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A literature review of the military uses of silver-nylon dressings with emphasis on wartime operations^{☆,☆☆}

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ABSTRACT

Medical support of military operations involves treatment of massive soft tissue wounds, thermal burns, open fractures, blast injuries and traumatic amputations under conditions that are often austere and far from supply lines. Military hospitals, as recently deployed in Iraq and Afghanistan, are designed and equipped for stabilization and rapid transfer of injured patients back to their home nation. These austere facilities are often tasked with the emergency or long-term treatment of local populations when injured or burned, further stressing the medical resupply system.

Pathogens encountered in contemporary wartime practice are increasingly resistant to antibiotics. Ionic silver is bactericidal against a broad spectrum of bacteria, yeasts and fungi, has been utilized as a topical antiseptic for over 100 years, and has no known clinically-relevant resistance. Silver-nylon dressings, initially stocked in US military hospitals as a burn dressing, are now finding utility as a universal dressing for all types of combat wounds. Compared to conventional burn dressings, they are easier to transport and store, easier to use, and do not need to be changed as frequently, allowing for conservation of nursing resources.

In this literature review, the recent military uses of silver-nylon dressings are examined. The stockpiling and use of silver-nylon as a universal military burn and wound dressing is advocated.

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1. Introduction

The nature of military operations is continually changing. For this reason, medical support for such operations must

constantly evolve. In recent years, emphasis has changed from the support of large-scale land wars to smaller regional conflicts that start rapidly and unpredictably and that occur far from established logistics hubs or supply routes. Recent operations in Iraq and Afghanistan are prime examples.

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In response, military medical facilities are now smaller and more mobile, but less extensively equipped than their Cold-War predecessors. This requires a corresponding change in medical doctrine: the very-rapid evacuation of casualties out of the combat zone to large fixed facilities in Europe or the United States for definitive care.

Deployed military hospitals often find themselves in the position of providing care to the local (civilian) population because the local medical system is either significantly disrupted or overwhelmed [1]. Cancio notes that 'during war, civilian health care, to include burn care for patients of all ages, may temporarily become the responsibility of the occupying forces' [2]. It is very difficult to provide proper burn care in a deployed environment, particularly if the medical facility is housed in tents. A lack of nursing personnel with formal training in burn care and the inability to provide conscious sedation on the ward means that most major burn dressing changes will have to be performed in the operating room. Because of the demands of personnel and materiel, US military doctrine recommends against providing definitive burn care within the theater of operations [2-4]. Extended burn care in a deployed facility becomes unavoidable, however, when care is provided to local civilians who cannot be evacuated or when either weather (e.g. sandstorms) or distance (e.g. injury occurring in the remote mountains of Afghanistan) precludes immediate evacuation of military personnel. In this situation, an anti-microbial dressing that could be applied by inexperienced personnel and left in place for several days would be ideal.

Both the pathogens and the injuries encountered in war are evolving. Ressler et al. examined the pathogens responsible for bacteremia in burn patients involved in combat operations overseas and found that the traditional pathogens, *Staphylococcus aureus* and *Pseudomonas aeruginosa*, are increasingly being supplanted by multi-resistant *Acinetobacter* and *Klebsiella* species [5]. When choosing topical antimicrobial therapy for burn or other open war wounds, these resistance patterns must be considered.

In current conflicts, the extensive use of body armor covering the head and trunk, and the introduction of Improvised Explosive Devices (IED) as a weapon have changed the patterns of injuries encountered. Open fractures and traumatic amputation injuries are commonly found in close proximity to thermal burns (Photograph 1). Abdominal Compartment Syndrome (ACS) is increasingly being diagnosed and managed by decompressive laparotomy in the deployed setting [6]. This has created a need for a dressing method that can be used to cover the open abdomen in flight. Operations Enduring Freedom and Iraqi Freedom are the first conflicts where Negative-Pressure Wound Therapy (NPWT) has been available in deployed medical facilities, and this method has been extensively used to treat open wounds, extremity amputations, fasciotomy sites and as a dressing for the open abdomen after decompressive laparotomy. Negative-pressure wound therapy by itself is reported to lower wound microbial counts, but a method of applying a potent and sustained-release antimicrobial dressing under NPWT would be useful for war wounds. Patients with such injuries are frequently flown long distances and handed off between multiple medical teams, precluding serial examination and frequent dressing changes.



Photograph 1 – Massive blast/amputation/open fracture/thermal burn typical of combat casualties.

Ionic silver is bactericidal against many species of bacteria, yeasts and fungi, including Methicillin-resistant *Staphylococcus aureus* (MRSA) and multi-drug resistant (MDR) *Acinetobacter*, *Klebsiella* and *Pseudomonas*. In 1881, it was discovered that application of silver nitrate solution to the eyes of newborns would prevent ophthalmia neonatorum, and this practice, still in use in some locations, became mandatory by state law in most US jurisdictions by the early 1900s [7,8]. Moyer et al. [9,10] pioneered the use of 0.5% silver nitrate solution as a topical therapy for burn patients in 1965. His work was influenced by the experiences of one of his co-authors, who had been using topical silver nitrate solutions as an adjunct for the management of necrotizing fasciitis since 1941 [10]. Fox introduced silver-sulfadiazine for burn management in 1968 [11,12]. Both 0.5% silver nitrate solution and 1% silver sulfadiazine cream continue to be used in contemporary burn care [9].

Several groups investigated the use of silver-nylon cloth as a topical dressing in the 1980s and 1990s including the US Army Institute of Surgical Research (Army Burn Center) at Brooke Army Medical Center in San Antonio, Texas [13-25]. Independent of these efforts, a commercial silver-nylon dressing was brought to the market in the following decade (Silverlon[®], Argentum Medical, LLC). Silverlon[®] was first evaluated at the Army Burn Center in 2003, and became available as a burn dressing in US military medical facilities in Iraq and Afghanistan in the same year. Initial success with burn patients led to more widespread use in-theater for other indications. Silverlon[®] dressings soon found utility as a trauma dressing for diverse applications including open wounds, amputation sites, fasciotomy incisions and in combination with NPWT placed over decompressive laparotomy incisions. By 2006, these dressings had also become a standard of care for transcontinental aero-medical evacuation of patients with large burns [26].

In this literature review, the evolution and contemporary use of silver-nylon dressings in military medical practice is summarized.

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