

Microbe of the month

Breaking The Chain of Infection

Cutimed®

NOVEMBER 2020

Newsletter

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Featured this month:

Clostridium perfringens

Clostridial myonecrosis ('gas gangrene')

Hello readers!

Gas gangrene is synonymous with myonecrosis ('muscle cell death') and is a highly lethal infection of deep soft tissue, caused by *Clostridium* species, with *Clostridium perfringens* being the most common.

Clostridium species are found in abundance in soil (especially livestock farming); however, *C. perfringens* is also an inhabitant of normal human intestinal flora, and is responsible for many gastrointestinal illnesses with severity ranging from mild enterotoxaemia to fatal gas gangrene (refer to Microbe of the Month March 2020 for another deadly pathogen in this species - *Clostridioides difficile* aka 'C. diff').

Historically, **Clostridial myonecrosis** was a common war wound infection with an incidence of 5%, but with improvements in wound care, antiseptics and the use of antibiotics, the incidence has fallen to 0.1% of war-related wound infections since the Vietnam War era.

Puncture wounds and surgical wounds – especially resulting from surgery performed on the biliary tract or intestines, or septic abortions – are causes of clostridial infections due to inadvertent inoculation with gut bacteria.

The combination of gross injury, massive infection and the release of bacterial endotoxins and inflammatory cytokines overwhelm the immune system and result in septic shock and death.

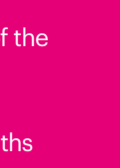
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A patient with gas gangrene prior to amputation of the right leg. Note the discoloration and necrotic bullae (large blisters); crepitation (a crackling sound) will be detectable on deep palpation.

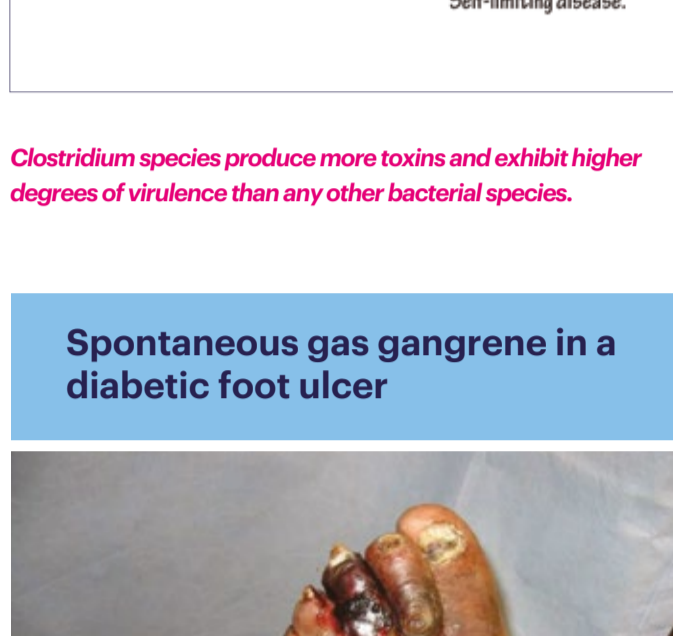
The drainage from the necrotic tissue often has the appearance of dishwater and a musty odour.



Gram staining clearly depicting rod-shaped *C. perfringens*, as well as the drumstick-shaped endospores, which are an extremely hardy part of the *Clostridium* lifecycle.

Spores remain viable in the environment for months to years.

Pathophysiology



Clostridial infections usually arise in deep or penetrating tissue injuries, but also can arise spontaneously as opportunistic infections in immunocompromised individuals with serious pre-existing medical conditions, especially those with local tissue hypoxia (due to trauma or poor vascular supply).

The typical incubation period for gas gangrene is frequently short (i.e., <24 hours).

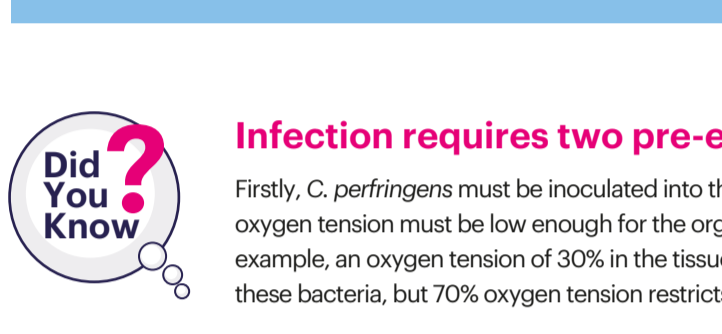
A self-perpetuating destruction of tissue occurs via a rapidly multiplying microbial population and the production of locally and systemically acting exotoxins.

C. perfringens is the most pathogenic, with at least **20 known** enterotoxins – the most toxic being the alpha toxin known as lecithinase (a phospholipase), which breaks down cell membranes triggering platelet aggregation, thrombosis and histamine release.

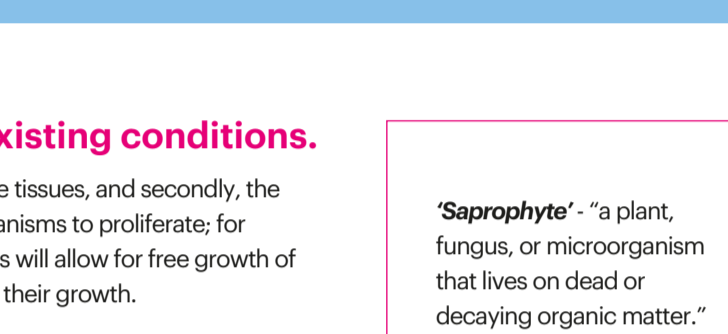
Also present are collagenase, hyaluronidase, hemagglutinins, and hemolysins, while theta toxins cause direct vascular injury and breakdown of leukocytes, causing a blunted host inflammatory response to the infection.

Collagenase breaks down connective tissue, allowing the rapid spread of the organism across tissue planes. Marked oedema may further compromise blood supply to the region.

Spontaneous gas gangrene in a diabetic foot ulcer



Fasciotomy depicting the necrotic muscle – termed 'myonecrosis'



These anaerobic, spore-forming Gram-positive rods multiply rapidly at 37°C – they ferment glucose in the muscle, and the hydrogen sulphide and carbon dioxide gases resulting from this metabolism tear the tissue apart. The gas also compresses blood vessels, thereby obstructing blood flow to the affected area.

Did You Know?

Infection requires two pre-existing conditions.

Firstly, *C. perfringens* must be inoculated into the tissues, and secondly, the oxygen tension must be low enough for the organisms to proliferate; for example, an oxygen tension of 30% in the tissues will allow for free growth of these bacteria, but 70% oxygen tension restricts their growth.

Inoculation of organisms into low oxygen tension tissues is followed by an incubation period that usually ranges from 12-24 hours. However, this period can be as brief as 1 hour or as long as several weeks. The organisms then multiply and produce exotoxins that result in myonecrosis.

'Saprophyte': "a plant, fungus, or microorganism that lives on dead or decaying organic matter."

Dictionary.com

RISK FACTORS FOR GAS GANGRENE

Prior trauma:

- Compound fractures
- Foreign bodies
- Frostbite
- Deep thermal or electrical burns
- Subcutaneous or intravenous administration of medication or illicit drugs
- Pressure sores
- Motor vehicle accidents

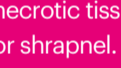
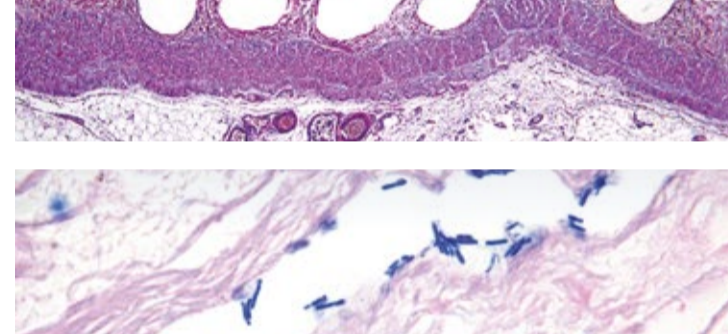
Postoperative risks:

- Gastrointestinal tract surgery
- Genitourinary tract surgery
- Septic abortion
- Amputation
- Tourniquets, casts, bandages or dressings applied too tightly

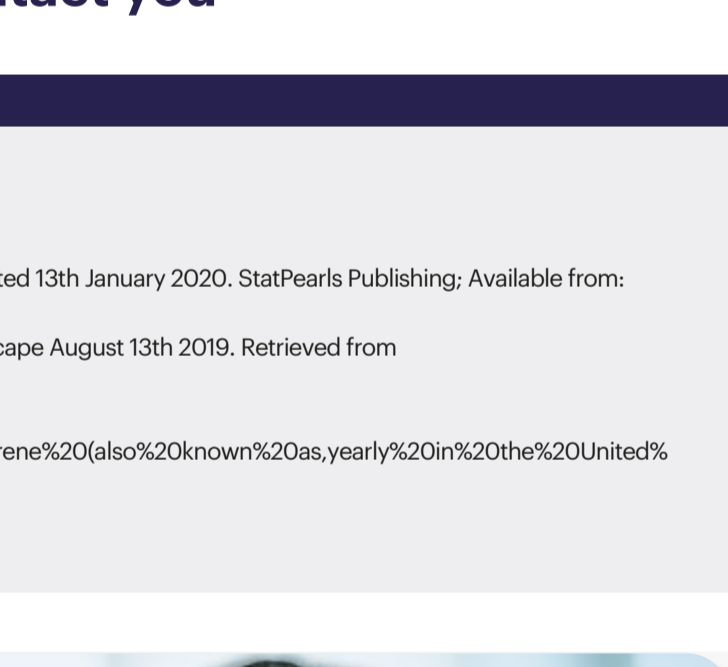
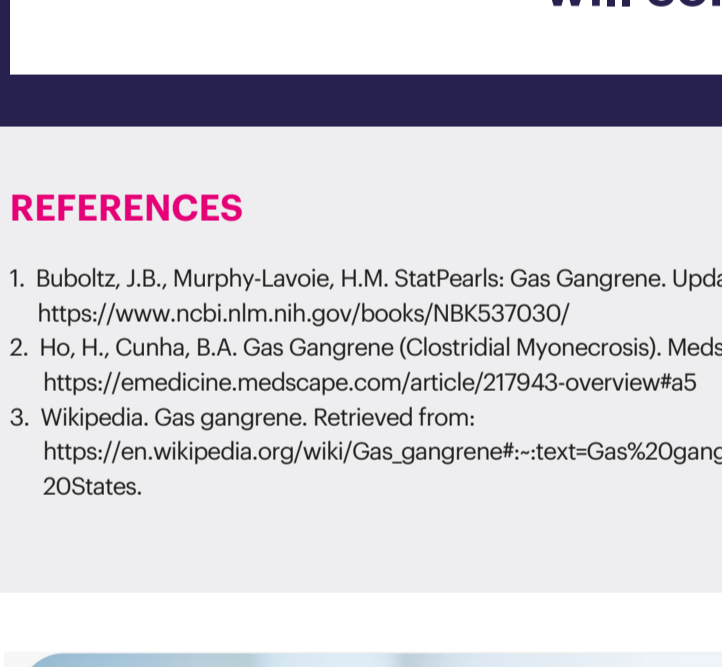
Spontaneous gas gangrene:

- Diabetes mellitus
- Peripheral vascular disease
- Alcoholism
- Drug abuse
- Advanced age
- Chronic underlying debilitating disease/s
- Immunocompromised state: e.g., corticosteroid use, malnutrition, malignancy, AIDS

Macroscopic appearance of intestinal gas gangrene, a histological cross-section of the bowel wall illustrating pockets of gas and electron microscopy of *C. perfringens*



Even with the best of care - including early recognition, surgical excision and hyperbaric oxygen therapy, the mortality rate approaches 100% in individuals with spontaneous gas gangrene or those in whom treatment is delayed.



- ✓ Antibiotic therapy should be aggressive because the infection progresses so rapidly.
- ✓ Intravenous empiric antibiotic therapy should be commenced ASAP, while cultures are awaited.
- ✓ It is important to get a surgical consultation without delay as this is a true surgical emergency.
- ✓ ICU monitoring, intravenous fluid resuscitation and adjuvant hyperbaric oxygen therapy is important to keep tissue oxygen tension elevated.
- ✓ Fasciotomy may be necessary to relieve compartment pressures. As the infection progresses into deep tissue along and under the fascia, tissue compartment pressures increase, which perpetuates further tissue ischemia and necrosis.
- ✓ Surgical debridement should focus on removing all the necrotic tissue, as well as foreign bodies such as soil, debris or shrapnel. It is also important to irrigate the wounds with copious amounts of sterile normal saline.
- ✓ Use strict aseptic technique and contact precautions (gloves, gown/s or drape aprons).
- ✓ Clostridial spores can survive in the environment for up to two years and can withstand extreme conditions.
- ✓ Clostridial species are resistant to many disinfectants, and the spores are not inactivated by alcohol-based hand rubs.
- ✓ Practise frequent hand hygiene with antibacterial soap and water.
- ✓ Clean and disinfect environmental surfaces with sodium hypochlorite (chlorine) based detergents, or disinfectants with proven sporicidal efficacy.
- ✓ Wash bedpans and faecal receptacles in automated washers which exceed 85°C.

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¹ Staninowski J, Blom M, Cendrowski K, et al (2016) Randomized controlled trial evaluating dialkylcarbamyl chloride impregnated dressings for the prevention of surgical site infections in adult women undergoing caesarean sections. Surg Infect (Larchmt) 17(4): 427-35

² Davies K, McFadden J, et al. Cost effectiveness of DACC dressing to prevent SSI following caesarean section. Presented at Wounds UK, Hammersmith, November 2019

³ Gattung K, Haglund J (2019) Site bioburden management: A clinical review of DACC technology. Journal of Wound Care Vol 24, No 5

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*Based on a comparative study of two antimicrobial dressings in infected leg ulcers in a pilot study. Journal of Wound Care. 2019 Mar;34(3):121-124.7
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