

Postoperative Topical Antimicrobial Use

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Allergic contact dermatitis associated with topical antimicrobial agents is an increasing problem in the postoperative wound care period. We reviewed the topical antimicrobial agents most commonly used postoperatively in North America and Europe, examined the incidence of allergic contact dermatitis from each agent, and provided guidelines for the use of topical antimicrobials on closed and open wounds in the postoperative period. Neomycin was the most common cause of allergic contact dermatitis both in the general patch-tested population (11%) and in the postsurgical population. Bacitracin was also a common culprit, although at a lower rate (8%). There is a risk of co-reactivity between these two agents. Polymyxin B and mupirocin were not significant allergens. The rate of postoperative infectious complications in dermatologic surgery (1–2%) was similar to the rate of allergic contact dermatitis from topical antimicrobials (1.6–2.3%). We concluded that for closed wounds, the use of topical neomycin postoperatively should be avoided. White petrolatum is an efficacious and cost-effective alternative for closed wounds. For open wounds, topical antimicrobials that do not contain neomycin should be recommended.

TOPICAL ANTIMICROBIALS are among the most commonly purchased medications, used by the general public for everything from simple abrasions and cutaneous infections to routine wound care. It has been estimated that 25 million procedures are performed in dermatologists' offices yearly, and an average of 31.5% of dermatologic visits involve the excision or destruction of a skin lesion.^{1,2} In addition, a random survey of dermatologic surgeons reported over 4.9 million procedures performed in 2005, 1.7 million of these being for skin cancers.³ With the incidence of skin cancer (and thus surgical excisions) on the rise,⁴ optimizing postoperative wound care is paramount. Most dressings used in the ambulatory surgery population involve the use of topical antimicrobial agents. However, it is important to remember that these frequently applied adjunctive medications are not without risk. One of the more common and easily observed adverse reactions is the development of an allergic contact dermatitis. The ease and convenience of patch testing makes it a readily available tool for investigating this phenomenon. Furthermore, one topical

antimicrobial (neomycin) is part of the standard series of patch tests. This underscores the frequency of topical antimicrobials as allergens. The purpose of this review is to understand the benefits and risks of topical antimicrobial agents, specifically as used postoperatively, and to provide evidence-based guidelines for the judicious use of these agents.

A systematic review of the literature was performed by searching MEDLINE articles published in English from 1950 to the present, using the keywords "patch test," "allergy," "antibiotic," "surgery," "postoperative," and "wound." We searched for publications that discussed topical antibiotic use that resulted in (1) a cutaneous eruption, (2) further evaluation by patch testing, or (3) both a cutaneous eruption and further evaluation. We found more results with "antibiotic" than with "topical antibiotic" and more results with "allergy" than with "contact allergy." We used the term "antibiotic" synonymously with "antimicrobial" because topical antiviral and antifungal agents were not investigated. In evaluating the incidence of allergic contact dermatitis from the substance in question, the frequency of positive patch-test reactions was often used as a surrogate marker in the studies evaluated. We also evaluated the incidence of topical antimicrobial-related allergic contact dermatitis in postsurgical patient populations, using the keywords mentioned previously. Finally, to develop specific guidelines for the use of topical antimicrobials in postoperative wound care, we identified studies comparing the use of topical antibiotics and other topicals in this setting.

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Standard Postoperative Wound Care

For patients undergoing ambulatory surgery, good wound care is important not only to promote healing of the surgical site but also to prevent infection. The most frequently used method is the application of topical antimicrobial products or white petrolatum both at the time of the initial dressing placement and by having the patient apply such substances on the wound daily until subsequent postoperative visits. After epidermal closure of the wound, a thin layer of the antimicrobial product is applied, followed by Steri-Strips (3M Healthcare, St. Paul, MN) and a pressure dressing, which usually consists of a nonadherent contact layer, gauze or cotton balls, and an adhesive material. This dressing is often left in place for up to 48 hours. The patient is then instructed to remove the overlying dressing and apply an antimicrobial ointment or white petrolatum daily. This is then covered with gauze and an adhesive layer. This process is repeated daily for at least 1 to 2 weeks.⁵⁻⁹

Topical Antimicrobials Commonly Used in North America and Europe

Neomycin Sulfate

Neomycin sulfate is an aminoglycoside antibiotic produced from *Streptomyces fradiae*. It is a combination of the sulfate salts of neomycin B and neomycin C. This compound exerts its effect by inhibiting protein synthesis via binding of ribosomal ribonucleic acid (RNA).^{10,11} Its spectrum of activity includes most gram-negative bacteria as well as some gram-positive bacteria, including *Staphylococcus* species. It is not effective against *Pseudomonas*, anaerobes, or streptococci.¹²⁻¹⁵ It is commercially available at a concentration of 0.5% in a petrolatum vehicle containing wool fat and mineral oil and is available for patch testing at a concentration of 20% in a petrolatum vehicle. It is also available in combination with bacitracin and polymyxin B in a vehicle consisting of butter, cottonseed oil, olive oil, sodium pyruvate, tocopheryl acetate, and white petrolatum (Table 1).

Bacitracin

Bacitracin is a polypeptide antimicrobial that is produced by *Bacillus subtilis*. By inhibiting the production of squalene and sterols¹⁶ and blocking peptidoglycan synthesis, it blocks the formation of bacterial cell walls. Bacitracin can be used effectively against many gram-

positive and gram-negative organisms.¹²⁻¹⁵ It is most commonly available as an ointment with a base of white petrolatum and light mineral oil. It is also available in combination with polymyxin B in a white petrolatum base.

Mupirocin

Mupirocin, also known as pseudomonic acid, is an antimicrobial agent produced from *Pseudomonas fluorescens*. Its chemical name is (α E,2S,3R,4R,5S)-5-[(2S,3S,4S,5S)-2,3-epoxy-5-hydroxy-4-methylhexyl]tetrahydro-3,4-dihydroxy- β -methyl-2H-pyran-2-crotonic acid, ester with 9-hydroxy-nonanoic acid, calcium salt (2:1), dihydrate. Its mechanism of action is also the inhibition of protein synthesis. This is accomplished by the binding of bacterial isoleucyl transfer RNA synthetase,¹⁷ which blocks the addition of isoleucine to proteins. Mupirocin has been noted to have a bactericidal effect against gram-positive species, including methicillin-resistant *Staphylococcus aureus*, and some gram-negative cocci.¹²⁻¹⁵ It is generally found at a 2% concentration in a cream formulation consisting of an oil-and-water emulsion of benzyl alcohol, cetomacrogol 1000, cetyl alcohol, mineral oil, phenoxyethanol, purified water, stearyl alcohol, and xanthan gum.¹⁸ It is also found as an ointment with a base of polyethylene glycol.

Polymyxin B

Polymyxin B is an antibacterial peptide produced from *Bacillus polymyxa*. It has been shown to disrupt bacterial cell membranes via a surfactant-like mechanism that renders the bacterial cell wall more permeable. It has a limited spectrum of activity, being effective mainly against some gram-negative organisms as well as *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Serratia marcescens*, *Escherichia coli*, *Enterobacter*, and *Klebsiella*.¹²⁻¹⁵ It is found both in combination with bacitracin in a petrolatum base as well as with bacitracin and neomycin in a petrolatum base.

Fusidic Acid

Fusidic acid is an antibiotic agent derived from the fungus *Fusidium coccineum*.¹⁹ Its mechanism of action involves the inhibition of ribosomal translocation which blocks protein synthesis. Coverage is largely limited to staphylococcal species; fusidic acid has only limited activity against streptococcal species and no activity against gram-negative organisms. However, there have also been reports of emerging *Staphylococcus* resistance to fusidic acid.²⁰

Table 1. Topical Antimicrobial Agents Most Commonly Used in North America and Europe

Antimicrobial Agent	Vehicle	Concentration or Amount	Spectrum of Activity
Neomycin	Petrolatum, wool fat, mineral oil	0.05%	GN, some GP including <i>Staphylococcus aureus</i>
Bacitracin	Petrolatum, light mineral oil	500 U	GP, GN
Mupirocin	Oil-and-water emulsion (cream) or polyethylene glycol (ointment)	2%	GP (including MRSA), GN cocci
Polymyxin B	Petrolatum (Polysporin,* Neosporin [†])	10,000 U	GN
Fusidic Acid	Lanolin	2%	Staphylococcal species
Gentamicin	Garamycin cream [‡] (cetostearyl alcohol, mineral oil, polyethylene glycol, white petrolatum); Garamycin ointment [‡] (methylparaben, propylparaben, white petrolatum)	0.1%	GP, GN

GN = gram negative; GP = gram positive; MRSA = methicillin-resistant *Staphylococcus aureus*; U = units.

*McNeil Consumer & Specialty Pharmaceuticals (Pfizer Inc., New York, NY), Fort Washington, PA.

[†]Pfizer, New York, NY.

[‡]Schering-Plough, Kenilworth, NJ.

Fusidic acid is available as a 2% cream as well as an ointment formulation containing lanolin. It can also be found in combination with 1% hydrocortisone as a cream and in combination with 0.1% betamethasone valerate.²¹

Gentamicin

Gentamicin is another aminoglycoside antibiotic, produced from *Micromonospora purpurea*. The mechanism of action is irreversible binding of the 30S ribosomal subunit which inhibits protein synthesis. Its spectrum of activity includes gram-positive and gram-negative bacteria, but it is thought to be less effective against streptococcal species. It is used more commonly in Europe as a topical antimicrobial agent. In the United States, its use is limited mainly to the treatment of bacterial conjunctivitis.¹⁴ It is available as a 0.1% cream or ointment preparation. The cream contains cetostearyl alcohol, chlorocresol, mineral oil, monobasic sodium phosphate, polyethylene glycol, water, and white petrolatum. Ointment preparations contain methylparaben, propylparaben, and white petrolatum.

Epidemiology of Positive Patch-Test Reactions to Topical Antimicrobials

Some of the earliest reports of contact dermatitis from topical antimicrobials were made in the 1960s.^{22,23} Since

these observations were made, several studies have been performed to try and quantify the risk of having a positive patch-test reaction to these agents. One of the earliest of such studies (from 1979) attempted to discern the rate of positive patch-test reactions in the general population.²⁴ In patch-testing 2,175 normal subjects with 20% neomycin ointment and performing readings at 72, 96, and 120 hours after application, the authors found that only 2 patients had a positive reaction.

In contrast, more recent articles examining the subset of patients with suspected allergic contact dermatitis have found a significantly higher incidence of positive patch-test reactions to topical antimicrobials in this population. A retrospective study by the North American Contact Dermatitis Group (NACDG) looked at 4,913 patients with suspected allergic contact dermatitis who were patch-tested with a panel of 65 antigens in Finn Chambers (Epitest Ltd Oy, Tuusula, Finland) attached with Scanpor tape (Norgesplaster A/S, Vennesla, Norway).²⁵ The study found that neomycin was the second most common allergen to which the study population had positive patch-test reactions (11.6% of patients had positive reactions). Bacitracin was the ninth most frequent contact allergen; 7.9% of patients reacted positively to it. This study further attempted to measure the relevance of positive patch-test reactions by noting (1) if the allergen in question or a product containing the allergen in question also gave a

positive result in a use test (defined as definite relevance), (2) if the allergen in question was found to be present in a known contactant in use by the patient (defined as probable relevance), or (3) if the patient had been exposed to the presumed allergen in the past (defined as possible relevance). Neomycin was found to have a combined relevance rate of 61.3% whereas bacitracin was found to have a combined relevance rate of 73%.

A similar study was performed by the contact dermatitis group at the Mayo Clinic, again looking retrospectively at 1,324 patients with suspected allergic contact dermatitis who were patch-tested with a tray of 60 allergens on average.²⁶ It should be noted that the screening tray changed over the course of data collection. Neomycin was found to induce a positive reaction in 11.2% of patients tested whereas bacitracin caused a positive reaction in 8.7% of patients. These numbers correlate well with the data from the NACDG study.

Internationally, the rates of positive patch-test reactions to these substances parallel the North American data above; differences in exact values are likely due to variance in the usage patterns of the specific antimicrobials being studied. Menezes de Padua and colleagues looked at data from Germany, observing that of the 47,599 patients tested in their contact dermatitis clinic over 6 years, 2.54% of patients tested had a positive reaction to neomycin, based on readings at 48 and 72 hours.²⁷ Furthermore, 3.3% of patients had positive reactions to gentamicin, and 1.1% had positive reactions to fusidic acid. Aminoglycosides were found to be the most common antimicrobial allergens, and gentamicin allergy was found to have increased in frequency over the previous 10 years. Among patients with a diagnosis of allergic contact dermatitis (which may have been from another allergen), 1.14% had a positive reaction to neomycin.²⁸ Morris and colleagues performed a similar analysis on patients in the United Kingdom and found that 3.6% of patients had a positive reaction to neomycin after two delayed readings.²⁹ Many of the patients who had positive reactions to neomycin also had positive reactions to one or more other allergens in the series, most commonly fragrance mix and nickel. Fusidic acid was also tested; 0.3% of patients had a positive reaction to it. The authors noted that from 1980 to 2000, the number of patients with positive reactions to fusidic acid decreased significantly. Patients who tested positively for fusidic acid often also tested positively for lanolins, possibly because a preparation containing both substances was widely sold for use on venous leg ulcers. The authors mention that the patch-test results were clinically relevant in a majority of cases. Of note,

polymyxin B and mupirocin were not evaluated in any of these studies. This is likely due to the fact that different antimicrobials are more commonly used in different countries as well as the fact that these two substances are not part of the standard series used at most contact dermatitis centers. However, it should be noted that several reports of contact allergy to polymyxin B have been reported after long-term use for otitis.³⁰

Goh et al attempted to study the innate sensitizing properties of various topical antimicrobials by applying them to the shaved skin of mice.³¹ The authors first applied topical antimicrobials suspended in petrolatum in varying concentrations. The concentration that induced moderate erythema and edema was used to sensitize the animals, and this was followed by an antigen challenge at a different location on the same animal. The vehicle alone was also tested in this phase. Neomycin was found to sensitize 2 of 10 animals tested. Polymyxin B and bacitracin did not sensitize any of the animals. This study is interesting for the fact that neomycin was able to induce sensitization on intact skin. It should be kept in mind that topical antimicrobials are usually applied to inflamed or injured skin, making them even more likely to induce an allergic response when used regularly with occlusion over a period of time. This is a well-documented phenomenon in patients with stasis dermatitis.^{32,33}

In conclusion, numerous studies from various groups have shown that allergic contact dermatitis from topical antibiotics is a significant phenomenon. Table 2 summarizes both US and international data comparing rates of positive patch-test reactions to neomycin and (when available) bacitracin in patients with a suspect allergic contact dermatitis. The highest risk of developing a contact allergy clearly seems to come from topical neomycin, but bacitracin also causes significant but fewer numbers of positive patch-test reactions. The finding of co-reactivity between the two substances, although not universally seen, should cause one to question the use of bacitracin in patients with a known allergy to topical neomycin.

Infection Rates in the Ambulatory Dermatologic Surgery Population

Importance of Topical Antimicrobials for the Care of Closed Wounds

Few studies have been performed to evaluate the risk of postoperative infections in patients undergoing ambulatory dermatologic surgery, and many of these do not detail

Table 2. Comparison of Rates of Positive Patch-Test Reactions to Neomycin and Bacitracin

<i>Study</i>	<i>Positive Patch-Test Reactions to Neomycin (%)</i>	<i>Positive Patch-Test Reactions to Bacitracin (%)</i>
Pratt et al ²⁵	11.6	7.9
Wetter et al ²⁶	11.2	8.7
Menezes de Padua et al ²⁷	2.5	Unavailable
Morris et al ²⁹	3.6	Unavailable

what routine was used for postoperative wound care. Whitaker and colleagues performed a prospective evaluation of dermatologic procedures carried out in predominantly procedure-dedicated rooms.³⁴ Class I procedures, which included both simple closures and complex repairs such as flaps or grafts, had an infection rate of 1%. This rate drops to 0.25% when simple excisions with primary closure are considered separately. It should be noted that the diagnosis of wound infection was made clinically, not by culture, thus possibly inflating the rates. This study also did not take into account the role of postoperative wound care, which is an important factor in infection control. Of importance, this analysis excluded patients who were receiving antibiotic prophylaxis for prosthetic heart valves or other factors. A similar analysis was performed by Dixon and colleagues, who found that for patients who did not receive prophylactic antibiotics, the overall rate of infection after the excision of skin lesions was 1.47%.³⁵ Other studies examining this issue have found similar rates of postoperative infection^{36–38} (Table 3).

Given the relatively low rate of closed-wound infections seen after ambulatory dermatologic surgery, it is important to compare this to the risk of developing adverse reactions

to preparations used in routine wound care to prevent such infections. These adverse reactions primarily consist of allergic contact dermatitis, but there have also been several case reports of contact anaphylaxis, most notably in regard to topical bacitracin.^{39–41} Several studies have looked at the ratio of risk to reward when topical antimicrobials are used in the postoperative setting. Gette and colleagues observed that of 215 patients undergoing dermatologic surgery, 5 patients developed an allergic contact dermatitis.⁴² Further patch testing revealed a positive reaction to neomycin, a formulation of which the investigators had used for routine wound care. Four of five of these patients also had some degree of positivity to bacitracin when patch-tested. Interestingly, no reactions to polymyxin B or mupirocin were seen, perhaps because of the small sample size and the lower frequency of contact dermatitis associated with these agents.

In another important study, Smack and colleagues assessed the incidence of allergic contact dermatitis from bacitracin ointment versus white petrolatum in 922 ambulatory dermatologic surgery patients.⁴³ They found that there was no statistically significant difference in postprocedural infection rates (2% in the petrolatum

Table 3. Comparison of Rates of Postoperative Infection in the Ambulatory Dermatologic Surgery Population

<i>Study</i>	<i>Rate of Postprocedural Infection (%)</i>	<i>Type of Procedure</i>	<i>Perioperative Oral Antibiotics Allowed</i>	<i>Culture Performed</i>
Whitaker et al ³⁴	1.0	Simple excision, flap or graft	No	No
Dixon et al ³⁵	1.47	Simple excision, Mohs' micrographic surgery, flaps, graft, wedge resection, and curettage	No	Yes (in the presence of suppuration or extension beyond site)
Rogues et al ³⁶	1.9	Excision of benign or malignant lesions (excluding cysts and pyodermas)	Yes	No
Amici et al ³⁷	2.0	Excision of benign or malignant lesions (excluding cysts and pyodermas)	Yes	No
Cook et al ³⁸	0.07	Mohs' micrographic surgery	Yes	Yes

group vs 0.9% in the bacitracin group, $p = .37$). They did find, however, that 0.9% of patients in the bacitracin group developed a contact allergy to the medication whereas no patients in the white petrolatum group developed such a reaction (Tables 4 and 5). Of note, there was no significant difference in healing rate between the two groups. These results suggest that the use of bacitracin ointment in closed postoperative wounds does not add significant benefit in terms of reducing postoperative infection rates or aiding in wound healing but does cause a notable amount of contact dermatitis. White petrolatum thus seems an attractive alternative to bacitracin.

Dixon and colleagues looked at the effects of paraffin ointment versus mupirocin ointment versus no ointment used with moist occlusive dressings on closed postoperative wounds.⁴⁴ Following the excision and closure of skin lesions, patients were randomized to receive either mupirocin ointment, paraffin ointment, or no ointment on their sutured wounds. Wounds were assessed at suture removal as well as 6 to 9 months after surgery. Infection rates were as follows: 1.4% for the group receiving no ointment, 1.6% for the paraffin ointment group, and 2.3% for the mupirocin ointment group ($p = .49$). The authors interpreted these results as showing that mupirocin was of no benefit in reducing the rate of wound infection.

Table 4. Studies Comparing Postprocedural Rates of Allergic Contact Dermatitis

Agent	Gette et al (%)	Smack et al (%)
Neomycin	2.3	n/a
Bacitracin	1.9	0.9
Mupirocin	0.0	n/a
Polymyxin B	0.0	n/a
Vehicle	n/a	0.0

n/a = not available.

Table 5. Studies Comparing Postprocedural Rates of Infection

Agent	Dixon et al (%)	Smack et al (%)
Neomycin	n/a	n/a
Bacitracin	n/a	0.9
Mupirocin	2.3	n/a
Polymyxin B	n/a	n/a
Vehicle	1.6	2.0

n/a = not available.

Importance of Topical Antimicrobials for the Care of Open Wounds

In contrast to the case of closed wounds, the bacterial colonization of open wounds and the efficacy of topical antimicrobial agents in such situations as they relate to dermatologic surgery are less well documented. Looking first at the issue of the bacterial colonization of open wounds, Mack and Cantrell surveyed a heterogeneous population of open wounds (including superficial burns, ulcers, and other granulating wounds) and found that 76% had positive cultures before treatment was initiated.⁴⁵

To assess the impact of bacterial colonization on wound healing, Marks and colleagues looked at deep granulating wounds from axillary excisions.⁴⁶ They found the presence of *Staphylococcus aureus* in 17 of 50 wounds and noted that prompt treatment of these wounds with topical fusidic acid ointment reduced healing time significantly.

Similar studies showed that the consistent use of topical antimicrobial agents in open wounds does lead to decreased bacterial counts. Leyden and Bartelt created blister wounds on the arms of human subjects and then inoculated them with *S. aureus*. The wounds were then (1) treated twice daily with a triple-antibiotic ointment (containing neomycin, bacitracin, and polymyxin B), (2) treated with another antiseptic, or (3) left untreated.⁴⁷ The authors found that the contaminated wounds that were treated with the triple-antibiotic ointment healed significantly faster (mean of 9 days) than did wounds that were treated with another antiseptic and wounds that received no treatment. Only the neomycin-bacitracin-polymyxin B combination effectively eliminated the bacterial contamination of the wounds, after two applications within 16 to 24 hours after contamination with *S. aureus*. In another study, which looked at partial-thickness wounds, lesions that were treated with neomycin-containing products had reduced *S. aureus* counts.⁴⁸ Furthermore, another study showed topical mupirocin to be comparable to triple-antibiotic ointment in reducing bacterial counts of *S. aureus*.⁴⁸

Topical antimicrobials are thus clearly effective in reducing bacterial counts in contaminated wounds, and they have also been shown to exert no deleterious effects on the wound healing process. Several studies have even shown that rates of re-epithelialization are enhanced in wounds treated with the daily application of bacitracin.^{49,50} Mupirocin, on the other hand, has not been shown to enhance rates of re-epithelialization, but it does not retard this process either. It does seem to retard wound

contraction, as does bacitracin, which may be exploitable in certain anatomic locations.⁴⁹ In contrast, topical antimicrobial products such as chlorhexidine and povidone-iodine, which are commonly used preoperatively, have been shown to be toxic to wound environments and (particularly in the case of povidone-iodine) to fibroblasts and keratinocytes.⁵⁰

Summary and Guidelines for the Use of Topical Antimicrobials in the Postoperative Setting

Wound care remains an important component of attaining positive outcomes after ambulatory dermatologic surgery. According to a survey of local practitioners in the Miami, Florida, area, 89% of the responding dermatologists use bacitracin as part of routine postbiopsy wound care.⁵¹ However, a careful review of the literature shows that routine use of topical antimicrobials on closed wounds may not be warranted. The rate of overall infection in this population of patients is low but is on a par with the risk of developing an allergic contact dermatitis to neomycin. Furthermore, although closed wounds are less open to the environment than open wounds are, there is still an impaired skin barrier. Since topical antimicrobials are applied under occlusion with a dressing, it is not unreasonable to expect that their regular use might lead to sensitization and the development of an allergic contact dermatitis. It should also be kept in mind that patients undergoing complex repairs that are closed primarily should be considered a special patient population. However, these patients usually receive postprocedural oral antibiotic prophylaxis. To date, no studies have been performed to assess whether the use of topical antimicrobials aids in further reducing the incidence of postoperative wound infections in this patient population. Patients with open wounds also constitute a separate patient population for which topical antimicrobial use is warranted because these wounds tend to harbor higher bacterial counts and are more prone to infection than are closed wounds.^{45,52}

Based on the information presented here, the authors suggest that routine use of topical neomycin postoperatively for closed wounds should be strongly discouraged. Furthermore, given the notable incidence of co-reactivity to bacitracin, patients with a known contact allergy to topical neomycin should be cautioned about the risk of a similar reaction if they use bacitracin. White petrolatum is a more affordable and equally efficacious alternative to these topical antimicrobials and should be recommended for all patients as part of routine postoperative care of

closed wounds. For open wounds, topical antimicrobials are recommended because they decrease bacterial counts in these higher-risk lesions without compromising wound healing. Whereas neomycin-containing substances have been shown to provide the greatest efficacy in reducing bacterial counts, given the potential for developing a contact dermatitis, bacitracin or mupirocin should be the agents of choice for daily use on open wounds. It should be kept in mind that rare but severe reactions such as contact anaphylaxis have been reported with bacitracin use, and patients should be counseled appropriately.

For patients suspected of having an allergic contact dermatitis from the topical antimicrobial they are using, patch testing is the recommended method of confirming the diagnosis. It is important to remember that bacitracin is not found in the T.R.U.E. Test panel (Allerderm, Phoenix, AZ). Furthermore, with patients suspected of having an allergic contact dermatitis from topical neomycin, it is advisable that they be tested with bacitracin and polymyxin B as these have been reported to confer concurrent positive patch-test reactions in some patients.⁵³ Referral to a provider specializing in allergic contact dermatitis and patch testing is advised.

The limitations of this review include the fact that although neomycin and bacitracin are part of the NACDG standard series of allergens, polymyxin B and mupirocin are not routinely used for patch testing. This makes it difficult to offer specific guidelines for these agents because most incidence rates of positive patch-test reactions are based on data accrued from retrospective reviews of patients tested with a standard panel of common antigens. However, from the data available, these products seem significantly less likely to cause an allergic contact dermatitis. Another caveat is that prevalence rates for positive patch-test reactions to neomycin are based on populations exhibiting a suspected allergic contact dermatitis, thus skewing the results somewhat. The relevance of such patch-test reactions has not been characterized in all studies reported here. However, the reports that did evaluate this showed relevance rates of 60 to 70%. Further studies are needed to help definitively determine whether the benefits of topical antimicrobials outweigh the risks.

References

1. Fleischer AB Jr, Feldman SR, White RE, et al. Procedures for skin diseases performed by physicians in 1993 and 1994: analysis of data from the National Ambulatory Medical Care Survey. *J Am Acad Dermatol* 1997;37(5 Pt 1):719-24.

2. Neville JA, Housman TS, Letsinger JA, et al. Increase in procedures performed at dermatology office visits from 1995 to 2001. *Dermatol Surg* 2005;31:160–2.
3. American Society for Dermatologic Surgeons. 2005 Procedure survey: dermasurgery trends and statistics. Available at: <http://www.asds.net/Media/Archives/ASDS2005StatsReport.pdf> (accessed August 8, 2007).
4. Centers for Disease Control and Prevention statistics on skin cancer. Available at: <http://www.cdc.gov/cancer/skin/statistics/> (accessed August 8, 2007).
5. Goodman N, Scales JT, Towers AG. Development and evaluation of a porous surgical dressing. *Br Med J* 1956;12:962–8.
6. Aindow D, Butcher M. Films or fabrics: is it time to re-appraise postoperative dressings? *Br J Nurs* 2005;14:S15–6, S18, S20.
7. Kannon GA, Garrett AB. Moist wound healing with occlusive dressings. A clinical review. *Dermatol Surg* 1995;21:583–90.
8. Eaglstein WH. Occlusive dressings. *J Dermatol Surg Oncol* 1993;19:716–20.
9. Telfer NR, Moy RL. Wound care after office procedures. *J Dermatol Surg Oncol* 1993;19:722–31.
10. Dahlberg AE, Horodyski F, Keller P. Interaction of neomycin with ribosomes and ribosomal ribonucleic acid. *Antimicrob Agents Chemother* 1978;13:331–9.
11. Clark JM, Chang AY. Inhibitors of the transfer of amino acids from aminoacyl soluble ribonucleic acid to proteins. *J Biol Chem* 1965;240:4734–9.
12. Spann CT, Taylor SC, Weinberg JM. Topical antimicrobial agents in dermatology. *Clin Dermatol* 2003;21:70–7.
13. Spann CT, Taylor SC, Weinberg JM. Topical antimicrobial agents in dermatology. *Dis Mon* 2004;50:407–21.
14. Spann CT, Tutrone WD, Weinberg JM, et al. Topical antibacterial agents for wound care: a primer. *Dermatol Surg* 2003;29:620–6.
15. Kaye ET. Topical antibacterial agents. *Infect Dis Clin North Am* 2000;14:321–39.
16. Stone KJ, Strominger JL. Inhibition of sterol biosynthesis by bacitracin. *Proc Natl Acad Sci U S A* 1972;69:1287–9.
17. Hughes J, Mellows G. Inhibition of isoleucyl-transfer ribonucleic acid synthetase in *Escherichia coli* by pseudomonic acid. *Biochem J* 1978;176:305–18.
18. Bactroban Glaxo Smith Kline prescribing information. Available at: http://us.gsk.com/products/assets/us_bactroban_oointment.pdf (accessed on August 8, 2007).
19. Fusidic acid prescribing information. Available at: <http://www.medsafe.govt.nz/Profs/Datasheet/f/Fucidintabinjsus.htm> (accessed on October 13, 2007).
20. O'Neill AJ, Larsen AR, Skov R, et al. Characterization of the epidemic European fusidic acid-resistant impetigo clone of *Staphylococcus aureus*. *J Clin Microbiol* 2007;45:1505–10.
21. Muller NF, Dessing RP. European drug index. London, England: CRC Press 1997. 520.
22. Binnick AN, Clendenning WE. Bacitracin contact dermatitis. *Contact Dermatitis* 1978;4:180–1.
23. Pirila V, Forstrom L, Rouhunkoski S. Twelve years of sensitization to neomycin in Finland. Report of 1760 cases of sensitivity to neomycin and/or bacitracin. *Acta Derm Venereol* 1967;47:419–25.
24. Leyden JJ, Kligman AM. Contact dermatitis to neomycin sulfate. *JAMA* 1979;242:1276–8.
25. Pratt MD, Belsito DV, DeLeo VA, et al. North American Contact Dermatitis Group patch-test results, 2001–2002 study period. *Dermatitis* 2004;15:176–83.
26. Wetter DA, Davis MDP, Yiannias JA, et al. Patch test results from the Mayo Clinic Contact Dermatitis Group, 1998–2000. *J Am Acad Dermatol* 2005;53:416–21.
27. Menezes de Padua CA, Schnuch A, Lessman H, et al. Contact allergy to neomycin sulfate: results of a multifactorial analysis. *Pharmacoepidemiol Drug Safety* 2005;14:725–33.
28. Menezes de Padua CA, Uter W, Schnuch A. Contact allergy to topical drugs: prevalence in clinical setting and estimation of frequency at the population level. *Pharmacoepidemiol Drug Safety* 2007;16:377–84.
29. Morris SD, Rycroft RJG, White IR, et al. Comparative frequency of patch test reactions to topical antibiotics. *Br J Dermatol* 2002;146:1047–51.
30. Grandinetti PJ, Fowler JF. Simultaneous contact allergy to neomycin, bacitracin, and polymyxin. *J Am Acad Dermatol* 1990;23(4 Pt 1):646–7.
31. Goh CL. Contact sensitivity to topical antimicrobials. *Contact Dermatitis* 1989;21:166–71.
32. Cameron J, Wilson C, Powell S, et al. Contact dermatitis in leg ulcer patients. *Ostomy Wound Manage* 1992;388:10–1.
33. Wilson CL, Cameron J, Powell SM, et al. High incidence of contact dermatitis in leg-ulcer patients—implications for management. *Clin Exp Dermatol* 1991;16:250–3.
34. Whitaker DC, Grande DJ, Johnson SS. Wound infection rate in dermatologic surgery. *J Dermatol Surg Oncol* 1998;14:525–8.
35. Dixon AJ, Dixon MP, Askew DA, et al. Prospective study of wound infections in dermatologic surgery in the absence of prophylactic antibiotics. *Dermatol Surg* 2006;32:819–27.
36. Rogues AM, Lasheras A, Amici JM, et al. Infection control practices and infectious complications in dermatologic surgery. *J Hosp Infect* 2007;65:258–63.
37. Amici JM, Rogues AM, Lasheras A, et al. A prospective study of the incidence of complications associated with dermatological surgery. *Br J Dermatol* 2005;153:967–71.
38. Cook JL, Perone JB. A prospective evaluation of the incidence of complications associated with Mohs micrographic surgery. *Arch Dermatol* 2003;139:143–52.
39. Vale MA, Connolly A, Epstein AM, et al. Bacitracin-induced anaphylaxis. *Arch Dermatol* 1978;114:800.
40. Schechter JF, Wilkinson RD, Del Carpio J. Anaphylaxis following the use of bacitracin ointment. Report of a case and review of the literature. *Arch Dermatol* 1984;120:909–11.
41. Saryan JA, Dammin TC, Bouras AE. Anaphylaxis to topical bacitracin zinc ointment. *Am J Emerg Med* 1998;16:512–3.
42. Gette MT, Marks JG, Maloney ME. Frequency of postoperative allergic contact dermatitis to topical antibiotics. *Arch Dermatol* 1992;128:365–7.
43. Smack DP, Harrington AC, Dunn C, et al. Infection and allergy incidence in ambulatory surgery patients using white petrolatum vs. bacitracin ointment. A randomized controlled trial. *JAMA* 1996;276:972–7.
44. Dixon AJ, Dixon MP, Dixon JB. Randomized clinical trial of the effect of applying ointment to surgical wounds before occlusive dressing. *Br J Surg* 2006;93:937–43.

-
45. Mack RM, Cantrell JR. Quantitative studies of the bacterial flora of open skin wounds: the effect of topical antibiotics. *Ann Surg* 1967; 166:886–95.
 46. Marks J, Harding KG, Hughes LE. Staphylococcal infection of open granulating wounds. *Br J Surg* 1987;74:95–7.
 47. Leyden JJ, Bartelt NM. Comparison of topical antibiotic ointments, a wound protectant, and antiseptics for the treatment of human blister wounds contaminated with *Staphylococcus aureus*. *J Fam Pract* 1987;24:601–4.
 48. Davis SC, Cazzaniga AL, Eaglstein WH, et al. Over-the-counter topical antimicrobials: effective treatments? *Arch Dermatol Res* 2005;297:190–5.
 49. Watcher MA, Wheeland RG. The role of topical agents in the healing of full-thickness wounds. *J Dermatol Surg Oncol* 1989;15: 1188–95.
 50. Mertz PM, Ovington LG. Wound healing microbiology. *Dermatol Clin* 1993;11:739–47.
 51. Jacob SE, James WD. Bacitracin after clean surgical procedures may be risky. *J Am Acad Dermatol* 2004;51:1036.
 52. Brown CD, Zitelli JA. A review of topical agents for wounds and methods of wounding: guidelines for wound management. *J Dermatol Surg Oncol* 1993;19:732–7.
 53. Sood A, Taylor J. Bacitracin: allergen of the year. *Am J Contact Dermat* 2003;14:3–4.