

# Wound infections on board ship — prevention, pathogens, and treatment

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## ABSTRACT

Wounds are common in seafarers and they can easily become infected in the marine environment. Pre-sea tetanus immunization is essential. Without diagnostic facilities and only a limited range of antibiotics onboard, injury prevention and early treatment to reduce the likelihood of infection are important measures. Suturing clean cuts reduces healing time and risk of infection. Fresh, clean cuts, especially on the face or head, can be closed by adhesive tape or sutures, but if infection arises, then one or more sutures should be removed to enable drainage. Most wounds must be considered contaminated and should not be closed, just covered with sterile dressing after cleaning. Antibiotic treatment should be started immediately in seafarers with hand and puncture wounds. The primary treatment for a simple abscess is incision and drainage. Antibiotic treatment is recommended for abscesses if the infection spreads to the surrounding tissue (associated cellulitis), if there is lack of response to incision and drainage alone, or if the abscess is in an area difficult or dangerous to drain (e.g. face, palm, genitalia). Recommended therapy for cellulitis is 5–10 days of dicloxacillin, cephalexin, clindamycin, or erythromycin, but if there is no improvement after 2–3 days, methicillin-resistant *Staphylococcus aureus* (MRSA) should be suspected. Bites and burn wounds require special attention. Since wound infections can deteriorate rapidly, a telemedicine advice service (TMAS) should be consulted during the early stages, and serial digital photographs of the affected area, transmitted by e-mail to TMAS, are often useful during treatment at sea.

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## INTRODUCTION

Shipping is perhaps the most international of all the world's great industries and one of the most dangerous. Accidents occur frequently at sea, and seafarers are exposed to microorganisms from all over the world. In the maritime environment, open and puncture wounds are easily infected. There is little information about the pathogens present aboard and no diagnostic facilities to determine the best treatment. The range of antibiotics in the ship's medical chest depends on flag state rules and regulations and is rather limited. Hence, it is particularly impor-

tant to reduce the likelihood of infection through prevention of injuries and early, proper treatment of wounds.

## PREVENTION

One essential preventive measure is tetanus immunization before embarkation to avoid this rare but serious infection. At pre-sea medical examinations the validity of the seafarer's tetanus immunization status should be checked. For primary immunization of adults, the vaccine is administered as two doses 4–6 weeks apart, with a third dose 6–12 months

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later. Booster doses are given every 10 years or at the time of major injury if it occurs more than 5 years after a dose [1].

Wounds are the most common reason for seeking treatment aboard after an accident: On cruise ships ca. 40% of crew accidents were wounds, and most of them were caused by sharp instruments during work in the galley [2, 3]. Wound infection was rare, but on cruise ships primary wound treatment is carried out by medical professionals. By contrast, radio-medical data indicate that ca. 70% of skin disorders on which advice is sought are infectious and the majority of these are cutaneous abscesses and cellulitis [4, 5].

To avoid infection, rigid sanitary measures should be used when treating wounds. Careful hand washing with soap and water or with an alcohol-based hand sanitizer is emphasized. Disposable gloves should be used and the wound should initially be thoroughly irrigated with physiological sterile saline solution, bottled water, or clean tap water.

Potentially contaminated wounds and wounds that contain visible foreign bodies after irrigation should be scrubbed carefully with a clean brush. An unused tooth brush can be used. If there is any doubt about cleanness afterward, the wound should be left open. Healing will then take longer and the resulting scar may be more pronounced, but the likelihood of a wound infection is less. Closed wounds must be monitored closely and if signs of infection (increased pain, redness, and swelling) develop, the wound should be promptly re-opened. Late signs of infection (> 5–7 days) suggest a retained foreign body.

Most wounds at sea should be considered potentially contaminated and therefore not be closed. An exception may be clean head wounds. As there is a plentiful blood supply to the head, head wounds usually bleed profusely, but rarely become infected. The ‘HAT-trick’ (Hair Apposition Technique) is an easy way to close a clean, less than 10 cm long scalp wound after it has stopped bleeding, provided that it is surrounded by hair > 3 cm long [6]:

Imagine the scalp hairs as suture ties already embedded in the skin. Twist together 3–7 strands of hair on one side of the wound. Do the same on the other side of the wound. Interlock these two hair bundles in a 360-degree revolution, thereby pulling the wound edges together and closing the wound. Do not tie a knot, but instead secure the intertwined hair bundles by applying a few drops of glue. (Tissue adhesive is recommended in most medical texts, but as most ships do not carry it, 1-2 tiny drops of a cy-

anoacrylate-based fast-acting glue (marketed as super-, crazy, or easy-glue) can be used, as long as care is taken to avoid getting glue into the wound). Repeat as needed to close the length of the laceration. The glued hair can be cut off with a pair of scissors after 8–10 days.

As part of the head, the face also has a good blood circulation, and for cosmetic reasons exact closure of non-contaminated facial cuts is tempting. It can be done with interrupted sutures, tape, or tissue glue. Adhesive tape strips are easiest and safest. If sutures are used for facial wound closure, they should be the thinnest type available aboard, be tied loosely, and be removed early (after 3–5 days) to prevent cross-hatching and visible needle entrance marks. After suture removal, adhesive strips can be applied across the wound for another few days to bolster the still healing wound.

The following wounds should **always** be left open:

Puncture wounds; wounds on hands, feet, perineum and genitals; wounds that involve deeper structures (tendon, cartilage, bone); human and cat bites; wounds that are oedematous or show signs of inflammation; wounds that are more than a few hours old; and wounds that have been contracted in or exposed to a contaminated environment (sea water, soil, sewage).

Hand and puncture wounds carry such a high risk of infection that antibiotic treatment should be started immediately. Hence, hand bites by any animal and humans and cat bites in any location should receive prophylaxis [1]. Deep wounds (near or into body cavities or joints) will also warrant systemic antibiotics, and a telemedical advisory service (TMAS) should be promptly contacted in such cases. Generally, the choice of antibiotic for prophylaxis should be similar to coverage for an established infection [7].

Both open and closed wounds should be covered by sterile dressings. Daily dressing changes should also be done under sterile conditions.

Elevation of the wounded area quickens improvement by promoting gravity drainage of the swelling.

Bites and burns; see ‘Special wounds’, below.

## PATHOGENS

The type of bacteria in a wound will depend on the cause, but – as ashore – methicillin-resistant *Staphylococcus aureus* (MRSA) infections are an emerging medical challenge, in particular on ships visiting North American ports [4, 5]. LaMar et al. [8] reported 2 MRSA skin infections on a US naval ship and found by nasal swab testing that 6.4% of 125

crew members in the same berthing areas were asymptomatic carriers. Clinically, MRSA infections can look exactly like ordinary staphylococcus infections: small red bump, pimple, or boil, and bug bites and various rashes have similar symptoms. If an open wound infection spreads or does not improve after 2–3 days on usual antibiotics, like amoxicillin, it may be MRSA. Most MRSA infections come from human carriers but, given the frequency of carriage, pre-embarkation screening and exclusion or treatment are not practical options.

Bites and burns; see 'Special wounds', below.

## TREATMENT

Since wound infections can deteriorate rapidly, a TMAS should be consulted during the early stages to determine whether antibiotics should be used, and serial digital photographs of the affected area, transmitted by e-mail to TMAS, may prove useful during treatment at sea.

If a contaminated wound closes or is closed with bacteria in it, an abscess will develop. For a simple cutaneous abscess or boil, incision and drainage is the primary treatment and likely to be adequate [9]. A wound that has been closed which shows signs of infection, usually within 1–3 days, may be a 'man-made' abscess. It should be promptly opened by removing covering tape and/or several sutures and the wound edges pried apart. The wound should be gently irrigated and a small drain should be inserted to ensure that the wound is not closing too fast. If drainage is adequate, antibiotics are in most cases not necessary.

Antibiotic therapy is recommended for abscesses if the infection seems to spread into the surrounding tissue (associated cellulitis), if there is lack of response to incision and drainage alone, or if the abscess is in an area difficult or dangerous to drain (e.g. face, palm, genitalia) [9].

Suitable agents for cellulitis include dicloxacillin, cephalexin, clindamycin, or erythromycin [10]. Five to ten days of therapy is recommended, but should be individualized on the basis of the patient's clinical response. If a skin infection spreads or does not improve after 2–3 days on usual antibiotics, MRSA should be suspected and trimethoprim-sulfamethoxazole, a tetracycline (doxycycline or minocycline), or linezolid can be tried, provided that there is no clinical abscess to be opened and drained first. If antibiotic coverage for both  $\beta$ -haemolytic streptococci and MRSA is desired, options include clindamycin alone or trimethoprim-sulfamethoxazole or a tetracycline in

combination with a  $\beta$ -lactam (e.g. amoxicillin) or linezolid alone [9].

The cause of a wound that becomes infected and the features of the infection may be a guide to antibiotic treatment: Infected wounds from shells or fish spines anywhere and from fish hooks or propellers in estuarine waters should be treated aggressively with several antibiotics, like amoxicillin + clavulanate **and** ciprofloxacin **and** doxycycline, and medical advice should be sought as soon as possible [11].

## SPECIAL WOUNDS

### BITE WOUNDS

- Some marine bites and stings are toxic; all create wounds that are at risk of infection with marine organisms. Seals carry marine mycoplasma, which are usually sensitive to doxycycline and trimethoprim-sulfamethoxazole [12].
- Pets are kept on some ships, and rats may be encountered aboard. While only 5% of dog wounds get infected, the infection rate of cat wounds (normally punctures) is about 80%. Bites from rats, pigs, dogs, and cats can be treated with amoxicillin + clavulanate, but in case of penicillin allergy erythromycin, cephalexin, and clindamycin are not good alternatives as *Pasteurella*, particularly frequent in all types of feline animals, is often resistant to them [12].
- Bats, foxes, and wild dogs can carry rabies and are luckily not frequently encountered by seafarers. However, in case of a bite following an unprovoked attack by a possibly rabid animal in port, immediate transport of the victim to a health centre able to provide rabies vaccine is imperative for survival.
- For human bites the current recommendations are amoxicillin/clavulanate or ampicillin/sulbactam. Cephalexin, which is commonly used for skin and soft-tissue infections, is ineffective against *Eikenella corrodens*, an important pathogen in infected human bites. Trimethoprim-sulfamethoxazole + clindamycin is an acceptable alternative in the penicillin-allergic patient [10].
- Among types of human bites 'the fight bite' deserves special attention. When someone strikes another person's face with their clenched fist, typically two wounds can occur: a cut on the fist of the hitter and a cut on the face of the victim. If the fist hits a front tooth, the hitter sustains a cut proximally on the dorsal aspect of the middle or ring finger. This extremely contaminated bite wound equivalent may divide the extensor ten-

don and contaminate the metacarpal head joint surface. Because such injuries frequently occur while the patient is intoxicated, initial medical evaluation is often delayed, and the patient may not present until there are signs of progressive infection. Neglected hand injuries may have dire consequences (function loss, finger or hand amputation). All suspicious injuries in this area should therefore be taken very seriously. They should be urgently seen by a hand surgeon and, awaiting that, be treated with broad-spectrum antibiotics appropriate for oral and skin organisms [13].

- A hard hit can fracture a front tooth and a small chip may become imbedded in the soft tissue. If the tooth fracture is not discovered and the wound closed without realizing that it may contain a foreign body, an abscess is likely to develop. This can be prevented by closely examining the front teeth of the victim or have him or her self-examine them by using their tongue. If the front tooth has been chipped, explore the wound carefully under sterile conditions and remove the fragment if this can be easily done. Whether a fragment is found or not, such a hand wound should not be closed.
- Similarly, if the fist hits the victim's chin, the victim may bite through his or her lip and deposit a tooth chip in the lip wound. The procedures are as described above: (Self-)examine the front teeth carefully for a new unevenness. If a front tooth is chipped, try to carefully explore the wound and remove the fragment. This is a type of face wound that should not be closed to allow the chip to work its way out.

## BURN WOUNDS

- Burns on board should be evaluated and treated according to the principles outlined in the International Medical Guide for Ships [11].
- The focus of initial medical care is to reduce the depth of the burn by instant cooling and to prevent infection. Immediately following a thermal burn, the surface of the burn wound is free of microorganisms. However, deep cutaneous structures that survive the initial burn injury (e.g. sweat glands, hair follicles) often contain *Staphylococci*, which colonize the wound surface during the subsequent 48 hours [14] and respond to penicillins. Over the following 5–7 days, other microbes, including gram-negative and gram-positive bacteria, colonize the wound. They typically come from the patients' gastrointestinal or upper

respiratory tract, or from those providing on-board medical care [14]. Burn wounds are less likely to become infected with multi-resistant bacteria aboard ships than in a highly specialized burn unit ashore.

- Infection may be avoided or treated by leaving blisters intact and covering the affected areas with topical antimicrobials (silver sulfadiazine or bacitracin ointment; alternatively honey). Non-adherent sterile compresses and fluffy, absorbing dressings should be loosely applied and the affected area elevated [1, 11]. Dry burn dressings in an afebrile burn patient with minimal pain may not be changed for days to avoid contamination from the environment or the person providing care.
- Burns that have not healed in 2 weeks should be evaluated by a doctor in the next port.
- If infection is suspected, contact TMAS with a view to early evacuation, leave the wounds open, clean them thoroughly several times a day, cover with topical antimicrobials between cleanings, and start systemic antibiotics like amoxicillin + clavulanate by mouth [11].

## CONCLUSIONS

Pre-sea tetanus immunization is essential. Fresh clean cuts, especially on the face and head, may be sutured or closed by adhesive tape or sutures. Most wounds must be considered contaminated and should not be closed, just covered with sterile dressing after cleaning. Antibiotic treatment should be started immediately in seafarers with hand and puncture wounds. A wound that has been closed and shows signs of infection should be re-opened and drained. The primary treatment for a simple abscess is incision and drainage. Antibiotic treatment is recommended for abscesses if the infection spreads to the surrounding tissue (associated cellulites), if there is lack of response to incision and drainage alone, or if the abscess is in an area difficult or dangerous to drain (e.g. face, palm, genitalia). Recommended therapy for cellulitis is 5–10 days of dicloxacillin, cephalexin, clindamycin, or erythromycin, but if there is no improvement after 2–3 days, methicillin-resistant *Staphylococcus aureus* (MRSA) should be suspected. Bites and burn wounds require special attention. Since wound infections can deteriorate rapidly, a TMAS should be consulted during the early stages, and serial digital photographs of the affected area, transmitted by e-mail to TMAS, are often useful during treatment at sea.

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