

Surgical Infections & antibiotics

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In this lecture we included davidson's notes...

❖ Introduction:

In this lecture we will discuss the topics of surgical wounds and their classifications, the prevention of surgical infections, postoperative fever, nosocomial (hospital acquired) infections, community acquired infections that might need surgical treatment, and finally we will briefly talk about needle stick injury and the viral infections associated with it.

❖ Infection is defined by:

1. Microorganisms in host tissue or the bloodstream "where aren't suppose to be ex. Skin flora are allowed to be in your skin, but whenever they invade the skin surface, and here the story of infection begins"
2. Inflammatory response to their presence. Sometimes cause more destruction than the organism.

So, we can say that: Infection= (Microorganism+Inflammatory response)

Whenever one of them exceed the balance level ⇒ sepsis or septic shock could happen..

❖ Types of inflammatory response:

✧ Localized:

Rubor, Calor, Dolor, Tumor, and functio laesa (loss of function) Ex, Abscess..

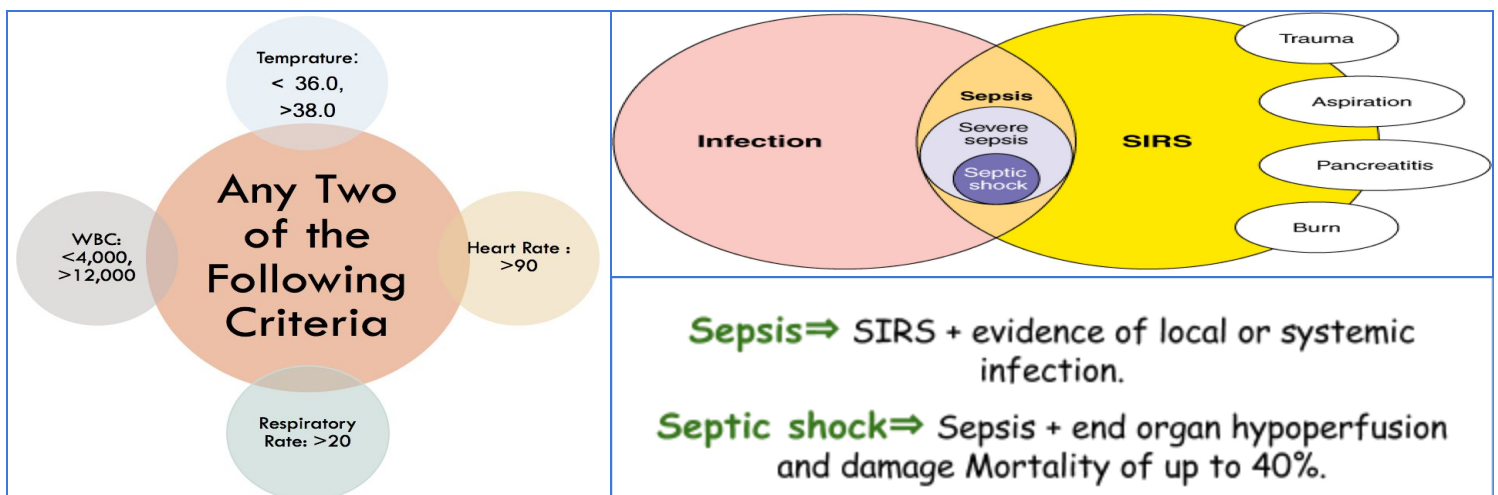
Systemic:

✧ Systemic Inflammatory Response Syndrome (SIRS):

THE FIVE CARDINAL SIGNS OF INFLAMMATION



Nature Reviews | Immunology



❖ Pathogenesis of infection:

The organism is presented by:

1-Direct touch (Instruments touches the skin or by contaminated substances ex. stool)

Normal flora should be treated with respect. They have a beneficial role in competing with other pathogenic bacteria. Therefore, we should "baby sait" the normal flora instead of trying to kill them with antibiotics.

2-Translocation of bacteria (bacteremia)

When thinking about surgical infections in general, we should have three variables in mind:

- How much bacteria were introduced in the site?
- How virulent (strong) are the bacteria?
- How susceptible is the host for this infection?

Which we are most interested in is the host factors that make a patient more susceptible to infections. Blood, dead tissue, and foreign bodies all facilitate the growth of bacteria . Therefore, surgical treatments of infections include debridement and removal of foreign bodies. Also, when a patient has a weakened immune system, it is much more likely to have an infection.

Take a look at the following table for risk factors of surgical infections.

Risk factors for surgical infections¹

Age of patient, obesity, smoking, malnutrition	Preoperative hair removal: patients should be instructed not to shave before surgery	Recent surgery, presence of infection at a non-surgical site, duration of preoperative hospital stay
Surgical technique, duration of surgery, and OR environment + The site colorectal surgery > Breast surgery + (look at the classifications of surgical wounds for more info)	DM, immunosuppression, history of skin infection, severity of underlying illness	Attention to basic infection control strategies and equipment sterilization Urgent surgeries might have less time to sterilize than elective ones :(
Preoperative management of the patient (glycemic control)	Presence of foreign bodies	Degree of tissue trauma

¹ Taken from uptodate.com

❖ Classification of surgical wounds:

It is important (and very easy) to classify surgical wounds because it relates to the risk of acquiring an infection and the type of organism causing the infection. Each type of surgical wound has a certain risk of infection. A dirty wound has a high risk of infection but might not be infected.

Type	Clean wounds	Clean-contaminated	Contaminated	Dirty
Example	The most common, where the GIT is not violated. They often involve the eye, skin, or vascular system.	Cut through the GIT, such as colon resection, gastric resection, etc.	Grossly contaminated with GI contents before or during the surgery. For example if stool was spilled in the wound site during colon resection, or the presence of GI contents during the repair of a perforated ulcers.	Established infection prior to surgical intervention. For example the resection of an infarcted bowel.
Organism involved	Gram +ve bacteria	Include GI flora which are polymicrobial (many bacteria causing the infection).		
The risk of infection	the lowest risk of 3%			the highest risk of around 50%.
Surgical Example	*Hernia repair *breast biopsy	*Cholecystectomy *planned bowel resection	*Unprepared bowel resection	perforation, abscess

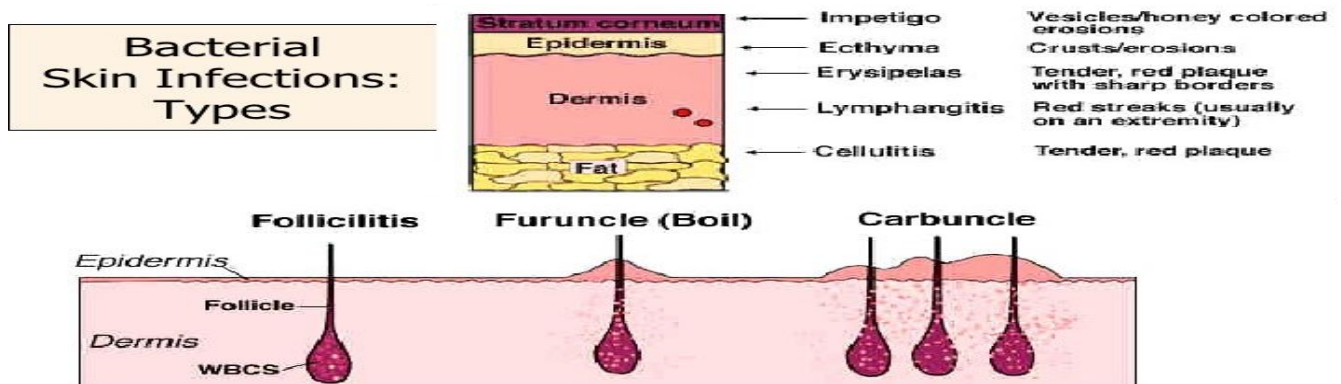
❖ Prevention of surgical infections:

<p>1. Skin preparation :</p>	<p>a. Most surgical infections are caused by patient's normal flora⇒ which means that proper skin preparation (applying antiseptics on incision sites) is done to decrease the risk of infections.</p> <p>b. In addition, the whole process of "scrubbing in" aims to decreasing the risk of infection by properly washing hands and wearing sterile gowns, masks, etc.</p> <p>c. Hair removal is an important part of preparation (if the surgery is to be done on a hair bearing area- that is an area with hair).</p> <p>d. Patients should be instructed not to shave prior to surgery as the use of shaving blades causes small skin cuts which increase the risk of infections.</p> <p>e. Special shaving machines are used (hair clippers) which decrease the risk of infection.</p>
<p>2. Surgical technique:</p>	<p>The surgical technique itself is also important in minimizing the risk of infection as longer procedure duration, and improper cleaning of the wound increase the risk of infections.</p>
<p>3. Perioperative antibiotics: Can be given to decrease the risk of infections.</p>	<p>a. The decision of giving prophylactic antibiotics and the choice of the drug are influenced by: the type of procedure. For example, colonic surgeries usually receive prophylactic antibodies while elective surgeries in the hand (carpal tunnel repair) may not require any prophylaxis.</p> <p>b. The main idea of prophylaxis antibiotics is that there must be an appropriate drug concentration in the patient's blood the moment the surgical incision is made. For this reason, the antibiotics are usually started shortly before surgery and continued for less than a day after surgery (may vary according to the type of surgery) . Surgeries with longer durations may require another dose of the antibiotic to maintain appropriate blood concentrations.</p>
<p>4. Glucose levels</p>	<p>Proper management of preoperative glucose levels is also important as higher levels are associated with a higher risk of surgical infections.</p>

❖ Spread of surgical infection:

- Necrotizing infection
- Phlegmons & superficial infections
- Spread of infection via blood stream
- Abscesses
- Spread of infections via lymphatic system

❖ Types of infectious diseases:



	Definition	Clinical features	Treatment
1.Cellulitis	<p>Diffuse infection with severe inflammation of dermal and subcutaneous layers of the skin.</p> <p>Surgical Recall: It is Blanching Erythema from superficial Dermal/Epidermal Infection.</p> <p>Risk factors: insect and animal bites , trauma</p> <p>Common Pathogens: Skin Flora (Streptococcus/Staphylococcus) (Usually Strep more than Staph)</p> <p>Staph is most likely to cause pus formation</p>	<p>Pain,</p> <p>Warmth,</p> <p>Hyperesthesia</p> <p>Diffused redness</p>	Antibiotics.

<p>2.Furuncles & Carbuncles²</p>	<p>-Cutaneous abscess that begins in skin glands and hair follicles.</p> <p>-When the opening of the hair follicle gets obstructed, this creates a 5 star resort for the bacteria and they start multiplying and causing an infection. So it increases the risk of getting an infection.</p> <p>-A carbuncle is a deep seated mass of fistulous tracts between infected hair follicles. Thus it is a connection between infected hair follicles.</p>	<p>Furuncles are the most common while carbuncles are rare</p>	<p>-Carbuncles: Can leave a scar after they resolve</p> <p>-The classic therapy of furuncle is drainage of the individual abscess, not antibiotics, followed by careful hygiene</p> <p>-Small furuncles may be treated with warm compressions.</p> <p>-Larger ones need drainage and antibiotic therapy</p> <p>-The classic therapy of furuncle is drainage of the individual abscess, not antibiotics, followed by careful hygiene</p> <p>-Invasive carbuncles must be treated by excision and antibiotics.</p>
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² -Folliculitis: superficial inflammation of a hair follicle

-Furuncle: deep infection of a hair follicle (usually due to *S. aureus*)

-Carbuncle: infection and inflammation of a number of adjacent hair follicles (multiple furuncles)


<p>3.Hidradenitis</p>	<p>Serious skin infection of the axillae or groin consisting of multiple abscesses of the apocrine sweat glands.</p> <p>The cause is unknown but may involve a defect of terminal follicular epithelium</p> <p>Nasty infection where there is accumulation of bacteria in apocrine sweat glands in skin folds. Rx: treatment is difficult and this condition has a poor prognosis.</p>	<p>The condition often becomes chronic</p>	<p>From Uptodate: Definitive evidence-based guidelines for the management of HS/AI are lacking due to a paucity of high-quality data.</p>
<p>4.Abscess</p>	<p>Infectious accumulation of purulent material (Neutrophils) in a closed cavity.</p>	<p>Fluctuant: Moveable and compressible</p>	<p>Drainage</p> <p>Why not to give antibiotics? Because they cannot penetrate the cavity</p>

<p>Cellulitis</p>	 <p>Diffused</p>		 <p>Fig. 2</p> <p>We might mark the borders of cellulitis with a pen to note the response to antibiotics</p>
<p>Furuncle</p>			

carbuncle	
Hidradenitis	 <p data-bbox="396 705 1247 741">Picture c shows a scar which can limit the shoulder movement..</p>
Abscess*	 <p data-bbox="396 972 1256 1008">"Raised localized" Right pic shows an abscess which drains pus..</p>

Diffuse necrotizing infection

Definition	<p data-bbox="391 1314 769 1356">-Particularly dangerous</p> <p data-bbox="391 1373 1520 1457">-Difficult to diagnose, extremely toxic, spreads rapidly, often leading to limb amputation</p>	
Pathogenic factors	<ul style="list-style-type: none"> <li data-bbox="444 1493 656 1524">● Anaerobic <li data-bbox="444 1535 922 1566">● Wound bacterial exotoxins <li data-bbox="444 1577 773 1608">● Bacterial synergy <li data-bbox="444 1619 1130 1650">● Thrombosis of nutrient bridging vessels 	
Classifications	<u>Clostridial</u>	<u>Non Clostridial</u>
	<ul style="list-style-type: none"> <li data-bbox="444 1776 837 1808">★ Necrotizing cellulitis <li data-bbox="444 1818 626 1850">★ Myositis 	<ul style="list-style-type: none"> <li data-bbox="1016 1776 1398 1808">★ Necrotizing fasciitis <li data-bbox="1016 1818 1451 1850">★ Streptococcal gangrene

<p>Microscopy</p>	<ul style="list-style-type: none"> -Fastidious anaerobes -On gram-stain they appear as relatively large, gram-positive, rod-shaped bacteria. 	<ul style="list-style-type: none"> -Caused by multiple non clostridial bacterial pathogens. -Microaerophilic streptococci, staphylococci, aerobic gram-ve bacteria, and anaerobes, especially peptostreptococcus and bacteroides.
<p>Clinical Findings</p>	<ul style="list-style-type: none"> -Severe pain suggests extension into muscle compartments (myositis). -The disease progresses rapidly, with loss of blood supply to the infected tissue. -Profound shock can appear early, rapidly leading to organ dysfunction. -Air bubbles often visible on plain radiograph - Crepitus³ is occasionally present <p style="text-align: center;"><u>Gas Gangrene</u></p> 	<ul style="list-style-type: none"> -Usually begins in a localized area such as a puncture wound, leg ulcer, or surgical wound. -Externally, hemorrhagic bullae are usually the first sign of skin necrosis -The skin is anesthetic and crepitus is occasionally present. -The fascial necrosis is usually wider than the skin appearance indicates. -At operation, the finding of edematous, dull-gray, and necrotic fascia and subcutaneous tissue confirms the diagnosis.

³ Crepitus is the sensation of air bubbles under the skin on physical examination

<p>Treatment</p>	<ul style="list-style-type: none"> ❑ Complete debridement and depress tight fascial compartment. ❑ Amputation if necessary. ❑ Broad-spectrum antibiotic therapy ❑ Resuscitative therapy ❑ Treat diabetes mellitus aggressively "Aggressive control of blood sugar levels" ❑ Hyperbaric oxygenation inhibits bacterial invasion but does not eliminate the focus of infection. Remember that Clostridia are anaerobic bacteria and they hate oxygen.
<p>Notes</p>	<ul style="list-style-type: none"> ❑ It is a clinical diagnosis (must be treated quickly- no time for investigations) but CBC would show leukocytosis, CT would show tissue inflammation or the presence of gas inside the tissue.. ❑ Most of these infections are polymicrobial (caused by a number of bacteria at the same time) ❑ Two monomicrobial (only caused by one pathogen) necrotizing soft tissue infections require special mention: <ul style="list-style-type: none"> ❑ Group A streptococcal necrotizing fasciitis ❑ Clostridial myonecrosis: Clostridium perfringens causing gas gangrene <ul style="list-style-type: none"> ❑ Physical exam might show gas crepitus ❑ Since this is an anaerobic bacterium, we can use hyperbaric oxygen therapy in treatment ❑ Bottom line: these infections require antibiotics, fluids, and emergent surgical debridement which might also lead to amputation. It is a clinical diagnosis.

Streptococcal gangrene group A

- streptococcus is a bacterium frequently found in in the skin and throat.
- Streptococcal gangrene is uncommon
- The **sudden** onset of severe pain is the most common presenting symptom, usually in an extremity associated with a wound.
- Fever and other signs of systemic infection are frequently present at the time of presentation.
- Shock and renal dysfunction are usually present within 24 hours.



Necrotizing Soft Tissue Infection

Cellulitis vs. Necrotizing soft tissue infection?

- 1) Cellulitis ⇒ longer duration "more controlled inflammatory response".
- 2) Necrotizing ⇒ within 1 hr there are SIGNIFICANT inflammatory response, the tissue is dead..

Postoperative Infections

(Postoperative fever):

Postoperative fever can be caused by many things. A good way to handle this problem is to think of the time period that the patient develops the fever. Early after surgery (1-2 days), it might be caused by lung atelectasis (anesthesia and intubation side effect). After that (2-3 days) it might be caused by UTIs or IV line infections. 3-5 days later, we might get surgical wound infections. Deep veins thrombophlebitis can be the cause 5-7 days after. Deep wound infections (abscess) presents late (7-10 days after surgery). Drugs can cause fever anytime after surgery but should only be considered when other causes are ruled out⁴ e.g. (Community acquired infections Skin and soft tissue infection).

⁴ This means that you can't say the fever is caused by drugs until you are sure that the patient doesn't have an infection atelectasis, etc.

Causes of postoperative fever (The 5 W's)

Site/ source	Postoperative timing (days)
Wind (atelectasis)	1-2
Water (UTI)	2-3
Wound (Surgical Site Infection)	3-5
Walking (deep venous thrombophlebitis)	5-7
Wonder drugs	Anytime after surgery. Exclude other causes before considering this.

*Although atelectasis, DVT, and drugs are not caused by infections, we still get fever because fever is a manifestation of inflammatory responses.

Surgical site infections (SSI)

- **The same as surgical wound infection**
- Characterized by inflammation (systemic and local) and the presence of bacteria in the wound (Bacterial Count $\geq 10^5$ cfu/mL).
- Infection occurs within 30 days of surgery
- Can be describes as purulent or nonpurulent
- 3rd most common cause of hospital acquired infection.
- Long of Stay effect: which leads the patients to spend more days in the hospital which leads to increased complications and costs.

Surgical Site Infection (Two Types)

Incisional		Organ Space	
Superficial	Deep	Generalized (peritonitis)	Abscess
<ul style="list-style-type: none"> Only involves the skin or subcutaneous tissue of the incision 	<ul style="list-style-type: none"> Involves the deep tissues: fascia and muscle layers Can occur up to 1 year after surgery if there was an implant 	<ul style="list-style-type: none"> Involve the organs or spaces that were manipulated during surgery Can be an abscess or generalized (peritonitis) Can occur up to 1 year after surgery if there was an implant 	

Risk Factors of SSI (Important)

Operation Factors	Patient Characteristics
<ol style="list-style-type: none"> 1-Duration of surgical scrub 2-Maintain body temp 3-Skin antisepsis 4-Preoperative shaving 5-Duration of operation 6-Antimicrobial prophylaxis 7-Operating room ventilation 8-Inadequate sterilization of instruments 9-Foreign material at surgical site 10-Surgical drains 11-Surgical technique: <ul style="list-style-type: none"> *Poor hemostasis *Failure to obliterate dead space *Tissue trauma 	<ol style="list-style-type: none"> 1-Age 2-Diabetes: <ul style="list-style-type: none"> *HbA1C and SSI *Glucose > 200 mg/dL postoperative period (<48 hours) 3-Nicotine use: delays primary wound healing 4-Steroid use: controversial 5-Malnutrition: no epidemiological association 6-Obesity: 20% over ideal body weight 7-Prolonged preoperative stay: surrogate of the severity of illness and comorbid conditions 8-Preoperative nares colonization with Staphylococcus aureus: significant association. 9-Perioperative transfusion: controversial 10-Coexistent infections at a remote body site 11-Altered immune response

Pre-operative shaving.

- *Shaving the surgical site with a razor induces small skin lacerations which serve as a potential site for infection (**Increase the risk of infections**).
- *Disturbs hair follicles which are often colonized with *S. aureus*
- *The risk of infection is greatest if shaving was done the night before surgery
- *Be sure patients know that they should not do you a favor and shave before they come to the hospital!

Needle stick injuries.

- Hepatitis B virus: must vaccinate all health care workers
- Hepatitis C virus: no vaccine available and no chemoprophylaxis.
- HIV: no Vaccine but can use chemoprophylaxis (use drugs to prevent the disease- which is known as post exposure prophylaxis).

Complications of surgical infections.

- Prolonged patient hospitalization
- Suppresses wound healing
- Bacteremia and sepsis

Treatment of SSI		Prevention of SSI
Incisional	Deep/Organ space	1-Use antibiotics appropriately. 2-Maintain normal body temp. 3-Maintain normal blood glucose. 4-Optimize oxygen tension. 5-Avoid shaving.
open surgical wound, antibiotics for cellulitis or sepsis	Source control, antibiotics for sepsis	

Recall Notes:

1- When do surgical wound infections arise?

Classically, PODs #5 to #7 (postoperative days)

2- What is a "clean" wound?

Elective, non traumatic wound without acute inflammation; usually closed primarily without the use of drains

3- What is a clean-contaminated wound?

Operation on the GI or respiratory tract without unusual contamination or entry into the biliary or urinary tract.

4- What Is Contaminated wound?

Acute Inflammation, traumatic wound, GI tract spillage, or a major break in sterile technique

5- What is dirty wound?

Pus present, perforated viscus, or dirty traumatic wound

6- What are the possible complications of wound infections?

Fistula, sinus tracts, sepsis, abscess, suppressed wound healing, superinfection, hernia

7- What factors influence the development of infection?

Foreign Body (e.g., suture, drains, grafts), Decreased blood flow (poor delivery of neutrophils and antibiotics), Strangulation of tissues with excessively tight sutures, Necrotic tissue or excessive local tissue destruction (e.g., too much Bovie), Long operations (. 2hrs), Hypothermia in O.R., Hematomas or seromas, Dead space that prevents the delivery of phagocytic cells to bacterial foci or poor approximation of tissues

8- What Patient factors influence the development of infections? *Uremia, Hypovolemic Shock, Vascular occlusive states, Advanced age and Distant area of infection.*

9- All abscesses must be drained except which type?

Amebiasis

10- What is necrotizing fasciitis?

Bacterial infection of underlying fascia (spreads rapidly along fascial planes)

11- What antibiotics can be used in the previous condition?

Triple therapy: e.g. Zosyn®(piperacillin), Vancomycin, Clindamycin

12- Why clindamycin?

Binds STAPH/STREPT exotoxin.

13-What causes wound infection on postoperative days 1 to 2?

Streptococcus Clostridia (Painful bronze-brown weeping wound).

