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Review

Wet-to-dry phase 2.0

G. Kammerlander [a,b,*], T. Eberlein [c], A. Lantin [d], G. Luch [e,a], C. Geyrhofer [a], P. Asmussen [f], T. Wild [c]

[a] WKZ®-WundKompetenzZentrum® Linz, Austria
[b] Akademie-ZWM®, Embrach/Zürich, Switzerland
[c] Deutsche Wundakademie DWA, Hamburg, Germany
[d] WundZentren, gvw GmbH, Germany
[e] LKH Steyr, Austria
[f] Akademie-ZWM®, Ellerbek, Germany

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ABSTRACT

The wet-to-dry phase as a basic accompanying measure in dressing changes on secondary healing wounds was first described and instructed 1989 by G. Kammerlander at the university hospital of Zurich. This development traces back to collective years of practical experiences at the Clinic of dermatology of the university hospital Zurich (Prof. U.W. Schnyder/G. Kammerlander). The positive empirical experiences over more than one and a half decade now require underlying this method with scientific facts. Using a literature survey, the importance and significance of this practical experience will be confirmed and supported. This article will show this established and widely-used method in an updated version.

Contents

1. Introduction

Wounds healing by secondary intention involve a multitude of processes hard to imagine, which have to proceed regularly and organised, partially parallel, partially in strict order. Very often, these complex reparative processes are disturbed [1–5].

The theoretically, exemplary and practically well examined basic processes of secondary wound healing take place in a chronic wound in a constant strain situation. The process of exudation, proliferation, organisation and epithelisation is in its entirety disturbed.

The disturbed balance of constructing and disassembling processes seems to be an essential element of the chronification process of a wound.

Here, an essential role are playing the local conditions, e.g. plaque or isles of necrosis, marked fibrin coating, dryness of the wound, but also imbalance of spreading and activity of especially proteolytic enzymes.

One of the most important groups of these proteinases, the matrix metalloproteinases (MMPs), are a family of enzymes which can disassemble parts of connective tissues.

MMPs are important for the normal remodelling (construction and disassembling) of connective tissue:

- MMPs submit the dismantling of damaged tissue ("autolytic debridement")
- MMPs support the re-epithelisation
- elastases and cathepsin are other proteinases necessary for structural dismantling

Temporary inhibitors of the metalloproteinases (TiMP) are the physiological antagonists of the MMPs.

If their concentration is too low, the disassembling characteristics of the MMPs will predominate. Increased concentration of MMP has a destructive effect on local growth factors!

Chronic wounds typically show the following problems:

* Corresponding author at: WKZ®-WundKompetenzZentrum Linz, Untere Donaulände 21–25, A – 4020 Linz, Austria.
E-mail address: kammerlander@wfi.ch (G. Kammerlander).

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- increased concentration of pre-inflammatoric cytokines
- pathologically increased concentration of proteinases
- disturbed activity of growth factors
- decreased concentration of TiMP

In chronic wounds contamination with microorganisms and slough contribute significantly as co-factors to underlying systemic diseases and multimorbidity.

Looking at these co-factors, there are on the one hand effects of underlying systemic diseases leading to a wound anyway, as chronic venous stasis, chronic lymphatic stasis and impairment of arterial circulation (micro- and macroangiopathy) as well as their interferences (leading to the overlapping factors) on the other hand.

Secondarily, there are concomitant diseases like diabetes mellitus, immune disorders with impaired cellular defence reaction or restitution and similar diseases which may lead to wound healing problems [2,3,5–7].

Besides these aspects, every wound is influenced by interactions to microbial exposure and thick, packing or dehydrating (e.g. necroses) wound coating.

Looking at chronic, clinically not infected wounds, it is to be expected that they are colonised. This germ colonisation is a complex, but not yet well researched microbiological ecosystem. During the process of chronification, the germ spectrum of wounds of different origins varies, unrelated to the pathophysiological elicitor of the wound condition [8–12]. Rightly, a stronger observation of this complex, synergistic ecosystem is required instead of the isolated view at one special microrganism. The local reduction or eradication of just one isolated species is, according to contemporary researches, a pointless, often counterproductive measure because it does not take in account the microbiological biotope character of a wound [9].

Nevertheless (or even because of that) chronic wounds heal under optimal environmental conditions and treatment of underlying and concomitant diseases. For this, it is a question of the local wound management, how quickly or slowly the process accomplishes.

To speak about important local factors for wound healing, it is obvious that freedom or scarceness of avital plaque or elements, so freedom of detritus, is a fundamental requirement for an optimal local environment to achieve a healing success [3,4,13].

This knowledge is as old as the systematic engagement in wounds and wound healing and has its roots in the wound management of the classical antiquity.

The fundamental findings of Friedrich, father of modern wound management, also formed the term of debridement in wound care. This term is nowadays used in care of both acute and chronic wounds [14].

Debris in a chronic wound shows up as pulp, often formless, which develops by cellular and tissue decay [22]. The type of detritus determines its attachment to the undercoat and thus the possibilities and techniques for its removal [3,5,15].

Undoubtedly, the plaque on a wound is both barrier for regeneration and important risk factor for relevant wound healing problems, especially infection.

Debris represents, with differing risk depending on its quality and quantity, the primary location for reproduction of pathogenic microorganisms in the wound.

As barrier for permeation and medium of retention it impedes access of host's immune system. Also it, as previously elaborated, inhibits the efficacy of regenerative and wound contracting processes and is a conclusive hindrance for healing.

In addition, toxic and immunologically active products of tissue decay depict relevant systemic risk elements for the wound patient [3,5,6].

Fig. 1. Typical situation of a chronic wound (wound bed and peri-wound skin).

The milieu modulating function of the detritus shows up (practically always negatively as demonstrated) in daily praxis of wound care as manifestation of wound infection.

Even with guarantee of proper hygienic wound dressing changes, frequently manifestations of infection occur in chronic wounds. Assuming constancy of the factor "exposition" (local microbiological ecosystem inside the wound), a change in the factor "disposition" must induce the infection. Actually, it is often the "dirty", coated wound, which is prone to this exacerbation of infection [3,9,16,17]. The typical finding in a chronic wound situation is shown in Fig. 1.

The verbalisation "a clean wound can easily heal secondarily" is a realisation of modern wound management and an explicit principle of surgical wound treatment [3,13,27].

It includes the rule, that wound cleansing shall be performed as quickly, radically and gently as possible.

The old surgical paradigm is valid that, referring to necrosis (and infection), approach has to be radical, referring to granulation tissue gentle.

These facts have found wide entrance in the standard literature of these areas and are issues of further education for different medical qualifications and specialities [3,4,13,15–18].

Fleischmann et al. describe the principles of surgical treatment of wounds of different origin under the key aspects:

- elimination of noxes
- reperfusion of the ischaemic wound
- necrosectomy/debridement
- elimination of the invasive infection
- closure of the wound [3]

2. Principle considerations regarding the concept "wet-to-dry phase"

In recent years a development loomed where continuous, relatively mild, recurrent (if necessary in every dressing change) physical wound cleaning with use of moist substrate (like swab or gauze pad) are favoured. This technique is referred to as "cleansing" and belongs to common wound management knowledge [19–31,38].

This procedure uses the phase of the dressing change actively for the mentioned cleansing activities [7,18].

Looking at the function of the dressing changes it is definitely necessary to leave the negative view of disturbing the wound quietness.

Undoubtedly, the dressing arrangement with its particular wound environment outlines is an absolutely important part of intelligent wound management.

Still, wounds need also cleaning, care for the wound edges and surroundings and of the skin.

The area of the wound edges and surroundings in wound management is often underestimated or less well acknowledged.

Yet, the vitality and stability of the wound surroundings are also significantly responsible for how quickly and uncomplicated a wound will heal and how its condition will present after healing.

With inadequate consideration of the wound surroundings in the concept of treatment, one may encounter increased problems with infections, irritation and other deterioration. These phases often lead to additional problems which will enforce increased treatment efforts and prolonged treatment duration.

If a dressing change is necessary, it definitely pursues further targets:

- wound cleaning with required (mild, moderate or enforced) cleansing or decontamination to reduce devitalized parts, if necessary in combination with germ reducing measures
- purging, regeneration and care of the wound edges and surroundings to minimise the risk of maceration, eczema and other complications
- assessment of wound, wound edges and surrounding skin to evaluate the therapeutic success for eventually necessary modifications of the local management

For years, concepts have been favoured of multi-phase dressing changes with active cleaning (wet) phase and subsequent short period or rest (dry phase) to restitute the integrity of the surrounding skin (first described and instructed by G. Kammerlander and U.W. Schnyder at the dermatologic University hospital of Zurich in 1989).

Within a short cleaning phase (about 15–20 min), warming up of the compress-/cleaning-solution to room temperature would be preferable but not mandatory.

The aim of this measure is not just to keep the physiologically "ideal" milieu factor "temperature" steady (although refrigeration should be avoided) but also the purification, also in terms of a eventually necessary reduction of itching and inflammation. With a stronger concomitant inflammative reaction the patient would feel such a phase to be very soothing. In these local circumstances, a consciously chosen "cooling phase" can be active part of "gentle" wound management.

Agents for wet packs – for wound and wound surrounding skin – could be:

Neutral agents (without active substance)

- isotonic saline solution
- Ringer's solution, Ringer's lactate

Pharmaceuticals with antiseptic declaration

- PVP-iodine based
- Polihexanide based
- Octenidine dihydrochloride and Phenoxyethanol based

Wound rinsing solutions with antimicrobial characteristics

- Singlet oxygen based
- Octenidine dihydrochloride based
- Polihexanide based
- products based on saline diaphragm-electrolysis

3. Wet-to-dry phase and its effects on wound temperature

A research of McGuiness et al. [32] showed that cleaning with saline solution at room temperature did not have an obvious effect on wound temperature (average of 2.7 °C loss of temperature in the wet phase of wound cleansing). Also, the choice of wound dressings did not show an obvious influence. After removal of the dressing, the average temperature at the ground of the wound was 32.6 °C (immediately after dressing removal). The core body temperature seems to be the essential factor for an acceptable wound temperature.

Long lasting rinsing phases (hours to days) as continuous irrigation (lavage) necessarily require warming of the cleaning solution [17,18].

A cleaning solution should of course not be toxic or irritative, allergologically uncritical and have good cleaning qualities. Besides the commonly used isotonic saline or ringer solution, there are also specific cleansing solutions in view which, besides the above mentioned effects, let expect especially good purification results [3,17,18].

If necessary, local antiseptic solutions can be applied if a local infection exists or impends. Some modern antiseptics, besides safe administration, obtain excellent microbial reduction potency.

Their application is temporally limited, based on indication as well as the substance themselves (except for the agent Polyhexanide) [34–36].

4. Procedure of a wet-to-dry phase (following G. Kammerlander)

The main aim of a marked wet-to-dry phase is the elimination of wound healing inhibiting agents of different origin out of the wound or the wound surroundings. Besides different micro organisms remainders of skin care and protect products, adhesive agents and rims, residual detritus and skin scales as well as inflammation inducing substances shall be eliminated as thoroughly as possible before applying a new dressing. That needs an adequate application time to achieve the requested intensive effects [33].

In macerated, inflamed or infected wounds or wound surroundings an application time of 15–20 min (wet phase) should be guaranteed to achieve an effective microbial reduction and decrease of inflammation [37]. This applies especially to modern wound rinsing solutions with an antiseptic side effect based on Polihexanide, Octenidine dihydrochloride or active oxygen. In stabilised wound surroundings without signs of irritation or infection during the further procedure, often 5–10 min wet phase would be enough. So the wet phase could be, depending on the current situation, adapted during the course of wound treatment.

With using antiseptic solutions like PVP-iodine or Octenidine dihydrochloride and Phenoxyethanol often shorter times (e.g. 5 min) of application time would be sufficient. In chronic wounds, using PVP-iodine packs a dilution down to 1% is possible [34–36].

5. Methods of the wet-to-dry phase

After removal of the dressing a basic cleaning of the wound and after that the wound surrounding skin shall be performed. In extended wounds, for cost concerns, this basic cleaning is recommended to be done with favourable isotonic saline solution. The following wet pack phase should, because of the additional

Fig. 2. Application and modelling of all over wetted gauze for the wet phase.

Fig. 3. Removal after 20 min of application.

antiseptic effect, as a rule be carried out with modern wound rinsing solutions. Packs with isotonic saline solution or Ringer solution do not lead to microbial reduction (shown in current researches with more than 600 bacterial cultures at the WKZ (Wound competence centre) Linz, data on file).

Fig. 4. Additional mechanical cleansing.

The coarse cleaning of the wound and the wound surroundings is performed separately, self-evidently solely with sterile materials (in the wound area) [33].

The strong wetting of the gauze or the non-woven fabric compress which will be placed circular above the wound and its spacious surroundings and will be fixed for optimal contact to wound surroundings and wound ground is of great importance.

- After the wet pack phase the wound and its surroundings should be purified and rinsed again with the same wound rinsing solution and with sterile gauze pads.
- Thereafter the so-called dry phase follows. Either a sterile gauze pad is placed on the wound for protection for 5–10 min or other additional therapeutic measures are adapted in this meantime.
- Subsequently, under optimal conditions, a new dressing can be applied to a thus prepared wound and wound surroundings [33].

Especially in strongly exuding chronic wounds in the inflammation phase, this practice is of high relevance because their type of exudate, other than in acute wounds, is marked by a high aggressiveness on vital tissue.

This can lead to irritative changes up to direct cell destruction by excessive maceration and/or microbial exposure.

Fig. 5. Comparison of the clinical findings before and after wet-to-dry phase.

6. Clinical procedure of a wet-to-dry phase

A typical clinical example on a venous leg ulcer is given within Figs. 2–5.

7. Summary

The necessity and reasonableness of cleansing and microbial reduction in soiled acute wounds as well as cleansing and microbial reduction (decontamination) in chronic wounds with the aim of optimal preparation of the wound bed (reduction of infection and germs, minimising of risks) can be referred to as principle in common wound treatment techniques and in modern wound management.

For cleansing and debridement there exist, according to requirements, different approaches. On special focus, there are methods of the so-called "wound cleansing" (as an important part of wound bed preparation) for continuous mild reduction of debris.

Besides physiological solutions (saline solution, Ringer's solution) also special preparations with antimicrobial characteristics or defined antiseptics can be used for wound purification (and if necessary anti-infectious treatment) up to the standards of treatment indication and wound phase.

References

[1] Winter G. Formation of the scab and the rate of epithelization of superficial wounds in the skin of the young domestic pig. Nature 1962;(193):293–4.
[2] Asmussen PD, Söllner B. Wundmanagement Prinzipien und Praxis. Hippokrates Verlag; 1995.
[3] Fleischmann W, Russ M, Moch D. Chirurgische Wundbehandlung. Chirurg 1998;(69):222–32.
[4] Brunner U, Eberlein T. Experiences with hydrofibres in the moist treatment of chronic wounds, in particular of diabetic foot. Vasa 2000;(29):253–7.
[5] Sedlarik K. Wundheilung. G. Fischer Verlag; 1993.
[6] Brunner u, Zollinger H. Wieviel Fuß ist besser als keiner. Langenbecks Arch Chir Suppl II (Kongreßbericht); 1989.
[7] Kammerlander G. Lokaltherapeutische Standards für chronische Hautwunden. Springer Verlag; 1998.
[8] Lookingbill D, Miller S, Knowles R. Bacteriology of chronic leg ulcers. Archives of Dermatology 1978;(114):1765–8.
[9] Bowler P, Davies B. The microbiology of infected and noninfected leg ulcers. International Journal of Dermatology 1999;(38):573–8.
[10] Hansson C, Hoborn J, Möller A, Swanbeck G. The microbial flora in venous leg ulcers without clinical signs of infection. Acta Dermato-Venereologica (Stockholm) 1995;(75):24–30.
[11] Bowler P. The anaerobic and aerobic microbiology of wounds: a review. Wounds 1998;(10):170–8.
[12] Lipsky BA. A current approach to diabetic foot infections. Current Infectious Disease Reports 1999;1(August (3)):253–60.
[13] Rodeheaver G, Baharestani MM, Brabec ME, Byrd HJ, Salzberg CA, Scherer P, et al. Healing and wound management: focus on debridement. An interdisciplinary round table, September 18, 1992, Jackson Hole, WY. Advances in Wound Care 1994;7(January (1)):22–36.
[14] Pschyrembel: Klinisches Wörterbuch. de Gruyter Verlag; 2001.
[15] Rodeheaver GT. Pressure ulcer debridement and cleansing: a review of current literature. Ostomy Wound Management 1999;45(January (1A Suppl.)):80–5.
[16] Brunner U. Der diabetische Fuß aus infektchirurgischer Sicht. Zentralbl Chir 1999;124(Suppl. 1):13–6.
[17] Phillips D, Davey C. Wound cleaning versus wound disinfection: a challenging dilemma. Perspectives 1997;21(Winter (4)):15–6.
[18] Chisholm CD. Wound evaluation and cleansing. Emergency Medicine Clinics of North America 1992;10(November (4)):665–72.
[19] Eich D, Stadler R. Differenzierte Lokaltherapie chronischer Wunden. Vasa 1999;(28):3–9.
[20] Selim P, Bashford C, Grossman C. Evidence-based practice: tap water cleansing of leg ulcers in the community. Journal of Clinical Nursing 2001;10(May (3)):372–9.
[21] Barber LA. Clean technique or sterile technique? Let's take a moment to think. Journal of Wound Ostomy and Continence Nursing 2002;29(January (1)): 29–32.
[22] McEwan C. Wound cleansing and dressing. American Journal of Clinical Dermatology 2000;1(January–February (1)):57–62.
[23] Parker L. Applying the principles of infection control to wound care. British Journal of Nursing 2000;9(April (7)):394–6.
[24] Davies C. Wound care. Cleansing rights and wrongs. Nursing Times 1999;95(October–November (43)):71–2. 75.
[25] Luedtke-Hoffmann K, Schafer D. Pulsed lavage in wound cleansing. Physical Therapy 2000;80(March (3)):292–300.
[26] Hollinworth H. The management of infected wounds. Professional Nurse 1997;12(September (12 Suppl.)):8–11.
[27] White C. Wound cleansing. Guidelines for A&E staff. Nursing Times 1997;93(January (2)). 46, 48.
[28] Trevelyan J. Wound cleansing. Nursing Times 1996;92(December (50)):44–6.
[29] Barr JE. Principles of wound cleansing. Ostomy Wound Management 1995;4(August).
[30] Chisholm C. Wound evaluation and cleansing. Emergency Medicine Clinics of North America 1992;10(November (4)):665–72.
[31] Morison MJ. Wound cleansing—which solution? Professional Nurse 1989;4(February (5)):220–5.
[32] McGuinness W, Vella E, Harrison N. Influence of dressing changes on wound temperature. Journal of Wound Care 2004;13(October (9)):383–5.
[33] Kammerlander G, Andriessen A, Asmussen PD, Brunner U, Eberlein T. Role of the wet-to-dry phase of cleansing in preparing the chronic wound bed for dressing application. Journal of Wound Care September 2005;14(8).
[34] Andriessen A, Eberlein T. Assessment of a wound cleansing solution in the treatment of problem wounds. Wounds 2008.
[35] Kramer A, Daeschlein G, Kammerlander G, Andriessen A, Aspöck C, Bergemann R, et al. Konsensusempfehlung zur Auswahl von Wirkstoffen für die Wundantiseptik. ZfW 03/2004: 110–20.
[36] Kirketerp-Møller K, Jensen P, Fazli M, Madsen K, Pedersen J, Moser C, et al. Distribution, organization, and ecology of bacteria in chronic wounds. Journal of Clinical Microbiology 2008;46:2717–22.
[37] Cutting KF, White RJ. Maceration of the skin and wound bed: its nature and courses. Journal of Wound Care 2002;11:275–8.
[38] DGfW Definition Dekontamination; AWMF-Leitlinienregister Nr. 029/031, Arbeitskreis „Krankenhaus- und Praxishygiene der AWMF (Hygiene in Klinik und Praxis, 3. Auflage, mhp-Verlag, Wiesbaden; 2004, S. 235–40.