https://doi.org/10.5272/jimab.2025312.6243

Journal of IMAB. 2025 Apr-Jun;31(2)

Journal of IMAB
ISSN: 1312-773X
https://www.journal-imab-bg.org

Original article

THERAPEUTIC APPROACH IN EXTENSIVE BURN INJURIES

Vania Anastasova[1], Elean Zanzov[1], Karina Ivanova[1], Petar Kiskinov[1], Elena Krasteva[1], Biser Ivanov[2]

1)Department of Plastic, Reconstructive, Aesthetic Surgery and Thermal Trauma, Medical Faculty, Medical University of Plovdiv, St George University Hospital, Plovdiv, Bulgaria.

2)Department of Pediatric Surgery, Medical Faculty, Medical University of Plovdiv, St George University Hospital, Plovdiv, Bulgaria.

ABSTRACT

Introduction: burns are the fourth most common trauma. Regardless of the percentage, all burns require specialised treatment. Burns over 20% of total body surface area/ÒBSA/ in adults and over 10% in children are called extensive. They require fluid resuscitation and surgical treatment. It is believed that tissue destruction, combined with capillary dysfunction and a pronounced inflammatory response, lead to the development of hypovolemia and thermal shock.

The goal: to validate a protocol for the treatment of extensive burns, including first aid, fluid resuscitation treatment, surgical interventions, rehabilitation, and care for the consequences of burns.

Material and methods: we tracked and compared the extensive burns of two random years, demographics, treatment types and outcome of it.

Discussion: treatment of thermal shock includes proper initial assessment, timely infusion therapy, early surgical treatment and wound covering, rehabilitation and active surveillance. For the outcome of the treatment, the general condition of the patient, the type and depth of the burn, as well as the time of starting the surgical treatment are important. These factors determine the outcome of the treatment, the development of cicatricial tissue and the preservation of the physiological capacity of motion.

Conclusion: extensive burns are a challenge for both plastic surgeons and anesthesiologists. The therapeutic approach follows a certain algorithm depending on many factors.

Keywords: extensive burns, thermal shock, surgical treatment, conservative treatment,

INTRODUCTION

Severe burns are among the most traumatic and debilitating injuries, affecting all organs and systems and resulting in significant morbidity and mortality. In an attempt to improve the treatment of patients with severe burns, as well as to reduce mortality and shorten hospital stays, therapeutic interventions have evolved over the years.

MATERIALS AND METHODS

The present study reviews patients with extensive burns treated at the Department of Burns, Plastic, Reconstructive and Aesthetic Surgery of the St. George University Hospital, Plovdiv, in 2015 and in 2018. All patients with extensive burns, involving over 20 % of total body surface area (TBSA), were recruited in the research. Participants, treated over the two years, were in parallel, assessed and compared based on demographic criteria, extent of burn, application of various dressings, timing and type of surgical interventions, microbiology control, presence of infection, mobilisation and rehabilitation, duration of hospital stay, etc.

Fig. 1. Severe burn injury in a child.

Fig. 2. Necrotomy incisions.

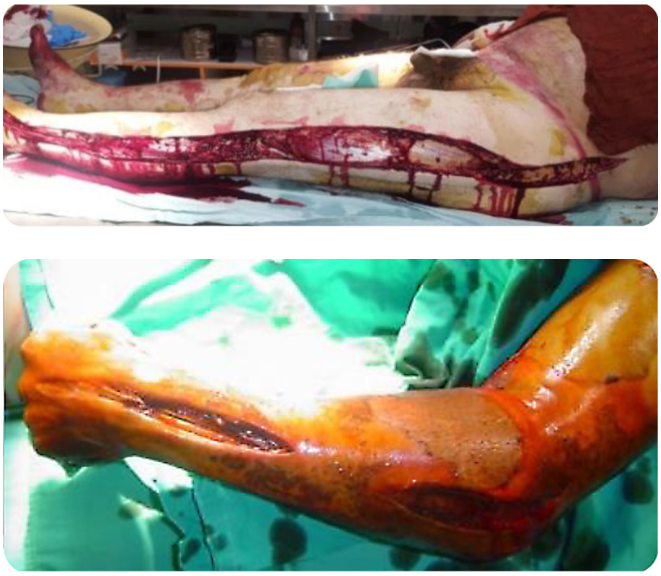


Fig. 3. Split-thickness mesh skin grafting.

Fig. 4. Electrical burn.

Fig. 5. Full-thickness autograft.

Fig. 6. Split-thickness mesh skin grafting.

Fig. 7. Split-thickness mesh skin grafting.

Fig. 8. Split-thickness micrografting.

Fig. 9. Boy with severe full-thickness electrical burns leading to an amputation of the right upper limb.

Fig. 10. Use of Biobrane in a male patient with extensive burns.

Fig. 11. Tangential excision.

RESULTS.

In 2015, 63 patients with extensive burns received treatment in the Clinic. Of them, 32 (51%) had burns of up to 30% of TBSA, and 31 (49%) – had over 30% of TBSA burns. Over >50% of TBSA burns were seen in 12 patients. In 2018, patients with extensive burns were 86, including 56 (65%) with <30% of TBSA burns>30% of TBSA burns were seen in 30 (35%). Patients with >50% of TBSA burns were 11.

Diagram 1. Different occurrence of burns in children and adults.

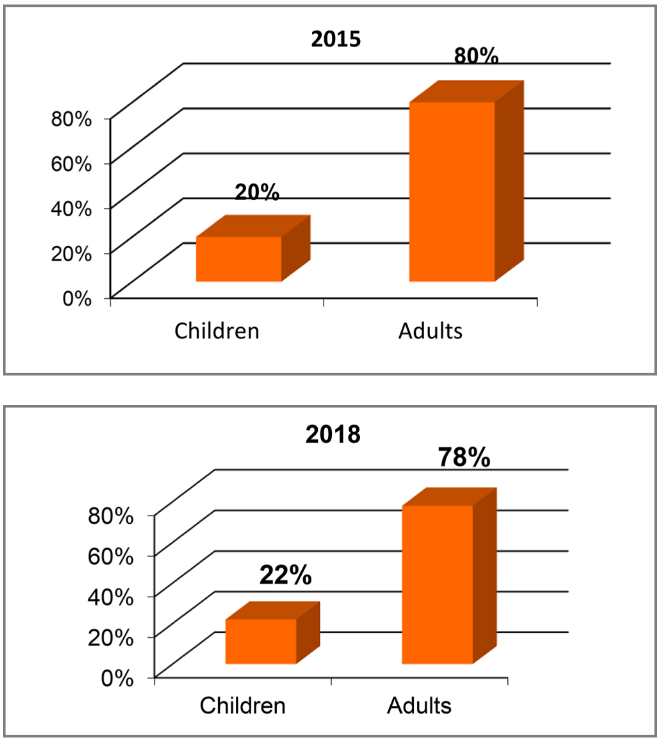
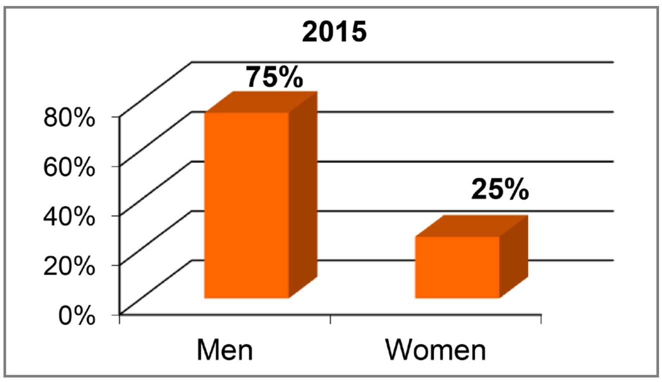
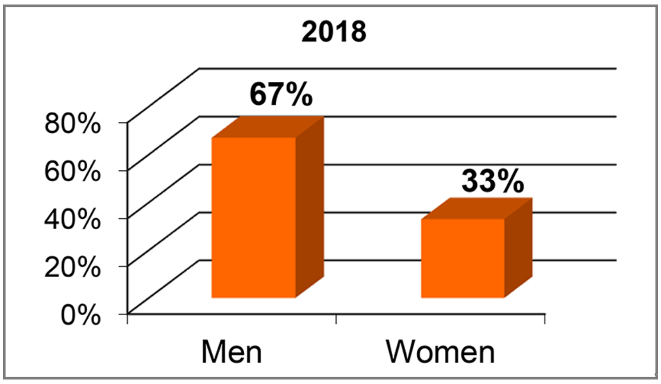


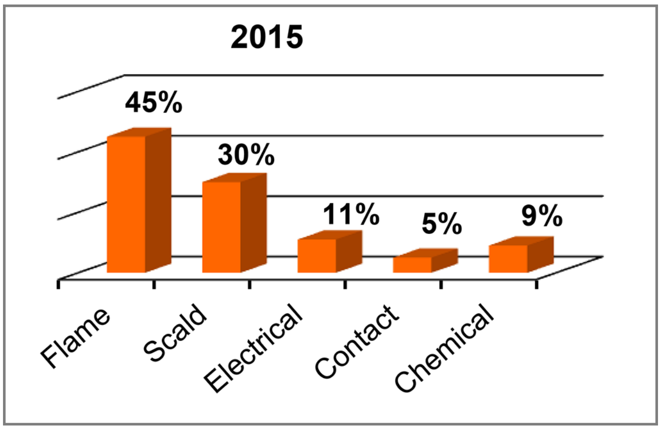
Diagram 2. Different occurrence according to gender.

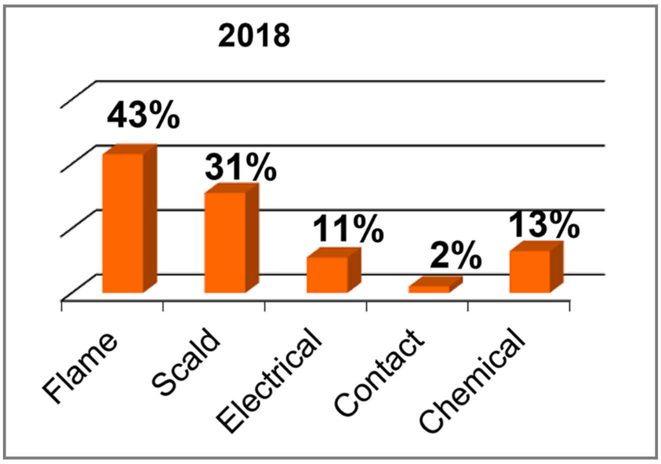




Extensive burns are most commonly caused by flame or hot iquids. No statistically significant difference in the etiology between the two studied years was found. In 2018, there was an increased incidence of occupational combined traumas caused by chemicals. In 2015, 6 cases were treated, the number went up to 11 in 2018, with some involving > than 50 % of TBSA, resulting in fatal outcomes.

Diagram 3. Burn ethiology





Upon admission to the Clinic, all patients underwent primary surgical treatment, which included the insertion of a central venous line and a urinary catheter. This initial intervention was followed by the excision of necrotic tissues, necrotomy incisions when needed, accompanied by resuscitation measures. In some cases, patients necessitated fluid bed therapy to enhance their recovery process.

Throughout this primary surgical procedure, general anesthesia was administered to all patients, and a comprehensive analgesia protocol was subsequently implemented to manage postoperative pain. Additionally, patients who sustained inhalation burns or exposure to toxic gases were placed under mechanical ventilation to ensure adequate respiratory support.

In 2015, 8 patients required mechanical ventilation, in 2018 – the number is 5. Only two patients presented with < 30 % of TBSA affected. Out of 13 patients – 2 were extubated, and treatment was completed, the remaining 11 had a lethal outcome.

The depth of the extensive burns in most cases is variable. However, in most patients - IIAB-to III degree burns were registered.

Resuscitation was based on the „Parkland" formula in all patients. Approximately one-third of the patients were placed on fluidized beds. Necrotomy incisions were performed in patients with circular burns of the extremities. Their number was 15 in 2015 and 19 – in 2018.

The most frequent surgical intervention was free skin autografting. All patients received skin grafting.

The number of surgical procedures in our patients was similar in the two studied years – between 3 and 5.

There was a difference in the timing of the surgical procedures. In 2018, surgery was performed on day 2-3 following the trauma. In 2015, intervention were usually on day 4-6 post trauma.

During both years of comparison, the functional sites were grafted at an earlier stage. In most patients, we used a full-thickness skin graft. In extensive burns involving > 50 % of TBSA, in order to secure timely coverage of larger surface areas, we applied split-thickness skin grafts with meshgraft perforations. Following blood necrectomy, the wound sites were covered with temporary byosynthetic dressing – Biobran and Acticot. In superficial injuries, these dressings are usually the definitive treatment.

In 2015, temporary byosynthetic dressings were used in 19% of the patients, in 2018 in 31%.

A notable difference in the treatment approach between the two studied years was observed. In 2018, there was an extended duration of treatment with low molecular weight heparins (LMWH), specifically Clexane and Fraxiparin. This adjustment was associated with a reduced incidence of coagulation complications, such as thrombosis. Furthermore, there was a notable decrease in the number of surgical interventions required, coupled with an increased utilisation of antibacterial and biosynthetic dressings. These changes collectively contributed to a shortened duration of hospital stays for patients.

Over the last couple of years, we have noted dynamic in the development of infectious complications in patients with burns - the bacterial agents are similar, however, the incidence of resistant strains is increasing.

Gram (-) - Pseudomonas aeruginosa and Acinetobacter baumanni, Escherchia coli Gram (+) - Staphylococcus aureus, MRSA

Over the last few years, Colistin and Vancomycin have been more frequently used for antibiotic therapy.

Table 1. Bacterial agents and antibiotic treatment

Group	Species	2015	2018	Antibiotic treatment
Gram negative	*Psuedomonas aeruginosa*	29	38	Pipercillin-tazobactam
	Actinetobacter baumanni	48	56	Carbapenems
	Enterobacteriaceae	12	17	Cephalosporins
Gram positive	*Staphylococcus aureus*	37	42	Penicillins
	Streptococcus	7	13	Penicillins
	Enterococcus	5	9	Penicillins
Drug resistant strains	MRSA	5	8	Vancomycin
	MDR *P. aeruginosa*	2	3	Colistin

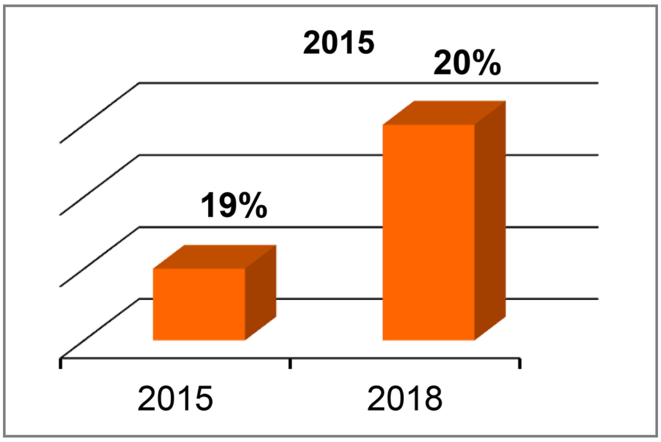
In most patients, there is a dynamic in the microbiology spectrum, likely attributable to infections with resistant hospital strains. In nearly all patients, more than 1 microbial agent has been isolated.

The most common complications observed over the years are:

lung complications, wound infections, sepsis, combined traumas, low protein levels, coagulation abnormalities and acute kidney failure.

No statistically significant difference was found in terms of mortality between the two studied years.

Diagram 4. Mortality rate.



DISCUSSION

Significant advances in the treatment of burns have been achieved in recent years. Shortly after World War One, it was concluded that stage dressings, surgical excisions, free skin grafting and pain management are the most effective therapeutic measures in patients with burns. [1]

In the 1950s, 45% of TBSA burns correlated with a 50% mortality rate in young men. In 2010, the World Health Organization reported a mortality rate of 50% in cases with 80 % burns. This drastic difference is due to the improvement in resuscitation and surgical therapy for extensive burns.

In children, in the 1980s, the mortality rate was 33% in patients with TBSA burns of 80%. Nowadays, we note a 50 % survival rate in children with 98 % of TBSA burns. [2]

Treatment of burns consists of a number of stages – stage dressings, resuscitation, surgical treatment, infection control and complications prevention.

The best dressings for burns treatment should possess good epitheliotropic and antimicrobial properties, should be non-permeable to water but should allow evacuation of the wound exudate and finally, should aid with pain management. So far, such perfect dressings are not available. [3]

The local therapy of burns has also undergone significant dynamics over the last few years. In 1985, Lineaweaver et al. demonstrated that the cellular toxicity of hydrogen peroxide and acetic acid supersedes their bactericidal activity, on the contrary, the concentration of iodine povidone and sodium hypochlorite are not toxic and are characterised by persisting bactericidal activity. [4]

Silver sulfadiazine has been the “golden standard” in the local antimicrobial treatment of burns for many years. [5]

Biological dressings as xenograft, allograft etc. are no longer used. They cause significant side effects as sensibilisation, are costly and hard to store. [6]

Epitheliotropic agents such as synthetic and hydrocolloid dressings are suitable for the treatment of superficial burns. [7]

Antimicrobial silver dressings, especially those with nanocrystal silver, are the first line treatment in cases of burns. Their usage results in the reduction of surgical interventions, they absorb the exudate and maintain the wound humid; they also minimise pain and reduce the duration of treatment as a whole. [3]

Recent bio-engineering technology advancements have made dressings and gels available, containing natural glycosaminoglycans, chitin and growth factors. There are reports that these products prevent burns from deepening, enhance fibroblast proliferation and angiogenesis, and have antimicrobial properties. [8]

Sepsis is considered the most common complication in burn injuries, which leads to lethal outcomes.

The best method to prevent wound infections is early surgical excision.

Unfortunately, in recent years, there has been increased incidence of resistant strains in burn wounds. Most of them are hospital acquired infections

Burn infections are most commonly caused by gram positive bacteria such as streptococci, staphylococci, and enterococci. They are sensitive to penicillin. Resistant strains of methicillin are known as MRSA (methicillin-resistant Staphylococcus aureus), and they are treated with Vancomycin and Linezolid. [9]

Aminoglucosides are the treatment of choice for gram negative bacteria. However, in the treatment of burn infections caused by resistant strains, a more aggressive approach is used. Branski considers that the polymyxins colistin and polymyxin E are safe and effective treatment for both children and adults without serious side effects. They should be used with caution, and close monitoring of kidney function is necessary. [10]

After the war periods, infusion therapy for burns also advanced rapidly. It was found that inadequate resuscitation results in intracellular deposition of sodium and water. [3]

Protein loss with the subsequent inflammatory reaction leads to a shift of intravascular fluid to the interstitial spaces. Over the years, various formulas have been proposed to manage low protein levels. In some patients, Human albumin and plasma infusions start in the first 24 hours. Resuscitation therapy is calculated based on the percentage of TBSA affected by the burn. A commonly used method for calculation is “the rule of nines”.

Cope and Moore proposed formulas based on which the volume and the composition of the intravenous fluids should be calculated. Examples of such formulas are those of Evans and Brooke. Baxter and Shires demonstrated that protein infusions in the first 24 hours increase edema and proposed a formula to calculate the volume of crystalloid solutions necessary for the first 24 hours after the burn in order to manage the shock. Parkland’s formula suggests 4 ml lactated Ringer solution (RL) / kg /% TBSA within the first 24 hours. Half of the calculated fluid is administered within the first 8 hours; the remaining volume is given for 16 hours. During the second day after the burn, half of the calculated 1st day volume crystalloid is given, and protein is added. On day three, half of the second day volume is administered, including Human albumin and fresh frozen plasma. Parkland’s formula is widely accepted and is a basic method for burns resuscitation in Bulgaria. [11,12]

There is no ideal formula; all the available should be adjusted according to the patient’s needs. Complications of inadequate resuscitation in burned patients in shock are hyper and hypovolemia, which in turn could result in pulmonary edema, renal dysfunction and deterioration of the toxi - infection.

Monitoring the urine output per minute is the main parameter used to assess the effectiveness of infusion therapy. For adults, the urine output per hour is approximately 50 mL / h, in children - 1 mL / kg per hour.

Some patients need larger volumes of fluid than calculated based on the Parklands formula. These are patients with polytrauma, alcohol abusers, inhalation burns and with delayed initial resuscitation. They very often need additional volumes of fluids and bioproducts. [13, 14]

Since the 1970s, we have evidence in favor of the opinion that early surgical excision and free autografting are the golden standard in the treatment of burns. Surgery is usually performed 3 to 5 days after the trauma. [15]

Early tangential excision and auto skin grafting reduce mortality rates and reduce hospital stays compared to conservative management. [16]

Herndon and Parks applied early surgical excision (within 48-72 hours after the injury) down to the fascia with mesh graft 4:1 of corpse skin to treat extensive burns in children. Results showed a shortening of hospital stays but no decreased mortality rates. In a prospective randomised study in 85 patients with stage 3 burns of over 30 % of TBSA, the early surgical excision showed an improved survival rate in patients without inhalation burns, aged 17 to 30. There is no statistically significant difference compared to patients over 30 years of age who also present with inhalation burns [17].

After Blair and Brown found out that preserved epithelial cells in the hair follicles play a crucial role in the healing of the skin donor sites, full thickness skin grafts became increasingly popular as a treatment option. Portable electric dermatomes and mesh graft dermatomes were designed, which allowed the expansion of the graft area to 9:1 and contributed to the rapid recovery in extensive burns with limited donor sites. Some authors recommended the application of micro grafts to cover extensive burns. [18]

The advance in genetic engineering have made it possible to investigate the role of tissue skin substitutes. In the 1970s, Yannas and Burke developed the first two-layer skin replacement tissue- Integra, which consists of a thin silicon epidermis and a porous matrix of collagen and chondroitin. Heimbach et al. were the leaders in the first randomised clinical trial of Integra in 1988. After the FDA approval in 1996 ã., Integra is widely used in the treatment of burn injuries as well as in reconstructive surgery. [19-20]

CONCLUSION

Extensive burns are a challenge for plastic surgery and anesthesiology. The therapeutic approach follows a certain algorithm depending on many factors. For the outcome of the treatment, the general condition of the patient, the type and depth of the burn, as well as the time of starting the surgical treatment are important.

The main objective in the treatment of extensive burns is patient survival, preservation of functional activity and good esthetic results, which allow for good quality of life and good resocialisation.

REFERENCES:

1. Herndon DN. Total Burn Care. Fifth Edition. Elsevier. 2018. [Crossref].
2. Barrow RE, Spies M, Barrow LN, Herndon DN. Influence of demographics and inhalation injury on burn mortality in children. *Burns*. 2004 Feb;30(1):72-7. [PubMed]
3. Kim H, Shin S, Han D. Review of History of Basic Principles of Burn Wound Management. *Medicina (Kaunas)*. 2022 Mar 7;58(3):400. [PubMed]
4. Lineaweaver W, McMorris S, Soucy D, Howard R. Cellular and bacterial toxicities of topical antimicrobials. *Plast Reconstr Surg*. 1985 Mar;75(3):394-6. [PubMed]
5. Jones I, Currie L, Martin R. A guide to biological skin substitutes. *Br J Plast Surg*. 2002 Apr;55(3):185-93. [PubMed]
6. Wasiak J, Cleland H, Campbell F, Spinks A. Dressings for superficial and partial thickness burns. *Cochrane Database Syst Rev*. 2013 Mar 28;2013(3):CD002106. [PubMed]
7. Khundkar R, Malic C, Burge T. Use of Acticoat dressings in burns: what is the evidence? *Burns*. 2010 Sep;36(6):751-8. [PubMed]
8. Alsarra IA. Chitosan topical gel formulation in the management of burn wounds. *Int J Biol Macromol*. 2009 Jul 1;45(1):16-21. [PubMed]
9. Maitz J, Merlino J, Rizzo S, McKew G, Maitz P. Burn wound infections microbiome and novel approaches using therapeutic microorganisms in burn wound infection control. *Adv Drug Deliv Rev*. 2023 May; 196:114769. [PubMed]
10. Branski LK, Al-Mousawi A, Rivero H, Jeschke MG, Sanford AP, Herndon DN. Emerging infections in burns. *Surg Infect (Larchmt)*. 2009 Oct;10(5):389-97. [PubMed]
11. Cope O, Moore FD. The Redistribution of Body Water and the Fluid Therapy of the Burned Patient. *Ann Surg*. 1947 Dec;126(6):1010-1045. [PubMed]
12. Baxter CR, Shires T. Physiological response to crystalloid resuscitation of severe burns. *Ann N Y Acad Sci*. 1968 Aug 14;150(3):874-94. [PubMed]
13. Zwierello W, Piorun K, Skórka-Majewicz M, Maruszewska A, Antoniewski J, Gutowska I. Burns: Classification, Pathophysiology, and Treatment: A Review. *Int J Mol Sci*. 2023;24(4):3749. [PubMed]
14. Dries DJ. Management of burn injuries—recent developments in resuscitation, infection control and outcomes research. *Scand J Trauma Resusc Emerg Med*. 2009;17:14. [PubMed]
15. Radzikowska-Büchner E, Lopuszynska I, Flieger W, Tobiasz M, Maciejewski R, Flieger J. An Overview of Recent Developments in the Management of Burn Injuries. *Int J Mol Sci*. 2023 Nov 15;24(22):16357. [PubMed]
16. Tannr JC Jr, Vandeput J, Olley JF. The Mesh Skin Graft. *Plast Reconstr Surg*. 1964 Sep;34:287-92. [PubMed]
17. Herndon DN, Parks DH. Comparison of serial debridement and autografting and early massive excision with cadaver skin overlay in the treatment of large burns in children. *J Trauma*. 1986 Feb;26(2):149-52. [PubMed]
18. Ozhathil DK, Tay MW, Wolf SE, Branski LK. A Narrative Review of the History of Skin Grafting in Burn Care. *Medicina (Kaunas)*. 2021 Apr 15;57(4):380. [PubMed]
19. Heimbach D, Luterman A, Burke J, Cram A, Herndon D, Hunt J, et al. Artificial dermis for major burns. A multi-center randomised clinical trial. *Ann Surg*. 1988 Sep;208(3):313-20. [PubMed]
20. van Zuijlen PP, van Trier AJ, Vloemans JF, Groenevelt F, Kreis RW, Middelkoop E. Graft survival and effectiveness of dermal substitution in burns and reconstructive surgery in a one-stage grafting model. *Plast Reconstr Surg*. 2000 Sep;106(3):615-23. [PubMed]

Please cite this article as: Anastasova V, Zanzov E, Ivanova K, Kiskinov P, Krasteva E, Ivanov B. Therapeutic approach in extensive burn injuries. *J of IMAB*. 2025 Apr-Jun;31(2):6243-6250. [Crossref - https://doi.org/10.5272/jimab.2025312.6243]

Received: 16/08/2024; Published online: 02/06/2025

Address for correspondence:
Karina Ivanova
Department of Plastic, Reconstructive, Aesthetic Surgery and Thermal Trauma, Medical Faculty, Medical University of Plovdiv;
66, Peshtersko shose Str., Plovdiv, Bulgaria
E-mail: karina.ivanova@mu-plovdiv.bg,