |                      |
|                                                                          | Much more likely  | 47          | 8.70        |                      |
| Question                                                                 | Response                | N responses | Percent (%) | Corresponding figure |
|------------------------------------------------------------------------|-------------------------|-------------|-------------|----------------------|
| Base Vignette Exit                                                     | Not at all likely       | 0           | 0           | Fig A                |
| How likely are you to practice hand hygiene upon exiting the room?     | Slightly likely         | 4           | 0.74        |                      |
|                                                                        | Moderately likely       | 4           | 0.74        |                      |
|                                                                        | Very likely             | 42          | 7.78        |                      |
|                                                                        | Extremely likely        | 490         | 90.74       |                      |
| Busyness                                                               | Much less likely        | 1           | 0.19        | Fig D                |
| Practicing HH when leaving the patient’s room with other demanding tasks on the mind | Somewhat less likely  | 11          | 2.04        |                      |
|                                                                        | No difference           | 382         | 70.74       |                      |
|                                                                        | Somewhat more likely    | 36          | 6.67        |                      |
|                                                                        | Much more likely        | 110         | 20.37       |                      |
| Peer Influence                                                         | Much less likely        | 0           | 0           | Fig D                |
| Practicing HH when seeing a fellow nurse outside the patient’s room    | Somewhat less likely    | 3           | 0.56        |                      |
|                                                                        | No difference           | 389         | 72.04       |                      |
|                                                                        | Somewhat more likely    | 53          | 9.81        |                      |
|                                                                        | Much more likely        | 95          | 17.59       |                      |
| Higher Status Social Influence                                         | Much less likely        | 0           | 0           | Fig D                |
| Practicing HH when seeing the hospital’s Infection Prevention Director outside the patient’s room | Somewhat less likely  | 1           | 0.19        |                      |
|                                                                        | No difference           | 316         | 58.52       |                      |
|                                                                        | Somewhat more likely    | 51          | 9.44        |                      |
|                                                                        | Much more likely        | 172         | 31.85       |                      |
| Higher Status Modelling                                                | Much less likely        | 1           | 0.19        | Fig D                |
| Practicing HH when leaving the patient’s room even though the Nurse Manager did not practice HH | Somewhat less likely  | 5           | 0.93        |                      |
|                                                                        | No difference           | 384         | 71.11       |                      |
|                                                                        | Somewhat more likely    | 44          | 8.15        |                      |
|                                                                        | Much more likely        | 106         | 19.63       |                      |
| Empty Dispenser                                                        | Much less likely        | 6           | 1.11        | Fig D                |
| Practicing HH when there is an empty ABHR dispenser                    | Somewhat less likely    | 70          | 12.96       |                      |
|                                                                        | No difference           | 347         | 64.26       |                      |
|                                                                        | Somewhat more likely    | 32          | 5.93        |                      |
|                                                                        | Much more likely        | 85          | 15.74       |                      |
| Interruption                                                          | Much less likely        | 4           | 0.74        | Fig D                |
| Practicing HH when interrupted upon leaving a patient’s room           | Somewhat less likely    | 75          | 13.89       |                      |
|                                                                        | No difference           | 351         | 65.00       |                      |
|                                                                        | Somewhat more likely    | 34          | 6.30        |                      |
|                                                                        | Much more likely        | 76          | 14.07       |                      |

(Continued)
practicing HH. Most notably, 90.7% (n = 490) of nurse respondents reported being likely to practice HH upon exiting a patient’s room after cleaning and bandaging the diabetic foot wound.

**Norms.** The results for empirical expectations, normative personal beliefs, and normative expectations have been presented in Table 4. Regarding empirical expectations, respondents felt that most nurses practiced hand hygiene before entering a patient’s room, when exiting a patient’s room, after taking a patient’s vitals, and after cleaning a patient’s wound. Concerning normative personal beliefs, for each moment apart from charting, most respondents claimed that HH should always be practiced. Of the 540 respondents, 81.7% (n = 441) of respondents said it should always be practiced before entering a patient’s room, 90.4% (n = 488) when exiting a patient’s room, 75.6% (n = 408) after taking patient’s vitals, and 98.7% (n = 533) after...
| Questions                                      | Response | N response | Percent (%) | Corresponding Figure in S1 Fig |
|------------------------------------------------|----------|------------|-------------|--------------------------------|
| before entering a patient’s room?             | 0        | 7          | 1.29        | Fig H                          |
|                                                | 1        | 9          | 1.67        |                                |
|                                                | 2        | 27         | 5.00        |                                |
|                                                | 3        | 23         | 4.26        |                                |
|                                                | 4        | 14         | 2.59        |                                |
|                                                | 5        | 91         | 16.85       |                                |
|                                                | 6        | 32         | 5.93        |                                |
|                                                | 7        | 52         | 9.63        |                                |
|                                                | 8        | 128        | 23.70       |                                |
|                                                | 9        | 82         | 15.19       |                                |
|                                                | 10       | 75         | 13.89       |                                |
| when exiting a patient’s room?                | 0        | 4          | 0.74        | Fig H                          |
|                                                | 1        | 1          | 0.19        |                                |
|                                                | 2        | 10         | 1.85        |                                |
|                                                | 3        | 6          | 1.11        |                                |
|                                                | 4        | 10         | 1.85        |                                |
|                                                | 5        | 45         | 8.33        |                                |
|                                                | 6        | 36         | 6.67        |                                |
|                                                | 7        | 52         | 9.63        |                                |
|                                                | 8        | 146        | 27.04       |                                |
|                                                | 9        | 116        | 21.48       |                                |
|                                                | 10       | 114        | 21.11       |                                |
| after taking a patient’s vitals?              | 0        | 14         | 2.59        | Fig H                          |
|                                                | 1        | 11         | 2.037       |                                |
|                                                | 2        | 37         | 6.85        |                                |
|                                                | 3        | 18         | 3.33        |                                |
|                                                | 4        | 23         | 4.26        |                                |
|                                                | 5        | 101        | 18.70       |                                |
|                                                | 6        | 43         | 7.96        |                                |
|                                                | 7        | 46         | 8.52        |                                |
|                                                | 8        | 103        | 19.07       |                                |
|                                                | 9        | 65         | 12.04       |                                |
|                                                | 10       | 79         | 14.63       |                                |
| after cleaning a patient’s wound?            | 0        | 2          | 0.37        | Fig H                          |
|                                                | 1        | 2          | 0.37        |                                |
|                                                | 2        | 2          | 0.37        |                                |
|                                                | 3        | 2          | 0.37        |                                |
|                                                | 4        | 0          | 0.          |                                |
|                                                | 5        | 10         | 1.85        |                                |
|                                                | 6        | 4          | 0.74        |                                |
|                                                | 7        | 9          | 1.67        |                                |
|                                                | 8        | 39         | 7.22        |                                |
|                                                | 9        | 96         | 17.78       |                                |
|                                                | 10       | 374        | 69.26       |                                |

(Continued)
Table 4. (Continued)

| Questions                              | Response          | N response | Percent (%) | Corresponding Figure |
|----------------------------------------|-------------------|------------|-------------|----------------------|
| before charting in the nurse station?  | 0                 | 53         | 9.82        | Fig H                |
|                                        | 1                 | 22         | 4.07        |                      |
|                                        | 2                 | 48         | 8.89        |                      |
|                                        | 3                 | 17         | 3.15        |                      |
|                                        | 4                 | 31         | 5.74        |                      |
|                                        | 5                 | 108        | 20.00       |                      |
|                                        | 6                 | 39         | 7.22        |                      |
|                                        | 7                 | 47         | 8.70        |                      |
|                                        | 8                 | 77         | 14.26       |                      |
|                                        | 9                 | 45         | 8.33        |                      |
|                                        | 10                | 53         | 9.82        |                      |
| after talking to a colleague in the hallway? | 0 | 156 | 28.89 | Fig H |
|                                        | 1                 | 40         | 7.41        |                      |
|                                        | 2                 | 67         | 12.41       |                      |
|                                        | 3                 | 31         | 5.74        |                      |
|                                        | 4                 | 25         | 4.63        |                      |
|                                        | 5                 | 89         | 16.48       |                      |
|                                        | 6                 | 22         | 4.07        |                      |
|                                        | 7                 | 24         | 4.44        |                      |
|                                        | 8                 | 38         | 7.04        |                      |
|                                        | 9                 | 19         | 3.52        |                      |
|                                        | 10                | 29         | 5.37        |                      |

**Normative Personal Beliefs**

Do you think you should practice hand hygiene:

| Questions                              | Response          | N response | Percent (%) | Corresponding Figure |
|----------------------------------------|-------------------|------------|-------------|----------------------|
| before entering a patient’s room?      | Never             | 0          | 0           | Fig I                |
|                                        | Seldom            | 11         | 2.04        |                      |
|                                        | About half the time | 12   | 2.22        |                      |
|                                        | Usually           | 76         | 14.07       |                      |
|                                        | Always            | 441        | 81.67       |                      |
| when exiting a patient’s room?         | Never             | 0          | 0           | Fig I                |
|                                        | Seldom            | 2          | 0.37        |                      |
|                                        | About half the time | 8    | 1.48        |                      |
|                                        | Usually           | 42         | 7.78        |                      |
|                                        | Always            | 488        | 90.37       |                      |
| after taking a patient’s vitals?       | Never             | 3          | 0.56        | Fig I                |
|                                        | Seldom            | 13         | 2.41        |                      |
|                                        | About half the time | 33   | 6.11        |                      |
|                                        | Usually           | 83         | 15.37       |                      |
|                                        | Always            | 408        | 75.56       |                      |
| after cleaning a patient’s wound?      | Never             | 0          | 0           | Fig I                |
|                                        | Seldom            | 0          | 0           |                      |
|                                        | About half the time | 2     | 0.37        |                      |
|                                        | Usually           | 5          | 0.93        |                      |
|                                        | Always            | 533        | 98.70       |                      |

(Continued)
cleaning a patient’s wound. With normative expectations, over 50% of respondents claimed that most other nurses always think that one should practice hand hygiene before entering a patient’s room, when exiting a patient’s room, after taking a patient’s vitals, and after cleaning a patient’s wound. [Figs H and I in the S1 Fig display the results.]

Habit. Respondents answered the SRHI about practicing HH before entering a patient’s room and after exiting a patient’s room. Responses were made on five point Likert scales anchored by the terms strongly agree–strongly disagree and were coded such that high values indicated strong habits (1 = strongly disagreeing and 5 = strongly agreeing). The means of the questions were calculated, and these in turn became the habit strength scores. Regarding

Table 4. (Continued)

| Questions                                      | Response   | N response | Percent (%) | Corresponding Figure |
|------------------------------------------------|------------|------------|-------------|----------------------|
| before charting in the nurse station?          | Never      | 23         | 4.26        | Fig I                |
|                                               | Seldom     | 57         | 10.56       |                      |
|                                               | About half the time | 71      | 13.15       |                      |
|                                               | Usually    | 150        | 27.78       |                      |
|                                               | Always     | 239        | 44.26       |                      |
| before entering a patient’s room?             | Never      | 2          | 0.37        | Fig J                |
|                                               | Seldom     | 13         | 2.407       |                      |
|                                               | About half the time | 51      | 9.444       |                      |
|                                               | Usually    | 136        | 25.185      |                      |
|                                               | Always     | 338        | 62.593      |                      |
| when exiting a patient’s room?                | Never      | 1          | 0.185       | Fig J                |
|                                               | Seldom     | 1          | 0.185       |                      |
|                                               | About half the time | 32      | 5.926       |                      |
|                                               | Usually    | 101        | 18.704      |                      |
|                                               | Always     | 405        | 75.         |                      |
| after taking a patient’s vitals?              | Never      | 9          | 1.667       | Fig J                |
|                                               | Seldom     | 30         | 5.556       |                      |
|                                               | About half the time | 78      | 14.444      |                      |
|                                               | Usually    | 148        | 27.407      |                      |
|                                               | Always     | 275        | 50.926      |                      |
| after cleaning a patient’s wound?             | Never      | 0          | 0.          | Fig J                |
|                                               | Seldom     | 1          | 0.185       |                      |
|                                               | About half the time | 8       | 1.481       |                      |
|                                               | Usually    | 43         | 7.963       |                      |
|                                               | Always     | 488        | 90.37       |                      |
| before charting in the nurse station?          | Never      | 37         | 6.852       | Fig J                |
|                                               | Seldom     | 92         | 17.037      |                      |
|                                               | About half the time | 126     | 23.333      |                      |
|                                               | Usually    | 140        | 25.926      |                      |
|                                               | Always     | 145        | 26.852      |                      |
| after talking with fellow nurses in the break room? | Never    | 82         | 15.185      | Fig J                |
|                                               | Seldom     | 146        | 27.037      |                      |
|                                               | About half the time | 116    | 21.481      |                      |
|                                               | Usually    | 86         | 15.926      |                      |
|                                               | Always     | 110        | 20.37       |                      |

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Determinants of hand hygiene compliance among nurses in US hospitals

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HH upon entering a room, 59.1% (n = 319) of respondents had a score of 4.5 or over (Fig 3). In the case of exiting, 68.0% (n = 367) of respondents had a habit strength score of 4.5 and over (Fig 4).

**Motives.** Upon receiving feedback from nurse managers and fellow nurses, 50.7% (n = 274) of participants and 55.4% (n = 299) said that there would be no difference in future HH action, respectively. Regarding receiving feedback from patients, 59.3% (n = 320) respondents said that feedback would positively impact their HH behaviour in the future. Results are summarized in Table 5.

**Safety culture.** The results for each question in this section of the survey are included in Table 6.

**Multivariate regression**

Presented in Table 7 are the results from the bidirectional stepwise procedure to analyse the relationships between various predictors and the outcome: reported HH on exiting a patient room after taking vitals. Included in the table are only the variables which met the selection criteria. Values are provided for the regression Estimate, as well as its Standard Error, T-value, and Pr(|t|) coefficients. Coefficients were assigned to each predictor; the sign on the coefficient (positive or negative) provides the direction of the effect of the predictor on the outcome variable.

![Self-Reported habit index: Entering](https://doi.org/10.1371/journal.pone.0230573.g003)

**Fig 3. Self-Reported habit index: Entering.**

![Self-Reported habit index: Exiting](https://doi.org/10.1371/journal.pone.0230573.g004)

**Fig 4. Self-Reported habit index: Exiting.**
Discussion

Univariate analysis

Vignettes. The reported higher likelihood of practicing HH upon performing a high-risk procedure as compared to a low-risk procedure aligns with the literature which shows that HHC is greater when involving higher-risk tasks.[2, 43, 44] In addition, nurses reported being more likely to practice HH upon exiting a patient’s room than entering, which is interpreted as nurses practicing HH as a form of self-protection.[44]

Role. Nurses work in close relationships with patients who are vulnerable and largely dependent on the nurse for care.[45] Nurses work with one another and on inter-professional healthcare teams to deliver care and provide support. Fagermoen’s (1997) proposed theoretical model for professional identity of nurses maintains that nurses’ perceptions of the ‘professional self’ focuses on both other-oriented and self-oriented values.[45] Other-oriented values encompass the nurse’s actions on behalf of the patient’s well-being and the interactions with patients in providing care. Self-oriented work values include work performance and collaboration with other professionals. While self-oriented work values directly impact the self, these values also affect the care delivered. For instance, better stress management can lead to a nurse feeling more confident, capable, and in control, which can then lead to better care delivered.

When asked which values the participants wish they had exhibited more of during their last shift, the traits most widely selected were those of self-oriented values such as stress management, patience, good communication, and physical and mental endurance. These in turn impact other-oriented values to a degree since work performance directly influences the kind of care delivered. Other-oriented values are the foundation of nursing care and an integral part of the nurses’ relationships with patients. Areas of improvement could be seen in how nurses engage in the work-setting and the actualization of the other-oriented values. When asked what the nurses would least like to hear said about them, the top responses were about the inadequacy in the delivery of care. This again demonstrates how integral other-oriented values are to the discipline of nursing.

Norms. There is agreement amongst participants as to when to practice HH—upon entering and exiting a patients’ room and after performing a procedure such as vitals or cleaning a
Table 6. Responses to questions about safety culture.

### Rating Overall Perceptions of Safety

| Questions                                                                 | Response          | N response | Percent (%) |
|--------------------------------------------------------------------------|-------------------|------------|-------------|
| Patient safety is never sacrificed to get more work done.                | Strongly disagree | 33         | 6.00        |
|                                                                          | Disagree          | 131        | 24.2        |
|                                                                          | Neither agree nor disagree | 96   | 17.8        |
|                                                                          | Agree             | 168        | 31.1        |
|                                                                          | Strongly Agree    | 112        | 20.7        |
| Our procedures and systems are good at preventing errors from happening. | Strongly disagree | 10         | 1.9         |
|                                                                          | Disagree          | 50         | 9.3         |
|                                                                          | Neither agree nor disagree | 73   | 14.6        |
|                                                                          | Agree             | 285        | 52.8        |
|                                                                          | Strongly Agree    | 122        | 22.6        |
| When a mistake is made that could harm the patient, but does not, how often is this reported? | Always  | 89         | 16.5        |
|                                                                          | Usually           | 234        | 43.3        |
|                                                                          | Half the time     | 155        | 28.7        |
|                                                                          | Seldom            | 59         | 10.9        |
|                                                                          | Never             | 3          | 0.56        |

### Supervisor and Manager Expectations and Action

| Questions                                                                 | Response          | N response | Percent (%) |
|--------------------------------------------------------------------------|-------------------|------------|-------------|
| My supervisor/manager overlooks patient safety problems that repeatedly happen. | Strongly disagree | 100        | 18.5        |
|                                                                          | Disagree          | 194        | 35.9        |
|                                                                          | Neither agree nor disagree | 68   | 12.4        |
|                                                                          | Agree             | 111        | 20.6        |
|                                                                          | Strongly Agree    | 67         | 12.4        |
| My supervisor/manager seriously considers staff suggestions for improving patient safety. | Strongly disagree | 16         | 2.96        |
|                                                                          | Disagree          | 56         | 10.4        |
|                                                                          | Neither agree nor disagree | 99   | 18.3        |
|                                                                          | Agree             | 252        | 46.7        |
|                                                                          | Strongly Agree    | 117        | 21.7        |
| My supervisor/manager says a good word when observing a job done according to established patient safety procedures. | Strongly disagree | 25         | 4.6         |
|                                                                          | Disagree          | 67         | 12.4        |
|                                                                          | Neither agree nor disagree | 129  | 23.9        |
|                                                                          | Agree             | 219        | 40.6        |
|                                                                          | Strongly Agree    | 100        | 18.5        |

### Teamwork Within Units

| Questions                                                                 | Response          | N response | Percent (%) |
|--------------------------------------------------------------------------|-------------------|------------|-------------|
| Nurses in our unit help each other out regularly.                        | Strongly disagree | 6          | 1.1         |
|                                                                          | Disagree          | 15         | 2.8         |
|                                                                          | Neither agree nor disagree | 22   | 4.1         |
|                                                                          | Agree             | 244        | 45.2        |
|                                                                          | Strongly Agree    | 253        | 46.9        |

(Continued)
### Table 6. (Continued)

| I can depend on getting help from other nurses. | Response          | N response | Percent (%) |
|------------------------------------------------|-------------------|------------|-------------|
| Strongly disagree                              | 5                 | 0.92       |
| Disagree                                       | 25                | 4.6        |
| Neither agree nor disagree                      | 38                | 7.0        |
| Agree                                          | 254               | 47.0       |
| Strongly Agree                                 | 218               | 40.5       |

| In this unit, people treat each other with respect. | Response          | N response | Percent (%) |
|---------------------------------------------------|-------------------|------------|-------------|
| Strongly disagree                                 | 8                 | 1.5        |
| Disagree                                          | 24                | 4.4        |
| Neither agree nor disagree                         | 46                | 8.5        |
| Agree                                             | 293               | 54.3       |
| Strongly Agree                                    | 169               | 31.3       |

| Closeness Questions | Response          | N response | Percent (%) |
|---------------------|-------------------|------------|-------------|
| Some of my closest friends are my work colleagues. | Strongly disagree | 18 | 3.3 |
|                     | Disagree          | 66 | 12.2 |
|                     | Neither agree nor disagree | 111 | 20.6 |
|                     | Agree             | 207 | 38.3 |
|                     | Strongly Agree    | 138 | 25.6 |

| Communication Openness Questions | Response          | N response | Percent (%) |
|----------------------------------|-------------------|------------|-------------|
| Staff will freely speak up if they see something that may negatively affect patient care. | Always | 117 | 21.7 |
|                                   | Usually           | 284 | 52.6 |
|                                   | Half the time     | 107 | 19.8 |
|                                   | Seldom            | 28  | 5.2  |
|                                   | Never             | 4   | 0.7  |
| Staff feel free to question the decisions or actions of those with more authority. | Strongly disagree | 20 | 3.7 |
|                                   | Disagree          | 103 | 19.1 |
|                                   | Neither agree nor disagree | 134 | 24.8 |
|                                   | Agree             | 202 | 37.4 |
|                                   | Strongly Agree    | 81  | 15.0 |
| Staff are afraid to ask questions when something does not seem right. | Strongly disagree | 48 | 8.9 |
|                                   | Disagree          | 241 | 44.6 |
|                                   | Neither agree nor disagree | 134 | 24.8 |
|                                   | Agree             | 84  | 15.6 |
|                                   | Strongly Agree    | 33  | 6.1  |

| Feedback and Communication About Error Questions | Response          | N response | Percent (%) |
|--------------------------------------------------|-------------------|------------|-------------|
| In this unit, we discuss ways to prevent errors from happening again. | Always | 117 | 21.7 |
|                                                   | Usually           | 284 | 52.6 |
|                                                   | Half the time     | 107 | 19.8 |
|                                                   | Seldom            | 28  | 5.2  |
|                                                   | Never             | 4   | 0.74 |

### Staffing (Continued)
wound. It is apparent that participants believed these to be norms, and believed others to hold the same norms in addition to conforming to such norms. This suggests that HH indications are well understood and agreed upon by nurses.

**Habit.** Habit is the cognitive mechanism by which actions occur reflexively and in a fixed sequence.[46] Habit scores were quite high, which is not unexpected for a behaviour that is practiced many times a day. This suggests that the SRHI may not be useful in measuring behaviour that is already being practiced intensively.

| Questions                                                                 | Response                  | N response | Percent (%) |
|---------------------------------------------------------------------------|---------------------------|------------|-------------|
| We sometimes work in “crisis mode” trying to do too much, too quickly.    | Strongly disagree         | 5          | 0.93        |
|                                                                            | Disagree                  | 48         | 8.9         |
|                                                                            | Neither agree nor disagree| 67         | 12.4        |
|                                                                            | Agree                     | 289        | 53.5        |
|                                                                            | Strongly Agree            | 131        | 24.3        |
| Hospital management seems interested in patient safety only after an adverse event happens | Strongly disagree         | 40         | 7.4         |
|                                                                            | Disagree                  | 136        | 25.2        |
|                                                                            | Neither agree nor disagree| 110        | 20.4        |
|                                                                            | Agree                     | 164        | 30.4        |
|                                                                            | Strongly Agree            | 90         | 16.7        |

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| Table 7. Stepwise regression model results. |
|--------------------------------------------|
| Estimate | Standard Error | T value | Pr(>|t|) |
| INTERCEPT | 3.228 | 0.511 | 6.315 | 5.84E-10 |
| HOSPITAL LEVEL FACTORS | | | | |
| Openness of communication | 0.117 | 0.049 | 2.388 | 0.017 |
| UNIT LEVEL FACTORS | | | | |
| Type of Unit: Emergency Department | -0.213 | 0.086 | -2.496 | 0.013 |
| Hours worked per week | -0.013 | 0.005 | 2.467 | 0.014 |
| Percent of time for patient care | 0.102 | 0.040 | 2.520 | 0.012 |
| Percent of time spent interacting with patient | 0.004 | 0.002 | 2.366 | 0.018 |
| Percent of time spent on professional interactions | 0.019 | 0.005 | 3.747 | 0.0002 |
| INDIVIDUAL LEVEL FACTORS | | | | |
| Which quality did you wish you had exhibited more during your last shift? | | | | |
| Good communication skills | -0.120 | 0.061 | -1.975 | 0.049 |
| Stress management | 0.135 | 0.058 | 2.334 | 0.020 |
| Which quality would you least like to hear during your last shift? | | | | |
| Unsure of self as nurse | -0.128 | 0.060 | -2.138 | 0.033 |
| NORMS | | | | |
| Out of 10 nurses working in your unit, how many do you think always use hand sanitizer or soap . . . | | | | |
| after talking to colleague in hallway | 0.041 | 0.010 | 1.970 | 0.049 |
| after cleaning a patient’s wound | -0.071 | 0.024 | -2.935 | 0.003 |
| after taking patient’s vitals | 0.041 | 0.014 | 2.823 | 0.005 |
| when exiting a patient’s room | 0.073 | 0.020 | 3.684 | 0.0003 |

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Motives. Over half of participants indicated that receiving feedback from a patient or a colleague would likely lead to an increase in future HH action. There is evidence that HH behaviour of HCWs is positively influenced by the presence and proximity of peers.[47, 48] Regarding patients, patient involvement in supporting their own safety has been widely discussed.[49–51]. Patient involvement in HH—such as praising HCWs for practicing HH or reminding HCWs to wash their hands—and its impact on HH behaviour has not been extensively studied [51], but our results show that it would be acceptable to HCWs for patients to recognize nurses for practicing HH.

Multivariate regression

The variable of interest was the reported HHC upon exiting a patient’s room after taking their vitals. This question had the most variance in responses. The regression analysis shows that reported HHC is a function of specific variables at all possible levels: the hospital, unit, and individual. At the hospital level, increased openness of communication—which was asked about in the safety culture portion of the survey—led to a higher reporting of HHC. There is evidence that features of a hospital’s safety climate are related to how well standard precautions and safety practices, such as HH, are adhered to.[52–54] Communication openness is a component of a hospital’s patient safety culture and is defined as the extent to which the staff freely speak up if they see something that may negatively affect a patient and/or question those with more authority.[40, 55] A core tenet behind communication openness is that all have a responsibility to speak out when certain actions, objects, or processes pose danger to the safety of the patient and others, and those who speak out should be able to do so without fear of being reprimanded. It could be surmised that those who are comfortable enough to speak out about threats to patient safety would also act on their own accord to protect patient safety by practicing HH at the proper indications.

At the unit level, the type of hospital unit played a role in the HHC reported—overall, participants who work in an emergency department reported lower HHC rates. This could be attributed to the fact that nurses must respond to various unpredictable situations that could be life-threatening to the patient, and the patient’s need for immediate attention and care is put first before practicing HH. Practicing HH in an emergency could be perceived as dilatory. This could also be because the emergency department is an environment with a high density of invasive procedures that require glove usage, and there is evidence that glove usage is inversely correlated with adequate HH. [1, 56, 57]

An interesting finding was that nurses who indicated having a higher proportion of shift time allocated to interaction with patients and with fellow healthcare professionals reported higher HHC. More time spent with a patient could lead to more opportunities to practice HH and thus more events completed. However, this challenges the notion that the higher the demand for hygiene (the more opportunities to practice it), the lower the adherence rates. Nevertheless, the more time spent with other HCWs could result in a nurse feeling the ‘watching eyes’ effect thus leading to increased HHC. More time with the patient could also result in the nurse bonding with the patient and is thus more cognisant of practicing HH to ensure the patient’s safety.

At the individual level, one’s personal ability to manage subjectively important aspects of the professional role—such as stress management, communication skills, and being confident in one’s self as a nurse—leads to increased reporting of HHC. All the individual-level variables in the analysis could be defined as other-oriented to a degree as presumably successful stress management can lead to providing better care. The significant individual variables show other-
oriented values involving care and communication as being of highest professional importance to nurses, and this orientation fosters better HH.

It has been noted in the literature that poor working conditions, increased levels of stress, and insufficient communication have a direct negative impact on the quality of nursing and have severe consequences for patients.[58–61] In addition, low HHC can result from fatigue or burnout. As a nurses’ shift progresses, HHC declines towards the end of the shift.[62] Continuous long shifts can lead to nurse burnout which in turn has been associated with increased HAI levels.[63] Thus, nurses who feel in control, confident in their abilities, supported, and have lower stress levels can better focus on and execute safety procedures such as HH.

Limitations

Surveys administered to HCWs are relatively inexpensive and allow for HCWs to focus and reflect on their own practices. However, self-report of infection prevention can be flawed, especially as reported HH practices and actual HH practice can differ significantly.[54, 64, 65] In using vignettes, we may have reduced socially desirable responses by allowing participants to report their HH practice and the practices of others through the vignette character(s) and situations.[65, 66] This may have reduced the potential for disparity between reported and actual behaviour. Additionally, generalizability of the findings may be limited by certain characteristics of the sample, achieved through online data recruitment. This limitation was addressed by administering the survey online, which allowed for us to collect responses from a wide variety of participants located in different regions and hospitals of the United States with varying degrees of experience and specialisation.

Conclusion

Formative research was undertaken to assess the potential impact of several unexamined factors that could influence HH among nurses: professional role and status, social affiliation, social norms, and physical modifications to the work environment, as well as institutional factors (like safety climate). A survey questionnaire looked at how these factors influence nurses’ reported HHC and also sought to identify barriers and levers to HH. Multivariate regression modelling suggested that HHC was most likely to be a function of a hospital management’s ‘openness’, perceived performance by peers, increased interactions with patients and other staff members, and the reduction in stress, busyness, and cognitive load associated with role performance. Thus, a powerful and effective intervention focusing on nurses’ HHC should address improving communication openness, consider the impact of perceived performance by peers, increase interactions with patients and staff, and determine how to reduce the stress and cognitive load associated with role performance. Use of Behaviour Centred Design increased the informativeness of the survey tool, and could be used more widely in formative research studies.

Supporting information

S1 File. Search strings. Concepts and their corresponding search strings.

S2 File. Survey tool.

S1 Fig. Results presented in figures.
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