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Endotracheal Aspirate Cultures in Predicting Sepsis in Ventilated Neonates

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Abstract : Nosocomial infections are the most common complications encountered in the neonatal intensive care unit (NICU). They are associated with high mortality and prolonged duration of hospitalization in the survivors, contributing to an increased cost of health care. In this article, we review the literature on the value of routine endotracheal aspirate cultures for the prediction of neonatal sepsis and provide guidelines to prevent nosocomial infections. Upon reviewing the literature it appears that the practice of routine cultures of endotracheal aspirate and cultures obtained from multiple body sites is an expensive proposition with low yield. The sensitivity of this test is at best 50% and all studies report a very low positive predictive value. The specificity of this test is 80%, hence its role is mainly limited to identifying infants who are at low risk for sepsis. As we do not have any reliable test for early diagnosis of neontal sepsis and also to identify infants at high risk for sepsis, our main emphasis should be towards preventing nosocomial infections. Guidelines for reducing nosocomial infections are described. **(Indian J Pediatr 1998; 65 : 79-84)**

Key words : *Nosocomial infection; Endotracheal aspirate; Neonatal sepsis*

During the last ten years, increasing number of hospitals are opening Neonatal Intensive Care Units (NICU) complete with assisted ventilation in India. Although survival of critically ill infants managed with assisted ventilation is increasing, a large number of complications are encountered. Among these, nosocomial infections are the most common. In spite of decades of experience with these problems, neonatologists are struggling to find best ways of early diagnosis of sepsis. In this article, we review the literature on the practical use of routine endotracheal (ET) aspirate cultures for the prediction of neonatal sepsis and also provide guidelines to prevent nosocomial infections in the NICU.

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PATTERNS OF TRACHEAL COLONIZATION

Sprunt *et al*[1] prospectively studied 223 neonates admitted for three or more days between 1971 and 1974. Cultures of oropharynx were taken twice weekly, beginning the first few days of life and continued until growth of normal flora was established. The pattern of colonization was divided into three groups, i.e. normal (alpha-streptococci predominately), low colony counts or no growth (< 10 CFU/ml) and high colony counts or abnormal growth. All infections occurred only in the group of infants with abnormal pharyngeal

colonization (18 infections in 115 abnormally colonized infants). With a single exception, the infecting organism showed the cultural characteristics of the colonizing organism. Hence they concluded that routine surveillance of oropharyngeal cultures helps identify infants at risk of infection and can also predict the infecting organism.

In a different study, Harris *et al*[2] prospectively studied the relationship between endotracheal intubation, respiratory tract bacterial colonization, systemic infection and antibiotic treatment in 54 critically ill neonates. Respiratory tract colonization was assessed from tracheal aspirate cultures obtained on intubation and daily thereafter. Systemic infection was monitored by blood cultures every three days. Infants were randomly assigned to a study group receiving antibiotics on intubation or a control group receiving antibiotics only on the basis of clinical or bacteriological findings suggesting infection. Colonization at intubation was five times more common in infants intubated 12 or more hours after birth than in infants intubated earlier. Subsequent colonization was twice as frequent in infants intubated longer than 72 hours. In the study group of infants initial cultures were sterile but subsequent cultures after discontinuation of antibiotics revealed colonization. Systemic infection occurred only in those infants who were initially or subsequently colonized. In 12 infants who had systemic infection ,the same organism was isolated from the tracheal aspirates. Hence the authors concluded that routine endotracheal aspirate cultures are useful because they can accurately predict the infecting organism if sepsis occurs.

ROUTINE CULTURES OF ET TUBE IN EARLY DETECTION OF SEPSIS

Isaacs *et al*[3] studied surveillance of ET colonization and late onset septicemia in neonates. It was a prospective study conducted over a period of 18 months. Routine surveillance consisted of ET aspirate cultures thrice weekly. Blood cultures were obtained when sepsis was clinically suspected. Of the 786 infants admitted in the 18-month period there were 45 episodes of proven sepsis. 18 episodes occurred in the first 48 hours of life and 27 neonates had late onset. Preceding ET aspirate cultures were available from 26 of the 27 infants who had late onset sepsis. Colonization with the same organism as the one causing sepsis could be documented only in 10 cases. Another interesting finding in this study was that *Pseudomonas aeroginosa* frequently colonized babies over the first eight months of the study but subsequently, virtually ceased to colonize. But the incidence of pseudomonas sepsis was the same throughout the whole study period. The authors concluded that the findings do not support the utility of routine surveillance cultures in predicting late onset sepsis. They also cast doubt on the value of eliminating colonizing organisms as a means of infection control.

Slagel *et al*[4] studied the role of routine ET aspirate cultures for prediction of sepsis in ventilated infants. Serial cultures of ET aspirate were carried out in 94 neonates who were intubated and ventilated for more than one week. More than 90% of the cultures obtained in the first week were sterile. Thereafter, colonisation with mixed Gram positive flora emerged followed by growth of Gram negative bacilli. Of the 26

cases of sepsis, only five (19%) neonates had the same organism isolated from both ET aspirate and blood culture. Other markers of infection such as ET aspirate, WBC count and changes in bacterial flora were not useful in predicting systemic infection. The authors concluded that routine surveillance cultures of ET aspirate in ventilated infants are not helpful in predicting the pathogens that are isolated from blood during the episodes of sepsis.

The only study in the recent literature for the support of the practice of routine ET cultures was by Lau *et al*[5]. They ascertained the sensitivity of daily tracheal aspirates in predicting neonatal bacteremia. Of the 354 intubated infants there were 48 episodes of proven sepsis over a period of four years. ET aspirate cultures were obtained daily and blood cultures were obtained when sepsis was clinically suspected. Of the 48 infants with proven sepsis, 14 infants had positive blood culture on the first day of life and 34 infants had bacteremia beyond the first day. The overall sensitivity of tracheal cultures in predicting results of blood cultures was 81%. The specificity was 64% and positive predictive value 0.26. They concluded that the role of daily ET aspirate cultures is limited to providing early information regarding potential pathogens when sepsis occurs rather than to identify infants who are likely to become septic. The difference in the results of this study from the previous two discussed is due to the fact that more than 90% of the infants in this study became septic within the first 10 days of life and were stable premature infants with no other invasive procedures. Thus the authors concluded that the respiratory tract was the primary route by which these ventilated neonates became infected.

RELATION OF BODY SURFACE CULTURES TO NEONATAL SEPSIS

Evens *et al*[6] did an extensive study over a three year period to assess the sensitivity, specificity and positive predictive value of various body surface cultures. They analyzed 24,584 cultures obtained from 3,371 infants from various sites such as ear canal, ET aspirate, axilla, umbilicus, groin, rectum etc. The frequency of sepsis was 3.3% among infants admitted to NICU. The sensitivity, specificity and positive predictive value of surface cultures was 56%, 82% and 7.5% respectively. From this data it could be concluded that surface cultures are of limited value in predicting the etiology of sepsis in neonates.

DISCUSSION

Bacterial infections continue to be a major problem in NICU[7]. They are associated with increased mortality rates and prolonged duration of hospitalization in survivors, contributing to an increased cost of neonatal health care. The prevention and early diagnosis of infections are thus major challenges. Infections acquired in the nursery are unique in several aspects. First, during birth and subsequently in the nursery, infants are experiencing their initial encounter with microbes. Second, the immunological immaturity of newborns, especially those born prematurely and the frequency of invasive procedures in NICU make them unusually susceptible to sepsis. In an effort to anticipate septic events and guide antimicrobial therapy, many NICUs attempt to identify potential pathogens before infections occur by routine culturing of a variety of body surface sites. This practice is based on the concept that coloniza-

tion of the infants precedes infection[8] and the identification of a potential pathogen in the colonizing surface flora is predictive of those that later cause invasive disease[9].

Upon reviewing the literature, we conclude that the practice of routine surveillance of ET aspirate cultures and culture obtained from various body surfaces for the prediction of neonatal sepsis is an expensive proposition and a futile exercise. The sensitivity at best is about 50% and all studies report a very low positive predictive value. Rather than helping in predicting which infants would become septic and what the infecting organism would be, they are useful only in identifying infants at low risk for infection. All studies uniformly report a high specificity of 80% hence a negative/sterile ET aspirate culture strongly suggests that the infant is at a low risk of developing sepsis. The clinician should understand the difference between colonization and infection. The mere presence of organisms on body surface (colonization) is not an indication for antibiotic usage. The signs and symptoms of sepsis are varied and other than a positive blood culture, we do not have any reliable and quick laboratory test for its diagnosis. Hence one should have a very high index of suspicion and strive towards decreasing the incidence of neonatal sepsis.

STRATEGIES TO REDUCE NOSOCOMIAL INFECTIONS

Handwashing before and after each patient contact remains the single most important practice in the control of infection. Centers For Disease Control (CDC) recommends universal precautions for all patients to protect health care workers from infectious body fluids[10]. An alternate system to prevent infections is the use of body substance isolation[11]. This includes the following components : gloves for anticipated contact with blood, body fluids, mucous membranes and non intact skin; hand washing for all other types of patient contact; gowns and other barriers such as masks or goggles, when soiling from secretions or blood is likely.

NURSERY EQUIPMENT

As often as possible disposable equipment should be used in the NICU. The intravenous tubing should be changed every day. Strict sterile precautions should be used while changing the tubing. The circuits for the ventilator should be replaced every week and the humidifier should be replaced every week or more often if the water level decreases. The suction catheters should be replaced every day.

NURSERY ATTIRE

Nursing personnel must wear a clean short sleeve scrub suit. A closed long sleeved lab coat must be worn upon leaving the nursery and removed upon re-entrance. Parents, visitors and other health care personnel who will have contact with infants must put on a cover gown to enter the patient care area. Cover gowns must be changed when re-entering the nursery. No rings, watches, bracelets or dangling ear rings are to be worn. Long hair must be secured so that it does not come into contact with infant or nursery equipment.

NURSERY DESIGN AND ENVIRONMENT

Adequate distance between bassinet and

equipment avoids crowding and reduces the risk of accidental contamination. The floor space recommended per bassinet increases with intensity of care, from 20-25 sq.ft per bassinet for Level I nursery, 30-50 sq.ft for Level II nursery, 80-100 sq.ft per incubator for Level III nurseries[13]. All nursery entrances should have foot operated sinks and soap dispenser with atleast one additional sink on each wall to allow appropriate hand washing. Sinks must be thoroughly scrubbed every day or more often as needed. All horizontal surfaces should be damp dusted daily. Floors should be cleaned each morning and removal of dirty linen should be done frequently throughout the day.

ISOLATION

Neonates with specific infectious diseases should be isolated. It is not necessary to have a separate isolation room in the NICU but isolation can be achieved by adequate physical separation. Only neonates with infections spread by airborne transmission such as varicella, for which distance and partial barriers may be inadequate control measures, need to be in separate rooms. The table below shows infections requiring isolation precautions[12].

Category of Isolation	*Disease/Microorganism*
Strict	Varicella
Contact	RSV congenital Rubella, gonococcal. conjunctivitis, herpes simplex, staphylococcal impetigo and wound infection
Enteric	Gastoenteritis, enteroviral infections (aseptic meningitis etc), necrotising enterocolitis.
Drainage/Secretions	Conjunctivitis (non-gonococcal and non chemical), wound infection non staphylococcal), CMV infection.

EMPLOYEE HEALTH

A hospital employee health program is an integral aspect of infection control. The program should include written policies and procedures for assessing the health of personnel working in the nursery and delivery rooms, restricting contact with newborns when indicated, maintaining immunization and other health records concerning susceptibility to communicable diseases and reporting any potentially transmissible illness. Personnel should have an initial medical evaluation on employment and subsequently evaluated for work-related illnesses and exposure to infectious disease.

PARENTS/SIBLING VISITS

Parents and family members must be encouraged to visit the infant. Guidelines for visits should be established to maximise opportunities for visiting and to minimise the nosocomial spread of pathogens brought into the hospital by visitors. Before the visit, a nurse or physician should interview the parent at a site outside the nursery to assess the current health status of the visitor. No child with fever or symptoms of an acute illness should be allowed to visit. Siblings who have recently been exposed

to a known communicable diseases should not be allowed to visit. Visitors should carefully wash their hands and wear gowns before patient contact. Any toy or clothing brought by the parents must be sterilized before use in the NICU.

In conclusion, as ET aspirates have a low sensitivity and positive predictive value for prediction of sepsis in ventilated neonates and routine surveillance cultures from multiple body sites is an exercise in futility, emphasis should be placed on following the above mentioned basic guidelines and hopefully decrease the incidence of nosocomial infections.

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