**Wound Infection**

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Objectives

* Understand common terms used to describe wound progression
* Recognize factors that contribute to wound infection
* Identify the risk factors that may predispose a patient to wound infection
* Assess wounds for clinical signs and symptoms of infection
* Use assessment tool to understand wound infection continuum
* Review the differential diagnosis of wound infection
* Describe different treatment and management options available for wound infection
* Apply risk-minimizing strategies to prevent wound infections

Case Overview

Ms. Daphne Basset is a 67-year-old lady who has been discharged from the hospital after treatment for pneumonia one week ago.

***\*Click on each subheading to find out more information about Ms. Basset\****

🡪 PMHx

* Cerebral vascular accident (CVA)
* Type 2 diabetes mellitus
* Chronic right medial malleolus leg ulcer

🡪 Meds

* ﻿Metformin 500 mg BD
* Aspirin 100 mg daily
* Captopril 12.5 mg BD
* Acetaminophen 1 g QID

🡪 SHx

* Lost 15 lbs over 1.5 years through diet modification recommended by her dietician
* Mobilizes with a four-pronged stick due to minimal loss of sensation and motor function in her left leg after CVA
* Lives alone in an apartment building
* Has been smoking 1/2 pack cigarettes daily since 15 years

Wound History

Ms. Basset has had a chronic right medial malleolus leg ulcer for six months, which initially developed post-trauma. She is currently concerned that her leg ulcer may be complicated by a wound infection. You are asked to assess her today.

**Question 1: Before we move forward, it is important to understand specific terms used to describe the progression of wounds. Match the following terms with their definition.**

|  |  |
| --- | --- |
| **Terms** | **Definitions** |
| ﻿Wound contamination | The presence of bacteria within a wound in the absence of a host reaction. |
| ﻿Wound colonization | ﻿The presence of bacteria within a wound that multiply or cause a host reaction without resulting in any harm to the host. This is a normal microbiological state of all chronic healing wounds during which there is a balance between the growth and death of bacteria. |
| ﻿Critical colonization | ﻿Bacterial multiplication resulting in delayed wound healing and is often associated with worsening of pain without any host reaction. This stage occurs between colonization and infection, during which there is imbalance between bacterial growth and host resistance. |
| ﻿Wound infection | ﻿Multiplication and deposition of bacteria that invade the tissue and yield a host reaction, resulting in to nonhealing or a decline in the wound. Infected wounds elicit classic signs and symptoms of infections. |
| ﻿Bioburden | The number of bacteria present. |
| ﻿Biofilm | Biofilm refers to the slime that encases the communities of bacteria attached to unstable wound surfaces. This provides protection against phagocytes, antibiotics and antimicrobials. Biofilms can result in local infections or weaken the collagen matrix in a recently healed wound, leading to re-ulceration of wound. |
| ﻿Bacterial synergy | ﻿The process in which agents work together to optimize the function and effect of each other. |
| ﻿Quorum sensing | The action in which microorganisms communicate within a group of organisms, allowing them to coordinate their activities and optimize their capacity to cause disease. |

**Question 2: What is a wound infection? Type your answer in the text box.**

*\*Text Box\**

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**Explanation:** Wounds are contaminated when bacteria enter the wound through:

1. Direct contact (e.g. hands of the carer while changing dressings)
2. Environment (e.g. micro-organisms deposited from the surrounding air)
3. Self-contamination (e.g. patient’s own skin)

Wound infection involves complex interactions between bacteria, host, and the surrounding environment (see **Figure 1**). All wounds are contaminated. When the host can no longer defend against the invading microorganisms, infection occurs. Basically, the wound may progress from a contamination to colonization to critical colonization to infection as the bacterial load increases. A state of wound infection slows the healing process and places the patient at a risk of poor wound outcomes.

**Question 3: What further questions about the wound do you wish to ask the patient? Type your answer in the text box.**

*\*Text Box\**

***\*You begin to ask the following questions. Click on each question to find out Ms. Basset’s replies\****

**﻿🡪 How are you feeling, Ms. Basset?**

Overall, I am feeling well. I am taking Tylenol 1g every six hours. My appetite is good and it’s just the pain that is bothersome. I usually check my temperature and it has been below 38 degrees celsius.

**🡪 How’s the pain?**

Leg ulcer pain has increased since compression therapy was stopped one week ago by Amy, my wound care nurse. She thought that I would be more comfortable without it.

**🡪 Is the wound pain today different from her usual wound pain?**

No, it’s the same.

**🡪 What usually resolves the wound pain?**

It gets better when my leg is elevated.

**🡪 Who is taking care of your wounds? What type of wound dressing regimen has been used?**

A wound care nurse, Amy, comes to my place twice a week. She changes my dressings.

**\*You look at patient’s records. *Click on each question below to see the response*\***

**🡪 What is Ms. Basset’s haemoglobin and serum albumin?**

Her haemoglobin is 10.1 mmol/L and her serum albumin is 32 mmol/L.

**🡪 What have Ms. Basset’s blood glucose levels been during the past week?**

Her blood glucose levels are within normal limits.

**🡪 What is Ms. Basset’s ankle brachial pressure index?**

0.8

**Question 4: With the known information, what factors do you think may be causing an increase in wound pain? Type your answer in the text box.**

*\*Text Box\**

**Explanation:** Potentially edema and lack of compression stockings. Physical examination and doppler studies are required to investigate further.

Physical Examination

* ﻿General:
  + On examination she appears anxious, short of breath and is complaining about pain in her leg ulcer (6/10 visual analogue scale).

***\*Click to see Figure 2\****

* Wound:
  + Malodour
  + An increase in purulent exudate
  + Some friable granulation tissue present
  + No change in wound dimensions
  + An increase in slough (was 30 % and is now 70 %) and a minimal increase in peri-wound erythema noted during the past week
  + No compression currently being worn

Clinical Symptoms and Signs

**Question 5: ﻿What are the clinical signs and symptoms of infections? Type your answer in the text box.**

*\*Text Box\**

***\*Click to expand Figure 3 and 4\****

**Question 6: ﻿What are the signs specific to wound healing by secondary intention? Type your answer in the text box.**

*\*Text Box\**

***\*Click to expand Figure 5\****

*﻿*Please note that wounds of varying etiologies may present with different clinical signs and symptoms (**see Table 1**).

As a result of comorbidities, some signs of infection may be masked. For example, erythema may be masked in venous leg ulcers due to lipodermatosclerosis and hemosiderin staining. Blue or purple discolouration in arterial leg ulcers may occur due to reduced blood flow and increased metabolic needs. Moreover, patients with diabetes often do not present with standard inflammatory signs of infection, making diabetic foot ulcers a major concern. Lastly, immunosuppressive drugs may also mask signs of infection.

**Question 7: What factors increase risk of infection? Type your answer in the text box.**

*\*Text Box\**

***\*Click to expand Figure 6\****

**Explanation:** Host resistance is a key factor in determining whether or not an infection will occur. Insufficient blood supply leads to bacterial proliferation and a greater bacterial bioburden, thus increasing the risk of infection. Tissue perfusion may be affected by uncontrolled diabetes or arterial/venous insufficiency. Local factors may also increase infection risks. These include large wound size, anatomic location and presence of foreign bodies (see **Figure 6**).

**Question 8:** **Are there any other factors in the case provided that may increase the risk of infection in Ms. Basset’s wound? Type your answer in the text box.**

*\*Text Box\**

**Explanation:**

1. Nonadherence to compression therapy

2. Smoking

3. Lack of exercise

4. Diabetes Mellitus

Assessment Tool

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The wound infection continuum is an assessment tool used to describe the clinical states and microbial growth in the wound, assisting in clinical decision making (see **Figure 7**).

**Question 9:** What stage of the wound continuum do you think Ms. Basset is at? Type your answer in the text box.

*\*Text Box\**

***Explanation:*** *Stage 2, progressing towards Stage 3*

Causative Organisms

**Question 10: ﻿What are the most common causative organisms associated with wound infections? Type your answer in the text box.**

*\*Text Box\**

***\*Click to expand Table 2\****

﻿Culture Techniques

Wounds that should be sampled include a) clinically diagnosed, b) suspected of infection, or c) deteriorating with no signs of infection. Antimicrobial sensitivities can be determined using bacterial culture for the selection of antibiotics and identification of resistant organisms (e.g. MRSA).

**Question 11: What options are available for performing culturing wounds? Type your answer in the text box.**

*\*Text Box\**

***Explanation:***

1. Tissue biopsies, considered to be gold standard for wound culture, identify causative microorganisms. However, they interfere with wound bed healing
2. Swab cultures are less invasive, however, they are unreliable
3. The quantitative swab (Levine) technique is the most useful for obtaining swab cultures, as it provides information on the numbers and types of microorganisms (see **steps** of performing a swab culture)

During infection, quantitative tissue biopsy or qualitative swab techniques should be performed.

**Steps:**

1. To ensure organisms are not killed, the wound must be first cleaned with saline
2. The swab should avoid exudate and debris, and be taken from granulation tissue
3. A rayon or alginate-tipped applicator moistened with saline should be twirled over a 1 cm2 area using pressure
4. For larger wounds (>5 cm2), a zig-zag pattern is useful
5. The swab is then placed into four quadrants on a standard media
6. The more quadrants showing growth, the more bacteria on the swab
7. Specimen must be properly labelled with the name, date, and site of removal. Information such as the type and position of the wound, and signs of infection are also useful to include

**Note:** The health and symptoms of the patient should be considered in conjunction with laboratory results**.** Also, blood cultures are recommended for patients showing signs of sepsis.

Differential Diagnosis

Non-infectious inflammatory conditions may complicate the diagnosis of a wound infection. ﻿The most common of these conditions are:

***\*Click on each condition to learn more\****

🡪 **Allergic contact dermatitis:** ﻿This is an allergic inflammatory skin reaction as a result of contact with an irritating material. It is characterized by redness, inflammation, pruritis and blistering.

🡪 ﻿**Erythematous maceration:** ﻿This is a chronic inflammatory irritation of the skin surrounding the wound. Serous exudate causes a shiny appearance on the surface of the skin.

🡪 ﻿**Pressure injury-related proinflammatory hypoxic changes:** These changes can occur over a pressure point. While the pathogenesis of such changes is unknown, common theories include oxygen deficiency or metabolic release from anoxic tissue.

🡪 ﻿**Vasculitic wounds:** This is a cutaneous manifestation of an inflammatory disease, which affects the cutaneous blood vessels and causes reddish/purple painful wounds. Inflammatory conditions include calciphylaxis, rheumatoid arthritis, scleroderma, polyarteritis nodosa and lupus erythematosus.

🡪 ﻿**Pyoderma gangrenosum:** This is a dermatological condition in which tissues become necrotic, leading to deep wounds mainly in the lower extremities. The wounds are initially characterized by papules or blisters, but later become larger painful necrotic wounds with irregular raised borders and purulent ulcers.

**Question 12: What do you think is the etiology of Ms Basset’s wound? Type your answer in the text box.**

*\*Text Box\**

***Explanation:***

The major etiology of Ms. Basset’s wound, as determined by review of her medical history, physical examination and Doppler studies, is venous hypertension with an element of arterial insufficiency (ankle brachial pressure index of 0.8).

Management and Prevention

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Once a wound infection has been clinically diagnosed, it is usually managed with a combination of local wound therapy, appropriate systemic antibiotics and/or topical antimicrobials (see **Figure 8 and Tables 3-4**).

**Question 13: What would you recommend for the management of Ms. Basset’s wound infection? Type your answer in the text box.**

*\*Text Box\**

***Explanation:***

1. Consider light compression stockings for edema control
2. Encourage exercises such as ankle flexion–extension to optimize venous return
3. Take a wound swab for specificity and culture
4. Begin antibiotics targeting the causative organisms
5. Review and evaluate the need for analgesia

5. Cleanse the wound and debride weakened tissue

6. Consider starting topical antimicrobial dressing. If this is not possible, cleanse and dress wounds more frequently and closely monitor wound status.

7. Minimize cross-infection

8. Implement appropriate exudate management dressings and peri-wound skin protection

9. Consult a dietitian for weight loss and wound healing supplement

10.   Monitor and optimize glycaemic control

11.   Educate Ms. Basset on the need for judicious compression therapy

12.   Construct a plan highlighting the expected healing progress to ensure early detection of changes or delays in the wound.

13.   Communicate the management plan with Ms. Basset, wound care nurse and other physicians

**Question 14: What would you recommend to Ms. Basset in order to prevent further wound infections. Type your answer in the text box.**

*\*Text Box\**

***Explanation:***

1. Ensure a balance of sleep and exercise
2. Smoking cessation strategies
3. Limit alcohol intake
4. Optimize adequate nutritional intake and consider dietician review to discussion nutritional supplementation
5. Seek psychosocial support

Costs

**Question 15: What impacts do the wounds have on patients and the healthcare system?**

***\*Click on each subheading to find out more information\****

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**🡪 Direct cost to healthcare**

- Diagnostics tests

- Extended inpatient length of stay

- Treatments

- Dressing Equipment

- Wound care nurse costs

**🡪 Direct cost to patients**

- Treatments and dressings not covered by insurance or OHIP

**🡪 Indirect cost to patients**

- Lost days from work

- Transportation costs

**🡪 Psychosocial impacts**

- Disturbing sleep

- Impairing mobility

- Poor quality of life

Post-Quiz

1. **What is the most important determinant of whether a wound will become infected?**
2. Wound size
3. Presence of foreign bodies
4. Anatomical location
5. Host resistance
6. **Wound deterioration is a sign of which stage of infection?**
   1. Stage 1
   2. Stage 2
   3. Stage 3
   4. Stage 4
7. **What is considered the gold standard for wound culture?** 
   1. Quantitative swab culture
   2. Tissue biopsy
   3. Levine technique
   4. Semi-quantitative swab culture
8. **Which of the following is least likely to be one of the discussed differential diagnoses for wound infection?**
   1. Allergic contact dermatitis
   2. Pyoderma gangrenosum
   3. Melanoma
   4. Erythematous maceration

Citations:

1. Adapted from: Ousey K, McIntosh C, editors. Lower Extremity Wounds: A Problem-Based Approach. John Wiley & Sons; 2008 Apr 30.
2. Wound Picture (Figure 2) from: Leg Ulcer [Internet]. DermNet NZ. Available from: <https://dermnetnz.org/>