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Prevention of health Care Associated Infections in neonates: room for improvement

Learning Objectives:

- Explain risk factors facilitating transmission of infectious agents in NICU
- Discuss epidemiology of infectious diseases in NICU
- Discuss Health Care Associated Infections in NICU
- Explain preventive strategies for Health Care Associated infections in NICU

Introduction

- Healthcare-associated infections (HCAIs) cause substantial harm to hospitalized neonates.
- They have considerable health and economic consequences, including
  - increased morbidity and mortality
  - prolonged length of stay (LOS)
  - & increased medical costs

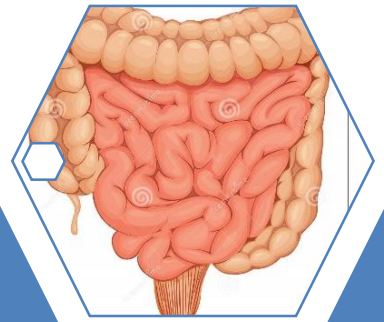
In North America, it is estimated that each episode of sepsis prolongs the duration of a neonate's hospital stay by two weeks, resulting in an incremental cost of US$25,000 per episode. In a recent study of very-low-birthweight (VLBW) infants, nosocomial BSIs were found to increase hospitalization costs by 26% for infants weighing 401–750 g and by 80% for infants weighing 1251–1500 g. This study also showed that the LOS increased by four to seven days in all VLBW categories with nosocomial bloodstream infections.[2] Infants admitted to

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Risk Factors facilitating transmission of infectious agents

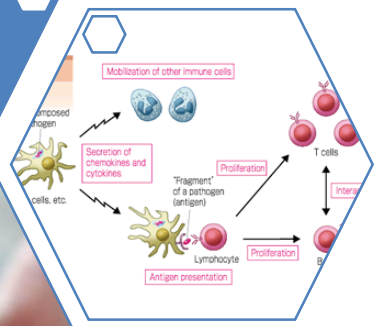


Preterm neonates – low birth weight &Intestinal disorders with proliferation of a pathogenic micro flora



Lack of effective skin barrier

Immature or ineffective immune system





frequent use of broad-spectrum antimicrobial drugs



Parenteral nutrition



Systematic and long terms use of invasive devices



Acid inhibitors and steroids

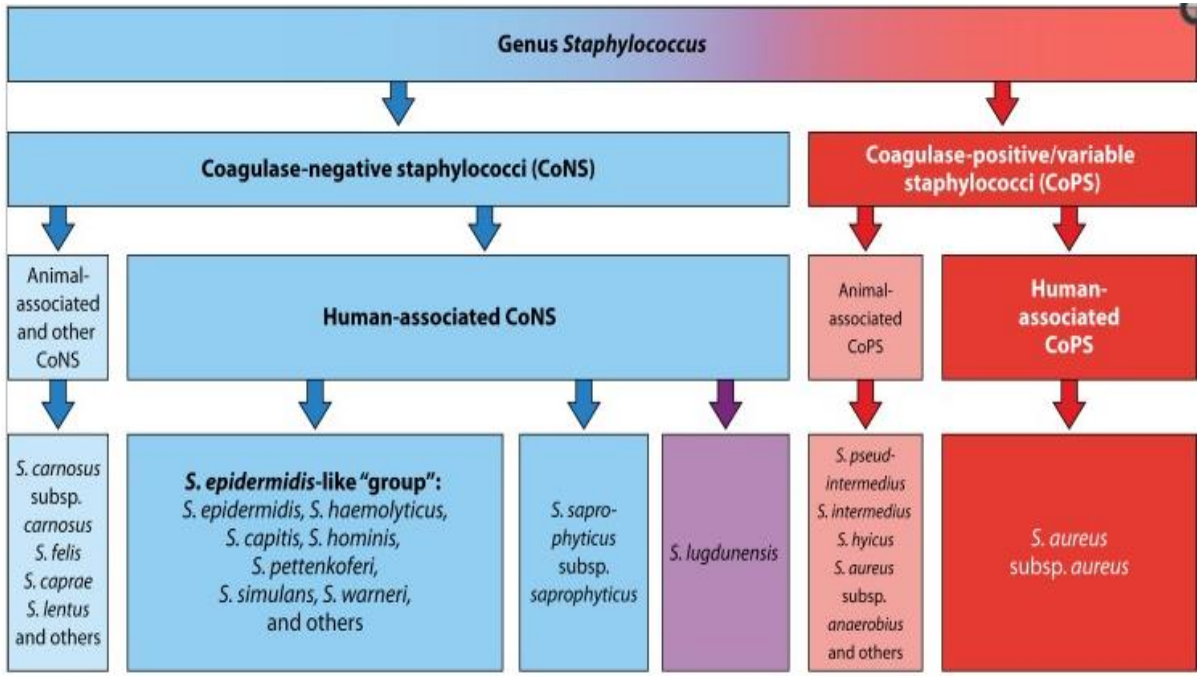


Nursing incubators may delay or impair normal intestinal colonization

Epidemiology

In 1999, the Pediatric Prevention Network national point prevalence survey in the USA found that 11.4% of infants in NICUs had an HCAI.[6] The most common HCAIs in this survey were BSIs (53% of HCAIs, overall prevalence 7.4%) and respiratory infections (13% of HCAIs, prevalence 1.8%). Pneumonia rates reported by others show considerable variation (7–32% of HCAIs), perhaps reflecting differences in the definitions used. Gram-positive pathogens account for up to 70% of cases of neonatal sepsis, with sepsis due to Gram-negative organisms accounting for 15–20% of infections. A study conducted between 2006 and 2008 reported the frequency of pathogens causing BSIs [coagulase-negative staphylococci (CoNS), 28%; *Staphylococcus aureus*, 19%; *Candida* spp., 13%] and the frequency of pathogens causing ventilator-associated pneumonia (VAP; *Pseudomonas aeruginosa*, 16%; *S. aureus*, 15%; *Klebsiella* spp., 14%).[7]

CoNS are the main pathogens involved in late-onset neonatal sepsis

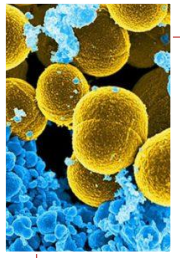


Clinical and epidemiological schema of staphylococcal species, based on the categorization of coagulase as a major virulence factor and its resulting impact on human health.

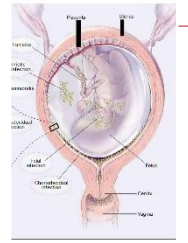
Coagulase Negative Staphylococci (CoNS) transmission



Within the first week of life, neonates are colonized rapidly by micro-organisms from the hospital environment (risk increases substantially with the use of CVS, mechanical ventilation, parenteral nutrition and exposure to other skin or invasive mucosa breeching procedures)



CoNS are common inhabitants of the skin and mucous membranes



Although a small proportion of neonates acquire CoNS by vertical transmission, acquisition is primarily horizontal by cross-transmission



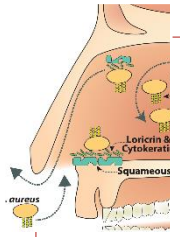
Consequently, infants admitted to a hospital acquire most of their micro-organisms from the hospital environment, their parents and staff



Transmission via the hands of hospital staff can lead to endemic strains circulating for extended periods.



colonization of the skin and of indwelling catheters are important sources of sepsis



Recent studies have suggested that epithelial loci other than the skin, such as the nares, may be important access points of infection.



Antibiotic resistance in skin-residing strains has been found to be low at birth, but increases rapidly during the first week of hospitalization. Therefore, selective pressure as a result of perinatal antibiotic exposure is a major factor influencing the spectrum and antibiotic resistance pattern of microorganisms isolated from neonates

Central-line-associated bloodstream infection

The problem	The solution
1. Central line infections are generally a result of poor insertion technique or failures in the hygiene protocol at the time of catheter placement and during ongoing care at the catheter site. 2. Data suggest that the hub is the common source of contamination and subsequent infection. 3. The risk of CLABSI is related to the duration of catheter use and the frequency of catheter manipulation.	Reducing CLABSI should be based on implementation of clinical practice guidelines for the insertion and maintenance of catheters. Improvement consists of five care steps: 1. maximal barrier precautions upon insertion 2. chlorhexidine skin antisepsis 3. optimal catheter site selection; optimal catheter site selection 4. daily review of the need for the line 5. prompt removal of unnecessary lines.

Several institutions have published the results of multi-faceted interventions to reduce CLABSI rates. A NICU centre conducted an educational programme aimed at reinforcing hand hygiene, and developed and implemented a checklist for care of the catheter hub. This led to a decrease in the CLABSI rate from 23 to 12 infections per 1000 catheter-days [odds ratio (OR) 0.33; 95% CI 0.20–0.90], and a decrease in the umbilical CLABSI rate from 15 to 5 infections per 1000 catheter-days (OR 0.47; 95% CI 0.17–0.91).[21] A recent literature review[20] showed that bundle implementations are effective for the reduction of CLABSI in NICUs.

Health Care Associated Pneumonia

The problem	The solution
• prolonged duration of mechanical Ventilation • severe underlying cardiopulmonary disease • previous thoraco-abdominal surgery. • aspiration of bacteria from the oropharynx or the gastrointestinal tract. • Uncuffed endotracheal tubes facilitate access of micro-organisms to the lower respiratory tract. • Neonates with bronchopulmonary dysplasia and those who have impaired swallowing mechanisms are at increased risk of aspiration.	• early extubation • strategies and switching to non-invasive respiratory support. • a recent study suggested that tracheal colonization by oropharyngeal bacteria was less common among neonates with mechanical ventilation when they are placed in a lateral position compared with a supine position • keeping the endotracheal tube and the ventilator circuit in a horizontal position may reduce tracking of oropharyngeal secretions into the lower respiratory tract • General concepts of prevention include: ✓ staff education and training; ✓ microbiological surveillance ✓ prevention of cross transmission (improving hand hygiene) ✓ early removal of mechanical ventilation

Healthcare-associated pneumonia (HAP) represents 6.8–32.3% of HCAIs in NICUs, and is the second most common hospital-acquired infection in critically ill neonates.[22] Rates of VAP vary between 0.7 and 2.2 per 1000 ventilator-days.[23] However, as for CLABSI, rates varied between NICUs depending on birth weight and gestational age. Indeed, the risk of VAP is significantly higher below 28 weeks of gestation.

Invasive fungal infections: candidaemia

The problem	The solution
• Previous mucosal and skin colonization are the main risk factors for IFIs • Neonatal colonization with Candida spp. is • secondary to either maternal transmission or nosocomial acquisition via healthcare workers' hands in the NICU • Several risk factors are associated with IFIs: ✓ Very low birth weight ✓ use of central lines ✓ Intubation ✓ Parenteral nutrition ✓ broad-spectrum antibiotic administration ✓ Prolonged hospitalization ✓ abdominal surgery ✓ exposure to H2 blockers ✓ and previous colonization	• Prevention is based on fluconazole prophylaxis.

Invasive fungal infections (IFIs) represent a leading cause of sepsis in VLBW infants, and result in high rates of morbidity and mortality.[28] IFIs are the third leading cause of late-onset sepsis in VLBW infants. The estimated incidence of IFIs is 1.6–3.0% in VLBW infants and up to 15–20% in extremely-low-birthweight

Skin & soft tissue infections

- Skin and soft tissue infections are commonly observed in NICUs as neonates have fragile skin that is easily traumatized.
- Cellulitis, abscesses and skin abrasion are frequently noted at sites of percutaneous puncture, in the nappy area or bandage area, and at surgical incision sites.
- S. aureus is the most common micro-organism responsible for skin and soft tissue infections in NICUs.

Miscellaneous : *Viral infections*

The great majority of published articles have focused on bacterial and fungal infections. Neonates are also exposed to viral infection although this is largely unexplored.

The problem	The solution
• as neonates are in contact not only with healthcare workers, but also with their families, sometimes including brothers and sisters. • The most frequently reported viruses include rotavirus, respiratory syncytial virus, enterovirus, influenza and adenovirus	• improved hand hygiene • patient screening • use of isolation precautions (gown, gloves, mask) • isolation and cohorting with dedicated staff when the situation is not controlled.

A recent prospective study was conducted over one year to determine the frequency of respiratory viral infections among infants who were evaluated for late-onset sepsis in NICUs at Parkland Memorial Hospital, Dallas, TX, USA.[35] During the 13-month study, eight (6%) of 135 cases of sepsis in 100 infants were positive for respiratory viruses by polymerase chain reaction (PCR) (two for enterovirus/rhinovirus, two for rhinovirus, two for coronaviruses and two for parainfluenza-3 virus). Bennett *et al*. conducted a prospective survey using multiplex PCR testing to detect respiratory viruses among infants in two NICUs over a one-year period, and found that 52% of infants aged <33 weeks of gestation tested positively for respiratory virus at least once during their birth hospitalization.[36] Viruses detected were parainfluenza virus, respiratory syncytial virus, enterovirus/rhinovirus and influenza B.

Miscellaneous : *Incubators and toys*

Neonates are exposed to a number of fomites during their hospital stay, including toys and incubators

During a three-day period in a longitudinal prospective study, Raginel *et al.* observed every neonate placed in a single incubator.[38] Seventy-six percent of incubators contained at least one item that was not strictly required for nursing procedures. This study analysed 33 toys; 24 (73%) scored the maximum score for fluffiness (4 out of 4), and only 10 had labels showing cleaning advice from the manufacturers. Without any records about the cleaning and disinfection of toys brought into hospital, the authors observed that the parents had been given varied advice about how to clean the toys at home before putting them in the incubator. In particular, two of the soft toys sampled were found to be contaminated with *Pseudomonas oryzihabitans*. In another study conducted in Belgium, 23% of the swabbed toys were found to be contaminated with various pathogens, and 9% were still contaminated despite washing at 60°C.[39]

Although there is little evidence that bacteria found on toys are a direct cause of infection in neonates, Hanrahan and Lofgren found that eliminating toys in the NICU decreased nosocomial infection rates from 4.60 to 1.99 per 1000 patient-days over a six-month period.[40]

From the authors' personal experience from Necker University Hospital, Paris (unpublished data), incubators can be the source of colonization and, in rare cases, of infection by environmental pathogens. Various case reports have described BSIs or cutaneous infections in neonates due to *Ralstonia pickettii*[41] or *Aspergillus fumigatus*.[42] The same organisms were detected in samples from the neonates and the humidity chambers, suggesting that the incubator environment may be a source of infection in NICUs.

Miscellaneous : *Necrotizing enterocolitis*

- Necrotizing enterocolitis is one of the most severe gastrointestinal diseases in preterm neonates.
- Its pathogenesis is still poorly understood, but risk factors include
  - ✓ Ischaemia
  - ✓ altered gut microbiota
  - ✓ immaturity and type of enteral feeding.
- Presumably initial antibiotics may alter the gut microbiota, and reducing the overall antibiotic exposure of infants may reduce the risk of necrotizing enterocolitis

Strategies for the prevention of health Care Associated Infections

Improving hand hygiene is one of the most important interventions and should be a primary goal of any NICU. Successful interventions include education, monitoring, performance feedback, reminders and motivation of healthcare workers.

Prevention of CVC infection is based firstly on reducing the duration of catheterization and avoiding unnecessary use of catheters. Precautions during insertion and management of catheters are also crucial.

Unnecessary and prolonged empirical broad-spectrum antibiotic therapy selects resistant bacteria and increases the risk of invasive fungal infections. Developing appropriate strategies to limit the use of antibiotics is the most effective way to reduce nosocomial infections due to multi-drug-resistant organisms

Successful management and prevention of outbreaks requires sufficient facilities for cohorting colonized and infected infants. The spread of multi-drug-resistant organisms is exacerbated by inadequate spacing between cots, high occupancy rates and low nurse infant ratios.

Optimal staffing ratios for neonatal nurses appear to reduce HCAIs and mortality in neonates

As environmental contamination is an important reservoir of antibiotic-selected organisms, it seems important to reduce environmental contamination by using equipment dedicated to each infant and enhancing routine cleaning.

Reference

- AJIC journal for Prevention of healthcare-associated infections in neonates: room for improvement
- APIC text book of Infection Control and Epidemiology