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 bacili 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 progrèss dans le soin et le traitement des néo-natals avait contribué à leur survivance angmentée.

L'infection nosocomique demeure un problème important dans les centres de soins intensifs. Les salles d'hôpital avaient été témoignées (d'agir) comme des réservoirs de microorganisms pathogéniques associés à l'infection. Pour évaluer la prévalence des organismes pathogéniques dans l'environnement du center néonatal, 92 tampons furent, par occurrencœ, accumulés de couches, couveuses et diverses installations dans le center, 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 plaques de culture pour 3 heures dans les endroits variés du center. Après 48 heures d'incubation, les isolés furent, biochimiquement identifiés.

Il y a une congestion jalonnée dans le center. Quatre-vingt-onze pour cent de tampons rapportèrent une croissancœ, d'avec staphylocoque négatif coagulum, 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 polymicrobiques. La présence de grammes variés-les bacilli négatifs, comprenant les pathogènes néo-natals (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 nosocomique.

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 bacteraemia in neonates[1]. Different types of microorganisms had been reported as important cause of bacteraemia from other African countries, for examples in Nigeria, apart from Gram-negative organisms, *Staphylococcus aureus* is a common cause of bacteraemia in neonates[2]. 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[3]. 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[4]. Hospitals provided a reservoir of various types of microorganisms some of them may be multiply resistant to antibiotics[5], 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 microoganisms 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, 2-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

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were examined for colony types. Bacteria isolates were identified by colony characteristics, Gram stain and standard biochemical reactions[6]. 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 *Moulds*-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 polybacteria 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 cefotaxime.

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[7] and *Acinetobacter*[8] 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[9] and *Klebsiella pneumoniae* in a cockroach infested unit[10].

Overcrowding and understaffing (especially a low nurse-to-patient ratio) had been known to set the scenario for breaches in aseptic protocols[11,12] 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[13] 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.

Table 1 Microorganisms isolated from equipment and environment of NICU

Areas	No.	No. of swab samples	Microorganisms isolated: Non Haem Streps.	Coag. Neg. Staph.	Bacillus Species	E. Coli	Kleb.	Pseu.	Other Gnr.	Dipth.	Candida	Moulds
Cots	33	33	3	33	15	9	7		2	2	1	
Incubators												
Outside	11	11	-	11	5	2	1	1				2
Inside	11	8		4	-	-	2					1
Suction Tubes												
Outlet	3	3		1	1	3	2	3				
Suction Machine	3	1				1						
Phototherapy	2	2		2	1	1						
Table Tops	4	4		3	1	1						
Sink Tap Handles	8	4		4	2						1	
Sink Outlets	8	4			1	1		1				
Feeding Table	1	1		1	1	1		1				
Floor Corners	10	5		3	1	2	2					
Trolleys	3	3		3	1							3
Locker Floors	3	3		5	3					2		
Oxygen Masks	8	8	1	4	1							
Radiant Heater	2	2										
Total	110	92	4	74	33	21	14	6	3	4	2	6

Non-haem strep - *Non Haemolytic Streptococcus*
Coag neg Staph - *Coagulase negative Staphylococcus*
Kleb - *Klebsiella*
Pseu - *Pseudomonas aeruginosa*
Dipth - *Diphtheroids*
Other GNR - *Other Gram-negative rods*

were coagulase-negative *Staphylococcus, Bacillus species, E. coli* and *Klebsiella species.*

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,

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 Chandrashekar et al from India[14] 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.

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 protocols[15] these must be enforced by the institution of adequate supervision of staff.

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References

1. Anyebuno M and Newman M.: Common causes of neonatal bacteraemia in Accra, Ghana East Afri Med J 1995, 72; 805-808.

2. Dawodu AH and Alausa OA.: Neonatal septicaemia in the tropics. Afr J Med Sci 1980; 9:1-6

3. Brodie SB, Sands KE, Gray JE, Parker RA, Goldmann DA, Davis RB and Richarson DK.: Occurence of nosocomial bloodstream infection in six neonatal intensive care units. Pediatr Infect Dis J 2000; 19:56-65

4. Halley RW and Bregman DA.: The role of understaffing and overcrowding in recurrent outbreaks of *Staphylococcal* infection in neonatal special-care unit. J Infect Dis 1982; 145:875-85

5. Haley RW, Cushion NB, M Tenover FC, Bannerman TL, Dryer D, Ross J, Sanchez PJ and Siegel JD.: Eradication of endemic Methicillin-resistant *Staphylococcus aureus* infection from a neonatal intensive care unit. J infect Dis 1995; 171:614-624

6. Barrow GI and Feltham RKA.: Editors in Cowan and Steel's Manual for the Identification of Medical bacteria 3rd Edition 1993. Cambridge University Press.

7. Gupta P, Talwar V, Revathi G and Kumar A.: Nosocomial *Salmonella bareilly* septicemia: A nursery outbreak. Indian Pediatr 1997; 34:144-147.

8. Pillay T, Pillay D G, Adhikari M, Pillay A and Sturm A W.: An outbreak of neonatal infection with *Acinetobacter* linked to contaminated suction catheters. J Hosp Infect 1999; 43:299-304

9. Van den Berg RWA, Claahsen HL, Niessen M, Muytjens HL, Liem K and Voss A.: *Enterobacter cloacae* outbreak in the NICU related to disinfected thermometers. J Hosp Infect 2000; 45:29-34.

10. Cotton MF, Wasserman E, Pieper CH, Theron DC, van Tubbergh D, Campbell G, Fang FC and Barnes J.: Invasive disease due to extended spectrum beta-lacatamase-producing *Klebsiella pneumoniae* in a neonatal unit: the possible role of cockroaches. J. Hosp Infect 2000; 44:13-17.

11. Kurlat I, Corral G, Oliveira F, Farinella G and Alvarez E.: Infection control strategies in a neonatal intensive care unit in Argentina. J Hosp Infect 1998; 40:149-154.

12. Archibald L K, Manning M L, Bell L M, Banerjee S and Jarvis W R: Patient density, nurse-to-patient ratio and nosocomial infection risk in a pediatric cardiac intensive care unit. Pediatr Infect. Dis J 1997; 16:1045-8

13. Newman M J.: Multiple-resistant *Salmonella* group G outbreak in a neonatal intensive care unit. West Afri J Med 1996; 15:165-169

14. Chandrashekar MR, Rathish KC and Nagesha CN: Reservoirs of Nosocomial Pathogens in Neonatal Intensive Care Unit. J Indian Med. Assoc. 1997; 95:72-77

15. Pawa A K, Ramji S, Prakash K and Thirupuram S.: Neonatal nosocomial infection: profile and risk factors. Indian Pediatr 1997; 34:297-302