Adoption of antimicrobial gauze bandages for standard use in heavily exudating wounds

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Abstract

Gauze bandages and pads are commonly used as dressings for patients with large wounds. A disadvantage of gauze bandages is the absorption of exudate into the dressing. Exudate absorption often contributes to development of high levels of bacteria in the dressing. We had previously reported on early observations on implementing a new antimicrobial gauze bandage (Bioguard™) with a bound antimicrobial polymer, instead of standard gauze bandages, in the treatment of patients with heavily exudating wounds. On the basis of very positive results from early patients, a policy was developed to use these dressings when traditional dressings showed any signs of fouling. Wounds encountered by caregivers in the burn unit (at Shands Hospital in Gainesville, FL) included thermal burns and Toxic Epidermal Necrolysis Syndrome (TENS) with epidermal involvement up to approximately 90% total body surface area (TBSA).

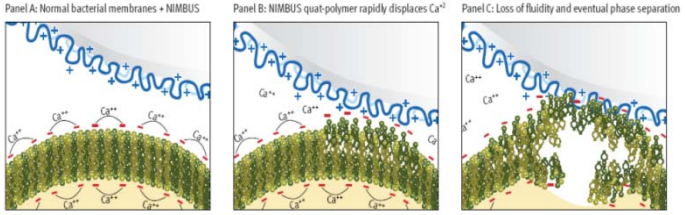
Within 24 hours of applying standard gauze bandages to the wounds, dressings developed a metallic green color and strong odor, characteristic of Pseudomonas aeruginosa. In marked contrast, the treated antimicrobial gauze bandages applied to the wounds adjacent to the standard gauze dressings, remained white with no visible evidence of bacterial fouling.

In response to these observations, the updated standard of care has been to substitute these polymeric antimicrobial dressings for traditional gauze if there was appearance of fouling in the dressings. This has been very positively received by patients, caregivers and family members visiting the patients. Original thinking had been that reduction in bacteria and attendant lower likelihood of infection would be a driving force, but the major features remarked on by caregivers and patients were reduced wound odor, reduced frequency of dressing changes, and improved hygienic appearance. This is a clear reminder that patient and caregiver comfort are compelling factors in determining quality of care.

An additional benefit of using an immobilized microbicide is that interactions with wound care agents are minimized, an important feature in increasingly complex wound care settings. Not having to worry about compatibility of dressings with wound care agents can allow the caregiver to focus more attention on care of the patient.

Mechanism of Antimicrobial Activity

The BIOGUARD antimicrobial barrier dressing is based on the patented NIMBUS® technology (Quick-Med Technologies, Inc.). The active antimicrobial agent is permanently bound to the dressing surface, and acts on the wound pathogen by physically disrupting the prokaryotic cell wall. The macromolecular agent responsible for this mode of action is poly(diallyldimethylammonium chloride), or polyDADMAC, a cationic quaternary ammonium polymer. Gilbert and Moore (2005) describe the mechanism of cell wall disruption induced by polymeric cationic biocides in detail as shown graphically in **Figure 1**. Cationic polymer chains coordinate to the anionic segments of the phospholipid membrane, displacing stabilizing calcium ions. As increasing numbers of cell membrane molecules coordinate to the polymer, the integrity of the bacterial membrane is compromised, leading to gaps and holes as shown in the conceptual representation below (**Figure 1**) and in the SEM micrographs of **Figure 2**.



Normal bacterial membranes (Panel A) are stabilized by Ca^{+2} ions binding anionically charged phospholipids. NIMBUS quat-polymer rapidly displaces Ca^{+2} (Panel B) leading to loss of fluidity (Panel C) and eventual phase separation of different lipids. Domains in the membrane then undergo a transition to additional smaller micelles.

Figure 1: Conceptual Representation: action of polymeric cationic biocidal agent

The theoretical representation is supported by electron micrographs (**Figure 2 on the right**), which show *Escherichia coli* cells before and after contact with a polymeric quaternary microbicidal agent (as immobilized on a gauze surface). The left panel shows healthy intact cells, while the right panel shows disrupted and lysed cells–deflated membrane sacs with their intracellular contents released (Mikhaylova et al, 2011).

Summary of Clinical Experiences

Since cotton gauze was first placed on exudating wounds, the need for a method to control the growth of bacteria in the gauze has prevailed. This inability to prevent the growth of pathogens in the dressing significantly increases the potential for skin and wound infections. The application of gauze with a bound antimicrobial polymer has changed the way wounds are treated at our facility [Shands Hospital burn unit and trauma center]. We no longer use plain cotton gauze on exudating wounds. BioGuard can be used with, and does not interfere with any silver based creams or dressings, enzymatic debriders, silver based devices, or supplemental skin coverings.

Antimicrobial Testing of BIOGUARD® Dressings

The gold standard of assessment is of course clinical performance. In order to design the product that provides patients and caregivers with effective antimicrobial activity, standard test procedures are utilized to quantitatively assess performance of dressings and devices. This testing is used prior to clinical implementation, as validation of performance for quality control and in research. The table below provides data on specific tested organisms with relevance to wound care. Testing was executed on cited bacterial strains, per protocols based on ISO 20743, JIS L 1902 and AATCC method 100.

Wound pathogen	ATCC number of species	Average log kill vs. untreated overnight control	Average % kill vs. untreated control, overnight
Staphylococcus aureus	ATCC 6538	7.10	99.999992%
MRSA *(Methicillin resistant S. aureus)*	ATCC BAA-44	7.70	99.999998%
Staphylococcus epidermis	ATCC 12228	7.52	99.999997%
Pseudomonas aeruginosa	ATCC 15442	7.00	99.99999%
Enterococcus faecium	ATCC 19434	6.89	99.999987%
Escherichia coli	ATCC 8937	7.52	99.999997%
Acinetobacter baumannii	ATCC 19606	8.00	99.999999%
VRE (Vancomycin resistant *Enterococcus faecium*)	ATCC 51299	7.05	99.999991%

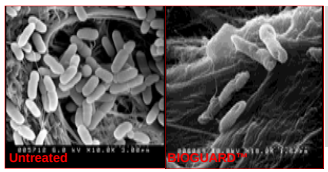
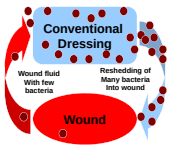
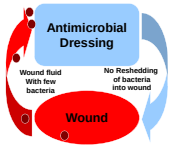


Figure 2 (left). Scanning Electron microscope images of *E. coli* on untreated gauze wound dressing and on BIOGUARD wound dressing (as labeled). *E. coli* bacteria grown in contact with control substrate had intact membranes and full rod shapes. *E. coli* exposed to BIOGUARD surfaces show clear membrane damage and altered general morphology. Some bacteria show small holes and indentations with exuding intracellular content.

Figure 2 (right). Reshedding of bacteria into a wound from a conventional dressing (far left image) compared to an antimicrobial dressing. Wound fluid absorbed by a non–antimicrobial dressing serves as nutrient to grow bacteria shed by the wound, which can in turn recolonize the wound. This scenario is interdicted by the use of an antimicrobial dressing.

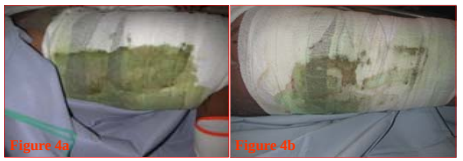




Clinical observations

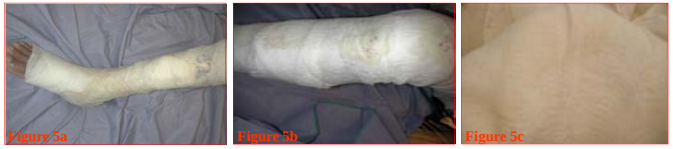
With plain cotton gauze, in order to maintain clean, non-contaminated dressings, burn unit staff were changing the dressings up to three times per day. Even with these frequent dressing changes, we continued to have evidence of bacterial fouling. As we have moved exclusively to the Bioguard dressing, we have been able to decrease the incidence of bacterial fouling as well as decrease the frequency of dressing changes to daily. These practice changes have led to fewer complications associated with contaminated gauze and better pain control. Additional benefits include reduced exposure and discomfort during dressing changes for the patients, and reduced workload on the caregivers. Patients, caregivers and family all expressed that they were uniformly pleased with the reduction in bacterial fouling and odor.

These clinical results suggest that BIOGUARD gauze bandages may prevent rapid bacterial growth in gauze dressings saturated with heavy exudates. The reduction in bacteria could lead to a decrease in the contamination of open wounds, as compared to standard dressings. Additional benefits of using BIOGUARD gauze bandages may include reduced wound odor, frequency of dressing changes , and the spread of bacteria from fouled dressings between patients and clinical personnel.



Figures 4a and 4b show a Donor Site treated with traditional gauze dressings. There is exudate that has developed metallic green color and strong odor. These signs are symptomatic of colonization with *Pseudomonas aeruginosa*, which CDC cites as the most prevalent burn wound pathogen.

Figures 5 (a, b, c) show Lower Extremity Graft Sites treated with BIOGUARD gauze bandages. Although there are large amounts of exudate present, the dressings are not discolored and, based on the observational input, are odor free. *Dressing prior to photo: Silvadene or Bacitracin with Liner, Bioguard followed by ace wraps*



Conclusions

Pre-clinical development testing of the BIOGUARD dressing demonstrated high microbicidal efficacy (~6-log kill) against common wound pathogens, while maintaining the highest possible level of biosafety per laboratory testing. Zone of Inhibition testing confirms that the BIOGUARD antimicrobial barrier dressing is able to control pathogens in the dressing without exerting a physiological effect on surrounding surfaces, such as on/in the wound bed.

Clinical observations at Shands Burn Center continue to be very positive. Burn Unit nurses have noted a significant reduction in exudate color and odor in patients treated with BIOGUARD as compared to standard gauze dressings. Further clinical trials are being discussed to show efficacy.

In summary, Bioguard has continued to prove its value as a staple in burn wound care. Our experiences with the Bioguard dressing have influenced our burn center to convert all cotton gauze to gauzes bound with an antimicrobial polymer.

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