Advanced Dressings in Pressure Ulcers

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Agata Janowska, Michela Macchia, and Battistino Paggi

Introduction

The management of pressure ulcers has a major impact on health. We are now increasingly focused on an "overall feel good" approach as a reference model. This involves not only an attitude toward healing, but also a propensity to reduce pain and improve quality of life for patients. Therefore a treatment that should not only protect and promote healing, but also reduce the complications and implications, where possible, seems to be key to a concrete prevention. Speaking of medications may appear simplistic if we consider only the quality of these technologies, but more significant if we carefully manage each stage of the process of taking care of patients with ulcers. This appears to be the only certain aspect in an approach to the treatment of pressure ulcers. Bibliographic reviews have highlighted the fact that there is still insufficient evidence to support dressings (Vermeulen et al. [1], Chaby et al. [2], MeReC Bulletin [3]), while recognizing a different ability to manage individual steps in the process of healing. If the approach to the clinical stage is a model to follow in choosing the most appropriate medication, we have to start with the classification of pressure ulcers that has a broad consensus in the scientific community. The current classification of pressure ulcers is the NPUAP-EPUAP-PPPIA of 2014, which divides skin ulcers into four categories/stages, completed by two clinical situations that do not allow a real categorization or staging [4]. There are also other factors that influence the management of a skin wound (Fig. 12.1), including the patient's general condition, the condition of the wound and the experience of the medical team.

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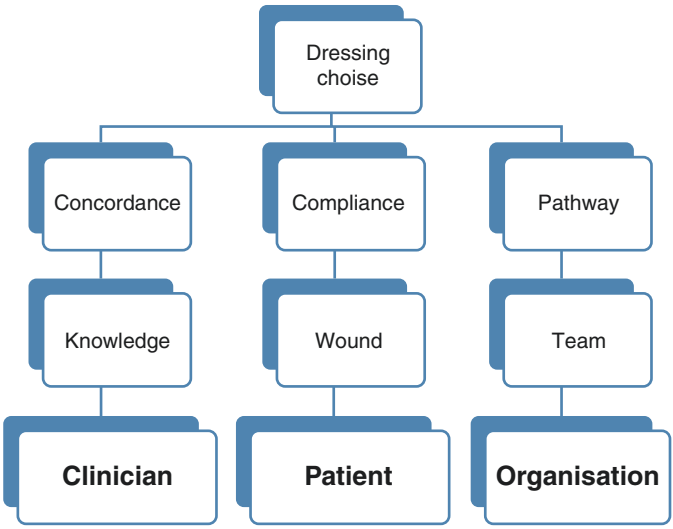


Fig. 12.1 Dressing pathway

One of the main problems for clinicians is related to the choice of the most appropriate medication and the clinical situation. Dressings are now divided into traditional and advanced dressings. The purpose of this article is to provide the reader with a brief guide to the process of taking charge of the patient, through the various phases of treatment, while providing reflection on the most appropriate choices. Currently available treatment options include traditional and advanced dressing, with biocompatible and/or bioactivity characteristics that manage the moist wound healing well. Such medications can be associated with devices (e.g. NPTW) or with other bioengineering products (Fig. 12.2). During the treatment of pressure, friction or slipping wounds, a suitable and personalized nutrition support should be associated, completed by the use of prevention devices (surfaces) and mobilization. Dressings, both advanced and traditional, are intended to protect the wound, to promote healing, to absorb exudate and stop bleeding, reduce odor, promote the growth of new tissue, avoid trauma during removal on the wound bed and on the perilesional skin. Today, it is conceivable to think of the classification of medications according to the composition (Fig. 12.3), the mechanism of action of each (Fig. 12.4), and the clinical situation (Fig. 12.5). The characteristics of an ideal dressing have been described for many years and are well known: permeable for fluid and gas but not for bacteria; thermal insulation; comfort; reduction of the frequency of application; pain management during dressing or during dressing removal, due to their non-adherence to the wound bed [5–7].

In our opinion, characteristics typically linked to the mechanism of action by which the dressings fulfill their function should be added to the list of characteristics of an ideal dressing. Not all materials behave in the same way on the wound bed. Technological developments in the basic materials (polyurethane, alginate, carboxymethylcellulose, etc.) have allowed clinicians to have constantly better performing dressings that meet the clinical needs of the patient and the wound. The materials are combined in different ways with each other and with antimicrobial agents or anti-adherent agents (including petroleum jelly, petrolatum, silicone, etc.);

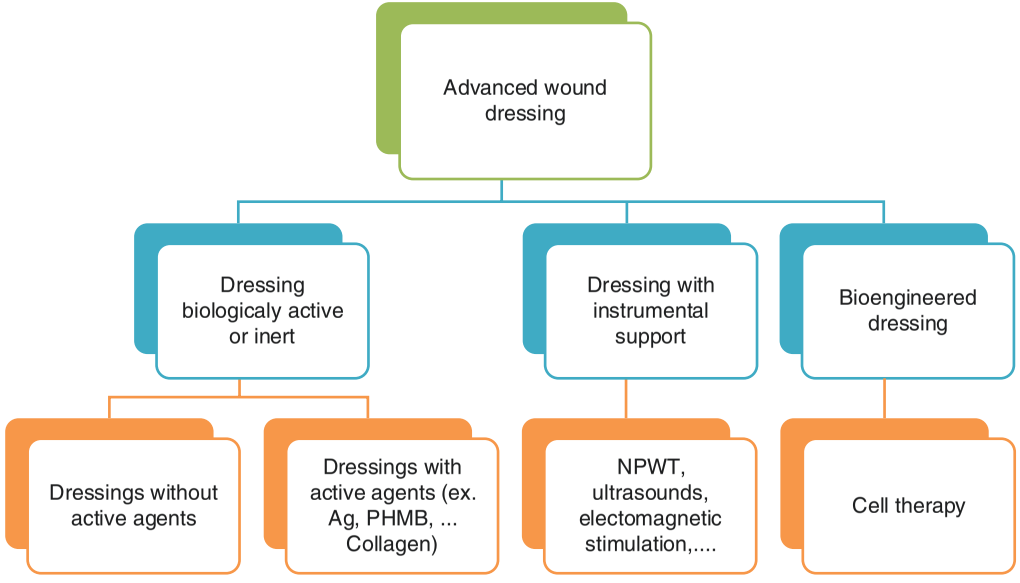


Fig. 12.2 The evolution of advanced medication

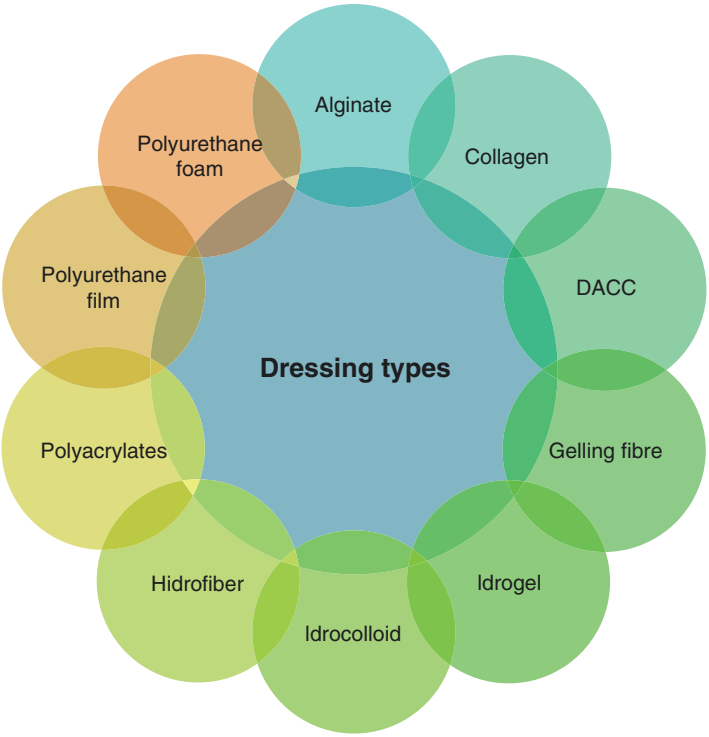
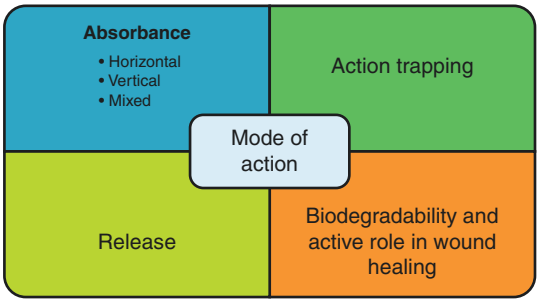


Fig. 12.3 Dressings according to composition

Fig. 12.4 Mechanism of action (MoA)



their basic properties, however, remained unchanged: degradation of necrotic tissue, exudate management, protection of the new tissue, development of ECM.

Dressing characteristics are particularly relevant where they actively participate in the repair process or in management of bacteria. In the repair process they promote the action of factors through their degradation (e.g., the large amount of water made with hydrogel induces the lysis of necrotic tissue; moreover, it supports the establishment of the new extracellular matrix); healing is enhanced by biodigestion and by collagen deposits that interact well with repair cells. Most dressings are used in wound exudate management; the different types of foams,

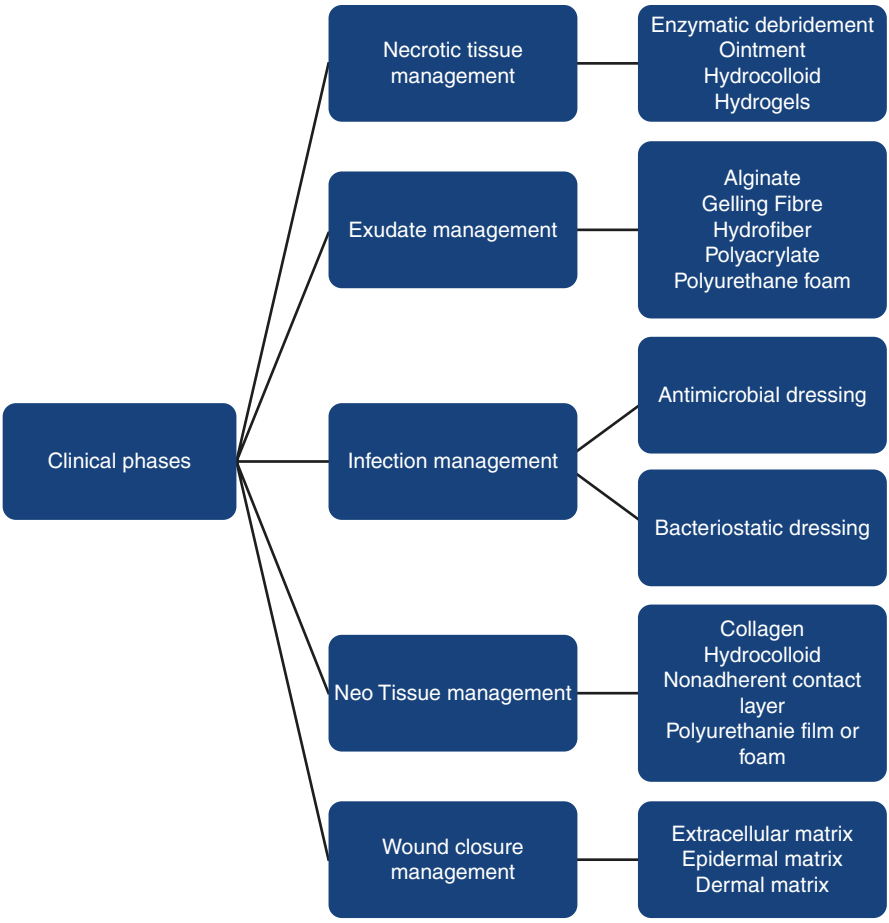


Fig. 12.5 Dressings compared to the clinical situation

alginates, fibers, gelling agents, hydrofibres and polyacrykates have been compared over time in terms of their capacity, absorption and management. Several articles have been written on the difference between the absorption of vertical exudates, horizontal exudates, and various combinations, as well as on the quantities they are capable of holding (Fig. 12.6) [8–10].

Antimicrobial dressings act through two mechanisms: the incorporation of bacteria and exudate in the dressing, and the release of the antimicrobial dressing scaffold contents (Figs. 12.7 and 12.8) [11].

One of the criteria that allows the proper use of medications involves considering the clinical stage according to the application of the principles of TIME [12]. The following figure helps to explain this concept.

In a context of treatment guided by the best clinical actions, it is necessary to learn and choose the medication materials that meet the needs of effective action, both clinical and technological.

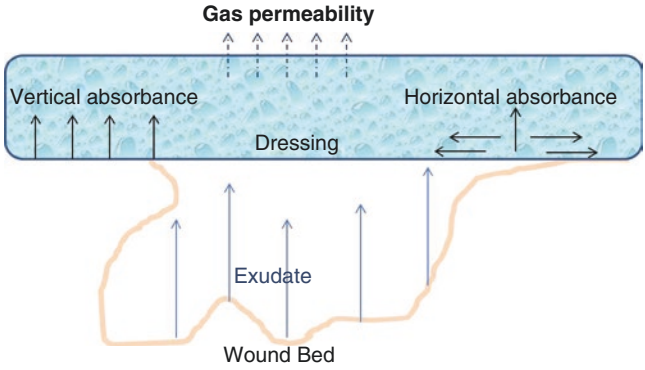


Fig. 12.6 Absorption capacity

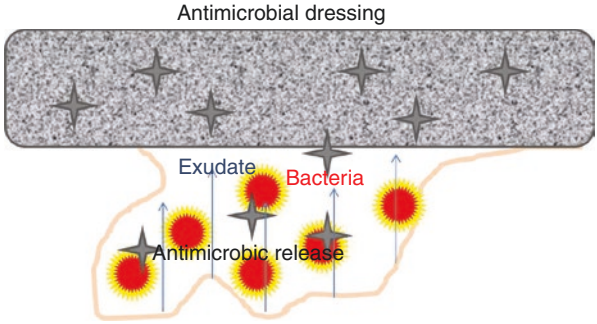


Fig. 12.7 Antimicrobial effect on the wound bed

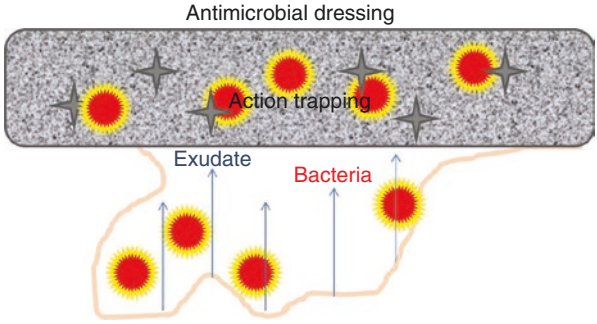


Fig. 12.8 Antimicrobial action within the dressing

Dressings for Pressure Ulcers

Non-Adherent

These dressings are made up of a single layer of non-adherent mesh and a structure of polyester, polyamid, cotton or rayon-viscose. Non-adhesiveness is ensured by the presence of vaseline, paraffin, polysaccharides, glycerol, petrolatum and silicone. Such dressings protect the wound from traumatic dressing changes and may be used for small exudative ulcers [6, 7, 13]. [EVIDENCE = C].

Absorbent

These dressings are polyacrylates, have an absorbent action and can be used as primary or secondary dressings. Some formulations need to be impregnated or wetted with Ringer lactate or saline to facilitate the absorption of exudates and bacteria. Some dressings contain saline gel, which is useful for debridement of fibrin and necrosis. They cannot be cut to prevent the escape of polyacrylate from the wound bed [6, 7, 14].

Advanced Dressings

Alginate

Derived from brown algae, these dressings have an absorbing action up to 20 times their weight and adapt perfectly to the shape of the wound. The high absorbency of this medication and the ability to adapt to the wound bed facilitate the removal of the bacterial residues that are captured by the gelification of the matrix, where there is carboxymethylcellulose [EVIDENZA = B]. Through their action they allow for the absorption and the reduced lysis of layers of slough and fibrin. They come in the form of calcium-alginate, sodium-alginate or in combination with collagen. They are indicated for wounds with moderate to high exudate and interact with the dressing material to **form a gel**. Alginates with calcium ions are indicated for bleeding lesions because they facilitate clotting after surgery. The removal can be carried out directly or by instillation of saline, causing an autolytic debridement. Absorption is increased if the alginate is associated with a layer of viscous [EVIDENCE = C]. These dressing are not recommended for low exuding wounds or dry eschar, as they are non-selective, absorbing every watery element and bringing about the dehydration of the wound bed [6, 7, 15, 16].

Foam Dressing

This dressing normally contains hydrophilic polyurethane foam and absorbs exudate, while keeping the wound moist and maintaining thermal insulation [EVIDENZA = B]. They are of various thicknesses and shapes, depending on the area of application (ex. the sacrum, heel and cavitary lesions with possible associations with secondary dressings); also, they do not cause any trauma at dressing change. They are indicated as primary or secondary dressings in partial thickness or full thickness wounds or under compression or negative pressure. They are not used in the case of dry eschar. They are indicated in category II and III ulcers [EVIDENCE = B]. We recommend a more frequent dressing change in the presence of high exudate, to prevent perilesional maceration [EVIDENCE = C] [6, 13, 14]. Bale et al. [19] introduced the use of hydrocolloid dressings with polyurethane foam and they concluded that foam was the most effective in the control of exudate, but did not have significant difference in terms of wear time [17–19].

Carboxymethylcellulose

This dressing contains sodium carboxymethyl cellulose fibers and in some cases alginate fibers. It has an action similar to that of alginates, but with improved resistance to flaking. The indications are ulcers with moderate or high exudate. The medication interacts with the exudate and turns it into a cohesive gel, which creates a moist environment and helps to control bacteria. There are types of dressings for undermined and tunneling wounds [20, 21].

Absorbent Polymers

These have a high capacity to absorb and incorporate exudate. They promote an association with a cleaning agent (ringer lactate), an osmotic action that cleanses and controls moist wound environments.

Hydrogel Dressings

These are made of insoluble cross-linked polymers (carboxymethyl cellulose) in association with water. Their action depends on the level of hydration and absorption of exudate or rehydration of the wound [EVIDENCE = C] and they are indicated in painful ulcers [EVIDENCE = C]. They are a form of amorphous hydrogel or flat sheets or beads [22].

Hydrogels

These are amorphous gels mostly made up of water and agents of various nature (glycerin, glycol-ethylene, etc.), that favor the rehydration of dry tissues. They are also effective in maintaining moist wound-healing environments, bringing about an autolytic debridement, granulation, epithelialization and pain reduction. They also can be used in cavity wounds [EVIDENCE = C]. There are formulations containing sodium chloride that facilitate and cause debridement of the lesion. Hydrogels may be used as primary or secondary dressings in the form of gauze. Use is not recommended in high-exuding lesions, because of the excessive maceration, or in infected wounds, because of their occlusive action and bacterial growth [EVIDENZA = C] [22]. Matzen et al. [23] compared this gel with saline gauze and reported a reduction in the volume of the wound and the necrotic component [23].

Hydrocolloids

These are semi-occlusive dressings, consisting of gelatin, pectin and carboxymethylcellulose, and bring about an autolityc debridement. Hydrocolloids are primary or secondary dressings and may be used on pressure ulcers in all categories [EVIDENCE = B]), low exuding with necrosis and eschar. They are adhesive, easily malleable, limiting the leakage of gas from the wound bed and preventing the penetration of bacteria and other contaminants, because they are waterproof. The exudate interacts with the dressing material to form a gel, which prevents the adhesion of the dressing. Use should be limited in infected lesions or altered perilesional skin [EVIDENCE = B]. Evidence of the use of hydrocolloids in the treatment of pressure ulcers comes from three meta-analyses, which assessed the impact of hydrocolloids

vs. dressings with paraffin gauze or vs wet to dry, which is significant for a better rate of healing in treated wounds [5, 6, 23–25].

Foam Films

These are permeable to water vapor and oxygen but not to water and bacteria. They can be used as primary and secondary dressings, to prevent or treat category I pressure ulcers. They may bring about autolysis if used with hydrogels on necrotic lesions or eschars [EVIDENCE = C]. They are not used on infected lesions or on moderate-high exuding wounds, because they do not have assorbent properties [EVIDENCE = C]. Use carefully in areas of skin fragility. [EVIDENZA = C] [23] WOCNS (Wound Ostomy and Continence Nurses Society) and AHCPR (Agency for Health Care Policy and Research) have indicated that their use may promote autolytic debridement [26–28].

Enzymes

These consist mainly of collagenase or non-specific proteases, but also exist in the form of fibrinolysis, deoxyribonuclease, papain and equine catalase. They act on the necrosis of protein deposits on the wound bed. The collagenase acts mainly on collagen bridges, elastin, and necrosis, whereas the papain acts on fibrin and fibronectin. The correct application of the product should be limited to the wound bed to prevent maceration and the alteration of the perilesional skin. Simultaneous use during the dressing of antiseptics and chemical products containing metal ions can, if not properly removed, cancel the action of the product [28, 29].

Antimicrobical Dressings

Silver Dressings

These are effective in reducing bacteria and preparing the wound bed. They are composed of silver and various types of substrates. They are indicated in infected or highly colonized pressure ulcers [EVIDENCE = B]. These dressings inhibit the proliferation of bacteria with a slow release, which reduces the histolesivity induced by a high concentration of ions. Vermeulen [30] confirmed by a Cochrane review that the use of this category of dressings induced a reduction in the area of the treated wounds [30]. Observed a reduction of bacteria in the comparison of an alginate with silver ions against alginate without silver ions [31].

Iodine Dressings

This medication releases iodine ions when in contact with exudate and brings about an antiseptic action [32].

Biguanide Dressings

These exist in various forms: post-surgical dressings, in water balance and interface in treatment with negative pressure. This is the only antimicrobial molecule that acts on biofilm [33].

Chlorhexidine Impregnated Dressings

These are made up of a weave gauze enriched with a percentage of chlorhexidine (0.5%) and paraffin. They are indicated for smaller wounds and are non-adherent [6, 7].

Honey Dressings

These have an anti-microbial and anti-inflammatory action and can be used for category II and III pressure ulcers. [EVIDENCE = C] [34].

Dressings with Bacterial Binding Action

These are inert dressings, made up of a synthetic tissue with high hydrophobic capacity, which is able to capture and remove bacteria and other microorganisms from the infected and colonized wound bed. The mechanism of action exploits the tendency to aggregate on the part of the hydrophobic particles [35].

Other

Dressings with Silicone

There are various different types of materials that have been enriched with a layer of silicone. These are useful in promoting non-traumatic adherence at the wound bed and the prevention of perilesional skin damege [EVIDENCE B]. Compared polyurethane foams with or without silicone on categary II ulcers [13]. The dressings with silicone were less traumatic for the perilesional skin. [EVIDENCE B].

Collagen

This is a material with high biocompatibility. The biological dressing is indicated in non-healing pressure ulcers of Category/stage III and IV. [EVIDENCE C].

Charcoal Activated Dressings

These dressings have a good absorbent capacity and the charcoal absorbs odor from the wound bed [36].

Hypertonic Dressings

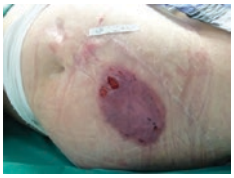
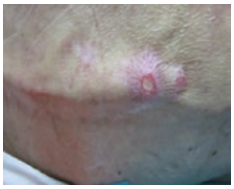
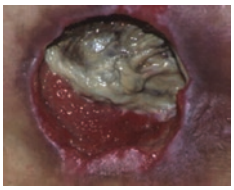
These contain a high quantity of sodium chloride, which induces an osmotic action on the wound bed and promotes the dilution of pus, bacteria and slough colliquation [37].

MMP Modulating Dressings

These modulate or inhibit metalloproteinases, which are often present in chronic wounds. They may be in collagen dressings or combined with secondary dressings. These dressings are very expensive [38].

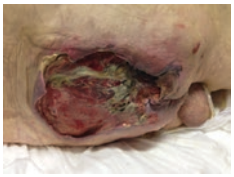
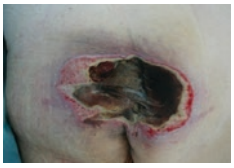
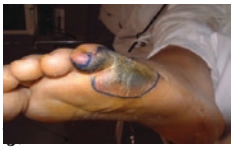
We suggest a list of dressings to choose from, based on the NPUAP—EPUAP—PPPIA criteria of 2014, depending on the situation of the wound bed and the perilesional skin [4] (Table 12.1).

Table 12.1 Cleansing and dressings in pressure ulcers

Category	Cleansing	Dressing	Frequency of dressing changes
	Saline or ringer lactate	Foam film, hydrocolloids extra thin or film barrier	Twice a week
	Saline or ringer lactate	**LOW EXUDATE (with fibrin)**	Twice a week
		Hydrocolloids, hydrogel	
		LOW EXUDATE (with granulation tissue)	
		MMP modulating dressings, collagen, non-adherent dressings	Twice a week
		MEDIUM EXUDATE	
	Antiseptic solution (PHMB, Chlorexidine, sodium hypochloride)	Carboxymethylcellulose (CMC), foam dressings, alginates	
		WITH INFECTION	3 times per week
		Silver dressings, iodine dressings, Chlorexidine impregnated dressings, Biguanide dressings, honey dressings	
	Saline or ringer lactate	Foam dressing or carboxymethylcellulose	3 times per week
		FIBRIN-NECROTIC TISSUE	
		Hydrogel + foam dressing with silicone interface or film foam, absorbent polymer	
		TUNNELING	
	Antiseptic solution	Ribbon dressings (CMC or foam dressing), cavity dressings	
		WITH INFECTION	Daily
		Foam dressings with silver, CMC with silver, charcoal activated dressings, dressing with bacterial binding action	
			3 times per week

(continued)

Table 12.1 (continued)

Category	Cleansing	Dressing	Frequency of dressing changes
	Saline or ringer lactate or antiseptic solution	Hydrogel with hydrocolloide, CMC with or without foam dressing	Daily
			2–3 times per week
		Foam dressing or cavity dressings or alginate, absorbent polymer	
		WITH INFECTION	2–3 times per week
	Antiseptic solution	Dressing foam with silver, CMC with silver, charcoal activated dressing, dressing with bacterial binding action	
	Saline or ringer lactate	Enzymes, hydrogel with film foam, hydrocolloids, non-adherent dressings	Daily
DEEP TISSUE 	Skin cleansing with skin care products	Pressure relief, costant mobilization. Inspection and revaluation	Daily

The classification of pressure ulcers is divided into 4 categories/stages, with the addition of an unclassifiable stage and deep tissue injury.

- **Category/stage I***:* Non-blanchable erythema.
- **Category/stage II**: Partial thickness loss of dermis.
- **Category/stage III**: Full thickness tissue loss. Bone, tendon and muscle are not exposed.
- **Category/stage IV**: Full thickness tissue loss. Bone, tendon and/or muscle are exposed.
- **Unstageable:** Full thickness tissue loss. The depth of the ulcer is completely covered by slough and/or eschar.
- **Deep tissue injury:** This is a discolored intact skin area or blood-filled blister. Deep tissue injury is caused by pressure and/or shear and friction**.** The wound may evolve and be covered by thin eschar.

Conclusions

The aim in the use of each product currently available for the treatment of skin ulcers is the formation of an adequate wound bed. Preparation of the wound bed is essential in order to accelerate endogenous healing or to promote the effectiveness of other therapeutic measures when the skin lesion does not heal spontaneously. Advanced medications should be used in an appropriate manner not only by medical specialists and medical personnel, but also by general doctors. Cost reduction and dissemination of use of these dressings must pass this first step. A UK study estimated that dressings and such materials account for 17–22% of the total cost of wound care [39]. In patients with pressure ulcers it is difficult to assess the outcome, such as improving the quality of life, control of exudate, pain and healing time, because of the precarious conditions and numerous comorbidities of the patient. The treatment chosen does not directly affect the duration of survival, so it is difficult to develop an analysis of cost effectiveness or cost benefit. The correct choice of medication is oriented towards clinical and morphological criteria that identify the most obvious signs within the wound bed or perilesional skin. The clinician must know the main and secondary functions of the dressing in order to obtain maximum efficiency in the management of wounds. From the literature it is clear that the proper use (best practice) of dressings and adequate prevention result in a reduction of frequency of application and a optimization of the dedicated health personnel, reducing both healing time and costs.

References

1. Vermeulen H, Ubbink D, Goossens A, de Vos R, Legemate D. Dressings and topical agents for surgical wounds healing by secondary intention. Cochrane Database Syst Rev. 2004;(2):CD003554. Review.
2. Chaby G, Senet P, Vaneau M, Martel P, Guillaume JC, Meaume S, Téot L, Debure C, Dompmartin A, Bachelet H, Carsin H, Matz V, Richard JL, Rochet JM, Sales-Aussias N, Zagnoli A, Denis C, Guillot B, Chosidow O. Dressings for acute and chronic wounds: a systematic review. Arch Dermatol. 2007;143(10):1297–304. Review.
3. MeReC Bulletin evidence-based prescribing of advanced wound dressings for chronic wounds in primary care. 2010;21:01.
4. Dunk AM, Carville K. The international clinical practice guideline for prevention and treatment of pressure ulcers/injuries. J Adv Nurs. 2015.
5. Bradley M, Cullum N, Nelson EA, Petticrew M, Sheldon T, Torgerson D. Systematic reviews of wound care management: dressings and topical agents used in the healing of chronic wounds. Health Technol Assess. 1999;3(17 Pt 2):1–35.
6. Bouza C, Muñoz A, Amate JM. Efficacy of advanced dressings in the treatment of leg ulcers: a systematic review. Wound Repair Regen. 2005;13(3):218–29. Review.
7. Dini V, Bertone M, Romanelli M. Prevention and management of pressure ulcers. Dermatol Ther. 2006;19(6):356–64.
8. World Union of Wound Healing Societies. Principles of best practice: wound exudate and the role of dressings: a consensus document. London: MEP Ltd; 2007.
9. Thomas S, Fear M, Humphreys J, et al. The effect of dressings on the production of exudates from venous leg ulcers. Wounds. 1996;8(5):145–50.

10. Vowden P, Bond E, Meuleneire F. Managing high viscosity exudate. Wounds Int. 2015;6(1):14–9.
11. Finnegan S, Percival SL. EDTA: an antimicrobial and antibiofilm agent for use in wound care. Adv Wound Care (New Rochelle). 2015;4(7):415–21. Review.
12. Schultz GS, Sibbald RG, Falanga V, et al. Wound bed preparation: a systematic approach to wound management. Wound Repair Regen. 2003;11(2):Suppl S1–28.
13. Maume S, Van De Looverbosch D, Heyman H, Romanelli M, Ciangherotti A, Charpin S. A study to compare a new self-adherent soft silicone dressing with a self-adherent polymer dressing in stage II pressure ulcers. Ostomy Wound Manage. 2003;49(9):44–51.
14. Brown-Etris M, Milne C, Orsted H, Gates JL, Netsch D, Punchello M, Couture N, Albert M, Attrell E, Freyberg J. A prospective, randomized, multisite clinical evaluation of a transparent absorbent acrylic dressing and a hydrocolloid dressing in the management of Stage II and shallow Stage III pressure ulcers. Adv Skin Wound Care. 2008;21(4):169–74.
15. Belmin J, Meaume S, Rabus MT, Bohbot S. Investigators of the sequential treatment of the elderly with pressure sores (STEPS) trial. Sequential treatment with calcium alginate dressings and hydrocolloid dressings accelerates pressure ulcer healing in older subjects: a multicenter randomized trial of sequential versus nonsequential treatment with hydrocolloid dressings alone. J Am Geriatr Soc. 2002;50(2):269–74.
16. Sayag J, Meaume S, Bohbot S. Healing properties of calcium alginate dressings. J Wound Care. 1996;5(8):357–62.
17. Parish LC, Dryjski M, Cadden S, Versiva XC, Pressure Ulcer Study Group. Prospective clinical study of a new adhesive gelling foam dressing in pressure ulcers. Int Wound J. 2008;5(1):60–7.
18. Guillén-Solà M, Soler Mieras A, Tomàs-Vidal AM, GAUPP-Expert Panel. A multi-center, randomized, clinical trial comparing adhesive polyurethane foam dressing and adhesive hydrocolloid dressing in patients with grade II pressure ulcers in primary care and nursing homes. BMC Fam Pract. 2013;14:196.
19. Bale S, Squires D, Varnot T, Walker A, Benbow M, Harding KG. A comparison of two dressings in pressure sore management. J Wound Care. 1997;6(10):463–6.
20. Philbin S. Pressure ulcer management using sodium carboxymethylcellulose hydrofiber® foam dressings. Ostomy Wound Manage. 2013;59(3):10–2.
21. Tickle J. Effective management of exudate with AQUACEL extra. Br J Community Nurs. 2012;Suppl:S38. S40–6.
22. Dumville JC, Stubbs N, Keogh SJ, Walker RM, Liu Z. Hydrogel dressings for treating pressure ulcers. Cochrane Database Syst Rev. 2015;(2). https://doi.org/10.1002/14651858.CD011226.pub2.
23. Matzen S, Peschardt A, Alsbjørn B. A new amorphous hydrocolloid for the treatment of pressure sores: a randomised controlled study. Scand J Plast Reconstr Surg Hand Surg. 1999;33(1):13–5.
24. Baxter H. A comparison of two hydrocolloid sheet dressings. Br J Community Nurs. 2000;5(11):572. 574, 576–7
25. Singh A, Halder S, Menon GR, Chumber S, Misra MC, Sharma LK, Srivastava A. Meta-analysis of randomized controlled trials on hydrocolloid occlusive dressing versus conventional gauze dressing in the healing of chronic wounds. Asian J Surg. 2004;27(4):326–32.
26. Dutra RA, Salomé GM, Alves JR, Pereira VO, Miranda FD, Vallim VB, de Brito MJ, Ferreira LM. Using transparent polyurethane film and hydrocolloid dressings to prevent pressure ulcers. J Wound Care. 2015;24(6):268. 270–1, 273–5
27. Bergman-Evans B, Cuddigan J, Bergstrom N. Clinical practice guidelines: prediction and prevention of pressure ulcers. Todays OR Nurse. 1994;16(6):33–40.
28. Ratliff CR, Tomaselli N. WOCN update on evidence-based guideline for pressure ulcers. J Wound Ostomy Continence Nurs. 2010;37(5):459–60.
29. Waycaster C, Milne C. Economic and clinical benefit of collagenase ointment compared to a hydrogel dressing forpressure ulcer debridement in a long-term care setting. Wounds. 2013;25(6):141–7.

30. Vermeulen H, van Hattem JM, Storm-Versloot MN, Ubbink DT. Topical silver for treating infected wounds. Cochrane Database Syst Rev. 2007;(1):CD005486.
31. Trial C, Darbas H, Lavigne JP, Sotto A, Simoneau G, Tillet Y, Téot L. Assessment of the antimicrobial effectiveness of a new silver alginate wound dressing: a RCT. J Wound Care. 2010;19(1):20–6.
32. Leaper DJ, Durani P. Topical antimicrobial therapy of chronic wounds healing by secondary intention using iodine products. Int Wound J. 2008;5(2):361–8.
33. Sibbald RG, Coutts P, Woo KY. Reduction of bacterial burden and pain in chronic wounds using a new polyhexamethylenebiguanide antimicrobial foam dressing-clinical trial results. Adv Skin Wound Care. 2011;24(2):78–84.
34. Yapucu Güneş U, Eşer I. Effectiveness of a honey dressing for healing pressure ulcers. J Wound Ostomy Continence Nurs. 2007;34(2):184–90.
35. Cutting K, McGuire J. In vitro and clinical experience of Cutimed Sorbact: the evidence base. J Wound Care. 2015;24(Suppl 5a):S6–S30.
36. Sornakumar L, Kalarani M, Srinivas CR. Activated charcoal dressing in malodorous leg ulcers. Indian J Lepr. 2010;82(3):147–8.
37. Xakellis GC, Chrischilles EA. Hydrocolloid versus saline-gauze dressings in treating pressure ulcers: a cost-effectiveness analysis. Arch Phys Med Rehabil. 1992;73(5):463–9.
38. Nisi G, Brandi C, Grimaldi L, Calabrò M, D'Aniello C. Use of a protease-modulating matrix in the treatment of pressure sores. Chir Ital. 2005;57(4):465–8.
39. Drew P, Posnett J, Rusling L, Wound Care Audit Team. The cost of wound care for a local population in England. Int Wound J. 2007;4(2):149–55.