The Management of Nosocomial Infection on Intensive Care Unit

Essay

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List of abbreviations

- **AIDS** : Acquired Immune Deficiency Syndrome
- **ARDS** : Acute Respiratory Distress Syndrom
- **ASA** : American Society of Anesthesiologists
- **BAL** : Broncho Alveor Lavag
- **BSI** : Blood Stream Infection
- **CDC** : Centers of Disease Control
- **CFU** : Colony Forming Unit
- **CLABSI** : Central Line Associated Blood Stream Infection
- **CNS** : Coagulase-negative Staphylococcus
- **CoNS** : coagulase-negative staphylococci
- **CVCs** : Central venous catheter
- **DIC** : Disseminated Intravascular Coagulapathy
- **DVT** : Deep Vein Thrombosis
- **EID** : Emerging Infectious Diseases
- **EPIC** : European Prevalence of the in Intensive Care
- **ESBLs** : Extended-Spectrum β-Lactamases
- **GISA** : glycopeptide-intermediate Staphylococcus aureus
- **GIT** : Gastro - Intestinal Tract
- **HIV** : Human immunodeficiency virus
- **HME** : Heated modifier exchanges
- **HOB** : Head-of-Bed
- **HSV** : Herpes simplex virus
- **MDR** : Multidrug-resistant

- **MIC**: minimum inhibitory concentration
- **MRSA** : Methicillin-resistant Staphylococcus aureus
- **MS**: medical/surgical
- **NIs** : Nosocomial Infections
- **NNIS** : National Nosocomial Infection Surveillance system
- **PBS** : Protected Brush Specimen
- **PICC** : peripherally inserted central catheter
- **PVP** : polyvinyl pyrrolidone
- **RSV** : Respiratory Syncytial Virus
- **SARS** : Severe Acute Respiratory Syndrome
- **SDD** : Selective Decontamination of Digestive Tract
- **SIRS** : Systemic Inflammatory Response Syndrome
- **SSTIs** : skin and soft tissue infections
- **TA** : Tracheal Aspirate
- **TEE** : Trans Esophegeal Echo
- **UTIs** : Urinary Tract Infections
- **VAP** : Ventilator-associated pneumonia
- **VISA** : Vancomycin-Insensitive S. aureus
- **VRE** : Vancomycin-resistant Enterococci
- **VRSA** : Vancomycin-resistant Staphylococcus aureus

Introduction

ICU nosocomial infection (NI) rate varies from 18 to 54%, five to ten times higher than other hospital units' rates. It is responsible for 5 to 35% of all NI and for approximately 90% of all outbreaks of diseases in an ICU. The ICU high mortality rates, commonly ranging from 9 to 38%, can reach 60% due to nosocomial infection occurrence ***(Colpan et al., 2005).***

The nosocomial infections are caused by bacterial, viral and fungal pathogens. Device associated infections (DAIs), particularly ventilator-associated pneumonia (VAP), central venous catheter-related blood stream infection (CVC-BSI), and catheter-associated urinary tract infection (CAUTI) pose the greatest threat to ICU patients ***(Tablon et al., 2004).***

The consequence and complications of infection might have variable clinical (sepsis, organ failure, death), health economic (bed utilization, hospital stay, cost of care, antibiotic utilization), infection control impact (spread of infection to patient/ staff/ visitor) ***(Digiovine et al., 1999).***

Precautions to prevent nosocomial infection in ICU include use of hand hygiene before and after contact with patient and respiratory devices, aseptic technique during catheter insertion and care, and prompt removal of catheters that are no longer essentials ***(O'Grady et al., 2002).***

The success or failure of antimicrobial treatment depends on many things, including the vulnerability of the host, the virulence of the organism, and the use of the appropriate antimicrobial (sensitivity, tissue penetration), and other clinical interventions (removal of foreign bodies, devitalized tissue, drainage of abscess)

Complicating the therapy of serious ICU-related infections is the problem of antibiotic resistance, a global issue with wide country to country variation ***(Jones et al., 2004).***

There is a tension between ensuring prompt treatment of infection, (which , unless the cause is obvious , requires the use of broad spectrum agents) and the risks associated with a poorer outcome from delayed or inappropriate treatment ***(Dellinger et al., 2008).***

EPIDIMIOLOGY

Nosocomial or hospital-acquired infection has been defined as an infection acquired by patients while they are in hospital or by members of hospital staff. Hospital acquired infections could be described as an intractable effect of hospitalization to which both patients and health care workers are at risks ***(Ricks and Dethia, 2007) .***

The prevalence of nosocomial infection is reported as being between 3 and 12% in most institutions but varies considerably between different sites within each institution ***(Rosenthal et al., 2003).***

The vulnerability of the patient population,the nature of interventions and cross-infection are but three of many factors. This is seen clearly if one compares the range between ophthalmology and critical care– 0–23% ***(Sax et al., 2001).***

Data collected on patients in US medical/surgical (MS) ICUs in the National Nosocomial Infection Surveillance (NNIS) system between 1992 and February 1998 showed that infections at three sites represented 68% of all reported infections . Nosocomial pneumonia (NI : 31%) was the most frequent, followed by Urinary Tract Infections (UTIs : 23%) and primary Blood Stream Infection (BSI : 14%) ***(Richards et al., 2000) .***

Additional data through the NNIS system have assessed nosocomial infections in differing types of ICUs and found that trauma/surgical and neurosurgical ICUs tend to have more nosocomial pneumonia than medical or coronary care ICUs; and that pediatric, trauma, and burn ICUs have more bloodstream infections than medical ICUs ***(National Nosocomial Infections Surveillance (NNIS) system report, 2004) .***

PATHOPHYSIOLOGY

A range of factors come together to enable nosocomial infection to occur. Some may be risk factors in their own right whereas other may simply represent an identifier of a sicker and therefore more vulnerable population ***(Soni, 2009*) .**

Risk Factor

The length of ICU stay is the predominant risk factor for nosocomial infection followed by the use of medical devices ***(Osmon et al., 2003).***

In the NNIS surveillance study, nosocomial infection rates for nosocomia pneumonia, bloodstream infections, and urinary tract infections have correlated strongly with device use **(*Richards et al., 2000).***

Other risk factors include the patient's underlying illness, selected medications, and the type of health care facility. In the European Prevalence of the in Intensive Care (EPIC) study seven risk factors were determined for ICU-acquired infection: increased length of stay (more than 48 hours), mechanical ventilation, diagnosis of trauma, central venous catheterization, pulmonary artery catheterization, urinary catheterization, and stress ulcer prophylaxis (***vincent et al., 1995) .***

A potential risk factor undergoing intense study at this time is hyperglycemia. Hyperglycemia is common in the ICU setting due to underlying disease, physiologic stress, and parenteral nutritional support. In vitro investigations suggest that hyperglycemia can impair polymorphonuclear leukocyte and monocyte phagocytic and bactericidal activities **(*Van den Berghe , 2004) .***

A large randomized trial performed in a single surgical ICU found that tight control of blood glucose during the ICU stay (maintaining blood glucose 80 to 110 mg per dL) reduced overall mortality, the incidence of bacteremias, and the number of patients who required more than 10 days of antibiotic therapy **(*Van den Berghe et al., 2001*).**

However, a subsequent study of the impact of tight glycemic control on outcomes in a medical ICU did not find the same benefit, and further investigation of both the risk of infection with hyperglycemia as well as optimal treatment is needed ***(Van den Berghe et al., 2006).***

Table (1) Risk factors for nosocomial infection

Patient	Environment	The organism
Severity of illness	Changes in procedures or protocols	Resistance
Underlying diseases	Multiple changes in staff; new staff	Resilience in terms of survival
Nutritional state	Poor aseptic practice – poor hand-washing	Formation of slime or ability to adhere
Immunosuppression	Patient-to-patient: busy, crowded unit, staff shortages	Pathogenicity
Open wounds		Prevelance
Invasive devices		
Multiple procedures		
Prolonged stay		
Ventilation		
Multiple or prolonged antibiotics		
Blood transfusion		

(Soni , 2009) .

ORGANISMS

The most common pathogens responsible for ICU infections in North American medical centers are Staphylococcus aureus (24.1%), Pseudomonas aeruginosa (12.2%) and Escherichia coli (10.1%). More than half of all S aureus and P aeruginosa isolates are collected from respiratory samples, while the most common source for E coli isolates are urine samples (32.1%) ***(Streit et al., 2004).***

In one report, gram-positive organisms were responsible for most of the nosocomial ICU infections documented in the National Nosocomial Infections Surveillance (NNIS) System**.** In this data set, coagulase-negative staphylococci (CoNS) were responsible for 42.9% of bloodstream infections, whereas S aureus was implicated in 27.8% of pneumonia cases. The most prevalent gram-negative pathogen was P aeruginosa, which was associated with 18.1% of pneumonia cases ***(Gaynes et al.,2005)***

Table (2) Organisms responsible for the majority of nosocomial infections

- Methicillin-resistant Staphylococcus aureus (MRSA)
- Coagulase-negative Staphylococcus (CNS)
- Enterococcus spp. (E. faecalis, E. faecium)
- Pseudomonas aeruginosa
- Acinetobacter baumani```
- Stenotrophomonas maltophilia
- Enterobacter spp.
- Klebsiella spp.
- Escherichia coli
- Serratia marcescens
- Proteus spp.
- Candida spp. (C. albicans, C. glabrata, C. krusei)

(Soni , 2009) .

Common Nosocomial infection in ICU

The relative prevalences of the 4 most common nosocomial infections in intensive care units (ICUs) in the United States -- pneumonia, bloodstream infections, urinary tract infections (UTIs), and surgical site infections changed between 1975 and 2003. Pneumonia and bloodstream infections increased in prevalence by approximately 5%, while UTIs and skin and soft tissue infections (SSTIs) decreased by approximately 40% and 15%, respectively. The prevalences of pneumonia and bloodstream infection and SSTIs are similar in both medical ICU and surgical ICU patients (≤3% difference), although UTIs are notably more common in the medical (30%) than the surgical (18%) ICU ***(Laura et al., 2008)***

NOSOCOMIAL PNEUMONIA

(A) Epidemiology

Nosocomial pneumonia is a common problem in the critically ill, particularly in ventilated patients, with an incidenceof 15–30% **(*Ostendorf et al., 2006)* .**

Ventilator-associated pneumonia (VAP) is common, has significant morbidity with increased length of stay, associated costs and a twofold increase in mortality ***(Safdar et al., 2005*** **) .**

(B) Pathophysiology

Pneumonia develops from one of three mechanisms:

(1) Inhalation of an aerosol containing infectious microorganisms.

(2) Hematogenous seeding of microorganisms in the lung.

(3) Aspiration of oropharyngeal flora ***(Laurie et al., 2008)* .**