

Chapter 2

Epidemiology of Healthcare-Associated Infections

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Key points

- Healthcare-associated infections (HAI) occur in all types of healthcare facilities.
- Understanding the risk factors associated with specific types of HAI is important in developing effective and efficient prevention and control measures.
- HAI risk is high when invasive medical devices are used on patients.
- Antimicrobial resistance among hospital pathogens is increasing.

Introduction

Hospitalized patients are at high risk of developing infections they did not have before admission. In the United States, more than one out of every 20 patients develops a healthcare-associated infection (HAI), so about 2 million patients become infected every year.¹ Most HAIs occur at four sites—blood, respiratory tract, surgical site, and urinary tract. HAIs occur in all types of hospitals, from small ones to large university hospitals and in countries with sophisticated health care systems and those that are newly organized. Regardless of size or location all hospitals are places where the infection risk is high. Risk factors fall into three groups:

1. intrinsic factors which mean the patient's susceptibility to infection;
2. extrinsic factors such as the hospital environment and devices used on the patients; and
3. the microorganisms involved.

The importance of the risk factors may differ in hospitals, but we can understand their potential role by examining the epidemiology of HAIs to see how often they occur, where, and why.

The Centers for Disease Control and Prevention (CDC) has been collecting epidemiologic data on HAIs in the U.S. since the late 1960s. Researchers and public health officials realized that HAIs were increasing in number and becoming more serious, leading to disability and death, pain and suffering, and high extra cost.

Other countries and regions have since begun surveillance and published epidemiologic data on HAIs. These areas include:

- Europe: Improving Patient Safety in Europe
<http://helics.univ-lyon1.fr>
- England: Nosocomial Infection National Surveillance Scheme
http://www.hpa.org.uk/infections/topics_az/hai/default.htm
- Australia: Victorian Nosocomial Infection Surveillance System
<http://www.vicniss.org.au>
- Canada: Canadian Nosocomial Infection Surveillance Program
http://www.phac-aspc.gc.ca/nois-sinp/cnisp_e.html

Most hospitals collect some data on HAIs. Comparing rates of HAI is difficult because of differences in surveillance methods and ongoing changes in how and where patients receive care. The purpose of this chapter is to use data from surveillance systems and studies to show the most important risk factors associated with HAIs and to describe how this information can be used to reduce the infection rate.

Intrinsic risks

The normal human body has many defences against infection. These defences may be compromised by very old age, underlying disease or injury. These are called intrinsic risks. Table 2.1 shows the association between the most common HAIs and some intrinsic risks. Although we may not be able to remedy these conditions, caregivers can take special precautions to protect patients who are highly susceptible to infections. Furthermore, when infections occur in low risk patients, infection prevention and control (IC) staff should be alert to new problems that may be preventable.

Extrinsic risks in the hospital environment or from treatments

The hospital is a busy place where people—patients, caregivers, and visitors—are in constant contact, where all types of equipment and supplies are used, and high risk procedures are performed. The hospital and those who work there maintain a safe environment for patients and caregivers by ensuring clean food, water and air, adequate sanitation, practicing IC, and using antibiotics wisely. IC should be focused on these factors. (See Table 2.1)

Caregivers must also be protected from becoming infected while working in hospital. Serious infections of concern to caregivers are human immunodeficiency virus/acquired immunodeficiency syndrome, viral hepatitis, tuberculosis, and (in some countries) viral hemorrhagic infections.

High-risk medical devices

Many HAIs are related to the use of a medical device, especially invasive devices that by-pass the normal barriers to entry of microorganisms into the body. HAI rates of urinary tract infections

Table 2.1. Intrinsic and extrinsic risk factors associated with hospital-associated infections

Site of infection	Intrinsic risk factors	Extrinsic risk factors
Bloodstream infection	Immunosuppressive therapy Loss of skin integrity Severe underlying disease Very young or very old	ICU Vascular access: Arterial pressure monitor Haemodialysis Intravenous line, especially central and umbilical line Receipt of large volume of parenteral fluids or blood products Systemic antimicrobial therapy
Pneumonia	Chronic lung disease Immunosuppressive therapy Long duration of surgical operation Surgical operation (especially high abdominal or thoracic and long duration) Very old	Enteral feeding Intubation with nasogastric tube Respiratory therapy equipment Tracheal suctioning
Surgical site infection	Loss of skin integrity Obesity or malnutrition Presence of infection at another site Severe underlying disease (e.g., high American Society for Anesthesiologists score, diabetes mellitus) Trauma	OR asepsis OR equipment and supplies Skin antiseptics Surgeon’s skill and experience Tissue perfusion Type of operation Length of operation
Urinary tract infection	Female Severe underlying disease, e.g., diabetes mellitus Very old	Indwelling urinary catheter Other urinary tract instrumentation, especially cystoscopy

ICU = Intensive Care unit; OR = Operating Room (theatre)

Adapted from Emori TG, Gaynes RP. An overview of nosocomial infections, including the role of the microbiology laboratory. *Clin Micro Rev* 1993;6:428-42.

(UTI), bloodstream infections, and pneumonia are significantly greater among patients when a medical device is used.² Almost 65% of healthcare-associated bloodstream infections (BSI) relate to an invasive device in the bloodstream and nearly all UTIs occur in patients with indwelling urinary catheters.^{3,4}

Use of invasive devices is especially high in the intensive care unit (ICU) where the risk of infection is increased because the patients are more severely ill or injured. About one-fourth of the HAIs in the U.S. are in ICUs,⁵ where the infection rate is 5-10 times greater than on the general wards.⁶ ICUs in hospitals worldwide had bloodstream infection rates associated with central venous catheters similar to those in US hospitals (5.02 vs. 3.82 BSI/1000 line days).⁷

As medical technology advances and new devices are introduced careful thought must be given to how they can be safely used on patients. Must they be sterile or clean? If re-used, how are they reprocessed? Patients should be examined for any evidence of infection related to the devices. Deciding against using an invasive device in favour of a non-invasive approach can be an effective infection prevention measure.

Surgical procedures

Surgical site infection (SSI) is often a serious event that, on average, prolongs hospital stay by eight days, doubles the risk of death, increases re-admissions to hospital 5-fold and imposes a huge extra cost of care.⁸ Because the risk of developing a SSI is strongly associated with bacterial contamination of the wound during the operation, SSI rates have been grouped by wound class—clean, clean-contaminated, contaminated and dirty. Recent SSI studies have grouped patients according to the operation performed, the length of the operation, and the general condition of the patient. Using more precise risk groups allows comparison of infections rates between patients with similar risks.

Infectious agents

Microorganisms are everywhere in hospitals and some of them will become resistant to antibiotics if these are over-prescribed.

Overall, about half of all HAIs are caused by four pathogens – *E. coli*, enterococci, *P. aeruginosa*, and *S. aureus*. However, the microbes are

different for each kind of infection. For example, *E. coli* is commonly found in UTIs, but less frequently found at other infection sites. *S. aureus* is rarely found in UTIs but is common in wounds, pneumonia and bloodstream infections.

The growing problem of antimicrobial-resistant microorganisms is one of the greatest challenges facing infection prevention and control. The trend of selected pathogens from ICUs in the U.S. that are antibiotic-resistant is shown in Figure 2.1. Inappropriate use of antibiotics, (unnecessary use, prescribing the wrong drug, dosage, or duration) is an important factor in promoting antimicrobial resistance. Patients need to be trained not to expect an antibiotic for every possible infection, and to follow the instructions on taking an antibiotic when one is ordered.

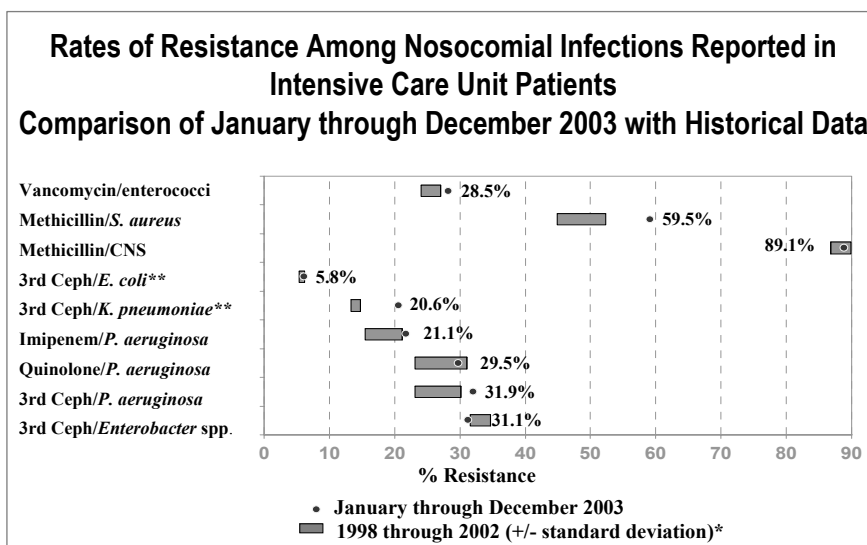


Figure 2.1. Selected antimicrobial-resistant pathogens associated with nosocomial infections in ICU patients, comparison of resistance rates from January through December 2003 with 1998 through 2002, NNIS System.

3rd Ceph = 3rd generation cephalosporin – such as ceftazidime

(From the NNIS System. National Nosocomial Infections Surveillance (NNIS) system report, data summary from January 1992 through June 2004, issued October 2004. *Am J Infect Control* 2004; 32:470-85)

Using epidemiologic data to reduce the infection rate

Data collected in surveillance systems are being used successfully by IC staff to identify high risk areas in their hospital, to provide objective data to the patient care staff, including physicians, to assist in developing prevention plans and to measure the program's effectiveness.

Conclusion

If hospitals are to be successful in reducing HAIs and using their resources most effectively, they should pay careful attention to factors that increase infection risk in their patients and institute specific prevention and control measures. The infection risk is highest when patients are treated with invasive medical devices, undergo surgical operations and are placed in the ICU. Pathogens resistant to antimicrobial drugs are continuing to increase.

References and Further Reading

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