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TACTICAL COMBAT CASUALTY CARE: TRANSITIONING BATTLEFIELD LESSONS LEARNED TO OTHER AUSTERE ENVIRONMENTS

Field Wound Care: Prophylactic Antibiotics

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Adequate management of wounds requires numerous interventions, one of which is the appropriate use of antimicrobials to attempt to minimize the risk of excess morbidity or mortality without increasing toxicity or multidrug resistant bacterial acquisition. There are numerous recommendations and opinions for not only the use of systemic prophylactic antimicrobials, but also the agent, dose, route, and duration. To best address the implementation of systemic antimicrobials in a field scenario, one must weigh the factors that go into that decision and then determine the best agents possible. The epidemiologic triangle (ie, the host, the agent, and the environment) forms the basis for selecting the correct prophylactic antibiotic for field wound care. Extreme conditions can be encountered in both military and nonmilitary systems, requiring a unique selection process to make the right antibiotic choice. A modifiable weighted matrix, recommended previously for point of injury combat casualty care, assists in selecting the best oral and intravenous/intramuscular agent based on the epidemiologic risk determination.

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Introduction

A cornerstone of infectious disease is the epidemiologic triangle, which consists of the interactions between the host (the who), the agent (the what), and the environment (the where) (Figure). Host factors are intrinsic risk factors that include the individual's exposure, susceptibility, and response to the causative agent. Factors such as hygiene, nutritional or immunologic status, anatomic structure, presence of disease, and medication all play roles. The agent includes the microorganism that is not only present but also causes disease. The virulence and pathogenicity of the microorganism, along with inoculum, influence the infection rate. The environment includes extrinsic factors such as climate, sanitation, supplies, and availability of health services. The interaction of elements in the epidemiologic triangle provides a framework to assess the myriad issues that ultimately stratify a wound's potential for infection, the identity of the microorganism, and potential outcomes. Understanding these interactions enables one to determine the best management options for field wound care to optimize outcomes.

Many of the fundamentals of wound management as described in Homer's *The Iliad* (~900 BC) are still used today: Mechanically debride with removal of arrow, irrigate with water or wine, cover wound with bandage soaked in wine, apply analgesic, and apply styptic herbal drugs.[1]

Clinical practice guidelines have been provided by the Infectious Disease Society of America (IDSA), the Wilderness Medical Society (WMS), the National Park Service (NPS), the International Committee of the Red Cross (ICRC), World Health Organization (WHO), and combat-related injury infections and tactical combat casualty care military committees (CoTCCC).[2–9] Interventions recommended include wound irrigation and debridement, immunization for rabies and tetanus, wound preparation and closure, bandaging, stabilization, prophylactic topical or systemic antimicrobial therapy, and close clinical monitoring for signs or symptoms of infection. At the core of wound care during field conditions are the challenges associated with the extremes of the epidemiologic triangle, including poor hygiene, lack of supplies, and prolonged field care,

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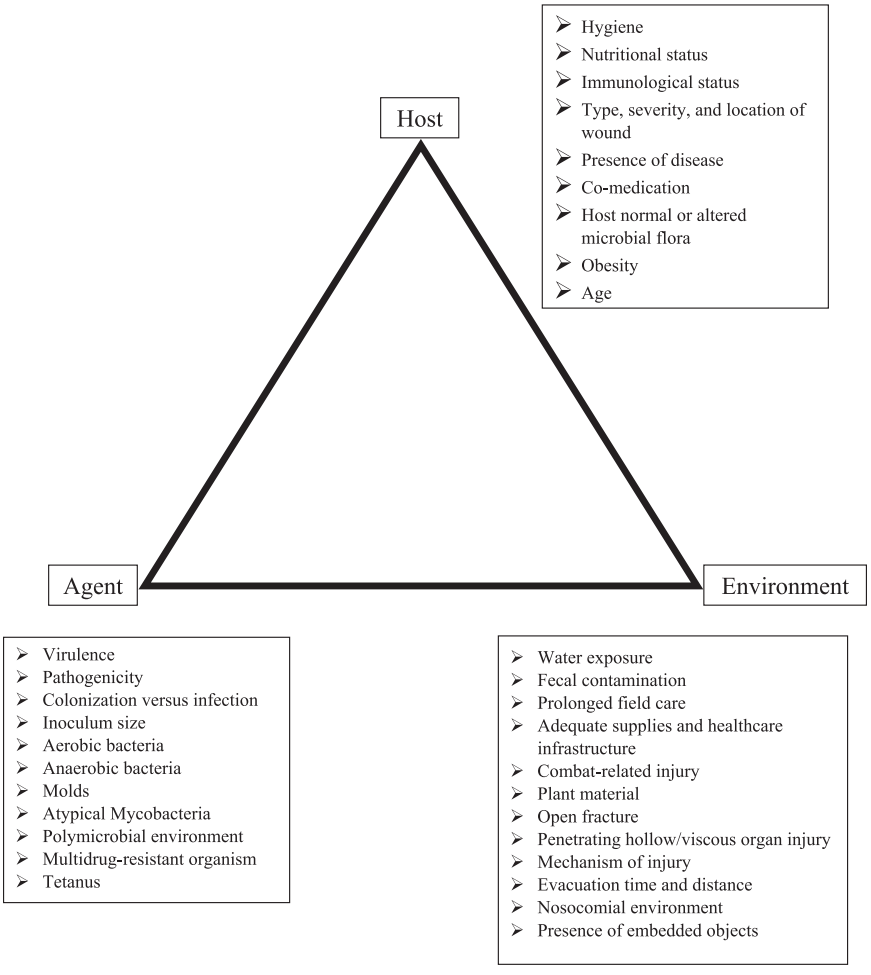

Figure. Epidemiologic triangle of the host, agent, and environment that leads to wound infection.[89]

among other extremes at the host, agent, or environment level.

This review will provide an overview of the incidence of traumatic wounds and infection rates, followed by examples of the epidemiologic triangle that influence wound infections. Antimicrobial options will then be provided, proposing a modifiable weighted matrix approach to assist determination of the ideal prophylactic antibiotic for field wounds. Overall emphasis is placed on extremity wounds and Food and Drug Administration (FDA)-approved antibiotics.

Traumatic wounds

Understanding the rates of traumatic wounds in austere settings is important in determining the ultimate need of field wound care and antimicrobial selection. During the spring climbing season of Mount Everest between 2003 and 2012, physicians in the clinical treatment area treated 2941 patients with 3569 diagnoses, of which 500 (14%) were trauma.[10] Lacerations comprised 21% of the trauma cases, with cellulitis in 21 cases and abscesses in 25 cases, but only 2 tibial/fibular fractures and 1 pelvic fracture. Search and rescue for 239 persons in the Adirondack Park in New York had soft tissue and skeletal systems as the most commonly reported traumatic injuries, with 98 (49%) and 56 (28%) reported, respectively.[11] Of 100,000 outdoor recreational injuries, 14.8% were lacerations.[12] Another study noted 4% of wilderness or outdoor activities were injuries to the skin or infection, with infection rates of 0.02–0.04 per 1000 participant days.[13] During a 10-day adventure race, there were 286 presentations for skin and soft tissue issues, of which avulsions/lacerations occurred in 2% of cases (n=9).[14] Differences in rates of trauma were also reported for urban versus rural expeditions, earthquakes, tsunamis, deserts, and flood-associated environments.[15–21] Overall, wound infection rates vary but typically are reported at the 1% to 10% rate, based upon many factors.[22] Specific infections such