American Journal of Infection Control 44 (2016) 80-4

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Health care–associated infection surveillance in a tertiary neonatal intensive care unit: A prospective clinical study after moving to a new building

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Key Words:
Health care–associated infection surveillance
Neonatal intensive care unit
Prevention
Relocation

Background: There are very few prospective clinical studies on neonatal health care–associated infection (HAI) surveillance. HAI surveillance helps reduce not only mortality, but also morbidity, length of hospital stay, and health care costs.

Methods: This prospective clinical study covered a period of 12 months in a tertiary neonatal intensive care unit (NICU). HAI rates were calculated using different denominators: number of patients hospitalized in the NICU, number of patient-days, and number of specific device-days.

Results: The HAI rate was 18%, and the incidence density was 17/1,000 patient-days. The most common HAI was bloodstream infection (n = 34; 50%). The most common pathogen was coagulase-negative staphylococci (CoNS; 54.9%) in gram-positive bacteria and in general. Methicillin resistance was 96.4% for CoNS. *Klebsiella* spp (13.7%) was the most common gram-negative bacteria. Extended-spectrum β-lactamase positivity was 14.3% for *Klebsiella* spp and 25% for *Escherichia coli*. HAI-related mortality was 0.3%.

Conclusions: NICUs should perform their own HAI surveillance with prospective clinical design. Attention paid to handwashing, disinfection and sanitizing, complying with the terms of asepsis, extending in-service training, increasing the number of medical staff, preventing frequent changes in health care staff positions, and improving physical environmental conditions in NICUs might eventually decrease HAI rates.

The health care–associated infection (HAI) data obtained in studies on neonates is quite limited compared with that in pediatric and adult patients. The increased survival of neonates with low birth weight and severe prematurity as a result of rapid advancements in medical technology, increased accessibility to advanced medical techniques and practices, and the widespread use of invasive procedures have increased the rate and importance of HAIs.[1] Neonatal HAI rates are 3-20 times higher in developing countries than in industrialized countries owing to inadequate infection control methods applied during or after birth.[2] It becomes possible to start more appropriate empirical antimicrobial therapy as a result of infection control programs, with HAI surveillance allowing each center to determine its patient profile and HAI rates, detection of the pathogens that constitute the microbial flora of the hospital, and monitoring of their time-varying resistance patterns. In addition, a significant reduction in mortality and morbidity can be provided through reevaluation of infection control methods.[3]

This study was a prospective analysis of HAIs observed over a 1-year period in the neonatal intensive care unit (NICU) of Suleyman Demirel University Research and Education Hospital. The aim was to evaluate the epidemiologic characteristics of the HAIs through the application of HAI surveillance.

MATERIALS AND METHODS

Patients and setting

The NICU of Suleyman Demirel University Research and Education Hospital is a tertiary care referral unit located in Isparta,

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Conflicts of interest: None to report.

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http://dx.doi.org/10.1016/j.ajic.2015.07.032

Turkey, with an annual admission rate of 400-500 neonates. We also have live births in the hospital; the youngest infant resuscitated in the NICU is 23 weeks. There are 15 beds in the NICU, and 34 neonates with HAI were included in the study during the 1-year study period.

Approval for the study was granted by the Clinical Research Ethics Committee of Suleyman Demirel University School of Medicine (Resolution 2012;78).

Type of study, follow-up, and definition of HAIs

In this study, all patients admitted to the NICU between July 1, 2012, and June 30, 2013, were observed prospectively for clinical and laboratory findings regarding HAIs. Owing to the study's prospective clinical design, both culture-positive and culture-negative infections were evaluated. Therefore, the study results are compared with those of previous studies that used the same methodology.

The data were obtained prospectively by making daily visits and examining the records of patients, including history, clinical course, laboratory results (eg, complete blood count, serology, microbiology, biochemistry, radiology), and nursing observations. The follow-up of each patient was continued until discharge, referral, or death.

The Centers for Disease Control and Prevention's definitions of HAIs were used.[4] All infections were diagnosed and followed daily by the pediatric infectious disease specialists. HAI was defined as infection occurring 48 hours after admission to the hospital and not in the incubation period at admission or occurring within the first 10 days after discharge. Rates were determined for all of the HAIs observed during the study period. Frequencies of causative pathogens and their resistance patterns were analyzed in detail in bloodstream infections (BSIs), pneumonia (PNEU), urinary tract infections (UTIs), and central nervous system (CNS) infections.

Microbiology methods

Clinical culture samples of blood, urine, cerebrospinal fluid (CSF), catheters, endotracheal aspirates, wounds, and other sources were obtained from the patients according to the type of infection being considered and were sent to the Microbiology Department laboratory for evaluation. Peripheral blood and catheter blood samples were inoculated into blood culture media (BACTEC Peds Plus/F; BD Diagnostics, Hunt Valley, MD). Other samples were plated on blood agar (Or-Bak, Alkim Saglik, Turkey), eosin methylene blue agar (Or-Bak), or chocolate agar (Gul Biyoloji Laboratuvari, Istanbul, Turkey). In cases of positive culture, they were replated on the aforementioned solid media. Blood and CSF cultures were incubated for 7 days, and other cultures were incubated for 2 days. Culture-positive samples were identified by biochemical identification or an automated systems (mini-API; [bioMérieux, Marcy l'Etoile, France]) and plated on Mueller-Hinton agar (BD Diagnostics) for antibiotic susceptibility testing through the Kirby-Bauer disk diffusion method. They were reevaluated 24 hours later according to Clinical and Laboratory Standards Institute (CLSI) criteria, and antimicrobial susceptibility testing was performed following the disc diffusion method in accordance with CLSI standards.[5,6]

Infection control methods

The NICU had 2 quarantine rooms. The average nurse-to-patient ratio was approximately 1:2. The infants' parents were not allowed to visit the unit; rather, they watched their babies via a live camera display. Two trained infection control nurses visited the unit each day. The NICU had a handwashing policy, and audits of staff compliance were undertaken at random intervals. Alcohol-based hand sanitizers were provided at handwash basins, and sufficient paper towels for hand drying were available. Sterile and clean nonsterile gloves were used during neonatal care according to the procedures performed. All catheters were inserted and cared for following standard protocols, and the maximum duration of catheterization was taken into account. Surveillance cultures were obtained when an outbreak was suspected.

Table 1
Demographic characteristics

Variable	Value
Age, d, mean ± SE	2.5 ± 1.6
Sex, n (%)	
Male	19 (55.9)
Female	15 (44.1)
Birth weight, g, mean ± SD	1964 ± 1021
Gestational age, wk, mean ± SD	33.2 ± 4.2
Mode of delivery, n (%)	
Cesarean delivery	29 (85.3)
Vaginal delivery	5 (14.7)

Statistical analysis

The infection rate was calculated as the number of infections per 100 admitted neonates (incidence rate) and the number of infections per 1000 patient-days (incidence density). The association between mode of delivery and the presence of HAI was analyzed using Fisher's exact test. Differences in continuous variables (birth weight and gestational age) between patients with HAIs and those without HAIs for were evaluated using the independent-samples *t* test. A value of $P < .05$ was accepted as statistically significant. All statistical analyses were performed using SPSS 15.0 for Windows (SPSS Inc, Chicago, IL).

RESULTS

A total of 377 patients were admitted to the NICU during the study period, and the NICU's occupancy rate was 72.9%. A total of 68 HAI episodes were evaluated in 34 of the patients (9%) over 3,991 patient-days. The HAI rate was 18%, and the incidence density was 17/1,000 patient-days. The patients with HAIs included 19 males (55.9%) and 15 females (44.1%); their demographic characteristics are shown in Table 1.

In analysis according to birth weight, the highest rate of HAI was 37.5% in neonates weighing <1,000 g. The proportion of patients with HAI was inversely associated with birth weight. In analysis according to gestational age, the highest rate of HAI was in those born between gestational weeks 28 and 31 and the lowest was in those born between weeks 36 and 37 (Table 2).

HAI was detected in 11.7% of those born by cesarean section and in 5.9% of those born by vaginal delivery. Although the HAI rate was higher in the cesarean delivery group, the difference was not statistically significant ($P = .089$).

The most common HAI was BSI (n = 34; 50%), followed by CNS infection (n = 14; 20.6%), UTI (n = 10; 14.7%), PNEU (n = 7; 10.3%), and skin and soft tissue infection (SST) (n = 3; 4.4%). When HAIs were analyzed by subgroup, 47.1% of BSIs, 57.1% of PNEU infections, and 71.4% of CNS infections (meningitis) were determined to be device-related.

The following pathogens were detected during the study: gram-positive bacteria, 68.6%; gram-negative bacteria, 25.5%; yeasts, 5.9%. The most common pathogens detected were coagulase-negative