



Major article

Surveillance of health care–associated infections in a tertiary hospital neonatal intensive care unit in Egypt: 1-year follow-up



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Key Words:

Infection rates
NICU
Egypt

Background: Reported rates of neonatal health care–associated infections (HAIs) in neonatal intensive care units (NICUs) have risen rapidly in recent years. Little data are available in Egypt, however. The aim of the present study was to determine the incidence of and risk factors for HAIs in the NICU of Ain Shams University Hospital of Obstetrics and Gynecology.

Methods: A prospective study was carried out on all neonates admitted in the NICU of Ain Shams University Hospital of Obstetrics and Gynecology in 2012. Centers for Disease Control and Prevention criteria were followed for identifying HAIs.

Results: A total of 434 neonates were enrolled in the study. The cumulative incidence of HAIs in the NICU was 28%. Bloodstream infections accounted for 85% of HAI episodes; pneumonia, for 10%. The most common organism isolated was *Klebsiella* spp. The main risk factors identified on multivariable analysis were gestational age <38 weeks (relative risk [RR], 1.63), birth weight <1,500 g (RR, 1.39), mechanical ventilation (RR, 1.74), and surgical procedures (RR, 1.65). The mortality rate attributed to HAIs was 11.75%, and the extra hospital length of stay attributed to HAIs was 8 days.

Conclusion: The high incidence of HAI identified in the study NICU mandates more vigorous infection control interventions.

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Neonatology and neonatal intensive care units (NICUs) have greatly increased the survival of very low birth weight and extremely preterm infants. Health care–associated infection (HAI) is the other side of the coin. HAI is defined as an infection occurring during hospitalization that was not present or incubating at the time of admission.¹

Reported rates of neonatal HAIs in NICUs have risen rapidly in recent years.^{2,3} The rate of HAIs per admission varies from 6.0%^{4,5} to 50.0%⁶ or, when reported as total infections per 1,000 patient-days, from 4.8⁴ to 62.0.⁵ Reported rates of neonatal HAIs are 3- to 20-fold higher in developing countries than in developed countries.⁷ These infants with an HAI have significantly longer hospital stay and higher mortality than uninfected infants.⁸

HAIs in the NICU result from the interaction of several risk factors. Prematurity, multiple underlying diseases, immune system immaturity, exposure to broad-spectrum antibiotics, and a high

likelihood of cross-infections owing to close contact with a multi-disciplinary care team have been related to the occurrence of HAIs.^{9,10} Prolonged duration of NICU stay (likely a surrogate marker of the patient's severity of illness) and low birth weight also have been associated with an increased risk for HAI.¹⁰ Intensive use of invasive medical devices (eg, urinary catheter, central venous catheter [CVC], mechanical ventilator [MV]) for both diagnostic and therapeutic purposes also likely increase the risk for HAI.^{9,10}

The HAI rate in a facility is an indicator of that facility's quality and safety of care. The development of a surveillance process to monitor the HAI rate is an essential first step in identifying local problems and priorities and evaluating the effectiveness of infection control (IC) activities.¹¹

Surveillance for HAIs is not implemented uniformly in Egyptian health care settings. Few previous studies have evaluated HAIs in NICUs in Egypt. One study reported an incidence rate of 20.0% in a tertiary hospital in Cairo,¹² whereas another study reported an incidence rate of 21.0% in a tertiary hospital in Mansoura in lower Egypt.¹³ The aim of the present study was to determine the incidence rate of different HAIs and their risk factors in the NICU of Ain Shams University Hospital of Obstetrics and Gynecology.

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Conflict of interest: None to report.

METHODS

Study design

In this prospective cohort study, all neonates admitted between January 2012 and December 2012 in the NICU of Ain Shams University Hospital of Obstetrics and Gynecology were followed up for the occurrence of HAIs.

Study setting

The study was conducted at the NICU of Ain Shams University Hospital of Obstetrics and Gynecology, an "inborn unit" that limits admission to infants born in the hospital. The hospital has 383 beds, with 12,900 deliveries recorded in 2012. The NICU is a level III unit with 36 incubators and 3 incubators in an isolation room (level IV). The NICU is operated by 13 consultants and 9 junior neonatologists. The nurse:patient ratio is 1:1 or 1:2 in morning shifts and 1:3 in night shifts. The hospital has an IC Committee, an IC physician, and 3 IC nurses (composing the IC team), together with link nurses (nurses that are trained in infection control and act as link between their own clinical areas and the central infection control team to facilitate implementation of policies and procedures and surveillance system) in different departments. IC policies applied in the NICU include proper handwashing as well as use of alcohol hand rubs, environmental cleaning, waste disposal, antiseptic guidelines for insertion of catheters and devices, and antiseptic preparation of medications. Environmental sampling is not regularly performed in this NICU.

Data collection

A data collection sheet was designed to include baseline and follow-up data for each admitted neonate. The baseline data included personal information, underlying diagnosis, birth weight, gestational age, and pregnancy history. The follow-up data were gathered each day from each neonate until discharge and included invasive procedures (eg, mechanical ventilation, CVC insertion), duration of device use, and laboratory and clinical follow-up data.

The criteria proposed by the Centers for Disease Control and Prevention were adopted as the standard case definitions throughout the study.¹⁴ In brief, bloodstream infection (BSI) was defined as the presence of the pathogens in blood culture with the presence of clinical signs and symptoms, including fever, hypothermia, frequent apnea, bradycardia, lethargy, hypotonia, unstable vital signs, and feeding intolerance. Pneumonia was defined as a clinically unstable respiratory condition with chest radiography showing new or progressive infiltrate and an infectious organism isolated from blood culture or from specimens obtained by endotracheal aspirate. Urinary tract infection was defined as the presence of aforementioned clinical signs and symptoms and a urine culture of ≥ 105 colonies/mL urine from bladder catheterization. The surveillance team received certified training from the National Program of Infection Control in Egypt. The surveillance activity was supervised by the head of the hospital's IC team and an epidemiologist. None of enrolled neonates developed an infection before 48 hours of hospitalization.

For the purpose of surveillance, HAI rate was calculated as the number of infections per 100 admitted neonates (cumulative incidence rate) and as the number of infections per 1,000 patient-days (incidence density). The rate of device-associated HAIs was calculated as infections per 1,000 device-days. The device utilization ratio was calculated as the ratio of specific device-days to total patient-days.

Crude excess mortality (ie, attributable mortality) was calculated as the difference between the crude overall case fatality rate

Table 1
General characteristics of the study population

Characteristic	n (%)
Total no.	434
Sex	
Male	239 (55.1)
Female	194 (44.7)
Gestational age, wk	
<38	304 (70)
≥ 38	130 (30)
Birth weight, g	
$\geq 2,500$	165 (38.1)
1,500-2,499	162 (37.3)
<1,500	107 (24.6)
Outcome of neonate	
Discharged	340 (78.3)
Died	94 (21.7)
Device utilization ratio (total patient-days, 8,526)	
CVC	802 (9.4)
Urinary catheter	27 (0.3)
Ventilator	2,135 (25.0)
Peripheral catheter	5,335 (62.6)

Table 2
Incidence of HAIs in the study NICU

Variable	Numerator (no. of infections)	Denominator	Incidence rate
Overall HAIs	149	434*	34.3
NICU patients infected	123	434*	28.3
Infections per 1,000 patient-days (incidence density)	149	8,526	17.5
Ventilator-associated pneumonia	15	2,135 [†]	7.0
Central line-associated BSI	127	802 [†]	158.4
Catheter-associated urinary tract infections	2	27 [†]	74.1

*No. of admitted neonates.

[†]Device-days.

of patients with an HAI and the crude case fatality rate of patients without an HAI in the NICU during the same time period. Extra length of stay (LOS) was defined as the difference in median LOS between patients with an HAI and those without an HAI.

Ethical considerations

The study protocol was approved by the Research Ethics Committee of Ain Shams Faculty of Medicine. Informed consent was waived because this observational study did not necessitate any deviation from routine medical practice.

Statistical analysis

Qualitative data are presented as frequencies and related percentages. LOS is presented as median and interquartile range (IQR) because the data are not normally distributed. Relative risk (RR) with 95% confidence interval (CI) was calculated for assumed risk factors for overall HAI. Because the HAI rate identified in this study was not unusual, use of odds ratios would have provided an inaccurate estimation of risk. Accordingly, logistic regression was not used in our multivariable analysis. Instead, log binomial modeling was used to preserve the estimation of RR.

All variables with a *P* value $< .25$ on univariate analysis were subjected to multivariable analysis. For multivariable analysis, a log binomial model with robust variance estimation was used to estimate adjusted RR with 95% CI. The 95% CI for extra LOS was estimated using the bootstrap technique. Statistical analyses were

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