

**ADVANCED THERAPEUTIC APPROACHES  
TO SORES AND BURNS IN CHILDREN**

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**Summary**

In our daily practice in the Surgical Emergency Unit of the Giannina Gaslini Institute of Genoa we treat different types of burns of different extension and depth, and bedsores, which have recently increased because of the improved paediatric surgery and resuscitation techniques. Advanced dressings offer effective support improving the quality of our work in terms of treatment duration, aesthetic and functional results, reduction of the patient's anxiety and pain, and reduction of the personnel's workload.

The aim of this paper is to describe our experience in the use of advanced dressings as compared to the conventional ones and to analyse critically their potential applications in different lesions. The results of this study suggest the use of the products most adequate to the different conditions observed in clinical practice.

**Key words:** burn, paediatric, advanced dressings, burn treatment, paediatric surgery

**Introduction**

In the 60s/70s, burns were treated mainly in dry environment, since it was thought to favour wound healing by preventing the bacterial colonization. Actually, dehydration reduces the cell vitality and slackens the cicatrization processes. For several years, a moist environment has been maintained on burns or sores to favour the appearance of a good granulation tissue and the subsequent tissue repair. This new approach introduced the first dressings consisting of polyurethane sponge, followed by more advanced and effective dressings aimed at creating a barrier against bacterial penetration and a favourable environment for tissue repair (1-2).

### Materials and methods

The new biomaterials (*Advanced Wound Care*) have almost completely replaced those used beforehand and present many advantages: 1) they create a microenvironment favouring wound healing; 2) they reduce to a minimum the loss of fluids; 3) they regulate the gaseous exchange; 4) they drain the exudates; 5) they decrease the risk of bacterial contamination even reducing the number of necessary dressings; 6) they favour the removal of the necrotic tissue (avoiding invasive surgical escharectomy) while preserving the newly formed tissue(1,2). These peculiarities allow the minimization of pain and discomfort for the patient and the rationalization of human resources (doctors and nurses) and financial resources. For this reason, though more expensive, these new dressing are characterized by a more favourable cost/benefit ratio (3-4-5-6).

Our daily experience in the Surgical Emergency Unit of the Giannina Gaslini Institute of Genoa includes the treatment of many types of burns, different in depth and extension, and of bedsores, that are more frequent today because of the improved surgical and resuscitation techniques (7-8).

**First dressing.** The first dressing of burns of any degree and extension includes the application of a hydrogel, a new product with immediate effectiveness available in different forms: gel, spray or sponge. The most common form is an easily removable sponge impregnated with a highly viscous gel with 95% water concentration. This dressing avoids the deepening of the lesion, cools the affected surface and maintaining it moist, and induces a cool sensation, and consequently a reduction of the pain, which is very important in paediatric age.

**First degree burns.** First degree erythematous lesions (sunburn, contact burns, e.g. with jellyfish, etc.) benefit from the application of emollient preparations such as seaweed glycerine, cortisone cream (beclomethasone + neomycin) mainly in case of prevalent inflammatory component, and hydrogel (9).

**Superficial second degree burns.** Many products can be used on these lesions and each of them has both pros and cons. Here a short survey of the products we have been using in our experience.

- *Porcine lyophilised skin.* Even though it is an old preparation, it is extremely effective since it avoids the loss of fluids and external contamination, reduces pain, and can easily be adapted to any surface. It is frequently the only dressing applied until healing, with optimal results and minimal discomfort for the patient. It is not expensive, but religious and cultural reasons limit its use (10). Porcine skin can be replaced with:
- *Microfibril hemicelluloses.* Hemicelluloses must be applied, after complete wound cleaning, using a moist flock, since in its original

form it is neither handy nor malleable. It is not permeable to water or bacteria and being transparent, it allows monitoring of wound healing (11).

- Hyaluronic acid. It allows a short-term wound healing. Hyaluronic acid membranes are available in pharmaceutical forms prepared for superficial burns (only membrane) and for deeper burns or escharectomized surfaces, with silicone support. Hyaluronic acid is normally present in the tissues of many organs and systems (vitreous humour, synovial fluid) and influences the cell migration, the proliferation of fibroblast, and the neoangiogenesis, thus favouring healing. In case of superficial second-degree burns, a hyaluronic acid membrane moistened with physiological solution can be used. This membrane is quite stiff and not very handy: it cannot be applied onto infected lesions, but allows the monitoring of wound evolution since it is transparent. One single dressing is often sufficient for healing (12-13-14-15).
- Hydrocolloids in polyurethane sponge. These dressings can be adhesive or non adhesive, enriched with silver ions or not. They are generally very effective in the exudates absorption and, in traditional forms enriched in silver, in the antiseptic action. However, they do not allow monitoring of wound evolution and are difficult to remove, especially when having adhesive margins.
- Equine collagen with antibiotic. We use it on deep sores. Though not handy (stiff), it has a very good haemostatic action, a good bactericidal effect even on resistant strains (it contains gentamycin), and guarantees optimal tissue regeneration, with complete re-absorption in 3-4 weeks. It is very expensive however (16-17-18).
- Povidone-iodine gauzes. They have mainly an antiseptic action thanks to the iodine proximate principle and are not expensive. However, their application is painful and more dressings are required (19).
- Lipidocolloid. They have the same features as non-adhesive fat gauzes, however, though easily adapted to surface, they are neither very effective nor handy, since they adhere repeatedly to sterile gloves when the latter are not abundantly moistened with physiological solution (20-21-22).

**Deep second degree burns.** We mainly use three products, that is to say hyaluronic acid, silver hydrofiber, and silversulphadiazine.

- Hyaluronic acid. On deep burns, a hyaluronic acid membrane with silicone support is successfully used. On lesions with limited extension, it allows direct healing, while in more extended lesions it favours the escharectomy and acts as a temporary coverage before grafting. The absorption is obtained through the gelatinisation of the substance, which becomes greenish. The removal is completely painless. It is contraindicated: 1) in case of presence of infection on

application surface, 2) because it is prepared with benzyl alcohol, for which adverse reactions have been described in the literature. It is therefore necessary to use an amount of product proportional to patient's body weight. In our experience we have always monitored the patient's haematological conditions and we never experienced any adverse reaction.

- *Silver hydrofiber.* For deep second degree burns with signs of infection, a hydrofiber with silver ions can be used. This does not require a large number of dressings, since it can be left in site for several days. This dressing is soft, easily applicable, has a very good antimicrobial action, does not macerate the skin surrounding the lesion and allows progressive applications over time. When the healing process is almost complete, its removal can be difficult. Activated charcoal enriched in silver resulted equally effective, but less handy (23-24-25).
- *Silver sulphadiazine.* It is always effective preparation on extended and infected burns; it is composed of silver and sulpha drug and has a wide-spectrum bactericidal action, it is neither toxic and nor too expensive. However, it requires almost daily dressings and wound cleaning, which is very annoying for the patient, and cause an excessive workload for the personnel (26).

**Third degree burns.** Deep and extended second degree burns or third degree burns require surgical treatment such as early escharectomy, temporary coverage with for instance with hyaluronic acid on silicone film, and surgical grafting with whole or mesh-grafted free flaps sampled from available donor areas (27).

When the burn extension does not leave sufficient free areas, in vitro cultivated derma and autologous keratinocytes can be used.

In 1986, we tested this technique for the first time in Italy. The Cell Differentiation Laboratory of the Cancer Institute of Genoa prepared keratinocytes. In those first grafts, keratinocytes were put onto gauzes impregnated with petroleum jelly and fixed by grafts. The first results were very successful as to take percentage and aesthetic outcome, while subsequent experiences were less successful. In a subsequent phase, we used keratinocytes laid onto a layer of human fibrin glue.

In severely deep and extended burns, we presently use autologous derma cultured in vitro, obtained from the classic 2 cm<sup>2</sup> bioptic sampling, and, later on, we graft keratinocytes cultivated in vitro. In those cases, keratinocytes are put onto a hyaluronic acid film.

In our experience, after this preparation the derma appears resistant, handy and with good take abilities. Grafts with keratinocytes alone generally allow partial take (30-40%), but results improve considerably using mixed grafts of free flaps and 1/9-1/6 mesh-grafts on which cultivated keratinocytes films are laid (90-100% take).

The use of grafts with derma and autologous keratinocytes cultivated in vitro allows not to use donor areas and yields good aesthetic results; on the other hand, these grafts deteriorate very quickly, grow slowly, and are extremely expensive.

### **Discussion**

The therapy of burns in the last few years presented a progressive evolution and today we can use innovative materials and biotechnologies. The traditional dressings have been integrated with others that paved the way for new therapeutic perspectives: it is the case of in vitro cultivated autologous keratinocytes.

Each treatment is aimed at obtaining the best possible result in a short time. We have not abandoned the use of porcine skin in superficial second degree burns, but the presence of patients with different cultures and religious beliefs does not allow the constant use of this dressing, which is successfully replaced by others (hemicelluloses, hyaluronic acid film or polyurethane sponge). In non-infected deep second-degree burns or limited third degree burns, we obtained good results with a hyaluronic acid product supported by a silicone membrane. When coming into contact with the exudates, hyaluronic acid gelatinises thus cleaning the wound, softening the eschar, and arranging connective fibbers correctly; in some cases it even allows spontaneous healing, or it prepare a good recipient bed for traditional graft. The silicone membrane preserves the sore from external contamination.

In case of infected lesions, we can use a carboxymethylcellulose membrane enriched with silver ions; silver sulphadiazine is always valid, though presenting the limits connected with the need of frequent dressings.

In case of extremely severe deep and extended burns, we resorted to the application of derma and autologous keratinocytes cultured in vitro.

Last year, we had to treat lesions extended to about 50% of the skin surface in a child aged < 1 year with purpura fulminans, which is the dramatic skin manifestation of pneumococcal meningitis. The treatment included all the above-mentioned dressings and determined patient's recovery.

### **Conclusions**

The use of modern advanced preparations allows the improvement of our job in terms of wound healing time, aesthetic and functional

results, and reduction of anxiety and pain for the patient and of workload for the personnel.

These results represent important stages that cannot be considered definitive however but must be the starting point for further development.

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