



TIME-MOTION ANALYSIS OF HEALTH CARE WORKERS' CONTACT WITH PATIENTS AND WORKERS' HAND HYGIENE: OPEN VS CLOSED UNITS

By Babar A. Khan, MD, Ken Yon Hui, MS, Siu L. Hui, PhD, Rajesh Gulati, MD, Jason Tricker, ACNP-BC, Noll L. Campbell, PharmD, Mark O. Farber, MD, Malaz A. Boustani, MD, MPH, and John D. Buckley, MD, MPH

Background The effects of open (care provided by general medicine teams with a pulmonary intensivist consultant) vs closed (care provided by a dedicated critical care team) intensive care units on health care workers' contact with patients and their hand hygiene is uncertain.

Objective To determine if closed intensive care units have fewer visits of patients by health care providers and greater hand-washing compliance among providers than do open units.

Methods Time-motion analysis was used to observe 2 rooms in a medical intensive care unit at a teaching hospital affiliated with Indiana University School of Medicine, Indianapolis, for 96 hours before and after closure of the unit. The main outcome measures were frequency of health care providers' visits and their hand-washing hygiene compliance rates.

Results Mean number of visits per room per hour by physicians (1.53 in the open unit vs 1.27 in the closed unit; $P = .93$) and nurses (3.98 in open unit vs 4.14 in closed unit; $P = .60$) did not differ. No differences were observed in gold-standard hand washing among physicians (0.00% in open unit vs 2.63% in closed unit; $P = .11$) or nurses (2.50% in open unit vs 3.49% in closed unit; $P = .51$). However, hand washing decreased significantly in nurses in the closed unit (40.94% in open unit vs 29.84% in closed unit; $P = .002$).

Conclusion Closing the intensive care unit did not decrease the number of contacts between health care providers and patients nor did it increase the providers' compliance with hand hygiene. (*American Journal of Critical Care*. 2011;20:e75-e79)

Transmission of infectious microbes via health care workers has been associated with increasing morbidity and mortality of hospitalized patients, but years after publication of guidelines on the subject, the incidence of health care–associated infections remains high,¹ contributing to morbidity, mortality, increased hospital stay,² and inflated health care costs. The majority of nosocomial infections are due to transmission of bacteria by direct or indirect contact between health care workers and patients,³ making proper hand hygiene one of the most effective ways to decrease transmission of infective organisms.⁴ However, simple hand washing is a difficult intervention to implement, especially in intensive care units (ICUs), where acuity is high and time is precious.

Traditionally, ICUs in the United States have been open units with teams of primary care physicians providing care for patients and intensivists acting as consultants. Recently, the trend has been to close the ICU and have a dedicated ICU team provide patient care. To date, no direct observations have been published on the practice patterns of health care workers regarding the number of contacts with patients and the workers' hand-washing habits in an open ICU vs a closed ICU.

We performed a time-motion analysis of patient contacts and hand washing among health care personnel in a medical ICU at Wishard Memorial Hospital, a 460-bed county teaching hospital affiliated with Indiana University School of Medicine in Indianapolis. The aim of the study was to determine prospectively the number of contacts that health care workers have with patients and the percentage of hand washing among health care workers in an open ICU and then to compare that information with similar observations collected in the same ICU after the unit was closed. We hypothesized that closing the ICU would decrease the number of

health care workers' contacts with patients while increasing the workers' hand-washing frequency.

Methods

Settings and Participants

The medical ICU of Wishard Memorial Hospital was an open unit until July 2007. Up to that time, 8 general internal medicine teams, each composed of 1 attending physician, 1 resident, and 2 interns, were primarily responsible for patient care in the ICU. The critical care team, consisting of a pulmonary intensivist and a critical care fellow, consulted on all patients admitted to the ICU. In July 2007, the unit was closed and a dedicated ICU team consisting of 1 attending physician, 1 critical care fellow, 2 residents, and 2 interns became the primary service providing care to all patients in the ICU. The dedicated team had no input from the general medicine teams.

The ICU has 9 rooms along a wide corridor, 1 row of 5 and 1 row of 4, with nursing stations outside the rooms. For hand washing, each room has a sink and a soap dispenser. A wall-mounted dispenser of alcohol-based hand cleaner is located immediately outside each room. The patient to nurse ratio is 2 to 1 for all 12-hour shifts. The patient to nurse ratio and the shift length did not change when the ICU was made a closed unit. The local institutional review board approved the study.

Data Collection

Patients' rooms in the ICU were selected randomly for data collection. A total of 2 rooms were observed simultaneously by one of the authors (K. Y. H.) in June 2007 in a time-motion manner for two 24-hour periods, for a total observation time of 96 hours. The sequence was repeated with the same observer in August 2007, after the ICU had been closed. Health care personnel who asked about the observer's role were told that he was part of a quality control project, but the details were not shared.

About the Authors

Babar A. Khan is a pulmonary fellow, **Mark O. Farber** is a professor, and **John D. Buckley** is an associate professor at Indiana University School of Medicine in Indianapolis. **Ken Yon Hui** is a medical and doctoral student at Yale University School of Medicine in New Haven, Connecticut. **Siu L. Hui** is a professor at Indiana University School of Medicine and a biostatistician at the Regenstrief Institute, Inc, Indianapolis, Indiana. **Rajesh Gulati** is an assistant professor in the Indiana University Medical Group, Indianapolis, Indiana. **Malaz A. Boustani** is associate director of the Indiana University Center for Aging Research and a scientist at the Regenstrief Institute, Inc. **Jason Tricker** is a nurse practitioner at Wishard Health Services, Indianapolis, Indiana. **Noll L. Campbell** is a research assistant professor at Purdue University, Indianapolis, Indiana.

Corresponding author: Babar A. Khan, MD, c/o Malaz A. Boustani, MD, MPH, 410 W 10th St, Ste 2000, Indianapolis, IN 46202 (e-mail: bakhan@iupui.edu).

Data on contacts between health care personnel and patients and on hand hygiene were recorded in a spreadsheet format with predefined codes for each type of contact. Any person entering a patient's room for at least 5 seconds was counted as a visitor of the patient. The person entering the room was classified as physician, nurse, or other (including housekeeper, policeman, respiratory therapist, and family member of the patient).

According to guidelines of the Centers for Disease Control and Prevention¹ and the protocol of the local infectious disease committee, optimal hand washing is defined as washing the hands with soap and/or using the alcohol-based preparation for 30 seconds before entering a patient's room and after exiting the room. For data analysis, the same guidelines were used except for the 30-second limit, because adhering to this time limit would be extremely difficult in a critical care environment. The modified procedure was termed gold-standard hand washing (GSHW). If only 1 of the steps in the procedure was completed, the hand washing did not meet the gold standard, and the episode was designated as just hand washing for statistical analysis.

Statistical Analyses

The mean number of visits per room per hour was compared between the 2 time periods of open and closed ICU, with adjustments for the time of day of the observations. Poisson regression models for the hourly counts of visits to each patient were fitted by using generalized estimating equations to account for correlations of repeated observations on the same patients. The percentages of hand washing and GSHW were compared between the open and closed ICU periods by using 2-tailed Fisher exact tests.

Results

After adjustments were made for the observer's time away from the rooms for meals and bathroom breaks, the total number of hours observed was 170.25. Of these, 80.5 hours were spent when the ICU was open and 89.75 hours when it was closed.

Frequency of Visits of Health Care Providers

During the study period, a total of 237 visits to patients' rooms by physicians and 690 visits by nurses were made. The mean number of visits per room per hour by physicians (1.53 for the open ICU vs 1.27 for the closed ICU; $P = .93$) and nurses (3.98 open vs 4.14 closed; $P = .60$) did not differ between the 2 ICUs (see Table). Parts A and B of the Figure show visits by physicians and nurses according to the hour of the day.

The mean length of a nurse's visit was 4 minutes and 19 seconds in the open ICU and 4 minutes and 5 seconds in the closed ICU. The mean length of a physician's visit was 2 minutes and 29 seconds in the open unit and 3 minutes and 22 seconds in the closed unit.

Gold-Standard Hand Washing

GSHW compliance rates for the 2 ICUs (Figure, parts C and D) did not differ among physicians (0.00% for the open ICU vs 2.63% for the closed ICU; $P = .11$) or nurses (2.50% open ICU vs 3.49% closed ICU; $P = .51$). However, hand washing by nurses in the 2 ICUs was significantly less in the closed unit (40.94% open vs 29.84% closed; $P = .002$).

Discussion

Hand hygiene is perhaps the most important element in an infection control program, but compliance with any hand hygiene procedure is barely 40% under study conditions.⁵ According to guidelines of the Centers for Disease Control and Prevention,¹ health care-associated pathogens are not only present in draining wounds but also on intact skin. The number of organisms (*Staphylococcus aureus*, *Proteus mirabilis*, *Klebsiella* species, and *Acinetobacter* species) present on intact skin can vary from 100 to $10^6/\text{cm}^2$.¹ Because of the continual shedding of these microbes, objects in a patient's vicinity can become contaminated with the organisms. The organisms can then be transferred from the objects to the hands of health care personnel and, if proper hand hygiene precautions are not undertaken, to the next patient, resulting in cross-infection. The possibility of such cross-infection is the reason why the Centers for Disease Control and Prevention¹ consider proper hand hygiene practices so important.

Several factors have been implicated in poor compliance with hand hygiene in institutions, including lack of time, hand irritation, forgetfulness, decreased awareness of cross-infection, and frequent visits by health care personnel.⁶ Our study was designed to observe the contact rates of health care workers with patients, in an open ICU and then in a closed ICU, to test the hypothesis that in a closed ICU system, contact rates would decrease and compliance with hand hygiene would improve. A MEDLINE search of publications from 1966 to 2009 with key words *ICU* and *hand washing* did not result in any other comparisons between an open and a closed ICU.

We found no significant differences between the number of visits per hour made by physicians and nurses in the 2 types of ICU. This finding did

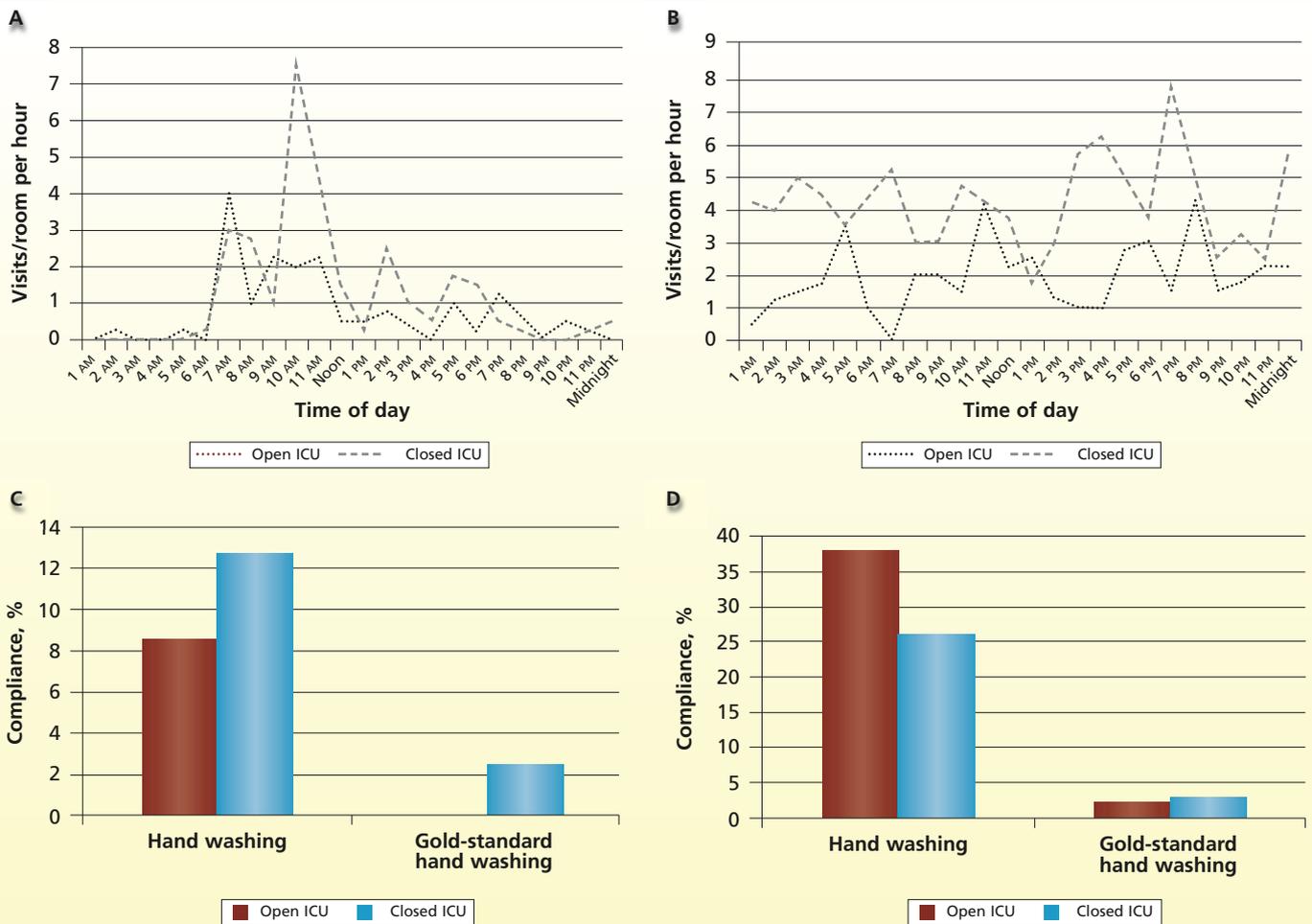


Figure Number of visits per room per hour for 24 hours by physicians (A) and registered nurses (B) and rates of hand washing and gold-standard hand washing by physicians (C) and registered nurses (D) in an open and a closed intensive care unit (ICU).

not support our hypothesis that a dedicated ICU team would result in a decrease in the number of visits to patients by health care providers. The rates of hand washing increased among physicians after closure of the ICU, but the differences between the open and closed ICUs were not significant. One reason for this finding may be the time the data were collected in the closed ICU, namely, early in the academic cycle of interns. The academic cycle begins in July and ends in June, and new interns freshly out of medical school start their training in July. Most of the interns undergo compliance training through a Web-based module just before the start of their internship, and this training may result in improved hand hygiene practices among physicians. Another explanation for the slight increase in the rate of hand washing is the possibility that the dedicated ICU team was more cognizant of hand washing than were providers in the open ICU.

The reason for the significant decrease in the rate of hand washing among nurses in the closed

Table
Comparison of total number of visits per room per hour between an open and a closed intensive care unit

Visitor	No. of visits per room per hour		P
	Open unit	Closed unit	
Doctors	1.53	1.27	.93
Nurses	3.98	4.14	.60
Others ^a	2.56	1.83	.04
Total	8.07	7.24	.93

^a Includes patients' family members, housekeeping, respiratory therapist, and police.

ICU is unclear to us. We made no adjustments for patient acuity, so patients might have had higher acuity during the closed ICU period, resulting in a higher number of visits from nurses that did not involve direct patient care and thus did not require hand washing.

Among physicians, compliance with GSHW was zero in the open ICU. Compliance increased slightly after ICU closure, but the difference was not significant. A similar trend was observed among nurses. The overall rate of hand washing remained extremely low, however, a finding similar to the results of the study by McArdle et al,⁷ who also used direct observation of contacts between health care workers and ICU patients.

Strengths of our study include having one observer collect the data, thus minimizing observer bias; an uninterrupted data collection; and data collection in both open and closed ICU systems. In addition, our study may be the first comparison of an open vs a closed ICU.

Limitations of our study include an observation time of only 170.25 hours; possible selection bias (only a few rooms were observed), no control over the diagnosis of patients observed (patients with more serious diagnoses may require frequent visits by physicians and nurses to provide care), the possible effect of the observer on the behavior of health care providers, and other unmeasured confounders. These limitations can be better addressed by using the expanding tele-ICU technology, which could make it easier to collect a more extensive data set over a longer time.

Conclusion

Closing the ICU did not decrease the number of contacts between health care providers and patients and did not increase the providers' compliance with hand hygiene. On the basis of our findings, an intensive teaching program to educate nurses and physicians about hand hygiene was started at Wishard Memorial Hospital. Nursing leaders played an active role in the program, and hand-washing rates improved after the program. Because of the increasing trend in the United States to close ICUs, a larger study to better delineate the factors that pre-

dispose health care providers to poor hand hygiene practices may be important. We should not just assume that closing an ICU will improve these practices. More emphasis on teaching young physicians and nurses early in their careers may result in higher gains in the long term.

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