



MONASH University

Medicine, Nursing and Health Sciences

Infection and Antimicrobial Dressings

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Using Antibiotics & Antiseptics in Wound Care

Need to understand:

- Issues with bacterial presence in wounds
- Difference between antiseptics & antibiotics
- Potential risks & benefits of use
- Use of best practice guidelines

Bacterial Burden in Wounds

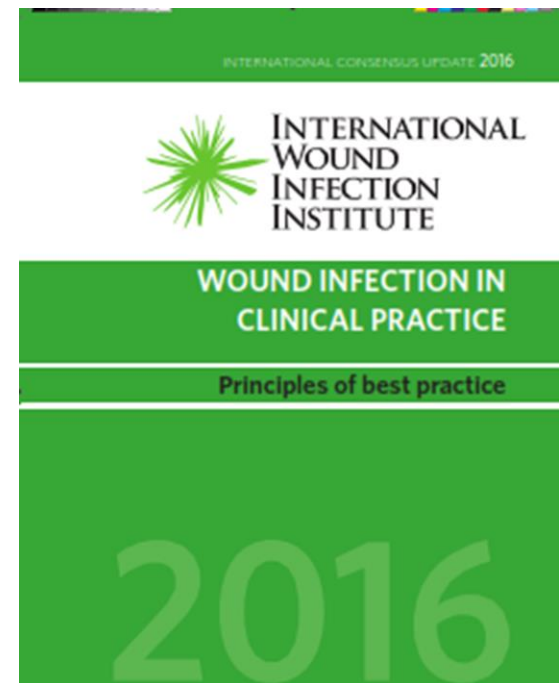
- Contamination
 - The presence of non-replicating micro organisms within the wound.
- Colonisation
 - The presence of replicating micro organisms that do not cause injury to the host.
- Local Infection
 - The presence of replicating micro organisms that are beginning to cause local tissue damage.
- Infection Spreading & Systemic
 - The presence of replicating micro organisms that are capable of causing injury to the host.

Patient Related Issues

- Allergic case History
 - Iodine, Silver, PHMB
 - Patients Age, Skin disorders
- Comorbidities
- Previous Experience with the Dressing
 - Patient compliance
 - Location
 - Fingers, Inter-digital space, foot, heel, close to a joint, groin
 - Size and Shape of the Wound

Summary of Consensus Document

- 30 page document
- 10 chapters
- Literature review
- Delphi process
- Expert opinion
- Key updates
 - The wound infection continuum
 - Definitions
 - Identification and diagnosis of wound infection
 - Addition of biofilm
 - Review of management strategies for biofilm efficacy



Investigations – When to swab

- Acute wounds with **classic signs** and symptoms of infection.
- Chronic wounds with signs of **spreading or systemic** infection.
- **Infected** wounds that have failed to respond to antimicrobial intervention, or are deteriorating despite appropriate antimicrobial treatment.
- In **compliance** with local protocols for the surveillance of drug-resistant microbial species.
- Wounds where the presence of certain species would negate a surgical procedure (e.g. beta haemolytic streptococci in wounds prior to skin grafting).

How to swab – Levine Technique

- Cleanse with non antimicrobial cleanser
- Debride
- Cleanse again
- Moisten swab
- Take sample from cleanest part
- Rotate over one square centimetre
- Inset in transport media
- Label and give history
- Should get to lab within 4 hours



Image Wounds International: TTT for taking a wound swab. 2010

Emerging Diagnostic Techniques

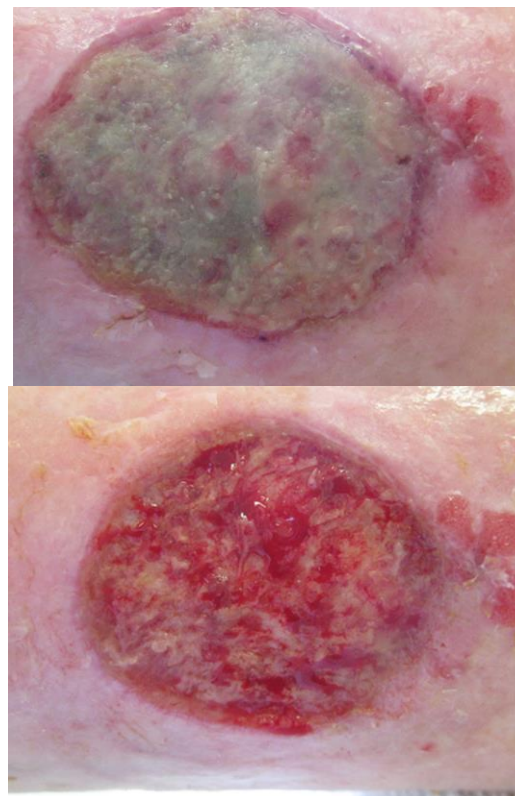
- Specialized microscopy
 - Con-focal
 - Fluorescence microscopy
 - Scanning electron microscopy
 - Transmission electron microscopy
- DNA sequencing
- Point of care (POC) beside diagnostics
- Wound biofilm mapping



Google image: Blog.cambridgeconsultants. How point of care diagnostics can help control the number of inappropriate antibiotic prescriptions. 2015

How do we manage wound infection?

- BBWC / WBP / TIME
- Debridement (initial and serial)
- Topical antimicrobials
- Systemic antibiotics
- Antibiofilm agents that prevent attachment of planktonic bacteria
- Interruption or prevention of quorum sensing
- Moisture Management
- Patient Centered Concerns



Therapeutic Cleansing

- Application of a cleansing solution that has potential to disrupt biofilm and kill planktonic bacteria and other organisms
- Promotion of safety of the wound and the individual
- Availability in a variety of settings (hospital, clinic and home environment)
- Irrigation that is performed at an appropriate pound per square inch pressure
- The peri-wound being maintained and protected from maceration.

Common Antiseptics

■ Hypochlorites

- Dakin's solution, Eusol
- thought to dissolve necrotic tissue
- highly toxic to fibroblasts
- occludes microcirculation
- retards the deposition of collagen
- can cause localised oedema, hypernatraemia, hyperthermia, burns
- chemically instable
- rapidly inactivated by organic material

Common Antiseptics Hypochlorites

Dilute Bleach Baths for *Staphylococcus aureus* Colonization in *Atopic Dermatitis* to Decrease Disease Severity.

- Explain to patients that their skin may benefit from “swimming in pool water.” Then, give them these instructions for making a pool right in their very own bathroom.
- Add lukewarm water to fill the tub completely (about 40 gallons of water).
- Depending on the size of the tub/amount of water used, add 1/4 to 1/2 cup of common bleach solution to the bath water. Any sodium hypochlorite 6% solution will do

Common Antiseptics

- Hydrogen Peroxide

composes to oxygen and water
oxygen bubbles mechanically loosen debris
very little anti-microbial activity
highly toxic to fibroblasts
risk of oxygen emboli

Do not use in place as a wound antiseptic

Common Antiseptics

■ Chlorhexidine

- toxicity to granulation tissue
- skin sensitivity reasonably common
- deactivated by organic material
- principally used on intact skin (eg in surgical scrubs)

■ Savlon

- chlorhexidine and cetrimide
- cetrimide has surfactant properties therefore useful in removing debris in acute wounds
- cetrimide highly toxic to fibroblasts

Acetic Acid

- 1% (vinegar)
- Action due only to its physiological unacceptable pH
- Two clinical trials have shown efficacy in treating Pseudomonas, due to acidic pH
- Topical wash for 10 minutes twice a day.
- Toxic in dilution to fibroblasts
- Recent research has shown that a 3-4% aqueous solution of Citric Acid is as effective in reducing pseudomonas as Acetic Acid with less risk of tissue damage

wound products for wound infection

Antimicrobial agent	Type	Biofilm Efficacy	Guidance for use
Enzyme alginogel	Alginate gel with two enzymes: Lactoperoxidase Glucose oxidase	Prevents formation of biofilms at concentration $\leq 0.5\%$ (w/v) Inhibits growth of established biofilms at higher concentrations Does not disrupt biofilm biomass	
Iodine (povidone)	Ointment & Cream Impregnated wound dressings Solution Throat Gargle Surgical Scrub	May Inhibits development of biofilm And reduces mature biofilm colonies	Contraindicated in individuals sensitive to iodine or with thyroid or renal disorders Contraindicated in extensive burns Topically 10% solution should be washed off after 3-4 minutes

Flaminal

Flaminal® contains lactoperoxidase which is an enzyme extracted from milk and acts as an important natural antimicrobial (Banks et al, 1986). It has been shown to be bacteriostatic against Gram-positive organisms and exhibits pH-dependent bactericidal action against Gram-negative organisms in the presence of hydrogen peroxide and thiocyanate.

Richard White Wounds UK, 2006, Vol 2, No 3

Flaminal



Flaminal is available as two hydrogels with a high alginate content which are promoted for the reduction of bacterial growth in wounds

wound products for wound infection

Brand name	Active ingredient	Formulation	Comments
Iodosorb	Cadexomer iodine	Ointment or powder, dressing Inhibits development of biofilm Eradicates young biofilm colonies Significantly reduces mature biofilm colonies	Highly absorbent, cadexomer iodine is a sustained release agent which releases the iodine in response to moisture at 0.1%
Inadine	Povidone iodine	Rayon dressing incorporating 10% PI	Effective against Gram +ve, Gram –ve bacteria, anaerobes, yeast, fungi and spores. Should not be used: Where there is known iodine hypersensitivity If the patient has kidney problems In pregnant or breast feeding women. In patients with thyroid disease In newborn babies and infants upto the age of 6

Common Antiseptics Iodine

- Iodine in its various forms has been used as a topical antiseptic since 1840.
- The newer forms of iodophores have been
- Used since the 1950's. Most of these new forms
- Combine Iodine in a complex with a polymer
- Eg. Povidone, Cadexomer these slowly release the iodine.
- Iodine is active against bacteria, mycobacteria, fungi, protozoas and viruses. There is no evidence of resistance to Iodine.

Common Antiseptics Iodine

- As a bactericidal agent, iodine penetrates bacterial cell walls, and although its precise killing mechanism is uncertain due to its extensive halogen reactivity, it's likely related to retardation of bacterial protein synthesis, disruption of electron transport, DNA denaturation or membrane destabilization. Over its hundreds of years of use, iodine hasn't elicited bacterial resistance, a trait that's due perhaps to its broad mechanism of action: It may have too many mechanisms for bacteria to adapt to.

Iodine is the only agent that is consistently active against gram positive and gram negative bacteria, spores, amoebic cysts, fungi, protozoa, yeasts, drug-resistant bacteria such as MRSA3 and viruses. Interest is keen, therefore, to minimize its side effects and maximize its killing efficacy.

Common Antiseptics Iodine

PVP and Cadexomer forms a polymeric complex with elemental iodine that improves tolerability, stability and solubility in water. Free iodine is delivered from the complex where it is carried in a less-irritating form. It's this delivery of free iodine that provides for the rapid microbicidal activity of the iodine complex. In-vitro analysis paradoxically suggests that solutions with a lower concentration may be more effective than those with higher concentrations.

Common Antiseptics Povidone Iodine

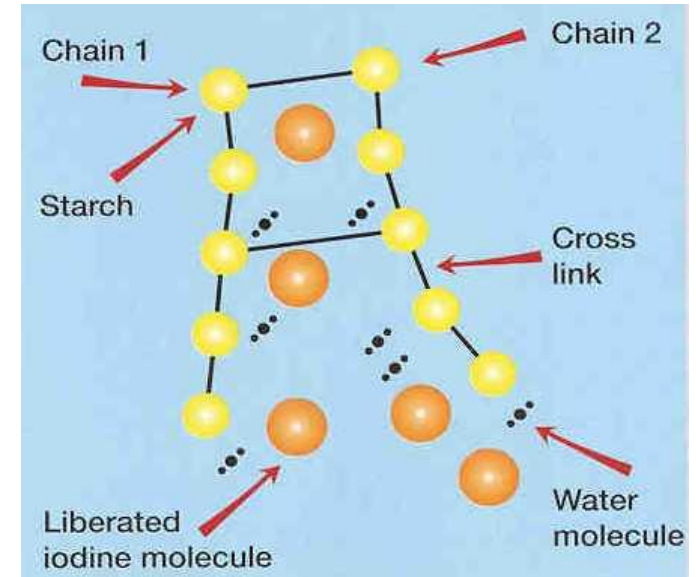
- Betadine (10% P-I)
- wide spectrum of activity
- inactivated by body fluids
- 5% solution causes cessation of blood flow
- toxic to fibroblasts, leukocytes, keratinocytes
- risk of systemic absorption
- Good skin antiseptic
- Absorption can cause metabolic acidosis
- On acute wounds apply for 3-4 minutes and wash off
- Chronic wounds dilute to 0.5-1% (c/f Mouth wash)
- This has been shown in a recent publish study that retention of the PI delayed reepithelialisation whereas removal did not and led to complete reepithelialisation ¹

1. Arai K et al Influence of various treatments including povidone iodine and healing stimulatory reagents in a rabbit ear wound model. Int Wound J 2013;10:542-548

Cadexomer Iodine Dressings (Iodosorb)

- Absorbent - forms gel with exudate
- Releases iodine as gel forms
- Pulses iodine at 0.1% (not cytotoxic)
- For sloughy/infected wounds
- Iodine may stimulate growth factors
- Reduces the pH of the wound, enhancing antimicrobial effect
- 'kick' 'starts chronic wound healing

Cadexomer Iodine Dressings (Iodosorb)



Cadexomer Iodine Dressings (Iodosorb)

- 0.9% Iodine immobilised in cadexomer is slowly released from the cadexomer to an iodine free environment in the presence of exudate (the wound)
- The Iodine (I_2) will move across a concentration gradient until an equilibrium is established between IODOSORB[◇] and the wound bed.
- Once in the wound bed, the I_2 will convert to I^- as it kills micro-organisms. When all the I_2 has been converted to I^- there will be a noticeable colour change which will indicate that it is time to change IODOSORB[◇].
- This product has been shown, in recent studies to promote wound healing by stimulating macrophage function.
- Due to its antibacterial effect it has also been shown to reduce malodour in a wound.



Cadexomer Iodine (Iodosorb)

Common errors:

- Failure to check for Iodine/shellfish sensitivities (Hashimoto's thyroiditis, Graves disease)
- Weekly maximum dose must not exceed 150gm
- Change to paste when powder begins to crust up
- Failure to remove all product before reapplication
- Failure to warn patient that some pain may be experienced

Inadine



INADINE® PVP-I Non-Adherent Dressing consists of a low adherent knitted viscose fabric impregnated with a polyethylene glycol (PEG) base containing 10% Povidone Iodine; equivalent to 1.0% available iodine.

INADINE® dressings are designed to protect the wound, even if infected. INADINE® is indicated for the management of ulcerative wounds and may also be used for the prevention of infection in minor burns and minor traumatic skin loss injuries.

wound products for wound infection

Antimicrobial agent	Type	Biofilm Efficacy	Guidance for use
Silver (metallic, nanocrystalline, ionic)	salts (e.g. silver nitrate) creams (e.g. silver sulphadiazine) impregnated wound dressings	Denatures existing bacterial biofilm in concentrations $\geq 5\mu\text{g/ml}$ Elemental silver dressings (e.g. silver hydroalginate, nanocrystalline silver) have higher silver concentrations than ionic silver dressings and sustain release for longer, therefore are more effective in inhibiting biofilm	Change more frequently in wounds with heavy exudate Consider using dressings with the highest available concentration of silver ions and/or sustained release products Avoid in individuals with silver sensitivities
Medical-grade honey	Manuka honey	some	Select products that have been gamma irradiated

What is Silver ?



Silver is a metallic element that in solution, exhibits Three Forms Ag^+ , Ag^{++} and Ag^{+++} Each capable of Forming inorganic and organic compounds and Chemical complexes.

Compounds involving Ag^{++} or Ag^{+++} are unstable or insoluble in water. Silver ions attack multiple microbial cells sites compared with antibiotics that mostly attack only one. Silver is effective against a broad range of aerobic, anaerobic, gram-negative and gram-Positive bacteria, yeast, filamentous fungi and viruses.

Silver

How safe is silver in wound care?

- The most common change seen in the skin in response to silver is argyria. This is the deposition of silver sulphide or possibly minute particles of silver in the dermis in the region of the sweat glands and hair follicles.
- It is not related to eczema or allergy, but a silver allergy may accompany argyria
- Argyria was reported in 11 out of 509 patients treated with silver sulphadiazine over 10 years. Widespread discolouration of the face, lips and gums faded over a year with no obvious after effects.
- Wang, X.W., Wang, N.Z., Zhang, O.Z. et al. Tissue deposition of silver following topical use of silver sulphadiazine in extensive burns. *Burns Incl Therm Inj* 1985; 11: 3, 197-201.

SILVER CONTAINING DRESSINGS

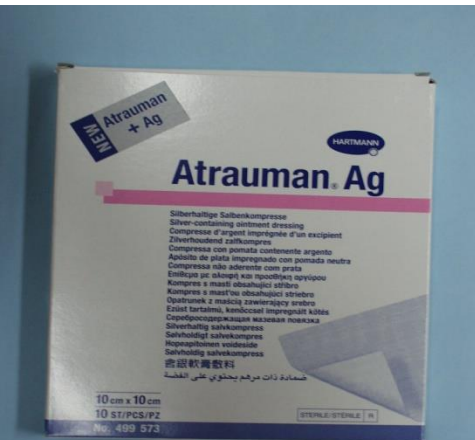
In recent year a range of dressings that Contain or combine Silver into their Structure have been released. They include

- ❖ High Density Polyethylene dressings [Acticoat]
- ❖ Foam Dressing [Acticoat Moisture Absorbing]
- ❖ Foam with Silicone Adhesive [Mepilex Ag]
- ❖ Alginate Dressing [Acticoat Absorbent,]
- ❖ Hydroactive Dressing [Biatain Ag]
- ❖ Hydrofibre Dressing [Aquacel Ag]
- ❖ Tulle Dressing [Atrauman Ag]

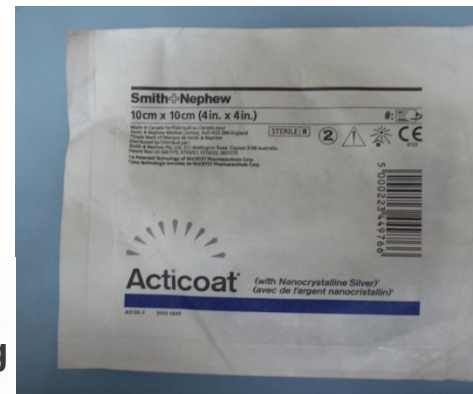
SILVER CONTAINING DRESSINGS

- The level of silver contained in the various dressings varies greatly.
- The mode of action also varies some
- Release the silver into the wound
- Some partly release the silver and hold some in the dressing
- Some keep the silver within the dressing

New Silver Dressings



BIATAIN Ag



SILVER CONTAINING DRESSINGS

Product Name	Acticoat 3 & 7 Dressing and Flex
Product Type	High Density Polyethylene, also Foam, Alginate
Manufacturer	Smith & Nephew
Silver Type	Nanocrystalline
Method of use	<p>Before application moisten with water { must not be saline as this will react with the silver}</p> <p>Dressing trimmed to wound size darker blue surface is placed in contact with the wound</p> <p>Cover with a secondary dressing depending on the level of exudate. Do not use with oil based products or topical antimicrobials</p> <p>May be used for 3 to 7 days</p>
Uses	Partial and full thickness wounds eg. Burns, donor sites, ulcers covered with a secondary dressing
Contraindications	Patients with known hypersensitivity

SILVER CONTAINING DRESSINGS

Product Name	Mepilex Ag
Product Type	Silicone Foam & Border Foam
Manufacturer	Molnlycke
Silver Type	silver sulphate that releases silver ions
Method of use	should overlap the dry surrounding skin by at least 1-2 cm for the smaller sizes (sizes up to 12.5x12.5 cm) and 5 cm for the larger sizes. may be left in place for up to 7 days depending on the condition of the wound and surrounding skin, or as indicated by accepted clinical practice.
Uses	management of low to moderately exuding wounds such as leg and foot ulcers, pressure ulcers and partial thickness burns
Contraindications	Do not use on patients with a known sensitivity to silver. Prior to commencing radiation therapy remove Mepilex Ag Do not use together with oxidising agents such as hypochlorite solutions or hydrogen peroxide

SILVER CONTAINING DRESSINGS

Product Name	Aquacel Ag
Product Type	Hydrofibre Silver
Manufacturer	ConvaTec
Silver Type	NaCMC containing Silver that is released into the wound
Method of use	<p>Apply to the surface or lightly packed(no more than 80%) into moderate to high exudating wounds</p> <p>Depending on the wound may need to be daily or every third day or up to 14 days in burns. Should not be used with other wound care products</p>
Uses	Partial and full thickness wounds eg. Burns, donor sites, ulcers and covered with a secondary dressing depending on the level of exudate
Contraindications	<p>Patients with known hypersensitivity</p> <p>Little value in lightly exudating or dry wounds</p>

SILVER CONTAINING DRESSINGS

Product Name	Biatain Ag
Product Type	Hydroactive
Manufacturer	Coloplast
Silver Type	Silver complex on contact with exudate provides sustained release of the silver 70% of the Silver is released within 7 days The silver is released into the wound
Method of use	Applied on and around surface wounds and lightly packed into cavity wounds. Used for up to seven days. May cause transient discolouration of wound bed Should be removed prior to radiation therapy, x-rays .
Uses	leg ulcers, pressure ulcers, second-degree burns, donor sites, diabetic foot ulcers, post-operative wounds and skin abrasions.
Contraindications	Patients with known hypersensitivity Should not be used with Hydrogen peroxide or hypochlorite solutions or over exposed muscle or bone

SILVER CONTAINING DRESSINGS

Product Name	Atrauman Ag
Product Type	Tulle
Manufacturer	Hartmann
Silver Type	Metallic Silver is released into the wound though mostly held in the dressing
Method of use	Apply to the wound and peri-skin covered with a secondary dressing depending on the level of exudate. Used Every three to seven days
Uses	Complementary use in infected or contaminated Partial thickness wounds eg. Burns, donor sites, ulcers
Contraindications	<p>Patients with known hypersensitivity</p> <p>Should not be used in combination with paraffin containing dressings or ointments</p>

Should Silver dressings be used in children ?

Silver dressings should be used in the treatment of children with caution and the dressings should not be used for more than two weeks without good clinical reasons

Silver dressings are toxic to wounds and delay healing

Silver dressings should not be used on wounds where bioburden is not a problem, ie they should be reserved for use in wounds with or at risk of high bioburden or local Infection

Bacteria become resistant to silver An apparent lack of response to silver does not relate to resistance, rather to inappropriate treatment of the underlying infection and/or wound aetiology



What do we mean by the two-week challenge?

It has been recommended that antimicrobial dressings should be used for two weeks initially and then the wound, the patient and the management approach should be re-evaluated. The consensus group has suggested that this initial two week period can be seen as a two week 'challenge' period during which the efficacy of the silver dressing can be assessed.

What do we mean by the two-week challenge?

If after two weeks:

- there is improvement in the wound, but continuing signs of infection it may be clinically justifiable to continue the silver dressing with further regular reviews
- the wound has improved and the signs and symptoms of wound infection are no longer present – the silver dressing should be discontinued
- there is no improvement – the silver dressing should be discontinued and consideration given to changing the dressing to one that contains a different antimicrobial agent and if the patient is unwell using a systemic antibiotic and re-evaluating possibly untreated comorbidities.

When not to use silver dressings

- In the absence of signs of localised (overt or covert), spreading or systemic infection
- Clean surgical wounds at low risk of infection, eg donor sites, closed surgical wounds
- Chronic wounds healing as expected according to comorbidities and age
- Small acute wounds at low risk of infection
- Patients who are sensitive to silver or any of the dressing components
- Wounds being treated with enzymatic debridement

INTERNATIONAL CONSENSUS

When not to use silver dressings

- During pregnancy or lactation
- When contraindicated by the manufacturer, for example, some manufacturers recommend that their silver dressings are not used during magnetic resonance imaging (MRI), or on/near body sites undergoing radiotherapy

silver dressings should be used in the context of accepted standard wound care which involves a holistic assessment of the patient and the wound, management of underlying comorbidities, and wound bed preparation

INTERNATIONAL CONSENSUS

Partial thickness burn Case Study 14.12.03



Burn being treated with Silvazine and Jelonet by a GP.

Grafting recommended as the next treatment phase.

Acticoat commenced 14.12.03



Partial thickness burn 17.12.03



Third day after
commencement of
Acticoat



Partial thickness burn 22.12.03



Eight days after commencement of Acticoat



**Three weeks after
commencement of
Acticoat**

Arm Burn 36 HRS POST-BURN Treated with Silver Sulfadiazine



Arm Burn 36 HRS POST-BURN

Application of Mepilex Ag



Arm Burn 36 HRS POST-BURN

Application of Mepilex Ag DAY NINE



Other antiseptics

- Honey
 - Antibacterial effect, also anti-fungal
 - bacteriostatic
 - tested against (at different dilutions)
 - staph aureus spp (inc MRSA), pseudomonas spp with inhibition of both
 - Daily dressings usual
 - may be up to tds depending on exudate
 - Produces H_2O_2
 - hydrogen peroxide in “slow-release” form due to enzyme action (antiseptic)



Honey positives

- High osmolarity
 - reduce oedema and maceration
 - unsuitable environment for bacterial growth
- low pH
 - inhibit cell growth
- Produces enzymes
 - may promote slough separation
- May reduce odour
- Inexpensive??
- Easily obtained
- Easy to apply
- May reduce pain
- Anti-inflammatory??

Honey negatives

- Infection not biggest problem in chronic wounds
- Doesn't address underlying causes
 - vascular problems
 - pressure, shear, etc
 - diabetes
- Anti-bacterial activity can vary by up to 100-fold from one batch to next
- Pain in some patients
- Hydrogen peroxide not recommended in wound care
 - Feeble antiseptic and may cause oxygen emboli
- May contain bacteria or spores if unsterilised
 - Inactive if heat sterilised

wound products for wound infection

Antimicrobial agent	Type	Biofilm Efficacy	Guidance for use
Dialkylcarbamoyle chloride Impregnated Fibre (DACC)	Tulle-like, Foam Hydrogel Absorbent Ribbon Post Op Dressing	Not actively biocidal or biostatic Reduces the bacterial load in a wound by binding bacteria or fungus to the hydrophobic fibre	Do not use with creams or ointments as the binding effect may be impaired

Common wound pathogens

- *Staph. aureus*
- *Pseudomonas*
- *E. coli*
- *Streptococcus*
- *Candida albicans*

Hydrophobic properties



Sorbact

Non-antibiotic

Non-antiseptic

Sorbact[®] areas of use



Infected Wounds



Critically colonized
Hard to heal wounds



Prevention



Fungal infection in skin folds



Athletes foot

Frequency of dressing changes

Recommended frequency of dressing changes

- *Infected wounds:* *Initially once daily*
- *Colonized/Critically colonized wounds:* *According to exudate level every 2 – 3 days*

The frequency will be decreased according to wound status improvement

- **"Clean"** wounds: *2 times/week or when needed*

Other antiseptics

Product	Type	Cytotoxicity	Biofilm affect	Comments
Hypochlorous Acid(HOCL) and Sodium Hypochloride (NaOCL)	antimicrobial	These newer solutions claim to be safe for the wound and patient while disrupting biofilm and killing planktonic bacteria and other organisms. this is NOT EUSOL!	Some	Comes in a spray-on format solution and gel

Other antiseptics

Product	Type	Cytotoxicity	Biofilm affect	Comments
Octenidine dihydrochloride (OCT)	Surfactant antimicrobial	In-vitro testing shows high toxicity, but as the preparation is not absorbed there are no systemic effects and it has not been shown to disrupt healing	Some	Comes in a gel and irrigation preparation that can be used together or separately Lowers liquid surface tension allowing greater spread and facilitating separation of non-viable tissue

Other antiseptics

Product	Type	Cytotoxicity	Biofilm affect	Comments
PHMB / Betaine	Surfactant antimicrobial	The toxicity profile of both the biguanides and the polymeric biguanides is excellent. Neither molecule is a primary skin irritant nor a hypersensitising agent.	Some claimed	There is little or no evidence to suggest that this would lead to the emergence of PHMB resistant.



New Antiseptics

Both ingredients are known to be extremely safe when used on skin and mucous membranes. Effective wound irrigation is highly important as it prepares the wound bed by removing debris, bacteria and coatings from the wound. This allows full inspection of the wound so the correct treatments can be applied.

New Antiseptics



Application Issues

Allow 2-3cm of dressing greater than wounds

Place 1/3 Above & 2/3 Below the wound

Remove when strike through occurs

Do not pre-moist Alginate dressings

Remove with care in older patients

As the wound changes so the needs of the tissue changes.

Consider the type of secondary dressing if required

Application Issues

With Packing Cavity wounds

Do not over Pack remember products expand
If possible leave a small wick outside to aid removal

If you believe there is product left in the cavity then irrigate carefully with warm Saline

Some products are reinforced to aid removal

Application Issues With Packing Cavity wounds



Conclusion

Despite the use of many other antiseptics in a wide range of situations evidence supporting their efficacy in the treatment of wound infection is more limited. Clinicians will use newer products however it is important that further good clinical research to be undertaken and published to validate their use in wound management

Conclusion

“I challenge each & every one of you to take the agents you are currently using in your wound management procedures & put them in your eye”

Rodeheaver