

## PEDIATRIC BURNS AND SCALDS - MODERN THERAPEUTIC CONCEPTS

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### Abstract

Burns and scalds are the second most frequent cause of accidents in children. In contrast to adults children usually suffer from hot water scalding and not flame burns. The treatment of burn wounds is subject to a defined management which can be divided into preclinical treatment, emergency room management, and the clinical phase. The initial therapy consists of pain management and maintenance of vital functions. During the first days of further treatment of larger burns, management of the massive fluid loss due to capillary leakage is important to avoid secondary organ damage. Later, avoidance or timely treatment of bacterial infections and the management of wound healing are core issues to achieve a good outcome. The management of fluid shifts and wound treatment are significantly different for children compared to adults and considerable experience is needed to guide therapy. Optimal treatment is best achieved in centres specialized in pediatric burns. Prevention is achieved through passive measures to enhance safety and active education of parents regarding mechanisms and risks for pediatric burn accidents.

**Key words:** burns scalds, preclinical treatment, analgesia, pediatric burns unit, occlusive dressing, surgical treatment prevention.

### Introduction

Burns and scalds are the second most frequent cause of accidents in children. In contrast to adults children usually suffer from hot water scalding and not flame burns. The treatment of burn /scald wounds is subject to a defined management which can be divided into preclinical treatment, emergency room management, and the clinical phase.

Burns of the body's surface have complex pathological effects which can influence numerous body functions even shortly after the accident and which may have severe consequences for the affected patients. The expression "burn disease" describes the pathophysiological condition which patients develop, even when only small areas of the body are affected by burns. The body is subject to multifactorial damage, as a result of the sudden release of vasoactive mediators from the burned body parts, including kinins, prostaglandins, catecholamines, and glucocorticoids. Loss of skin integrity leads to loss of body temperature and in turn to increased energy consumption. Disorders of

capillary integrity ("capillary leak syndrome") lead to volume displacement into the extravascular space. These changes can result in immune deficiency.

Burn injuries in children represent a significant management burden for hospitals committed to this area of specialisation. Ideally all children with major burns should be admitted, without delay, to a pediatric burns unit. The two most important differences between children and adults which influence burns management are the different body dimensions and the psychological immaturity. The effects of major burns on the body are widespread and profound. The larger the surface area involved, the more diffuse is the effect. Extensive burns in children pose a particularly large challenge to the emergency physician. Initially the main focus is on stabilizing vital functions and managing pain. The ensuing physical examination must assess the extent and depth of the burn wounds and identify an inhalation injury.

About 75%-80% of burns are provoked by hot fluids. More dangerous are burns provoked by hot fat or explosions. Small children are extremely in danger because of their lower skin thickness compared to adults. A 54 °C hot fluid affects the whole depth of a small child's skin in 10 seconds, while it needs 30 seconds to do the same damage in an adult patient.

In the presence of a child with burns/scalds there are a few criteria for transporting the patient to a specialized burn center [1,2]:

- Infants and small children with more than 5 % body area 2-nd degree burns and schoolchildren with more than 10 % body area 2-nd degree burns
- Third and fourth degree burns
- Burn which affect the head area, hands, feet or the anal/genital area.
- Electrocutions or chemical burns
- Suspicion of inhalatory trauma
- Association with other kind of trauma in the presence of polytrauma
- Child abuse

If children with severe burns and scalds are timely admitted and treated in a specialized burn centre this leads to shorter hospital stay, fewer complications and therefore a reduction in hospital stay costs [3].

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*First aid*

The first and most important operational maxim is self-protection. Open fire or active power supply lines jeopardize the rescue maneuver. Is it safe to rescue the injured person? If yes, is it possible to rescue the injured person and other endangered persons from the danger zone? First aid consists in taking the victim away from the accident site (dangerous zone), checking of vital signs, removal of clothes and cooling of the burned area to avoid after-burn of deeper skin layers. The cooling should be undertaken with water which has a temperature of 15-20 °C for approximately 10-15 minutes and should be done immediately after the accident (2 to 3 minutes after the accident). If the accident is more than 30 minutes away there is no reason in doing any cooling of the affected area. Cooling is especially effective in the first 20 to 30 minutes after being burned and after this only has an analgetic effect [4]. Cool-packs or even ice are unsuitable, as they can lead to a sustained and harmful decrease in capillary perfusion around the burned skin area [5,6]. An inhalation trauma is present in many patients and this alone increases the mortality rate by a factor of nine[5]. Many patients are often mistakenly cooled during the whole transport and arrive at the burn care center with greatly decreased body core temperature. Special attention should be paid to hypothermia which is especially important in newborns and infants – each grade Celsius of hypothermia increases the overall mortality with 10% [7]. Therefore one can abandon cooling in newborns, infants, patients with affected body area surface > 15% and intubated and ventilated children. After cooling the affected area should be covered with sterile drapes which will keep the body temperature constant (metallic sheet).

At the location of the accident, vital functions, i.v. catheters, fluid management, the decision for intubation, and sufficient pain control are crucial.

During the first examination of the patient the following questions should be asked and answered:

- Is there a a inhalation trauma present?
- Are there any circular burns or scalds on the extremities or torso?
- Are there any lesions affecting the face, eyes, ears, hands, feet or the genital area?
- Is there any chemical or electric burn?
- Is there any suspicion of maltreatment?

*Initial resuscitation and analgesia*

Parallel to cooling, it is necessary to prepare a venous access with as large a lumen as possible, accompanied by fluid therapy with crystalloid solutions according to Baxter (4–8 mL Ringer lactate x kgBW x BS/24 h; BW= body weight, BS= percentage of affected body surface) [8] or using more advanced calculation formulas[8]. Within 30 minutes, the water content in the burn increases by 80%, which can lead to massive redistribution of the body fluid in large burns. If early analgesia with sedation—normally with S-ketamine and

midazolam—is insufficient, or the general condition of the patient deteriorates due to the severity of the inhalation trauma, quick intubation (best before transport) is sensible. The importance of inhalation trauma as a factor determining survival cannot be overstated[10]. Clinical signs for inhalation trauma (IHT) include burns in the area of the face, soot in the oral cavity and in the throat, as well as inspiratory stridor. The classification of severity of the IHT is performed bronchoscopically after admission to the burn care center. In the case of carbon monoxide intoxication, pulse oxymetry supplies falsely high values, as the device cannot differentiate between CO-Hb and oxygenated hemoglobin.

If a venous access is difficult, an intraosseous access must be established.

Analgesia can also be established by applying drugs intranasally or intrarectal. If the burned area is under 10% and the transport to a specialized burn centre will take under 30 minutes there is no need to loose precious time to establish a venous access under difficult conditions.

Analgesia is usually established by the following medication:

|                               |                   |
|-------------------------------|-------------------|
| Ketamin i.v./ intraosseous    | 2-4 mg/ kg        |
| S- Ketamin i.v./ intraosseous | 1,5-3 mg/ kg      |
| Ketamin intrarectal           | 10 mg/ kg         |
| Fentanyl i.v.                 | 0,001-0-01 mg/ kg |
| Piritramid i.v.               | 0,05-0,1 mg/ kg   |
| Midazolam i.v.                | 0,05-0,1 mg/ kg   |

If there are second degree burns and the affected body surface is <10 percent a fluid therapy is not obligatory from the accident scene. If the affected body surface is >10 percent a fluid therapy with isotone crystalloid solutions should be started in a bolus of 20 ml/kgBW. Urine output of 1-1,5 ml/kgBW/h is a good sensor of adequate fluid therapy. Volumes should be modified as necessary to maintain adequate perfusion and urine output, colloidal solutions, cortisone, diuretics and profilactic antibiotics should be avoided during the first 24 hours.

*Affected body surface and degree of burns/scalds*

The affected body surface area and the degree of burns is also critical to establish at the first examination of the patient.

The assessment of the affected body surface is performed by sight. This is best done using Wallace's "Rule of Nine". Here different body areas correspond to a percentage of the body surface (arms and head 9% each, chest/abdomen/back and legs 18% each, palms, including fingers and genital area 1% each). In this context, the rule that the palm size of the patient corresponds to about 1% of his total body surface area (TBSA) is also helpful.

In small children the scheme by Lund and Browder is better suited.

The degree of burns is synthesized in the underlying Figure 1:

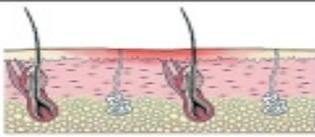
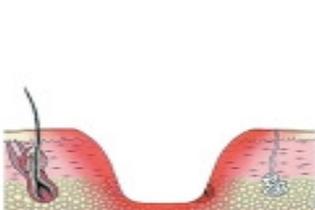
| Degree | Anatomic correlate   | Schematic aspect  | Clinical aspect  |
|--------|--|---|--|
| I      | Reddening, swelling, pain (epidermis)                        |  |   |
| IIa    | Reddening, blistering, pain (superficial dermis)             |  |   |
| IIb    | Pallor, blister, pain (partial dermis)                       |   |   |
| III    | Greyish white or black necrosis, analgesia (complete dermis) |  |   |
| IV     | Carbonization (may extend to the bones and joints)           |   |  |

Figure 1. The degree of burns.

Even specialized plastic surgeons need many years of experience to assess the degree of burns successfully. Cone et al. reported that non-specialist physicians providing first aid wrongly assessed the degree of burns in 75% of cases, whereby in two thirds of all cases the degree of burns was classified as too deep[11]. Blistering (degree IIa), the

whitish discoloration of the insensitive skin in the affected area (degree IIb/III) and black carbonization (degree IV) can help in the rough determination of the degree of burns (Figure 1).

The final degree of burns is hard to establish at first examination (Figure 2 a and b):



Figure 2. a – Child at admission – the burns were classified as grade I to IIb.  
b – Child at 72 hours after accident – the burns were classified as grade IIb and III.

The quantity of administered fluid is also hard to establish in regard to degree of the burns and the affected body surface and studies of Cartotto et al. und Yowler et al. [12, 13] have shown that the Parkland formula is not the ideal instrument, concluding that a close monitoring of urine output is necessary. The same conclusions arise from the study of Jester et al.[14]

After performing life-saving measures, a standardized polytrauma check must be performed while still at the site of accident, in order to be able to detect less obvious injuries.

After initial stabilization the patient should be transported by the quickest way to a specialized centre. Transfer to a center specialized in treating children with burns adheres to predetermined criteria to ensure that the patients receive appropriate further treatment.

As guidelines the following aspects apply to pediatric patients:

- Second degree burns <5% percent can be treated as a outpatient case
- The following patients need admission to the hospital:
  - o Children under the age of 1 year
  - o Second degree burns with BS 5-10% or third degree with BS 1-5 % (medium burns) , respectively second degree burns with BS greater than 10% or third degree with BS greater than 5 % (severe burns)
  - o Burns associated with inhalatory trauma
  - o Electrical burns
  - o Burn which affect the head area, hands, feet or the anal/genital area or respiratory tract
  - o All patients with multiple trauma and burn injuries where the main injury is the burn

The admission of patients to the emergency room should be subject to a standardized protocol, which is quickly and effectively performed by an interdisciplinary team. Emergency room management consists of a mechanical cleaning and subsequent accurate assessment of the extent of the burn injury, monitoring of vital functions, diagnosis and treatment of an inhalation injury as well as associated injuries, and the appropriate care of the burn wounds.

At presentation, the burned child should be managed using a protocol which combines rapid assessment with resuscitation of life-threatening aspects of the injury, before definitive burn wound care commences (Figure 3). Anaesthesia may be required either in the resuscitation phase, in the post-resuscitation phase for debridement and grafting procedures or for plastic surgery in the long-term. Optimal anaesthetic management of these children requires detailed attention to their psychological requirements, and awareness of the influence of the pathophysiology of burns on tolerance of anaesthesia and of the special difficulties associated with airway compromise and massive haemorrhage during debridement.

The affected children should be managed in a well heated emergency room (35-38 °C).

Body temperature at admission should be recorded, a stable venous access should be established (if not already present), blood for analysis should be withdrawn and any hair that stands in the way of proper treatment should be shaved. Swabs from the affected area should be taken and send to laboratory for culture and antibiogram determination (Figure 4). Profilaxis for tetanus should be carried out if it is not present.



Figure 3 – Aspect of a affected child at arrival in the emergency room.



Figure 4 – Necessary equipment in the emergency room.

One specific danger is that a compartment syndrome of the extremities or the trunk may develop from deep dermal burns. For example, the abdominal compartment syndrome has a mortality of over 40%. If this

seems possible, a rapid escharotomy (separation of superficial burned layers of the skin) or even a fasciotomy is carried out (separation including muscle fascia)( Figure 5).



Figure 5 – Escharotomy for circular deep burns of the extremity.

Professional intensive care therapy is a basis for further surgery therapy and plays an important role for the survival of the patient with severe burns. Controlled fluid and electrolyte management with continuous and close meshed monitoring of various laboratory parameters decreases the risk of common complications of the burn injury.

The most common complications are:

- pneumonia
- sepsis,
- lung failure, renal failure
- infection of the wound and
- acute respiratory distress syndrome (ARDS) [15]

Severe complications such as cholecystitis [16] or acute renal [17] and organ failure [18] must be detected early and treated adequately. Due to the necessary analgesia, patients often receive long term respiration. Therefore, the use of a tracheotomy tube is sensible.

In view of the greatly increased nutritional requirements of severely burned patients, appropriate nutrition must be initiated rapidly. The patient loses massive quantities of proteins as part of his burn injury—on the one hand through his burn wounds which release abundant quantities of protein into the bandages and on the other hand through the resulting consumption of available protein depots. Early and adequate provision of proteins not only improves the resulting osmotic gradients from intra- to the extravascular space but also the wound healing competence in affected patients [19]. No clear guidelines are available for the nutrition of pediatric burned patients[20]. Enteral food supply should be targeted as early as possible, in order to avoid regression of intestinal villi[21]. The capillary leak, which is responsible for the massive displacement of fluids, spontaneously ceases after 24 hours. Till then, intensive

fluid therapy must be continued, in order to counteract the increased cardiac output, the reduced perfusion of the kidney, the liver and the intestine, and the rapid increases in hematocrit [5].

#### *Surgical therapy*

First degree burns are treated conservatively by applying locally fatty ointments, for example Bepanthen®.

Second degree burns (IIa) are treated with occlusive dressings like Biatain Ag®, Briobane®, Actcoat /Allevyn®, Urgotuel S Ag®, Contreet®. Each of them has advantages and disadvantages. The dressings are changed every 3 to 4 days under mild sedation and analgesia or anesthesia depending on the extent of the burned area, the type of dressing used, the hospital protocols,etc. The cost factor of occlusive dressings is also to be considered (Figure 6, Figure 7).

For IIb degree burns dermabrasion and application of Suprathel® (polymer related skin substitute) is a good option (Figure 8). The degradation products of SUPRATHEL® stimulate the healing process by supporting the angiogenesis and the re-building of the dermis. The acidification of the wound with SUPRATHEL® has an additional bactericidal effect and thus minimizes the risk of infections. Is also is resorbed in about 6 weeks.

More deeply burned areas (degree III to IV) are initially dressed in a sterile manner after cleaning and are usually treated according to the principle of early tangential excision, i.e. removal of necrotic skin (about three to four days after the accident) with wound cover as soon as possible. For scalds the time interval is 9-12 days sometimes even 21 days after the accident. Different techniques must be considered here.

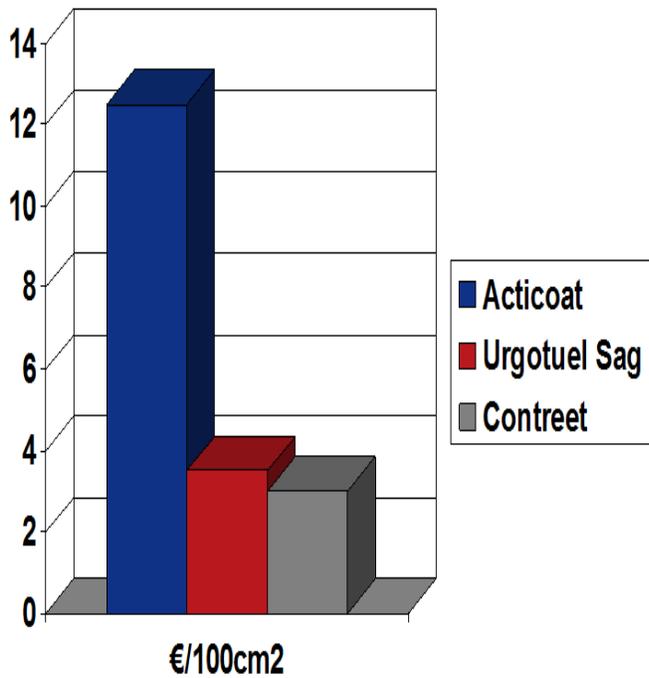


Figure 6 – Comparative costs of occlusive dressings.



Figure 7 – Aspect of a patient after treatment with occlusive dressings.



Figure 8 – Aspects of patient treated with Suprathel®.

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These techniques have to be selected according to the size, texture and thickness of the defect in the soft tissue.

One possibility is to use 0.1 to 0.4 mm split-thickness skin grafts and the area of these can be increased by a lattice (the so-called mesh graft) by a factor of 1:1 to 1:6. The head is therefore an excellent donor area, because of the relative big area of the head in children and also because after growth of hair the scars are no longer visible. Another reason is the rapid healing of the donor site, so that in case of need another skin graft can be harvested from the area in 10-12 days after the primary procedure (Figure 9).



Figure 9 – Intraoperative aspects of split thickness grafts from head area.

"Cultured skin" (keratinocyte transplantation) is used in special cases (burned area over 60 %) when the donor area is too small to conduct autologous skin transplantation [22,23]. As an alternative, cadaver or pig skin can be used, in order to obtain temporary cover when donor areas are inadequate. This cover can later be replaced by autologous skin grafts. This also apply to temporary coverage by use of Integra® or Matriderm®, but high expenses should be taken into consideration. Depending on depth and localization, pedicled or free tissue grafts (flaps) may be used as well[24].

On the throat, in the face, on the hands and over the joints, only cover techniques are used which later lead to satisfactory texture, color, and elasticity of the grafted skin. Thus, stigmatizing scars in visible skin areas are avoided and contractures of the scars near the joints are prevented[25].

#### *Infections*

Bacterial infection is a common complication which can endanger the burned patient and threaten his life. The partially damaged integrity of the skin allows devastating superficial infection which, however, is rarely the direct cause of death. In contrast, if bacteremia and consecutive sepsis develop, mortality greatly increases. 75% of patients with extensive burns die as a consequence of a

severe infection[26]. Invasive forms of infection of subcutaneous tissue layers play an especially important role, as well as surgery-related infections and superficial wound infections. These infections, which are mostly evoked by staphylococci, streptococci and pseudomonads, must be detected without delay and aggressively treated with broad spectrum antibiotics [27,28]. In this context, enterococci of group D and the increasing common colonization with multiresistant bacteria are especially feared. Due to these multiresistant bacteria, the early use of combined broad spectrum antibiotics is necessary. These antibiotics must be administered early at high dosage, in order to protect the life of the patient [29].

#### *Follow up and rehabilitation*

After completion of the intensive care period in extensive burns/scalds, the patients are transferred in-house to a follow-up ward where further wound care, physiotherapy, ergotherapy, and psychiatric care help to maximize the patients' autonomy. Generally, rehabilitation therapy for patients with burn injuries begins on the day of the burn. As soon as possible, rehabilitation measures should be implemented in the therapy. All physiotherapy requires adequate analgesia. Early respiration training deepens inhalation and therefore prevents pulmonary infections. Edema prophylaxis and therapy, scar care, for

example through external agents, compression garments and the specific prophylaxis of scarred contractures in critical locations (throat, face, hands, and joints) are the fundamental pillars of multimodal rehabilitation [30,31,32]. Although physical deficiencies are most important, the diagnosis and treatment of posttraumatic stress symptoms play a significant role in rehabilitation therapy as well [32]. Over 60% of all severely burned patients develop posttraumatic psychological problems [33] which in puberty can sometimes lead to suicide. Therefore, pediatric psychiatrists and psychotherapists should be permanent team members on burn wards.

*Late complications. Secondary Therapies*

Generally in severely burned patients, a differentiation must be made between functional and aesthetic late complications. The extensive and deep loss of skin is the source of most problems. Scarring of areas not given surgery, or scar formation within the graft, lead to symptoms which can affect patients' quality of life. If deep dermal burns are not identified as such and are wrongly given conservative treatment, scar contractures may form. These contractures may lead to disfigurement and/or functional impairment, depending on the localization.

The consequences of the loss of skin and the resulting surgery are more severe: burns and scalds near joints can often make them less mobile. Scarred strands along longitudinal axes over the flexor and extensor sides of joints cause overextension or flexion contractures, preventing adequate mobility. Smaller joints may be permanently and irreversibly damaged by contractures. After the acute phase, this may have to be corrected by plastic surgery. Numerous techniques have been described for the prolongation of scar strands.

In some cases, it may be necessary to pre-stretch healthy adjacent skin (expander). The resulting excess skin can be used to replace the scar strand. As transplanted skin often develops contractures, skin transplantation should not be repeated, as this can lead to relapses.

*Esthetic complications*

In the long term, many patients suffer from their changed appearance. Burns of the face and hands are felt as especially disturbing, as they are continuously visible to other people. Therefore, for example, no meshed split-thickness skin grafts should be used on the face and hands. The donor skin site should have the same texture as the recipient site. For example, a donor site with low pigmentation should be selected for a site with low pigmentation.

Fresh (active) scars are initially given regreasing ointment therapy with simple silicone-based preparations or similar material. In this early stage, the scar tissue should be massaged in a circular fashion several times a day[34]. In this way, consistent orientation of the collagen fibers can be obtained, leading to a softer and flatter scar. The scarred tissue should not be exposed to the sun for at least six months. If necessary, this can be assured by a plaster or a sun blocker with sun protection factor over 50. In the course of treatment, silicone-based plasters may be useful. These lead to softening and flattening of the scar through occlusive hydration of the stratum corneum [35]. Other topical immune modulatory substances, such as retinoids, calcineurin inhibitors and imidazolaquinolines, are also used as external agents for the treatment of hypertrophic scar tissue.

Furthermore, injectable substances such as corticosteroids, 5-fluorouracil, interferons and bleomycin, are used in the local therapy of hypertrophic scars.

**Conclusions**

The therapy of burned patients is classified into five sections:

- Emergency care
- Intensive care burn unit
- Follow-up ward
- Rehabilitation
- Follow-up in the primary care setting.

The first and last of these therapeutic stages, as they are provided by primary care physicians, are of particular importance. Functional and esthetic aspects play important roles in the follow-up by the primary care physician. Scar contractures with functional restrictions must be detected and adequately treated. Normally the patient should be returned to the burn care center which provided initial care, as the physicians there are familiar with the patient and his injuries. Esthetic aspects of the scars can only be treated in close collaboration between primary care physicians and clinics for burn injuries. Scar treatment—often started in the hospital—should be continued and extended by silicone and compression products if this had not already been done. Unstable, painful or esthetically disturbing scars may be treated again by a plastic surgeon. In such cases, after the wound has completely healed, the patient should return to the hospital for plastic surgery.

Prevention of burns and scald plays also an important role. Prevention is achieved through passive measures to enhance safety and active education of parents regarding mechanisms and risks for pediatric burn accidents.

**References**

1. Sheridan LR (1998) The seriously burned child: resuscitation through reintegration, part 1. *Curr Probl Pediatr* 28: 101–132
2. Sheridan LR (1998) The seriously burned child: resuscitation through reintegration, part 2. *Curr ProblPediatr* 28: 132–176
3. Sheridan R, Weber J, Prelack K et al. (1999) Early burn center transfer shortens the length of hospitalization and reduces complications in children with serious burn injury. *J Burn Care Rehabil* 20: 347–350
4. Bartlett N, Yuan J, Holland AJ, et al. Optimal duration of cooling for an acute scald contact burn injury in a porcine model. *J Burn Care Res.* 2008;29:828–834

5. Buhre W, Wappler F. Initial care of the severely burned patient. *Anesthesiol Intensivmed Notfallmed Schmerzther.* 2009;44:100–107
6. Sawada Y, Urushidate S, Yotsuyanagi T, Ishita K (1997) Is prolonged and excessive cooling of a scalded wound effective? *Burns* 23:55–58
7. Lonneck S, Schoder V. Hypothermia in patients with burn injuries: influence of prehospital treatment. *Chirurg.* 2001;72:164–167
8. Baxter CR. Sixth National Burn Seminar. Fluid therapy of burns. *J Trauma.* 1967;7:69–73. [PubMed]
9. Benicke M, Perbix W, Lefering R, et al. New multifactorial burn resuscitation formula offers superior predictive reliability in comparison to established algorithms. *Burns.* 2009;35:30–35.
10. Grunwald TB, Garner WL. Acute burns. *Plast Reconstr Surg.* 2008;121:311e–319e
11. Cone JB. What's new in general surgery: burns and metabolism. *J Am Coll Surg.* 2005;200:607–615
12. Cartotto RC, Innes M, Musgrave MA, Gomez M, Cooper AB (2002) How well does the Parkland formula estimate actual fluid resuscitation volumes? *J Burn Care Rehabil* 23:258–
13. 26Yowler CJ, Fratianne RB (2000) Current status of burn resuscitation. *Clin Plast Surg* 27:1–10
14. Jester I, Jester A, Demirakca S, Waag KL (2005) Not-fallmanagement bei der Primärversorgung kindlicher Verbrennungen. *Intensivmed* 42:60–65
15. Kim GH, Oh KH, Yoon JW, et al. Impact of burn size and initial serum albumin level on acute renal failure occurring in major burn. *Am J Nephrol.* 2003;23:55–60
16. Theodorou P, Maurer CA, Spanholtz TA, et al. Acalculous cholecystitis in severely burned patients: Incidence and predisposing factors. *Burns.* 2009;35:405–411.
17. Mustonen KM, Vuola J. Acute renal failure in intensive care burn patients (ARF in burn patients) *J Burn Care Res.* 2008;29:227–237.
18. Sheridan RL, Ryan CM, Yin LM, Hurley J, Tompkins RG. Death in the burn unit: sterile multiple organ failure. *Burns.* 1998;24:307–311.
19. Gore DC, Chinkes DL, Wolf SE, Sanford AP, Herndon DN, Wolfe RR. Quantification of protein metabolism in vivo for skin, wound, and muscle in severe burn patients. *JPEN.* 2006;30:331–338
20. Strauß JM, Sümpelmann R (2013) Perioperatives Flüssigkeitsmanagement bei Säuglingen und Kleinkindern. *Anesthesiol Intensivmed Notfallmed Schmerzther* 48(4):264–271
21. Chen Z, Wang S, Yu B, Li A. A comparison study between early enteral nutrition and parenteral nutrition in severe burn patients. *Burns.* 2007;33:708–712
22. Dorai AA, Lim CK, Fareha AC, Halim AS. Cultured epidermal autografts in combination with MEEK micrografting technique in the treatment of major burn injuries. *Med J Malaysia.* 2008;63(Suppl A):44.
23. Spilker G, Reifenrath MW, Kaiser HW. Skin cultivation in treatment of severely burned patients. *Langenbecks Arch Chir Suppl Kongressbd.* 1996;113:1149–1155.
24. Iglesias M, Butron P, Chavez-Munoz C, Ramos-Sanchez I, Barajas-Olivas A. Arterialized venous free flap for reconstruction of burned face. *Microsurgery.* 2008;28:546–550.
25. Horch RE, Jeschke MG, Spilker G, Herndon DN, Kopp J. Treatment of second degree facial burns with allografts—preliminary results. *Burns.* 2005;31:597–602.
26. Atiyeh BS, Gunn SW, Hayek SN. State of the art in burn treatment. *World J Surg.* 2005;29:131–148
27. Polavarapu N, Ogilvie MP, Panthaki ZJ. Microbiology of burn wound infections. *J Craniofac Surg.* 2008;19:899–902.
28. Ramakrishnan MK, Sankar J, Venkatraman J, Ramesh J. Infections in burn patients—experience in a tertiary care hospital. *Burns.* 2006;32:594–596
29. Leseva M, Khadzhiski O, Grigorov G, Dimitrova A. The basic principles of the antibiotic therapy of burn patients. *Khirurgiia (Sofia)* 1995;48:8–11
30. Edgar D, Brereton M. Rehabilitation after burn injury. *BMJ.* 2004;329:343–345.
31. Kamolz LP, Kitzinger HB, Karle B, Frey M. The treatment of hand burns. *Burns.* 2009;35:327–337.
32. Esselman PC, Thombs BD, Magyar-Russell G, Fauerbach JA. Burn rehabilitation: state of the science. *Am J Phys Med Rehabil.* 2006;85:383–413.
32. Dyster-Aas J, Willebrand M, Wikehult B, Gerdin B, Ekselius L. Major depression and posttraumatic stress disorder symptoms following severe burn injury in relation to lifetime psychiatric morbidity. *J Trauma.* 2008;64:1349–1356.
33. Reish RG, Eriksson E. Scar treatments: preclinical and clinical studies. *J Am Coll Surg.* 2008;206:719–730
34. Mustoe TA. Evolution of silicone therapy and mechanism of action in scar management. *Aesthetic Plast Surg.* 2008;32:82–92.
35. Berman B, Viera MH, Amini S, Huo R, Jones IS. Prevention and management of hypertrophic scars and keloids after burns in children. *J Craniofac Surg.* 2008;19:989–1006.

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