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Healthcare associated infections in neonatal intensive care unit and its correlation with environmental surveillance

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ABSTRACT

Healthcare-associated infections (HAI) are frequent complications in neonatal intensive care units (NICU) with varying risk factors and bacteriological profile. There is paucity of literature comparing the bacteriological profile of organisms causing HAI with the environmental surveillance isolates. Therefore, this study aimed to evaluate demographic profile, risk factors and outcome of HAI in NICU and correlate with environmental surveillance.

Three hundred newborns with signs and symptoms of sepsis were enrolled in the study group and their profile, risk factors and outcome were compared with the control group. Univariate analysis and multivariable logistic regression were performed. Environmental surveillance results were compared to the bacteriological profile of HAIs.

We identified lower gestational age, male gender and apgar score less than 7 at 5 min, use of peripheral vascular catheter & ventilator along with their duration as significant risk factors. Mortality rate was 29% in the study group ($p < 0.05$). The HAI site distribution showed blood-stream infections (73%) to be the most common followed by pneumonia (12%) and meningitis (10%). Gram positive cocci were the most common isolates in HAI as well as environmental surveillance.

The bacteriological profile of HAI correlates with the environmental surveillance report thus insisting for periodic surveillance and thereby avoiding irrational antibiotic usage.

Introduction

Healthcare associated infections (HAIs) are of increasing concern in neonatal intensive care units (NICUs) due to advances in invasive therapeutic and diagnostic procedures and increased survival of preterm babies. It is defined as localized or systemic condition resulting from adverse reaction to the presence of an infectious agent(s) or its toxin(s) and that was not incubating at the time of admission to the hospital [1]. Most authors describe HAIs as equivalent to late-onset, or infection after the first 72 h of life [2]. Reported rates of HAIs per admission in the literature range from 6% to 50% with 3-to 20-fold higher rates in developing countries as compared to developed countries [3]. The overall mortality rate varies between 20% and 80% depending on the risk factors [4]. In addition, there exists wide variation in the bacteriological profile and antibiogram of microorganisms in different NICUs which changes consistently with time.

Surveillance of HAI is an essential part of quality and safe patient care. There are few reports of National Healthcare Safety Network (NHSN) surveillance in neonatal intensive care units and none in developing countries [5]. However, hospital based infection control policy is present in different hospitals in India with the constituting members responsible for surveillance of infections and providing methods of control. Surveillance specimens include clinical material and environmental samples.

The NICU environmental surfaces harbor large number of bacterial and fungal taxa associated with nosocomial infection in neonates. These genera contain many species commensal in healthy humans but do not necessarily represent pathogenic strains. Bokulich et al. [6] isolated several taxa, Staphylococcus and *Streptococcus* from the NICU surfaces and simultaneously identified members of these two genera too responsible for the most

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prevalent cause of the infectious outbreaks in the NICU. But failed to demonstrate species specific causal association between environmental contamination and neonatal infection.

This study therefore, aims to evaluate demographic characteristics, risk factors and bacteriological profile of healthcare associated infection in NICU and correlate with the environmental surveillance.

Methods

An observational study was conducted over one-year period with neonates born and investigated for late-onset sepsis during the hospital stay included in the study group. A total number of three hundred babies were enrolled on odd days in the study group based on the prevalence of late-onset sepsis at 20% [7], confidence interval of 95% and margin of error at 5%. Neonates presenting with signs of infection with first 72 h of life and those who were discharged home & later presented with sepsis were excluded from the study. Another three hundred babies who neither developed sign and symptoms of sepsis nor investigated for late-onset sepsis during their hospital course were enrolled consecutively for the control group.

The study was done at the NICU of a tertiary care teaching hospital in India with approximately sixteen to twenty thousand deliveries occurring per year. It is an inborn unit with admission limited to babies born in the same hospital. The NICU comprises of two sub units: low risk (level II) and high risk (level III). The total number of beds is 50 (25 in each) with average bed occupancy rate of 40–50 babies per day. Our hospital has Infection Control team (HICT). The team comprises of heads from all the clinical departments, head of microbiology, representatives from the hospital administration and two infection control (IC) nurses. The IC policy for NICU includes following: standard precautions, proper hand rub/hand wash guidelines, minimal invasive procedure, proper disinfection and sterilization, biomedical waste disposal and surveillance.

A data collection sheet was prepared separately for the study and control groups mentioning birth weight, gestation age, gender, mode of delivery, small for gestation age, resuscitation requirement, Apgar score at 1 and 5 min less than 7 and presence of co-morbidities such as hyaline membrane disease and congenital malformation. The follow up data was collected on the invasive device usage (peripheral vascular catheter and ventilation), duration of device usage, and duration of hospital stay.

The study group patients were followed and categorized into site specific health-care associated infections using the standard definitions proposed by the Centre for Disease Control and Prevention [1]. The required samples (blood, cerebrospinal fluid, urine, endotracheal tube aspirates etc.) were collected using aseptic precautions and processed using standard methods [8,9]. Blood sample were analyzed for sepsis screen {Absolute neutrophil count, Immature to total neutrophil ratio (I/T ratio), μESR, C- reactive protein, Peripheral smear for sepsis} and blood culture. 1–2 ml of neonate's blood was taken in BacT/Alert® culture media and incubated in the instrument. From day 2 onwards, when the machine beeps for growth, bottle was taken out after scanning as positive. It was followed by subculture on blood agar, chocolate agar and MacConkey agar. Plates were incubated at 37 °C aerobically and examined for bacterial growth. Finally, gram stain, catalase and coagulase test were done for identification and Kirby Bauer disc diffusion technique for antibiotic sensitivity. Cerebrospinal spinal fluid (CSF) samples were analyzed for cell count and protein & glucose estimation. Gram's stain and latex agglutination was done to identify bacteria. 1–5 drops of CSF were inoculated on culture media and incubated for 24 h. Any bacterial growth noted was further tested for identification and antibiotic sensitivity. Urine samples were collected by either suprapubic aspiration or catheterization technique and underwent routine & microscopic examination and culture & sensitivity analysis. Skin scrapings, endotracheal tube, ear discharges and conjunctival secretions were collected only in the applicable study subjects for culture and sensitivity. As per prevailing antibiotic policy, Cefotaxime and Amikacin was used as the first line drug as per hospital policy and switched to second line drugs Vancomycin or ciprofloxacin if there was no improvement in 48 h. Meropenem, piperacillin-tazobactum and Linezolide were used as third line drugs after culture and sensitivity report or in consultation with microbiologist.

Regular surveillance was carried out in the NICU every four to six weeks. IC nurses take surveillance specimens from both the clinical and environmental surfaces. Environmental surfaces regularly screened in the NICU included: phototherapy lights, radiant warmers, baby cot, weighing machine, suction tubing's, laryngoscopes, feeding trays, thermometers, feeding counter, air etc. The surfaces of inanimate articles were sampled with sterile cotton-tipped swabs. The swabs were moistened with sterile phosphate buffered saline and streaked across a 4-in^2 area (or the entire surface for surfaces of 4 in^2); swabs were rotated to ensure full contact of all parts of the swab tip and the surface. Simultaneously culture plates were exposed to the room environment of both the NICU for one hour. The collected samples were sent to the microbiology laboratory for analysis. In case of significant growth from any environmental sample, proper advice was given to the NICU staff for disinfection. Subsequent sampling was done from the contaminated article after proper disinfection measures to ensure decontamination. If the increase in the isolation percentage during a specified period matched with the monthly growth of that organism in the surveillance, it was presumed to have some association.

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

The Institutional ethical committee of Vardhmann Mahavir Medical College and Safdarjung Hospital ethically approved the study. Informed consent was waived for this observational study as there was no deviation from the routine medical practice.

Statistical analysis

Statistical analysis was performed by the SPSS program for Windows, version 17.0. Quantitative and qualitative variables are expressed in mean ± SD and relative frequencies respectively. Odds' ratio with 95% confidence interval (CI) was calculated for all variables responsible for causing HAI. p Value was calculated using parametric and non-parametric tests (t-test, Wilcoxon test and Pearson's chi-square test). All risk variables except for interventional risk factors were subjected to multivariate analysis. Multivariate logistic regression values were expressed in adjusted odds' ration with 95% CI.

Results

Three babies in the study group and two babies in the control left against medical advice and were not considered in the evaluation. Thus, the analysis was carried out of 298 babies in the study and 297 babies in the control group.