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# Choice of wound care in diabetic foot ulcer: A practical approach

Kavitha KV *et al*. Wound care management

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**Abstract**

Diabetic foot ulcers are the consequence of multiple factors including peripheral neuropathy, decreased blood supply, high plantar pressures, *etc.*, which pose a significant risk of morbidity, limb loss and mortality. The critical aspects of wound healing mechanism and host physiological status in patient with diabetes necessitate the selection of appropriate treatment strategy based on complexity and type of wound. In addition to systemic antibiotic and surgical intervention, wound care is considered to be an important component of diabetic foot ulcer management. This article will focus on the use of different wound care materials in diabetic foot. From clinical perspective, it is important to decide the wound care material depending on the type and grade of the ulcer. Also, this article will provide clinicians with a simple approach on the choice of wound care materials in diabetic foot ulcer.

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**Key words:** Diabetes; Foot; Wound; Debridement; Topical

**Core tip:** Diabetic foot ulcers are an important complication of diabetes. There is no conventional guideline regarding the selection of wound care materials in diabetic foot wounds. This article includes fundamental aspects of wound care and management with special emphasis on selection of appropriate wound care materials depending on the type of wound tissue. Risk factors for foot ulceration, classification and grading of wound, bacteriology, multidisciplinary team approach, types of debridement, importance of offloading, wound care and choice based on the complexity of wound and properties of the dressing regiment in each category based on clinical experience and practice have been discussed.

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**INTRODUCTION**

The increasing prevalence of diabetes exposes the world to a burden of concomitant illness[1].The critical effects of hyperglycemia include micro-vascular complications (nephropathy, neuropathy and retinopathy) and macro-vascular complications (coronary artery disease, stroke and peripheral arterial disease). Diabetes is a leading cause of non-traumatic lower extremity amputation, which is often preceded by a non-healing ulcer. The life time risk for foot ulceration in people with diabetes is 15%-20%[2]. More than 15% of foot ulcers result in amputation of the foot or limb[3].Several other population-based studies indicate a 0.5%-3% annual collective incidence of diabetic foot ulcers. The prevalence of foot ulcers reported varies from 2% to 10%[4]. Approximately 45%–60% of all diabetic foot ulcerations are purely neuropathic, whereas 45% have both neuropathic and ischemic components[5]. It has been estimated that around 15%-27% patients with diabetes require lower limb amputations predominantly (50%) due to infection[6].

**DIABETIC FOOT**

***Definition***

Infection, ulceration or destruction of deep tissues associated with neurological abnormalities and various degrees of peripheral vascular diseases in the lower limb (WHO definition, 1995).

***Risk factors***

Diabetic foot ulcers are consequences of many factors including loss of protective sensation due to peripheral neuropathy where the feet become numb and the injury goes unnoticed. Also, arterial insufficiency complicates the neuropathic ulcer which leads to poor wound healing. Foot deformity and calluses can result in high plantar pressure, which adds additional risk. Mechanical stress at the wound site is hypothesized to affect wound healing[7]. Many other factors contribute to risk of foot ulceration and its subsequent infection in patients with diabetes. Uncontrolled hyperglycemia, duration of diabetes, trauma, improper footwear, callus, history of prior ulcers/amputations, older age, blindness/impaired vision, chronic renal disease and poor nutrition has also been well explicated to play a role in pathogenesis and progression of diabetic foot ulceration. Infection further deteriorates the diabetic foot resulting in a non-healing chronic wound. Also, recently vitamin D deficiency has been proposed to be a risk factor for diabetic foot infection[8].

***Classification***

Based on the Red-Yellow-Black (RYB)[9] wound classification system by Marion Laboratories wound can be classified as[10]: (1) Necrotic tissue-either dry or infected and usually black or dark green in color as shown in Figure 1A; (2) Sloughy tissue-combination of wound exudate and debris forming a glutinous yellow layer of tissue over the wound which is often mistaken for infection as shown in Figure 1B; (3) Granulating tissue-highly vascularized, red in color and sometimes highly exudating as shown in Figure 1C; and (4) Epithelializing tissue-Epithelium grows over a wound formed by migration of keratinocytes from the wound margins, which looks pink in color as shown in Figure 1D.

Debridement of necrotic tissue is an integral component in the treatment of chronic wounds as they do not heal in the presence of unviable tissue, debris, or critical colonization[11,12] and may be contraindicated in arterial ulcers[13]. Excision of necrotic tissue is necessary for wound healing. Calluses or thickened skin surrounding the ulcer need to be excised. Necrotic tissue removed on a regular basis can expedite the rate at which a wound heals and has been shown to increase the probability of attaining full secondary closure[14,15].

***Grading***

Can be done using Wagner's or Texas wound classification system[16]. The most common is the University of Texas wound classification system, which describes the wound with regard to depth, presence or absence of infection or ischemia or both. Description of the wound is important for wound care choice which includes the location, stage, dimension in length, breadth and depth (length and breadth can be measured in centimeters by tracing it on a sterile acetate sheet and depth can be taken by inserting a sterile swab gently into the deepest part of the wound), wound edges (undermining), wound base description, drainage (heavy or low), color, odor, pain and progression, *etc.*[17].

***Microbiology***

Hyperglycemia, impaired immunologic responses, neuropathy, and peripheral arterial disease are the major predisposing factors leading to limb-threatening diabetic foot infections[18-20]. The prevalence of infection noted in India was 6%-11%, whereas the prevalence of amputation was 3% in patients with type 2 diabetes[21]. Both aerobic and anaerobic bacteria have shown to infect diabetic foot wounds[22-25]. Also, fungal infections are common in diabetic foot[26-28]. Polymicrobial etiology of diabetic foot infections has been widely reported[22-25,29]. However it is not uncommon to have predominance of mono-microbial infection in diabetic foot[30]. Researchers have shown the predominance of both gram negative[30] and gram positive[26] bacteria in diabetic foot infections. Various studies have reported high prevalence of *Pseudomonas*[31], *E. coli*[30], and *S. aureus*[26,30] infections in diabetic foot. Pattern of microbial infection in patients with diabetic foot infections is inconsistent and therefore evaluation of microbial characteristics and their antibiotic sensitivity is necessary for selection of appropriate antibiotics for management of diabetic foot infection.

**MANAGEMENT TECHNIQUES**

Foot is a complex structure, which acts as a foundation for the whole body, and it is important to see that the diabetic foot problem does not get worse. Integration of knowledge and experience through a multidisciplinary team approach promotes more effective treatment, thereby improving outcomes and limiting the risk of lower extremity amputation[32,33]. Therefore the following specialists play an important role: (1) Endocrinologist/Diabetologist (optimize blood glucose control); (2) Podiatrist (focus on the foot including prevention and treatment of diabetic foot wounds); (3) Vascular surgeon (manage vascular issues); (4) Microbiologist (look into microbiological etiology and antibiotic selection based on cultures); (5) Orthotist (ensures that therapeutic or custom made footwear aids in minimizing pressure); and (6) Nutritionist (concentrates on diet which helps in management of diabetes as well as wound healing).

Wound healing is a complex process involving highly regulated responses of specified cell types, which harbor locally secreted growth factors that play a key role[34]. Treating a diabetic foot infection requires proper wound care and appropriate antibiotic therapy[19]. The fundamentals of good clinical care includes adequate frequent debridement, offloading, moist wound care, treatment of infection, and revascularization of ischemic limb[35].Apart from this it can be enhanced by the appropriate choice of topical regimen (mixed ranges of standard and advanced topical therapies) available but to use this adequate training and immense clinical experience is essential. Many factors including the assessment of wound, its classification, and the need for debridement including sharp surgical, mechanical, chemical etc., have to be taken into consideration before proceeding with the appropriate selection of topical regimen.

***Debridement***

Involves removal of dead, damaged, or infected tissue, which improves the healing potential of remaining healthy tissues. Depending on the wound tissue type, different debridement techniques are recommended[36,37]: (1) Surgical debridement or sharp debridement–recommended for necrotic and infected wounds. The terms surgical debridement and sharp debridement are often used synonymously, some clinicians refer to surgical debridement as being performed in an operating room, whereas sharp debridement is performed in a clinic setting[38]. Sharp surgical debridement is the most effective and fastest method of debridement; (2) Autolytic debridement-a selective process in which the necrotic tissue is liquefied. Wound covered with occlusive dressing allows accumulation of tissue fluids containing macrophages, neutrophils, and enzymes, which remove bacteria and digest necrotic tissues. This is attained by a moist wound healing environment[36]. Autolytic debridement is not advisable for the treatment of infected pressure ulcers[39]; (3) Mechanical debridement–involves removal of unhealthy tissue using a dressing, which is changed regularly by wound irrigation (pressure: 4-15psi), without damaging healthy/new tissues[40]. Scrubbing the wound aids in removal of exudates and devitalized tissues, however this leads to bleeding as well as pain resulting from wound trauma. This technique is used in the management of surgical wounds and venous leg ulcers. The drawbacks of the method is that it is time consuming and expensive; (4) Enzymatic debridement-a method of debriding devitalized tissue by topical enzymes such as collagenase, fibrinolysin, or papain. Recommended for sloughy, infected, necrotic wounds where surgical debridement is contraindicated[41]; and (5) Maggot debridement-a technique in which maggots or fly larva that are raised in a sterile environment are used. The most commonly used fly is *Lucilia sericata,* which is used for human wound treatment when conventional treatments fail[42]. Maggots are placed on the wound followed by wrapping with secondary dressing. The larvae feed on the necrotic (dead) tissue and bacteria present at the wound site and secrete antimicrobial enzymes, which help in the wound healing process.

***Offloading***

Completely or partially relieving pressure from the weight bearing area of the foot by providing mechanical support with the intention of giving rest to the wound area aids in healing. Repetitive trauma and high plantar pressure on the ulcer bed are two primary reasons for the persistence of ulcers once they have developed[43]. Offloading is very important in diabetic wound healing. There are many types of offloading techniques including total contact casts, removable cast footwear, wedge foot wears, half shoes, mobilization by wheelchair etc. Total contact casts are considered to be the gold standard method of offloading and treating diabetic patients with neuropathic ulcers[32,44-46].

***Wound care***

Wound care plays a pivotal role in the management of diabetic foot ulcer, which comprise cleaning of wound with normal saline following aseptic techniques and use of modern wound care techniques that promote moist wound healing environment[47,48].Although topical treatment is an important aspect of wound care, it is always considered secondary to surgical and systemic care[49]. There are numerous topical regimens and devices available for the management of diabetic foot wounds including hydrogels, hydrocolloids, alginates, foam, silver impregnated dressing, growth factors,silicon impregnated atraumatic dressings, vacuum aided devices, hyperbaric oxygen therapyetc.*,* but before choosing any regimen one should give importance to the factors including general health of the patient, process of tissue repair, assessment of wound by means of grading, description and classification of wound, local environment of the wound, knowledge on specific properties of dressing materials and devices as well as their availability, affordability, and accessibility.

The ideal characteristics of wound dressing should[50,51]: (1) Be sterile, easy to use, cost effective; (2) Maintain moist wound healing environment; (3) Absorb excess exudate; (4) Be non-adherent/non-toxic, non-allergic; (5) Not contaminate the wound with foreign particles; (6) Protect the wound from microorganisms; (7) Allow gaseous exchange and control wound odor; and (8) Provide thermal insulation and mechanical protection.

***Antibiotic selection***

The principle of antibiotic treatment is based on evidences provided by reports on bacteriological culture and sensitivity from different centers all over the world[52,53].

Use of anti-infectives/antibiotics must be guided by appropriate cultures. Inappropriate use of antibiotics could lead to resistance and adverse effects.

Oral and parenteral antibiotics are prescribed for mild soft tissue infections and moderate to severe infections respectively. See Table 1[54]. Evidence-based regimes should be followed for the management of infection in diabetic foot. Appropriate dosage, optimal duration, identification and removal of infective focus and recognition of adverse effects should be critically evaluated in all outpatients and inpatients with diabetic foot infections[54-56].

Every hospital should develop an institutional antibiotic policy containing guidelines and protocols for antibiotic use. It is advisable to have different sections for treatment and prophylaxis including surgical procedures as well as how to treat different infections[57].

Three levels of antibiotic prescribing are generally recommended: (1) First line of choice – antibiotics prescribed by all doctors; (2) Restricted antibiotic group - for resistant pathogens, polymicrobial infections, special condition, and expensive antibiotics. When prescribing antibiotics from this group the prescriber should discuss with the committee and head of the department; and (3) Reserve antibiotics - for life-threatening infections, to be used after taking permission from the committee.

Institutional antibiotic committee should update their policy by collecting surveillance on antimicrobial resistance and data on antibiotic consumption, which will improve clinical and laboratory standards. The committee should monitor implementation of the policy, receive feedback information, assess the outcome, and discuss with various specialty doctors. The policy should be reviewed every year based on the experience of prescribers and the susceptibility reports of microbiology and laboratory.

# *Revascularization*

With advances in both vascular and orthopedic reconstructive surgeries, limb salvage has become an option for limbs that previously would have been amputated. Patients with both diabetes and peripheral arterial disease are more prone to ischemic ulceration than those without the disease[58,59].Several endovascular options, including percutaneous transluminal angioplasty (PTA), balloon-expandable stents, self-expanding stents, and covered stents are now available. The success rate after stent implantation in the iliac arteries is greater than 95%[60]. Revascularization plays a crucial role in the treatment of ischemic lower extremity wounds and should be performed before drainage or debridement[61]. Endovascular techniques such as cryoplasty, drug eluting stenting, plaque debulking lasers etc., are being investigated and are potentially useful adjuncts to PTA. Subintimal angioplasty for arterial lesions below the ankle in diabetic patients could achieve a limb salvage rate of 94.6%[62]. Several retrospective studies suggest considerably better results of transmetatarsal amputations done after a revascularization procedure[63,64].

## CHOICE OF TOPICAL REGIME

Choice of wound care materials should be based on wound tissue type, complexity, and its properties (Tables 2 and 3).

***Wet to dry dressing or simple saline***

This dressing has a good debriding action and helps in wound bed preparation. Wet-to-dry dressings are described in the literature as a means of mechanical debridement[65]. It is very absorptive as well as adherent dressing and one of the cheapest dressings used throughout the world, but requires frequent dressing change (twice or thrice a day) based on wound severity. Dressings should be moistened before removal to minimize any chance of bleeding. A gentle cleanser (normal saline or neutral-pH cleanser) will minimize wound irritation and discomfort[66]. When treating granulating or epithelizing wound one should soak the dressing thoroughly with normal saline for five minutes (based on our clinical experience) to prevent trauma and heavy bleeding.

*Antibacterial agents*

Used solo or in combination for each category except dry necrotic wounds. Topical antibiotics have broad-spectrum antibacterial coverage which lasts for 12 h and are less toxic. Metronidazole gel [Ornidazole (IP – 10 mg and water soluble gel base q.s)] has good anaerobic coverage and helps in maintaining moist wound healing environment. By weight, gels are mostly liquid, yet they behave like solids due to a three-dimensional cross-linked network within the liquid. It is the crosslinking within the fluid that give a gel its structure (hardness) and contribute to the adhesive stick[67]. Both by weight and volume, gels are mostly fluid in composition and thus exhibit densities similar to those of their constituent liquids, such as hydrogels. Topical metronidazole gel (0.75%–0.80%) is frequently used directly on the wound once per day for five to seven days or more often as needed[68,69], and metronidazole tablets can be crushed and placed onto the ulcer bed[66,70]. There are numerous other articles (case studies or anecdotal experience) reporting the reduction of wound odor with topically applied metronidazole[71-73].Antibiotics likeNeomycin, Gentamycin, and Mupirocin have good antibacterial coverage when used topically. Silver containing dressings come in different formulations and have very good antibacterial coverage. Silver dressing and polyherbal preparations have shown good results in healing diabetic foot wounds[74]. It is very effective in burn wounds and can also be used in infected or colonized wounds. Sisomycin (0.10%) and acetic acid at concentrations between 0.5% and 5% are effective against *Pseudomonas*, other gram-negative bacilli, and beta hemolytic streptococci wounds infections. Povidone iodine solution dressing is very effective in healing sutured wounds and hypergranulating wounds to suppress or hamper further granulation. Povidone iodine soaked gauze is a good dressing for dry gangrene which hastens the process of demarcation. Iodine has been found to be toxic to human cells as well as bacteria and fungi at high doses[75,76]. Also, it should not be used on granulating or epithelizing wounds because it slows down the healing process and is cytotoxic to keratinocytes and fibroblasts.

*Tulle dressings*

Are gauze dressings impregnated with paraffin, which lowers the dressing adherence but this property is lost if the dressing dries out. Tulle dressings are mainly indicated for superficial clean wounds and skin grafts. It can be used in granulating and epithelizing wounds. Tulle dressing not only prevents trauma to the new and delicate epithelium during dressing removal, but also provides a good moist environment, which is preferred for epithelial cell proliferation and migration[77].This concept is well supported by evidence from many previous studies which showed faster re-epithelialization rates when moist environment dressings were compared with traditional dry dressings[77-79]. Evidence showed that gauze based dressings still have a place in wound care[80].

*Polyurethane films*

These films are coated with adhesive (water-proof dressing) are comfortable. Its vapor-permeable films allow diffusion of gases and water vapor which helps in maintaining moist wound healing environment. Its transparency allows for wound monitoring without dressing removal but there is a chance of maceration of surrounding skin. It can be used for low exudating wounds.

*Polyurethane foam*

These dressings are extremely absorbent, non-adherent, and have a semi-permeable backing which allows moisture to escape. Polyurethane foam dressings loosen slough by creating a moist wound environment, assisting in proper wound bed preparation, and promoting wound healing[81]. It maintains moist wound environment which implies that they can be easily removed without pain. They are also used as outer dressing after application of topical antibiotics, such as metronidazole, or hydrogels. Polyurethane foam is widely used in diabetic foot wounds and is capable of absorbing light to heavy amounts of exudate thereby preventing maceration, facilitating removal of slough, and promoting the proliferative stage of wound healing[82].

***Hydrogel dressings***

Consists of cross linked insoluble starch or carboxymethylcellulose polymers and 96% water. The term hydrogel implies that the material is already swollen in water. Hydrogels donate fluid to dry necrotic and slough wounds and promote autolysis, it debrides apparently by rehydrating the wound. These dressings are the best choice for the treatment of dry wounds with necrotic eschar, and hydrogel reaches a 50% debridement level more quickly than wet-to-dry dressings and are more cost-effective[83-85]. Hydrogel hydrates, cools the wound and provides analgesic effect.

***Hydrocolloid dressing***

Is a combination of polymers such as gelatin, pectin and cellulose which forms a waterproof adhesive dressing. Exudates produced by the wound gets absorbed into the dressing and form a gel. Hydrocolloid dressings are capable of absorbing low to moderate levels of exudate and can be used to promote autolytic debridement of dry, sloughy, or necrotic wounds[86]. It maintains moist wound healing environment and promotes autolytic debridement of necrotic and sloughing tissues. It can be used as an occlusive dressing and is very good in absorbing exudate. Hydrocolloid dressings should be avoided on plantar ulcers of the foot, as the periwound skin is susceptible to maceration. Additionally, hydrocolloids have been shown to retain growth factors under the dressing as well as promote granulation and epithelialization[87]. The low pH created by the hydrocolloid is effective for the treatment of wounds infected by *Pseudomonas* bacteria[88].

*Alginate dressings*

Are highly absorbent and are available in two forms as calcium alginate and calcium sodium alginate. The use of alginate dressings as haemostatic agents was reported both in vitro and in clinical studies. The selection of alginate dressing is to manage wound exudate, it is claimed that they can absorb 15–20 times their own weight in wound fluid[89]. The alginate forms a gel when it comes in contact with the wound surface. It can be used in granulating, epithelializing, and cavity wounds. Cochrane reviews detail the role of alginate dressings in the treatment of diabetic foot ulcers[90, 91].

*Growth factors*

Like platelet-derived growth factor (PDGF), insulin like growth factor, transforming growth factor (TGF)-β, TGF-α, epidermal growth factor (EGF), *etc.*, are very effective in diabetic wound healing and each have been reported to accelerate formation of various components of healing. Growth factors stimulate different functions including angiogenesis, enzyme production, cell migration, and cellular proliferation[92]. Diabetic wounds are enriched in proteases supports the premise that impaired growth factors availability may act as a rate limiting factor in diabetic wound healing[93]. PDGF regulates cell growth and division. It plays a significant role in blood vessel formation (angiogenesis). rh-PDGF dressing is an effective modality to facilitate wound healing in patients suffering from diabetes and can be used as an adjunct to conventional mode of treatment for healing of diabetic wounds[94]. It can be used in granulating stage of the wound. EGF stimulates the proliferation of fibroblasts, keratinocytes, and vascular endothelial cells, which contribute to scar tissue formation. Recombinant human EGF local injections offer a favorable risk-benefit balance in patients with advanced diabetic foot ulceration and were significantly enhanced by 75 microg EGF treatment in neuropathic versus ischemic ulceration[95].

*Honey-impregnated dressings*

Proposed to have antimicrobial and anti-inflammatory properties, it can be used for acute or chronic wounds. Antimicrobial properties of honey have been demonstrated in the laboratory, *in vivo* evidence is scant, particularly in comparison to literature on silver antimicrobial dressings[96,97].

*Topical enzymes*

Like collagenase, fibrinolysin, or papain containing ointments help in enzymatic debridement of sloughy tissues and thus promotes granulation formation. Collagenase and papain/urea formulations have been demonstrated to have degrading effects on wound components, such as collagen, fibrin, and elastin both in vitro and clinically. Papain-urea and collagenase have proven efficacy in bringing out enzymatic wound debridement. Papain-urea (89.2%) is a better enzymatic debriding agent than collagenase (82.2%)[98].

*Mechanical device*

Vacuum assisted closure generates a topical negative pressure over the wound bed. Pressure of 125 mmHg is the ideal pressure. Vacuum-assisted closure is extremely effective in removing exudate and reducing edema, while leaving the surface of the wound moist. It is contraindicated in avascular wound or exposed tendons or bones. Some of the contraindications include untreated osteomyelitis, non-enteric and unexplored fistula, presence of necrotic tissue, exposed organs or blood vessels, and malignancy in the wound[99]. Vacuum-assisted closure is effective in promoting wound closure in patients with treated osteomyelitis or soft tissue infections[100,101]. Hyperbaric oxygen therapy (HBOT) is another therapy which is used as an adjunct to standard wound care in the treatment of diabetic foot wounds. It has limited side effects, relatively safe, and its use is widely appreciated [102].

CONCLUSION

The successful management of diabetic foot wounds requires multidisciplinary team work of specialist. The management of diabetic foot wound needs timely detection of complications and frequent assessment of the wound. No wound should be treated as simple. It is important to take into account all the related causes, identify the problem, and treat it. There are various topical regimes available, but the choice depends only on the treating physicians, podiatrist, or clinical care nurse. While selecting wound care materials one should keep in mind about the properties of ideal wound care dressing which can maintain moist wound healing environment, absorb exudates, control infection/odor and is effective in treating diabetic foot wounds. In addition to all these wound care techniques, antibiotic therapy and offloading plays a very important role.

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**REFERENCES**

1 Available from: URL http: //www.idf.org/sites/default/files/EN\_6E\_Ch2\_the\_Global\_Burden.pdf accessed on 22 may 2014

2 **Singh N**, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. *JAMA* 2005; **293**: 217-228 [PMID: 15644549 DOI: 10.1001/jama.293.2.217]

3 **Reiber GE.** Epidemiology and health care costs of diabetic foot problems. In: Veves A, Giurini JM, LoGerfo FW, editor(s). The Diabetic Foot. New Jersey: Humana Press, 2002: 35–58

4 **Frykberg RG**, Zgonis T, Armstrong DG, Driver VR, Giurini JM, Kravitz SR, Landsman AS, Lavery LA, Moore JC, Schuberth JM, Wukich DK, Andersen C, Vanore JV. Diabetic foot disorders. A clinical practice guideline (2006 revision). *J Foot Ankle Surg* 2006; **45**: S1-66 [PMID: 17280936 DOI: 10.1016/S1067-2516(07)60001-5]

5 **Reiber GE**, Vileikyte L, Boyko EJ, del Aguila M, Smith DG, Lavery LA, Boulton AJ. Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. *Diabetes Care* 1999; **22**: 157-162 [PMID: 10333919 DOI: 10.2337/diacare.22.1.157]

6 **Richard JL**, Sotto A, Lavigne JP. New insights in diabetic foot infection. *World J Diabetes* 2011; **2**: 24-32 [PMID: 21537457 DOI: 10.4239/wjd.v2.i2.24]

7 **Farahani RM**, Kloth LC. The hypothesis of 'biophysical matrix contraction': wound contraction revisited. *Int Wound J* 2008; **5**: 477-482 [PMID: 18593398 DOI: 10.1111/j.1742-481X.2007.00402.x]

8 **Tiwari S**, Pratyush DD, Gupta B, Dwivedi A, Chaudhary S, Rayicherla RK, Gupta SK, Singh SK. Prevalence and severity of vitamin D deficiency in patients with diabetic foot infection. *Br J Nutr* 2013; **109**: 99-102 [PMID: 22715859 DOI: 10.1017/S0007114512000578]

9 **Cuzzell JZ**. The new RYB color code. *Am J Nurs* 1988; **88**: 1342-1346 [PMID: 3177488 DOI: 10.2307/3470923]

10 . Carolina W, Geoff S. Wound dressings update. J Pharm Pract Res 2006; 36: 318–324

11 **Falanga V**. Wound healing and its impairment in the diabetic foot. *Lancet* 2005; **366**: 1736-1743 [PMID: 16291068 DOI: 10.1016/S0140-6736(05)67700-8]

12 **Falanga V.** Wound bed preparation: science applied to practice. In: European wound management association (EWMA) wound bed preparation in practice, 2004: 2–5

13 **Miller M**. The role of debridement in wound healing. *Community Nurse* 1996; **2**: 52-55 [PMID: 9450452]

14 **Steed DL**, Donohoe D, Webster MW, Lindsley L. Effect of extensive debridement and treatment on the healing of diabetic foot ulcers. Diabetic Ulcer Study Group. *J Am Coll Surg* 1996; **183**: 61-64 [PMID: 8673309]

15 **Steed D.** Modulating wound healing in diabetes. In: Levin and O’Neal’s. The Diabetic Foot. St Louis: J Bowker and M Pfeiffer, 2001: 395–404

16 **Armstrong DG**, Lavery LA, Harkless LB. Validation of a diabetic wound classification system. The contribution of depth, infection, and ischemia to risk of amputation. *Diabetes Care* 1998; **21**: 855-859 [PMID: 9589255 DOI: 10.2337/diacare.21.5.855]

17 **Grey JE,** Enoch S, Harding KG. ABC of wound healing-Wound assessment. *BMJ* 2006; **332:** 900-3 [PMID: 16613966]

18 **Lipsky BA**. A report from the international consensus on diagnosing and treating the infected diabetic foot. *Diabetes Metab Res Rev* 2004; **20 Suppl 1**: S68-S77 [PMID: 15150818 DOI: 10.1002/dmrr.453]

19 **Lipsky BA**, Berendt AR, Deery HG, Embil JM, Joseph WS, Karchmer AW, LeFrock JL, Lew DP, Mader JT, Norden C, Tan JS. Diagnosis and treatment of diabetic foot infections. *Clin Infect Dis* 2004; **39**: 885-910 [PMID: 15472838 DOI: 10.1086/424846]

20 **Calhoun JH**, Cantrell J, Cobos J, Lacy J, Valdez RR, Hokanson J, Mader JT. Treatment of diabetic foot infections: Wagner classification, therapy, and outcome. *Foot Ankle* 1988; **9**: 101-106 [PMID: 3229695 DOI: 10.1177/107110078800900301]

21 **Vishwanathan V,** Thomas N, Tandon N, Asirvatham A, Rajasekar S, Ramachandran A, Senthilvasan K, Murugan VS, Muthulakshmi. Profile of diabetic foot complications and its associated complications - a multicentric study from India. *J Assoc Physicians India* 2005; **53:** 933–936

22 **Anandi C,** Aaguraja D, Natarajan V, Ramanatham M, Subramaniam CS, Thulasiram M, Sumithra S. Bacteriology of diabetic foot lesions. *Ind J Med Microbiol* 2004; **2:** 175–178

23 **Gadepalli R**, Dhawan B, Sreenivas V, Kapil A, Ammini AC, Chaudhry R. A clinico-microbiological study of diabetic foot ulcers in an Indian tertiary care hospital. *Diabetes Care* 2006; **29**: 1727-1732 [PMID: 16873771 DOI: 10.2337/dc06-0116]

24 **Citron DM**, Goldstein EJ, Merriam CV, Lipsky BA, Abramson MA. Bacteriology of moderate-to-severe diabetic foot infections and in vitro activity of antimicrobial agents. *J Clin Microbiol* 2007; **45**: 2819-2828 [PMID: 17609322 DOI: 10.1128/JCM.00551-07]

25 **Ramakant P**, Verma AK, Misra R, Prasad KN, Chand G, Mishra A, Agarwal G, Agarwal A, Mishra SK. Changing microbiological profile of pathogenic bacteria in diabetic foot infections: time for a rethink on which empirical therapy to choose? *Diabetologia* 2011; **54**: 58-64 [PMID: 20835702 DOI: 10.1007/s00125-010-1893-7]

26 **Abdulrazak A**, Bitar ZI, Al-Shamali AA, Mobasher LA. Bacteriological study of diabetic foot infections. *J Diabetes Complications* 2005; **19**: 138-141 [PMID: 15866058 DOI: 10.1016/j.jdiacomp.2004.06.001]

27 **Raja NS**. Microbiology of diabetic foot infections in a teaching hospital in Malaysia: a retrospective study of 194 cases. *J Microbiol Immunol Infect* 2007; **40**: 39-44 [PMID: 17332905]

28 **Bansal E**, Garg A, Bhatia S, Attri AK, Chander J. Spectrum of microbial flora in diabetic foot ulcers. *Indian J Pathol Microbiol* 2008; **51**: 204-208 [PMID: 18603682 DOI: 10.4103/0377-4929.41685]

29 **Singh SK**, Gupta K, Tiwari S, Shahi SK, Kumar S, Kumar A, Gupta SK. Detecting aerobic bacterial diversity in patients with diabetic foot wounds using ERIC-PCR: a preliminary communication. *Int J Low Extrem Wounds* 2009; **8**: 203-208 [PMID: 19934183 DOI: 10.1177/1534734609353080]

30 **Tiwari S**, Pratyush DD, Dwivedi A, Gupta SK, Rai M, Singh SK. Microbiological and clinical characteristics of diabetic foot infections in northern India. *J Infect Dev Ctries* 2012; **6**: 329-332 [PMID: 22505442]

31 **Shanmugam P**, M J, Susan S L. The bacteriology of diabetic foot ulcers, with a special reference to multidrug resistant strains. *J Clin Diagn Res* 2013; **7**: 441-445 [PMID: 23634392 DOI: 10.7860/JCDR/2013/5091.2794]

32 **American Diabetes Association**. Consensus development conference on diabetic foot wound care. 7-8 April 1999, Boston, MA. American Diabetes Association *Adv Wound Care* 1999; **12**: 353-361 [PMID: 10687555]

33 **Sumpio BE**, Aruny J, Blume PA. The multidisciplinary approach to limb salvage. *Acta Chir Belg* 2004; **104**: 647-653 [PMID: 15663269]

34 **Bennett NT**, Schultz GS. Growth factors and wound healing: biochemical properties of growth factors and their receptors. *Am J Surg* 1993; **165**: 728-737 [PMID: 8506974 DOI: 10.1016/S0002-9610(05)80797-4]

35 **Basile P,** Rosenbloom B. Local care of the diabetic foot. In: Veves A, Giurini JM, LoGerfo FW, editor(s). The Diabetic Foot. New Jersey: Humana Press, 2002: 279–29 [DOI: 10.1385/1-59259-168-X: 279]

36 **Sibbald RG**, Williamson D, Orsted HL, Campbell K, Keast D, Krasner D, Sibbald D. Preparing the wound bed--debridement, bacterial balance, and moisture balance. *Ostomy Wound Manage* 2000; **46**: 14-22, 24-8, 30-5; quiz 36-7 [PMID: 11889735]

37 **Landis S,** Ryan S, Woo K, Sibbald RG. Infections in chronic wounds. 4th ed. HMP Communications, 2007: 299– 321

38 **Driver VR.** Treating the macro and micro wound environment of the diabetic patient: managing the whole patient, not the hole in the patient. *Foot and Ankle Q Sem J* 2004; **16:** 47–56

39 **Cervo FA**, Cruz AC, Posillico JA. Pressure ulcers. Analysis of guidelines for treatment and management. *Geriatrics* 2000; **55**: 55-60; quiz 62 [PMID: 10732005]

40 **Rolstad B,** Ovington L, Harris, A. Principles of wound management. 2nd ed. Bryant R, editor. St. Louis: Mosby, 2000: 85-124

41 **Ramundo J,** Gray M. Enzymatic wound debridement. *J Wound Ostomy Continence Nurs* 2008; **35:** 273–280 [DOI: 10.1097/01.WON.0000319125.21854.78]

42 **Sherman RA,** Wyle F, Vulpe M. Maggot therapy for treating pressure ulcers in spinal cord injury patients. *J Spinal Cord Med* 1995; **18:** 71–74 [PMID: 764097]

43 **Lavery LA**, Armstrong DG, Wunderlich RP, Tredwell J, Boulton AJ. Predictive value of foot pressure assessment as part of a population-based diabetes disease management program. *Diabetes Care* 2003; **26**: 1069-1073 [PMID: 12663575 DOI: 10.2337/diacare.26.4.1069]

44 **Boulton AJ**. Pressure and the diabetic foot: clinical science and offloading techniques. *Am J Surg* 2004; **187**: 17S-24S [PMID: 15147987 DOI: 10.1016/S0002-9610(03)00297-6]

45 **Armstrong DG**, Nguyen HC, Lavery LA, van Schie CH, Boulton AJ, Harkless LB. Off-loading the diabetic foot wound: a randomized clinical trial. *Diabetes Care* 2001; **24**: 1019-1022 [PMID: 11375363 DOI: 10.2337/diacare.24.6.1019]

46 **Brem H**, Sheehan P, Boulton AJ. Protocol for treatment of diabetic foot ulcers. *Am J Surg* 2004; **187**: 1S-10S [PMID: 15147985 DOI: 10.1016/S0002-9610(03)00299-X]

47 **Queen D**, Orsted H, Sanada H, Sussman G. A dressing history. *Int Wound J* 2004; **1**: 59-77 [PMID: 16722898 DOI: 10.1111/j.1742-4801.2004.0009.x]

48 **Sibbald RG**, Torrance G, Hux M, Attard C, Milkovich N. Cost-effectiveness of becaplermin for nonhealing neuropathic diabetic foot ulcers. *Ostomy Wound Manage* 2003; **49**: 76-84 [PMID: 14652415]

49 **Higgins KR**, Ashry HR. Wound dressings and topical agents. *Clin Podiatr Med Surg* 1995; **12**: 31-40 [PMID: 7720031]

50 Available from: URL http: //www.nhssb.n-i.nhs.uk/publications/primary\_care/Wound\_Manual.pdf accessed on 1 November 2013

51 **Moura LI**, Dias AM, Carvalho E, de Sousa HC. Recent advances on the development of wound dressings for diabetic foot ulcer treatment--a review. *Acta Biomater* 2013; **9**: 7093-7114 [PMID: 23542233 DOI: 10.1016/j.actbio.2013.03.033]

52 **Shortt R**, Thoma A. Empirical antibiotics use in soft tissue infections. *Can J Plast Surg* 2008; **16**: 201-204 [PMID: 19949497]

53 Edmonds M, Foster A. The use of antibiotics in the diabetic foot. *Am J Surg* 2004; **187:** 25–28 [DOI: 10.1016/S0002-9610(03)00300-3

54 **Lipsky BA**, Berendt AR, Cornia PB, Pile JC, Peters EJ, Armstrong DG, Deery HG, Embil JM, Joseph WS, Karchmer AW, Pinzur MS, Senneville E. 2012 Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. *Clin Infect Dis* 2012; **54**: e132-e173 [PMID: 22619242 DOI: 10.1093/cid/cis346]

55 **Matsuura GT,** Neil Barg. Update on the antimicrobial management of foot infections in patients with diabetes. *Clinical Diabetes* 2013; **31:** 59–65 [DOI: 10.2337/diaclin.31.2.59]

56 **Chahine EB,** Harris S, Williams R. Diabetic foot infections: an update on treatment. *US Pharm* 2013; **38:** 23–26

57 **Cookson B.** The HARMONY project’s antibiotic policy and prescribing process tools. *APUA Newsletter* 2000; **18:** 4–6

58 **Dolan NC**, Liu K, Criqui MH, Greenland P, Guralnik JM, Chan C, Schneider JR, Mandapat AL, Martin G, McDermott MM. Peripheral artery disease, diabetes, and reduced lower extremity functioning. *Diabetes Care* 2002; **25**: 113-120 [PMID: 11772911 DOI: 10.2337/diacare.25.1.113]

59 **McDaniel MD**, Cronenwett JL. Basic data related to the natural history of intermittent claudication. *Ann Vasc Surg* 1989; **3**: 273-277 [PMID: 2673321 DOI: 10.1016/S0890-5096(07)60040-5]

60 **Rosanio S**, Tocchi M, Uretsky BF, Stouffer GA. Use of intraluminal stents in the treatment of carotid, renal, and peripheral arterial disease. *Am J Med Sci* 2000; **319**: 111-117 [PMID: 10698096 DOI: 10.1097/00000441-200002000-00008]

61 **Lepäntalo M**, Biancari F, Tukiainen E. Never amputate without consultation of a vascular surgeon. *Diabetes Metab Res Rev* 2000; **16 Suppl 1**: S27-S32 [PMID: 11054884 DOI: 10.1002/1520-7560(200009/10)16: 1]

62 **Zhu YQ**, Zhao JG, Liu F, Wang JB, Cheng YS, Li MH, Wang J, Li J. Subintimal angioplasty for below-the-ankle arterial occlusions in diabetic patients with chronic critical limb ischemia. *J Endovasc Ther* 2009; **16**: 604-612 [PMID: 19842730 DOI: 10.1583/09-2793.1]

63 **La Fontaine J**, Reyzelman A, Rothenberg G, Husain K, Harkless LB. The role of revascularization in transmetatarsal amputations. *J Am Podiatr Med Assoc* 2001; **91**: 533-535 [PMID: 11734610]

64 **Chalmers R.** Surgical techniques to save the diabetic foot. *Diabetic Foot* 2003; **6:** 38–42

65 **Bryant RA.** Acute and chronic wounds. 2nd ed. St. Louis, MO: Mosby; 2000: 189–196

66 **McDonald A**, Lesage P. Palliative management of pressure ulcers and malignant wounds in patients with advanced illness. *J Palliat Med* 2006; **9**: 285-295 [PMID: 16629558 DOI: 10.1089/jpm.2006.9.285]

67 Available from: URL http: //en.wikipedia.org/wiki/Gel assessed on 26 january 2014

68 **Kalinski C,** Schnepf M, Laboy D, Hernandez LM, Nusbaum J, McGrinder B, Comfort C, Alvarez OM. Effectiveness of a topical formulation containing metronidazole for wound odor and exudates control. *Wounds* 2005; **17:** 84–90

69 **Newman V,** Allwood M, Oakes RA. The use of metronidazole gel to control the smell of malodorous lesions. *Palliat Med* 1989; **34:** 303–305 [DOI: 10.1177/026921638900300412]

70 **Barton P,** Parslow N. Malignant wounds: holistic assessment & management. 3rd ed. Krasner DL, Rodeheaver GT, Sibbald RG, editors. Wayne (PA): HMP Communications, 2001: 699–710

71 **Finegold SM**. Anaerobic bacteria. Their role in infection and their management. *Postgrad Med* 1987; **81**: 141-147 [PMID: 3588458]

72 **Rice TT**. Metronidazole use in malodorous skin lesions. *Rehabil Nurs* 1992; **17**: 244-25, 255 [PMID: 1448604 DOI: 10.1002/j.2048-7940.1992.tb01558.x]

73 **Burnakis TG.** Topical metronidazole for decubitus ulcers. *Hospital Pharmacy* 1989; **24:** 960–961

74 **Viswanathan V**, Kesavan R, Kavitha KV, Kumpatla S. A pilot study on the effects of a polyherbal formulation cream on diabetic foot ulcers. *Indian J Med Res* 2011; **134**: 168-173 [PMID: 21911968]

75 **Geronemus RG**, Mertz PM, Eaglstein WH. Wound healing. The effects of topical antimicrobial agents. *Arch Dermatol* 1979; **115**: 1311-1314 [PMID: 507884 DOI: 10.1001/archderm.1979.04010110017016]

76 **Kashyap A**, Beezhold D, Wiseman J, Beck WC. Effect of povidone iodine dermatologic ointment on wound healing. *Am Surg* 1995; **61**: 486-491 [PMID: 7762895]

77 . Innes ME, Umraw N, Fish JS, Gomez M, Cartotto RC. The use of silver coated dressings on donor site wounds: a prospective, controlled matched pair study. Burns 2001; 27: 621–662 [DOI: 10.1016/S0305-4179(01)00015-8]

78 **Kilinç H**, Sensöz O, Ozdemir R, Unlü RE, Baran C. Which dressing for split-thickness skin graft donor sites? *Ann Plast Surg* 2001; **46**: 409-414 [PMID: 11324884 DOI: 10.1097/00000637-200104000-00010]

79 **Field FK**, Kerstein MD. Overview of wound healing in a moist environment. *Am J Surg* 1994; **167**: 2S-6S [PMID: 8109679 DOI: 10.1016/0002-9610(94)90002-7]

80 **Ubbink DT**, Vermeulen H, Goossens A, Kelner RB, Schreuder SM, Lubbers MJ. Occlusive vs gauze dressings for local wound care in surgical patients: a randomized clinical trial. *Arch Surg* 2008; **143**: 950-955 [PMID: 18936373 DOI: 10.1001/archsurg.143.10.950]

81 **Lohmann M**, Thomsen JK, Edmonds ME, Harding KG, Apelqvist J, Gottrup F. Safety and performance of a new non-adhesive foam dressing for the treatment of diabetic foot ulcers. *J Wound Care* 2004; **13**: 118-120 [PMID: 15045807]

82 **Karlsmark T**, Agerslev RH, Bendz SH, Larsen JR, Roed-Petersen J, Andersen KE. Clinical performance of a new silver dressing, Contreet Foam, for chronic exuding venous leg ulcers. *J Wound Care* 2003; **12**: 351-354 [PMID: 14601228]

83 **Schultz GS**, Sibbald RG, Falanga V, Ayello EA, Dowsett C, Harding K, Romanelli M, Stacey MC, Teot L, Vanscheidt W. Wound bed preparation: a systematic approach to wound management. *Wound Repair Regen* 2003; **11 Suppl 1**: S1-28 [PMID: 12654015 DOI: 10.1046/j.1524-475X.11.s2.1.x]

84 **Trudgian J**. Investigating the use of Aquaform Hydrogel in wound management. *Br J Nurs* 2000; **9**: 943-948 [PMID: 11261031]

85 **Mulder GD**. Cost-effective managed care: gel versus wet-to-dry for debridement. *Ostomy Wound Manage* 1995; **41**: 68-70, 72, 74 passim [PMID: 7598779]

86 . Advanced wound dressings. British National Formulary 2011; 62

87 **Ono I**, Gunji H, Zhang JZ, Maruyama K, Kaneko F. Studies on cytokines related to wound healing in donor site wound fluid. *J Dermatol Sci* 1995; **10**: 241-245 [PMID: 8593269 DOI: 10.1016/0923-1811(95)00454-Z]

88 **Meehan F.** Hydrocolloid update. Journal of Community Nursing May issue 1993

89 MA Healthcare Ltd, London. Wound Care Handbook 2011–2012

90 **Dumville JC**, O'Meara S, Deshpande S, Speak K. Alginate dressings for healing diabetic foot ulcers. *Cochrane Database Syst Rev* 2012; **2**: CD009110 [PMID: 22336860 DOI: 10.1002/14651858.CD009110.pub2]

91 **Dumville JC**, Deshpande S, O'Meara S, Speak K. Hydrocolloid dressings for healing diabetic foot ulcers. *Cochrane Database Syst Rev* 2012; **2**: CD009099 [PMID: 22336859 DOI: 10.1002/14651858.CD009099.pub2]

92 **Fitton AR**, Drew P, Dickson WA. The use of a bilaminate artificial skin substitute (Integra) in acute resurfacing of burns: an early experience. *Br J Plast Surg* 2001; **54**: 208-212 [PMID: 11254411 DOI: 10.1054/bjps.2000.3525]

93 **Burrow JW**, Koch JA, Chuang HH, Zhong W, Dean DD, Sylvia VL. Nitric oxide donors selectively reduce the expression of matrix metalloproteinases-8 and -9 by human diabetic skin fibroblasts. *J Surg Res* 2007; **140**: 90-98 [PMID: 17418871 DOI: 10.1016/j.jss.2006.11.010]

94 **Basavaraj GV,** Uppin IV, Raghavendra BYP. Chronic diabetic wound healing: recombinant PDGF v/s normal saline dressing. *J Pharm Biomed Sci* 2012; **24;** 118–120

95 **Fernández-Montequín JI**, Valenzuela-Silva CM, Díaz OG, Savigne W, Sancho-Soutelo N, Rivero-Fernández F, Sánchez-Penton P, Morejón-Vega L, Artaza-Sanz H, García-Herrera A, González-Benavides C, Hernández-Cañete CM, Vázquez-Proenza A, Berlanga-Acosta J, López-Saura PA. Intra-lesional injections of recombinant human epidermal growth factor promote granulation and healing in advanced diabetic foot ulcers: multicenter, randomised, placebo-controlled, double-blind study. *Int Wound J* 2009; **6**: 432-443 [PMID: 20051095 DOI: 10.1111/j.1742-481X.2009.00641.x]

96 **Molan PC**, Betts JA. Using honey to heal diabetic foot ulcers. *Adv Skin Wound Care* 2008; **21**: 313-316 [PMID: 18600072 DOI: 10.1097/01.ASW.0000323523.38800.9f]

97 **Molan PC**. The evidence supporting the use of honey as a wound dressing. *Int J Low Extrem Wounds* 2006; **5**: 40-54 [PMID: 16543212 DOI: 10.1177/1534734605286014]

98 **Vijaykumar H,** Pai SA, Pandey V, Kamble P. Comparative study of collagenase and papain-urea based preparations in the management of chronic nonhealing limb ulcers. *Indian J Sci Technol* 2011; **4:** 1096–1100

99 **Andros G**, Armstrong DG, Attinger CE, Boulton AJ, Frykberg RG, Joseph WS, Lavery LA, Morbach S, Niezgoda JA, Toursarkissian B. Consensus statement on negative pressure wound therapy (V.A.C. Therapy) for the management of diabetic foot wounds. *Ostomy Wound Manage* 2006; **Suppl**: 1-32 [PMID: 17007488]

100 **Venturi ML**, Attinger CE, Mesbahi AN, Hess CL, Graw KS. Mechanisms and clinical applications of the vacuum-assisted closure (VAC) Device: a review. *Am J Clin Dermatol* 2005; **6**: 185-194 [PMID: 15943495 DOI: 10.2165/00128071-200506030-00005]

101 **Petrie N**, Potter M, Banwell P. The management of lower extremity wounds using topical negative pressure. *Int J Low Extrem Wounds* 2003; **2**: 198-206 [PMID: 15866848 DOI: 10.1177/1534734603261067]

102 **Duzgun AP**, Satir HZ, Ozozan O, Saylam B, Kulah B, Coskun F. Effect of hyperbaric oxygen therapy on healing of diabetic foot ulcers. *J Foot Ankle Surg* 2008; **47**: 515-519 [PMID: 19239860 DOI: 10.1053/j.jfas.2008.08.002]

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A



B



C



**D**

**Figure 1 Wound classification based on the Red-Yellow-Black wound classification system by Marion Laboratories.** A: Necrotic tissue; B: Sloughy tissue; C: Granulating tissue; D: Epithelializing tissue.

**Table 1 Antibiotic recommendation based on the severity of the infection**

|  |  |  |  |
| --- | --- | --- | --- |
| **Site** | **Severity or extent** | **Route of administration** | **Duration of therapy** |
| Soft tissue only | Mild | Topical or oral | 1-2 wk may extend up to 4 wk if slow to resolve (outpatient) |
| Moderate | Oral (or initial parenteral) | 1-3 wk (Outpatient/inpatient) |
| Severe | Initial parenteral, switch to oral when possible | 2-4 wk (Inpatient, then outpatient ) |
| Bone or joint | No residual infected tissue (*e.g.*, post amputation) | Parenteral or oral | 2-5 d |
| Residual infected soft tissue( but not bone) | Parenteral or oral | 1-3 wk |
| Residual infected (but viable) bone | Initial parenteral, then consider oral switch | 4-6 wk |
| No surgery, or residual dead bone post-operatively | Initial parenteral, then consider oral switch | ≥ 3 mo |

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 2 Choice of wound care materials for Necrotic and Sloughy wounds** | | | |
| **Wound classification** | **Choice of wound care material** | Advantages | **Disadvantages** |
| Necrotic wound | Wet to dry | Good debriding capacity and cheap | Frequent dressing change  Painful if not soaked with saline prior to dressing |
| Topical antibacterial like metronidazole | Very good antibacterial coverage  Maintains moist wound healing environment by promoting autolysis and controls odor | Chance of maceration  Contraindicated in infected necrotic wounds |
| Hydrogel | Hydrates the wound by promoting autolysis | Chance of Maceration  Contraindicated in infected necrotic wounds and is expensive |
| Hydrocolloid | Maintains moist wound healing environment, which helps in autolytic debridement | Expensive  Contraindicated in infected necrotic wounds |
| Sloughy wound | Wet to dry | Good debriding capacity  Absorptive, adhesive, and cheapest | Frequent dressing change  Painful if not soaked with saline prior to dressing |
| Topical enzymes like collagenase, papain, fibrinolysis | Promotes autolytic debridement by desloughing  Can be used in combination with metronidazole or hydrogel | Contraindicated in granulating or epithelizing wounds |
| Topical antibiotics like metronidazole | Very good antibacterial coverage  Maintains moist wound healing environment by promoting autolysis and controls odor | Chance of maceration |
| Polyurethane Foam | Very effective in desloughing  Maintains moist wound healing environment by promoting granulation | Sometimes painful if not soaked with saline prior to dressing change |
| Hydrogel | Hydrates the wound by promoting autolysis | Chance of maceration and is expensive |
| Hydrocolloid | Maintains moist wound environment, which helps in autolytic debridement | Chance of maceration and is expensive |

Table 3 Choice of wound care materials for Healing/Sinus or cavity wounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Wound classification** | **Choice of wound care materials** | **Advantages** | **Disadvantages** |
| Granulating wounds | Non adherent dressing | Reduces trauma to the healing tissue  Maintains moist wound healing environment | Chance of shearing to new epithelium |
| Wet to dry dressing | Promotes healing | Chance of bleeding if not soaked with saline before dressing |
| Polyurethane Foam | Maintains moist wound healing environment  Promotes healing process | Chance of bleeding if not soaked before dressing change |
| Topical Antibacterial like metronidazole, mupirocin, Tulle, Silver containing ointments, Acetic acid 0.5%-5% and povidone iodine | Maintains moist wound healing, promotes epithelization and controls odor  Effective against Gram positive coccai including MRSA Silver Sulphadiazine has broad antibacterial coverage, accelerates epithelization, and are very effective in burns Acetic acid is very effective against pseudomonas Povidone iodine is very effective for gangrene as it hastens demarcation | Silver containing ointments can't be used in Sulpa allergy patients  Povidone iodine is cytotoxic to fibroblasts and delays the healing process |
| Platelet derived growth factor | Faster healing and very effective | Expensive |
| Hydrogel | Promotes healing | Chance of maceration and is expensive |
| Hydrocolloid | Promotes healing  Reduces the interval of dressing change | Chance of maceration and is expensive |
| Epithelizing wounds | Non adherent | Reduces trauma to the healing tissue  Maintains moist wound healing environment | Chances of shearing |
| Wet to dry dressing | Promotes faster healing | Soaking of dressing is required while dressing change |
| Topical antibacterial | As mentioned in granulating wounds | As mentioned in the granulating wounds |
| Epidermal growth factor | Effective and faster healing | Expensive |
| Hydrogel | Effective | Chance of maceration and is expensive |
| Hydrocolloid | Effective | Chance of maceration and is expensive |
| Cavity/Sinus wounds | Alginate | Highly absorbent and non-adherent  Maintains moist wound healing | Needs adequate padding and is expensive |
| Hydrogel | Effective in promoting granulation tissue | Needs adequate padding and is expensive |