Neonatal intensive care unit: Reservoirs of Nosocomial pathogens

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Summary

Improvement in the care and treatment of neonates had contributed to their increased survival. Nosocomial infection remains an important problem in intensive care units. Hospital wards had been shown to act as reservoirs of pathogenic microorganisms associated with infection. To assess the prevalence of pathogenic organisms in the environment of the neonatal unit, 92 swabs were randomly collected from cots, incubators and various equipments in the unit and were cultured on Blood agar and MacConkey agar plates. Air contamination was detected by exposing the same types of agar plates for 3 hours in several areas of the unit. After 48 hours incubation, isolates were identified biochemically.

There is marked congestion in the unit. Ninety one percent of swabs yielded growth, with coagulase negative Staphylococcus being the predominant organism (44%), followed by Bacillus species (20%), E. coli (12.5%), and Klebsiella (8.5%). Pseudomonas species (3.6%) and moulds (3.6%). Sedimentation plates had colony counts of from 10 - 100 per plate and the majority of the cultures were polymicrobial cultures. The presence of various Gram-negative bacilli including known neonatal pathogens (like E. Coli and Pseudomonas) especially on ward equipment and congestion in the ward has the potential to cause nosocomial infection.

Keywords: Neonates, Pathogenic microorganisms, Intensive care unit.

Résumé

Le progrès dans le soin et le traitement des néo-nataux avait contribué à leur survie améliorée. L'infection nosocomiale demeure un problème important dans les centres de soins intensifs. Les salles d'hôpital avaient été témoignées (d'agir) comme des réservoirs de microorganismes pathogènes associés à l'infection. Pour évaluer la prévalence des organismes pathogènes dans l'environnement du centre néonatal, 92 tampons furent, par occurrence, accumulés de couches, couveuses et diverses installations dans le centre, et furent cultivés sur la gélose de sang et (la gélose) de plaque MacConkey. La contamination d'air fut découverte en exposant les mêmes types de plages de culture pour 3 heures dans les endroits variés du centre. Après 48 heures d'incubation, les isolats furent, biochimiquement identifiés.

Il y a une congestion jalonnée dans le centre. Quatre-vingt-onze pour cent de tampons rapportèrent une croissance, d'avec staphylocoque négatif coagulase, étant l'organisme (44%) prédominant, suivi par l'espece de bacilli (20%), E.coli (colique) (12.5%), et Klebsiella (8.5%). L' espece de Pseudomonas (3.6%) et les moisissures (3.6%). Les plaques de sédimentation avaient des calculs de colonie de 10-100 par plaque et a majorité des cultures furent des cultures polymicrobiennes. La présence de grammes variés-les bacilli négatif, comprenant les pathogènes néo-nataux (comme E. coli et Pseudomonas) particulièrement sur l'installation de salle d'hôpital et la congestion dans la salle d'hôpital a du potentiel de causer l'infection nosocomiale.

Introduction

Neonates are at high risk of infection since their immune system is not well developed. These infections are a leading cause of morbidity and mortality in the neonates and may either be endogenous or exogenous. In Korle Bu Teaching Hospital, Enterobacter species were found to be the leading cause of bacteremia in neonates. Different types of microorganisms had been reported as important cause of bacteremia from other African countries, for examples in Nigeria, apart from Gram-negative organisms, Staphylococcus aureus is a common cause of bacteremia in neonates. Although improvement in the care and treatment of neonates had contributed to increased survival of premature and sick neonates, nosocomial infections are still important problems in intensive care units. Nursing neonates in the intensive care unit of the hospital is to provide them with protective barrier isolation in a hygienic and relatively bacteriologically safe environment. Unfortunately, this condition is not always satisfied. It had been shown that reducing overcrowding and providing enough nurses could result in a reduction of the rates of colonization and infection. Hospitals provided a reservoir of various types of microorganisms some of them may be multiply resistant to antibiotics, and the selective pressure of high antimicrobial use in hospitals, therefore makes the environment a repository for these resistant strains. Comprehensive cleaning of the hospital environment in addition to other measures could remove most of these organisms and disrupt the chain of infection. An environmental study to determine the types of microorganisms in the hospital wards had never been reported from Korle Bu Teaching Hospital.

This study assesses the prevalence of pathogenic microorganisms in the environment of the neonatal intensive care unit.

Material and Methods

The study was conducted at Korle Bu Teaching Hospital neonatal intensive care unit. The unit is made up of 4 rooms (all of which open onto a corridor). These rooms are highly congested, with cots arranged in such way that they are touching each other, making it difficult for staff to move around easily to perform procedures for the babies. One room is set-aside for infected babies. There were 11 incubators, 33 cots, 2 radiant heaters, 1-phototherapy equipments, 3 suction machines, 8 sinks, and 3 trolleys.

There are usually 2 or 3 nurses for each eight hours shift (with one sister as supervisor). A medical team comprising one Consultant, three Residents and three house officers covers the unit during the day while one house officer does so at night. Neonatal occupancy rate is 50-60 babies at any one time (more than 100%, since several cots and incubators have 2 babies each). Protective clothing such as gowns, mask, caps etc is not always available for attending staff and mothers to change into, before handling babies.

Samples

As shown on Table 1, 92 random samples were taken from equipments, incubators, cots and some areas of the unit. Sterile swabs dipped in nutrient broth were used, one for each equipment by rolling the swab on the surfaces. The swabs were immediately inoculated on blood agar (BA) and MacConkey agar (Mac) and the inoculum was streaked to get discrete colonies. Measurement of air contamination in the unit was carried out by sedimentation method, using BA and Mac plates. Open agar plates were exposed for 3 hours in various areas of the unit.

All plates were incubated at 37°C for 2 days, after which they
were examined for colony types. Bacteria isolates were identified by colony characteristics, Gram stain and standard biochemical reactions. Sensitivity of strains of *Pseudomonas aeruginosa* from the suction tube outlet was performed using the disc diffusion method.

**Results**

Culture yielded growth in 91% (84) of 92 swabs samples taken from different areas in the intensive care unit. Coagulase negative *Staphylococci* were the most predominant organism followed by *Bacillus* species. The prevalence of microorganisms were *Staphylococci* - 74 (44%), *Bacillus* - 34 (20%), *Escherichia coli* - 21 (12.5%), *Klebsiella* - 14 (8.3%), *Pseudomonas aeruginosa* - 6 (3.6%), and *Molds* - 6 (3.6%). The rest is made up of *non-haemolytic Streptococci*, *Candida*, *Diphtheroids*, and other Gram-negative bacilli (total of 8.4%) as shown in the table. Out of the 167 isolates, there were 22 monobacteria cultures (13%) and the rest were polymicrobial cultures on BA and Mac. The commonest monobacteria species was *coagulase-negative Staphylococci*. Sensitivity test on isolates of *Pseudomonas aeruginosa* from the suction tube outlet showed resistance to gentamicin, amikacin, and ceftoxime.

Sedimentation plates exposed to intensive care unit air revealed colony counts from 10-100 per plate, with growth of three (3) or more different bacterial species on eleven (73%) of 15 plates. Five plates had moulds in addition to bacteria. Microorganisms isolated with multiple bacteria in 87% of these cultures. This signified gross contamination of surfaces with organisms that had the potential to act as sources of infection. Proper cleaning of dirt and dust from equipment, floor and surfaces will improve the hygiene of the ward's environmental.

*Salmonella* and *Acinetobacter* had been reported as causing nosocomial infection and the source was traced to suction machines, so the isolation of *Pseudomonas aeruginosa* from a suction machine in the unit, had the potential for causing nosocomial infection. Other Gram-negative bacteria had also been reported as causative agents of infection in neonates, examples are *Enterobacter cloacae* associated with disinfected thermometers and *Klebsiella pneumoniae* in a cockroach infested unit.

Overcrowding and understaffing (especially a low nurse-to-patient ratio) had been known to set the scenario for breaches in aseptic protocols and associated with it may be, an increase in nosocomial infection. When there is sufficient number of nurses in a ward, cohorting of infants and staff may decrease transmission of infection but it is not a substitute for performing procedures according to properly set up guidelines. There must be enough space between cots (about 1-1.5m) so that hospital personnel can move about easily in the ward. Keeping two babies in one cot, leads to increase in cross-contamination. An earlier reported nursery outbreak of *Salmonella* infection in the neonatal intensive care unit in Ghana was also associated with overcrowding. It is clear that conditions in the intensive care unit had not changed very much. There is therefore the need for dedicated and concerted effort to look at the design of the intensive care unit and also it's admission and discharge policy, so as to minimize overcrowding.

During the frequent feeding and other treatment procedures that lead to direct contact with babies, microorganisms from clothing, footwear, skin scales and hair can be transferred to the babies. All persons who enter the unit should change into fresh gowns to prevent cross infection of susceptible infants. As has been suggested by Chandra sheker et al from India, environmental hygiene could be improved by removal of dust and dirt using vacuum cleaners with air exhausts and scrubbing of equipment and inanimate objects will provide a really clean environment. It will be expensive to install laminar flow ventilation, but a marked reduction in bacteria content of environmental air could be achieved by the use of proper environmental cleaning guidelines.

**Table 1 Microorganisms isolated from equipment and environment of NICU**

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**Microorganisms isolated**

- *Non-Haem Strep* - *Non-Haemolytic Streptococci*
- *Coag. Neg Staph* - *Coagulase-negative Staphylococci*
- *Kleb* - *Klebsiella*
- *Pse* - *Pseudomonas aeruginosa*
- *Diph* - *Diphtheroids*
- Other Gnr. - Other Gram-negative rods

**Discussion**

Microorganisms like *Staphylococcus aureus*, *Klebsiella species*, *Pseudomonas aeruginosa*, and *Salmonella* species responsible for nosocomial infections are constantly present in the hospital environment. In this environmental study, coagulase-negative *Staphylococcus* is the predominant organism isolated from 44% of swabs, followed by *Bacillus* species from 20% of swabs. *Klebsiella* species, *E. coli* and *Pseudomonas aeruginosa* were the pathogenic Gram-negative organisms isolated from ward equipment, cots and environment. Ninety-one percent of swabs yielded growth, in Ghana was also associated with overcrowding. It is clear that conditions in the intensive care unit had not changed very much. Therefore the need for dedicated and concerted effort to look at the design of the intensive care unit and also it's admission and discharge policy, so as to minimize overcrowding.
The results of this study show that, the intensive care unit is congested, there is overcrowding in cots and it has an environment which contains equipment that can potentially transmit serious infection to babies. To reduce this potential, more space must be provided between cots and there must be only one baby per cot / incubator. There must be a thorough review of all existing guidelines for infection prevention and control procedures such as hand washing, sterilization, disinfection, cleaning and decontamination and also all aseptic techniques in the intensive care unit. Where necessary re-training should be provided for staff. Finally, there must be strict adherence to aseptic protocols13 these must be enforced by the institution of adequate supervision of staff.

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References