Infection Control In Intensive Care Units

an essay

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BY

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Abbreviations:

- **AIDS**: acquired immuno deficiency syndrome.
- **ARDS**: acute respiratory distress syndrome.
- **ATS:** American Thoracic Society.
- **ASA**: American Society of Anesthesiologists.
- **BAL:** bronchoalveolar lavage.
- **CDC:** Centers for Disease Control and Prevention.
- **CFU**: colony forming units.
- **CoNS**: coagulase negative staphylococci
- **CVC:** central venous catheter
- **DOMV:** duration of mechanical ventilation.
- **ESBL**: extended spectrum B-lactamase.
- **HCWs:** heath care workers.
- **HMEs**: heat – moisture exchanger.
- **HPF**: high power field
- **H2RA:** H2 receptor antagonist.
- **ICD**: irritative contact dermatitis.
- **IMV**: invasive mechanical ventilation.
- **LOS:** length of stay.
- **MIC**: minimum inhibitory concentration.
- **MRSA:** methicillin resistant staphylococcus aureus
- **MSSA:** methicillin sensetive staphylococcus aureus
- **NI :** nosocomial infection.
- **NIV**: non invasive mechanical ventilation.
- **NNIS:** National Nosocomial Infection Surveillance system.
- **PK/PD**: pharmacokinetic/pharmacodynamic.
- **PICU**: pediatric intensive care unit.
- **PVP:** poly vinyl pyrrolidone.
- **SDD:** selective digestive decontamination.
- **SSI**: surgical site infection.
- **SSTIs:** skin and soft tissue infection.
- **TEWL**: transepidermal water loss.
- **UTI:** urinary tract infection.
- **VRE**: vancomycin resistant enterococci.
- **VAP:** ventilator associated pneumonia.

Introduction

Introduction

Nosocomial infections (NIs) affect more than 2 million persons annually in the United States and concern 5 to 35% of patients who are admitted to ICUs They are viewed as an inexorable tribute to pay to the more aggressive management of the population, characterized by the use of sophisticated technologies and invasive devices.**(Eggiman and Pittet .2001).**

The pathophysiology of NIs includes colonization of the host by potentially dangerous pathogens, such as microorganisms from exogenous or endogenous sources, including resistant strains such as methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE), azole-resistant Candida spp, and extended-spectrum ß-lactamase (ESBL) Gram-negative pathogens. Ventilator-associated pneumonia, catheter-related bloodstream infections, surgical site infections (SSIs), and urinary catheter-related infections account for > 80% of NIs**.(Pittet et al .,1999)A.**

The Study on the efficacy of Nosocomial Infection Control from the Centers for Disease Control (CDC) has suggested that at least one third of NIs are preventable through infection control programs, which have been implemented in most centers during the last 2 decades. Risk factors are well-identified and have been the target of efficient preventive measures. This may explain why NI rates are now included in the criteria used for assessing the quality of patient care in many institutions**. (Widmer et al .,1999).**

Control and prevention include general measures such as hand hygiene, isolation and restriction of antibiotic use, and more specific measures that have been demonstrated to be efficient in reducing particular types of NIs**. (Fagon et al., 2000).**

Epidemiology of Hospital Acquired Infections in I.C.U

- **Epidemiology of Hospital Acquired Infections in I.C.U.**

Definition

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 untoward effect of hospitalization to which both patients and health care workers are at risks. **(Ricks and Dethia. 2007)**

Epidemiology of Nosocomial Infections (NIs).

Epidemiologic data collected from surveillance activities are used to determine NI rates and may be used to monitor their evolution and to detect any unusual variation that may be potentially suspect of outbreaks or high endemic rates of NI. Importantly, NI rates vary widely according to the type of ICU and the population served. They may also vary with the type of surveillance. **(Raymond and Aujard .,2000)**

A prevalence of 20.6% was reported in the European Prevalence of Infection in Intensive Care study, which included 10,038 patients from 1,417 European ICUs in 1995. Pneumonia was the most common NI (46.9%), followed by lower respiratory tract infection other than pneumonia (17.8%), urinary tract infection (UTI) (17.6%), and laboratory-confirmed bloodstream infection (12%)**. (Vincent et al., 1995**)

Importantly, NIs are easier to compare if they are presented as incidence densities related to device use (*eg*, endotracheal tube, central venous catheter [CVC], or urinary catheter). **(Eggimann et al., 2000).**

An incidence of 9.2%, corresponding to an incidence density of 23.7 episodes per 1,000 patient-days, was reported for the 164,034 patients in 119 ICUs surveyed from 1986 through

1990 in the National Nosocomial Infection Surveillance (NNIS) system. **(Jarvis et al., 1991)**.

Data collected from 112 European medical ICUs between 1992 and 1997 indicated that NIs developed in 7.8% of hospitalized patients (14,177 of 181,993 patients), corresponding to an incidence density of 19.8 episodes per 1,000 patient-days. UTIs (31%) were the most common, with 95% occurring in catheterized patients. Pneumonia, which was ventilator-associated in 86% of cases, represented 27% of all NIs, and bloodstream infections represented 19% (laboratory-confirmed, 18.2%, and clinical sepsis, 0.8%), of which 87% were found to be catheter-related. **(Richards et al., 1999)B**

NI device-related rates (*ie*, catheter-related UTI, central venous catheter-related bloodstream infections, and ventilator-associated pneumonia) were 5.5, 4.0, and 7.1, respectively, episodes per 1,000 device-days for European coronary ICUs, 6.4, 5.3, and 6.8, respectively, for medical ICUs, 4.8, 6.9, and 4.0, respectively, for pediatric ICUs, and 4.6, 5.1, and 12.5, respectively, for surgical ICUs**. (Richards et al., 1998)**

Comparable incidences of NIs have been reported in ICUs from other developed countries**. (Pittet et al., 1999)A**

Moreover, preliminary data from the National Nosocomial Infection Surveillance (NNIS) system suggested that risk-adjusted NI rates decreased over time for these three infections that are continuously monitored in ICUs **.(Richards et al., 1998)**

Risk Factors of NIs

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

In the NNIS surveillance study, nosocomial infection rates for nosocomial 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 a 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. **(Irwin and Rippe. 2008))**

Although therapeutic agents are superior to no prophylaxis in preventing stress ulcer bleeding, there is a growing concern about potential complications of prophylaxis, particularly nosocomial pneumonia. The incidence of nosocomial pneumonia is approximately 20-fold higher in mechanically ventilated patients, in whom the mortality rate from the pneumonia can be as high as 60%. **(Tryba and Cook .1995).**

Gastric alkalinization and colonization with gram-negative bacilli is thought to play a causal role, rendering pH-altering drugs potentially disadvantageous. Although a persistently alkaline gastric environment increases the likelihood of bacterial colonization, it is unclear if this is influenced by the pharmacologic agent used for stress ulcer prophylaxis, as several metaanalyses have provided conflicting results. (**Ortiz et al., 1998).**

Studies show a higher incidence of nosocomial pneumonia in patients treated with antacids when compared with sucralfate, a drug that does not alter the gastric pH and appears to have bactericidal properties. (**Tryba .1987).**

Other studies and one metaanalysis have shown no statistically significant difference in the rate of pneumonia in sucralfate- and H2RA-treated mechanically ventilated patients. (**Pickworth et al., 1993).**

Teaching hospitals with higher rates of device utilization have had higher device-associated infection rates. **(Richards et al., 2000)**

As in adult ICUs the most important risk factors for nosocomial infection in Pediatric ICUs appears to be the length of ICU and rate of device utilization. **(Richards et al., 1999)A.**

A potential risk factor 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).**

Pathophysiology of NIs

The colonization of the host by potentially pathogenic microorganisms is a prerequisite for the further development of most NIs and may occur from exogenous or endogenous sources. As a consequence of the severity of the underlying diseases with possibly impaired host defenses, and in the presence of risk factors, critically ill patients are particularly susceptible to a rapid colonization by endemic pathogens of the hospital flora. The endemic transmission of exogenous staphylococci and other potential pathogens by the hands of health-care workers (HCWs) is well-documented**. (Vicca .1999).**

Many NIs are believed to arise from the endogenous flora of the skin, oropharyngeal, or Gastro-intestinal (GI) tracts due to treatments such as chemotherapy, corticosteroid therapy, or antibiotic therapy, and also by the use of invasive devices such as intravascular or urinary catheters and nasogastric or endotracheal tubes. This flora also is responsible for the majority of surgical wound infections. **(Rangel et al., 1999)**

Pathogens responsible for nosocomial infections.

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)**

- **Changes in pathogen prevalence over time.**

According to United State NNIS data, little change has occurred in the prevalences of most gram-negative pathogens (including K pneumoniae, Enterobacter spp, and P aeruginosa) associated with occurrence of pneumonia in the ICU between 1986 and 2003**.** One exception is Acinetobacter baumannii, which increased significantly during this interval. Gram-positive pathogens, which have shown substantial increases in prevalence in both ICU and non-ICU hospital settings, include methicillin-resistant S. aureus (MRSA) and vancomycin-resistant enterococci (VRE). **(Gaynes et al., 2005)**

- ## Resistance

Several factors encourage the development and spread of resistance among pathogens in the ICU which include:

- Previous exposure to antibiotics
- Inappropriate use of antibiotics, particularly broad-spectrum agents
- Length of hospital stay
- Insufficient nursing/support staff
- Poorly enforced infection control practices. **(Rao. 1998).**

Drug use and duration of therapy.

Antibiotics are highly prescribed among hospitalized patients. In a study of 9471 patients, showed that 25.1% and 33.9% of patients in medical and surgical clinics respectively