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Major Article

Understanding nurses' workflow: Batching care and potential opportunities for transmission of infectious organisms, a pilot study

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Background: Caring for patients in contact precautions can be challenging. In this pilot study, we sought to understand, using qualitative and visual methods, how nurses provide care for patients in contact precaution rooms and to identify potential breakdowns in practice that could increase risk of disease transmission.

Methods: Qualitative data were collected while shadowing 4 nurses on 2 medical/surgical units at a university medical center between September and October 2016. Observers documented nurses' movements in handwritten fieldnotes. Fieldnote data were analyzed using a descriptive approach with visual depiction to map care delivery in precaution and non-precaution rooms.

Results: Nurses moved between non-precaution rooms, completing 1-4 tasks per room entry, over the course of several brief room entries and exits. In contrast, nurses rarely entered contact precaution rooms to complete only a few tasks, generally completing ≥10 tasks per room entry. Although hand hygiene on room entry/exit was consistently performed, a breakdown in practice occurred in precaution rooms as nurses tended to move between tasks and contact with the environment without performing hand hygiene.

Conclusions: Differences in how nurses structure their work in contact precaution rooms may contribute to risk of infectious disease transmission. Understanding and addressing the challenges specific to how nurses work is a critical part of infection prevention in today's hospital environment.

Despite improvements in some health care–associated infection rates in US hospitals, opportunities for further improvement remain.[1] Accordingly, the Centers for Disease Control and Prevention and other health care professional organizations continue to prioritize efforts to optimize health care–associated infection prevention knowledge and the effective use of prevention strategies.[2] This includes strategies to prevent disease transmission, which commonly include hand hygiene and transmission-based precautions requiring personal protective equipment (PPE) use (eg, gloves and gowns).[3] Patients who require transmission-based precautions (contact, droplet, or airborne) for specific infections can, however, present unique challenges for nurses.

In one study, for example, nurses described the precautionary measures required in caring for patients with *Clostridium* (also known as *Clostridioides*) *difficile* infection (CDI) as "overwhelming."[4] Yanke et al[5] also observed that full compliance with PPE use during care for patients with CDI was not only complex but impacted time demands and required changes in work flow. Similarly, in another study nurses estimated that the use of PPE for patients in transmission-based precautions added up to 2 hours per shift, and resulted in "trade-offs" or "cutting corners" when providing care.[6]

Although prior observation studies have described some of the complexities, challenges, and breaches in infection control practices that can occur while caring for patients in precautions,[7] most research to date has focused on issues involving PPE donning and doffing.[5,8] Less is known about potential issues related to care

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delivery, including how care delivery patterns might differ for precaution patients compared with patients in non-precaution rooms or how nurses deliver care in precaution rooms. The primary aim of this study was to better understand, using data collected through qualitative observation and by employing visual analysis methods, how nurses provide care for patients in contact precaution rooms and to identify potential breakdowns in practice that could increase risk of transmission of infectious organisms.

METHODS

Study design and setting

This qualitative study used observation data collected while shadowing inpatient nurse volunteers. Shadowing entails closely following an individual over an extended period of time, documenting such things as their actions, behaviors, movements, interactions and conversations with others.[9] Shadowing took place on 2 general medical/surgical units at a tertiary care university medical center between September and October 2016. The primary focus of the study was to better understand real-time use of PPE, including hand hygiene practices, primarily for patients in contact precautions, which at the time of the observations were required for methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant *Enterococcus*, and enteric organisms (eg, CDI). Institutional review board approval was obtained.

Data collection

Data were collected by 2 observers, a senior nursing student and a pre-med student, who shadowed 4 individual nurses working on 2 medical/surgical units during their normal workday. Both observers received a general infection prevention overview and skills training on use of PPE as well as training (didactic and field-based) on the purpose and logistics of observation by research study staff, including a medical anthropologist. Didactic training included a formal presentation on how to enter the field, how to collect and document data, and examples of well-documented field notes. For field-based training, we paired experienced observers with the newly trained observers. Each pair observed the same activities, documented what they saw, compared field notes, and discussed the quality of documentation. New observers received specific feedback on improving documentation by including such things as the type of hand hygiene performed or sequence for donning/doffing PPE. Paired observations continued until it was determined that new observers were proficient in documentation. To ensure data quality, experienced team members (LW and MH) periodically reviewed field notes and provided ongoing feedback throughout the observation period.

Data were collected using unstructured field notes, in which observers wrote exactly what they saw and heard while shadowing the nurses. Specifically, observers documented each nurse's activity and movement throughout the unit as well as their actions while providing direct patient care inside precaution and non-precaution rooms. All activity observed during the shadowing session was described in detail, including preparation and use of equipment and supplies, movement in and out of patient rooms and shared hospital spaces, individual components of patient care tasks, surfaces touched, method of PPE use, and interaction with other health care personnel, patients, or the observer. Observers transferred their notes to an electronic format after the observation (ideally directly after the shadowing session but within 24 hours) to help with recall.

Beyond the type of precaution assigned (eg, contact, droplet, protective, none), no patient data, such as diagnosis, acuity, or demographics, were collected. Patients were informed of the study purpose and that observers were present to document nurse activity and would not be recording any identifiable information. Patients could opt out if they did not want the observer in the room while receiving care.

Data analysis

Data were analyzed using a descriptive approach with visual depiction to (1) compare patterns in care delivery for patients in contact precaution and non-precaution rooms, and (2) characterize the workflow of nurses while providing care for patients in contact precaution and non-precaution rooms. For both contact precaution and non-precaution rooms, we assessed the amount of time and number of tasks completed per room entry. We also outlined each nurse's movement between patient and environmental contact points while providing care in contact precaution and non-precaution rooms, with a focus on potential transmission opportunities, noting in particular the timing of hand hygiene and glove changes.

We defined a task as a discrete nursing activity of patient care as shown by the examples in Table 1. Tasks were counted beginning at room entry until room exit. A single task involved a discrete and fully completed action (eg, repositioning patient without interruption) or the same action occurring multiple times as part of an uninterrupted activity sequence. For example, if medication preparation, administration, and charting were completed in a distinct sequence, charting was counted only once as a task even if it occurred more than once during medication administration. If a nurse moved back and forth between different activities, however, without fully completing an activity in a sequence, each occurrence of the activity was counted as a task. For example, if a nurse charted, started medication preparation, moved to examination, resumed medication preparation, and returned to the computer to chart again, charting was counted as 2 tasks. Two study analysts [LG, LW], 1 with a clinical background and 1 without, reviewed the field notes independently to characterize individual tasks and calculate the frequency of occurrence. In general, interpretation of field notes was consistent and, if not, discussion involving multiple members of the research team [LG, LW, MH, SK] occurred until consensus was reached. The 2 observers were not involved in the data analysis process.

Next, we identified contact points during the nurse's movements inside the room focusing on direct hand touches. Contact points were limited to movements inside the patient room between room entry and exit. We then classified each task and contact point as clean, dirty, or environmental (Table 1). For example, medication preparation or assessment of an intravenous (IV) device were characterized as clean tasks, whereas touching a urinary catheter bag to assess fullness was considered a dirty task, and computer use while charting was considered an environmental contact. In accordance with

Table 1
Characterization of observed tasks and contact points

Task and/or contact point type	Example tasks and contact points
Clean	➢ Medication preparation/administration ➢ Physical assessment ➢ Repositioning, ambulation assistance ➢ Talking with patient, other health care providers ➢ Dropping off supplies ➢ Intravenous therapy assessment
Dirty	➢ Foley/colostomy assessment and care ➢ Bathroom/patient hygiene assist ➢ Trash ➢ Suctioning
Environmental	➢ Charting/computer ➢ Equipment/supply removal (glucometer, meal trays) ➢ In-room supply management ➢ Curtain, furniture, bedrail, tables

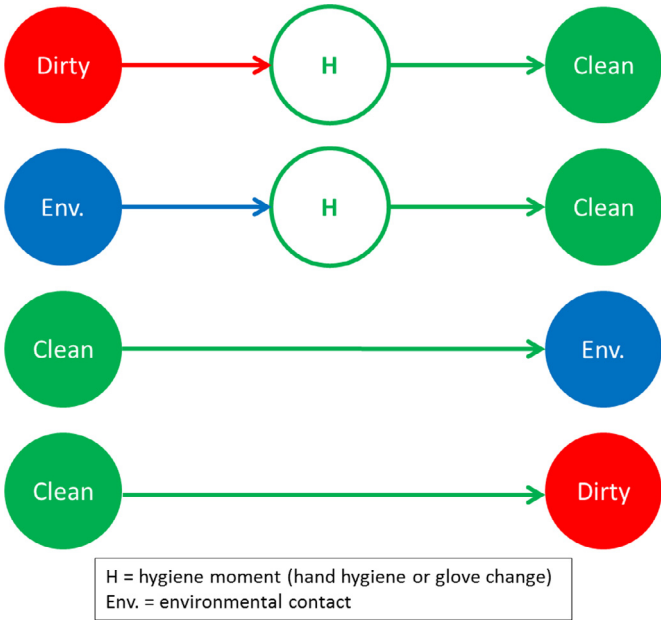

Fig 1. Appropriate movement patterns.

Wolfensberger et al,[10] the patient environment was presumed contaminated but environmental contact was characterized distinctly from a dirty patient care task for this analysis.

Finally, we traced movement patterns and identified when a hygiene moment, either hand hygiene or glove change, should occur (Fig 1) based on the World Health Organization recommendations[11] and review of institutional policy. For example, hand hygiene should occur when moving from a dirty task, such as providing urinary catheter care, to a clean task, such as medication administration. Similarly, hand hygiene should occur after contact with the computer, which is part of the environment and presumed contaminated, to a clean task like IV care. Moving from clean to either an environmental or dirty contact would not routinely require hand hygiene.

RESULTS

Two nurses on day shifts (7:00 AM to 7:00 PM) and 2 on evening/night shifts (7:00 PM to 7:00 AM) were shadowed, with an average of 183 minutes per shadowing session and a range of 180-195 minutes. The observed nurses were assigned 3-5 patients for their shift with the number of patients in contact precautions ranging from 1-4 (Table 2). Only 1 precaution-related nursing assignment included a patient on contact precautions for diarrhea most likely due to possible or confirmed CDI.

We found that when providing care, nurses structured their work differently in contact precaution rooms as compared with non-precaution rooms. Nurses spent more time and completed more tasks per room entry (a strategy that we described as “batching”) in precaution rooms when compared with non-precaution rooms. Also, while in contact precaution rooms nurses tended to move between tasks and/or contact with the room environment without performing the recommended hand hygiene. These patterns are further illustrated in the examples provided in the next paragraphs and in the Appendix Figures A1-A3.

Time and task patterns

Although the type of tasks completed in both non-precaution and precaution rooms were similar, nurses generally moved between non-precaution rooms, completing 1-4 tasks sequentially per room entry, over the course of several brief room entries and exits. In contrast, in contact precaution rooms, nurses rarely entered to complete only a few tasks. In some cases, they completed 10 or more tasks per room entry. This contrast is illustrated in Figure 2 (Nurse 1), which follows 1 nurse providing care in 1 contact precaution and several non-precaution rooms.

The top panel in Figure 2 shows the nurse providing care in 2 non-precaution rooms over 45 minutes. Although care was delivered over a longer time frame, the nurse had 8 room entries and exits and completed only 1-4 tasks on each entry. Room entries to complete only 1 task were for supply drop off and IV management. Hand hygiene occurred regularly on entry and exit. In comparison, the same nurse remained in 1 contact precaution room (bottom panel) for 28 minutes and completed 10 tasks before exiting. Tasks included topical medication preparation/administration, charting, IV medication preparation/administration, repositioning, oral medication preparation/administration, updating the white board, examining, repositioning, charting, and patient assist. After initial room entry, no hand hygiene moments were observed.

Patterns of movement between clean and dirty spaces

When providing care in contact precaution rooms, nurses moved between clean and dirty spaces frequently as they completed multiple tasks during each room entry. Movement also appeared less organized or directed in precaution rooms compared with non-precaution rooms, as nurses often moved between multiple different tasks during a room entry, without fully completing a single task prior to initiating a new task. In addition, although institutional policies outline when glove changes should occur, less compliance with hand hygiene in the form of glove changes was observed during care in contact precaution rooms. The movement patterns of Nurse 2 in a precaution room and a non-precaution room are shown in Figure 3.

Figure 3A shows movement patterns of Nurse 2 providing care in a non-precaution room during a 10-minute room entry. There is hand hygiene on entry, then environmental contacts at points 1 and 2 (turn off call light, check IV pump). Gloves are donned before clean contacts at points 3 and 4 (patient examination) followed by an environmental contact to adjust the room temperature at point 5. After a dirty contact at point 6 (assess urinary catheter then colostomy bag), gloves were changed with hand hygiene prior to completing the examination at point 7, a clean contact. The nurse then moved to environmental contacts (tray table, patient phone) at points 8 and 9 before exiting with hand hygiene.

Figure 3B follows the same nurse (Nurse 2) providing care over 45 minutes in a CDI contact precaution room. Although no specific “dirty” contact points were noted, there were multiple environmental

Table 2
Nurse work assignments

Nurse	Shift	Total number of patients	Total number of rooms	Contact precaution rooms	Non-precaution rooms
1	Day	4	3	2	1 (shared room)
2	Evening/night	3	3	1	2
3	Evening/night	4	4	1	3
4	Day	5	5	4	1

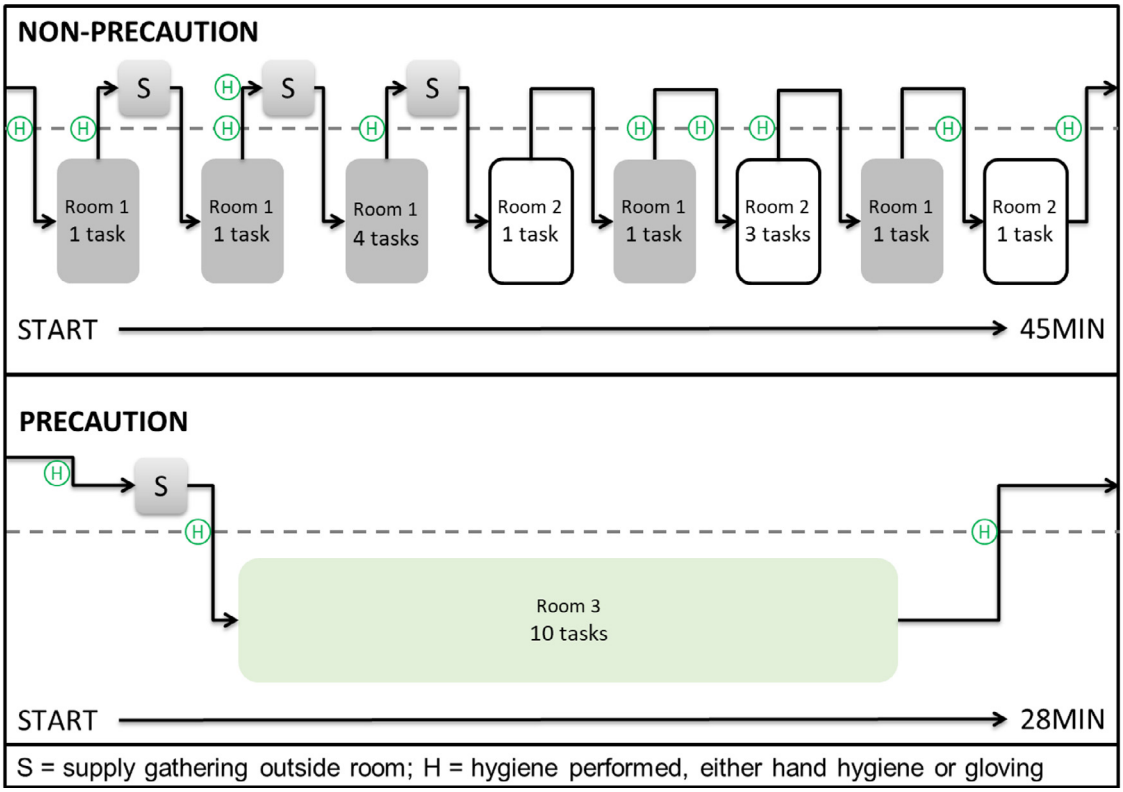

Fig 2. This figure illustrates differences in time and task organization for nurses between contact precaution and non-precaution rooms.

contacts and no observed hand hygiene moments after room entry. For example, movement between the environment (computer) at point 3, presumed contaminated, and the clean task of changing IV fluid (point 4) should have prompted a glove change or hand hygiene. Subsequent movement from environmental to clean contacts included computer use for scanning medications at point 5 before checking a blood sugar at point 6, and points 11-12 with an IV site assessment after contact with the computer, wall objects, tray table, and the in-room supply cabinet. These movement patterns illustrate both the volume of activity associated with batching care and the general lack of attention to hand hygiene moments while providing care in contact precaution rooms.

DISCUSSION

Providing nursing care for patients who are placed in contact precautions to prevent the transmission of infectious organisms presents a unique set of challenges. Nurses spent more time in contact precaution rooms, completed more tasks per room entry (batching care), and had more interaction with patients and their room environment during a given room entry. Batching care also resulted in more movement between tasks, whereas reduced room entry and exit, as well as the extended time spent in precaution rooms, seemed to negatively affect the frequency of appropriate hand hygiene and glove changes.

The nurses we observed frequently entered and exited non-precaution rooms for relatively brief periods of time and completed only 1-4 tasks with each room entry. The time spent after entering a contact precaution room, however, tended to be substantially longer with numerous tasks (often 10 or more) performed while in the room. Our results are consistent with those by Barker et al,[12] who also found that nurses spent more time in precaution patient rooms compared with those not in contact precautions (7.14 vs 5.08 minutes). Moreover, our study builds on this finding by showing that nurses performed more tasks while in precaution rooms, which likely accounts in part for this time differential. We identified this tendency to group tasks as a form of "batching," similar to a previously identified workaround used by nurses to increase efficiency during medication administration.[13,14]

The potential infection-related consequences of batching care are yet to be determined. Nonetheless, a literature review by Pittet et al,[15] found hand contamination increased as the duration of care increased. A study by Landelle et al[16] also showed that health care provider hand contamination after caring for a CDI patient increased as the number of overall contacts with the patient and the room environment increased. Even with gloves on, a longer duration of high-risk contacts in CDI rooms increased the likelihood of hand contamination.[16] Although a specific task may not seem to pose a significant infectious risk, cumulative contact during sequential tasks may increase contamination risk.[16] Roghmann et al,[17] for example, found transmission of methicillin-resistant *Staphylococcus aureus* was higher when more than 1 type of care was provided during patient care. Therefore, the time and task patterns associated with batching care for patients in contact precautions may increase the potential for transmission as the number of tasks increases in proportion to the time spent in precaution rooms.

The time and task patterns observed in our study also showed more extensive nursing interaction with the patient and environment in contact precaution rooms, and less attention to hand hygiene as nurses moved between tasks. This finding could be due in part to cognitive overload if there is an imbalance between task requirements and nurses' capacity to complete tasks as required by infection prevention and control guidelines. The likelihood of errors occurring because of distracted practice increases in parallel with cognitive overload as nurses shift from thinking critically to automatic responses.[18] Moreover, batching and the resulting cognitive overload can negatively affect situational awareness, the process by which nurses respond to cues from the patient and the environment to understand and anticipate what they should be doing.[19] With

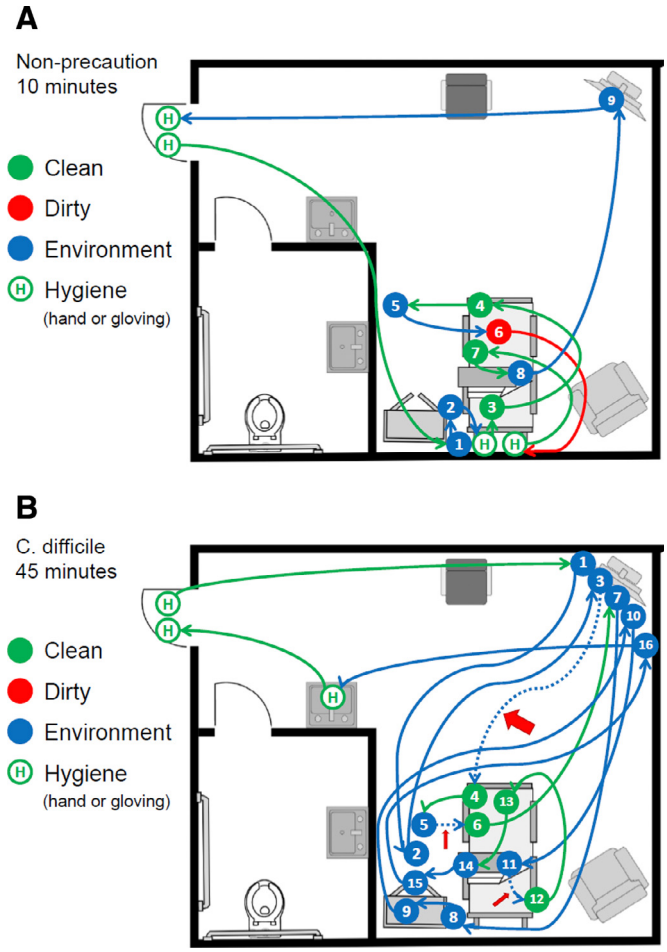

Fig 3. (A) This figure illustrates the sequential clean, dirty, and environmental contact points that correspond with patient care tasks in a non-precaution room. (B) This figure illustrates the sequential clean, dirty, and environmental contact points that correspond with patient care tasks in a contact precaution room. Bolded red arrows indicate movement from environmental to clean contact in which a hygiene moment might be warranted.

fewer precaution room entries and exits, the cues for hand hygiene and glove changes may be lost and as the demand for care in a precaution room increases, glove changes may no longer be a conscious behavior.[20]

The extent to which gloves and the environment contribute to disease transmission to patients is not well understood,[21] but evidence is increasing in support of the environment's role in transmission.[22] The likelihood of glove and hand contamination after environmental contact is similar to that with patient contact[15,23,24] and gloves should be considered, as hands are, a potential transmission source.[21] Guerrero et al,[25] found that acquisition of CDI spores on gloved hands was as likely after contact with common environmental contact points as after contact with common patient skin contact points. Therefore, contact with the environment should be considered a potential source of transmission and cross-contamination.[23] Current institutional policy recommends visual cues to encourage hand hygiene on entry and exit. Additional visual cues inside precaution rooms to prompt glove changes at appropriate moments should be considered because a lack of glove changes as nurses moved between clean, dirty, and environment spaces was a common finding.

Finally, situational awareness is also influenced by a nurse's knowledge base, how a task is managed, and whether the nurse has the ability to switch attention between multiple pieces of information.[19] The nurses we observed seemed aware of the potential for environmental contamination when managing tasks in non-precaution rooms but behaved differently in precaution rooms, suggesting that nurses may not be aware of how their task management when batching care in precaution rooms may result in a potential transmission opportunity. Lack of awareness of the impact of recurrent contacts,[26] lack of glove changes, and movement patterns may all be contributing factors. Batching also seemed to be an attempt by nurses to save time by completing multiple tasks, consistent with prior research.[4,6] However, although health care personnel may perceive that multitasking is helping them work more efficiently, research suggests that multitasking may actually increase the time needed for task completion and the potential for errors.[27]

This study has several limitations. First, we were unable to account for any potential differences in acuity between patients in precaution and non-precaution rooms. Second, the shadowing time frame only captured care during the first 3 hours of 8-12 hour shifts, so we do not know the total amount of time spent and task completion in precaution as compared with non-precaution rooms over the course of a full shift. Third, shadowing observations were limited to 2 units and 4 nurses, with observations of both day and evening routines only occurring on 1 of the units. Fourth, data were collected using handwritten field notes that potentially limited the ability of the observer to accurately document and recall all details they observed. Finally, the potential for the Hawthorne effect, as with other observational studies, exists. However, our shadowing was done after the same research study staff had spent several weeks conducting general observations on these units, so unit staff were comfortable with our presence. Moreover, changes in behavior related to being shadowed would, if anything, be expected to promote more optimal or mindful behavior.

Our findings suggest that differences in how nurses structure their work in contact precaution rooms may contribute to transmission risk. Batching care may lead to transmission opportunities as a result of breakdowns in precaution practices as nurses (1) spend more time in precaution rooms, (2) complete multiple tasks, and (3) have more extensive interaction with patients and the room environment during a single room entry. Extended time in precaution rooms also appears to reduce appropriate glove changes, adding to the risk of potential transmission of an infectious organism. This pilot study highlights the need for further research to understand the implications of nurses' work patterns on the potential transmission of infectious organisms. Furthermore, our study suggests opportunities for collaboration between infection prevention and nursing in identifying strategies for effectively implementing precaution practices by taking workflow-related issues into account. Because multiple factors influence potential transmission opportunities, understanding and addressing the challenges specific to how nurses work is a critical part of infection prevention in today's hospital environment.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.ajic.2019.03.034.

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