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RESEARCH ARTICLE

INFECTION CONTROL AMONG ANESETHSIA PRACTICE

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Abstract

Nosocomial infections, or hospital-acquired infections, are complex and have multiple causes. They interfere with patient recovery, increase hospital stays, and lead to higher morbidity, mortality, and costs. The CDC estimates that a third of these infections result from not following established infection control practices. Anesthesia practices are critical in controlling the spread of these infections due to the invasive nature of procedures like catheter and airway management. Although direct cause-and-effect data is limited, most anesthesia-related infections are preventable. Anesthesia personnel must understand the epidemiology and pathogens to implement preventive measures. Risk factors include invasive procedures, cross-contamination, and hand transmission. Common signs of infection include fever, tachycardia, tachypnea, skin rash, and general malaise. The main sources of healthcare-associated infections are bloodstream infections (28%), pneumonia (21%), and urinary tract infections (15%), often linked to invasive devices. Standard precautions should be applied to all patients to prevent infection transmission. Additional transmission-based precautions are necessary for patients with specific pathogens. Infection control programs in the US are mandated by the Joint Commission for Accreditation of Healthcare Organizations (TCAHO) and guided by the CDC.

Introduction:-

Chapter I: Nosocomial Infections

Healthcare-associated infections (HAI) or Nosocomial infections or are the infections that were not present -and without evidence of incubation- at the time of admission to a healthcare setting. Currently, the term healthcare-associated infections replaced other ones such as nosocomial, hospital-acquired or hospital-onset infections [(1)].

The patient's flora begins to acquire characteristics of the surrounding bacterial pool within hours after admission and most infections that become clinically evident after 48 hours of hospitalization are considered hospital-acquired. Infections that occur after the patient is discharged from the hospital can be considered healthcare-associated if the organisms were acquired during the hospital stay. Hospital-based programs of surveillance, prevention and control of healthcare-associated infections have been in place since the 1950s. The Study of the Efficacy of Nosocomial Infection Control Project (SENIC) from the 1970s showed nosocomial rates could be reduced by 32% if infection surveillance were coupled with appropriate infection control programs[(2)].

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The National Healthcare Safety Network (NHSN) was established in 2005, with the purpose of integrating and succeeding previous surveillance systems at the Centers for Disease Control and Prevention (CDC): National Nosocomial Infections Surveillance (NNIS), Dialysis Surveillance Network (DSN) and National Surveillance System for Healthcare Workers (NaSH). Continued surveillance, along with sound infection control programs, not only lead to decreased healthcare-associated infections but also better prioritization of resources and efforts to improving medical care. Healthcare-associated infections are of important wide-ranging concern in the medical field. They can be localized or systemic, can involve any system of the body, be associated with medical devices or blood product transfusions[3].

Pathophysiology of healthcare-associated infections

Healthcare-associated infections are caused by infectious agents that may come from endogenous or exogenous sources**.** Endogenous sourcesincludebody sites normally inhabited by microorganisms. Examples include the nasopharynx, GI, or genitourinary tracts. Exogenous sources include those that are not part of the patient. Examples include visitors, medical personnel, equipment and the healthcare environment. Patient-related riskfactors for invasion of colonizing pathogen include severity of illness, underlying immune-compromised state and/or the length of in-patient stay [4]**.**

The epidemiology

Healthcare-associated infections are estimated to occur in 5% of all hospitalizations in the United States, [5]**.** In 1999, national point-prevalence surveys in pediatric intensive care units (PICU) and neonatal intensive care units (NICU) showed 11.9% of 512 patients had PICU-acquired infections, whereas 11.4% of 827 patients had NICU-acquired infections, [6 , 7]**.**

The healthcare-associated infections put a great burden on both developed and resource-poor countries. In a World Health Organization (WHO) cooperative study (55 hospitals in 14 countries from four WHO regions), about 8.7% of hospitalized patients had nosocomial infections. A 6-year surveillance study from 2002-2007 involving intensive care units (ICUs) in Latin America, Asia, Africa, and Europe, using CDC's NNIS definitions, revealed higher rates of central-line associated blood stream infections (BSI), ventilator associated pneumonias (VAP), and catheter-associated urinary tract infections than those of comparable United States ICUs.[8]**.**

With increasing recognition of burden from healthcare-associated infections, national surveillance systems have been developed in various countries; these have shown that nationwide healthcare-associated infection surveillance systems are effective in reducing healthcare-associated infections[9]**.**

Morbidity/ Mortality

Healthcare-associated infections result in excess length of stay, mortality and healthcare costs. In 2002, an estimated 1.7 million healthcare-associated infections occurred in the United States, resulting in 99,000 deaths. In March 2009, the CDC released a report estimating overall annual direct medical costs of healthcare-associated infections that ranged from $28-45 billion[10]**.**

Relation with age and sex

Healthcare-associated infections do not have a noticeable sex predilection and it occur in both adult and pediatric patients. Bloodstream infections, followed by pneumonia and urinary tract infections are the most common healthcare-associated infections in children; urinary tract infections are the most common healthcare-associated infections in adults**.** Among pediatric patients, children younger than 1 year, babies with extremely low birth weight ($\leq$ 1000 g) and children in either the PICU or NICU have higher rates of healthcare-associated infections [11]**.**

Major risk factors for healthcare-associated infections

Healthcare-associated infections are most commonly caused by viral, bacterial, and fungal pathogens. These pathogens should be investigated in all febrile patients who are admitted for a non-febrile illness or those who develop clinical deterioration unexplained by the initial diagnosis. Most patients who have healthcare-associated infections caused by bacterial and fungal pathogens have a predisposition to infection caused by invasive supportive measures such as endotracheal intubation and the placement of intravascular lines and urinary catheters. 91% percent of bloodstream infections were in patients with central intravenous lines (CVL), 95% of pneumonia cases were in patients undergoing mechanical ventilation, and 77% of urinary tract infections were in patients with urinary tract catheters [11]**.**

Catheter-associated bloodstream infections in neonates have some risk factors including catheter hub colonization, exit site colonization, catheter insertion after the first week of life, duration of parenteral nutrition, and extremely low birth weight (< 1000 g) at the time of catheter insertion [(12)]. In patients in the PICU risks, for catheter-associated bloodstream infections increase with neutropenia, prolonged catheter usage time (>7 days), use of percutaneously placed CVL (higher than tunneled or implanted devices), and frequent manipulation of lines [(13)].

Candida species are increasingly important pathogens in the NICU. Risk factors for the development of candidemia in neonates include gestational age less than 32 weeks, 5-min Apgar scores of less than 5, shock, disseminated intravascular coagulopathy, prior use of intralipids, parenteral nutrition administration, CVL use, H2 blocker administration, intubation, or length of stay longer than 7 days [(14)].

Risk factors for the development of ventilator-associated pneumonia (VAP) in pediatric patients include reintubation, genetic syndromes, immunodeficiency, and immunosuppression [(15,16)]. In neonates, a prior episode of bloodstream infection is a risk factor for the development of VAP [(17)].

Risk factors for the development of healthcare-associated urinary tract infection in pediatric patients include bladder catheterization, prior antibiotic therapy, and cerebral palsy [(18)].

Clinical picture of HAI

In addition to the presence of systemic signs and symptoms of infection (e.g., fever, tachycardia, tachypnea, skin rash, general malaise), the source of healthcare-associated infections may be suggested by the instrumentation used in various procedures. For example, an endotracheal tube may be associated with sinusitis, tracheitis, and pneumonia; an intravascular catheter may be the source of phlebitis or line infection; and a Foley,s catheter may be associated with a urinary tract infection. Patients with pneumonia may have fever, cough, purulent sputum and abnormal chest auscultatory findings such as decreased breath sounds, crackles or wheezes. Patients with urinary tract infection may present with or without fever. Patients with cystitis can have suprapubic tenderness while those with pyelonephritis can have costovertebral tenderness. Upon inspection, their urine can be cloudy and foul-smelling (19).

Neonates on the other hand usually do not present with any of the above findings and may have very subtle and nonspecific signs of infection. Fever may or may not be present. Signs of infection can include temperature and/or blood pressure instability, apnea, bradycardia, lethargy, fussiness, and feeding intolerance [(11).]

Etiology of HAI

In a survey done on 110,709 pediatric ICU patients, 6,290 healthcare-associated infections were noted,. The top 3 major sites of infections, accounting for 64% of all healthcare-associated infections, were bloodstream infections (28%), pneumonia (21%), and urinary tract infection (15%). Each of these infections was strongly associated with use of an invasive device.

The top 3 pathogens in bloodstream infections were coagulase-negative staphylococci (38%), Enterococcus (11%), and staphylococcus aureus (9%). Candida albicans accounted for about 5.5% of bloodstream infections. The top 3 pathogens for pneumonia were Pseudomonas aeruginosa (22%), staphylococcus aureus (17%), and Haemophilus influenzae (10%). The top 3 pathogens for urinary tract infections were Escherichia coli (19%), Candida albicans (14%), and Pseudomonas aeruginosa (13%). Gram-negative enteric organisms accounted for about 50% of all urinary tract infections. The top 3 pathogens for surgical site infections were Staphylococcus aureus (20%), Pseudomonas aeruginosa (15%), and coagulase-negative staphylococci (14%) [(11)].

Surgical site infections (SSI) occur within 30 days after the operative procedure or within 1 year if an implant was placed. Criteria for the diagnosis of SSI include purulent drainage at the site of incision, clinical symptoms of infection (such as pain, redness, swelling, etc), presence of an abscess, isolation of organism from the site culture, and clinical diagnosis of SSI by the surgeon [(20)].

The most common cause of acute gastroenteritis in hospitalized children is Rotavirus, with greatest susceptibility in children younger than 3 years. Aside from having non bloody diarrhea, patients may present with fever, vomiting, and abdominal cramps. Other viruses that can cause hospital-associated gastroenteritis include norovirus and adenoviruses. Gastroenteritis due to adenovirus can be especially debilitating in immune-compromised patients [(21)].

Clostridium difficile is the most important bacterial cause of healthcare-associated gastroenteritis. Associated clinical conditions include asymptomatic carriage, diarrhea, and pseudo membranous colitis. Diagnosis is suspected in a patient with diarrhea and recent history of antibiotic use (especially cephalosporin and clindamycin)[22].

Pathogens and their diagnosis

Acinetobacter, Adenoviruses, Burn Wound Infections, Candidiasis, Clostridium Difficile Colitis, Colitis, Croup, Bacterial and fungal Endocarditis, Enterobacter Infections, Enterococcal Infections, Enteroviral Infections, Escherichia Coli Infections, H1N1 Influenza (Swine Flu), Hepatitis A, B, C, HIV Disease, Influenza, Legionella Infection, Measles, Nosocomial Pneumonia, Nursing Home Acquired Pneumonia, Parainfluenza Virus Infections, Pseudomonas Infection, Respiratory Syncytial Virus Infection, Rhinovirus Infection, Bacterial Sepsis, Staphylococcal Infections, Staphylococcus Aureus Infection, Stenotrophomonas Maltophilia, Streptococcus Group A Infections, Thrush, Toxic Shock Syndrome, Tuberculosis, Urinary Tract Infection and Varicella-Zoster Virus.

Investigations needed for HAI

Laboratory Analysis

Laboratory investigations should be guided by the results of a detailed physical examination and review of systems. Caution should be taken when interpreting laboratory results because not all bacterial or fungal growth on a culture is pathogenic. Growth on cultures may reflect simple microbial colonization and we should take into consideration the following precautions:

1. Clinical picture of the patient
2. Urine culture obtained through a newly placed Foley catheter is less likely to be contaminated by microbial colonization,
3. The presence of other supporting evidence of infection (e.g., the significance of bacterial growth on tracheal aspirate culture is strengthened by the presence of radiographic changes and clinical signs compatible with pneumonia)
4. Known "contaminant" skin organisms such as coagulase-negativestaphylococcus-viridians,streptococcus, Micrococcus, Corynebacterium, Propionibacterium, and Bacillus species should not easily be dismissed as contaminants if they grew on cultures of normally sterile body fluids (e.g., blood, joint fluid, cerebrospinal fluid [CSF]), especially if the patient was at high risk for severe infections (e.g., immunocompromised, neonates).
5. Repeating cultures may help establish presence or absence of infection.
6. Fungal growth on a blood culture should never be dismissed as "contamination."

Bloodstream infections

Among the different methods used to establish the catheter as the source of bloodstream infections (catheter-associated bloodstream infection), the differential time to positivity of paired blood cultures is the simplest [23].

The catheter is confirmed as the source of bloodstream infection if the blood culture from the catheter showed microbial growth 2 hours or earlier than a peripheral blood culture obtained at the same time. The other methods include quantitative cultures of blood obtained from the catheter and peripheral vein and also, quantitative culture of catheter segment. Unfortunately, quantitative culture is not readily available in most laboratories and culture of the catheter requires pulling out the device [24].

Multiple blood cultures over 24 hours and appropriate volume of blood sample may increase the yield in cases of intermittent or low-inoculums bacteremia. Fungal cultures should be obtained if fungal infection is suspected. The laboratory should incubate cultures longer for fungus detection than for other pathogens.

Imaging studies such as echocardiography should be considered if thrombosis or vegetations is a concern. Candidate patients include those who have prolonged or persistent bacteremia or fungemia despite antimicrobial therapy or in patients with a new-onset murmur. In immune-compromised patients, special studies are occasionally requested, such as cultures for atypical mycobacteria, cytomegalovirus, and cytomegalovirus antigenemia detection.

Pneumonia

Acute phase reactants (peripheral WBC count, erythrocyte sedimentation rate, C-reactive protein) may be elevated but are not specific in distinguishing bacterial from viral pneumonia. Decreasing oxygen saturation and worsening hemodynamic status are clues to the presence of pneumonia. The presence of a new infiltrate on chest radiograph is supporting evidence of pneumonia; however, it may sometimes be difficult to differentiate from atelectasis. Sputum gram stain and cultures may be useful. However, especially in the case of young children unable to effectively cough up phlegm, sputum samples maybe contaminated by saliva and upper respiratory tract organisms. An acceptable sample should have less than 10 squamous epithelial cells, more than 25 neutrophils per low-power field and culture growing a predominant organism [(25)].

As in the case of sputum samples, materials obtained via suctioning of endotracheal, nasotracheal, and tracheostomy tubes may not be reliable because these may be contaminated by upper respiratory tract organisms. Other methods to obtain specimens for microbiologic evaluation include bronchoalveolar lavage and thoracentesis. Efforts to distinguish tracheobronchial colonization, ventilator-associated tracheobronchitis, and ventilator-associated pneumonia may help avoid inappropriate antibiotic use [(25)].

Urinary tract infection
Urinalysis and urine culture along with clinical findings are essential in differentiating asymptomatic bacteriuria, cystitis and pyelonephritis. The presence of pyuria, bacteria, nitrites and leukocyte esterase on urinalysis makes urinary tract infection likely.

Urinary tract infection is highly likely when the urine culture (obtained by transurethral catheterization) is growing more than 100,000 colony-forming units/mL of a single organism. Urine culture interpretation should be taken with caution as this may lead to over-diagnosis and subsequent unnecessary evaluation and treatment. The following factors should be kept in mind when interpreting urine cultures:

1. Number of colonies and species isolated
2. Method of sample collection
3. Time from collection to laboratory processing
4. Sex of the patient
5. Previous antibiotic use

Although imaging studies are controversial, they are recommended by most experts in evaluating children with first-time urinary tract infection. Renal ultrasonography and voiding cysto-urethro-graphy are the 2 most commonly used modalities to evaluate for anatomical abnormalities. Renal ultrasonography may also help detect abscesses or phlegmons in patients unresponsive to antibiotic therapy [(23)].

Other healthcare-associated infections
Cultures of specimen from the surgical site infection may reveal pathogens and help tailor antibiotic therapy. Detection of rotavirus antigen in stool confirms gastroenteritis due to rotavirus. Available tests to detect Clostridium difficile include stool culture, enzyme immunoassay for toxin detection, and polymerase chain reaction tests.

Imaging Studies
Special imaging techniques (e.g., ultrasonography, CT scan, MRI) may be helpful in evaluating obscure-site infections.

Management of HAI
Symptomatic treatment of shock, hypoventilation, and other complications should be provided, along with administration of empiric broad-spectrum antimicrobial therapy.

Management of bloodstream infections
Line removal should be considered if the line is no longer needed; if the infection is caused by Staphylococcus aureus, Candida species, or mycobacteria; if the patient is critically ill; if the patient fails to clear bacteremia in 48-72 hours; if symptoms of bloodstream infection persist beyond 48-72 hours; and if noninfectious valvular heart disease, Endocarditis, metastatic infection, or septic thrombophlebitis is present [(23)].

Antibiotics with coverage against gram-positive and gram-negative organisms, including Pseudomonas, should be empirically started and then tailored according to susceptibility pattern of isolated organisms. Antifungal therapy (e.g., fluconazole, caspofungin, voriconazole, amphotericin B) in some cases is added to empiric antibiotic coverage. Antiviral therapy (e.g., ganciclovir, acyclovir) can be used in the treatment of suspected disseminated viral infections. Duration of therapy depends on several factors, including isolated pathogen, retention of catheter, or presence of complications (endocarditis, sepsis). For most bacterial organisms, the duration of therapy is 10-14 days after blood cultures become negative [26].

Management of pneumonia

Initial empiric antibiotic therapy should be broad and later on streamlined based on results of examination and cultures of sputum, endotracheal suction material and bronchial lavage wash. The choice of empiric antibiotic coverage should take into consideration the risk for multidrug-resistant (MDR) pathogens. Risk factors for MDR include antimicrobial therapy over the past 90 days, current hospitalization of 5 days or more, high frequency of antibiotic resistance in the community, or hospital and immunosuppression [27].

No clear consensus has been reached as to the duration of antimicrobial therapy for ventilator-associated pneumonia (VAP). Many experts treat for 14-21 days. However, shorter course of antibiotic therapy (about 1 wk) may be adequate therapy for some cases[28].

Antiviral medications against influenza have been used to treat symptomatic patients and patients with immunodeficiency or chronic lung diseases to limit morbidity and mortality.

Management of Urinary tract infection

To avoid persistence and recurrence of infection, indwelling catheters should be removed if possible. In some cases, removal of catheter may result in spontaneous resolution of bacteriuria or asymptomatic cystitis.

Empiric antibiotic and antifungal therapy should be considered to avoid major complications, including pyelonephritis, renal damage, and bloodstream infections. Duration of therapy is controversial. Most experts recommend at least 10-14 days of therapy for children with sepsis, pyelonephritis, or urinary tract abnormalities [29].

Management of surgical-site infection

Surgical-site infections (SSIs) should be managed with a combination of surgical care and antibiotic therapy. Antibiotic coverage should be modified once culture results are available. Severe infections such as streptococcal gangrene and extensive tissue necrosis need aggressive surgical intervention. For these kinds of infections, antibiotics alone may not work.

Management of other healthcare-associated infections

Rotavirus gastroenteritis is a self-limited disease and only needs supportive care. Medical management should focus on preventing dehydration. Treatment is not necessary for asymptomatic carriers of Clostridium difficile. For those who have mild symptoms, discontinuance of antibiotics alone may result in resolution of symptoms. For those who have more severe diarrhea, oral metronidazole is the preferred treatment. Oral vancomycin is reserved for treatment failure with metronidazole. Clinical improvement is usually seen within 2 days of initiating therapy, and duration of treatment is usually 10 days [30].

Prevention of nosocomial infections

The Healthcare Infection Control Practices Advisory Committee (HICPAC) has developed a guideline for isolation precautions to prevent transmission of infectious agents in healthcare settings [31, 32].

Standard precautions are to be applied to the care of all patients in all healthcare settings regardless of the suspected or confirmed presence of an infectious agent. This is the primary strategy in preventing transmission of infectious agents among patients and healthcare personnel.

Transmission-based precautions are used in addition to standard precautions when caring for patients who are infected or colonized with pathogens transmitted by airborne, droplet, or contact routes.

Airborne precautions are used to prevent transmission of airborne droplet nuclei–containing microorganisms. These droplet nuclei remain suspended in air. Precautions include use of single-patient rooms, negative air-pressure ventilation, and N95 respirator masks or higher. Organisms transmitted by airborne route include Mycobacterium tuberculosis, rubeola (measles) virus, and the varicella-zoster virus.

Droplet precautions are used to prevent transmission of droplets containing microorganisms propelled less than 3 feet by coughing or sneezing by an infected person. Precautions include use of mask in the room and use of single-patient room or, if not feasible, cohorting of patients separated at least 3 feet apart[32].

Conditions/pathogens for which droplet precautions should be used include adenovirus, diphtheria, Haemophilus influenzae type b, hemorrhagic fever viruses, influenza, mumps, Mycoplasma pneumonia, Neisseria meningitidis, parvovirus B19, pertussis, plague (pneumonic), rubella, severe acute respiratory syndrome (SARS), streptococcal pharyngitis, pneumonia, or scarlet fever.

Contact precautions are used to prevent transmission of microorganisms via direct or indirect contact with infected or colonized persons. Precautions include use of single-patient room (if not feasible, cohort patients infected with the same organism), use of gowns and gloves, and hand hygiene after glove removal.

Conditions/pathogens for which contact precautions should be used include multidrug-resistant bacteria (e.g., vancomycin-resistant enterococci, methicillin-resistant Staphylococcus aureus [MRSA], multidrug-resistant gram negative bacilli), Clostridium difficile, diphtheria, enteroviruses, Escherichia coli and other Shiga toxin-producing Escherichia coli, hepatitis A virus, herpes simplex virus (neonatal, mucocutaneous, or cutaneous), herpes zoster in a normal host (localized with no evidence of dissemination), impetigo, noncontained abscess, cellulites or decubitus ulcer, parainfluenza virus, pediculosis, respiratory Syncytial virus, rotavirus, scabies, Shigella, Staphylococcus aureus (cutaneous or draining wounds), and viral hemorrhagic fevers (e.g., Ebola, Lassa, Marburg) [32].

Prevention of intravascular catheter-associated infections includes avoidance of unnecessary catheter placement, removal of catheter as soon as possible, aseptic technique during catheter insertion, and minimal manipulation of catheter [32].

Prevention of catheter-associated urinary tract infections includes several recommendations, including education of personnel in proper techniques of catheter insertion and care, catheterizing only when necessary, emphasizing hand washing, using aseptic technique for catheter insertion, securing catheter properly, maintaining closed sterile drainage, obtaining urine samples aseptically, and maintaining unobstructed urine flow [43].

CDC highly recommends hand washing with either a nonantimicrobial soap and water or an antimicrobial soap and water when hands are visibly dirty or soiled with blood and other body fluids. If hands are not visibly soiled, alcohol-based hand rub may be used for routine decontamination of hands [31].

CDC guidelines address specific strategies in preventing intravascular catheter-associated infections, prevention of healthcare-associated bacterial pneumonia includes several category IA recommendations, including education of healthcare workers about infection control procedures, thorough cleaning of devices for sterilization or disinfection, changing the breathing circuit only when it is visibly soiled, hand hygiene, and change of soiled gloves [32].

Chapter II: General principles of infection control

The discipline that applies epidemiologic and scientific principles and statistical analysis for preventing or reduction in rates of nosocomial infections is known as **infection control**. Some experts in the field now prefer to use the phrase **"infection prevention and hospital epidemiology"** over the term infection control, as the words prevention and epidemiology more accurately define the discipline. Indeed, infection control is a key component of the broader discipline of hospital epidemiology. Effective infection control programs reduce rates of nosocomial infections and are cost-effective [34].

The recognition that infectious agents can be transmitted within hospitals to susceptible patients and health care workers began in the 1840s when Semmelweis noted that puerperal fever was associated with the lack of hand washing among clinicians performing autopsies. This discovery, in turn, led to the introduction of hand dips with chlorinated lime at Vienna General Hospital. Eventually these ideas evolved into current guidelines about hand washing, although Semmelweis promoted hand cleansing and, paradoxically, was opposed to hand washing with soap and water [35,36].

Infection control programs became a requirement in the United States largely as a result of the mandates of the Joint Commission for Accreditation of Hospitals (JCAHO) and the leadership guidelines and definitions of the Centers for Disease Control and Prevention (CDC).

In order to achieve the main goal of preventing or reducing the risk of hospital-acquired infections, a hospital epidemiology program should have the following oversight functions and responsibilities [(37)]:

1. Surveillance, either hospital-wide or targeted
2. Education about prevention of infections (e.g., by hand disinfection)
3. Outbreak investigations
4. Cleaning, disinfection, and sterilization of equipment and disposal of infectious waste
5. Hospital employee health, specifically after exposure to either bloodborne or respiratory pathogens
6. Review of antibiotic utilization and its relationship to local antibiotic resistance patterns
7. Prevention of infections due to intravascular devices
8. Development of infection control policies and procedures
9. Oversight on the use of new products that directly or indirectly relate to the risk of nosocomial infections

Hospital infection control departments usually derive authority and communicate with other administrative components of hospitals via an infection control committee. This committee typically includes representatives from medical and surgical services, nursing, microbiology, hospital administration, and employee health.

In order to be successful, infection control programs must have administrative support, resources, and an organizational commitment to a safety culture, [(38).] The authority of infection control personnel to direct policies and ensure compliance should be documented in writing and supported by the administrative leadership.

Four major areas of infection control will be reviewed:

1. Standard precautions, including hand hygiene
2. Isolation precautions
3. Environmental cleaning
4. Surveillance

Standard Precautions

Various forms of isolation have been used in an attempt to reduce the spread of nosocomial infections. In 1996, the CDC and Hospital Infection Control Advisory Committee (HICPAC) issued a new system of isolation precautions [(39)]. These guidelines were updated in 2007 [(38)].

Standard precautions are recommended in the care of all hospitalized patients. Standard precautions include the basic features of body substance isolation policies and universal precautions. When properly followed, they reduce the risk of transmission of infectious agents between patient and healthcare worker even when the presence of an infectious agent is unknown or not apparent.

Standard precautions apply whenever contact with blood, other body fluids, non-intact skin, mucous membranes and secretions and excretions except sweat is likely or possible [(39),(40)].They entail:

1. Hand hygiene before and after every patient contact (including hand hygiene after gloves are removed)
2. The use of gloves, gowns and eye protection in situations in which exposure to body secretions or blood is possible or likely
3. The safe disposal of sharp instruments and needles in impervious containers
4. The placement of soiled linens in impervious bags and bloody or contaminated materials such as feces or urine in sanitary toilets

The 2007 CDC guidelines included several additional components [(38)]:

1. Safe injection practices.
2. Use of a mask when prolonged procedures involving puncture of the spinal canal are performed (such as myelography, epidural anesthesia, and injection of chemotherapeutic agents).
3. Respiratory hygiene/cough etiquette, which applies to all patients and accompanying family or friends who have signs of respiratory illness such as cough, congestion, rhinorrhea or increased volumes of respiratory secretions. Such individuals should cover their nose or mouth when coughing, promptly dispose used tissues

and practice hand hygiene after contact with respiratory secretions. Use of a mask and spatial separation of such patients in waiting or patient care areas is also recommended [38].

Hand hygiene

Hand hygiene refers to either hand washing with soap and water or the use of alcohol-based gels or foams that do not require the use of water. Hand hygiene is the single most important measure to reduce transmission of microorganisms from one person to another or one site to another on the same patient [41].The primary problem with hand hygiene is laxity of practice, not a paucity of good products[42].

Clean Your Hands annual initiative is part of a major global effort led by the World Health Organization (WHO). It includes the "My Five Moments for Hand Hygiene", which define the key moments when healthcare workers should perform hand hygiene. This evidence-based, field-tested approach is applicable in a wide range of settings. The WHO approach recommends HCWs clean their hands:

1. Before touching a patient
2. Before clean/aseptic procedures
3. After body fluid exposure/risk
4. After touching a patient
5. After touching patient surroundings

The 2010 National Patient Safety Goals developed by the Joint Commission require all US hospitals to develop formal programs to promote and monitor hand hygiene by healthcare workers. Compliance became a criterion for hospital accreditation in January 2010.

Soap and water

CDC guidelines advise use of a plain (nonantimicrobial) soap with water for routine hand washing, with use of an antimicrobial agent for specific circumstances [42]. There are limited data with respect to the choice of plain soap, antiseptic soap, or antiseptic hands rub [33].

There are a number of problems with hand washing with soap and water:

1. In the past, compliance with hand washing rarely exceeded 45 percent, even under study conditions and even in intensive care units[44]. However, aggressive programs to improve compliance with hand hygiene, as outlined by the 2010 National Patient Safety Goals, have been highly successful in many institutions. Unfortunately proper technique is often not followed when hand washing is performed. In one report, for example, the mean observed washing time was usually less than 10 seconds, compared with the recommended 15 to 30 seconds. The importance of duration of hand washing was illustrated in a study in which vancomycin-resistant enterococci (VRE) were inoculated onto the hands of healthy volunteers [45] .A 30-second wash with water plus soap was necessary to completely eradicate VRE hand carriage. In contrast, a 5-second wash with water alone produced virtually no change in VRE recovery.
2. The frequency of hand washing by HCWs is affected by the accessibility of sinks and by the characteristics of the soap used (eg, its smell, consistency, color, and even the ease in which the soap induces lathering) [42]. In addition, the location and type of soap dispensers can affect compliance.
3. Hand washing with plain soap does not consistently or reliably prevent microbial transmission [46].
4. Frequent handwashing may cause skin damage and irritation, with resultant changes in microbial flora, increased skin shedding, and risk of transmission of microorganisms[46].
5. **Alcohol based hand disinfection — Alcohol-containing hand disinfection** (AHD) is an effective and practical alternative to standard soap and water. Alcohol-based hand hygiene products have rapid antimicrobial effects and are equally effective against gram-positive and gram-negative organisms (when compared with chlorhexidine) [47]. Alcohol-based preparations also require less time than chlorhexidine gluconate to affect a maximum reduction in bacteria counts and are at least as tolerable on skin as are antiseptic detergents [46].
6. AHD is easier to perform and faster than hand washing with soap and water. This was illustrated in a study that estimated the time required for hand washing and bedside AHD in a typical 14-bed intensive care unit (ICU) with 12 healthcare workers, using an ideal duration of hand washing of 40 to 80 seconds and 20 seconds for AHD [47]. If 100 percent compliance were achieved, hand washing would consume 16 hours of nursing time per day shift (24hours), compared with only three hours required for AHD.

These benefits have led to improved compliance and reductions in nosocomial infections [48]. In a report from a Swiss teaching hospital, introduction of a bedside alcohol-based hand disinfectant led to a significant improvement in hand hygiene compliance and decreased the rates of nosocomial infection (9.9 versus 16.9 percent) and transmission of methicillin-resistant Staphylococcus aureus (0.9 versus 2.2 episodes per 10,000 patient days) [49].

Although AHD improves hand hygiene adherence rates, it is only one component for prevention of infection. A crossover trial of alcohol-based hand gel demonstrated that improved hand hygiene adherence was not associated with detectable changes in the incidence of healthcare-associated infection, although the study was underpowered to detect a statistically significant effect [50].

An important limitation of AHD is that it does not reduce the incidence of Clostridium difficile colitis [48]. This reflects the lack of activity of alcohol-based hand rubs against spore-forming bacteria.

Monitoring compliance

Monitoring of hand hygiene compliance by dedicated trained personnel is considered to be the most reliable method, but it is time consuming and expensive, and the results are subject to sampling biases. Alternatives such as monitoring use of hand hygiene products such as soap or alcohol foam are less useful. Electronic methods to monitor compliance suffer from a variety of methodological problems [51].

Fingernails

Much of the resident microflora of hands is found in the periungual and subungual areas. When the fingernails are long and when artificial fingernails are worn, there is an increase in periungual colonization with a variety of pathogens [42].Thus care should be taken to specifically clean fingernails and the surrounding periungual areas during hand hygiene.

Both artificial fingernails and inadequately cleaned native fingernails have been epidemiologically linked to outbreaks of infection in intensive care unit patients, neonates, and patients undergoing surgery [52, 53, and 54]. Freshly applied nail polish does not increase the number of bacteria recovered from periungual skin, but chipped nail polish has been associated with increased numbers of organisms on fingernails. These organisms are not routinely removed by careful hand washing or even by surgical scrubs [42].

Guidelines from the CDC and Association of Operating Room Nurses (AORN) prohibit the use of artificial fingernails or extenders by health care workers with "direct contact with patients at high risk" (e.g., those in intensive care units or operating rooms).

There is no consensus on the need to prohibit the wearing of rings in healthcare settings, even though several studies have shown that skin beneath rings is more heavily colonized with bacteria than adjacent skin not covered by rings [42].

Gloves

In addition to hand washing, gloves play an important role in reducing the risks of transmission of microorganisms. There are three important reasons why gloves should be worn by hospital personnel [39]:

1. To provide a protective barrier for the hands from contaminated material such as blood or body fluids, or other potentially infectious material (such as vomit or feces) or from contaminated equipment.
2. To reduce the chance of skin acquisition (colonization) of healthcare workers with microorganisms from a patient who is colonized or infected with pathogenic organisms.
3. To reduce the transmission of existing microorganisms on the hands of hospital staff to patients

However, wearing gloves does not replace the need for hand hygiene for several reasons: (1) gloves may have small defects or tears that are unapparent, and (2) hands routinely become contaminated during removal of gloves. This was illustrated in a report that examined 206 glove pairs after they were worn by surgeons. Unrecognized perforations were noted in 14 percent; the majority was on the thumb and index fingers of the gloves. Surgical experience, type of gloves, type of surgery, and double gloving did not affect rates and sites of perforation. Reinforcement of the thumb and index fingers of gloves may be a way to reduce perforation risk [55].

Masks

Masks are used for three purposes in infection control:

1. To protect healthcare personnel from infectious material from patients (such as respiratory secretions and aerosols containing blood or body fluids).
2. To protect patients undergoing sterile procedures from respiratory aerosols generated by healthcare personnel.
3. To limit spread of infectious respiratory secretions from patients who are coughing.

Masks should not be confused with particulate respirators that are used to prevent transmission by airborne droplet nuclei of infectious agents such as M. tuberculosis.

Isolation Precautions

In addition to the standard precautions, there are 3 isolation categories that reflect the major modes of microorganism transmission in nosocomial settings: contact, droplet, and airborne spread [39]. The rooms of patients requiring contact precautions should be clearly marked with signs containing instructions regarding the type of precautions that must be observed. Ample supplies should be readily available outside the patient room to facilitate adherence, and hospital policies should be enforced [56].

Contact precautions

Microorganisms can be transmitted to patients via contact between the patient and a healthcare worker, or by contact between the patient and a contaminated object (such as toys, clothing, inadequately disinfected endoscopes or other medical equipment) [57, 58, and 59].

Contact precautions are recommended for the care of patients with selected multidrug-resistant bacteria, and various enteric, parasitic, and viral pathogens. Ideally, patients who require contact precautions should either be in a private room or cohorted with patients who have the same active infection or are colonized with the same pathogen [39].

Healthcare workers involved in the care of patients on contact precautions should wear non-sterile gloves for all patient contact. Gowns are required if there is likely to be substantial direct contact with the patient or any infective material. Gowns and gloves should be removed prior to exiting isolation rooms, and hand hygiene must be performed immediately after patient contact. Medical equipment should be dedicated to a single patient when possible, to avoid transfer of pathogens via vomits. Equipment that must be shared should be cleaned and disinfected before use for another patient [56].

Many healthcare workers incorrectly believe that the use of gloves and hand washing are not required upon room entry for patients on contact precautions if no direct contact with patients is anticipated. In fact, the environment in the rooms of such patients are frequently heavily contaminated with pathogens such as methicillin-resistant Staphylococcus aureus, vancomycin-resistant enterococci, and Clostridium difficile, thus indirect contamination of hands or clothing is likely to occur if appropriate isolation equipment is not used and if hand hygiene is ignored.

Droplet precautions

Droplets are particles of respiratory secretions larger than 5 micron. Because droplets remain suspended in the air for limited periods, exposure of less than 3 feet (1 meter) is usually required for human-to-human transmission of droplet-borne pathogens. However, investigations during the 2003 outbreak of severe acute respiratory syndrome (SARS) suggested that droplets can occasionally be transmitted up to 6 feet from the source patients [38].

Droplet precautions should be used in the care of patients with suspected or confirmed infections with Neisseria meningitidis, Bordetella pertussis, influenza, adenovirus, Haemophilus influenzae type b, Mycoplasma pneumoniae, rubella, and other pathogens spread by droplets. A few organisms (eg, some respiratory viruses) can be transmitted by droplets and via direct patient contact. In this setting, both droplet and contact precautions should be implemented [38].

Health care workers within six to ten feet of patients on droplet precautions should wear a facemask. Special air handling systems and use of higher level respirator masks are NOT required for the care of patients with diseases that are capable of droplet transmission. The doors of rooms used to house these patients may remain open, in contrast to airborne precautions [38].

Airborne precautions

In contrast to larger droplets in the preceding section, airborne droplet nuclei are particles of respiratory secretions smaller than 5 micron. Droplet nuclei can remain suspended in the air for extended periods, and thus they can be a source of human inhalational exposure to susceptible individuals.

Airborne precautions should be used in the care of patients with suspected or confirmed tuberculosis (TB), measles, Varicella, smallpox and SARS. TB is principally transmitted in hospitals by droplet nuclei, and thus the hospital can be a place where TB is transmitted to other patients and healthcare staff, [60, 61]. Healthcare workers immune to measles or varicella don't need to wear respiratory protection. Also, airborne precautions are not needed in the setting of herpes zoster infection [62].

Although SARS is transmitted predominantly by droplet spread and direct contact, airborne transmission can also occur. As a result, the CDC recommends contact and airborne precautions for this condition [63].

Patients placed on airborne isolation precautions should be placed in an airborne infection isolation room (AIIR). The AIIR should be a private room with negative air pressure and a minimum of 6 to 12 air changes per hour. Doors to the isolation rooms must remain closed, and all persons entering must wear a respirator with a filtering capacity of 95 percent that allows a tight seal over the nose and mouth [38].

If patients in respiratory isolation require transport outside their isolation rooms for medical procedures, they should wear surgical masks that cover their mouths and noses during transport. Procedures for these patients should be scheduled at times when they can be performed rapidly and when waiting areas are less crowded [38].

Immunocompromised patients

Special protective environments are used for patients undergoing hematopoietic cell transplantation to minimize their exposure to invasive fungal infections such as aspergillosis. Such protective environments include HEPA filtration of incoming air, positive room air pressure relative to corridors, directed room air flow, ventilation systems that provide at least 12 air changes per hour, dust control measures and the prohibition of flowers and potted plants in patient rooms.

High-Efficiency Particulate Air or HEPA is a type of air filter that remove 99.97% of all particles greater than 0.3 micrometer from the air that passes through. A filter that is qualified as HEPA is superior to those unqualified[66].

Environmental Cleaning

Environmental cleaning, disinfection, and sterilization are basic and important measures used to prevent or reduce infections in the hospital environment. The oversight and monitoring of cleaning, sterilization, and disinfection practices are direct responsibilities of an infection control unit. The exact definition of each term is important, since protocols for each procedure are different and their use in hospital infection control has to be precisely determined.

Cleaning

Cleaning is the removal of all foreign material (eg, soil, organic material) from objects. It is normally accomplished with water, mechanical action, and detergents or enzymatic products. Meticulous physical cleaning must always precede disinfection and sterilization procedures [64, 65],and is adequate alone for cleaning items such as blood pressure cuffs.

Enforcement of routine environmental cleaning measures, as illustrated in a nonrandomized hospital based intervention study, was remarkably effective in reducing vancomycin-resistant enterococcus (VRE) acquisition among patients in a medical intensive care unit [66].

The importance of environmental decontamination of rooms previously occupied by patients with MRSA and/or VRE in ICUs is illustrated by a retrospective cohort study of patients admitted to eight ICUs [67]. Patients admitted to rooms previously occupied by patients colonized or infected with MRSA or VRE were significantly more likely to become MRSA or VRE colonized than patients admitted to rooms whose prior occupant was MRSA or VRE negative.

Ultraviolet markers may be used to assess the adequacy of environmental cleaning. In one study in which investigators evaluated for persistence of fluorescent markers on environmental surfaces, the efficacy of routine cleaning improved from 49 to 82 percent [(68)]. Monitored environmental cleaning should be a fundamental component of all hospitals' commitment to basic hygiene [(69)].

Disinfection

Disinfection describes a process that eliminates many or all pathogenic microorganisms from inanimate objects, except for bacterial spores. In healthcare settings, disinfection is usually accomplished by the use of liquid chemicals. The efficacy of disinfection is affected by several factors [(65)]:

1. Previous physical cleaning of the object
2. Organic load on the object
3. Type and level of microbial contamination
4. Concentration of and exposure time to the germicide
5. Physical configuration of the object
6. Temperature and pH of the disinfection process

Sterilization

Sterilization is the complete elimination of all forms of microbial life. Sterilization can be accomplished by either physical or chemical processes. Steam under pressure, dry heat, low temperature sterilization processes (ethylene oxide gas, plasma sterilization), and liquid chemicals are the main sterilizing agents used**,** Steam sterilization remains the most widely used technique [(64, 65)].

Reuse of single-use medical devices — Reuse of devices labeled "single-use only" remains controversial. Many such devices are costly, but their reuse may include the risk of exposing patients to cross-infection [(70)]. Reuse is only acceptable if several important criteria are met:

1. The device can be adequately cleaned and sterilized
2. The cleaning process does not adversely affect the quality of the device
3. The device will remain safe and effective for its intended use

Commonly reused "single-use" devices include [(70)]:

1. Diathermy pencils used in surgery
2. Scissors and forceps used in laparoscopic surgery
3. Sclerosing needles, snares, and cytology brushes used in endoscopy
4. Stone-removing baskets, and balloon dilators used in ERCP
5. Angiography catheters used in both cardiology and radiologic imaging
6. Cardiac catheters, pacing electrodes, and pacemakers used in cardiology
7. Bone-marrow trephine sets
8. Plasma membrane filters used in hemodialysis
9. Stopcocks used in bronchoscope [(71)]

Satisfactory cleaning and sterilization of any device should theoretically prevent infection transmission and make "single-use" devices safe to reuse. However, the physical characteristics of some devices (especially those constructed with heat-sensitive materials) may not withstand the process of sterilization and disinfection. Devices with a hollow narrow lumen or tiny narrow crevices and/or devices that cannot be disassembled for cleaning may be difficult or impossible to reliably clean and sterilize via autoclaving or with ethylene oxide. Even when requirements for satisfactory cleaning are followed, organic material frequently remains on these devices [(70)]**.**

Plasma sterilization

Low-temperature plasma is a promising method for destroying microorganisms, an alternative to conventional methods which have numerous drawbacks. Several plasma-based sterilization technologies are presently under development, but their mechanisms of action are still incompletely understood. The mechanism of etching (volatilization) of microorganisms by plasma may constitute a powerful solution to the clinical problems of deactivating also prions and endotoxins. However, plasma effectiveness is influenced by numerous experimental parameters. These inherent complexities, and the weak penetrating power of plasma species, that severely limits plasma effectiveness in the presence of organic residues, packaging material, or complex geometries, is the main limitations of plasma sterilization.

Disease transmission

Iatrogenic transmission of Creutzfeldt-Jakob disease (CJD) has occurred in neurosurgical patients when contaminated neurosurgical instruments, such as an implantable electrode that had previously been used in a patient with known CJD, were reused. The electrode had been "sterilized" with 70 percent alcohol and formaldehyde vapor, yet two years later the electrode was retrieved and implanted into a chimpanzee in which the disease subsequently developed. Contaminated neurosurgical instruments have been suspected as modes of transmission in other patients. The following agents cannot inactivate the CJD prions protein: alcohol, ethylene oxide, formaldehyde, glutaraldehyde, hydrogen peroxide, iodine, ionizing radiation, phenolics, quaternary ammonium compounds, steam sterilization at 121ºC, and urea at concentrations of 6 to 8 mol/L [72].Recommendations for sterilization require: precleaning, soaking in 1 to 2N sodium hydroxide for one hour, followed by steam sterilization at 121ºC for 30 minutes. Also, precleaning, and sterilization at 132ºC for 30 minutes without soaking in sodium hydroxide.

Instruments used in neurosurgery on known or suspected cases CJD should not be autoclaved and reused, but should be discarded, [73]. Pseudo-outbreaks of infection from reuse of single-use devices [71] and cross-infection with serious blood borne pathogens have been reported [74]. The Food and Drug Administration (FDA) recommends that single-use devices must be reprocessed with the same quality assurance and safety criteria used by the original manufacturer. One group studied whether reprocessed single-use devices would meet regulatory standards for sterility [75].Shockingly, they found that none of the reprocessed single-use instruments were effectively cleaned, disinfected, or sterilized. Given the stringency of the FDA directives, and the above data, it is likely that hospitals cannot comply with the regulations on reuse.

Chapter III: Infection Control Measures in Anesthesia

Environmental hygiene in hospitals encompasses a wide range of routine activities that are important in the prevention of healthcare associated infections (HAI). The hospital must be visibly clean and acceptable to patients, visitors and staff. Statutory requirements must be met in relation to safe disposal of clinical waste, laundry and linen. Bed occupancy should ensure enough time between patient admissions to ensure adequate cleaning and decontamination of the patient area. Healthcare providers are responsible for the health and safety of their employees and others (including visitors and patients), and the control and management of the risk of infection [76].

Anesthetists will be involved in the care of patients who may harbor potentially pathogenic organisms, which may not be obvious or readily identifiable. Precautions aimed at preventing the transmission of organisms between patient and anesthetist or between patients must be a routine part of anesthetic practice. Preventative measures should be based on the likelihood of an infectious agent being present, the nature of the agent and the possibility of dispersion, e.g. splashing [76].

Hand hygiene

Anesthetists must ensure that good hand hygiene becomes an indispensable part of their clinical culture. Hand-mediated transmission is the major contributing factor to infection associated with healthcare [77].Effective hand decontamination immediately before every episode of direct patient contact will result in a significant reduction in the transfer of potential pathogens and a decrease in the incidence of preventable HAI. Despite consistent advice, staff often neglect hand hygiene when caring for patients [49].

At the start of every session, and when visibly soiled or potentially contaminated, hands must be washed with liquid soap and water. When there is no soiling, the staff should use an antimicrobial hand rub between patients or activities, as this is effective and quicker. It is vital to ensure that the whole hand and fingers (particularly the tips), are exposed to the hand rub. Antimicrobial hand rub is not effective in preventing cross infection with Clostridium difficile[78].

Trusts must ensure that sinks, soap and antimicrobial hand rubs are conveniently placed to encourage regular use. Watches and jewelry (including dress rings and wrist adornments) must be removed at the beginning of each clinical session, before regular hand decontamination begins. Cuts and abrasions must be covered with waterproof dressings, which must be changed as appropriate. Staff with dermatitis, psoriasis or other skin conditions should consult the Occupational Health Department for further advice [79].

Gloves

It is important to undertake a risk assessment regarding the safe use of gloves. Although they may offer some protection against inoculation with blood-borne viruses, incorrect use of gloves could actually spread infection between patients. Sterile gloves must be worn for invasive procedures and contact with sterile sites. Non-sterile examination gloves must be worn for contact with mucous membranes and all activities that carry a risk of exposure to blood, body fluids, secretions and excretions. All blood and body fluids, substances, secretions and excretions may be considered to be potentially infective regardless of the perceived risk of the source [80].

Gloves must be worn as single-use items. They should be put on immediately before an episode of patient contact and removed as soon as the activity is completed, and before contact with fomites, including curtains, pens, clinical notes, keyboards and telephones. Gloves should be changed between patients and between different procedures on the same patient. Gloves must be disposed of as clinical waste and hands should be washed or decontaminated following the removal of gloves. It has been demonstrated that 98% of anesthetists' contact with patients' blood could be prevented by routine use of gloves [80].

Gloves of an acceptable quality must be available in all clinical areas. Latex-free gloves must be available for use for staff or patients who have an allergy or sensitivity to rubber gloves.

Facemasks

The use of facemasks to decrease the incidence of postoperative wound infection has been questioned. However, masks with a face shield should be worn when there is a risk of blood, body fluids, secretions and excretions splashing into the face and eyes. Masks must also be worn by anesthetists when carrying out a sterile procedure under full aseptic conditions. If worn, masks should not be taken down to speak and should be changed if they become damp or contaminated. Masks must only be handled by the ties. Correctly fitting facemasks may also give some protection to the anesthetist against inhaling infected droplets from the respiratory tracts of patients with infectious respiratory diseases [81].

Theatre caps

Theatre personnel in most UK operating theatres wear disposable headgear although there is little evidence for the effectiveness of this practice except for scrub staff in close proximity to the operating field. However, theatre caps should be worn in laminar flow theatres during prosthetic implant operations [82].

Theatre suits and gowns

The skin of staff working in the operating theatre is a major source of bacteria that have the potential for being dispersed into the air. Clean theatre suits should be available for all staff in theatre. Full body, fluid-repellent gowns should be worn where there is a risk of extensive splashing of blood, body fluids, secretions and excretions. Sterile gowns should be worn when invasive procedures are undertaken. Disposable plastic aprons are often worn on wards in situations where there is a risk of physical soiling of clothing in order to prevent transmission of infection between patients [82].

Contaminated clothing should be changed and safely discarded into an appropriate receptacle at the earliest opportunity. There is little evidence to show that wearing surgical attire outside the theatre and returning to the theatre without changing increases surgical wound infection rates. With the widespread move to admission on the day of surgery, the times when anesthetists will have to leave theatre have increased and repeated changing will impact on theatre efficiency. Local policies must be developed and reflect the necessity for 'theatre discipline' and allay perceived concerns of patients and visitors. Local policies should be agreed between all theatre users and Trusts must ensure adequate provision of appropriate clothing [83].

Shoes and overshoes

Special footwear should be worn in the operating department and cleaned if contaminated or after every use. Trusts should ensure that a system for cleaning theatre footwear is in place in each theatre suite. Plastic overshoes may increase bacterial contamination of floors and, in addition, hands become contaminated when overshoes are put on or removed. Their use is not recommended [82].

Movement within the theatre complex

To reduce airborne contamination, general traffic in and out of the operating theatre itself should be kept to a minimum. Doors should be kept closed to ensure the efficiency of the ventilation system [82].

Moving patients on their beds into the operating theatre may increase the bacterial count on floors, but it is claimed that this is of little significance if bed linen is changed before transfer. All used linen must be handled safely to minimize the risk of contamination of the environment and staff. Used bed linen must be handled with care to reduce the release of small fomite particles into the air – bed linen should be 'bagged' by the bed or patient trolley. The use of separate trolleys from ward to transfer area and transfer area to table has not been shown to have benefit although this practice continues in many operating areas. If entering the operating theatre itself, visitors should change into theatre suits and wear designated footwear [82].

Order of patients

There should be a written hospital policy requiring accurate printed theatre lists to be available prior to the scheduled date. 'Dirty cases', i.e. patients likely to disperse microbes of particular risk to other patients, should be identified before surgery and theatre staff should be notified. These patients should be scheduled last on an operating list to minimize risk. Where this is not possible, the Hospital Infection Society (HIS) advises that a plenum-ventilated operating theatre should require a minimum of 15 min before proceeding to the next case after a 'dirty' operation [84].

The most probable routes for transmission of infection between successive patients are airborne or on items and surfaces that have been in contact with the patient. Appropriate cleaning of the operating theatres between all patients should be undertaken. Whenever there is visible contamination with blood or other body materials, the area must be disinfected with sodium hypochlorite (according to local protocols) and then cleaned with detergent and water. Floors of the operating room should be disinfected at the end of each session [85].

Safe use and disposal of sharps

Accidental injury has long been recognized as an occupational hazard in the healthcare setting. Accidental inoculation with infected blood, however small in amount, presents a significant risk to anesthetists.

In the UK, 16% of occupational injuries occurring in hospitals are attributed to sharps injuries. These are predominantly caused by needles and are associated mainly with venepuncture, administration of intravenous drugs and recapping of needles. These should be preventable by adhering to national guidelines and agreed standards [86]:

1. Sharps must not be transferred between personnel and handling should be kept to a minimum.
2. Needles must not be bent or broken prior to use or disposal.
3. Needles and syringes must not be disassembled by hand prior to disposal.
4. Needles should not be recapped or resheathed.
5. Used sharps must be discarded into an approved sharps container at the point of use.
6. The sharps container should be sealed and disposed of safely by incineration when about two-thirds full or in use for more than four weeks.
7. Blunt aspirating needles should be used for drawing up drugs.

Preventing contamination of drugs

Drugs and fluids require safe handling by anesthetists, who should follow local protocols for preparation and administration to prevent contamination. Syringes and needles are sterile, single-use items and, after entry or connection to a patient's vascular system or attachment to infusions, a syringe and needle should be considered contaminated and used only for that patient. A syringe must not be used for multiple patients even if the needle is changed. Before use, prepared syringes and needles should be stored in a clean container and syringes capped to avoid contamination. After use or at the end of the anesthetic, all used syringes with needles should be discarded into an approved sharps container [87].

Care must be taken when drawing up drugs. Single use ampoules should be discarded after the required amount of drug is drawn up and not re-used for subsequent patients. Ampoules can be kept for identification purposes and discarded at the end of the list. Multiple-use ampoules are not recommended.

All infusions, administration sets or items in contact with the vascular system or other sterile body compartments are for single-patient use. An aseptic technique should be used when preparing infusions and breaks/taps in lines should be kept to a minimum. Injection ports should be maintained with a sterile technique, kept free of blood and covered with a cap when not in use. Connections and injection ports in intravenous lines should be kept to a minimum [87].

Anesthetic equipment and infection control

Items of anesthetic equipment may become contaminated either by direct contact with patients, indirectly via splashing, by secretions or from handling by staff. Contamination is not always visible and all used pieces of equipment must be assumed to be contaminated and disposed of or, if reusable, undergo a process of decontamination. The Code of Practice has specific requirements for the decontamination of surgical equipment and other equipment used in patient care. There is a need to designate a person who is responsible for ensuring equipment cleanliness [88].

Single-use equipment

Where appropriate; single-use disposable equipment will remove the difficulties of re-use and decontamination procedures. The use of such equipment is to be encouraged. However, there are problems of cost, storage and disposal of single-patient use devices and for some equipment there is no feasible disposable alternative. The balance between single-use items and re-usable equipment will require local determination based on an assessment of patient safety, the available facilities and cost. Packaging should not be removed until the point of use for infection control, identification, traceability in the case of a manufacturer's recall, and safety [89].

A multidisciplinary research team at the University of Nottingham has carried out a study investigating the use and re-use of single-use devices in English NHS operating theatres. The published paper clarified some of the issues around single-use devices such as single-use equipment that must be immediately discarded after use, e.g. suction catheters, and some that may be re-used in the same patient in the same episode, e.g. disposable laryngoscope blades [90].

Decontamination

Decontamination is a combination of processes including cleaning, disinfection and/or sterilization used to make a re-usable item safe to be handled by staff and safe for further use on patients. Effective decontamination of re-usable devices is essential in reducing the risk of infection. It is recommended that each department identifies a designated consultant who, in conjunction with the appropriate bodies in their Trust, will develop specific guidelines for anesthetic practice which satisfy national recommendations and that these practices are audited on a regular basis [91].

Decontamination processes

Cleaning–

Removal of foreign material from an item. This usually involves washing with a detergent to remove contamination followed by rinsing and drying. All organic debris, e.g. blood, tissue or body fluids, must be removed before disinfection or sterilization, as its presence will inhibit disinfectant or sterilant from contacting microbial cells. Cleaning before sterilization is of the utmost importance in the effectiveness of decontamination procedures in reducing the risk of transmission of prions.

Low Level Disinfection:

Kills most vegetative bacteria (except TB and endospores), some fungi and some viruses using disinfectants such as sodium hypochlorite, 70% alcohol and chlorhexidine.

High Level Disinfection:

Kills vegetative bacteria (not all endospores), fungi and viruses. With sufficient contact time (often several hours), these high level disinfectants may produce sterilization, e.g. the use of aldehydes, peracetic acid and chlorine dioxide.

Sterilization:

A process used to render an object free from viable micro-organisms, including all bacteria, spores, fungi and viruses, with techniques such as autoclaving [91].

Risk assessment

The choice of equipment and/or the level of cleanliness/disinfection/sterility required of re-usable items may be assessed against the risk posed to patients of transmission of infection during any procedure in which the equipment is employed. It has been proposed by the MHRA Microbiology Advisory Committee that three levels should be considered:

1. High Risk–the device will penetrate skin or mucous membranes enter the vascular system or a sterile space–these devices require sterilization e.g. central lines.
2. Intermediate Risk–the device will be in contact with intact mucous membranes or may become contaminated with readily transmissible organisms–these devices require high level disinfection or sterilization e.g. laryngoscope .
3. Low Risk–the device contacts intact skin or does not contact patient directly–these devices require low level disinfection or cleaning e.g. Anesthesia machine.

Infection control policy in anesthesia

Anesthetic face masks

Although normally in contact with intact skin, these items are frequently contaminated by secretions from patients and have been implicated in causing cross-infection; local disinfection is not normally effective. These items should be single-use items [92].

Airways and tubes

Oral airways, nasal airways and tracheal tubes should be of single-use type since they readily become contaminated with transmissible organisms and blood. Ideally, supraglottic airways should be of the single-patient use type but the re-usable design is in common use and many anesthetists perceive it as being less traumatic. Therefore, a supraglottic airway designed for repeated use should be sterilized {in an audited sterile service department (SSD)} no more often than the manufacturer recommends. A supraglottic airway used for tonsillectomy or adenoidectomy should not be used again. The AAGBI recommends single-use supraglottic airways [93].

Catheter mounts–angle pieces

It is recommended that these items are single-patient use type.

Anesthetic breathing systems

The AAGBI has previously recommended that 'an appropriate filter should be placed between the patient and the breathing circuit (a new filter for each patient)'. Although it appears that pleated hydrophobic filters have a better filtration performance than most electrostatic filters, the clinical relevance of this has yet to be established [94].

The AAGBI recommends that anesthetic circuits are routinely changed on a daily basis. If visibly contaminated or used for highly infectious cases, e.g. tuberculosis, the circuits should be changed between patients and safely discarded. No attempt should be made to reprocess these items [94].

Anesthetic machines

Routine daily sterilization or disinfection of internal components of the anesthetic machine is not necessary if a bacterial/viral filter is used between patient and circuit. However, manufacturers' cleaning and maintenance policies should be followed, and bellows, unidirectional valves and carbon dioxide absorbers should be cleaned and disinfected periodically. All the surfaces of anesthetic machines and monitors should be cleaned on a daily basis with an appropriate disinfectant or immediately if visibly contaminated [95].

Laryngoscopes

As with anesthetic facemasks, laryngoscopes are known to become contaminated during use. Current practices for decontamination and disinfection between patients are frequently ineffective, leaving residual contamination that has been implicated as a source of cross-infection, [96,97]. Blades are also regularly contaminated with blood [98], indicating penetration of mucous membranes, which places these items into a high-risk category. Proper cleaning of laryngoscope blades is of great importance before decontamination/sterilization, particularly of residue around light sources or articulated sections. New purchases should be of a design that is easy to clean. Although repeated autoclaving may affect the function of laryngoscopes [99] the Working Party recommends that re-usable laryngoscope blades should be sterilized by an audited SSD between patients, following the manufacturers' instructions. Plastic sheaths may be used to cover blades and handles to reduce contamination but it has been noted, especially with blade covers, that these have created difficulties during tracheal intubation.

There are an increasing number of inexpensive, single-use laryngoscope blades and handles of improving design available, and their use is to be encouraged. The choice of blade must be dictated by Departments of anesthesia. Traditional blades should be available at all times in case difficulty is encountered[100].

Laryngoscope handles also become contaminated with micro-organisms and blood during use, and they should be washed/disinfected and, if suitable, sterilized by SSDs after every use. The knurled handles of laryngoscopes cannot be cleaned reliably manually if covered in blood or body fluids[100].

Anesthetists should show great care when handling laryngoscopes: wear gloves during intubation and place used instruments in a designated receptacle to prevent contamination of surfaces, pillows and drapes[100].

Fibreoptic bronchoscopes
These are expensive items which cannot be autoclaved. Decontamination is dependent on sufficient contact time with high level disinfectants and it is particularly important that the washing and cleaning process removes all tissue residues from the lumens. Decontamination is best achieved with an automated system [90].

Bougies
Re-use of these items has been associated with cross-infection. Manufacturers recommend that a gum elastic bougie may be disinfected up to five times between patients and stored in a sealed packet. It is preferable that alternative single-use intubation aids are employed when possible [101].

Surfaces
The surfaces of anesthetic machines and monitoring equipment, especially those areas which are likely to have been touched by the gloved hand that has been in contact with blood or secretions, should be regarded as contaminated and should be cleaned at the earliest opportunity, probably between patients. Local policies should be in place to ensure that all equipment that touches intact skin, or does not ordinarily touch the patient at all, is cleaned with a detergent at the end of the day or whenever visibly contaminated. This includes non-invasive blood pressure cuffs and tubing, pulse oximeter probes and cables, stethoscopes, electrocardiographic cables, blood warmers etc., and the exterior of anesthetic machines and monitors. Items such as temperature probes should be for single patient use.

Oxygen masks and tubing
Single-patient use products should be used.

Resuscitation equipment
Single-patient use equipment should be kept in a sealed package or should be re-sterilized between patients according to the manufacturer’s instructions. All training equipment should be handled similarly.

Prions diseases
Transmissible Spongiform Encephalopathies (TSEs) are a group of illnesses in which there is progressive neurological degeneration associated with characteristic pathological changes. TSEs are caused by abnormal prions, which are infectious proteins. Microscopic traces of tissue often remain on surgical instruments after washing and autoclaving or disinfecting and any prion protein in these traces could still transmit the disease if inoculated into another patient. However, successive washing after use reduces the concentration so that, after about 10 decontamination cycles, infectivity becomes negligible [102].

Anesthetic management of cases of CJD
Isolation is not needed. Blood and other samples should be labeled ‘Biohazard’. Invasive procedures such as central venous cannulation and spinal anesthesia mandate the use of full aseptic procedures, including mask and eye protection. The area around where invasive procedures are performed should be clear enough to allow easy mopping of spillages. High infectivity tissues are those in the brain, spinal cord and posterior eye; medium risk tissues–any needles or probes used by anesthetists near these tissues will be disposable [102].

Infection control precautions for anesthetic procedures

Carrying out procedures in an operating theatre does not pose a lower risk of infection than other hospital locations and the risk of infection depends on the procedure and on the level of barrier protection rather than the surrounding environment.

Maximal barrier precautions

Maximal barrier precautions involve full hand washing, the wearing of sterile gloves and gown, a cap, mask and the use of a large sterile drape. The skin entry site should be cleaned with an alcoholic chlorhexidine gluconate solution or alcoholic povidone-iodine solution. The antiseptic should be allowed to dry before proceeding [(103)].

Certain invasive anesthetic procedures require this optimum aseptic technique:

1. Insertion of central venous catheters.
2. Spinal, epidural and caudal procedures.

The Working Party is aware that many anesthetists do not employ this level of asepsis for 'one-shot' spinals or epidurals but believes that, when central neural spaces are penetrated, full aseptic precautions are required.

Comprehensive guidelines have been prepared for insertion and maintenance of central venous cathetersand are commended to all anesthetists. The use of care bundles has been advocated by IHI (Institute of Health Improvement) to reduce catheter related bacteremia. Originally developed in the USA, Care Bundles is an approach that systematically appraises clinical processes. It is based on measuring the actual provision of therapeutic interventions according to standards, informed by evidence, which local clinicians set themselves [(104)].

Other barrier precautions

Certain invasive procedures do not require full barrier precautions as above but nevertheless demand appropriate aseptic techniques. Such precautions involve the wearing of sterile gloves and use of small drapes, although similar attention is required to hand washing and skin preparation. These procedures include:

1. Peripheral regional blocks.
2. Arterial line insertion.

Peripheral venepuncture or intramuscular injection in low-risk patients will involve hand-washing, non-sterile gloves and skin preparation with propyl alcohol. Peripheral intravenous catheters are a significant source of nosocomial bacteremia and care is required [(105)].

High-risk patients

Certain patients may be especially vulnerable to infection, e.g. the immune-compromised, or offer particularly high risk of transmitting infection, e.g. tuberculosis and HIV. For the immune-compromised, maximal barrier precautions are required for all invasive procedures and similarly, where there is a high infection risk, staff should concentrate not only on preventing cross-infection between patients but in protecting themselves by ensuring compliance with all precautions [(106)].

Antiseptic commonly used

Iodophors:

Contains iodine in a complex form. This is relatively nonirritating and nontoxic. Effective against a broad range of microorganisms. Less irritating to the skin. Recommended for surgical scrub and is the best antiseptic for use in the genital area, vagina, and cervix. Iodophors are effective few minutes after application. Do not dilute them.Popular brand: Betadine.

Chlorhexidine Gluconate:

Useful against a broad range of microorganisms, but the effect is minimum on tuberculosis and fungi. Remains effective for at least 6 hours after being applied. Has a good, persistent effect. If irritaion occurs, it can be reduced by hard water, creams, and natural soaps. This is also used for surgical scrub and skin prep, in the genital area, vagina, and cervix.Popular brand: Peridex, Betasept.

Iodine:
This is a popular antiseptic used against a broad range of microorganisms. It acts fast but can cause skin irritation. It cannot be used for routine use in surgical scrub or on mucous membranes as it causes irritation. Because of this, when used for pre-procedure skin application, iodine must be allowed to dry and then removed from the skin using alcohol.

Alcohol Based Products:
This is another popular antiseptic product. Effective against a broad range of microorganisms. It acts fast in killing microorganisms. Has a drying effect on skin and hence not recommended to be used on mucous membranes. Wash the skin before applying it. To be effective, it must dry completely. Alcohol can also be diluted for optimal killing of microorganisms.Popular brand: Sterlium.

PCMX (Para-chloro-meta-xylenol):
This is fairly effective against most microorganisms. This antiseptic has a persistent effect over many hours but it is less effective than chlorhexidine and iodophors. Available in both antiseptic and disinfectant preparations. It should not be used on mucous membranes.

Basic practices for prevention and monitoring of Central line-Associated Blood Stream Infection (CLABSI):
Recommended for all acute care hospitals

Before insertion

1. **Educate healthcare personnel involved in the insertion, care, and maintenance of Central venous catheter (CVCs) about CLABSI prevention.**
   a. Include the indications for catheter use, appropriate insertion and maintenance, the risk of CLABSI, and general infection prevention strategies.
   b. Periodically assess healthcare personnel knowledge of and adherence to preventive measures.

B. At insertion

1. **Use a catheter checklist to ensure adherence to infection prevention practices at the time of CVC insertion.**
   a. Use a checklist to ensure and document compliance with aseptic technique.
      i. CVC insertion should be observed by a nurse, physician, or other healthcare personnel who has received appropriate education, to ensure that aseptic technique is maintained.
   b. These healthcare personnel should be empowered to stop the procedure if breaches in aseptic technique are observed.
2. **Perform hand hygiene before catheter insertion or manipulation.**
   a. Use an alcoholbased waterless product or antiseptic soap and water.
      i. Use of gloves does not obviate hand hygiene.
3. **Avoid using the femoral vein for central venous access in adult patients.**
   a. Use of the femoral access site is associated with greater risk of infection and deep venous thrombosis in adults.
      i. Increased risk of infection with femoral catheters may be limited to overweight adult patients with a body mass index higher than 28.4.
      ii. Femoral vein catheterization can be done without general anesthesia in children and has not been associated with an increased risk of infection in children.
   b. Several nonrandomized studies show that the subclavian vein site is associated with a lower risk of CLABSI than is the internal jugular vein.
   c. The use of peripherally inserted CVCs is not an evidencebased strategy to reduce the risk of CLABSI.
      i. The risk of infection with peripherally inserted CVCs in ICU patients approaches that

with CVCs placed in the subclavian or internal jugular veins.

4. **Use an all inclusive catheter cart or kit**.
   a. A catheter cart or kit that contains all necessary components for aseptic catheter insertion is to be available and easily accessible in all units where CVCs are inserted.

5. **Use maximal sterile barrier precautions during CVC insertion.**
   a. Use maximal sterile barrier precautions.
      i. A mask, cap, sterile gown, and sterile gloves are to be worn by all healthcare personnel involved in the catheter insertion procedure.
      ii. The patient is to be covered with a large sterile drape during catheter insertion.
   b. These measures must also be followed when exchanging a catheter over a guidewire.
6. **Use a chlorhexidine based antiseptic for skin preparation in patients older than 2 months of age.**
   a. Before catheter insertion, apply an alcoholic chlorhexidine solution containing a concentration of chlorhexidine gluconate greater than 0.5% to the insertion site.
      i. The antiseptic solution must be allowed to dry before making the skin puncture.
      ii. Chlorhexidine products are not approved by the US Food and Drug Administration for children younger than 2 months of age; povidone iodine can be used for children in this age group.

C. After insertion

1. **Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter.**
   a. Before accessing catheter hubs or injection ports, clean them with an alcoholic chlorhexidine preparation or 70% alcohol to reduce contamination.
2. **Remove nonessential catheters.**
3. **For nontunneled CVCs in adults and adolescents**, change transparent dressings and perform site care with a chlorhexidine-based antiseptic every 5-7 days or more frequently if the dressing is soiled, loose, or damp; change gauze dressings every 2 days or more frequently if the dressing is soiled, loose, or damp.
4. **Replace**administration sets not used for blood, blood products, or lipids at intervals not longer than 96 hours.
5. **Perform surveillance for CLABSI.**
6. **Use antimicrobial ointments for hemodialysis catheter insertion sites.**
   a. Povidone-iodine or polysporin ointment should be applied to hemodialysis catheter insertion sites in patients with a history of recurrent Staphylococcus aureus CLABSI.
   b. Mupirocin ointment should not be applied to the catheter insertion site due to the risks of mupirocin resistance and damage to polyurethane catheters[107].

English summary

Nosocomial infections are generally related to a complicated phenomenon with multiple etiologies. They significantly interface with the therapeutic progress, harm the hospital, the medical and the paramedical professionals, and there administers. this resulting in extended duration of care, substantial morbidity and mortality and excess cost

The centers of the disease control (CDC) estimate that are third of all hospital acquired infection are caused by a lack of adherence to established infection control practice.

One of the key components for limiting spread of nosocomial infection is adequate infection control practice during anesthesia. The practice of Anesthesiology has the potential for transmitting a number of pathogens to the patient because it requires invasive procedures that violate the body buriers asintravascular catheter, airway control, although this fact, there is a little date to support a cause and effect relationships.Because of most infections associated with anesthesia(both anesthesia- related and occupationally acquired) are preventable, anesthesia personal must know the epidemiology and pathogens of such infection in objective to implement preventive measures.

There are many risk factors for infections associated with anesthesia like invasive supportive measure such as endo-tracial intubation and the placement of intravascular lines and urinary catheter, but cross contamination, and transmission by hand are the most two important point in occurrence of nosocomial infections, In addition to the presence of systemic signs and symptoms of infection (e.g. fever, tachycardia, tachypnea, skin rash, general malaise). The source of the healthcare associated infection may be suggested by the instrumentation used in various procedures

The top 3 major site of infections occurring 64% of all healthcare- associated infections, were:
Blood stream infection (28%).
Pneumonia (21%).
Urinary tract infection (15%).
Each of these infections was strongly associated with the use of invasive device.

Standard precaution are to be applied to the care of all patient in all healthcare setting regardless of the suspected or confirmed presence of an infectious agent. This is primary strategy in preventing transmission of infectious agent among patients and healthcare personnel.

Transmission-based precautions are used in addition to standard precautions when caring for patients who are infected or colonized with pathogens transmitted by airborne, droplet, or contact routes.

Infection control program became a required in the US largely as a result of the mandates of the joint commission for accreditation of hospital TCAHO and the leadership's guidelines and definition of the centers for disease control and prevention (CDC).

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الملخص العربي

تعتبر عدوى المستشفيات (عدوى المنشآت الصحية) ظاهرةً معقدة وخطرًا ذي مسببات متعددة. تحدث عدوى المستشفيات تزامنًا مع تلقي المريض العلاج في المنشأة الصحية, ويتعرض الجميع داخل المنشأة الصحية للإصابة بالعدوى, بدءًا بالأطباء المعالجين وطاقم التمريض, مرورًا بعمال النظافة والصيانة، وحتى الإدارة. ينجم عن عدوى المستشفيات والأمراض التي تنشأ من خلالها ارتفاع حدة الإصابة ببعض الأمراض لدى المرضى, زيادة نسب الوفاة، بالإضافة إلى إهدار موارد الرعاية الصحية وزيادة التكلفة.

تقدر مراكز مكافحة الأمراض وإتقائها أنّ ثلث العدوى المكتسبة جرّاء العمل في مجال الرعاية الصحية تقريبًا تنتج عن عدم الالتزام بالإجراءات والتدابير الوقائية التي تنص عليها قواعد مكافحة العدوى.

تمثّل تدابير مكافحة العدوى الخاصة بالتخدير مكونًا رئيسيًا لكل الإجراءات والتدابير الطبية التي تهدف إلى الحد من عدوى المستشفيات.قد تتسبب عملية التخدير في نقل عدد من مسببات المرض أو الباثوجين لما تتضمنه من إجراءات تخترق الحواجز الجسدية مثل الأجهزة العلاجية التي تدخل إلى الجسم كالقسطرة الوريدية أو الممرات الهوائية. على الرغم مما سبق ذكره, إلا أنه ينقصه البيانات والمعلومات الكافية لتأكيد العلاقة بين المسببات والأثر الناجم عنها. نظرًا لأن معظم الأمراض المرتبطة بالتخدير (سواء المتعلقة مهنيًا بالتخدير والمكتسبة من خلاله) يمكن الوقاية منها، مما يتعين على طبيب التخدير معرفة وبائيات ومسببات العدوى بهدف اتباع جميع التدابير الوقائية.

هناك عوامل كثيرة لخطر العدوى المصاحبة للتخدير مثل: الأجهزة العلاجية التي تدخل إلى الجسم (مثل: الأنبوبة الحنجرية, أجهزة التغذية المركزية, والقسطرة البولية), إلا أنّ العدوى المتنقلة عن طريق اليد تعتبر من أهم العوامل المسببة لحدوث عدوى المستشفيات.هذا بالإضافة إلى وجود علامات وأعراض للعدوى مثل: الحمى, سرعة ضربات القلب, سرعة معدل التنفس, الطفح الجلدي, إعياء عام.

أعلى ثلاث معدلات لعلامات العدوى والتي تمثل نسبة 64% من العدوى المصاحبة للعدوى الصحية هي:

عدوى مجري الدم (28%).

الالتهاب الرئوي (21%).

التهاب المسالك البولية (15%).

ترتبط جميع أنواع العدوى سابقة الذكر بشكل قوي باستخدام أجهزة علاجية تدخل إلى الجسم (invasive device), مما يجعل الأجهزة المستخدمة في مختلف العمليات والإجراءات العلاجية مصدرًا للعدوى المصاحبة للرعاية الصحية.

يتعين تطبيق جميع إجراءات الاحتياطات القياسية لرعاية جميع المرضى في جميع مراكز الرعاية الصحية بغض النظر عن اشتباه وجود عامل معدي أو لا. هذه هي الاستراتيجية الرئيسية المتبعة لمنع انتقال الجراثيم المعدية بين المرضى والعاملين في الرعاية الصحية.

تستخدم احتياطاتالعدوى الانتقالية بالإضافة إلى الاحتياطات القياسية عند رعاية المرضى المصابين بالعدوى أو بمسببات الأمراض التي تنتقل عن طريق الهواء، عن طريق الرذاذ، أو طرق الاتصال الأخرى.

أصبح برنامج مكافحة العدوى ضرورة أساسية في الولايات المتحدة نتيجة توصيات اللجنة المشتركة لاعتماد المستشفيات, والمبادئ التوجيهية لمراكز مكافحة الأمراض وإتقائها.