Gauze, Impregnated Gauzes, and Contact Layers

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Abbreviations and Acronyms

BIPP = bismuth, iodoform, and paraffin paste

CL = contact layer

CMS = Centers for Medicare and Medicaid Services

MRSA = methicillin-resistant *staphylococcus aureus*

MWH = moist wound healing

NPWT = negative pressure wound therapy

PHMB = polyhexamethylene biguanide

WTDD = wet-to-dry dressing

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Background: Gauze has long been used as a primary and secondary dressing. It is frequently impregnated with substances for bactericidal, moisture-balance, hemostatic, or debridement purposes. Contact layers (CLs) provide a nonadherent protective layer over the wound when needed.

The Problem: Though commonly used, gauze is potentially recognized to harm wound tissue through desiccation and adhesion. Contemporary research on gauze is largely limited to being the control group of a product trial. Impregnated gauzes vary widely in the materials used. Iodoform, commonly impregnated on gauze, is weakly antimicrobial and can be toxic when absorbed.

Basic/Clinical Science Advances: Wet-to-dry dressings (WTDDs) are not supported in modern wound care, as they slow healing and destroy viable tissue. Gauze dressing orders should be written "moist-to-damp." The composition of a CL can affect cell viability and interface pressure through negative pressure therapy. Gauze dressing changes release more bacteria into the air than other types of dressings. Gauze has long been impregnated with various substances. The most recently used materials have antimicrobial and hemostatic properties.

Clinical Care Relevance: WTDDs are more expensive over the course of care despite its inexpensive supply cost. Iodoform and bismuth dressings may result in allergic reactions, toxicity with cognitive changes, and multisystem problems. CLs can reduce tissue trauma with dressing changes, with different types preferred for different wounds. Gauze may be impregnated with a large number of substances to achieve different goals, both during manufacturing or at the point of care.

Conclusion: Despite evidence against the use of WTDDs, they are still used. There is limited evidence on impregnated gauzes (other than iodoform) and CLs, but they are commonly used. More research should be done on gauzes, impregnated gauzes, and CLs.

BACKGROUND

GAUZE HAS BEEN used to support wound healing throughout recorded history. Healers have impregnated gauze or other materials such as papyrus, lint, sponges, or wool with honey, wine, vinegar, poultices, salves, and other compounds thought to aid healing.[1,2]

Gauze is a versatile product. It is commonly used to absorb blood and exudate. It is applied with pressure to achieve hemostasis, placed as a wound filler or cover, made wet or kept dry, and used as a secondary dressing to secure a primary product. Sterile cotton gauze was first mass-produced[1] in 1891. Since then, gauze has evolved into a wider variety of products and sizes, including rolls for wrapping extremities or ribbons for packing into tracts/tunnels, and a choice of woven cotton or nonwoven synthetic gauze.

Heavily used since the early 20th century are contact layers (CLs).

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Early CLs included tulle gras,[3] a wide-mesh net material coated with a blend of paraffin, oil, and Balsam of Peru. Later, CLs included a synthetic net or mesh, uncoated or coated. CLs serve several functions. They may be used directly on the wound to reduce trauma from dressing changes while allowing exudate and topical agents to pass through it to and from the wound. CLs also prevent adhesion to dressings, especially with negative pressure wound therapy (NPWT) or over skin grafts.

Gauze products are frequently impregnated with a number of substances (Table 1). In the quest to provide wound care for minimal cost, the pennies-per-use cost of gauze has been appealing, as well as its wide availability and general ease of use. However, there are several areas of concern with some gauze applications, and the previously popular gauze "wet-to-dry dressings" (WTDDs) has fallen out of favor because of the tissue trauma and wound desiccation associated with its use.

Table 1. *Common uses of impregnated gauzes*

Impregnated Ingredient	Non-adherent	Debridement	Moisture-retentive	Moisture-additive	Absorbent	Wound drying/ desiccation	Anti-microbial	Hemostasis	Primary Dressing	Contact Layer	Manufactured impregnated	Impregnated at point of use
Sodium Chloride (saline)		■	□	□	■	□			■		■	■
Hypertonic Sodium Chloride (dry)		■			■				■		■	
Iodoform					■	■	■		■		■	
Petrolatum	■		■						■	■	■	□
Paraffin	■		■						■	■	■	
Bismuth and Petrolatum	■		■			□	□		■	■	■	
BIPP	■		■					■	■		■	
Oil Emulsion	■		■						■	■	■	
Hydrogel	■			■					■		■	■
Honey	■	■	■		□		■		■		■	■
PHMB					■	■	■		■		■	
Cellulose								■	■		■	
Chitosan								■	■		■	
Kaolin								■			■	
Zeolite								■			■	
Polymer	■		■	■	■				■		■	

Legend: ■ Primary effects □ Secondary effects

This table represents the most commonly used impregnation substances. Clinicians often manually impregnate gauze with other desired substances. This technique may be especially valuable in resource-poor nations where preimpregnated dressings may be unavailable or prohibitively expensive. The properties of saline gauze vary depending on use—whether placed wet, moist or dry, and whether removed wet, damp, or dry. Hemostatic dressings vary in use across manufacturers. Some are designed to be left in place as a primary dressing, whereas others are designed to be temporary until clotting occurs, at which point they are removed and a different primary dressing is applied. Dark gray shades: primary effects; light gray shades: secondary effects.

BIPP = bismuth, iodoform, and paraffin paste; PHMB = polyhexamethylene biguanide.

BASIC SCIENCE CONTEXT

In 1962, Winter published his seminal paper supporting moist wound healing (MWH) as superior to dry wounds.[4] Wounds that are kept moist heal faster, with less scarring, a better cosmetic outcome, and fewer infections.

Critical colonization and infection are well understood to impair wound healing through the production of inflammatory cytokines and bacterial toxins, which lead to a prolonged inflammatory phase of wound healing.

The choice of dressing can influence the wound bed's moisture and bacterial loads, thus influencing wound viability and progression. Depending on its use, gauze may dry or hydrate the wound and is typically very permeable to bacteria.

EXPERIMENTAL MODEL OR MATERIAL—ADVANTAGES AND LIMITATIONS

Because it has long been the "standard of care," there has been little research on gauze, especially recently. Most research has been on the treatment for the control group, with the test product usually proving superior to gauze for wound healing. These trials are often sponsored by the manufacturer of the product. As gauze and impregnated gauzes are inexpensive, there is little financial incentive to invest in studies. Published papers on these materials may be based on clinical experience or professional opinion. Studies rarely compare CLs. Those that do include few types and these studies often are not replicated or expanded.

Iodoform has proven to be more bacteriostatic than bactericidal *in vitro*.[5] However, it is thought that it may react with body fluids and become more bactericidal *in vivo*. However, the research on this question is limited, and it has not been examined for decades in the context of current knowledge. Other antimicrobial substances, such as cadexomer iodine and Dakins solution, have been studied as stand-alone products, not necessarily impregnated on gauze. (See Section 3, Antibacterial Dressings for more information on antimicrobial substances.)

The contemporary research cited in this chapter was produced in western nations with access to advanced wound care. Resource-poor nations may not have access to these more expensive products, and so more of traditional materials may be encompassed in the primary approach. Therefore, older research may prove valuable when these products are the only available ones. Research on outcomes in these settings is important.

DISCUSSION OF FINDINGS AND RELEVANT LITERATURE

Gauze has been used since ancient times, because of its availability, ease of use, inexpensive cost, familiarity, and longevity in practice, as well as clinicians' lack of knowledge about the variety of alternatives available.[6]

Plain gauze is commonly used in several manners. Dry gauze is often used on closed surgical sites to absorb any exudate and provide a mild barrier from the environment. With moistened gauze or a wet-to-moist dressing, gauze is wet with normal saline, or other liquid solution, and changed several times daily to prevent the wound from drying. For WTDDs, saline-moistened gauze is applied to the wound and allowed to dry before removal to facilitate debridement. Fifty years post-Winter, WTDDs continue to be prevalent.[6–8]

Though gauze dressings appear inexpensive, it has been demonstrated that these dressings are actually much more expensive than advanced dressings because of the labor involved multiple times per day, longer time to healing, greater need for pain medications, and a higher infection risk.[6–12] As the moisture evaporates the wound bed cools, slowing healing through vasoconstriction, reducing oxygen release by hemoglobin, and reducing the mobility and activity of leukocytes.[6] The gauze also becomes hypertonic, drawing fluid from the wound bed, causing dessication.[6,7] In addition to inhibiting MWH, WTDDs tightly adhere to slough and granulation tissue. As a result, dressing changes cause significant trauma to the newly growing tissue through nonselective debridement[6,8] and a prolonged inflammatory state. Of particular concern for patients lacking coagulation, WTDDs also increase the risk of bleeding upon dressing removal.[3] For these reasons, Centers for Medicare and Medicaid Services (CMS) regulations for long-term care indicate that this approach should be used only for mechanical debridement when the wound has no significant viable tissue.[13] Clinicians often re-wet the gauze before removal to reduce the adherence and associated pain, thus preventing mechanical debridement while maintaining the disadvantages of a dry wound bed.[8] There is a commercially available hypertonic salt-impregnated dry gauze designed to debride slough.

Iodoform gauze has been used to prevent or treat infection since 1837.[14] In the 1880s there was a debate over the toxicity of iodoform because of the complications from its use, including several deaths.[14] Iodoform and bismuth are common sensitizers,[15–17] with an allergic reaction rate for bismuth, iodoform, and paraffin paste (BIPP) dressings up to 11% after a second exposure.[18] Despite these risks, and a weak antimicrobial effect,[14,15,19–22] it is still in use.

TAKE-HOME MESSAGE

Basic science advances

There is little research on gauze, impregnated gauze, and CLs. Most modern research is on a control group's standard of care while another product is being studied. The studies focused on these products are older.

- Iodoform is incompatible with silver nitrite, metallic salts, strong oxidizers, and strong bases.[23]
- WTDDs are not supported in modern wound care.
- Iodoform is more bacteriostatic than bacteriocidal.[5]
- Iodoform and other substances may respond differently in *in vivo* and *in vitro* environments.
- CL composition affects cell viability.

Clinical science advances

- Gauze and impregnated substances have been used since ancient times.
- There is a wide variety of CLs and impregnated gauzes (which may serve as CLs or primary dressings). They serve several purposes, including the following:
  - Protection of the wound bed through nonadherence, leading to reduced pain, bleeding, and trauma,
  - Bacteriostatic or bacteriocidal environment,
  - Hemostasis,
  - Management of moisture balance.
- Gauze and impregnated gauzes may promote or hinder MWH, depending on the product and its use.
- Gauze is not an adequate bacterial barrier, especially when wet. Greasy, oily, or gel-based substances on the gauze may provide better occlusion.
- Iodoform and bismuth are strong allergic sensitizers.
- With a WTDD, evaporative cooling delays wound healing through vasoconstriction, reduced leukocyte activity, and increased oxygen binding.
- As the moisture evaporates from a WTDD, it becomes more hypertonic, desiccating the wound as it pulls fluid osmotically.
- Polyhexamethylene biguanide-impregnated gauze may be helpful in reducing the risk of Methicillin-resistant *Staphylococcus aureus* (MRSA) and other infections.
- The removal of gauze dressings releases significant amounts of bacteria into the air.

Relevance to clinical care

- Despite inexpensive supply costs, gauze dressings have a higher total cost of care.
- The clinician can impregnate gauze with nearly any solution, gel, or paste at the point of care.
- Wound-care professionals must be aware of the risks and benefits of each product being used.
- Sudden changes in behavior, mental status, neurological status, renal function, or overall medical condition should trigger assessment of iodine or bismuth levels if dressings containing them have been used. If toxicity is suspected or confirmed, the type of dressing must be changed and supportive measures implemented. Hemodialysis or chelation may be necessary in severe cases.
- With systemic absorption, iodoform can transmit to a fetus through the placenta or to an infant via breastmilk, causing hypothyroidism.[37]
- CLs are used to reduce tissue trauma and pain at dressing changes with NPWT,[35] over skin grafts, and with fragile tissue.
- Each type of CL has advantages and disadvantages, and the clinician should consider which option best serves a particular patient.

Iodoform may be absorbed systemically, especially if the wound is large or if it is used for a prolonged time. The Material Safety Data Sheet for iodoform[23] labels it a severe health risk with multiple problems, such as inhalation, ingestion, or transdermal absorption, including dermatitis, irritation, and effects on the cardiovascular system, nervous system, liver, and kidneys. Other reported symptoms of iodoform toxicity include acid/base disturbance, thyroid disorders, abnormal liver function, and neutropenia.[24]

There are many reported cases of iodoform toxicity causing reversible cognitive impairment,[5,15,25–29] with both iodopor gauze and BIPP-impregnated gauze. Bismuth can result in systemic toxicity.[24] Iodoform may affect peripheral nerves. Gauze impregnated with an iodophor paint placed adjacent to a nerve blocked conduction.[30] The same effect was not found with iodoform gauze, but facial paralysis has been noted with BIPP use.[31]

Gauze may be impregnated with antimicrobial agents. Antiseptics such as Dakin's solution have broad cytotoxicity, but may be used in limited situations. (See Section 3, Antibacterial Dressings.) One study[32] found a 24% reduction in surgical site infections and a 48% reduction in MRSA surgical site infections with an antimicrobial gauze impregnated with polyhexamethylene biguanide.

Gauze is often used as a secondary dressing to secure primary dressings and provide a bacterial barrier. However, 64 layers of dry gauze are required to block bacteria.[33] Moist gauze is even more permeable to bacteria.[6] The risk of aerosolization and cross-contamination is also higher with gauze. Compared with a hydrocolloid, gauze dressing changes resulted in five times the amount of bacteria released into the air.[33,34]

Woven cotton gauze adheres to tissue more strongly than nonwoven synthetic gauze and may shed fibers, especially if cut. These tiny foreign bodies prolong inflammation and may form granulomas in the tissue.

There has been little research on CLs; however, their value is clinically recognized. They are most commonly a synthetic mesh, either raw or coated with a nonadherent material such as petrolatum, oil, or silicone. CLs may dry and stick if left in place too long or the exudate is sanguinous.[3] The composition and permeability of a CL used under NPWT will affect the force at the surface, and so this should be considered in planning care.[35] Petrolatum-impregnated gauze resulted in lower local pressure than the foam alone or with silicone or mylar-polyester CLs. (See Section 11, Topical Negative Pressure Therapy for Acute and Chronic Wounds.)

The composition of the CL affects cell viability. *In vitro* tulle gras with chlorhexadine produced a significant reduction in fibroblasts and keratinocytes, whereas a silicone-coated viscose CL showed an increase in the number of fibroblasts after 3 days of treatment, but not 7.[36]

CAUTION, CRITICAL REMARKS, AND RECOMMENDATIONS

At this time there is little independent research on impregnated gauzes and CLs. Most product trials compare their efficacy to plain gauze, which usually is not conducive to wound healing, making the alternatives appear superior. Comparative trials of products within or across categories are rare. Many published articles are commentary or informational pieces based on opinion or experience.

There are some reports that silicone-coated CLs may be more difficult to apply and are more time consuming than other CLs.[38] They also have been reported to adhere less to the wound base, however, and may be a better choice in some cases, despite a higher cost.[39]

Despite the wide array of advanced wound products available, and the knowledge base that has accumulated about the harm WTDDs and iodoform-impregnated gauze may cause to wounds, they are

still in common use by nonwound specialists. Efforts must be taken by the wound-healing community to bring the practice of wound care by all health professionals up to current standards.

Despite being highly toxic, iodoform is still used in open wounds. The Material Safety Data Sheet advises wearing protective garments to prevent skin contact when working with iodoform. It is not, however, a carcinogen.[23]

FUTURE DEVELOPMENT

There is a need for further work in this area, with new products being developed, and the efficacy of new and existing products being explored.

The older dressings, such as gauze, petrolatum gauze, BIPP, and iodoform gauze, have some evidence available about their use, both favorable and unfavorable, albeit mostly decades old. The newer products have limited independent research. As there is much variability in the composition and properties of CLs and impregnated substances, comparative research should be conducted so that wound-care professionals will be able to select the optimum product for a given wound.

New impregnations are sure to be developed, with multiple aims. Recently, several gauze impregnations previously reserved for emergency settings have become available for achieving hemostasis. Another new product impregnated with a polymer designed to maintain moisture balance by moving fluid between the dressing and the wound as needed has been developed. Real-world outcomes for these products should be studied.

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