Overview

The individual warfighter is a vital component of U.S. military strength. [1] Health issues and injuries encountered by the warfighter in the line of duty pose unique challenges compared with civilian environments. Discovering and implementing new technologies supporting the health and wellness of U.S. warfighters continues to be important due to the correlation between the health of individual soldiers and the strength of the overall military. Nanomedicine, the integration of nanotechnology into medical practice, is an emerging technology being researched by the Department of Defense as a means to maintain and improve the health of the individual warfighter. Three nanomedicine applications, especially promising, for DoD are artificial blood products; wound dressings/bandages; and pharmaceutical delivery systems.

Artificial Blood Products

More than 80 percent of battlefield deaths are caused by uncontrollable hemorrhage, remaining the single largest cause of combat death. [2] Tourniquets are an effective first-line method for treating hemorrhaging in extremity wounds; [3] however, tourniquets are not effective in treating thoracic and abdominal wounds. [3] Synthetic platelets and artificial red bloods cells represent potential solutions to the problem of hemorrhaging in a non-compressive area of the body.

Synthetic platelets could be injected into or near a wound site to prevent hemorrhaging and promote coagulation. Synthetic platelets, made from nanoparticles mixed with an albumin serum derived from a cow, offer significant advantages over platelets derived from human donors. They are not subject to shortages in donors, and their shelf life is much longer. [4] Artificial red blood cells made of biodegradable polymers containing enzymes and hemoglobin [5] could effectively replace blood cells lost due to a traumatic battlefield injury. Artificial red blood cells would not be subject to the same supply shortages as those from donors, and there would be longer expiration dates, thus extending the shelf life for use.

Wound Dressings/Bandages

Bandages with antihemorrhagic/hemostatic properties are also likely to save the lives of U.S. warfighters. Chitosan, a biodegradable, nontoxic, complex carbohydrate derivative of chitin, [3] can clot blood from traumatic injuries. HemCon, ChitoFlex and CELOX Chitosan Gauze all contain chitosan. [3] Another risk faced by those with traumatic battlefield injuries is exposure to dangerous microbes. Bandages containing silver and copper nanoparticles have a high likelihood of preventing the incubation of microbes in open wounds. [7] Several products utilizing silver on cotton bandages are already on the market, including Acticoat, Actisorb, Aquacel, Contreet Foam and Urgotul. [8] Nanoparticle formulations of both chitosan and silver take advantage of a high surface area-to-volume ratio of nanoscale materials and offer better coverage and less leaching compared to traditional formulations of these materials. [8]

Pharmaceutical Delivery Systems

Conventional antibiotics and anti-infection medications are increasingly less effective against antibiotic resistant strains of bacteria, [9] such as methicillin resistant staphylococcus aureus, more commonly known as MRSA. Pharmaceutical delivery systems at the nanoscale, however, offer improved treatment efficacy, specific localization, decreased toxic side effects, improved patient compliance, reduced dosage and controlled biodistribution. [10] This method of treatment could alleviate the adverse conditions of soldiers suffering from infection as a result of a traumatic wound.

Pharmaceutical delivery systems also apply to vaccines, as new approaches can remove the need for needles while allowing vaccines to target specific tissues and cells. This needleless approach uses liposomes, emulsions and polymer-based/carbon nanoparticles to develop nasal spray vaccines. [11] This type of vaccine delivery will make force protection of DoD personnel in areas with endemic diseases rapid, simple and cost effective.

Summary

Developing nanotechnology applications in medicine advances U.S. soldier health care. Although an emerging discipline, early stage nanomedicine offers innovative solutions for the U.S. soldier, such as protection against massive blood loss from hemorrhage, infection from battlefield wounds and rapid, easy-access vaccines protecting against region-specific diseases. Nanomedicine has effectively revolutionized health care for U.S. warfighters before, during and after combat operations, [3] and merits continued research and funding from the DoD.
REFERENCES


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