our HEROs

ELITE education

The Hidden Complexity of Biological "Dirty Bombs"

Autor: Michael A. Washington, PhD; Jauchia Blythe, PhD
Zpracoval: Jaroslav Duchoň

Abstract:
The recent capture of a terrorist in Belgium carrying explosives, fecal matter, and animal tissue may indicate a shift from conventional weapons to crude bacteriological preparations as instruments of terror. It is important to note that although such weapons lack technological sophistication, bacteria are inherently complex, unpredictable, and undetectable in the field. Therefore, it is important that Special Operations medical personnel understand the complications that such seemingly simple devices can add to the treatment of casualties in the field and subsequent evaluation in the clinic.

Keywords: "dirty bombs"; terrorists; warfare, biological

Introduction
Recently, a terrorist bomber arrested in Belgium was found to be carrying a backpack containing a crude mixture of fermented fecal matter, animal testicles, and explosives.1 It is believed that this device was prepared with the intention of spreading infection during a terror attack. On the surface, the individual components carried by the terrorist appear to lack complexity and sophistication. However, this apparent simplicity masks the fact that, in combination, these components can be a genuine threat to Special Operations military personnel and pose a significant challenge to the practice of Special Operations medicine during counterterrorism or counterinsurgency operations. Framing the Threat The threat posed by the materials recovered during this incident arise from the fact that the detonation of a bomb made of fermented feces and animal testicles can cause the traumatic inoculation of bomb debris into the resulting wound. This can result in the development wound infection and/or sepsis. Despite the lack of refinement of the device carried by the Belgian terrorist, fecal matter is far from a simple substance. It is an incredibly complex aggregation of gut-derived bacteria. 2 Studies of the microbial composition of the human gut have indicated that bacterial cells outnumber human cells by a factor of 10 and that the average human gut contains more than 1000 microbial species. Human feces may contain Escherichia spp., Bacterioides spp., Clostridium spp., Klebisella spp., and Pseudomonas spp., all organisms that have been implicated in the development of wound infection. It has been previously noted that wounds healing is impaired when the concentration of bacteria exceeds 1 million bacterial cells/mL of fluid.2 Given that the average concentration of bacteria in 1g of feces can range from 10 million cells to 10 billion cells/g, it can be concluded that infection can be induced in bomb victims with a relatively small amount of starting material and that these infections can impact wound healing and recovery and/or cause lifethreatening sepsis. The inclusion of animal testes in the device is adds a level of complexity that may not be immediately obvious. Animal protein, typically in the form of chopped meat, has long been used to support the growth of bacterial pathogens. Previous studies have demonstrated that a bacterial broth consisting of chopped meat as a protein source is capable of maintaining the viability of pathogens in for up to 8 weeks. It is therefore possible that the animal testicles were added to the mixture as a means of encouraging fecal bacterial growth and maintaining bacterial viability. It is worth noting that this inclusion is an act that indicates knowledge of basic microbiology on the part of the bomber and a desire to maximize the effectiveness of his or her weapon. However, it should also be noted that Brucella spp., a highly pathogenic group of organisms, tends to localize in animal testes. Although it is unknown whether the bomber intended to cultivate Brucella spp., the use of testes in the mixture is concerning because Brucella has long been considered a potential biological weapon. This is because it can be transmitted via the aerosol route and because it can cause a debilitating infection in an immunocompetent host with as few as 10 organisms. In addition, Brucella produces toxins that suppress the immune response, an activity that may serve to exacerbate the effects of the other bacterial species in the mixture, delay wound healing, and increase the probability of a negative outcome.

Historical Precedent
The development of such a "low-tech" device is reminiscent of the use of "punji sticks" during the Vietnam conflict. Typically consisting of a sharpened stick smeared with feces, these implements were responsible for many of the penetrating and perforating wounds that were encountered by military medical personnel.10 If the use of such devices becomes more frequent, it will be essential that Special Operations medical personnel understand the complexity of these devices, that they avoid direct contact with them, and that they decontaminate themselves if contact is unavoidable. Further, if a patient is suspected to have been the victim of one of these devices, it is necessary that this suspicion is communicated to the hospital staff so that the appropriate antibiotic treatment and diagnostic testing procedures can be initiated.

During the Vietnam conflict, it was found that following the general principles of war wound treatment such as adequate debridement, open wound creation, irrigation, and the use of prophylactic antibiotics was adequate for the treatment of punji stick injuries. Experience will determine whether these methods are adequate for the treatment of contaminated blast injuries caused by biological “dirty bombs.”

Recommendations

The detonation of an improvised explosive device can produce complex injuries ranging from shock wave–induced barotrauma to deep penetrating injury. It has accepted that all combat wounds are susceptible to infection. 12–14 Although some bacteria may die from the blast and heat of an explosive detonation, it can be expected that wounds resulting from a biological dirty bomb will have an increased likelihood of bacterial contamination. Nonetheless, the current principles of tactical combat casualty care should be adhered to in all cases.15–17 Because animal studies have indicated that antimicrobial therapy reduces progression to sepsis, prophylaxis should be administered as soon as possible. To this end, a broad-spectrum antibiotic is typically included in the combat pill pack. However, this treatment should not replace the techniques of proper cleaning, irrigation, and debridement, which are essential components of wound care. It should be noted that fecal material is a potential source for antibiotic-resistant bacteria.Therefore, all suspected exposures and wounds resulting from a biological dirty bomb detonation should be documented on the tactical combat casualty card and communicated to providers at each successive echelon of care so that bacterial culture and antibiotic sensitivity studies can be performed and the results used to guide treatment.

Conclusion

Although the insertion of fecal matter and animal tissues into a terrorist’s bomb may, at first glance, seem to be a simple and insignificant development, there is an underlying complexity to these materials that can pose a significant threat to military personnel. This complexity arises because the fecal and animal tissue components of these materials harbor numerous pathogenic bacteria capable of magnifying the morbidity and mortality of injuries sustained during detonation. To reduce the impact of these devices on military personnel, it is essential that providers understand and recognize the threat, identify incidents of potential exposure, promptly communicate all potential exposures to the healthcare team, and adhere to the previously established principles of wound care.

Jaroslav Duchoň