Staff-Developed Infection Prevention Program Decreases Health Care–Associated Infection Rates in Pediatric Critical Care

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The health care team identified the causes of health care–associated infections (HAI) and developed interventions in a pediatric intensive care unit in Gaza. A quasi-experimental pretest-posttest design was used. All 26 full-time staff members in the pediatric intensive care unit participated. The HAI rate decreased significantly from the first to the second year following the implementation of the intervention (208 vs 120.55, odds ratio: 3.21, 95% confidence interval: 1.87-5.11; $P < .001$).
Key words: *HAI prevention*, *health care associated infections*, *infection control*, *pediatric ICU*

HEALTH CARE–ASSOCIATED INFECTIONS (HAI) are acquired by a patient while receiving care in hospitals, outpatient surgery centers, long-term care facilities, rehabilitation centers, and community clinics.[1] Health care–associated infections are not present at the time of admission. Adherence to infection prevention guidelines is needed more than ever to decrease the incidence of HAI. These infections disproportionately affect patients in the intensive care unit (ICU) where an estimated 25% to 33% of ICU patients contract HAI.[2] The purposes of this study were to explore health care team (registered nurses, physicians, physical therapists, x-ray technicians, environmental staff, and laboratory assistants/transporters) perceptions of causes of HAI and to develop and implement prevention measures in the ICU of a specialty pediatric hospital in Gaza.

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BACKGROUND

Health care–associated infections are an international problem that occurs in an estimated 10% of all hospital admissions globally.[3] Health care–associated infections not only increase morbidity and mortality in patients

but also cause a considerable economic burden on health care.[4] According to the Centers for Disease Control and Prevention, the incidence of HAI is 1.7 million infections and 99 000 deaths per year.[1] Health care–associated infections cost an estimated $28 billion to $33 billion each year.[1] The mean prevalence of HAI in Europe is 7.1 per 100 patients. In England, £1000 million annually is budgeted by the National Health Service for HAI.[5] In Canada, the incidence of HAI is greater than 220 000 per year and results in 8500 to 12 000 deaths; the direct costs of HAI are estimated at $1 billion annually.[6] Health care–associated infections cost Thai hospitals 10% of their annual budget.[7] It is important to develop interventions to decrease HAI and develop effective prevention strategies.

Gravel et al[8] found that pediatric HAI prevalence was comparable with that reported of adult patients internationally. According to Gravel et al, the HAI rate was 8%, ranging from 0% in pediatric trauma/burn units to 19% in the pediatric ICUs. Bloodstream infections were reported as the most common pediatric HAI.[8–10] Health care–associated infections research in pediatric ICU is lacking and needs further development.[11–13]

Health care–associated infections are a concern in ICU settings. Intensive care unit patients represent 8% to 15% of all hospital admissions.[14] Health care–associated infections in ICU settings can cultivate in a number of places: numerous invasive lines, mechanical ventilation, Foley catheters, central lines, arterial lines, endotracheal tubes, or other mechanisms disproportionately seen in ICU patients. The presence of an invasive device increases the risk of infection because it provides a means of entry for bacteria into the patient. In addition, patients in the ICU are severely ill, have low immunity, and are often on bed rest.[15] Infection control measures are a top priority in the ICU and must be integrated fully into the processes of quality improvement of care in the ICU.[16–18]

To evaluate factors contributing to HAI in the pediatric hospital ICU, we emphasized the 3 Donabedian[19] components of the health care system: structure, process, and outcome. Structural elements are those related to the patient and tangible resources. Process refers to the activities, policies, procedures, and tasks performed within the health care system. Examples of the outcomes are infection rates, patient satisfaction, morbidities, and mortality rates.[20–22]

METHODS

Design

The study was a 3-phase project. In the first phase of the pilot study, the researchers used staff meetings to investigate perceptions of staff on issues related to infection control. Staff information were analyzed, and a questionnaire was developed to further assess consensus among staff. In the second phase, interventions suggested by the staff were implemented over a 2-month period using a quasi-experimental design. In the third phase, we measured the effects of the interventions by evaluating HAI 4 months following implementation. Institutional review board approval was obtained from the Helsinki Committee for Research and Ethics in Gaza.

Sample and setting

All full-time staff members who worked in the ICU participated in the study (N = 26). Inclusion criteria included all full-time staff working in the pediatric ICU (15 nurses, 7 physicians, 1 x-ray technician, 1 physical therapist, 1 environmental staff member, and 1 assistant/transporter); the exclusion criterion was staff not working in the pediatric ICU. The specialty pediatric hospital is a referral center for tertiary medical services in Gaza. The hospital has capabilities across the full spectrum of tertiary care services for both inpatient and outpatient care. The hospital seeks to meet the standards of World Health Organization quality of care.

The Gaza Strip is one of the most overpopulated areas in the world. Depending on the political volatility at any given time, the area lives in crisis with shortages of food, water, power, and poor infrastructure. The crippled

health care system suffers from periods of shortages of medical supplies, medications, and lack of spare parts to maintain functioning medical equipment. According to the Ministry of Health—Gaza report in 2012, the pediatric hospital has 54 beds for inpatient services and 33 beds for outpatient services for children up to 12 years of age. The hospital has 8 units, an emergency department, outpatient clinics, a diagnostic laboratory, and radiology services. Specialty services include dialysis, neurology, cancer, cardiac/echo, endocrine, electroencephalography, and pulmonology. In 2012, the ICU had 5 beds with an average length of stay of 5.8 days, an occupancy rate of 48%, and a reported 33 deaths in 2012. Respiratory distress, end-stage cancer, kidney failure, and congenital diseases are examples of the medical conditions of patients admitted to the ICU. The hospital refers an average of 87 children per month for advanced care and surgery to hospitals in Egypt and Israel. The referral process is complicated, and many children die while waiting to cross the border.[23]

Outcome measures

The 2 outcomes explored pre- and post-intervention were (1) infection rates (number and percentage of positive cultures [blood, sputum, urine, wounds, or cerebrospinal fluid] collected 48 hours after admission in the ICU) and (2) average number of antibiotics vials used in 1 week.

Intervention

The researchers and the ICU team members (including registered nurses, physicians, x-ray technicians, and laboratory assistants) brainstormed to identify possible causes of HAI and to identify preventive measures that could decrease HAI and foster appropriate and effective use of antibiotics in the ICU. Six possible causes were identified as contributing factors to the occurrence of HAI in the ICU: (1) lack of infection control knowledge; (2) lack of leadership, supervision, and follow-up; (3) lack of ICU experience; (4) lack of infection control protective measures; (5) lack of antiseptic materials; and (6) large numbers of visitors (see Supplemental Digital Content Figure, available at http://links.lww.com/JNCQ/A114). Lack of infection control knowledge, leadership and supervision, and ICU experience were identified as the main causes of HAI in the ICU, which represented about 76% of possible causes identified by staff.

The researchers developed new strategies on the basis of staff feedback and recommendations of ways and methods to minimize HAI in the ICU.

Infection prevention medical supplies and equipment

Personal protective equipment was provided to the ICU unit including disposable gloves, gowns, laboratory coats, protective face shields, resuscitation masks or shields, and mouth pieces. Also, we provided any equipment necessary to prevent exposure to blood or other potentially infectious material. Effective personal protective equipment was designed to prevent potentially infectious materials from passing through or reaching skin, eyes, mouth, or clothes under normal conditions of use.[24] In addition, an alcohol-based hand rub was provided to the ICU unit to reduce the number of viable microorganisms with maximum efficacy and speed.[25,26]

Educational sessions and training programs

Registered nurses, physicians, pharmacists, and laboratory workers were educated and trained on basics of infection control and prevention, effective use of available resources, and developing and using work policies. The activities included the following:

- Giving lectures for staff (physicians, nurses, and technicians) to enhance awareness of basic aseptic measures. The researchers created compact disks to distribute the lectures to the staff to ensure full involvement of the team.
- Increasing weekly requisition of aseptic equipment from central supply including antiseptics, gowns, gloves, goggles, masks, shoes, and head covers.

- Distributing pamphlets to visitors demonstrating proper procedures in the ICU during visiting time including hand hygiene.[26] The culture of Gaza is supportive with large numbers of immediate and extended family members and friends who visit and stay for long hours. The team instituted a policy limiting the number of visitors to 2 to 3 close immediate relatives at 1 time for 10 to 15 minutes per visit.
- Minimizing the unnecessary invasive procedures to ICU patients.
- Developing and enforcing policies and procedures, for example, frequency of systematic cleaning of walls, ceiling, floors, and beds.

Methods to improve compliance with infection control and prevention precautions

Methods included creating an environment and culture that support trust and emphasize learning. Hospital and ICU leadership was involved to ensure that staff provided safe, effective, and clean care.[27] In addition to fostering hand hygiene for health care workers and visitors,[25,26,28] the health care team discussed and received verbal instructions about the rationale for and technique of hand hygiene (hand washing and alcohol-based hand rub). World Health Organization posters and reminders were posted in multiple locations in the ICU for employees and visitors.

RESULTS

Previously performed positive cultures and sensitivities 48 hours after admission for patients were used as an indicator of the HAI rate prior to the intervention. There were 76 (63%) positive cultures out of the 120 cultures collected during the year before the intervention, with a nosocomial infection rate of 208 per 1000 ICU days. The ICU nosocomial infection rate was calculated by dividing the number of infections by the number of hospital days and multiplying by 1000. In the first half of the second year (2 months of implementation and 4 months post-implementation), the researchers collected 60 cultures, and only 22 (36%) were positive cultures; the nosocomial infection rate was 120.55 per 1000 ICU days. The infection rate significantly decreased from the first to the second year following the implementation of the intervention (208 vs 120.55, odds ratio: 3.21, 95% confidence interval: 1.87-5.11; $P < .001$). That is, in the first year, the odds of a positive culture were 3.21 times higher than that in the second. The Supplemental Digital Content Figure, available at http://links.lww.com/JNCQ/A115, shows the infection rate stratified by month pre-intervention, during the intervention, and post-intervention.

The mean number of antibiotic vials used before the intervention (in the first year) was 130 vials per week. After the intervention, the mean number of antibiotics used weekly was 92 vials, representing a significant decrease in antibiotic use ($P = .002$).

DISCUSSION

The results of this pilot study suggest that this intervention decreased the rate of HAI in our pediatric ICU. Some of these activities were conducted with the hospital's infection control committee. The research team worked to raise awareness of the need for personal hand hygiene. The involvement and concern of the hospital administration and the researchers increased compliance with the instructions and infection control measures. Offering of medical supplies and equipment played a major role in the success of this project.

The findings of this study are consistent with the latest recommendations of the Agency for Healthcare Research and Quality to implement a comprehensive unit-based safety program (CUSP), which focuses on the use of effective team work, leadership, and communication to create a culture of safety.[29] In the CUSP, staff are educated on the science of safety and complete an assessment of patient safety culture. Hospital executives partner with the unit to improve communications

and educate the leadership. Staff learn from unit failures and use effective evidence-based safety tools, such as checklists, to improve teamwork, communication, and work systems.[30]

Our findings are similar to those of Brilli et al,[31] who implemented a comprehensive patient safety program and significantly reduced HAI, associated costs, and hospital mortality. Other studies found a significant effect of enforcing basics of infection control such as the use of universal gloving at the point of care.[8,10,12] Gaza suffers from shortages of medical supplies and medications from time to time. The research team was able to secure needed supplies and medications, but it is doubtful that this can be the case at all times. The financial and political situation in Gaza and the ability of the ministry of health to pay salaries for all employees and provide appropriate resources present challenges to continue effective infection control and prevention.

CONCLUSIONS

Our results revealed a significant decrease in the HAI and antibiotic use after implementing the intervention program. Staff involvement was an effective tool to minimize infections and decrease antibiotic use provided at the specialty pediatric hospital. Because of limited resources and funding, the research team could not increase the intervention period or postintervention evaluation period. There are no electronic medical record information systems in Gaza hospitals.

There are several limitations in this study. First, the researchers are in an area of the world where infection control and prevention are not the norm. Most of the work described here is about using a CUSP-like approach to teach and enforce the basics of infection control and prevention, teamwork, improved leadership roles, and developing and using policies and procedures. Second, the study did not categorize infections by type such as central line–associated blood stream infections or catheter-associated urinary tract infections. Third, the overall intervention and follow-up was limited to 6 months. Finally, hand hygiene compliance was not measured as an outcome of the study. Future research should use observation pre-and postintervention to document hand hygiene.

This pilot study shows that hospitals in similar volatile situations may decrease HAI rates and antibiotic use. The findings in this study support the effectiveness of implementing staff-developed education and infection prevention programs to reduce HAI in pediatric hospitals. Including the health care team in the process of developing and implementing effective interventions is essential. Effective leaders who were interested and valued staff members' opinions and efforts to decrease the rates of HAI were critical to the success of this project. Finally, this study used a comprehensive approach to decrease HAI similar to that recommended in the CUSP.

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