

PREVENTION and management of infection
FOLLOWING ORTHOPEDIC PROCEDURES

E s s a y

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B y

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ

أَنْتَ الْعَلِيمُ الْحَكِيمُ

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Abstract

In orthopedics, the surgical site infection after surgery procedure is a disaster both for the patient and surgeon. This may lead to increased antibiotic use, prolonged hospital stay, repeated debridement, prolonged rehabilitation, morbidity and mortality.

The treatment goal is achieving patient safety and avoiding development of infections. In this essay, pathogenesis, classification, diagnosis, and treatment of infections associated with orthopedic procedures are reviewed.

Key words: infection, orthopedic surgery, inflammations, surgical procedures, infection prevention.

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LIST OF ABBREVIATIONS

AAMI	The Association for Advancement of Medical Instrumentation
AAOS	The American Academy of Orthopedic Surgeons
ABLC	Antibiotic laden cement
AORN	Association of Perioperative Registered Nurses
AST's	Association of Surgical Technologists
CFD	Computational fluid dynamic
CFUs	colony forming units
CHG	Chlorhexidine gluconate
Cl. perfringens	Clostridium perfringens
CMS, CNA	the Centers for Medicare & Medicaid Services
CRP	C-reactive protein
CSD	Closed suction drains
CT	computerized axial tomography
ESR	erythrocyte sedimentation rates
FDA	Food and Drug Administration
FiO₂	Fraction of Inspired Oxygen
FnBP	Fibronectin binding protein
Ga⁶⁷	gallium citrate

HAI s	Healthcare-associated infections
HbA_{1c}	Glycated hemoglobin or glycosylated hemoglobin
HVAC	heating, ventilation and air conditioning
In¹¹¹	Indium
MAC	monitored anesthesia care
MICS	Multiple Indicator Cluster Surveys
MRI	magnetic resonance imaging
MRSA	Methethilline resistant Staphylococcus aureus
NNIS	the National Nosocomial Infections Surveillance
ODRI	Orthopedic device related infection
OR	Operation room
PCMX	p-Chloro-m-Xylenol
PET	Positron emission tomography
RCT s	randomized control trials
<i>S. aureus</i>	Staphylococcus aureus
<i>S. epidermidis</i>	Staphylococcus epidermidis
SIPP	The National Surgical Infection Prevention Project
SSIs	Surgical site infection
<i>Staph aureus</i>	Staphylococcus aureus
Tc^{99m}	technetium
TiO	titanium dioxide
TJA	total joint arthroplasty
VRE	vancomycin-resistant enterococcus
WBC	White blood-cell count

INTRODUCTION

This work examines infection following orthopedic procedures through a literature review, attempts to seek out ways to improve the policies and procedures that are currently being practiced to prevent infections following orthopedic surgical procedures.

The key issues that will be addressed in this discussion are: the types of bacteria commonly seen in orthopedic infections; the chain of infection for these bacteria; current policies and procedures in place at many facilities; the types of orthopedic procedures performed and their associated infection-risk factors; the different types of precautions taken with orthopedic surgical patients; prophylactic antibiotic therapy preoperatively; and new recommendations and standards of care in relation to infection control in the surgical setting.

By discussing these key issues and researching current recommendations, it is the author's hope to improve current practices, thereby decreasing orthopedic infection rates in the future.

Commonly-performed orthopedic procedures include: total hip and knee arthroplasty, open reduction and internal fixation of fractures, external fixation of fractures using an external fixation unit and spinal laminectomy and discectomy. All of these procedures carry a chance of infection because a portal of entry is made either by surgical incision or from traumatic laceration ⁽¹⁾.

Contamination of the surgical site by either direct or indirect means is a common cause of infections.

The most common microorganism responsible for orthopedic infections is *Staphylococcus* ⁽¹⁾.

The normal habitat for these microbes is on the human skin, and is most commonly spread by direct contact and airborne routes. However, *S. aureus* thrives in the nares of 25 percent of the population ⁽¹⁾.

According to **Bamberger & Boyd**, *Staph aureus* is the most commonly isolated microorganism in osteomyelitis ⁽²⁾.

The second strain, *S. epidermidis*, is a normal resident of human skin, mouth and nose. This bacterium has a distinct affinity for plastic, making it a common contaminant of orthopedic prostheses ⁽³⁾.

The last strain, MRSA, is a strain of *S. aureus* that is resistant to methicillin-containing medications, such as penicillin, oxacillin and amoxicillin. The most common cause of osteomyelitis cases are MRSA ⁽⁴⁾.

The portal of entry is either a surgical incision made by a surgeon's scalpel, a traumatic wound or a pin site, as in the case of an external fixation of a fractured bone. *Staphylococcus* can spread very rapidly when introduced to the mucous membranes and underlying tissues in a surgical incision. A traumatic open wound usually becomes a portal of entry at that time of the injury and is usually exposed to debris and contaminants before entering the operating room. Pin sites allow for a continued portal of entry, even after the surgery is over, because they remain in place for six to eight weeks. Surgical implants can become a fomite, which can contaminate the surgical portal of entry if contaminated either before or during a joint-replacement procedure ⁽²⁾.

Environmental controls are established to reduce the ability of microbes to colonize and reproduce. These include the temperature, humidity and air flow in the operating room, and keeping traffic through the operating room to a minimum ⁽⁴⁾.

According to the Association of Perioperative Registered Nurses **(AORN) Perioperative Standards and Recommended Practices**, the temperature in the operating room should be maintained between 18-23 degrees Celsius, and the humidity is maintained at 30-60 percent. This is controlled because most microbes do not survive well in colder temperatures and low humidity. Laminar air flow, which is a form of positive pressure ventilation, is used in many health care facilities to decrease the rate of air exchange from the semi restricted area of the outside hallway to the operating room. Additionally, traffic in the operating room should be kept to a minimum while a procedure is in progress to prevent contaminants from becoming airborne, thus reducing the contact patients have to airborne microbes and fomites, as discussed and described in *Association of Surgical Technologists (AST's) Recommended Standards of Practice for creating the sterile field* ⁽⁵⁾.

Disinfectants used in the operating room setting must be tuberculocidal, antiviral, antimicrobial and antifungal. The surfaces in the operating room, including the operating room table, Mayo stands, back table, prep table, sitting stools, operating room lights and floors are disinfected with an antimicrobial solution at the beginning of each day and between each procedure. In addition, terminal cleaning of every surface including the walls, lights, floors, and working surfaces should be performed at the end of each working day to decrease overnight microbial

colonization. These practices help to reduce the amount of cross contamination between patients and operating room personnel and provide a clean environment for the patient ⁽⁶⁾.

The diagnosis of deep implant infection can be done by clinical examination, laboratory investigation, histopathology, microbiology and imaging studies, i.e., ultrasonography, three phase technetium99 indium111 and gallium⁶⁷ bone scan, magnetic resonance imaging (MRI) and computerized axial tomography (CT) ⁽⁷⁾.

Positron emission tomography or PET-CT is a new imaging diagnostic tool regarding implant related deep infection. Biopsy can also be done for undiagnosed infection but it is rarely done ⁽⁸⁾.

Management of these infections depends on the extent of the involvement. Infections that involve a localized area may only require antibiotic therapy with the appropriate agents and may involve irrigation and drainage of the wound. Because of the increasing concern of community-acquired MRSA, purulent lesions that require systemic therapy should be cultured so that antimicrobial susceptibility testing can be performed and initial empiric treatment should consider the local prevalence of community-acquired MRSA ⁽⁹⁾.

Bone and joint infections are treated in much the same way that superficial infections are treated with antibiotics and drainage of the wounds. Usually, a four-week antibiotic therapy is ordered ⁽²⁾.

Prosthetic joint infections, like those seen in total knee and total hip arthroplasty, are difficult to eradicate with the foreign prosthesis still in place. Removal of the prosthesis is usually indicated with a follow-up of antibiotic therapy of four to six weeks ⁽¹⁰⁾.

AIM OF THE WORK

This essay covers the etiology, risk factors, different diagnostic options and management of infection related to orthopedic procedures. We will highlight preventive measures and discuss different guidelines to minimize infections related to orthopedic procedures.

EPIDEMIOLOGY

In **1969 Charnley** reported an infection rate for total hip arthroplasty of 9.5 per cent ⁽¹¹⁾. In the following years, various precautions such as prophylactic antibiotics, ultra clean-air operation rooms, better operative techniques, different modes of fixation of the implant and careful selection of patients, considerably reduced the prevalence of an infected prosthesis. As a result, in the more recent years, infection rates of 1 to 2 percent have been reported for primary total hip arthroplasties ⁽¹²⁾.

In the **Mayo Clinic, between 1969 and 1996**, the prevalence of infection of a primary total hip prosthesis and primary total knee prosthesis, was 1.3 percent and 2.0 per cent respectively. The rate of deep infection was influenced by previous surgery of the affected joint for revision operations, the rate of infection was 3.2 per cent and 5.6 per cent for hip and knee arthroplasty respectively ⁽¹³⁾.

According to data from the National Nosocomial Infections Surveillance (NNIS) Report, the most commonly isolated pathogens in postoperative infections are *Staphylococcus aureus*, coagulase-negative staphylococci, *Enterococcus spp.*, and *Escherichia coli* ⁽¹⁴⁾.

Of most immediate concern is the increase in multi-drug resistant organisms, as quantified by a 2003 NNIS survey of nosocomial infections in intensive-care units ⁽¹⁴⁾.

In addition to the ongoing rise of methicillin resistant *staphylococcus aureus* (MRSA), NNIS investigators found a nearly 50% increase in *Klebsiella pneumoniae* isolates that were nonsusceptible to