

## Techniques and solutions used in cleansing ulcers: a review of the literature

Elsa Vitale,<sup>1</sup> Lucia Rosa De Angelis,<sup>2</sup> Francesco Germini<sup>3</sup>

<sup>1</sup>Department of Mental Health ASL Bari; <sup>2</sup>Vascular Surgery ward, Di Venere hospital ASL Bari; <sup>3</sup>Manager of Health Professions, ASL Bari, Italy

### ABSTRACT

The ulcer is the loss of continuity of the epithelium, epidermis or mucous membrane caused by the expulsion of inflamed necrotic tissue. It is the expression of degenerative processes caused by inflammatory, infectious phenomena, circulatory disorders or tissue damage for chemical and physical causes. The treatment of a chronic skin lesion must be multidisciplinary and require the collaboration of numerous specialists, nursing staff, the patient and/or the family unit. The purpose of the review is to verify the effects of cleansing on wounds considering both the approaches adopted and the solutions used, evaluating the relative cure and infection rates of ulcers. The literature search was performed in the Pubmed and Cochran Library databases. Randomized clinical trials and literature reviews from 2003 to 2018 were considered. 276 scientific papers have been identified. Of these, 15 studies were considered potentially eligible. After the complete reading of each work, 6 articles were finally included. The management of ulcers involves many wound care professionals who should work together to heal wounds. Specifically, cleansing is considered a routine intervention that is carried out with sterile physiological solution through the tamponade method, this is because the literature does not provide satisfactory research in the context of the use of tap water.

### INTRODUCTION

Recently, a panel of experts reached consensus on the definition of ulcer as *an alteration of the normal anatomical and functional structure of the tissues, determined by endogenous and exogenous pathological processes with respect to the organs involved, which does not evolve according to the normal distribution process*.<sup>1</sup> The impact that the ulcer has on the patient's quality of life is widely documented: the pain, the frustration that the ulcer could not heal, the relapses, the problems in mobility, social isolation, the lack of adherence to therapeutic treatment they are all active problems in this category of patients, considered chronic. In clinical practice the documentation of the ulcer

includes: the collection of the clinical history, the observation of the site, depth and size, the description of the appearance of the wound bed and the surrounding skin, an analysis of the exudates and the signaling the presence of pain.

The challenge facing healthcare professionals is to establish effective therapeutic strategies in a timely and cost-effective way, with the aim of reducing the complexity of the wound, treating the patient's symptoms, responding to his expectations and, if possible, achieving full wound healing. In the field of wound care, the nurse manages multiple aspects such as: management of therapy, medication, education, optimization of compliance with therapy, pain management.<sup>2,3</sup>

Wound cleansing is one of the most important topics in wound care nursing. The latter is considered to be the first moment of wound care, often identified as a ritual action that, however, if not properly performed, can cause delays in healing.

In literature, there are different theoretical concepts of *cleansing*. For example, in the complete holistic approach to the patient suffering from ulcers *the patient exists with a wound, not a wound with the patient*.<sup>4</sup>

The literature defines cleansing as the application of a liquid on the wound, usually before applying a dressing in order to facilitate the removal of exudates, soluble and contaminated debris, but does not include the use of dressings or mechanical debridement.<sup>1,6</sup>

The reality is that in many clinical contexts cleansing is performed more out of habit than necessity. If cleansing occurs automatically, this implies that health professionals do not question what it means to cleanse a wound or an ulcer, nor reflect on what they intend to achieve by cleansing them.

Correspondence: Vitale Elsa, ASL Bari, Centre of Mental Health, via X marzo n. 43, Modugno, Bari, Italy.  
Tel.: + 393339910154.  
E-mail: vitaleelsa@libero.it

Conflict of interest: The authors declare no conflict of interests.

Key words: Abrasion Wound; Ulcer; Laceration; Cleaning.

Received for publication: 17 May 2019.

Accepted for publication: 6 May 2020.

This work is licensed under a Creative Commons Attribution Non-Commercial 4.0 License (CC BY-NC 4.0).

©Copyright: the Author(s), 2020

Licensee PAGEPress, Italy

Italian Journal of Wound Care 2020; 4(1):8-14

doi:10.4081/ijwc.2020.51

Cleansing represents *an evident aspect of nursing where a great emphasis is placed on acquiring technical skills, while little space is given to the search for the rationale behind the action itself*.

Cleansing is an essential component for wound management. However, there is limited research to develop protocols.<sup>7</sup>

Good cleansing removes most of the bacterial load. It can be recommended to use detergents with surfactant, if there are signs of critical contamination of the ulcer bed or in the presence of necrotic tissue with slough.<sup>1,5</sup> The application should be suspended if side effects appear, such as burning not tolerated by the patient.

The purpose of this review is to focus attention in the area of medication or better on the methods of cleansing ulcers which represents a very important component for wound management, although there are few studies useful for daily practice. In fact, the published studies mainly deal with the type of dressing, leaving little room for the solutions and techniques that are used to cleanse wounds. Furthermore, there is no uniform agreement between clinicians on the type of solution to be used and on the technique to be preferred, it follows that the chosen guidelines tend to reflect individual preferences. Therefore, the aim of the review is to verify the effects of cleansing on the wounds considering both the technique and the solutions used, evaluating how these affect the cure and infection rates.

## MATERIALS AND METHODS

To respond to the objective of this literature review, the key words were identified, such as: Abrasion, Cleansing, Irrigate, Laceration, Rin, Ulcer, Wash, Wound Shower.

These keywords were identified and searched separately through a rough search and subsequently joined by the Boolean AND operator.

The search string used was: “wound” OR “wounds” OR “bite” OR “ulcer” OR “ulcers” OR “abrasion” OR “abrasions” OR “laceration”, AND: clean \* OR wash \* OR irrigation \* OR shower \* OR rins.

The literature search was carried out in the Pubmed and Cochrane Library databases from January 1<sup>st</sup>, 2003 to December 31<sup>st</sup>, 2018. The studies that met the following inclusion criteria were considered: i) types of study: Meta-Analysis, systematic reviews, randomized clinical trials; ii) reference population: adult population, neither pediatric nor elderly; iii) healthy population, where the ulcer represented the primary pathology and not secondary to other pathologies; iv) the keywords were contained within the title and summary; v) the writing language was English.

In addition, studies with populations represented by patients with psychiatric and oncological pathologies, patients with burns, pre-surgery cleansing and cleansing with the Vac method were excluded.

The intervention sought in the studies was the cleansing of ulcerative wounds and the outcome assessed was the reduction of the wound volume or the increase in the wound healing rate or the reduction of the infection rate.

## RESULTS

The initial bibliographic research in the PubMed and Cochrane Library databases allowed to identify 276 articles relevant to the objective of our review. Titles and summaries were subsequently screened and only 15 full-length articles were considered eligible for our work. Overall, only 6 papers were included in the final review. 9 articles were excluded because they did not meet the inclusion criteria and the purpose of our review. All included studies were summarized in Appendix.<sup>8-34</sup>

## DISCUSSION

In this review, an attempt was made to summarize the current evidence available on wound cleansing, highlighting that there is no evidence to support the use of a particular cleaning solution or technique. Furthermore, the results obtained should be interpreted with caution as each study should consider the nature of the wounds, the quality and temperature of the water and the presence of comorbidities of the selected patients. Some of the included studies have methodological flaws in the randomization phase of the components of the samples in relation to the demographic characteristics, the size of the samples that are usually small and undersized. Furthermore, outcomes such as comfort, patient satisfaction and operator satisfaction are not sufficiently described and need to be investigated.

Specifically, the revised literature offers different solutions for the cleansing of ulcerative lesions, such as: i) Drinking tap water: recommended with the advantage of being efficient, with a good cost-effectiveness ratio and accessible<sup>15-18</sup>. However, the studies considered do not recommend their use in the cleaning of wounds with bone or tendon exposure. In these cases the use of 0.9% sterile physiological solution is recommended; ii) Saline solution: it is the preferred solution for wound cleansing because it is isotonic and does not interfere with the normal healing process, does not damage the tissues, does not cause sensitization and does not alter the normal bacterial flora of the skin;<sup>9-11</sup> iii) Solution with polyhexanide (PHMB) and betaine (Prontosan): it is a colorless transparent irrigation solution containing betaine, sodium hydroxide and purified water. The solution is used to cleanse wounds, to moisten and lubricate absorbent dressings for ulcers, burns, post-surgical wounds and abrasions.<sup>10</sup> Betaine is an effective and particularly well tolerated surfac-

tant that disintegrates the biofilm, dissolves the patinas thus reducing the contamination of the wound by bacteria and cellular debris. Polyhexanide (PHMB) is an effective and extraordinarily well tolerated antimicrobial substance that inhibits the growth of microorganisms and reduces the patina.

The literature offers the characteristics of a wound cleaning solution as a non-toxic substance for human tissues, effective in the presence of organic material, capable of reducing the number of microorganisms, insensitive, widely available, with a good cost-effectiveness ratio.<sup>26</sup> However, Lawrence<sup>35</sup> maintains that any anti-microbial irrigation effect is probably due to the physical action of the fluid rather than its possible antimicrobial effects. In fact, most antiseptics require to be in contact with bacteria inside the wound for longer than that allowed for irrigation.

It has still been suggested that the effectiveness of cleansing is to attribute to the actual physical action of cleaning thanks to which the undesirable material is removed and removed from the wound bed rather than the type of solution used. For this reason, the goal of the various cleaning techniques should be the induction of an adequate hydraulic force capable of overcoming the adhesive forces that keep bacteria and contaminants attached to the wound surface.<sup>36</sup> Among the available antiseptics, the revised literature proposes: i) Sodium hypochlorite: classically used in pressure ulcers with necrotic tissue to reduce the incidence of infections. Sodium hypochlorite has a bactericidal effect against most organisms commonly found in lesions. It is used extensively on cancerous growths to control bacterial growth and minimize odor. However, the solution is known for its cytotoxic power towards healthy cells and granulation tissues. Finally, its use is not recommended for periods longer than 7-10 days; ii) Chlorhexidine: it is an antiseptic widely used in hand washing and oral products but also as a disinfectant.<sup>37</sup> It is produced in two forms, namely 0.05% for wound cleaning and 4% for the preparation of the epidermis before surgery. It has a high level of antimicrobial activity, low toxicity and strong affinity for the link with the epithelium and mucous membranes. It is more effective against gram positive than gram negative bacteria compared to fungi and tuberculous bacilli. It is inactive against the spores of bacteria, except at high temperatures;<sup>38</sup> iii) Iodopovidone (10% povidone iodine): contains polyvinylpyrrolidone iodine, soluble in water. It has a bactericidal action and is effective against a wide range of bacteria, fungi and spores. Iodine solutions are not effective in the presence of organic material, pus, slough and necrotic tissue in ulcers;<sup>39</sup> iv) Hydrogen peroxide or hydrogen peroxide: commonly used for the antiseptics of ulcers. However, some studies report its effectiveness in wound healing as an antiseptic, but its use remains controversial. Some studies have shown its cytotoxicity to healthy cells and granulation tissue. Other animal and human studies

have shown no adverse effect on wound healing.<sup>40</sup> Irrigation with physiological solution is recommended immediately after the use of hydrogen peroxide.

In the literature, a detergent solution is defined as a non-toxic substance for human tissues, effective in the presence of organic material, capable of reducing the number of microorganisms, insensitive, widely available, with a good cost-effective, stable ratio.<sup>40</sup>

However, it is argued that any antimicrobial irrigation effect is probably due to the physical action of the fluid rather than its possible antimicrobial effects. In fact, most antiseptics require to be in contact with bacteria inside the wound for longer than that allowed for irrigation.<sup>41</sup> It has also been suggested that the effectiveness of cleansing should be attributed to the actual physical action of cleaning thanks to which the undesirable material is removed and removed from the wound bed rather than the type of solution used. For this reason, the objective of the different cleaning methods should promote the induction of an adequate hydraulic force capable of overcoming the adhesive forces that keep bacteria and contaminants attached to the wound surface.<sup>36</sup>

From the available literature, it emerges that the most commonly used cleaning techniques are: i) Irrigation: can be performed with a variety of aids such as syringes, pouches, sprays which have the purpose of introducing the cleaning solution or water with sufficient pressure to remove cellular debris, bacteria and dressings residues. The easiest way to obtain an adequate washing pressure is to use a 30mL syringe with an 18-20-gauge needle. In this case, in addition to the precautions for the needle, care must be taken not to exert too much pressure because this can be harmful to the fabric and because the operator can be hit by the return spray. Spray containers with manual or pressure dispenser are more practical even if more expensive. In general, when using irrigation cleaning, the hygiene rules, for the prevention of contamination of personnel and the environment, must be scrupulously respected.<sup>30</sup> There are many other wound irrigation procedures such as the bulb syringe, high pressure washing, pulsatile washing devices but they are expensive, bulky and difficult to keep sterile. Irrigation must balance the cleaning effect on the one hand and the possible secondary tissue trauma at too high a pressure level on the other: we therefore speak of *safe and effective irrigation pressure*.<sup>40</sup> Wound irrigation represents an important activity aimed at reducing the risk of wound infection, however there are no official evidences and recommendations that describe the method of execution in terms of irrigation methods, solutions and volumes of detergents to be used; ii) Diving: expensive but effective technique. The patient is immersed with the affected part (more often the lower limbs) in special tanks where the water, sometimes added to antiseptics, is stirred with forced movement so as to facilitate the removal of the devitalized

tissue and made less adherent by the use of occlusive dressings;<sup>41</sup> iii) Tamponade: most frequently used since it is the fastest. Usually, gauze or cotton swabs soaked in the solution are used and cleansing is done by tamping or rubbing the ulcer. In this method, the removal of debris and dressing residues occurs, mostly mechanically; therefore, care must be taken not to damage the tissues.<sup>1</sup>

Particular consideration should be given to the temperature of the washing solution. In fact, in order not to cause damage to the mitotic activity of the cells, the washing temperature should be between 28 and 30 degrees centigrade. In a 1982 Myers study it was found that after a bath at a temperature below 28 degrees centigrade it takes 40 minutes to recover the initial temperature and the cell division is blocked for at least 3 hours. In addition, the application of cold detergent solution can cause vasoconstriction, with a decrease in the nutritional supply to the tissue, as well as the appearance of painful sensation.<sup>42</sup>

In this regard, Barnes *et al.*<sup>43</sup> set out to research the recommendations currently available for this issue with the aim of standardizing the practice of wound irrigation. In this regard, the American College of Surgeons defines irrigation pressure as *high* as a pressure between 15 and 35 psi, low pressure if between 1 and 15 psi. Numerous studies have been carried out to evaluate the optimal pressure required for wound irrigation and most of them have shown that high pressure irrigation is more effective in removing bacteria from the wound bed. However, the high irrigation pressure has also been associated with a greater risk of damage to the tissue and the propagation of bacteria deeper; for this reason, it should be avoided in lesions where the risk of contamination is high and the difficulty in removing bacteria is foreseeable.

There are no references in the literature on the optimal irrigation pressure values. In any case, the literature recommends the use of a pressure between 8 and 12 psi in traumatic wounds to overcome the adhesive force of the bacteria.

However, there are no recommendations on the use of a pulsate or continuous irrigation mode and in terms of the volume of detergent to be used for optimal irrigation of the wound.

As regards the cleaning fluids, the physiological solution represents the most commonly used detergent. Nonetheless, numerous detergents, commonly grouped in the categories of antibiotics, surfactants and antiseptics, have been combined with irrigation fluids in order to optimize the prevention of wound infections.

Antibiotics are very frequently used as additives to the irrigation fluid despite the lack of evidence that supports their use and the numerous studies that suggest their use with deleterious consequences while promoting bacterial resistance.

Surfactants are additives designed to facilitate the re-

moval of bacteria from the wound but interfere with their ability to adhere to surfaces.

Antiseptics exert their bactericidal power by damaging the bacterial cell and membrane. Povidone iodine is the most commonly used antiseptic despite the scarce evidence that supports its effectiveness. It is also toxic to tissue cells, delaying and weakening wound healing, particularly if used at high concentrations.

Some studies have shown that povidone iodine, like other disinfectants, can be diluted sufficiently to mitigate its toxic effect without eliminating its bactericidal power.

Barnes *et al.*<sup>43</sup> point out that the only antiseptic currently approved by the Food and Drug Administration (FDA) for debridement and wound cleaning is an irrigation fluid containing sterile water and 0.05% Chlorhexidine Gluconate (CHG).

The authors conclude that wound irrigation plays a key role not only to reduce the risk of wound infection but also to reduce bacterial resistance, avoiding the need for more aggressive post-infection treatment (*e.g.* removal of implants, insertion of central and peripheral venous lines for the infusion of antibiotics systemically, etc.), also containing the costs for the healthcare company.

Finally, the authors recommend that you deepen the topic of infection prevention in order to standardize the type of irrigation solution, the volume and the method to be used for optimal irrigation of the wound bed.

The authors conclude that there is sufficient evidence that does not recommend antibiotic solutions for wound irrigation and that expert opinion could instead be used to guide best practices.

The management of ulcers involves many professional figures who must collaborate to achieve goals in the field of wound healing, but often ulcers are considered as a pathology in themselves and not as a secondary manifestation of a pathology of which it is a sign or symptom.

Furthermore, being operators specialized in emergencies, we find ourselves in difficulty in managing ulcers as there is a lack of training with respect to wound care. Specifically, cleansing is considered a routine intervention that is carried out with sterile physiological solution through the tamponade method, this because the literature does not provide satisfactory research in the context of the use of tap water.

Furthermore, in the ward practices the physiological solution is considered as the only existing detergent, even if it is not determined by a scientific rationale but mostly by practical reasons and by the operators' habits.

From our review, it emerged that the physiological solution is, in all probability, the most applied cleaning agent in the world, is isotonic with the wound fluids and for this reason it does not yield or subtract liquid from the wound; this characteristic allows it, on the one hand, to fully exercise the mechanical action of cleaning the wound, but

on the other hand, it makes it an expensive and mainly hospital management product.

The randomized clinical trial by Griffiths *et al.*<sup>13</sup> compared the effects of tap water and normal saline solution on the cure and infection rates of acute and chronic wounds.

The trial was conducted in two metropolitan community health centers in New South Wales, Australia. Thirty-five patients with 49 acute or chronic wounds were randomized to receive wound irrigation with saline or tap water. The statistical analysis showed that there was no significant difference between the infection and the cure rates in wounds irrigated with saline or tap water. Although the small sample size is a limitation of this study, the researchers conclude that drinking tap water appears to provide a safe alternative to normal saline wound cleaning solution and may be preferred by some patients.

However, the decision to use tap water must take into account the quality of the water, the nature of the injury and the general condition of the patient. Furthermore, according to the authors in future studies, the characteristics of the participants, of the water, the duration of the cleaning process, the volume of the liquid of the detergent used, as well as the tools and the cleaning method should be uniform. In the absence of drinking tap water, the cooled boiled water or distilled water can be used as wound cleansers.

In the study by Moore *et al.*,<sup>20</sup> on the other hand, the solution containing aloe vera and the physiological solution are compared. Treatment with solution containing aloe vera produced statistically significant results compared to treatment with physiological solution or tap water. In addition, as regards the technique, pressure ulcers cleaned with pulsatile washing reported a statistically significant reduction in the volume of the ulcer compared to the simulation group.

In the study of Romanelli *et al.*<sup>24</sup> the surface pH of venous ulcers treated with prontosan was compared with the surface pH of venous ulcers treated with saline. The lesions cleaned with prontosan reported a significant improvement in the control of the bacterial load and in the reduction of the pH of the lesion surface.

However, the selected sample was small and it was not possible to make the objective improvement in the wound healing rate clearly evident. In this regard, the authors conclude that the size of the wounds for both treatment samples has remained unchanged, postponing the evaluation of the pH associated with other indicators of evaluation of ulcerative wounds to future studies.

In the study of Moscati *et al.*<sup>17</sup> the infection rates of simple wounds, which need to be sutured, irrigated with tap water or with saline solution within an emergency department were compared with each other reporting the same infection rate in both treatment groups. Compared to the physiological solution, tap water for wound irriga-

tion seems to be more convenient and equally safe and effective, reevaluating it especially in the contexts of the emergency departments as a valid alternative to the physiological solution.

However, the data collected in the study should be carefully considered, as any indications in the management of ulcerative wound with tap water at home have not been described. Furthermore, the administration of the telephone questionnaire for the evaluation of the infection indicators is not the most suitable tool for measuring the outcomes of the study.

Mak *et al.*<sup>25</sup> compares the method of cleansing pressure irrigation with that of swabbing in wounds that heal by secondary intention. The authors demonstrated that pressure irrigation applied to wounds that heal by secondary intention is safer, more convenient and reduces wound healing times. However, the samples obtained were not homogeneous and not very balanced due to the different etiologies. As regards pain, greater satisfaction has been reported in patients in the group treated with pressurized irrigation. No clinically important difference in wound infection rates between the two groups was reported.

The New South Wales Center for Evidence Based Nursing & Midwifery in collaboration with the Joanna Briggs Institute conducted a systematic review<sup>26</sup> reporting the effectiveness of the solutions, as well as the cleansing and pressure technique to be applied in wound cleansing. All this has shown that tap water is recommended only if it is drinkable in the cleansing of lacerations, sutured surgical wounds and in case of chronic wounds. In addition, boiled and cooled water is recommended as a viable alternative for cleaning wounds. In addition, the review highlighted how to shower by wetting the surgical wound does not increase the risk of infection nor slow down the healing process but promotes the patient's well-being. As regards the use of povidone iodine, the latter can be used to cleanse contaminated wounds but rinsing is recommended afterwards.

The review recommends exerting pressure during the cleansing of 13 psi, considered effective in reducing the infection in case of traumatic wounds and lacerations.

The study conducted Barnes *et al.*<sup>43</sup> reports that the optimal pressure necessary for the cleansing of acute wounds is high pressure irrigation. However, the high irrigation pressure has also been associated with a greater risk of damage to the tissue and of the propagation of bacteria deeper: for this reason it should be avoided in injuries where there is a high risk of contamination and difficulty in bacteria removal.

The study by Khan *et al.*<sup>27</sup> reported information on the use of antiseptics, especially povidone iodine which, in the management of acute wounds, remained an inhibitory substance for the growth and development of pathogenic microorganisms.

Povidone iodine contains polyvinylpyrrolidone which

is a water-soluble iodine complex in 10% solution with water. It has a bactericidal and effective action against a wide range of bacteria, fungi and even spores. Its bactericidal action takes place in a few seconds by inactivating the cytoplasmic substrates, which are necessary for the life of the bacteria. The presence of organic matter has a depressive effect on iodine concentrations. In the absence of disinfection inhibitors, it acts in 10 seconds.

However, in the study by Robert *et al.*,<sup>44</sup> no negative effects of povidone iodine were reported and the infection rate of the lesions treated with the latter was lower than in the control group.

## CONCLUSIONS

The technique and cleaning solutions used for wound cleansing remain an open and unsolved debate. The routine of wound cleansing varies from country to country, hospitals and departments, and very often both the choice of the cleaning liquid and the cleaning technique to be used is not motivated by a real scientific rationale but only by practical reasons and habit of the operators.

In fact, there are no guidelines regarding an optimal irrigation pressure value, however the literature recommends the use of a pressure that varies between 8 and 12 psi in traumatic wounds to overcome the adhesive force of the bacteria.

And yet, there are no recommendations regarding the use of a pulsatile or continuous irrigation mode and in terms of the volume of detergent to be used for optimal irrigation of the wound.

As regards the cleaning fluids, the physiological solution represents the most commonly used detergent. Nonetheless, numerous detergents, commonly grouped in the categories of antibiotics, surfactants and antiseptics, have been combined with irrigation fluids in order to optimize the prevention of wound infections.

It is argued that cleansing should include both the technique and the solution and the tools, however the scientific literature of the sector currently offers little evidence to clearly understand which is the most suitable type of solution and cleaning technique, nor is there a consolidated basis of scientific consensus on the criteria for the use of fluids.

The ideal cleaning agent should not be toxic or allergenic, remain active in the presence of organic material, be able to dilute the microbial load, cheap and easy to store.

However, the simultaneous presence of all these characters is particularly difficult to find in a single fluid.

According to the indications that emerged from the literature studied, the implementation of cleansing in wound management must first of all provide for a training project aimed at the whole multi-professional team, whose development must be supported not only by the individual pro-

fessional but also by the organizational policy. In particular, the implementation program will: i) provide for a training event with presentation of didactic and multimedia contents that contrast the cleansing with physiological solution currently in use in the operating unit with tap water and povidone iodine proposed by the literature; ii) provide indications on how to obtain crucial information in the field of the technique to be used by contrasting the tamponade technique, with the pressurized irrigation technique with a 30 ml syringe and 18 gauge cannula needle (the cheapest irrigation method available in the department to ensure pressure greater than 8 psi); iii) provide didactic reference material readily available for consultation; iv) promote the use of the computerized injury assessment form recently introduced in the ward by making available computer stations positioned on trolleys, allowing greater accessibility to patient information and the electronic instrument.

Finally, it will be important to accompany professionals in the application of the new cleaning technique and the use of new detergents throughout the training course. To this end, it is important to identify a nurse specialized in wound care in order to provide all team members with support to deal with any critical situations.

Once the new cleansing techniques have been implemented, it would be interesting to see if they are actually used continuously in daily practice and if such application determines an improvement in the wound healing process, continuity of care in wound management, as well as an increase in patient satisfaction and healthcare workers. To do this, data collection should be organized before and after the introduction of new detergents and new cleaning techniques.

In conclusion, to work all this requires the effort and collaboration of all the staff.<sup>45</sup>

## REFERENCES

1. Monti M (ed). [L'ulcera cutanea - Approccio multidisciplinare alla diagnosi ed al trattamento.] Milano: Springer Verlag; 2000. [In Italian].
2. Vowden K. VPB. Bridging the gap: the impact of patient choice on wound care. *J Wound Care* 2006;15:143-5.
3. Lindholm C, Bergsten A, Berglund E. Chronic wounds and nursing care. *J Wound Care* 1999;8:5-10.
4. Ricci E, Cassino R. [Piaghe da decubito.] II ed. Torino: Minerva Medica; 2004. [In Italian].
5. Dowsett C, Claxton K. Reviewing the evidence for wound bed preparation. *J Wound Care* 2006;15:439-42.
6. Preece J. Development of a wound-management formulary for use in clinical practice *Prof Nurse* 2004;20:27-9.
7. Lindholm C, Bergsten A, Berglund E. Chronic wounds and nursing care. *J Wound Care* 1999;8:5-10.
8. Fernandez R, Griffiths R. Water for wound cleansing. *Cochrane Database Syst Rev* 2008;1:CD003861. doi: 10.1002/14651858.CD003861.pub2

9. Goldberg H, Rosenthal S, Nemetz J. Effect of washing closed head and neck wounds on wound healing and infection. *Am J Surg* 1981;141:358–9.
10. Riederer SR, Inderbitzi R. Does a shower put postoperative healing at risk? *Der Chirurg* 1997;68:715–7.
11. Neues C, Haas P. Modification of postoperative woundhealing by showering [Beeinflussung der postoperativen Wundheilung durch duschen]. *Der Chirurg* 2000;71:234–6.
12. Angeras MH, Brandberg A, Falk A, Seeman T. Comparison between sterile saline and tap water for the cleaning of acute traumatic soft tissue wounds. *Eur J Surg* 1992;158:347–50.
13. Griffiths RD, Fernandez RS, Ussia CA. Is tap water a safe alternative to normal saline for wound irrigation in the community setting? *J Wound Care* 2001;10:407–11.
14. Bansal BC, Wiebe RA, Perkins SD, Abramo TJ. Tap water for irrigation of lacerations. *Am J Emerg Med* 2002;20:469–72.
15. Godinez FS, Grant-Levy TR, McGuirk TD, et al. Comparison of normal saline vs tap water for irrigation of minor lacerations in the emergency department. *Acad Emerg Med* 2002;19:396–7.
16. Valente JH, Forti RJ, Freundlich LF, et al. Wound irrigation in children: saline solution or tapwater? *Ann Emerg Med* 2003;41:609–16.
17. Moscatti RM, Mayrose J, Reardon RF, et al. A multicentre comparison of tap water versus sterile saline for wound irrigation. *Acad Emerg Med* 2007;14:404–10.
18. Museru LM, Kumar A, Ickler P. Comparison of isotonic saline, distilled water and boiled water in irrigation of open fractures. *Int Orthop* 1989;13:179–80.
19. Tay SK. Is routine procaine spirit application necessary in the care of episiotomy wound? *Singapore Med J* 1999;40: 581-3.
20. Moore ZE, Cowman S. Wound cleansing for pressure ulcers. *Cochrane Database Syst Rev* 2013;3:CD004983. doi:10.1002/14651858.CD004983.
21. Bellingeri A, Forma O, Polignano R, Attolini R, Accardi S, Fabbri C, et al. Multi-centre research on a cleanser for cutaneous wounds. *Wound Repair and Regeneration* 2003;11:A36. In: Moore ZEH, Cowman S. Wond cleansing for pressure ulcers. *Cochrane Database of Systematic Reviews* 2005;4:108. doi: 10.1002/14651858.CD004983.pub2
22. Van Der Cammen TJM, O'Callaghan U, Whitefield M. Prevention of pressure sores, a comparison of new and old pressure sore treatments. *Br J Clin Pract* 1987;41:1009-11.
23. Hartman D, Coetzee JC. Two US practitioners' experience of using essential oils for wound care. *J Wound Care* 2002;11:317-20.
24. Romanelli M, Dini V, Barbanera S, et al. Evaluation of the efficacy and tolerability of a solution containing propyl betaine and polihexanide for wound irrigation. *Skin Pharmacol Physiol* 2010;23:41-4. doi: 10.1159/000318266.
25. Mak SS, Lee MY, Cheung JS, et al. Pressurised irrigation versus swabbing method in cleansing wounds healed by secondary intention: a randomised controlled trial with cost-effectiveness analysis. *Int J Nurs Stud* 2015;52:88-101. doi: 10.1016/j.ijnurstu.2014.08.005.
26. Joanna Briggs Institute. Solutions, techniques and pressure in wound cleansing. *Nurs Stand* 2008;22:35-9.
27. Khan MN, Davies CG. Advances in the management of leg ulcers – the potential role of growth factor. *Int Wound J* 2006;3:113-22. doi: 10.1111/j.1742-4801.200211.x
28. Longmire JL, Albright KL, Lewis AK, et al. A rapid and simple method for the isolation of high molecular weight cellular and chromosome-specific DNA in solution without the use of organic solvents. *Nucleic Acids Res* 1987;15:859. doi:10.1093/nar/15.2.859
29. Chisholm CD, Cordell WH, Rogers K, Woods JR. Comparison of a new pressurized saline canister versus syringe irrigation for laceration cleansing in the emergency department. *Ann Emerg Med* 1992;2:1364–7.
30. Morse J, Miles M, Clark D, Doberneck B. 'Sensing' patient needs: Exploring concepts of nursing insight and receptivity used in nursing assessment. *Sch Inq Nur Pract* 1994;8:233–55.
31. Weller K. In search of efficacy and efficiency. An alternative to conventional wound cleansing modalities. *Ostomy Wound Manage* 1991;37:23–8.
32. Hollander JE, Valentine SM, McCuskey CF, et al. The Stony Brook Wound Registry Study Group. Long-term evaluation of cosmetic appearance of repaired lacerations: validation of telephone assessment. *Ann Emerg Med* 1998;31:92-8.
33. Fraser I, Askew A, Biles J, Pinchin J. Prospective randomized controlled trial of early postoperative bathing. *Br Med J* 1976;1:1506–7.
34. Burke DT, Ho CH, Saucier MA, Stewart G. Effects of hydrotherapy on pressure ulcer healing. *Am J Phys Med Rehabil* 1998;77:394-8.
35. Lawrence JC. Wound irrigation. *J Wound Care* 1997;6:23-6.
36. Atiyeh BS, Dibo SA, Hayek SN. Wound claesing, topical antiseptics and wound healing. *Int Wound J* 2009;6:420-30. doi: 10.1111/j.1742-481X.2009.00639.x.
37. Thomas GW, Rael LT, Bar-Or RBS, et al. Mechanisms of delayed wound healing by commonly used antiseptics. *J Trauma* 2009;66:81-91. doi: 10.1097/TA.0b013e31818b146d.
38. Meijers JMM, Jos MGA, Pam AJMP, et al. Differences in nutritional care in pressure ulcer patients whether or not using nutritional guidelines. *Nutrition* 2008;24:127-32.
39. Rodeheaver GT. Pressure ulcer debridement and cleansing: A review of current literature. *Ostomy Wound Manag* 1999;45:80S–85S.
40. Flanagan M. Wound management. Edinburgh: Churchill Livingstone 1997.
41. Furlini S, Somà K. [Lettura della ferita. Trattamento locale-metodologia di approccio alla lcc: l'importanza di adottare un metodo di lavoro.] Available from: <http://www.lesioncutaneeecroniche.it/TRATTAMENTOLOCALE%20C/D/PDF/lettura.pdf> [In Italian].
42. Myers JA. Modern plastic surgical dressing. *Health Society Service Journal* 1982;4:336-7. In: Grainger AN. *Essential Practice for healthcare Assistants*. Mark Allen Healthcare Limited; 2009.
43. Barnes S, Spencer M, Graham D, Jonhson HB. Surgical wound irrigation: a call for evidence-based standardization of practice. *Am J Infect Control* 2014;42:525-9. doi: 10.1016/j.ajic.2014.01.012.
44. Robert IB. Povidone-Iodine Solution in Wound Treatment. *Phys Ther* 1998;78:212-8.
45. Vitale, E. Clinical teaching models for nursing practice: a review of literature. *Prof Infer* 2014;67:117-25. doi: 10.7429/pi.2014.672117.