

Practical Guide for Burn Injuries

Guide No. 5

2nd Edition

Collection of Practical Guides for Wounds from the Servizo Galego de Saúde



XUNTA
DE GALICIA

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CONSELLERÍA DE SANIDADE

Servizo Galego de Saúde
Dirección Xeral de Asistencia Sanitaria
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Collection of Practical Guides for Wounds from the Servizo Galego de Saúde

- ♥ Pressure Injuries
- ♥ Ulcers of the Lower Limb
- ♥ Diabetic Foot Ulcers
- ♥ Neoplastic Skin Lesions
- ♥ **Burn Injuries**
- ♥ Acute Surgical Wounds
- ♥ Moisture Associated Skin Injuries
- ♥ Soft Tissue Traumatic Injuries



Úlceras Fóra Programme. Servizo Galego de Saúde, 2024



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PRESENTATION

Everyone knows that the approach to ulcers and wounds implies a health problem of great magnitude due to the loss of quality of life in patients, the impact that it has on their families and carers and also due to the workload that their care represents for healthcare professionals. To which must be added the additional cost that it poses for the economic sustainability of the healthcare system.

The Servizo Galego de Saúde is aware of the importance and healthcare impact that the proper management of prevention and treatment of these types of injuries has; so for many years and more intensively from the Subdirección Xeral de Xestión Asistencial e Innovación through the Servizo de Integración Asistencial, we are working to improve the structure, resources and conditions required to try to normalise and systematise the healthcare activity resulting from these care processes.

The Úlceras Fóra Programme was set up as a reference framework to develop and establish strategic lines in the approach of everything that is related to ulcers and wounds, and includes as one of the basic goals the setting up of common care criteria (to identify the risk, assess the injuries, establish preventive measures, establish treatments, use of products, monitoring, registration, etc.) which allow us to move towards the unification of criteria and a corresponding reduction in the clinical variability for this type of injuries.

That is why this *Collection of Practical Guides for Wounds from the Servizo Galego de Saúde*, describes the effort and enthusiasm of many professionals (doctors and nurses) to improve their clinical practice in the care and comprehensive approach to patients affected by ulcers and wounds, or at risk of suffering them, in order to incorporate the best available evidence available so as to achieve an improvement in the patient's quality of care and safety.

Jorge Aboal Viñas
Director xeral de Asistencia Sanitaria
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PREFACE

This Practical Guide was prepared with the participation of health professionals in primary care and hospital care of the Servizo Galego de Saúde and reviewed by expert professionals and scientific institutions at national level, under the coordination of the Subdirección Xeral de Ordenación Asistencial e Innovación Organizativa and Dirección Xeral de Asistencia Sanitaria of the Servizo Galego de Saúde.

The recommendations for clinical practice based on evidence that are included in this guide are of a general nature and therefore do not define a single course of conduct to be followed in a procedure or treatment for the integral care that is intended to be carried out. Any amendment or variation in the recommendations set forth herein, shall be based on clinical judgement (internal evidence) of the healthcare professional who applies them and the best clinical practices of the time; as well as the specific needs and preferences of each patient in particular; the resources available at the time of the sanitary attention and in the regulations established by the institution or health centre where they are intended to be applied.

DISSEMINATION AND IMPLEMENTATION

The dissemination and implementation strategy of this practical guide; as well as, of the entire *Collection of Practical Guides on Wounds from the Servizo Galego de Saúde*, will be coordinated through the Technical Department of the Úlceras Fora Programme; that is, by the Servizo de Integración Asistencial, of the Subdirección Xeral de Ordenación Asistencial e Innovación Organizativa, of the Servizo Galego de Saúde.

The dissemination process entails a ceremonial presentation at the Consellería de Sanidade of Xunta de Galicia, the official presentation in all public institutions in the Rede Sanitaria do Servizo Galego de Saúde, the dissemination of an official statement to the media, its disclosure in scientific events and dissemination on the Internet through the official website of the Servizo Galego de Saúde, through its Úlceras Fóra portal. <https://ulcerasfora.sergas.gal/>

VALIDITY AND UPDATE

The guide should be reviewed after 3 years from the date of its publication. It may be updated before the end of this period if any of the evidence recommendations change its categorisation, which may lead to a clinical safety risk to the patient and/or affect the quality of care.



This document responds to the revision and updating of the scientific evidence used in the first edition published in 2016.

DECLARATION OF CONFLICTS OF INTEREST AND EDITORIAL INDEPENDENCE

The authors of this practical guide declare to have made an effort to ensure that the information contained herein is complete and up to date, and state that they have not been influenced by conflicts of interest that could change the results or contents during the preparation and development stage of the guide. Furthermore, the authors of the guide assume responsibility for the content expressed, which includes evidence and recommendations.

The editors of the *Collection of Practical Guides on Wounds of the Servizo Galego de Saúde* declare the existence of editorial independence with regard to the decisions taken by the Technical Division and the Coordinators of the Working Group.

ASSESSMENT AND CLASSIFICATION OF THE EVIDENCE

The scientific evidence and recommendations set forth in this Practical Guide were the result of the assessment and analysis of the sources of information consulted as bibliographic reference (clinical practice guides, guides based on the best evidence, other documents based on evidence, systematic reviews and original articles); the critical reading method and consensus through a nominal group between authors and panel of experts was used to prepare it.

The classification of the level of evidence and grading of the recommendations has been maintained while respecting the original source consulted and the scale of evidence that has been used. For this, the method that CENETEC (Centro Nacional de Excelencia Tecnológica en Salud-National) of Mexico in the development of their Clinical Practice Guidelines (CPG) has been used:

- ♦ Classify with the symbol **[E]** that evidence which is published in any CPG, followed by its alphanumeric classification (quality of the study, if it is referenced) and bibliographic citation.



- Categorise with the symbol **[R]** those recommendations identified by any CPG, followed by their strength of recommendation (by A-B-C-D levels, in descending order according to clinical importance, or by their grading in high-moderate-low evidence).
- Identify with the symbol **[BP]** those actions and/or activities considered as best practices, which are not referenced or supported by any CPG, but that appear in other documents based on the evidence (guides to best clinical practice, clinical pathways, protocols based on evidence, etc.) and whose evidence has been obtained through systematic reviews, meta-analyses, clinical trials, etc. The modified Shekelle et al. scale was used for this classification of **[BP]**:

MODIFIED SHEKELLE SCALE (*)	
CATEGORY OF EVIDENCE	STRENGTH OF THE RECOMMENDATION
Ia. Go Evidence for meta-analysis of randomized clinical trials	A. Directly based on category I evidence
Ib. Evidence from at least one randomized controlled clinical trial	
IIa. Evidence from at least one non-randomized controlled study	B. Directly based on Category I evidence or recommendations extrapolated from I evidence
IIb. At least another type of quasi-experimental study or cohort studies	
III. Evidence from a non-experimental descriptive study, such as comparative studies, correlational studies, case-controls, and clinical reviews	C. Directly based on category III evidence or recommendations extrapolated from category I or II evidence
IV. Evidence from the expert committee, reports, opinions or clinical experience of authorities in the field or both	D. Directly based on evidence category IV or recommendations extrapolated from evidence categories II, III

(*) Shekelle PG, Wolf SH, Eccles M, Grimshaw J. *Clinical Guidelines. Developing Guidelines*. BMJ. 1999 [Access April 2015]; 3:18:593-6. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1115034/pdf/593.pdf>



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01. LIST OF AUTHORS, COORDINATORS AND REVIEWERS

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HOW TO QUOTE THE DOCUMENT

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02. INTRODUCTION

2.1. JUSTIFICATION

The approach to chronic ulcers and wounds implies a health problem of great magnitude due to the extra financial cost it means for the health systems, due to the loss of quality of life in patients, due to the impact that this has on their families and carers (which in many cases have to take on the prevention and caring), and also by the workload that their care represents for healthcare professionals. Therefore, making decisions about how to approach them requires taking into account various alternatives from different sources of information (clinical data, professional experience, patient preferences, scientific evidence, protocols, guidelines, etc.) which in turn lead to a considerable variability in decisions depending on the time, the information available and the person making the decision. This gives rise to a great disparity in the actions taken by professionals for techniques, tests and diagnostic skills, clinical judgement and decision-making when faced with the same problem or patient and even within the same professional in relation to patients with the same symptoms and pathology.

This *Practical Guide to Burn Injuries* (Practical Guide No. 5) is integrated into the *Collection of Practical Guides for Wounds of the Servizo Galego de Saúde*; in accordance with the strategies and lines of action promoted through the Úlceras Fora Programme coordinated by the General Sub-Directorate for Healthcare Management and Innovation. This document responds to the revision and updating of the scientific evidence used in the first edition published in 2016. This guide is therefore meant as a summary of the best interventions and preventive or therapeutic practices available for the care of adults with a burn injury; according to the clinical practice based on the most current evidence.

2.2. SCOPE AND OBJECTIVES

The scope of The Guide is addressed to the people affected, informal carers and all health professionals with direct or indirect responsibility for the integral approach of burn injuries, in any of the three healthcare levels in the Community of Galicia: Primary Healthcare, Hospital Care and Socio-Health Care.

The aim of the Guide is to provide guidelines and/or standardised criteria to serve as a reference to identify risk factors, perform specific actions of prevention, detection, referral and treatment, which burn injuries pose as a health problem. The aim is to contribute to the well-being of people, reduce the variability of treatments and professional uncertainty, reduce the prevalence and incidence of this health problem



in society, as well as achieve greater optimisation in the management of human and economic resources available to the Galician health and socio-health care system based on the recommendations of practice based on evidence-based practice recommendations and; achieve indicators of quality of care and patient safety that allow greater efficiency in the process between the different levels of care.

2.3. QUESTIONS TO BE ANSWERED BY THIS PRACTICAL GUIDE

- What are burn injuries and how are they defined?
- What is their epidemiology and etiopathogenesis?
- What type are they and how are they classified?
- What are the most frequent locations?
- How to diagnose a burn injury?
- What measures must be implemented for the best healing?
- What treatments and/or therapeutic measures are most appropriate?
- What complications can occur?
- What prevention recommendations are the most appropriate?
- What treatment recommendations are the most suitable?
- What therapeutic and health education guidelines should patients, informal carers and professionals follow to facilitate their care?



03. DEFINITION

Burns are injuries that are produced in living tissues, due to the action of different physical agents (flames, liquids, hot objects, radiation, electric current, cold, chemicals (caustic) and biological products; that cause changes ranging from a simple erythema to the total destruction of dermal and subdermal structures^(1, 2).

3.1. ANATOMICAL REMINDER⁽¹⁻²⁾

The skin, our outer covering, essential for life, consists of three distinct layers: epidermis, dermis and subcutaneous cellular tissue (figure 1).

Each of these three layers can be affected in a burn, and this involvement is used to classify burns according to their depth.

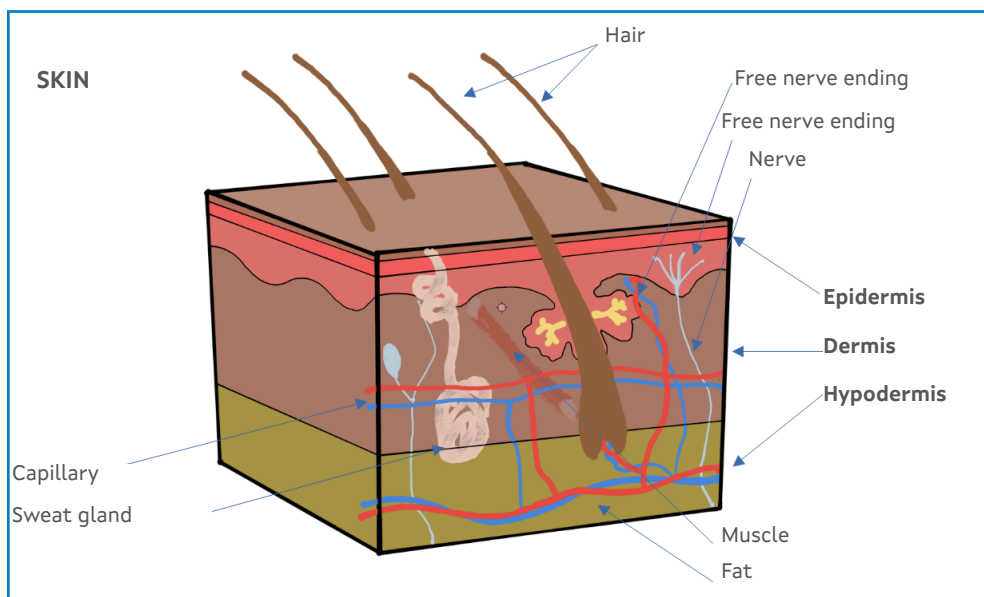


Figure 1. Diagram of skin structure (own source)

♥ Epidermis

This is the outermost portion of the skin, constituting 5% of the total thickness of the skin. It is a poly-stratified stratum (maximum thickness of 200 microns). It lacks blood vessels (it is nourished from the dermis by diffusion). It has a germinative layer that multiplies and at the same time keratinises until it is eliminated in the outermost layer.

It basically contains three cell types: keratinocytes, melanocytes, Langerhans cells. Occasionally Merkel cells and indeterminate cells may be found.



♥ Dermal-epidermal junction

This has a great complexity of structures, functions and chemical composition. It is semi-permeable and allows the exchange of cells and fluids between the epidermis and dermis. It also acts as a structural support for the epidermis and provides cohesion to the junction between the epidermis and dermis.

♥ Dermis

This is the intermediate layer, constituting 95% of the total skin thickness. It is a layer of variable thickness (1-2 mm) that is separated from the epidermis by the basement membrane. Two layers are differentiated in the dermis: papillary and reticular dermis.

The dermis is a fibrous connective tissue system that contains the nerve and vascular networks and appendages formed by the epidermis. Its own cells are fibroblasts, macrophages, mast cells and lymphocytes.

It is mainly composed of collagen (synthesised by the fibroblast), which is a fibrous protein that acts as a structural protein throughout the body (70% of the dry weight of the skin). Fibroblasts also synthesise elastic and reticulin fibres. Collagen, the fundamental substance of the dermis, is the main pressure-resistant material, while elastic fibres are important for the maintenance of skin elasticity.

The dermal vascularisation consists of a superficial plexus, which crosses the dermis parallel to the epidermis; and a deep plexus, which is located in the lower portion of the dermis next to the subcutaneous tissue and is composed of larger vessels. The dermal lymphatics are associated with the vascular plexus.

The dermis is rich in nerves, such as Meissner's corpuscles and Pacini's corpuscles (mechanoreceptors) that mediate touch and pressure, and other receptors for temperature and pain. In addition, there are nerve fibres that regulate vasoconstriction, secretion of the apocrine glands, eccrine sweat secretion and contraction of the hair erector muscles.

♥ Hypodermis or subcutaneous cellular tissue

This is the innermost layer of the skin. It is composed of adipocyte lobules, separated by fibrous partitions formed by collagen and large blood vessels.

♥ Skin appendages

Eccrine and apocrine sweat glands, pilosebaceous follicles and nails.



3.2. PROPERTIES OF THE SKIN

- ♥ **Viscoelasticity of the skin:** two aspects must be taken into account, the capacity for temporary stretching and the capacity for recovery after maximum stretching.
- ♥ **Tightening properties of the skin:** the skin is normally kept under some tension, more so in young people than in adults. This tension has a negative influence on the outcome of the scar. Incisions that follow the lines of least skin tension (Langer's) heal better and faster. Collagen fibres break and skin striae develop when skin tension is faster than its ability to stretch. Blood and lymphatic vessels become blocked when the tension exceeds the skin's ability to stretch. This mechanism leads to numerous ulcers and flap necrosis.
- ♥ **Skin extensibility:** skin elasticity is greater in children and in areas of thin skin. Elasticity is lost with age and replaced by skin laxity. The skin over the joints is more extensible, which allows movement. On the contrary, in areas with greater skin thickness, with the presence of hair and fixation by trabeculae to deep planes (palms and soles), the extensibility will be lower.

3.3. FUNCTIONS OF THE SKIN

The skin has multiple functions, including: barrier function (against micro-organisms and ultraviolet radiation), protective organ, maintenance of water and electrolyte balance, melanin production, metabolism of internal and external secretions, temperature regulation, skin pH regulation (pH 5.5), lubrication function, wound repair, inflammatory reactions, personal identification, communication with the environment, immunological function...

All these functions are altered to a greater or lesser extent when a burn occurs, depending on the percentage of body surface area burned, and depending on the depth of the burn.



04. EPIDEMIOLOGY

Burns are the fourth most frequent cause of trauma worldwide, after traffic accidents, falls, and interpersonal violence.

Incidence and prevalence figures for burns in Spain have been estimated from different studies:

- ♦ According to data published by the World Health Organisation (WHO) in 2018, 180,000 deaths due to burns occur worldwide every year, being more frequent in countries with medium and low per capita incomes⁽³⁾.
- ♦ In 2004, almost 11 million people worldwide suffered burns severe enough to require medical attention⁽³⁾.
- ♦ With regard to the data available in Spain.
 - According to the document of Centres, Services and Reference Units of the National Health System (CSUR) for 2019⁽⁴⁾:
 - 300 out of every 100,000 inhabitants require medical attention for burns.
 - 14 out of every 100,000 inhabitants require hospital admission after suffering a burn.
 - Flame burns and scalds are the most frequent burns in all age groups.
 - The three main risk factors for the survival of burn patients are: total burned surface area, age and associated smoke inhalation.
 - According to the MAPFRE Foundation's report on burn injuries in Spain⁽⁵⁾.
 - The number of emergencies attended in the period for 2011-2017 in all Spanish CSUR units for critical burns was 46,325.
 - The age group with the highest incidence of admissions was between 30 and 50 years of age with 3,417 cases, i.e. 37.5%, occurring to a greater extent among men (62.9%) compared to 37.1% among women in the total sample.
 - The main cause of burns in children was very prominently scald burns, with 68% of cases and a mean age of the child of 2.8 years for this aetiology.
 - In the case of adult patients, the most prominent cause of burns was flame, with 53.1% of cases, having produced a burned body surface area of 16.2% in these patients.

Non-fatal burn injuries are a major cause of morbidity, including prolonged hospitalisation, disfigurement and disability⁽³⁾.



The financial impact of burns is very significant. In Spain, it is estimated that annual direct and indirect costs per burn patient are €83,000, and the total annual cost is €262 million⁽⁵⁻⁷⁾.

Between 60% and 80% of the burns occur in the domestic sphere and between 10% and 15% in the work environment, with explosion and flames being the main mechanisms, followed by electrical and chemical burns. Within domestic burns the most frequent are those produced by hot liquids (scalding), especially by water and oil, followed by hot solids (iron, stove).

The stages of the life where the greatest number of burns are produced are old age and infancy⁽⁶⁻⁷⁾.

Although it is difficult to obtain the exact figures for burns that occur in our community, because many patients do not go to a medical centre, we can obtain the data from the Burns Unit of the Hospital Complex of A Coruña, recognised as a CSUR centre⁽⁸⁻⁹⁾:

- The age group with the highest incidence was under 10 years of age. The next age group in terms of incidence was 50-60 years of age, with 16%.
- Almost 70% were domestic accidents (mainly contact with hot liquids).
- The majority (60.03%) were 2nd degree superficial burns, followed by 2nd degree deep burns (26%). By age range, more than 60% of 3rd degree burns affected patients over 50 years of age, while 25% of superficial 2nd degree burns affected the 0-20 age group. Deep 2nd degree burns were more frequent between 40 and 60 years of age.
- The most common mechanism for burns was scalding (40%), followed by flame (22%) and direct contact (15%). Less frequent were explosions, electric flash, electrical burns, chemical burns, etc.
- The mean burned body surface area (BSA) burned was 4.61%, with a range between 0.3% and 98%.
- The most frequent location of the burns was the hands, except in patients over 80 years of age, which was the lower limbs.
- Thirty-seven percent of the patients seen in the unit required hospital admission. The mortality rate was 1.2%.

Most burns are preventable with proper education and information⁽³⁾.



05. CLASSIFICATION⁽¹⁾

5.1. ACCORDING TO DEPTH

We can classify burns according to the depth of the injury, depending on the involvement of the different layers of the skin and subcutaneous tissue. The degree alone is not synonymous with seriousness.

5.1.1. EPIDERMAL BURN (1ST DEGREE):

The injury partially affects the epidermis (figures 2 and photo 1).

SIGNS	SYMPTOMS	PROGNOSIS
♥ Erythema	♥ Pain: from mild to severe	♥ Healing in less than a week
♥ No phlyctenae	♥ Hypersensitivity	♥ Without scar, except in complications
♥ Hot and dry skin	♥ Sensation of itching, stinging/burning	
♥ No exudate		



Figure 2. Diagram of 1st degree skin involvement

Photo 1. 1st degree burn (own source)

5.1.2. SUPERFICIAL DERMAL BURN (2ND DEGREE SUPERFICIAL):

The injury affects all epidermic layers, reaching the papillary dermis. Does not affect the reticular dermis or the root of the pilosebaceous follicles. Islets of epithelial cells remain in the epidermal ridges and in the interior of the glands and follicles to facilitate re-epithelialisation (figures 3 and photo 2).



SIGNS	SYMPTOMS	PROGNOSIS
- Phlyctenae - Bed of the wound is deep red or pink - Very exudative - Negative hair traction	- Hyperaesthesia - Tend to be very painful, especially when handling	- Healing: between 7 to 21 days - Just leave slight temporary dyschromia

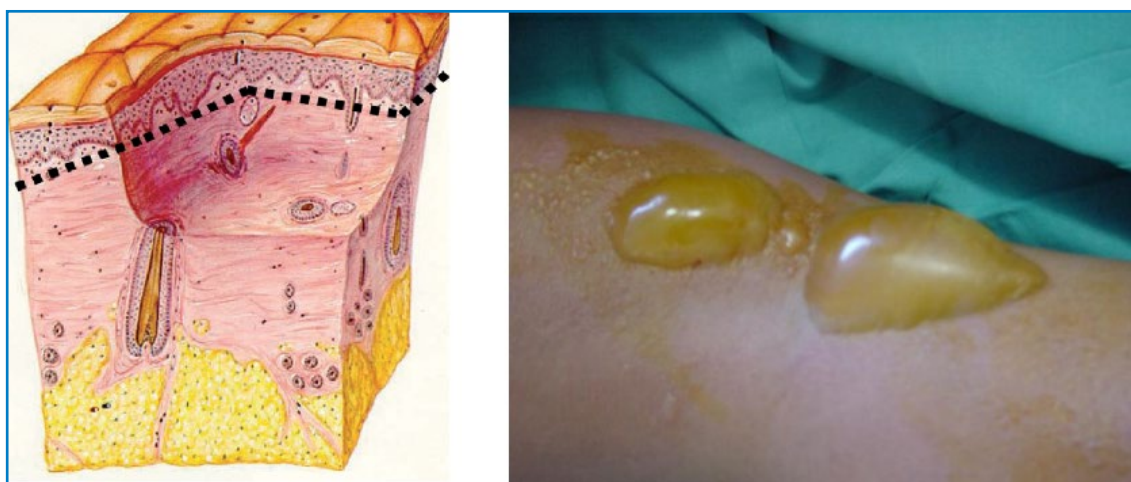


Figure 3. Diagram of 2nd degree superficial skin involvement

Photo 2. 2nd degree superficial burn (own source)

5.1.3. DEEP DERMAL BURN (DEEP 2ND DEGREE):

The injury affects all epidermic layers, reaching the reticular dermis. Does not affect the subcutaneous tissue. There are only some viable epidermal cells that are part of the sweat glands and the pilosebaceous follicles. The superficial sensitive terminations are destroyed (figure 4 and photo 3).

SIGNS	SYMPTOMS	PROGNOSIS
- There may be phlyctenae - Surface of the wound pale red or white, smooth, shiny and exudative - Positive hair traction	- Pain - Less painful on examination than superficial dermal lesions	- Epithelialisation between 15 and 21 days - Significant sequelae - If they do not epithelialise within 21 days, refer for surgery - Treatment: debridement and skin autograft



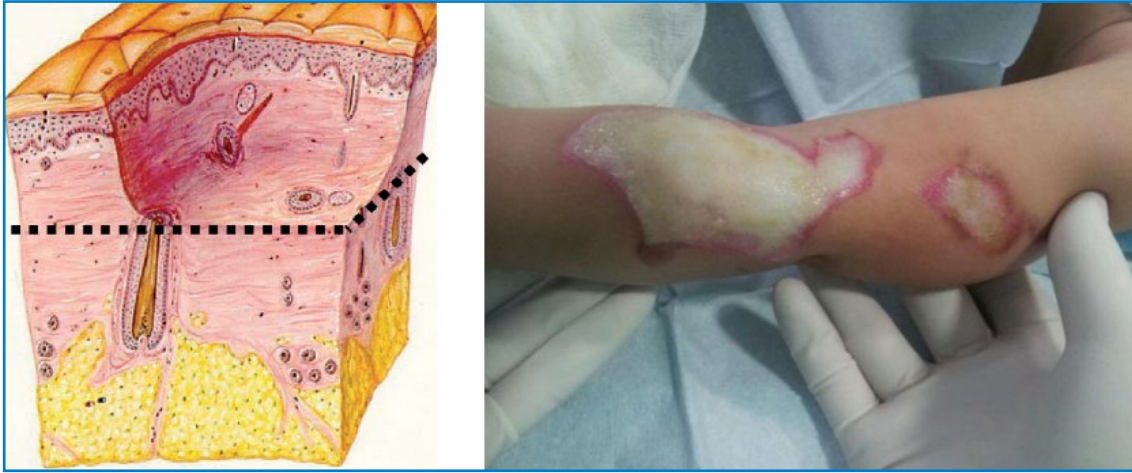


Figure 4. Diagram of 2nd degree deep skin involvement

Photo 3. 2nd degree deep burn (own source)

5.1.4. SUBDERMAL BURN (3RD DEGREE):

Complete destruction of the entire thickness of the skin, affects subdermal tissue and other structures (fascia, muscle, tendon, vessels, periosteum). The nerve endings and the annexed skin are destroyed (follicles, glands, etc.) (figures 5 and photo 4).

SIGNS	SYMPTOMS	PROGNOSIS
♥ Eschar (mummification of burned tissue) ♥ Colour: from pearly white, dark brown to black	♥ Anaesthesia, without sensitivity ♥ Sometimes pain due to compression of underlying planes and due to irritation of adjacent tissues	♥ Spontaneous healing is possible only in very small lesions ♥ Most require surgical treatment with autografts ♥ Important sequelae (keloids, dyschromia, amputations, retractions), psychological damage

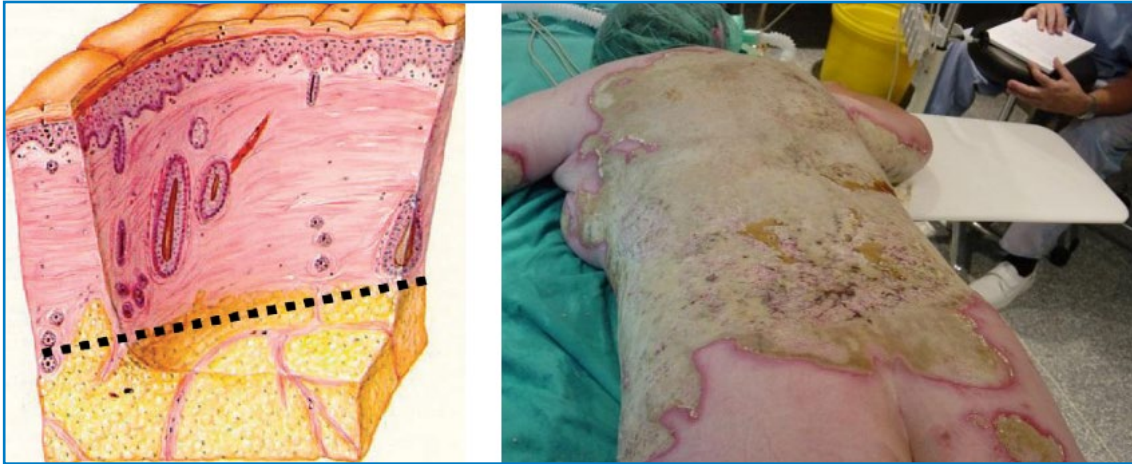


Figure 5. Schematic diagram of 3rd degree skin involvement

Photo 4. 3rd degree burns (own source)

HAIR SIGN



To consider: This is a very useful sign to differentiate the different degrees of burn (photo 5).

If pulling on the hair offers resistance and hurts, the burn is superficial.

If pulling the hair offers little or no resistance and does not hurt, the burn is deep.

Photo 5. Hair sign (own source)

5.2. ACCORDING TO AETIOLOGY

Depending on the aetiology, burns can be thermal, electrical, flash, chemical, radioactive or cold burns. The aetiology of the burn is especially important during the first actions, in the urgency and emergency.

5.2.1. THERMAL BURNS

Produced by the action of heat.

- ♦ **Scalding:** Due to hot liquids. Tend to be clean, superficial, but extensive.
- ♦ **Flame:** Due to direct contact with fire. They are dirtier burns.



- ♥ **Contact:** The mechanism is hot solids. They tend to be limited and deep.
- ♥ **Due to friction:** The burn is caused by the sudden friction of the skin with another surface.

5.2.2. ELECTRICAL BURNS

These are produced by the direct action of an electric current or heat generated when passing through the tissues. The resistance of each tissue is inversely proportional to the amount of water it contains. They can be:

- ♥ **De baixa voltagem (<1.000 V),** produces little destruction of tissues. Risk of cardiac arrest.
- ♥ **High voltage (>1.000 V),** presents great tissue destruction at the contact points and in the internal structures close to the path of the long bones. They can cause cardiac arrest, alteration of rhythm, fractures, rhabdomyolysis and compartmental syndrome. Cardiac a monitoring should be performed and referral to a burn unit.

5.2.3. BURNS DUE TO ELECTRICAL FLASH

A short circuit is usually produced because of the flash. Their treatment differs from the burn produced by electric current, being considered as a contact (thermal) burn for treatment purposes.

5.2.4. CHEMICAL BURNS

Produced by acidic or base substances and corrosive substances that alter the pH of the tissues. The severity of the burn will depend on the nature of the substance and its concentration and the time of contact. They should all be referred to a specialist centre.

5.2.5. RADIOACTIVE BURNS

Produced by ionizing radiation (X-rays, gamma rays, etc.) and non-ionizing radiation such as solar radiation, ultraviolet, laser, microwave, infrared radiation, etc.



5.2.6. BURNS DUE TO COLD

The effect of extreme cold on tissues produces vasoconstriction and solidification of water from inside the cells, which produces tissue necrosis. The injuries mainly affect acral areas (fingers, ears and nose).

5.3. ACCORDING TO EXTENSION

The extent of the burn, that is, the amount of burned body surface area (BSA), is the first thing to consider when assessing the severity of a burn. Referral to a specialist centre will depend on this. Moderate and severe burns should be treated in a hospital.

5.3.1. WALLACE RULE OF NINES (figure 9)

This is a method that is used to calculate the burned skin extension in a patient. This involves dividing the body surface in areas equivalent to 9% of the **total body surface area** that is burned (TBSA) or by multiples of 9.

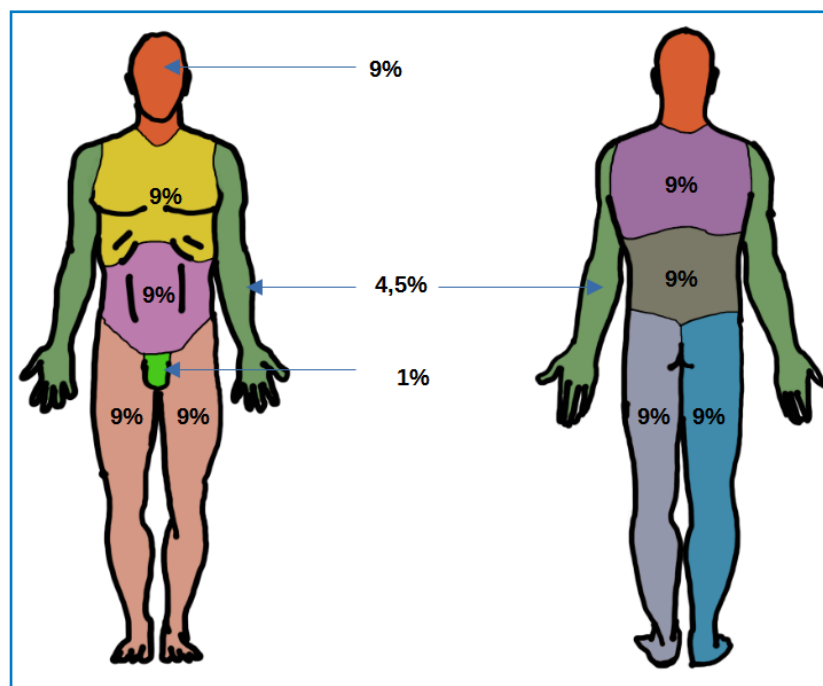


Figure 6. Rule of Nines (own source)



5.3.2. RULE OF 1 (PALM RULE) (figure 6)

This is a rapid assessment tool to calculate the TBSA % that is burned. The palm of the patient's hand is taken as a reference (fingers together and extended), the surface that can be covered in this way is 1% of the patient's TBSA. It is useful for small surfaces and as a complementary tool to the Wallace rule.

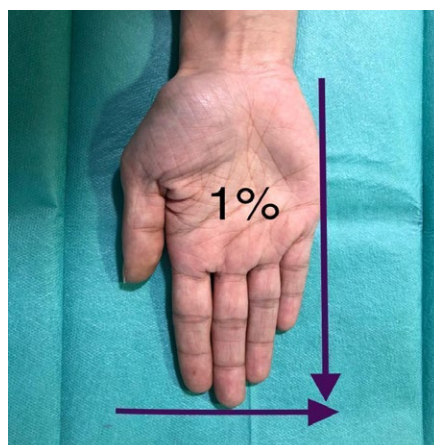


Photo 6. 1% rule (own source)

5.3.3. LAND & BROWDER CHART

In children the proportions of the % of TBSA vary in the different anatomic areas during their growth, with their head being much bigger and the limbs much smaller.

BURNED AREA	0 TO 1 YEAR	1 TO 5 YEARS	5 TO 9 YEARS	9 TO 14 YEARS	ADULTS
Head	19 %	17 %	13 %	11 %	7 %
Upper arm	2 %	2 %	2 %	2 %	2 %
Anterior trunk	13 %	13 %	13 %	13 %	13 %
Hind trunk	13 %	13 %	13 %	13 %	13 %
Nádegas	5 %	5 %	5 %	5 %	5 %
Right arm	4 %	4 %	4 %	4 %	4 %
Left arm	4 %	4 %	4 %	4 %	4 %
Right forearm	3 %	3 %	3 %	3 %	3 %
Left forearm	3 %	3 %	3 %	3 %	3 %
Right hand	2,5 %	2,5 %	2,5 %	2,5 %	2,5 %
Left hand	2,5 %	2,5 %	2,5 %	2,5 %	2,5 %
Right arm	5,5 %	6,5 %	8 %	8,5 %	9,5 %
Left arm	5,5 %	6,5 %	8 %	8,5 %	9,5 %
Right leg	5 %	5 %	5,5 %	6 %	7 %
Left leg	5 %	5 %	5,5 %	6 %	7 %
Right leg	3,5 %	3,5 %	3,5 %	3,5 %	3,5 %
Left leg	3,5 %	3,5 %	3,5 %	3,5 %	3,5 %
Genitals	1 %	1 %	1 %	1 %	1 %
Total	100 %	100 %	100 %	100 %	100 %

Table 1. Land & Browder table



In a more practical way of assessing a burn extension in children it is assumed that the percentage extension of the head in children under 10 year old is 18% less age and that of the lower limbs is 27% plus the age (figure 7).

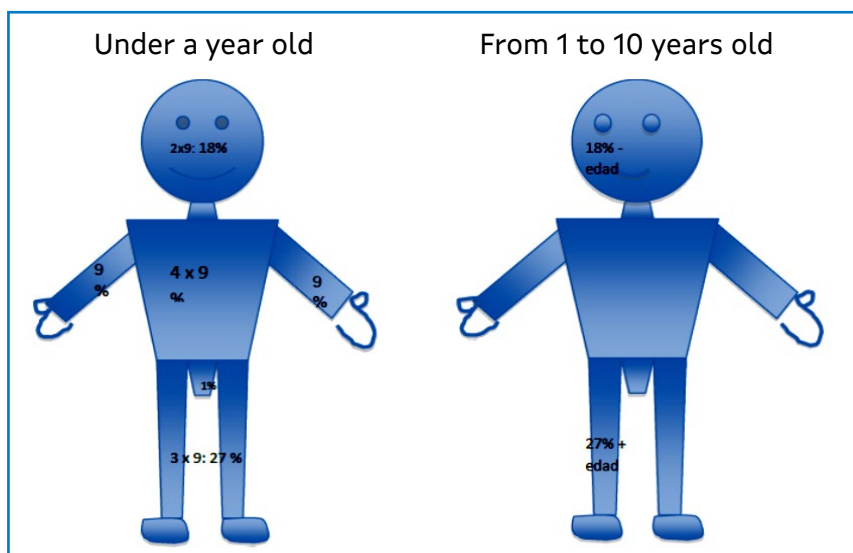


Figure 7. Own source

Children under 10 years old

Head = $18\% - \text{age}$
 MMII = $27\% + \text{age}$

RECOMMENDATIONS ⁽¹⁰⁻¹¹⁾	
It is recommended that the extent of the burn be assessed in adults and children using the Lund & Browder template.	B & C
The palm method and rule of nines are recommended as a method for estimating the burned area.	B
Periodic reassessment of burn depth in children and adults is recommended.	C



5.3.4. CAMERICAN BURN ASSOCIATION (ABA) EXTENSION CLASSIFICATION, ADAPTED⁽¹⁾

ABA BURN EXTENSION CLASSIFICATION

Minor burn

- Second-degree burn, less than 15% of BSA in adults or less than 10% of BSA in children.
- Third degree burn less than 2% of TBSA without affecting special areas (eyes, ears, face, feet, perineum and joints).
- Excludes electrical lesions, due to inhalation, concurrent injuries and patients with high risk.

Uncomplicated moderate burn

- Second-degree burn of 15% to 25% of BSA in adults or 10% to 20% of BSA in children.
- Third degree burn less than 10% of BSA that does not affect areas of special attention.
- Excludes electrical lesions, due to inhalation, concurrent injuries and patients with high risk.

Serious burn

- Second-degree burns of more than 25% of BSA in adults or 20% in children.
- Third-degree burns greater than or equal to 10% of BSA.
- Burns affecting eyes, ears, face, feet, perineum and joints.
- Electrical burns.
- Chemical burns in risk areas.
- All inhalation injuries.
- Burns with trauma.
- Burns in pregnant women.
- Burns in people at high risk: diabetes, lung disease, cardiovascular, immuno-compromising, cancer, AIDS, etc.

5.4. JACKSON ZONES^(1, 13, 14)

Jackson zones were postulated in 1963; it is not strictly a classification of burns, because it serves for all degrees, but it helps to understand the evolution of the burned area. Jackson defined the concentric zones that are present in all burns, regardless of the degree (photo 7).

- **Coagulation zone (A).** This is the epicentre of the burn, where the direct damage has occurred. It is an irreversible injury, which does not change with resuscitation, due to the coagulation of the constituent proteins of the tissue. It is an area where the injured tissue is not viable, it evolves into necrosis.



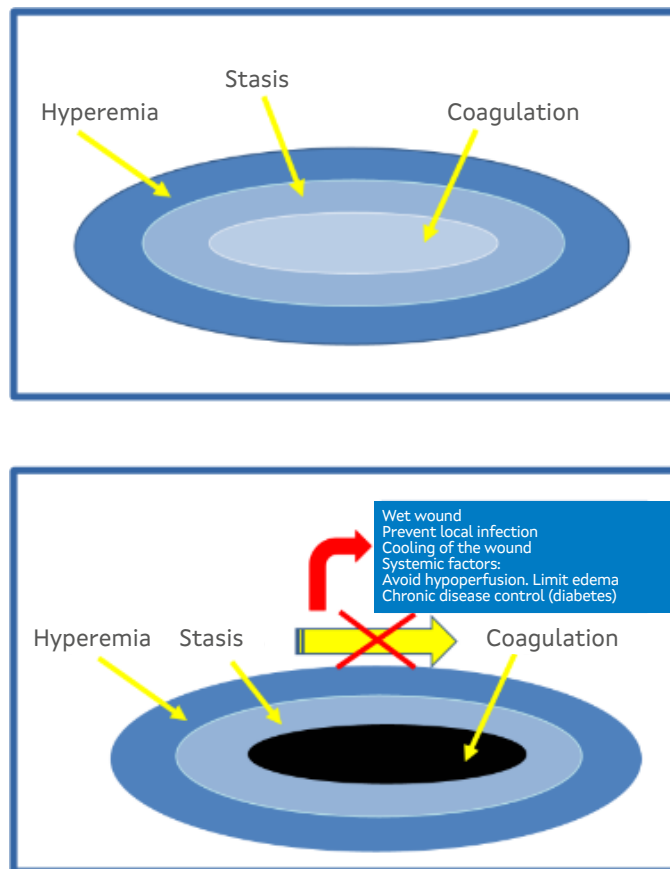
- **Ischaemia, stasis or venous congestion zone (B).** This is the most important zone, because it is the zone where adequate resuscitation can have the greatest impact. It surrounds the coagulation zone. The tissue in this zone is potentially salvageable, because tissue perfusion is decreased in this zone, and the aim of resuscitation is to increase tissue perfusion to prevent progression to irreversible damage. This zone can be further affected by conditions that favour tissue hypoperfusion, such as hypotension, infectious processes and marked oedema, all of which can lead to total tissue loss. This area is initially not devitalised.
- **Hyperemia zone (C).** This is the outermost part of the injury. In this zone there is an increase in tissue perfusion in the space surrounding the area of ischaemia. It is vasodilated by inflammatory mediators released in the ischaemic zone. It is a viable segment of the injury, and may remain unchanged until the healing process is complete.



Photo 7. Jackson zones (own source)

These Jackson zones allow us to understand the pathophysiology of the burn, and the aim of adequate resuscitation, which is none other than to avoid the progression of zones B and C towards A (figures 8 and 9).





Figures 8 & 9. Jackson zones (own source)



06. ETIOPATHOGENESIS PREDISPOSING FACTORS. DIAGNOSIS^(1, 14)

6.1. ETIOPATHOGENESIS

The factors that determine the injury are the intensity of heat, duration of exposure, and conductance of the tissue.

In the first phase after the burn, the predominant phenomenon is pro-inflammatory and is known as the systemic inflammatory response syndrome. The central element of this phase are the macrophages, as well as the TNF-alpha cytokine and interleukin 6 (IL-6).

The second phase after the burn is predominantly anti-inflammatory. It relies primarily on T-lymphocytes and three main mediators, the IL-4, IL-10 and TGF cytokines.

Severe burns produce a response that affects all systems. Inflammation, hypermetabolism, muscle damage and insulin resistance are the hallmarks of the body's pathophysiological response to the burn, with changes in metabolism that may persist for years after the damage.

Pathophysiologically, there are two phases in the resuscitation of the burn patient^(1, 10, 14):

- ♦ The first phase would be resuscitation itself, lasting 24-72 hours. This period is characterised by increased vascular permeability, which leads to intravascular volume depletion and formation of oedema. The aim of resuscitation in this phase would be to restore and preserve tissue perfusion to avoid ischaemia resulting in hypovolaemia and cellular shock. Resuscitation is the key in this phase, primarily by fluid replacement.
- ♦ The second phase occurs after the first 24-72 hours. A hyperdynamic and hypermetabolic phase occurs. This is characterised by decreased vascular permeability, increased cardiac work, and decreased peripheral vascular resistance. During this phase the blood flow to the burned areas is increased. In addition, the metabolic workload is increased up to three times higher than usual.

The burn causes the following **pathophysiological damage^(1, 14)**:



6.1.1. SKIN LESION

The burn produces inflammation, which manifests itself in the form of heat, redness, pain, functional impotence and oedema. There is an increase of vascular permeability and vasodilation.

6.1.2. HAEMODYNAMIC ALTERATIONS

The burn produces a loss of skin integrity, which in turn produces loss of capillary integrity, which causes the extravasation of fluid from the intravascular compartment toward the interstice, with the consequent formation of oedema. But the large oedema that occurs due to the burns is not only due to the loss of the capillary integrity, but it is also due to the other factors:

- ♦ **Alteration in the integrity of the microcirculation:** As result of the extravasation of fluid from the plasma towards the interstice and also of proteins. Generally, the oedema formed in a small burn reaches its maximum level between 8 and 12 hours after the injury, in the case of large burns this occurs later, between 18 and 24 hours, because the systemic hypovolemia delays the extravasation of fluid.
- ♦ **Change of the cellular membrane.**
- ♦ **Increase of osmotic pressure in the burned tissue:** Mainly due to the extravasation of sodium from the plasma compartment, which generates hyponatremia.
- ♦ **Haemodynamic instability:** There is a marked and early reduction in plasma volume and an increase in peripheral vascular resistance with decreased cardiac output.

6.1.3. METABOLIC DISORDERS

The burns produce a series of hormonal changes in the body that produce significant increase of metabolic expenditure and increase of nutritional requirements.

6.1.4. RESPIRATORY DISORDERS

The first cause of death in the first few days after the burn is respiratory failure. All levels of the respiratory tract (larynx, trachea, bronchi and lung parenchyma) may be affected by the effects of constriction and oedema caused by smoke or direct burns.



- Smoke poisoning is the main cause of morbidity and mortality during a fire.
- The combustion of materials frequently used in construction and in the domestic environment (synthetic products such as polyurethane, acrylic, nylon, plastics... and natural products such as silk, wool, cotton, wood...) under conditions of high temperature and lack of oxygen cause a mixture of toxic gases, among which the main ones are carbon monoxide (CO) and hydrocyanic acid (HCN).
- Inhaled smoke can cause local respiratory tract irritation, tissue hypoxia due to oxygen consumption by the combustion itself, and systemic toxicity more frequently due to CO and HCN.
- In developed countries the most frequent cause of cyanide poisoning is smoke inhalation in fires.

6.1.5. RENAL DISORDERS

Burns produce renal hypoperfusion, this being the main cause of acute renal failure (ARF) in the burn patient. ARF is of a prerenal type in the first hours or days (due to flow deficit), and renal type from the second week onwards (usually due to sepsis, nephrotoxicity, etc.).

6.1.6. HAEMATOLOGICAL DISORDERS

There is an alteration of the white blood cells (leukocytosis with neutrophilia) and platelets (thrombocytopenia and thrombocytosis).

6.1.7. IMMUNOLOGICAL DISORDERS

Infection remains the leading cause of death after the first few days post-burn. This is due to three mechanisms: the alteration of the mechanical barrier of the human body (skin and mucous membranes), the loss of proteins, and the alteration of the body's defence systems (humoral and cellular).

6.1.8. MUSCLE DAMAGE

Muscle damage occurs for two reasons, the burn itself, and because the badly burned person is a critical patient.



- In a burn patient, muscle is the first place where the body takes up glucose, so it plays an important role in regulating the metabolism. In addition, muscles function as an endogenous source of amino acids, providing fuel to maintain vital functions.
- On the other hand, there is a loss of muscle mass associated with the critically ill patient, which the burn patient will also suffer.

6.1.9. NEUROLOGICAL DISORDERS

Cellular hypoxia occurs, increasing intracranial pressure and formation of cerebral oedema. Agitation, confusion, ataxia, loss of consciousness, convulsions, abnormal postures, etc. may occur. In addition, peripheral neurological disorders may occur due to burned cutaneous nerves, in the form of anaesthesia/hypoaesthesia, chronic pain... Polyneuropathy in critically ill patients is very rare.

6.1.10. GASTROINTESTINAL DISORDERS

The burn patient may present intra-abdominal hypertension and secondarily abdominal compartment syndrome as a side-effect to systemic damage. This occurs in those patients with more than a 60% of BSA. It is not known whether these syndromes are iatrogenic (excess or insufficient fluid during resuscitation) or whether they are inevitable side effects of the primary injury.

6.2. PREDISPOSING FACTORS^(1, 3)

In principle, anyone is susceptible to burns.

However, it should be noted that there are two special populations with special characteristics when suffering from burns, namely children and the elderly.

- In the case of children, the younger they are in age, the greater the proportion between the body surface area (loss of heat) and total body mass (production of heat), so that the loss of heat is easier and quicker, in addition to not having defence mechanisms to slow down the cold by having an immature thermoregulation system.
- With regards to the elderly, there is a decrease in the basal metabolism, so that their heat production is less.



How is the risk of burns distributed?

- According to gender: In the most recent data, the burn death rate is slightly higher in women than in men. However, the burns rate is higher in men than in women.
- According to age: Adult women and children are especially vulnerable to burns. Burns are the fifth most common cause of non-fatal injury during childhood. While inadequate parental supervision is a major risk, a significant number of burn injuries to children are due to child abuse.
- Regional factors: There are important regional differences in burn rates, mostly related to the income of the country. For example, the incidence of burn deaths is more than twice as high among children under five in the WHO African region than among children under five in the rest of the world.
- Socio-economic factors: People living in low- and middle-income countries are at higher risk of burns than those living in high-income countries. However, within all countries the risk of burns correlates with socio-economic status.
- Other risk factors:
 - Jobs involving exposure to fire.
 - Poverty, overcrowding and lack of adequate security measures.
 - Underlying health problems, such as epilepsy, peripheral neuropathies and physical and cognitive disabilities.
 - Excessive alcohol consumption and smoking.
 - Easy access to chemicals.
 - ...

6.3. DIAGNOSIS^(1, 14)

The diagnosis of burns is primarily clinical. The correct initial assessment of a burn is very important.

The anamnesis should include the following data:

- Personal background.
- Date and time of the burn.
- Causal agent.
- Percentage of BSA (Rule of the 9 or 1% rule of the palm of the hand).



- ♥ Degree of the burns.
- ♥ Anatomic location of the burn.
- ♥ Place where the accident occurred.
- ♥ First aid received.



07. GENERAL GUIDELINES FOR TREATMENT

7.1. GENERAL CONSIDERATIONS

One of the factors that most influence the reduction of morbidity and mortality of the burn patient is the speed in starting suitable treatment. It is therefore necessary to have protocols in place to provide continuity to the interventions and ensure the correct care of the burned patient at the accident site, during transport or in the hospital until transfer to the referral burn unit is possible.

In general, all moderate burns and severe burns are referred to the hospital. Minor burns (which we can treat outside the hospital environment) can be referred if they are associated with a complex clinical development or are children under the age of 15 years or adults over 60 years old.

Burn victims can be treated in primary or specialised care depending on the degree, extent and depth of the burns they present. According to the CSUR, **admission criteria are**⁽⁴⁾:

- 2nd or 3rd degree burns > 20% BSA at any age.
- 2nd or 3rd degree burns > 10% of BSA in children under 10 years of age and over 50 years of age.
- Chemical and electrical burns.
- Burns in critical areas.
- Burns with associated injuries (smoke inhalation, trauma...).
- Burns with associated risks (clinical history of the patient such as diabetes, immunosuppression, etc.).

7.2. ON-SITE CARE

All burned patients must be considered as a potential multiple trauma patient.

The first step is to identify and rule out life-threatening problems⁽¹⁾. This is standardised in the application of the ABC protocol; ensuring adequate cardiocirculatory function, clear airway and respiratory function (see CPR 2021 algorithm, annex 1 and 2)⁽¹⁵⁾.



RECOMMENDATIONS⁽¹¹⁾

It is recommended that the ABC protocol be applied for the initial management of major burn patients, taking into account the technical capabilities of health personnel and local infrastructure.

C

General considerations to be taken into account at the accident site⁽¹⁶⁾:

- ♥ Always take universal precautions.
- ♥ The potential danger to the rescuer posed by the mechanism producing the burn should be taken into account. Remove the person from the burn source when it is safe to do so.
- ♥ Stop the combustion process with water or the **"STOP, DROP and ROLL"** method.
 - STOP – stop where you are.
 - DROP – drop to the ground and cover your eyes and mouth with your hands.
 - ROLL – roll from side to side until the flames are extinguished.
- ♥ Identify the victims, ensure their rescue and place in a safe area as far away as possible from the place of the event and in a safe place with clean air. If necessary, call for help (fire brigade, ambulance, etc.).
- ♥ Remove clothes, rings, watches, belts⁽¹¹⁾.
- ♥ Assessment of the burns. Estimate the approximate BSA in a first assessment to differentiate between severe and minor burns (rule of 9, palm of the hand rule).
- ♥ Cooling the burn with running water for a period of at least 20 minutes should be done as soon as possible and up to three hours after the injury. Water gel dressings can be used, but there is no evidence that they are more effective than water in cooling burns. If used, they should remain uncovered to allow air movement for cooling. DO NOT USE ICE or ice water (<8°C) (may increase tissue necrosis). Sea water should also not be used.
- ♥ The patient should be covered to avoid hypothermia.
- ♥ The headboard should be raised by 30° to limit the formation of facial oedema. Raise burned limbs above the chest.



- ♥ If it is a chemical burn, irrigate immediately within 10 minutes from the time of injury; this has been shown to reduce the severity of full thickness by five times and halve the length of hospital stay. Continue irrigation, if possible, until you reach the hospital. It is necessary to irrigate with a large volume of water at low pressure.
- ♥ For chemical burns, wear appropriate protective equipment to minimise the risk of cross-contamination. Use amphoteric solutions if available.
- ♥ If they are an electrical casualty, switch off the power before touching the patient, if safe to do so.
- ♥ Do not debride the phlyctenas until you reach a suitable location (hospital, health centre), except for those caused by burns of chemical aetiology^(11, 12, 17, 18).
- ♥ **IT IS NOT ADVISABLE TO APPLY ANY TYPE OF TOPICAL TREATMENT PRIOR TO REFERRAL TO A HOSPITAL CENTRE^(18,19).**

RECOMMENDATIONS ⁽¹²⁾	
The use of running cold water for at least 20 minutes, as soon as possible after the trauma, and up to 3 hours after the injury.	B
Do not use ice water for cooling burns.	B
Use warming measures to avoid hypothermia and perform temperature control during the pre-hospital phase.	C
Treat chemical burns as soon as possible, and at the earliest opportunity, regardless of delay in application.	D
Irrigate chemical burns for as long as safely possible.	D
Use amphoteric solutions, if available, as first aid for chemical burns.	D

7.3. TRANSFER OF THE BURN PATIENT TO THE HEALTH CARE CENTRE^(1, 11, 14, 19)

Burn patients who meet the criteria for referral to the hospital/referral burn unit (section 5.3.4. Classification of ABA burns and section 9.2 CSUR criteria for hospital admission) will be transferred in accordance with the conditions indicated in the previous section.

Burns can occur in a large-scale context, such as traffic accidents, accidents at work, fires in the home, etc., so 061 or 112 will be notified, who after the first assessment will decide on the transfer to the nearest health centre / primary care facility (PAC in Spanish) / hospital / burns unit of reference in an ambulance with basic life support (BLS), advanced life support (ALS), helicopter or by their own means.



Those minor burns that can be treated in primary care, if they subsequently require a consultation with the specialist unit due to poor evolution, delays in healing, etc., will be referred to the outpatient department of the burn unit by the primary care professional.

The burn is treated under the most aseptic conditions possible, both at the site of the accident and throughout the transfer to the health centre or reference hospital. It is important to cover the lesions, either with compresses or towels soaked in saline solution or water, or with water gel dressings^(10,11).

Patients with extensive burns require special attention, bearing in mind that in addition to the burn, patients may suffer from smoke inhalation. For transfer, in addition to paying attention to the burn, the airway should be isolated and fluids should be replaced as soon as possible. For this purpose, venous cannulations are performed⁽¹⁾:

- The first option is a peripheral vein in the unburned area, followed by a central vein in the unburned area.
- If this is not possible, a peripheral vein in the burned area.
- Lastly, and as the worst option, a central vein in the burned area.
- If the burned patient is unstable, an arterial line can be cannulated in the unburned area.
- In case of real severity, at least two routes should be cannulated.

Fluid replacement for patients with extensive burns should take place as soon as possible, starting at the site of the accident, or at the first centre where the patient is treated^(1, 10, 20-23):

- The most commonly used formula is the Parkland formula: 4 ml of Ringer's lactate (RL) x % BSA x kg patient weight. If the extension is greater than 50%, 50% is considered as "ceiling" to avoid overhydration. Of the total intake calculated for 24 hours, half should be given in the first 8 hours, and the other half in the following 16 hours. Then adjust according to diuresis, aiming for a target of 0.5-1 ml/kg/h (adults and adolescents) and 1-2 ml/kg/h (infants and children).
- Another option is the modified Brooke formula: 2 ml RL x % BSA x kg (adults) or 3 ml RL x % BSA x kg (children). Of the total intake calculated for 24 hours, 50% is administered in the first 8 hours, and the remaining 50% in the following 16 hours^(12, 14, 17, 23).



It is important to make the patient transfer as comfortable as possible, so we will deal with pain by administering the necessary analgesia and/or sedation.

RECOMMENDATIONS ^(10, 11, 12)	
Initiate fluid resuscitation using the Parkland method.	B
In adult major burns patients, volume replacement with isotonic crystalloids (Ringer's lactate solution, rather than colloids) is recommended.	A
In paediatric major burns patients, volume replacement with crystalloids (physiological solution, rather than colloids) is recommended.	A
Calculate and adjust volume replacement appropriately to avoid the complications of over-volumisation.	A
Initiate fluid resuscitation in burned adults and children with BSA > 20%.	D
Fluid infusion rate should be adjusted to urine volume, in adults 0.5-1 ml/kg/hr and 1-2 ml/kg/hr.	B



08. PRIMARY CARE TREATMENT OF BURN PATIENTS

It is essential that professionals in the primary care setting know how to provide quality care to the burn patient, reducing variability in clinical nursing practice as well as the occurrence of complications.

Minor burns could be treated in primary care according to the ABA (American Burn Association) classification, always taking into account the characteristics of the patient and the burn itself^(1, 10, 16-17, 24):

- All epidermal burns, regardless of the extent, except in children.
- Superficial dermal burns with an extension of less than 15% of the total body surface area (TBSA) in adults and less than 10% in children.
- Deep dermal burns with an TBSA extent of less than 2%.
- Subdermal burns with an extension of less than 1-2% of the total body surface area (TBSA) in adults and children depending on their location.

Current means allow close contact with the reference burn unit, using imaging for initial differential diagnosis, and also for monitoring, if necessary.

8.1 LOCAL TREATMENT OF BURNS IN PRIMARY CARE

1ST DEGREE BURNS (EPIDERMAL)^(1, 21, 25-27)

1st degree burns involve the epidermis. These are typical burns caused by the sun or by water scalding. They heal spontaneously.

Treatment guidelines for 1st degree burns⁽²⁴⁻²⁷⁾:

- First of all, the burn should be cooled and cleaned to neutralise the causal agent (slowing the action of heat, diluting and dragging chemical substances), relieve pain and reduce the release of inflammatory mediators.
 - The use of cold liquids for cooling causes vasoconstriction and accelerates the deepening of the injury, as well as an increased risk of hypothermia.
 - Tap water (if it is potable water), distilled water or isotonic saline (0.9% saline) is effective.
 - The ideal temperature for irrigation is between 15 and 20°C, with an average duration of 20 minutes.



- The area can be irrigated, the affected area can be submerged, or gauze or clean wet cloths can be placed over the affected area^(1, 14).
- Water gel dressings are a good option for cooling, although they are not usually necessary for 1st degree burns (they are used for transferring the burn patient).
- They do not require treatment, except for pain relief.
- When a burn occurs, a physiological dehydration mechanism is initiated, so it is essential to actively moisturise the skin, providing adjuvant substances for its recovery, thus avoiding itching.
 - The substances used may be applied in the form of creams, emulsions or gels. They should contain glycerine, sorbitol, propylene glycol, urea, fat-soluble vitamins (vitamin A and E) and collagen.
 - Apply several times a day to avoid skin dryness.
 - The patient will be instructed on the importance of not wearing clothes that compress or cause friction, as the skin could easily peel off.
 - Avoid exposure to the sun⁽²⁴⁻²⁶⁾.

2ND DEGREE BURNS (DERMAL)^(1, 24-27)

2nd degree burns affect the dermis.

Phlyctenas appear in these burns (photo 8). There has always been controversy about whether or not to debride the phlyctenas, and whether or not to aspirate their contents.

In a hospital setting, phlyctenas are always debrided, because they are larger burns that are more easily broken, and can be contaminated by their own bacterial flora, present in the skin appendages.

In primary care, phlyctenas can be debrided or not. Phlyctenas smaller than 6 mm can be left intact, as they are unlikely to rupture spontaneously, damage the wound bed or impede healing. For larger ones the following considerations should be taken into account⁽²⁸⁾:

- A correct assessment of the burn cannot be made if they are not debrided and the denatured epidermis is not removed.
- Phlyctena fluid negatively affects chemotaxis, opsonisation and intracellular death of neutrophils. It may serve as a medium for bacterial growth.
- On the other hand, the fluid in the phlyctena may exert pressure on the wound bed damaging micro-circulation and the burn may continue to deepen.



- ◆ If the phlyctenas are left in place and the epidermis is not debrided, the epidermis can act as a biological dressing and no treatment is necessary as these would not act on the wound bed.
- ◆ It is appropriate to debride blisters on the fingers, palms of the hands and soles of the feet. Blisters in these areas are associated with discomfort and limited mobility.
- ◆ The phlyctenas can be trimmed with sterile scissors and tweezers, leaving the burn as clean as possible of epithelial cells, so that the topical treatment will be more effective and cause less damage in subsequent dressings^(1, 17).



Photo 8. Broken and intact blisters (own source)

The first action for a 2nd degree burn is the same as for any other burn: irrigate with water at room temperature for 15 to 20 minutes to cool the area.

Cleaning is performed with lukewarm water with neutral soap or physiological saline solution.

- ◆ The application of antiseptics is only recommended in very specific cases, such as areas at high risk of infection or very dirty wounds.
- ◆ Under no circumstances is the application of colouring antiseptics recommended, as they mask the appearance of the wound and prevent a correct assessment of its extent and depth.
- ◆ If there is visible dirt or a high risk of infection (large burns), cleaning with water and broad-spectrum antiseptic soap (such as 4% chlorhexidine soap with subsequent rinsing) or cleaning with antiseptic solutions is indicated. After washing, the area should be carefully dried without rubbing so as not to damage viable tissue.



Once the cleaning and debridement of the denatured tissue is complete, the burn is properly assessed and covered with the dressing best suited to the conditions present, since burns go through different phases: the first phase of inflammation, which is more exudative, and the phases of granulation and epithelisation, which are not very exudative or dry⁽¹⁷⁾.

There is no single ideal dressing for burn treatments. One can choose from the range of moist wound healing (CAH in Spanish) dressings available in our healthcare system⁽²⁹⁾.

Antimicrobial dressings, antibiotic ointments or gels can be used when the burn is contaminated, infected or dirty, depending on the stage of the burn.

Consideration to the following is given when selecting the type of dressing to be used:

- ♥ The amount of exudate.
- ♥ Type of tissue.
- ♥ The extension, location and aetiology of the burn.
- ♥ Bacterial contamination or colonisation.
- ♥ The interval between treatments.
- ♥ The use of poorly adherent dressings.
- ♥ If there is a risk of infection or signs of colonisation or infection (bad smell, cellulitis, purulent exudate...) we have dressings made with ionic silver, nanocrystalline silver, iodised cadexomer, with honey... These dressings have a longer lasting and more effective effect than the usual ointments. Silver sulphadiazine ointment would not currently be the first indication for the treatment of burns, except for third degree burns⁽³⁰⁾.
- ♥ The evolutionary stage of the burn.
- ♥ The availability of material.

The use of SYSTEMIC ANTIBIOTICS is NOT recommended as prophylaxis in any type of burn because they can create resistance and there is no evidence that they improve prognosis^(1, 24-27).



SUBSEQUENT DRESSINGS follow the same protocol as the initial dressing:

- Clean the wound, removing abundant exudate, as well as the remains of existing ointment, and then apply physiological saline to perform a lavage.
- Debride the phlyctenas and remove the remains of devitalised epidermis, except if there are adhesions.
- Granulation tissue appears after 4-6 days.
- Dressings should not be vigorous (to avoid bleeding) and an excessive amount of ointment should not be applied.
- They can be spaced out depending on the type of treatment chosen.
- The epithelialisation phase begins after 7-12 days, usually at this stage the burn can be kept uncovered, with the application of moisturising cream.
- If the wound is very dirty (dirt, sand), do not rub the area to avoid bleeding. It would be advisable to apply gauze with plenty of ointment, and change it every 12-24 hours; the dirt will fall off by itself.
- It is recommended to put an elastic support mesh in place.

Second-degree burns use the same criteria and materials for their treatment, whether superficial or deep.

It should be borne in mind that deep 2nd degree burns will not heal spontaneously. If epithelialisation has not occurred after 2-3 weeks, a consultation with plastic surgery will be carried out, which will assess debridement and coverage with skin grafting.

In the case of 2nd and 3rd degree burns that are circular, the appearance of compartment syndrome should be monitored, which will require urgent surgical treatment (see section 9.5)^(1, 18, 19).

3RD DEGREE BURNS^(1, 23-27)

Third-degree burns affect the dermis and subcutaneous cellular tissue. Those that affect a small BSA can be managed in primary care.

These are burns that will require surgery (debridement with/without grafting) for them to heal; depending on their extension, outpatient treatment may be carried out for monitoring in the meantime.



Compartment syndrome should be monitored and treated if necessary in the case of circular 3rd degree burns.

3rd degree burns are usually treated with **SILVER SULPHADIAZINE** (photo 9):

- ♦ **The ointment is applied in a 1 cm thick layer on a gauze or compress.**
- ♦ **No interface should be placed between the compress and the burn** as this prevents the product from reaching the burn properly^(10, 24-25, 29).

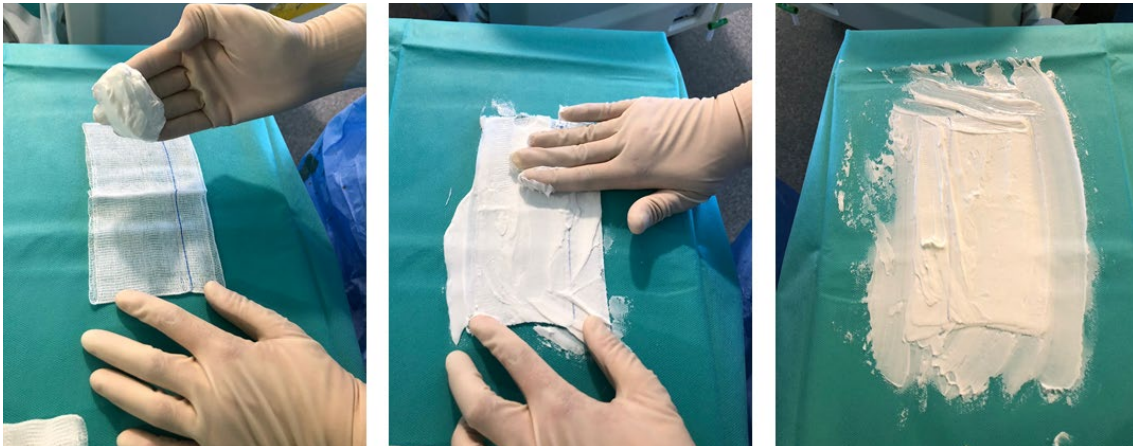


Photo 9. Application of silver sulphadiazine (own source)

8.2. PAIN MANAGEMENT IN PRIMARY CARE^(1, 31-33)

Analgesia is necessary to soothe the pain of the burn itself, but also to alleviate the pain caused by dressing changes and wound cleaning^(1, 31-33).

We must bear in mind that burns hurt a lot, and that susceptibility to pain is individual. The individual and the pain they perceive must therefore be assessed and treated appropriately.

Pain from minor burns is most often controlled with oral analgesics such as paracetamol, NSAIDs or metamizole. Occasionally, if necessary, subcutaneous, rescue or dressing doses of morphine chloride may be used.

In paediatric patients, analgesia should be adjusted to their age and weight.

As the burn heals, pruritus may develop and should be managed with oral treatment^(1, 31-33).



8.3. OTHER CARE NEEDED IN PRIMARY CARE^(1, 10,11, 17, 23)

Burns require non-compressive bandages that allow mobility of the affected area, especially if the burn is on a joint.

Bandaging of the fingers should be done one by one, to avoid adherence between them and to allow mobility. Tubular mesh is a good option, but a non-compressive cohesive bandage can also be used (photo 10 and 11).



Photo 10 and 11. Individualised mesh finger bandage (own source)

Bandages are used to hold compresses, gauze or non-adhesive dressings. Elastic tubular mesh is a good choice for areas that can be flexed, upper limbs, head and face. Elastic or cohesive bandage can be used for the lower limbs, without stretching, so as not to compress (photo 12 and 13). It is important to allow physiological oedema to expand.



Photos 12 and 13. Use of elastic bandage and tubular mesh (own source)



In the initial stage, the burned area must be rested and raised.

- The use of a sling is recommended for the first few days in the case of burns on the upper limbs.
- In case of burns on the lower limbs it is not suitable to remain in a static position, as this increases the oedema due to the fall and orthostatic pressure of the blood in the capillaries in the formation process (neoangiogenesis).
- Relative rest of the limbs on pillows or cushions so they can be raised above the body plane is recommended.
- The need for thromboembolic prophylaxis should be assessed.
- In case of neck burns, the use of a pillow should be avoided, to prevent the neck bending that may result from its use. If necessary, a neck brace (made of tubular mesh) can be used to prevent the neck from bending (photo 14).



Photo 14. Full face bandage (own source)

In case of burns affecting the **eye region**:

- In the presence of clinical signs (pain, exudate, ulceration, impaired vision) or suspicion of these, the patient should be referred to ophthalmology.
- The usual treatment usually consists of the use of eye drops and ointments with antibiotics, corticoids, epithelialising agents or lubricants.



Chlorhexidine mouthwash 0.12% is the antimicrobial of choice to prevent infections in the oral cavity. Mucosal barrier products form a film in the mucosa by relieving the pain in the states of inflammation.

8.4. RECOMMENDED PRODUCTOS FOR THE CARE FOR BURNS

We will discuss moist healing dressings, ointments and antiseptics.

8.4.1. MOIST ENVIRONMENT HEALING (CAH IN SPANISH) DRESSINGS^(29, 34)

In our community there is a continuously updated catalogue of CAH dressings, many of which can be used on burns^(29, 34). <https://ulcerasfora.Servizo Galego de Saúde.es/Informacion/Cat%C3%A1logo-de-productos?idioma=es>



Figure 10. Product catalogue Healing in a moist environment. Source Úlceras Fóra Programme

Recent studies show a better evolution, lower cost and lower incidence of infection with CAH dressing coverage. However, in certain circumstances (orography of the area, lack of suitable material, etc.), the application of ointments may be an option.

MOIST WOUND HEALING DRESSINGS		
PRODUCT	CHARACTERISTICS	INDICATIONS
Alginates	High absorption capacity. Haemostatic. Secondary support required.	2 nd degree very exudative burns.
Hydrogels	High water content.	Powerful autolytic and enzymatic debridement. Cools and relieves pain.
Polyurethanes	Absorption and exudate management. Semi-permeable adhesives and non-adhesives. Silicone ones have low adhesion.	2 nd degree burns. Silicone ones respect the epithelialised tissue. Apply in injuries with good granulation tissue.
Hydrocolloids	Absorbent gel formers.	Superficial 2 nd degree burns. Superfine is ideal in final stages of epithelialisation.
Hydrocolloids with hydrofibre	High absorption capacity. Gel formers. Secondary support required.	Exudative 2 nd degree burns.
Antimicrobial	Wide spectrum bactericides. Silver releasing and non-releasing.	2 nd degree burns with risk or signs of infection.
Interface meshes	They are hydrophobic Protect the wound bed and newly formed tissue.	Superficial burns. Sometimes with a mesh and a gauze this is sufficient. Deeper burns with granulation tissue.
With ionic charge	Bioactive with Zn+, Mn+ and Ca+ Stimulate the formation of a scar.	Lesions in a granulation and epithelisation phase.



MOIST WOUND HEALING DRESSINGS		
Matrix metallo-proteinases modulators (MMP)	Modulates the action of the MMP. Recovers the activity of forming a scar.	Burns that are free of necrotic tissue and infection have a delay informing a scar.
Polyurethane + alginate + silver ions	Outer layer of polyurethane foam that absorbs exudate, with alginate matrix and broad-spectrum antimicrobial Ag ions. Contains propylene glycol which may cause skin irritation.	2 nd degree burns and graft donor sites.

Table 2. Moist wound dressings: indications for burns

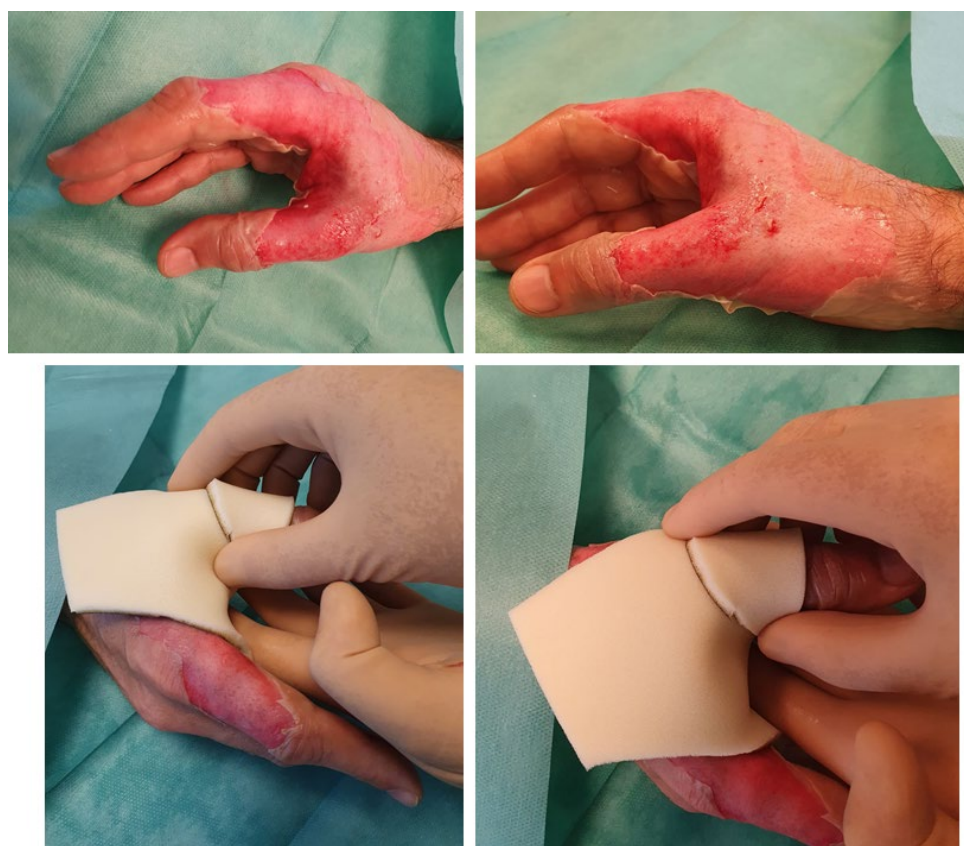


Photo 15. Moist wound dressing (own source)

8.4.2. OINTMENTS^(29, 34)

♥ **Silver sulphadiazine – NOT CURRENTLY INDICATED AS A FIRST CHOICE IN THE TREATMENT OF A BURN**

- Combines the action of sulphonamides with silver. It is effective against gram positive and gram negative, being a fungicide against Candida. Resistance may be observed.
- Addition of cerium nitrate to sulphadiazine eliminates resistance (hospital use). Its activity is short with treatment left open to the air, requiring treatment every 12 hours. In occlusive treatment, a generous layer of the cream preparation of silver sulphadiazine with cerium nitrate can be effective for up to 24 hours, although it is recommended to change every 12 hours in deep, extensive burns. It has the capacity of penetration in the eschar. Adverse effects are very rare.
- Silver sulphadiazine has been the most widely used topical agent in burn units⁽¹¹⁾. Recent advances in the treatment of burns have reduced the use of silver sulphadiazine because its use in combination with enzymatic debridement agents with bromelain, which have been widely used since their recent appearance in the treatment of burns, is contraindicated.

♥ **Manuka honey.** This is a gel with 80% honey, which is antibacterial, with natural waxes and oils. It is indicated for 2nd degree burns.

♥ **Antibiotic ointments.** Antibiotics used for superficial skin infections such as mupirocin and gentamicin can be used on burns in case of infection.

♥ **Betamethasone.** Corticosteroid with anti-inflammatory and antipruritic effect, this may be indicated in advanced stages of burns in which excess growth of granulation tissue is observed.

8.4.3. ANTISÉPTICOS^(29, 34, 35)

♥ **Chlorhexidine.** This is the antiseptic of choice due to its broad antimicrobial spectrum, being active against gram +, gram – and spores. Its activity is fast and its action is long-lasting. It has few adverse effects due to its practically null skin absorption. It is used on dirty burns or burns at risk of infection, also on large burns. It is also the antiseptic of choice for burns in the oral cavity.

♥ **Gel or solution with polyhexanide.** Combines the action of the antimicrobial substance polyhexanide with the surfactant betaine. It can be used on first and second degree burns, chemical, thermal and post-radiation burns. It can be applied for at least 15 minutes or simply rinsed off the burn. Avoid contact with the eyes and entry into the ear. Not for use on pregnant women or nursing mothers due to lack of clinical trials.



- ♥ **Sodium hypochlorite 5.25%.** Broad spectrum antiseptic and germicidal solution, effective against gram positive and gram negative bacteria, fungi, viruses and spores.

EVIDENCE		
[E]	Honey-based treatments heal burns better than those treated with silver sulphadiazine.	MODERATE (COCHRANE, 2017)
[E]	Silver sulphadiazine for extensive 3rd degree burns.	C (Yoshino, 2016)



9. HOSPITAL TREATMENT OF THE BURN PATIENT^(1, 10, 12, 17, 36)

Burn units are complex units for the care of the burn patient, i.e. they are a true integrated unit within the hospital (photo 16). They have an inpatient unit, outpatient clinics and an operating theatre, as well as a positive pressure system.

They must have a multidisciplinary team including: nursing professionals, plastic surgery, intensive care and anaesthesia specialists, physiotherapy, psychology, occupational therapy, nutrition... in order to prioritise patient-centred care⁽¹⁾.

When there is no Burn Unit, the patient can be admitted to a hospitalisation unit (usually Plastic Surgery) or conventional critical care unit. The treatment would be the same, with the difference being the location of the patient. The patient will preferably be admitted to a single room.



Photo 16. Entrance to the HUAC burn unit (own source)

9.1. NON-CRITICAL BURN PATIENT HOSPITALISATION^(1, 26, 36, 37)

Non-critical burn patients are those who require admission to a burn unit according to CSUR criteria, but are stable and therefore do not require critical care (respiratory support, circulatory support, vasopressors or specific critical care devices).



9.1.1. ADMISSION^(4,26, 37)

The burn patient comes to the hospital emergency department, either directly or from a health centre or PAC. An initial assessment is made by the plastic surgeon, and admission is coordinated with the corresponding burn unit or hospitalisation unit. The treatment will be carried out if possible in the admission unit, not in the emergency department.

9.1.2. INITIAL TREATMENT^(1, 4, 36, 37)

The patient is given an explanation about the care they are going to receive and any questions are answered.

The first action is cleaning:

- In case of admission to the burn unit – There is a therapeutic bath (photo 17) where cleaning will be carried out: irrigation washing of the burns using a shower head with water at room temperature⁽¹⁷⁾ and neutral soap. The use of antiseptics is not sure to be beneficial, as it may interfere with the healing process, it would be used in case of dirty wounds⁽³²⁾. The wound is then rinsed, debrided,^(11,40) epithelial debris is removed, covered with sterile towels and the patient is transferred to their room.
- In case of admission to a conventional unit – Cleaning would be done in the shower or on the patient's bed.



Photo 17. Burn patient bath (own source)

Attempts should be made to maintain an adequate room temperature (**26° C**), both in the bathroom and in the patient's room, as well as in the different areas.



RECOMMENDATIONS ⁽¹¹⁾		
[R]	To prevent hypothermia, it is recommended to maintain a stable room temperature, close to 26° C for adults and children, rather than lower temperatures.	C

Throughout the procedure, the patient is given analgesia as necessary for adequate pain control^(31, 32).

Once the cleaning is complete, **the burn is reassessed, and the local treatment to be applied is decided.** The depth and extension of the burn is decisive in the choice of the type of treatment^(1, 18, 19).

- In general, 2nd degree burns are treated with an antiseptic moist wound healing process or SSF (physiological saline solution) until the next day (photo 18).



Photo 18. Moist dressing (own source)

- After 24 hours, the burn is reassessed.
 - In the case of a superficial 2nd degree burn, honey dressing, polylactic acid film or CAH can be used.
 - In the case of a deep 2nd degree burn, enzymatic debridement with bromelain is performed. After enzymatic debridement, a moist dressing is performed again, with or without hydrocolloid dressing as secondary coverage.
 - If the burn is undoubtedly 3rd degree, dressing with silver sulphadiazine is performed and surgery is scheduled.

Patients will be monitored by measuring the following parameters and performing laboratory tests:



- ♥ Blood pressure, heart rate and temperature.
- ♥ Pain level with a validated scale.
- ♥ Electrocardiogram.
- ♥ Laboratory: Biochemistry, haemacytometry and coagulation tests.

RECOMMENDATIONS ⁽¹⁰⁾		
[R]	Silver sulphadiazine for the treatment of extensive third-degree burns.	C
[R]	Dressing materials such as hydrocolloids, hydrogel, polyurethane film or foam, alginate and hydrofibres are recommended as an option for topical treatment of burns.	C1
[R]	Hydrotherapy for minor burns not requiring hospitalisation.	B
[R]	Hydrotherapy for severe extensive burns with bath disinfection.	C1

9.1.3. CONTINUED TREATMENT^(1, 11,23, 36, 37)

During the stay in the unit, a protocolised assessment of the burns is carried out according to the chosen treatment.

All treatments are carried out under sterile conditions and with appropriate pain management.

With each new treatment, a new assessment of the burn is carried out and the treatment to be applied is selected, with the possibility of continuing with the same treatment or choosing another.

- ♥ There are different treatment options for **superficial 2nd degree burns**: ^(29, 34).
 - CAH dressings follow the treatment protocol depending on the dressing chosen.
 - Polylactic acid film dressing has a specific protocol: it cannot get wet and is not removed. They require secondary coverage with impregnated dressings, sterile gauze and mesh support. The secondary cover is changed every 48 hours, without removing the first layer placed over the polylactic acid sheet. It acts as a second skin. In the course of burn healing, the film peels away from the burned surface, which may occur within 14 to 21 days, without causing pain. The peeling part is trimmed off.
 - For facial burns, they can either be left in the open air or occlusive treatment can be chosen depending on the depth of the burn. The Manuka honey treatment follows the pattern of 3 applications on consecutive days, one on top of the other, without removing the previous layer (photo 19). In the following days a crust is created that is removed as epithelialisation takes place.





Photo 19. Facial burn treatment with Manuka honey (own source)

- ♥ **Deep 2nd degree burns** – Enzymatic debridement with bromelain followed by moist dressing.
- ♥ **3rd degree burns** – Will require surgery for debridement and grafting for healing. In general, and until surgery is scheduled, daily treatment with silver sulphadiazine or nano crystalline silver mesh is performed, taking into account the comfort of the burn patient.

Surgical treatment (acute and planned) of the burn patient will be discussed in section 9.4.

9.2. HOSPITALISATION OF CRITICAL BURN PATIENTS^(1, 10, 12, 17, 19, 23, 25)

As we have already mentioned, **every major burn patient is potentially a polytrauma patient**, so we must bear in mind that there may be other types of injuries.

Thus, the first thing we do is to identify and rule out problems that could compromise the patient's life, applying the ABC for resuscitation:

- ♥ **Airway⁽³⁸⁻⁴¹⁾** – Airway compromise in patients with facial burns will be treated appropriately with placement of an orotracheal tube (OTT). Sometimes in patients with severe burns, orotracheal intubation is also performed, even if there is no immediate airway compromise⁽²¹⁾.



- The upper airway is affected by the local thermal effect and by oedema.
- Signs indicating thermal injury are: burnt nasal vibrissae, burns of the lips or oropharyngeal mucosa, productive cough, hoarseness and stridor.

♥ **Respiratory Function**⁽³⁸⁻⁴¹⁾ – Oxygen saturation monitoring. Oxygen saturation should be maintained at 94-98%. In extensive burns administer oxygen at 35%. If there is exposure to gases and smoke, humidified oxygen should be administered at 50-100%. In all other cases, administer the oxygen necessary to maintain O₂ saturation above 98%.

♥ **Circulation**⁽³⁸⁻⁴¹⁾ – Burns involving more than 20% of BSA result in cardiovascular changes known as “burn shock”. Their initial pathophysiology occurs due to plasma leakage from the intravascular space into the interstitial space.

♥ **Spinal cord injury**⁽³⁸⁻⁴¹⁾ – If spinal cord injury is suspected, immobilise the cervical and dorsolumbar spine until no injury is demonstrated.

♥ **Resuscitation/Reanimation**^(20, 21, 42, 43) – Attempts to avoid shock from the burn. In general, the objectives of resuscitation are:

- Maintain the perfusion of vital organs and prevent the development of multiple organ failure.
- Restore the loss of fluid seized in the burned tissue and, to a lesser extent, in the healthy tissue.
- Provide the least amount of fluid volume necessary to maintain adequate perfusion of the organs (the fluid accentuates the oedema).
- Replenish sodium plasma losses, produced by the passage of this towards the burned tissue and the intracellular space.
- Dextrose-containing solutions should be avoided in adults and older children, as this would result in an excessive and detrimental total intake of dextrose. An exception are small children, whose glycogen deposits are very scarce and require an extra contribution of carbohydrates.
- In general fluids that contain salt at least in isotonic quantities with the plasma are suitable for use in resuscitation, as long as they are provided in the right amount.
- The resuscitation ends when the oedema formation ceases, which usually occurs between 24 and 48 hours after the burn. We cannot forget, from that moment, the replenishment of the daily loss of fluids that occurs through the burn. The most commonly used replacement fluids will be discussed below.



- ♥ **Physiological measurements** – The following should be monitored:
 - Oxygenation using pulse oxymeter.
 - Blood pressure – Try MAP (mean arterial pressure) of 70 mmHg.
 - Heart rate (HR)(the presence of tachycardia > 130 bpm usually indicates volume deficit).
 - Urinary catheterisation with hourly diuresis Renal blood flow is a reflection of systemic perfusion during the early burn phase.
 - Adequate balance of inputs and outputs of liquids.
 - Electrocardiography monitoring Arrhythmias are common in the elderly and in electrical burns.
 - Body temperature – Attempting to maintain normothermia.

- ♥ **Neurological function** – Assessment and reassessment of the level of awareness using the Glasgow Outcome Scale and through pupil assessment.

- ♥ **Secondary assessment** – A system-by system physical examination must be carried out, in addition to identifying associated trauma, researching the patient's previous clinical history, basal life and the characteristics of the thermal trauma that they have suffered.

- ♥ **Pain control** – Intravenous treatment must preferably be used, avoiding administration using an intramuscular or subcutaneous route.

- ♥ **Anti tetanus prophylaxis** – Depending on the patient's history of immunisation.

- ♥ **Diet** – Should always be nil by mouth until assessed by specialist staff. Subsequently, nasogastric tube placement is necessary (see nutritional care).

- ♥ **Complementary tests** – Those which must be carried out are:
 - Arterial blood gas analysis with carboxyhaemoglobin determination
 - Chest x-ray
 - ECG
 - Laboratory:
 - Arterial blood gas
 - Haemocytometry - should include haemoglobin, haematocrit and platelets.
 - Biochemistry – Should include plasma electrolytes, creatinine, urea nitrogen, proteinemia, glycaemia, calcium, phosphorus, magnesium and CPK, renal function, lactate (43)
 - Coagulation (prothrombin and aPTT)
 - Urine analysis to rule out myoglobinuria (especially in electrical burns)⁽¹¹⁾
 - Others.



9.2.1. RECEPTION

The critically burned patient will be admitted to the reference Burn Unit or to an Intensive Care Unit (ICU) in the absence of a burn unit. In the case of severe burns in children, treatment takes place in the paediatric ICU of the reference hospital.

The coordination between the transfer and the arrival of the patient at the reference unit must work as a parataxis, as it is necessary to have the necessary devices ready to carry out a proper admission, which includes essential safety and quality measures.

The patient will be admitted to a bed in a critical care unit, whether in the burn unit or in the ICU. In no case will the patient be treated in the therapeutic bath due to the need for devices to stabilise the patient.

It is important to look after the family, to give them information in a calm, friendly manner, without rushing, allowing them time to ask questions, resolve concerns and provide comfort. We must bear in mind that people who suffer major burns have a high mortality rate, and the hospitalisation period will be prolonged.

9.2.2. INITIAL CARE OF THE CRITICAL BURN PATIENT

As we have already mentioned, **every critical burn patient is potentially a polytrauma patient – In the initial assessment of the patient we will first deal with the airway and respiration, haemodynamic stabilisation and then treatment of the burn.**

9.2.2.1. RESPIRATORY FUNCTION^(1, 12, 17, 37-41)

The main aim is to maintain a clear airway and meet oxygenation needs.

Extensive burns patients usually have the airway isolated with an orotracheal tube from initial care and during transfer. Sometimes this is not the case, and OTI (orotracheal intubation) is performed on arrival. To do this, the patient is first informed of the procedure to be performed, then given relaxing, sedative medication, the orotracheal tube is placed and the patient is connected to mechanical ventilation.

Adequate sedation and analgesia are maintained during the time the patient is connected to mechanical ventilation⁽⁴⁴⁾:

It may be necessary to also give the patient muscle relaxants such as cisatracurium if there is poor adaptation to mechanical ventilation. It is advisable to use them occasionally, or if continuous infusion is necessary, try to use them for as short a time as possible to avoid complications.



The degree of sedation and analgesia is assessed according to validated scales, such as the RASS scale (Richmond Agitation-Sedation Scale) and the ESCID scale (pain indicator behaviour scale) (figures 10 and 11)⁽⁴⁵⁻⁴⁷⁾.

This medication will be maintained in continuous perfusion, with boluses at necessary moments, such as mobilisation, oral hygiene, dressings...

RASS (RICHMOND AGITATION-SEDATION SCALE)		
CORE	TERM	DESCRIPTION
+4	Combative	Overtly combative or violent. Immediate danger to personnel
+3	Highly agitated	Removes tube(s) or catheter(s) or behaves aggressively towards staff.
+2	Agitated	Frequent unintentional movement or patient-ventilator asynchrony
+1	Restless	Anxious or fearful, but no aggressive or vigorous movements
0	Alert and calm	
-1	Drowsy.	Not fully alert, but has been awake (more than 10 seconds) with eye contact, to voice (call)
-2	Mild sedation	Briefly awake with eye contact (less than 10 seconds) to call.
-3	Moderate sedation	Some movement (but no eye contact) to call
-4	Deep sedation	No response to voice, but some movement to physical stimulation.
-5	No awakening	No response to voice or physical stimulation

Table 3. Agitation / sedation scale (RASS) (own source)



ESCID (PAIN BEHAVIOUR INDICATOR SCALE)			
	0	1	2
Facial musculature	Relaxed	Frowned brow Pain gesture Tension	Frowned brow in a habitual manner Clenched teeth
Calmness	Calm Relaxed Normal movements	Occasional movements Restlessness	Frequent movements including head and limbs
Muscle tone	Normal	Increased bending of fingers and toes	Stiff
Adaptation to mechanical ventilation (MV)	Tolerates MV	Coughs, but tolerates MV	Fights with ventilator
Comfort	Comfortable Calm	Calm with touch or voice. Easily distracted	Difficult to control by touch or speaking
0- No pain 1-3 Mild/ moderate 4-6 Moderate/ severe >6 Very severe			

Table 4. Pain Indicator Behaviours Scale (ESCID) (own source)

9.2.2.2. CIRCULATORY FUNCTION^(1, 21- 23, 44)

Burns greater than 20% in extension produce a systemic inflammatory response with loss of plasma from the intravascular space to the interstitial space known as burn shock, a combination of hypovolaemic shock and cellular shock resulting in haemodynamic changes. This combination produces oedema, hypovolaemia and haemoconcentration. If concomitant with smoke inhalation it will increase the severity of the patient and affect the subsequent treatment and prognosis due to tissue hypoxia.

It is very important for the patient's evolution that volume replacement needs to be started as quickly as possible, and the amount of volume administered until arrival at the reference centre must be communicated at the time of admission. Adequate volume replacement requires a good assessment of the BSA.

As mentioned above, Ringer's lactate (LR) is the ideal solution for rehydration of major burns, although other balanced crystalloids are now beginning to be used.

There are different formulations for fluid resuscitation (figure 12)^(1, 20-23).



- The most widespread in our environment is the PARKLAND formula – 4 ml / kg / BSA in adults and 3 ml / kg / BSA in children in the first 24h.
- The PARKLAND formula adds colloids in the following 24h (albumin 0.3-0.5 ml / Kg / % BSA / 16h), thus maintaining volume and avoiding oedema.
- Another option is the modified BROOKE formula – 2 ml / BSA / Kg is administered. 50% in the first 8 hours and the remaining 50% in the following 16 hours.
- In children the Galveston formula can be used: 5000 ml/m² of BSA + 2000 ml/m² of BSA 50% in the first 8 hours and the other 50% in the following 16 hours.
- Paediatric patients need fluids with glucose, their hepatic glycogen stores are depleted by 12-14 hours of fasting.
- In burns greater than 50% of BSA consider 50% replacement as a “ceiling”.

FLUID REPLACEMENT FORMULAS		
PARKLAND	GALVESTON (children)	MODIFIED BROOKE
<u>First 24 h</u>	<u>Primeiras 24 h</u>	<u>Primeiras 24 h</u>
4 ml R. Lactate/Kg/%BSA (adults)	5000 ml/m ² BSA + 3000 ml/m ² TBA	2 ml R. Lactate/Kg/%BSA (adults)
3 ml/Kg/%BSA (children)	50% first 8h	3 ml/kg/%BSA (children)
50% in first 8h 50% in follow-ing 16h	50% following 16h + 12.5 gr albumin	50% in first 8h 50% in following 16h
<u>Next 24h</u>	<u>Next 24 h</u>	<u>Next 24h</u>
Albumin 0.3 – 0.5 ml/Kg/%BSA	1500 ml/m ² TBA + 3750 ml/m ² BSA + 12.5 gr albumin	Albumin 0.3 – 0.5 ml/Kg/%BSA

Table 5. Fluid replacement formulas (own source)

If volume replacement is not sufficient to maintain haemodynamic control, a vasopressor infusion is started.



The volume of fluid infusion will be monitored by, among other things, the measurement of diuresis via a bladder catheter, expecting a diuresis of 0.5-1 ml/kg/h in adults and children > 30 kg and 1-2 mg/kg/h for < 30 kg. MAT and HR are also used for volume adjustment, although they are nowadays proving to be unreliable, as they can lead to under- or over-replenishment of fluids.

Intra-abdominal pressure (IAP) is also measured in these patients, as its elevation is a complication that increases mortality by more than 80%.

The administration of large volumes of fluids in burn patients can lead to fluid creep, which increases the risk of developing intra-abdominal hypertension and abdominal compartment syndrome (level 1 evidence)⁽¹¹⁾.

Critical care units have invasive devices for haemodynamic and volumetric monitoring of patients. They are increasingly used in major burn patients, as they allow individual and more precise adjustment of fluid replacement and thus avoid volume overload or volume deficits. The most commonly used monitoring is transpulmonary thermodilution. The parameters recorded provide information on preload, afterload, cardiac contractility and excess lung water among others.

9.2.2.3. RENAL FUNCTION⁽¹⁾

Burn patients present a decrease in renal flow, which is initially a consequence of the decrease in cardiac output and volume. If not promptly resolved, this can lead to acute renal failure (ARF). This is why fluid replacement is so important.

Hourly monitoring of the level of urine output, using a bladder catheter, will provide information on the onset of ARF, which is confirmed by laboratory tests such as osmolarity and sodium values. ARF may also be due to drug toxicity or sepsis (an important complication in major burn patients). Renal replacement therapy (RRT) may be necessary.

9.2.2.4. NUTRITION^(17, 48-49)

The critical burn patient will have a state of hypercatabolism and severe hypermetabolism maintained from the first moment of thermal aggression, with the consequent increase in energy expenditure.

A gastric protector is needed to avoid stress ulcers and enteral nutrition is started early.

Nutritional assessment must be a dynamic process that will present multiple variations throughout the process.



Enteral nutrition (EN) is preferable to parenteral nutrition (PN), as it delivers nutrients directly to the intestinal mucosa, thereby reducing bacterial translocation and sepsis. Early EN can be safely administered and will help preserve the functionality and integrity of the small intestine. Enteral nutrition may not be sufficient because it is not tolerated by the patient (vomiting, measurement of nasogastric tube output above 300 cc, sustained diarrhoea) and may be accompanied by PN to prevent malnutrition.

Parenteral nutrition has drawbacks:

- It requires central venous access, which is not always available in major burn patients, as the central catheter has a certain number of lumens and PN must go only through one of the catheter lumens.
- There are important elements that cannot be added to PN, such as glutamine.

Patients on mechanical ventilation (MV) require the placement of a nasogastric or orogastric tube for nutrition until invasive respiratory support can be withdrawn and an oral intake can be started to meet nutritional needs.

Nutritional formulas should be tailored to the patient's needs. They should contain:

- Essential amino acids such as glutamine and arginine. These are depleted by the burn process and are essential for resistance to infection and as antioxidants.
- Protein 1.5- 2 g/kg/day in adults and 3g/kg/day in children.
- Carbohydrates 4-5 g/kg/day which should be the main source of energy for burn patients.
- Blood glucose monitoring every 6 hours. Hyperglycaemia (values above 180 mg/dl) leads to adverse clinical outcomes such as delayed wound healing, increased incidence of infection and increased mortality.
- Lipids 1.0-1.5 g/kg/day. The major source of lipids is omega-6 fatty acids. Omega-3 supplementation as a single immunotherapy has shown beneficial effects.



In addition, micro-nutrients such as vitamins and trace elements will be necessary:

- Vitamin C, essential for collagen synthesis and cross-linking. It has a protective effect on the endothelium. A dose of 3 g/day for 3-6 days would be necessary to restore vitamin C levels in the post-aggression period.
- Zinc, necessary for various aspects of healing. Dose 75 mg / 12 h. Also selenium and copper.
- Folic acid, important in tissue formation. Dosage 5 mg / day.
- Vitamin D deficiency is often present, although there are no clear recommendations for supplementation.

9.3.2.5. LOCAL TREATMENT OF CRITICAL BURNS^(1, 12, 17-19, 23, 50-51)

The initial assessment consists of an anamnesis including: place and time of burn, causal agent, first aid received, extension and degree of burns.

It is important to assess the need for escharotomies to avoid compartment syndrome, which occurs in the case of circular burns. Enzymatic debridement with bromelain (ED) can avoid escharotomies if compartment syndrome is not present^(18-19, 50-52).

The initial treatment of the burn is currently performed moist dressings with physiological saline or cleansing solutions. The following day, the burn is reassessed, changing or maintaining the initial treatment applied.

- If enzymatic debridement is decided – Follow the steps explained in the following section, surgical treatment of the burn.
- Treatment can be carried out by applying compresses impregnated with silver sulphadiazine. This was the most commonly used treatment in burn units until a few years ago. Today it is still used for very extensive burns, deep 2nd degree and 3rd degree burns, which will require grafting.
- Nanocrystalline silver dressings can also be used.
- It is difficult to find a dressing that is suitable for large burns, is easy to handle, and is cost-effective, so silver sulphadiazine is still used, although it is recommended only for 3rd degree burns and those that are infected.
- It is very important that the dressings do not shift and that alignment and physiological position are maintained. For this purpose, mesh suits are made



(photo 20) and pillows, pressure reducing devices are used, to prevent ulcers and clubfoot.

- ♦ The burns are often very exudative, so it is necessary to reinforce the medical treatment over the hours. Mesh suits allow us to remove secondary compresses and replace them with dry ones.



Photo 20. Severely burned patient in a mesh suit (own source)

The eyes and mouth require specific care:

- ♦ Prescribed treatments are applied (eye drops, corticoids, antibiotics...) for the eyes, after assessment by the ophthalmology department. They must be protected with epithelising ointments or lubricating gels.
- ♦ Oral cavity care is carried out with 0.12% chlorhexidine and toothbrushing.

MONITORING, SURVEILLANCE AND CARE OF CRITICALLY ILL BURN PATIENTS⁽¹⁾

The monitoring and evolution of people with severe burns requires intensive surveillance. These are people with prolonged admissions.

- ♦ Analytical controls are performed including arterial and venous blood gases, lactic acid, haemacytometry, biochemistry and coagulation.
- ♦ Monitoring of BP, HR, RF, temperature and O2 Sat is maintained.
- ♦ Care of the healthy skin, the devices and immobility is carried out according to protocol.



- The level of analgesia and sedation is adjusted to the patient's comfort, and is measured with validated scales.
- The presence of complications resulting from the burns (such as infections), or as a consequence of the critical patient's own treatment (such as delirium), and those derived from immobility (such as flaccidity, paresis, risk of pressure ulcers, etc.) must be carefully observed.
- The good evolution of the burns and the improvement in the haemodynamic and respiratory status allows us to remove devices and improve the autonomy of the patients.

SEDATION, ANALGESIA AND DELIRIUM IN CRITICALLY ILL BURN PATIENTS^(47, 53-56)

Pain is the ultimate expression of discomfort. It is necessary to assess and measure it with validated scales so that adequate analgesia can be provided at each stage of the process.

Burn victims go through different phases that will be clearly differentiated in relation to the pain they suffer. We must not forget that pain is a subjective sensation, so we must assess it individually and treat it according to the needs of each person.

A priority aim in critically ill patients is to keep them alert, free of pain, anxiety or delirium. This may not be possible in the early stages of the process, but it should be the goal to be achieved.

- **SEDATION:** With sedation we aim to decrease anxiety, seeking comfort and adaptation to mechanical ventilation (MV). The use of sedatives must ensure correct analgesia and avoid delirium. Nowadays, the trend is towards dynamic sedation, attending to the needs of the patient in each situation. More advanced is cooperative sedation that allows the patient to respond appropriately to verbal and tactile stimuli. Frequent monitoring using validated scales is essential. The most commonly used scale in our environment is the RASS and the BIS objective system for deep sedation or when neuromuscular blockers are used.
- **PAIN:** The burn patient is going to have pain at different times of the day, both at rest, as well as from therapeutic procedures, mobilisations, etc. Therefore, pain must be assessed systematically and appropriate analgesia must be provided for each occasion. The most commonly used scales are the visual numeric analogue scale (VNA and VAS) for conscious patients who can communicate; and the pain indicating behaviour scale (ESCID in Spanish) for unconscious patients undergoing MV. We also have the Faces scale for children or people with cognitive deficits. Critically ill patients are given intravenous analgesia in continuous perfusion combined with sedatives.



♥ **DELIRIUM:** Appears in a non-negligible percentage of critically ill patients. It is a toxic situation for the burn victim that delays weaning from the respirator, increases disability and the risk of death, causes post-traumatic stress, risk of injury, self-removal of devices... with the consequent harm to the patient and increased healthcare costs.

- There are four major predisposing factors for delirium: previous dementia, chronic pathology, alcoholism and high severity on admission.
- Other factors are the patient's vulnerability, pharmacological, environmental or genetic factors.
- Identifying them early and avoiding them whenever possible will help us to manage and prevent delirium appropriately.
- The CAM-ICU or ICDSC scales (according to the FEPIMCTI and SCCM guidelines) are recommended to measure delirium.
- Some measures to prevent delirium are: early mobilisation and exercise, promoting a good night's sleep, administering psychiatric treatment if necessary, avoiding physical restraints and the use of benzodiazepines.

9.3. SMOKE POISONING^(1, 14-15, 37-41)

9.3.1. INTRODUCTION

Smoke poisoning is recognised as the leading cause of morbidity and mortality during a fire and may be concomitant with burn injuries. In fact, smoke poisoning is an important risk factor for burn injuries.

The presence of smoke poisoning in a patient does not in itself indicate the need for respiratory support.

- ♥ Smoke poisoning should be suspected when the fire occurs in an enclosed, poorly ventilated area, if the patient presents with soot in the nostrils and oropharynx, burnt vibrissae and coughs with carbonaceous sputum. These signs alone do not indicate the need for respiratory support.
- ♥ Other symptoms such as hoarseness, stridor and tachypnoea may indicate the need for respiratory support.

Patients exposed to smoke inhalation may frequently develop carbon monoxide (CO) or hydrogen cyanide (HCN) poisoning, due to exposure to these and other gases (hydrofluoric acid or ammonium hydroxide) that occur during combustion.



9.3.2. PATHOPHYSIOLOGY OF SMOKE POISONING (1, 14-15, 37-41)

CO or HCN poisoning is caused by the combustion of organic or synthetic material (nylon, silk, wool, plastics, paper, wood, etc.).

Carbon monoxide (CO) binds to haemoglobin and the mitochondrial cytochrome oxidase system, resulting in metabolic acidosis. Symptoms of poisoning are directly related to carboxyhaemoglobin (COHb) levels (figure 13).

SYMPTOMS RELATED TO CARBOXYHAEMOGLOBIN LEVELS	
LEVEL	SYMPTOMS
0-10 %	Minimal (similar to those reported by smokers)
10-20 %	Nausea, headache
20-30 %	Fatigue, drowsiness
30-40 %	Agitation, confusion
40-50 %	Respiratory depression, coma
> 50 %	Death

Figure 13. Symptoms related to carboxyhaemoglobin levels (own source)

Cyanide poisoning causes asphyxia through inhibition of intracellular cytochrome oxidase activity. Cells convert cyanide into thiocyanate, which is easily excreted in the urine. When excessive amounts are inhaled, this mechanism becomes saturated and ceases to function, leading to hypoxia and cell death. The lethal dose of HCN is inhalation of 100 ppm for 30 minutes or 300 ppm for 5 minutes.

Symptoms range from headache, dizziness, nausea/vomiting, tachycardia, tachypnoea which may progress to bradycardia, hypotension, coma, respiratory arrest and death (figure 14).

SYMPTOMS RELATED TO CYANIDE LEVELS	
LEVEL	SYMPTOMS
0.5-1 mg/l	Headache, nausea/vomiting, dizziness
1-2.5 mg/l	Confusion, stupor
2.5-3 mg/l	Hepatic
> 3 mg/l	Death

Figure 14. Symptoms related to cyanide levels (own source)

Both poisonings cause a pink colouring of the patients and their blood due to excess plasma oxygen, the presence of cyanosis being exceptional.



There may be a correlation between plasma lactate and blood HCN levels in cyanide poisoning and inhalation syndrome. Elevated plasma lactate concentrations (greater than 10 mmol/L) may suggest such poisoning, although this is non-specific as lactic acidosis is found in many critically ill patients and in pure CO poisoning. Therefore, we will act under suspicion if we observe the signs and symptoms mentioned above.

9.3.3. TREATMENT OF SMOKE POISONING^(1, 10, 14-15, 37-41)

It is important to implement measures as soon as possible. As in all cases, an ABCDE assessment of the multiple trauma patient should be carried out:

- Remove the victim from the scene of the accident.
- Start administration of high-flow oxygen (FiO₂ 1), if necessary, continue with invasive ventilation.
- If necessary, initiate cardiorespiratory support.
- In cyanide poisoning, intravenous hydroxocobalamin is the preferred antidote^(10, 57-58).
 - Early administration has been shown to improve outcomes in terms of effectiveness and tolerance.
 - The dose is 70 mg/kg, not exceeding 5 g in children.
 - The initial dose in adults is 5 g (two vials).
 - The administration time is 15 minutes, and the dose may be repeated depending on the severity of the poisoning. The second dose can be administered within 15 minutes to two hours and is usually half of the first dose.
 - The maximum recommended dose is 10 g in adults and 140 mg/kg in paediatric patients.
 - The mechanism of action of hydroxocobalamin is to bind to cyanide ions. Each hydroxocobalamin molecule binds to a cyanide ion, by substitution of the hydroxocobalamin ligand, linked to the trivalent cobalt ion, to form cyanocobalamin, a stable, non-toxic compound that is excreted in the urine.
- Other treatments:
 - 3% sodium nitrate is a potent inducer of methaemoglobinaemia (ferrous ion of the heme group is oxidised to the ferric state which has a high affinity for cyanide).
 - Amyl nitrite which is in a liquid state. It is administered by inhalation 0.2-0.4 ml (one ampoule every 30s).



- Sodium thiosulphate which provides sulphuric groups that favour the formation of thiocyanate. Dose of 12.5 g (50 ml of 25% solution). It has the disadvantage of delayed onset of action (30 minutes).

9.3.5. IMPORTANT CONSIDERATIONS IN SMOKE POISONING^(1, 14-15, 37-41)

Smoke poisoning is often associated with burns of varying severity that may require treatment by enzymatic debridement, therefore, it should be borne in mind that early administration of hydroxocobalamin, even outside the hospital, may interfere with the diagnosis of the burns.

Hydroxocobalamin transiently produces a red discolouration of the skin that can last up to 15 days. Urine is also stained red, more intensely in the first 48 hours. Chromaturia can last up to 35 days.

Skin discolouration interferes with both the initial assessment of the burn and the assessment after enzymatic debridement. Pre-assessment may suggest a greater extension of BSA and imply changes in therapeutic approach and enzymatic debridement may be used in more areas than necessary. Similarly, the whitish appearance of deeper burns may be masked and appear to be more superficial.

It is important to take these issues into account and determine the most appropriate treatment accordingly.

RECOMMENDATIONS ^(10, 11, 12)	
Preventive intubation when there is suspicion of impending airway compromise, accompanied by full-thickness facial burn, stridor, smoke inhalation or singed nasal hairs.	D
Intraosseous circulatory access when intravenous access fails.	D
In contaminated burns administration of tetanus toxoid and immunoglobulin.	B
It is recommended that the extent of the burn be assessed in adults and children using the Lund & Browder template.	B e C
The palm method and rule of nines are recommended as a method for estimating the burned area	B
Periodic reassessment of burn depth in children and adults is recommended	C
Initiate fluid resuscitation using the Parkland method.	B
In adult major burn patients, volume replacement with isotonic crystalloids (Ringer's lactate solution, rather than colloids) is recommended.	A



RECOMMENDATIONS ^(10, 11, 12)	
In paediatric major burn patients, volume replacement with crystalloids (physiological solution, rather than colloids) is recommended.	A
Calculate and adjust volume replacement appropriately to avoid the complications of over-volumisation.	A
Initiate fluid resuscitation in burned adults and children with BSA > 20%.	D
Fluid infusion rate should be adjusted to urine volume, in adults 0.5-1 ml/kg/hr and 1-2 ml/kg/hr.	B
Perform aggressive, multi-modal pain management at all stages of treatment.	C
Add adjuvants to routine pain management in major burn patients.	C
Assess pain several times a day and during procedures	A (ABA, 2020)
Assess pain using patient-reported scales, when possible	C (ABA, 2020)
Opioid analgesics should be used in conjunction with non-opioid and non-pharmacological measures.	C (ABA, 2020)
Ketamine should be considered for sedation during procedures.	C (ABA, 2020)
Use dexmedetomidine as a first-line sedative in intubated burn patients	D (ABA, 2020)
Early provision of oral or enteral nutrition rather than parenteral nutrition	C
Preventive intubation when smoke inhalation is suspected	B
Administration of high-flow oxygen and hydroxycobalamin in patients with altered mental status and/or cardiovascular instability	D

9.4. SURGICAL TREATMENT OF BURN PATIENTS

9.4.1. URGENT SURGICAL TREATMENT^(1, 10, 12, 17, 23, 25, 50)

Burns sometimes require urgent surgical treatment.

When the initial assessment of a burn patient is carried out special attention should be given to the presence of circular burns on limbs, neck or chest.

- ♦ The presence of circular burns on the limbs (even superficial) can lead to compartment syndrome of extrinsic origin, compromising blood circulation and even causing muscle necrosis in the affected limb.



- It can also occur in the neck, thorax and abdomen in the presence of circular burns.
- Special attention should be paid to such burns, with urgent surgical intervention –escharotomy– if necessary (photo 21).



Photo 21. Deep, circumferential, lower limb burns requiring urgent surgery (own source)

The most common technique used for urgent surgical treatment of burns is decompression SCAROTOMY, with urgent debridement of the burned tissue being much less common.

However, this technique has fallen into disuse in recent years following the appearance of a product that allows the **ENZYMATIC DEBRIDEMENT(ED)** of burned areas, which we will discuss in depth in the section on programmed surgery^(18-19, 50-52, 58).

Urgent surgery classically consisted of performing decompression escharotomies in the affected areas (photo 22 and 23).



Photo 22. Deep dermal burn in upper limbs, circumferential, requiring urgent surgery (own source)

Although most of the urgent surgeries are performed on the limbs, it may also be necessary to perform them on the chest or neck when the airway or ventilation of the patient is compromised.



Escharotomy, although necessary, is not free of associated morbidity, since it involves opening the full thickness of the eschar, and is sometimes associated with delayed healing, colonisation and unsightly results.

In the case of deep burns (especially in burns due to electrical trauma) an urgent amputation of the affected limb may be needed.



Photo 23. Deep dermal burn in upper limbs, circumferential, requiring urgent surgery (own source)

The occurrence of **ENZYMATIC DEBRIDEMENT** ^(18-19, 50-52, 58) has been shown in several studies to be effective in reducing intra-compartment pressure in the context of burn-induced compartment syndrome:

- ◆ Theoretically, it is explained by eliminating the extrinsic factor contributing to increased intra-compartment pressure.
- ◆ The use of enzymatic debridement has been shown in experimental animals to be effective in reducing compartmental pressure, although the efficacy in reducing it in burn patients has not been published.
- ◆ However, there are several studies that demonstrate the reduced need for escharotomy in burn patients with circular burns treated with enzymatic debridement compared to other burn patients with circular burns.



9.4.2. PLANNED SURGICAL TREATMENT IN THE BURN PATIENT^(1, 12, 17, 23, 25, 36-37)

Burns are one of the traumas that can cause the greatest morbidity, not only because of their severity but also because of the serious aesthetic consequences they entail. Their treatment focuses on the surface area affected, as well as the depth of the injury.

Intermediate dermal or deep dermal burns are the barrier for surgical indication, and in most cases debridement is necessary in order to choose the best possible coverage for the defect created.

The aim of the treatment is to remove the damaged tissue and provide definitive coverage of the area.

It is now accepted that debridement should be performed early, within the first 48-72 hours, because early removal of the burned tissue reduces the rate of infection, sepsis and hospital stay in burn patients, as well as bacterial colonisation, when compared to later debridement.

However, this early debridement is a source of morbidity in itself, especially associated with blood loss and loss of healthy tissue due to the poor selectivity of this technique. Thus, the removal of viable tissue is associated with the loss of the potential for re-epithelialisation of the surgical site, as well as the removal of viable dermis necessary for a better aesthetic and functional outcome of the resulting scars.

SURGICAL DEBRIDEMENT⁽¹⁾

SURGICAL DEBRIDEMENT (SD) consists of complete excision of the burned tissue.

- It is not always possible to perform complete excision of the burn area in a single surgical time. It will depend on the amount of body surface area burned, the patient's stability.
- Excision of the burned tissue results in blood loss. It is estimated that 2-3 red blood cell concentrates are needed for every 10% of the body surface to be excised.
- Excision of more than 25-35% of the TBSA at each surgical time is not usually performed.
- In massive deep burns (>60%) the complete excision of the affected tissue cannot be carried out, so areas to be operated must be prioritised:
 - Some authors favour dealing first with functional areas, giving priority to the hands and joints, especially of the upper limb. Then face and neck (for its aesthetic importance) provided that the depth of the injury is



confirmed. The lower limbs would then be next, followed by the chest and abdomen, and finally back, palms and soles.

- Other authors argue that the priority is the excision of the highest percentage of burns possible, starting with any area.
- **Each patient requires individual assessment and prioritisation of the areas to be operated on.**

SURGICAL DEBRIDEMENT of burned tissue can classically be of two types:

TANGENTIAL DEBRIDEMENT:

- Tangential removal of burned tissue with dermatome (manual or electric – photo 24) or hydro-scalpel (58), until underlying healthy tissue is reached.
- It is not a selective debridement; burned tissue is removed, but also healthy tissue and viable dermis.
- Produces capillary bleeding, which stops with pressure, electrocoagulation of vessels, and coverage of the debrided tissue.



Photo 24. Electric and manual dermatome (own source)

FASCIAL DEBRIDEMENT:

- Removal of the burned tissue down to the fascia.
- Advantages: more straightforward technically, less bleeding and better viability of the plane.
- Disadvantages: interrupts venous and lymphatic drainage routes, higher aesthetic consequences, should not be done on the face or perineum, requires immediate coverage to avoid desiccation of the tissues.
- It is performed only in special cases.



ENZYMATIC DEBRIDEMENT WITH BROMELAIN^(18-19, 50-52, 60-62)

The usual surgical treatment of burns has recently undergone a major change with the emergence of a new product for **ENZYMATIC DEBRIDEMENT**.

Enzymatic surgery is a new concept, a developing technology, which has advantages over conventional treatment:

- The main advantage of enzymatic debridement is that it allows the removal of damaged tissue while preserving healthy dermis. It is a less traumatic and more selective debridement.
- It reduces surgical times.
- It reduces the need for urgent escharotomies.
- It reduces the use of blood products during the procedure.
- It reduces the surface area requiring grafting.
- In the healing process, it has a low rate of hypertrophic scarring.
- The epithelisation time of the burn may be prolonged.
- It allows early diagnosis of the real depth of the burn by facilitating the early removal of eschars, which facilitates a better indication of post-debridement coverage.
- It can be performed outside the operating theatre, in the patient's own room, although it requires monitoring and correct sedation and analgesia. This reduces the surgical burden on burn units and patients.

The current indications for its use are:

- Treatment of adults. Use in children is pending the results of the multi-centre clinical trial currently ongoing. Initially its use was limited to ages 18-65 years, but it is being used in older patients as compassionate use, with very good results.
- There is no evidence for its use in chemical or electrical burns to date.
- The indication per data sheet is for a maximum of 15% of BSA, although successive applications of the product can be made, even on the same day for larger burn extensions. It has been used on larger surfaces, off-label,



where the risk of compartment syndrome is recognised, but its use is not yet established, as an alternative to conventional escharotomy.

- The burn surface area should be prepared using a moist dressing prior to application of the product (requires at least 2 hours of moist dressing), to allow enzyme contact with the necrotic bed and to lower the temperature generated by the enzyme reaction.
- It is indicated for use on deep burns, intermediate depth burns and areas with a mixture of superficial and deep burns.
- It is indicated for use on large burns and circular burns on limbs, because it avoids the need for escharotomy.
- It is not indicated for use in cases of thoracic compartment syndrome causing respiratory compromise. In this case, decompression escharotomies are indicated.
- There is consensus for its application in special areas (face, hands, feet, genitalia...).
- Enzymatic debridement should be performed within 48-72 hours post-burn, with a limit of 4-7 days.

The **product used** for enzymatic debridement⁽¹⁸⁻¹⁹⁾:

- This is a concentrate of proteolytic enzymes enriched with bromelain in a solution of acetic acid and ammonium sulphate, which comes in two bottles, one powder and one gel, in containers that should be mixed before use.
- It should be kept in a refrigerator between 2°C and 8°C in an upright position.
- The amount of medicine needed is 2 g/100 cm² of skin.

Procedure to be carried out for enzymatic debridement⁽¹⁸⁻¹⁹⁾:

- Before starting the procedure, the patient or their representative if they are unconscious, should be informed of the procedure.
- Inquire about allergies, mainly to pineapple, papaya, latex or other components of the preparation.
- It is also important to know what medication the patient is taking, as there is a contraindication in the case of active anticoagulation.



- ♥ Enzymatic debridement requires a **specific previous treatment** to maintain the humidity of the burn in order to favour the access of the enzyme to the burn. The usual protocol is to perform a **moist dressing**:
 - The burn must be kept moist for a minimum of 2 hours prior to the application of the product, and it is recommended that the moist dressing remains moist from the time of the burn until the following day.
 - If enzymatic debridement is to be performed immediately to avoid compartment syndrome, try to keep the dressing moist for a minimum of two hours.
 - The usual moist dressing is performed with antiseptic solution or physiological saline.
 - The use of sulphadiazine or iodine creams is not recommended because of the possible formation of a pseudo-eschar.

The **application method for enzymatic debridement (ED)** is as follows:

- ♥ BP, O2 saturation, RF will be monitored and we will have the necessary material to deal with any change that occurs (hypotension, bradycardia, hypoxia, ...). Patients who do not have orotracheal intubation (OTI) will initially be fitted with a nasal cannula which will be replaced by another device if necessary.
- ♥ It is essential to control the pain caused by its application, so it is advisable to have a protocol for analgesia, sedation and/or regional anaesthesia.
 - The most common drugs for sedation-analgesia are midazolam, ketamine, propofol, fentanyl or morphine chloride. This is administered 15 min before starting treatment. Pain is measured with the validated EVN scale or the ESCID scale.
 - Sedoanalgesic control is necessary during the 4 hours of product application, with a first hour under heavier sedation, then residual. Withdrawal of the product requires a further increase in analgesia.
 - Regional anaesthetic blocks can be performed in case of isolated limb burns, or even local anaesthetic blocks in case of small burns.
- ♥ During the procedure, the patient is continuously monitored to assess the need for analgesia, sedation, respiratory or circulatory support and to respond to complications. The patient remains monitored.
- ♥ The burn has a moist dressing. The dressing is removed and the wounds are sterile washed and the eschar tissue or blisters are removed with saline solution with neutral soap, or 0.4% chlorhexidine soap solution if the burns are very dirty (photo 25).





Photo 25. 2nd degree deep burn, prior to ED (own source)

- After washing the burn area, the area around the injury is protected with petroleum jelly to prevent the product from moving to healthy skin (photo 26). In case of use on the face, the eyes should be protected and covered with epithelial ointment and gauze.
- The product is prepared at the same time or prior to the preparation of the burn. Use 2 g of product for 1% of BSA to be treated, or 5 g for 2.5% of BSA. The average preparation time of the product is 15 minutes, and no more than 15 minutes should elapse between preparation and use (photo 27).
- The mixture obtained is applied to the burned tissue with a sterile depressant to form a layer 1.5 to 3 mm thick. The petroleum jelly prevents the displacement of the product (photo 26).



Photo 26. Protection of surrounding skin (own source)





Photo 27. Preparation of debridement product (own source)

- After application, the product is covered with a transparent, waterproof dressing, without pressure on the burn and without leaving air between the dressing and the mixture (photo 28). The entire area can be covered to avoid patient discomfort, so that the patient cannot see how the debridement is proceeding. The transparent dressing allows the patient to observe how the debridement is taking place, and to move it in case there is any displacement of the product, allowing it to be repositioned (the product loses effectiveness if it is not in contact with the burned surface).



Photo 28. Application of debridement product (own source)

- After four hours, the product is removed with a depressant and sterile compresses. A pink surface with haemorrhagic spots or whitish tissue will appear (photo 29). It is washed with saline solution and compresses.





Photo 29. Tissue after ED (own source)

- Subsequently, a moist dressing with gauze soaked in antiseptic solution is performed until the following day.

The successive dressings offer various alternatives depending on the visual diagnosis of the burn bed, following a consensus document – figure 15 and photo 30⁽¹⁸⁻¹⁹⁾:

VISUAL DIAGNOSIS FOR POST ENZYMATIC DEBRIDEMENT	PROGNOSIS
Intradermal purplish red 2A Uniform superficial red	Probable epithelialisation
2AB Fine stippled red 2B Intermediate dermal white	Intermediate probability of epithelialisation
2C Depressed white with surrounding step 3A Fatty	Grafting required

Figure 15. Visual diagnosis post ED





Photo 30. Visual diagnosis post ED

The post enzymatic debridement dressing will be performed according to this classification:

- In patients with probable epithelialisation we can use a dressing with synthetic polylactic dressing (photo 31) or hydrofibre dressing. Manuka honey or polylactic acid dressing should be used if the burns are on the face.
- If for burns with a high likelihood of grafting – Use hydrocolloid dressings with or without pre-application of antiseptic gel solution every 48-72 hours.
- It is very important to keep the dermis moist.



Photo 31. Post-ED dressing with synthetic dressing



After application of the ED⁽¹⁸⁻¹⁹⁾:

- The patient's temperature should be monitored, as the application of the product may cause hyperthermia.
- Have the necessary means to control pain.
- Pay attention to signs of infection of the burn.
- In case of insufficient debridement, repeating the enzymatic debridement is not indicated except in cases where a technical error in its application is clearly identified as the cause of insufficient debridement (lack of contact with the product, leakage of the product, alteration in enzyme concentration, etc.).

SKIN COVERAGE^(1, 29, 51-52, 63-66)

The treatment of the burned patient does not only consist of debridement of the burned tissue, but after its removal, a CUTANEOUS COVERING must be performed to restore the body surface.

Traditionally, skin coverage was performed at the same surgical time as surgical debridement, in order to obtain immediate wound closure, whenever possible. The procedure consists of debridement + grafting in the same surgical time. However, this is not always the case today.

The emergence of enzymatic debridement, which is performed within the first 72 hours after the burn, results in a higher rate of spontaneous healing, even in deep burns. For this reason, enzymatic debridement is performed initially, after which the patient spends some time with dressings. As the days go by, the evolution is assessed, which may or may not be towards spontaneous epithelialisation. If epithelialisation does not occur, surgery will be scheduled, which will consist of a new debridement if necessary (surgical in this case) + skin coverage at the same time.

The **debridement and coverage** of an intensely burned patient is performed serially, provided that the haemodynamic condition of the patient permits it. **The challenge in the treatment of the major burn patient is not the elimination of tissue that is not viable, but its coverage.**

Several methods of **CUTANEOUS COVERAGE** are available, **TEMPORARY OR DEFINITIVE**, although none of them is ideal⁽⁶³⁻⁶⁶⁾:

- **SYNTHETIC COVERAGE:** with CAH dressings (hydrocolloid, with silver, hydrofibre, etc.).



♦ BIOSYNTHETIC COVERAGE:

- BIOBRANE: is the most universally used, made up from a nylon mesh in which purified collagen of porcine origin is intersected together with an external silicone sheet (photo 32).



Photo 32. Coverage with Biobrane (own source)

♦ DERMAL MATRICES

- The use of dermal matrices has had a positive impact on the functional and aesthetic aspects of the burn patient, especially in the reconstruction of special areas such as the face, scalp, back of hands and feet, elbows, knees, popliteal hollow, armpits and neck (areas where grafts can compromise function and aesthetic results). They have been known about for around 40 years, and since then their use has been standardised, with handling protocols being created.
- Most of the sequelae in burn patients are a consequence of not having dermis. There is a maxim "the epidermis gives us life, but the dermis gives us quality of life"⁽¹⁸⁻¹⁹⁾.
- Enzymatic debridement allows us to preserve a greater amount of dermis than with classical surgical debridement. But this is not always enough.
- To cover the dermal deficit, there are dermal matrices, which are nothing more than a scaffold, a vehicle through which the patient's own cells climb until they form a neodermis that is architecturally practically identical to the patient's healthy dermis.
- One of their advantages is that they do not generate new lesions in the patient, and that they provide long-term skin elasticity similar to that of unburned skin. Their main disadvantage is their cost, and that they require very specific care until they heal.
- The most commonly used matrices are Integra® (two-layer) and Matriderm® (single-layer), which have been the only permanent dermal substitutes available in our healthcare system.



— INTEGRAL

- 2 mm porous dermal matrix composed of irreversible cross-linked collagen of bovine origin plus shark cartilage glycosaminoglycan, topped by a silicone layer.
- Its initial presentation was as a two-layer, but it is now also available as a single-layer.
- Its placement requires two surgeries.
- 1st surgery – Debridement to healthy, viable tissue, thorough haemostasis (bleeding is one of the main problems for failure of matrix attachment) and coverage of the bed with Integra. (photo 33)
- Subsequently, serial dressings are performed every 2-3 days.
- 2nd surgery –after three weeks– replacement of the outer layer of the matrix with a thin autograft.



Photo 33. Covering of burns with Integra (own source)

— MATRIDERM

- A porous dermal substitute composed of collagen type I, II and V of bovine origin plus elastin, without chemical additives.
- Single-layer –a single surgical procedure– placement + grafting.

RECOMMENDATIONS⁽¹²⁻¹⁷⁾

For the care of major burn patients, there should be transitional and definitive coverings, and protocols for the management of each of them.

C

♦ AUTOGRAFTS

- This is the best final coverage when the patient has sufficient donor sites.
- They are applied during the same operation in which the burn debridement takes place.
- An adhesion by fibrin and collagen is produced in the first hours after application of the graft. In 24-48 hours, the plasma of the receptor bed



will nourish the capillary system of the graft, and between the third and fifth day there is a definitive capillary neovascularisation from the bed.

- Any unburned skin area (except the face and hands) can be used as a donor area.
- The graft is obtained using a dermatome.
- The ideal thickness is 0.20-0.25 mm, except for coverage of face, neck, hands and joints where that of increased thickness is preferable, using thinner ones in massive burns in the elderly and children. The greater the thickness of the autograft, the less retraction of it, but it is more difficult for it to take.
- The grafts can be applied in a laminar or meshed form:
 - Laminar graft (photo 34) – Better cosmetic result but higher frequency of bruising.
 - Mesh graft (photo 35) – Greater capacity to cover more surface area and less bruising, but has a worse aesthetic appearance, and does not act as a barrier until epithelialisation occurs.



Photo 34. Partial laminar skin graft on foot (own source)



Photo 35. Partial mesh skin graft on forearm, and laminar on the back of hand (own source)



♥ DONOR AREA (DA)

- This is the anatomical site from which a sheet of skin (dermoepidermal graft) has been obtained by means of a dermatome (photo 36). It is an iatrogenic wound, caused in the operating theatre, to repair the burn area.
- Usually the donor area chosen first is the lower limbs, provided they are not burned, as it is an area that is easily hidden by clothing. If they are not available, any area of the body can be used as a graft, always taking into account the damage/benefit we wish to obtain.
- If the graft obtained is full-thickness, the DA is treated by direct closure (a small amount of graft is obtained).
- If the graft obtained is of partial thickness, the DA is covered with a compress containing 1/10000 adrenaline as a clotting agent during surgery (photo 36).



Photo 36. Graft donor area, taken with an electric dermatome, and coverage of the area with compresses with adrenaline (own source).

- Treatment is then carried out
 - This can be done with moist wound dressings
 - CAH is usually performed with hydrocolloid dressings (photo 37), compresses and compressive bandaging with elastic bandage:
 - If there is deterioration or leakage it is reinforced with more dressings and bandaging.
 - As far as possible, the dressing should not be lifted before 72 hours, and may remain in place for a maximum of 7 days.





Photo 37. Healing of the donor site with hydrocolloid dressings (own source).

- The donor site can be treated with polylactic acid dressings (photo 38).



Photo 38. Donor site dressing with polylactic acid dressings

- Afterwards, successive dressings are carried out, consisting of a careful washing with SSF and its progress is assessed.
 - If the evolution is adequate, it is covered again with CAH dressing.
 - If there are complications (haematoma, excess fibrin or infection), the dressing protocol can be changed
- The patient should remain resting and the donor site raised until the first dressing is applied.
- After epithelialisation of the donor site (photo 39), it is recommended to wash it with water and neutral soap and moisturise it several times a day.



Photo 39. Epithelialised donor site (own source)

- ♦ **BIOLOGICAL SUBSTITUTES:** developed in skin banks to solve the problems of cutaneous coverage that major burns pose. There are:
 - Xenografts (pig) – Limited use, high antigenic capacity that produces rejection in approximately 72 hours.
 - Homografts or allografts Cryopreserved and/or preserved in glycerol – very used. Has a high antigenic power, therefore it is lost in a few days.
 - ALLODERM® – Another form of skin substitute.
 - Cultivation of Autologous Keratinocytes – Large sheets of keratinocytes are obtained, which are grown from a biopsy of the patient's healthy skin. This is the first definitive coverage as described for the treatment of patients who do not have sufficient donor areas.
 - Cultivation of Allogeneic Keratinocytes – Would act as a neodermis on which a culture of keratinocytes or a fine autograft would subsequently need to be implemented.
 - Autologous and Allogenic Artificial Skin (cultivated compounds for grafts) – Is the latest coverage being researched, it is a complete skin that is created from fibroblasts and keratinocytes from a biopsy of the patients themselves. These are the ones that are currently creating the most expectations, their fundamental advantage being the only substitute that offers the two components of the skin in a definitive way. Their price is high.

9.5. LOCAL INFECTION OF THE BURN^(1, 36)

The most effective action to prevent infections in burn patients is the correct handling of the burns: correctly using topical antiseptics, correctly setting out the elimination of thermal surgical injuries covering the bloody surfaces early.

Antibiotic prophylaxis is NEVER administered to burn patients under any circumstances. A few years ago the exception to this rule was electrical trauma, but nowadays its use as a prophylactic measure is discouraged.



The clinical suspicion of local infection (photo 40) must be accompanied by microbiologic culture through a skin biopsy (do not carry out cultivation through swabs given their zero effectiveness).

The treatment is then performed starting a more aggressive topical empirical antiseptic treatment: use of broad-spectrum antiseptics, increase in the frequency of the dressings...

In the event that the local infection is accompanied by signs of sepsis, broad spectrum empirical intravenous systemic antibiotherapy shall be started until the results of the microbiological cultures are available that allow us to perform specific treatment for each infection.

The germs that are isolated with greatest frequency in the tissues with burns are *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Pseudomonas aeruginosa*.



Photo 40. Burn infection (own source)

RECOMMENDATION ⁽¹⁰⁾	
No systemic antibiotics are administered prophylactically.	C2
Prophylactic antibiotics administered according to patient condition and situation.	C1



10. CARE OF BURN AREAS AFTER FORMATION OF SCAR TISSUE

The patient who suffers a burn will have changes in the burn area that can be lifelong (scars). In addition to the resulting scars, patients with extensive burns, or with burns in critical areas, may have physical and psychological sequelae.

PSYCHOLOGICAL SEQUELAE^(1, 67-68)

When we think of a burn, we usually think of a healthy patient, who suffers an accident, usually a random one. Most burns are small in size and heal quickly.

But there are also patients with extensive burns who require admission to burn units. These admissions are usually very long, the patient and their family become very dependent, on the one hand, because of the long time they are in hospital, but also because they are previously healthy people whose lives are suddenly interrupted.

Inpatients and their families develop physical and psychological dependence, and require psychological support from the outset, both when they are in hospital and when they are at home with follow-up consultations. There is a psychologist assigned to the burn units to help in these cases, but it is also essential that the staff caring for the patient be aware of their psychological state.

PHYSICAL AND FUNCTIONAL SEQUELAE^(1, 67-71)

Apart from the psychological repercussions, burns can have physical and functional repercussions, especially when we are talking about extensive burns or the involvement of critical areas (hands, feet, joints, face).

The best way to avoid sequelae is to prevent them.

It is very important to carry out a good treatment from the very beginning in order to prevent sequelae⁽⁶⁷⁻⁷¹⁾:

- The dressing should be correct, in a functional position, with splint support if necessary.
- Hand – Individualised bandaging of the fingers should be carried out, with splints in functional position if necessary. Hand mobilisation should be initiated from the outset, actively and/or passively. This should be strongly emphasised.
- In the case of burns on limbs, elevation of the limb reduces oedema.



- Collaboration with the Rehabilitation Department is necessary from the beginning. Rehabilitation should begin passively at the beginning of the admission, to the extent the patient's haemodynamic condition and burns allow. As the patient's condition permits, rehabilitation should be progressively advanced. It should be maintained after discharge from hospital⁽⁷⁰⁻⁷¹⁾.
- Early mobilisation is safe and feasible. It leads to a significant decrease in pneumonias, deep vein thrombosis, as well as vascular, pulmonary and airway complications (level of evidence 2).

In addition to dressings, adequate surgical treatment of burns is important, because the reduction of scarring by secondary intention reduces the likelihood of pathological scarring⁽⁷⁰⁾.

Despite adequate treatment and follow-up, secondary deformities in the form of sequelae may occur. These should be treated whenever there is a change that can be improved by surgical intervention.

Special care must be taken with CHILDREN who suffer burns. Children grow and burned areas that do not present problems at first may present them later, so continuous monitoring must be carried out, at least until their growing is complete. If body growth exceeds scar growth, sequelae may develop and require treatment⁽⁷²⁻⁷³⁾.

There are different treatment options for the sequelae, both conservative and surgical. Sequelae can be mild or severe. It depends above all on the type of involvement and the location of the injury.

Perhaps the most frequent physical sequela is aesthetic changes, especially the alteration of the colour of the burn area^(1, 69-70):

- The first thing you notice after a burn is the change in the appearance of the skin. The extension and, above all, the depth and the areas affected by the burn will determine how permanent and visible this change will be.
- Dyschromia may occur on the skin, which may disappear to a greater or lesser extent with the care applied.
 - First-degree burns – Do not leave changes in the skin over time, only a change in colour during the first few days, except in the case of complications. They require the recommendations and care of healthy skin. Hygiene, moisturising and protection from the sun.
 - Second-degree superficial burns – May leave changes in the skin. After healing, they need to be moisturised more often than first-degree burns, approximately 2/3 times a day. Avoid exposure to the sun.



- 2nd degree and 3rd degree deep burns – Will always leave changes in the skin. They need more specific care. These burns will leave permanent, often disabling lesions. Apart from moisturising and protection from the sun, they will require adjuvant treatments.
- Sometimes the scarring will cause retractions in joint areas and there can be formation of abnormal scars, such as hypertrophic scars, keloids, or even atrophic areas.

General care of burn areas after they have healed⁽¹⁾:

- The use of loose cotton clothing is recommended.
- Moisturise the burned area several times a day (2 or 3 times a day is recommended).
- Avoid exposure to the sun for at least the first 6 months (1 year recommended). Avoid the hours of highest incidence between 12pm and 5pm. Use of sun protection (factor +50) even on cloudy days⁽⁷⁴⁾.
- There is special make-up for burns that can be optionally used⁽⁷⁵⁾.
- Use of silicone dressings on burn areas. They can be used alone or in combination with pressure therapy garments.
- Use of progressive pressure therapy garments, custom-made for each patient. They can be used up to 23h/day, for a prolonged period of time.
- Prostheses or orthoses can be fitted

Apart from the scarring of the burn area itself, the main functional sequela is the **appearance of scar contractures** that limit the movement of an area. The treatment options are:

- Initial, rehabilitative / physiotherapy treatment.
- Surgical options:
 - Scar release / excision.
 - Covering with stable, quality tissue – Primary closure, grafting, skin - muscle - fascial - free flap
 - Skin expansion...
 - Treatment of the joint: capsulotomy, arthrodesis.
 - Amputation of the affected limb may be considered.



RECOMMENDATIONS⁽¹⁾

Design and implement a comprehensive rehabilitation plan for each major burn patient on admission with the aim of achieving biopsychosocial reintegration.	B
Perform comprehensive rehabilitation assessment within 24 hours of admission to hospital.	C
Perform early mobilisation of the major burn patient on admission to the hospital.	A
Perform soft tissue mobilisation and stretching with dressing changes, treatments and procedures on the ward.	B
Perform early respiratory kinesitherapy according to the patient's needs.	C
It is recommended that functional or anti-retraction positions be favoured, using orthotic treatment when indicated.	C
In patients with lower limb burns, it is recommended to use elastic bandages to start walking.	A
It is recommended that compressive treatment be tailored to each patient by a competent professional.	C
Periodic monitoring of the effectiveness of compression systems is recommended.	A
In patients with severe burns, it is recommended that a physical rehabilitation programme be maintained over time until functionality is restored.	



11. SPECIAL BURNS. TREATMENT CONSIDERATIONS

There is a group of burns that we can consider special due to their action mechanism, and their different behaviour from other burns, being potentially more destructive since that they generate higher haemodynamic and functional changes than other burns.

11.1. ELECTRICAL BURNS^(1, 76, 77)

Electrical burns are thermal burns produced by a very high intensity heat when the victim's body becomes an accidental resistance, producing a cytotoxic reaction. They are the most devastating of all thermal lesions in relation to their size, normally affecting the skin and deeper tissues.

It should be borne in mind that approximately 15% of patients who suffer an electric burn are associated with another type of trauma injury in addition to the burn, which is why we usually speak of **ELECTRICAL TRAUMA**. Electrical trauma usually affect mainly young males at work, and children in the domestic sphere. They are the most frequent cause of amputations in the Burn Unit.

The damage the electric current causes depends on several parameters: voltage, current (amperage), the type of current (continuous or alternate), the flow path of the current, the duration of the contact, the resistance at the contact point and individual susceptibility.

The **different types of electrical trauma** refer to:

- ◆ **DIRECT ELECTRICAL TRAUMA** (photo 41) – There is passage of electrical current through the body:
 - Low voltage electrical trauma (<1000 V) – Constitute approximately 80% of all electrical injuries. They are especially frequent in the child population in the domestic sphere. The burn is usually located in the area close to the injury, which tend to be the mouth and hands. They can cause severe arrhythmia
 - High voltage electrical trauma (>1000 V) – Are burns to the skin of several degrees that are associated with intense destruction of deep tissues that affect multiple organs. It is a trauma that is similar to that produced by a crushing





Photo 41. Electrical burn (own source)

- ◆ **INDIRECT ELECTRICAL TRAUMA OR VOLTAIC ARC** – Are the result of the exit and the re-entry of the current from one part of the body to another, especially in areas of flexing like the wrist, elbows, armpit or popliteal gap.
- ◆ **ELECTRICAL FLASH** – A flash burn occurs and is handled like a flame (contact) burn.
- ◆ **ELECTRICAL TRAUMA CAUSED BY LIGHTNING** – The typical skin manifestation of a trauma caused by lightning is a branched, dendritic, tree-like erythematous pattern, or that looks like a fern on the skin, which appears in the first hour after the injury and fades quickly (similar to a reaction of hives and erythema). There can be cardiorespiratory arrest, in which the cardiopulmonary resuscitation is especially effective when it is started quickly, aggressively and must be maintained for quite some time (> 1 hour).

The electricity that flows through the tissues generates heat. The resistance offered by tissues varies according to their composition (figure 16):

- ◆ Bone is the tissue that offers the most resistance, and the one that accumulates the most heat. It can be said that the damage from electrical trauma is from the inside out (Iceberg effect).
- ◆ The muscle tissue develops oedema and necrosis, and compartmental syndromes may appear in the first 48 hours after the trauma.



+ GREATER RESISTANCE
BONE
FATS
TENDONS
SKIN
MUSCLES
VESSELS
NERVES
- LESSER RESISTANCE

Figure 16. Resistance of tissues to the passage of electricity

The **main clinical manifestations of electrical trauma** are:

- ♦ **CUTANEOUS:** Burns of varying degrees (dermal and subdermal). An attempt should be made to identify the entry door/burn (in the electric current) and the exit burn (of the electric current).
- ♦ **MUSCLE:** The behaviour of the electrical trauma in relation to the muscles is similar to a crush syndrome. Compartment syndromes can occur without the need for the burn to be circular (photo 42). It produces oedema and muscle necrosis that produces an enzymatic increase (CPK and myoglobin) and potassium. The monitoring of the increase of the CPK is useful in the diagnosis of muscle damage and in the control of the response to treatment. The increase of the myoglobin can result in kidney damage that must be controlled.



Photo 42. Electrical burn, in the first image fasciotomy + escharotomy, in the second image coverage with graft (own source).



- ♥ VASCULAR: Electrical trauma produces thrombosis of the vessels.
- ♥ CARDIAC: Cardiac monitoring should be performed for at least 24 hours. Low voltage: produces cardiac arrhythmias early. High voltage: produces sinus tachycardia and changes in T. **wave**
- ♥ NEUROLOGICAL: The neurological clinical symptoms are highly variable and can be seen as acute or late peripheral neuropathy (29%), medullary damage (2-5%), loss of consciousness, headache, seizures...
- ♥ BONE: Fractures occur in up to 10% of cases due to muscle tetanization.
- ♥ Others: injuries can occur in the intra-abdominal organs, abdominal perforation, pancreatic necrosis or liver, kidney damage, ocular alterations.

A substitución de hidroelectrólitos no paciente con traumatismo eléctrico non segue a fórmula de Parkland, senón que debe manterse unha pauta de soroterapia con Ringer Lactato para diurese 1 ml/kg/h.

The topical treatment of electrical trauma burns is the same as that of any thermal trauma. There is no evidence for the use of enzymatic debridement in electrical trauma to date.

11.2. CHEMICAL BURNS^(1, 76, 78-79)

Most chemical burns are not very extensive but deep.

The intensity of a chemical burn will depend on:

- ♥ Concentration of the chemical agent.
- ♥ Quantity of product that causes the burn.
- ♥ Exposure time or contact with the skin.
- ♥ Tissue penetration.
- ♥ Action mechanism or toxicity of the chemical agent.

Chemical burns are classified according to the characteristics of the causal agent and according to the mechanism of the tissue injury. Unlike thermal burns, the tissue damage does not cease until the tissues or medical treatment neutralise the product,



therefore, the estimate of the burn depth is difficult and varies according to the time elapsed since the exposure to the product (photo 43).



Photo 43. Chemical burn (bromine) (own source)

The **main types of chemical agents** are:

- ♦ **ACIDS** – They are proton donor substances, releasing hydrogen ions and can lower the pH from 7 to 0. Acids with a pH less than 2 cause necrosis by clotting on contact with the skin. Burns through acids are more frequent and less severe than burns through bases.
- ♦ **BASES** – They are proton acceptor substances, the pH can vary from 7 to 14. Those with a pH greater than 11.5 produce serious damage by causing necrosis due to liquefaction.
- ♦ **ORGANIC SOLUTIONS** – Act by dissolving the lipid membrane of the cells and altering the cellular protein structure.
- ♦ **INORGANIC SOLUTIONS** – Damage the skin by direct contact and the formation of salts. They also produce an exothermic reaction, which contributes to tissue damage.

The **main action mechanisms of chemical substances** are:

- ♦ **OXIDATION** – Protein denaturation is produced by inserting oxygen ions, sulphur or halogenated substances (chromic acid, bleaches, potassium) into the protein molecule.



- ♦ REDUCTION – The reduction of the amino links leads to protein denaturation (mercurial, hydrochloric acid and nitric derivatives).
- ♦ CORROSION – Cause direct and massive protein denaturation (cement, sodium hydroxide).
- ♦ CELLULAR OR PROTOPLASMIC POISONS – Produce formation of esters from fatty acids of cell membranes, or interfere with the cellular homeostasis mechanisms (oxalic acid and hydrofluoric).
- ♦ DEHYDRATING – Substances that extract water from the affected tissues (sulphuric acid).
- ♦ VESICANT OR THAT FORM BLISTERS (Spanish flies, Nitrogen mustards, etc.).

The initial management of a chemical burn is exactly the same as that of any thermal trauma with the following special considerations:

- ♦ Abundant irrigation with water or physiological saline solution (never immersion) at the place of the accident and which must be repeated on reaching the hospital centre. The irrigation period should be at least 30 minutes. Copious irrigation with water has been shown to reduce the severity of the burn and reduce the hospital stay.
- ♦ Special attention should be given to the identification of the causal agent of the burn and the exposure time to be able to address the treatment accurately.
- ♦ Avoid the use of neutralising agents, in the majority of cases the neutralising agents are difficult to obtain and have not shown to be better than continuous irrigation with water or physiological saline with the exception of a few cases. In addition, the use of neutralisers can aggravate the injury by producing heat generating chemical reactions with some chemical agents (lithium, sodium, magnesium and potassium).
- ♦ Avoid hypothermia due to the continuous irrigation with water or physiological saline. An attempt should be made to avoid this complication maintaining the temperature of the place of the accident between 28 and 31°C if possible, and the temperature of irrigation as close as possible to the body temperature.
- ♦ The alteration of the pH is the largest systemic complication, so that arterial blood gases and electrolyte analysis must be carried out on a regular basis to ensure metabolic stability.
- ♦ Valuation by ophthalmology in case of ocular burns. It is recommended that irrigation is begun with water as soon as possible and for a long time (30-



60 minutes), since a minimum amount of chemical may produce a significant damage.

- If affection of the respiratory tract is suspected it should be treated like an injury by inhalation – Protect the airway, oxygen therapy and if necessary orotracheal intubation and mechanical ventilation with positive pressure at the end of the expiration.
- The principles of treatment of the wound-burn produced by chemical agents are the same as in any thermal injury. Dressings should be carried out with topical antimicrobials (silver sulphadiazine), initial debridement and cutaneous coverage in non-viable tissues.
- There is no evidence for the use of enzymatic debridement in electrical trauma to date.
- The exposure to hydrofluoric acid generates an intense heat and important tissue damage.
 - If this affects more than 5% of the BSA or more than 1% of the BSA if its concentration is higher than 50%, then hospitalisation is required for electrocardiographic monitoring and to monitor the serum levels of calcium, because arrhythmias and hypocalcemia may appear.
 - Its treatment includes abundant washing/irrigation with water followed by the application of a calcium gluconate gel or subcutaneous injection of calcium gluconate at 10% (0.5 ml / cm²) with the aim of relieving the pain.
 - If there is no response to the medical treatment immediate surgical excision of the injury must be carried out in the Burn Unit.
- Exposure to caustic soda (sodium hydroxide) (photo 44) is very common because it is present in many cleaning products.
 - Chemical burns are frequent due to oral ingestion of soda in the context of suicide attempts.
 - In home environments burns are generally small in size, but in industrial environments there can be extensive burns.
 - Caustic soda has the ability to penetrate deeply into the skin and tissues causing tissue destruction that is perpetuated in the time after the initial exposure.
 - Systemic effects can occur due to the absorption of the chemical.
 - Ocular affection is particularly serious because of the rapid corneal penetration (it can cause scars, corneal ulcer and perforation).





Photo 44. Burn due to caustic soda (own source)

- The treatment consists in continuous irrigation with water or physiological saline (at least 2 hours with periods of rest of 4 hours).
- Water irrigation may not eliminate the chemical product from the deeper layers of the burn, in these cases, and if the status of the patient allows it, a tangential excision of the deep burns must be performed and covered with skin graft or temporary dressings.
- In the event of ingestion, the person must be given a glass of milk or water (provided that the person does not present convulsions, difficult airway or decreased consciousness), and vomiting must NOT be provoked.

11.3. INJURIES DUE TO CONTRAST EXTRAVASATION OR CYTOSTATIC AGENTS

Injuries caused by the extravasation of an agent **cannot be considered burns as such, however, they can cause a acute skin failure similar to a burn**, which is why we include them in this section.

Their treatment will be similar to that of a burn, but with certain considerations depending on the type and quantity of extravasated agent, as well as the reaction of the patient's skin.

Contrast extravasation injuries must be differentiated from those caused by cytostatic agents, as their effects and treatment are different.

11.3.1. DEFINITION OF EXTRAVASATION⁽⁸⁰⁻⁸³⁾

Intravenous drug administration is associated with a number of complications inherent to the process of infiltrating a foreign substance into the body, extravasation being one of them.



It is defined as a condition characterised by the leakage of a pharmacological or biological substance from the infusion site into the surrounding tissue, that is, the infiltrated substance leaks out of the vein used for its inoculation, causing dissemination of the substance through the soft tissues.

Any substance used for intravenous infusion is susceptible to extravasation, although the most common substances are cytostatics and radiographic contrasts. Some published series report extravasation of substances as the most frequent iatrogenic cause of skin and soft tissue injury.

11.3.2. EPIDEMIOLOGY OF EXTRAVASATION INJURIES⁽⁸⁰⁻⁸³⁾

Although extravasation injuries from both cytostatic and contrast agents are infrequent, they should be taken into consideration as they can lead to skin failure similar to burns:

- Extravasation of cytostatic agents occurs with an incidence between 0.01% and 6% when administered peripherally and between 0.26% and 4.7% when administered centrally.
- In the case of radiographic contrasts, the incidence of extravasation ranges from 0.1% to 1.2% in the case of CT and 0.05% in the case of MRI.

Extravasation of substances has two main effects:

- On the one hand, the extravasated substance will not produce the intended therapeutic effect.
- On the other hand, the extravasation of the substance will infiltrate the soft tissues of the area, associating a series of local processes that can lead to tissue injuries.
 - The processes by which soft tissue injury occurs depend on a number of factors: the osmolarity of the extravasated substance, the inherent cytotoxicity of the extravasated compound, the infusion pressure and the possible vasoconstrictive effects of the drug in question.

The most frequent sites are the back of the hand, the forearm, the antecubital fossa and the back of the foot. The greatest morbidity is associated with the location on the back of the hand or foot, and on the ankle, because these are areas with little subcutaneous tissue and close to tendons, nerves and vessels.

RISK FACTORS for extravasation are classified into three groups:



♥ Patient-associated factors

- Patients with limitations in detecting and indicating alarm data: extreme age (children and the elderly), alterations in mental state (cognitive impairment), alterations in local sensitivity.
- Poor collaboration of the patient at the time of the injection (voluntary or involuntary movements...).
- Patients with fragile veins: the elderly, repeated venous punctures, previous radiotherapy in the area, previous chemotherapy.
- Weakened patients with little muscle mass and atrophy of the subcutaneous cellular tissue.
- Previous history of peripheral vascular diseases (arteriosclerosis, diabetes, Raynaud's syndrome) or patients with venous or lymphatic return problems (thrombosis or venous insufficiency, lymphoedema, etc.). These factors probably do not increase the risk of extravasation, but they do increase the likelihood of greater severity if it occurs.
- Extensive skin diseases (psoriasis, dermatitis...).

♥ Drug-associated factors – depend on the physico-chemical characteristics that give the agent the capacity to cause harm.

- Osmolarity – Number of particles in solution, measured in osmoles or milliosmoles per litre of solvent (mOsm/l) – Is directly related to cell lysis, the higher the osmolarity of the extravasated substance in relation to the osmolarity of the plasma, the higher the osmolarity.
- pH – Concentration of hydrogen ions present in a solution. Plasma pH ranges from 7.35 to 7.4. The greater the difference between the pH of the extravasated agent and the pH of the plasma, the greater the damage.
- Cytotoxicity – Direct cell damage by the extravasated agent, closely associated with the extravasation of chemotherapeutic agents, especially those with a blister effect. There are two types, those that produce damage by binding to nucleic acids (such as anthracyclines, more prolonged damage over time) and those that do not bind (such as Vinca alkaloids and taxanes).
- Vasoconstrictive effect – Extravasation of vasoactive substances – Leads to ischaemia and necrosis due to decreased local blood flow.

♥ Technique-associated or iatrogenic factors

- Infusion pressure – Is a factor mainly associated with extravasations of iodinated contrast agents injected with automatic injectors, increasing the risk of extravasation if the puncture site is not monitored throughout the process.
- Extravasation volume, although less important than cytotoxicity in relation to the appearance of lesions. Large volumes of non-ionic contrast agents may not cause complications, while small volumes of cytostatics may lead to necrosis.



- IAccess with metal needles or catheters (extravasations are more frequent than when using plastic needles).
- IPuncture in suboptimal sites.
- IInjection through catheters in place for more than 24 hours
- IRepeated punctures in the same vein.
- IWhen the injection rate is not appropriate to the calibre of the catheter used.

11.3.3. ETIOPATHOGENESIS INJURIES DUE TO EXTRAVASATION⁽⁸⁰⁻⁸³⁾

Although the most obvious cause of extravasation is the poor positioning of the catheter, it sometimes occurs with a well-placed catheter, because there is really no direct cause for the outflow of a substance once it has been infiltrated into a vein. Multiple theories have been put forward, one of the most widely accepted being that the occurrence of phlebitis derives from the acidotic nature of most of the substances that are extravasated. Spasm of the vessel occurs which increases resistance to flow and may cause the substance to escape into the perivascular environment.

Once extravasated, local involvement will depend on the characteristics of the extravasated substance. In general, an acute inflammatory response occurs initially, followed by slow-onset chronic inflammation, with the development of chronic inflammatory cells and fibrosis. Ischaemic damage may occur due to compression of the arterioles caused by oedema resulting from inflammation and fluid accumulation in the intradermal space. Compartment syndrome may develop.

The agents that produce skin alterations due to extravasation are sorted simply into antineoplastic and non antineoplastic:

- Antineoplastic agents, or cytostatics, can be blister forming, exfoliating, irritant, inflammatory and neutral. Blister agents particularly associated with tissue necrosis include doxorubicin hydrochloride, carmustine and mitomycin, and to a lesser extent actinomycin D and vincristine.
- Non-neoplastics agents are mainly contrast agents used in conventional radiology or interventionist studies.

Extravasation can cause secondary skin necrosis which is not considered a chemical burn as such, but constitutes a separate entity, because the effect of cell necrosis is not due to skin contact with the substance (as it would be in the case of chemical burns), but is explained as secondary to two mechanisms:

- Direct action of the substance, which can induce cytotoxicity and necrosis.



- Indirect action of the substance – Mass effect in the subcutaneous or muscular compartment generates suffering and skin ischemia as the volume of the deep planes is increased. Skin necrosis would be secondary to prolonged skin ischemia and absence of surgical treatment of compartment syndrome associated with it.
- Usually the two mechanisms interact to produce the skin failure.

Extravasation associated with skin lesions is usually due to blister agents, but large extravasations of irritants may initially have a similar appearance. However, by 24 to 48 hours, lesions caused by irritants improve rapidly with conservative management while lesions caused by vesicants remain the same or worsen. These lesions evolve over 24 to 72 hours to determine whether they will benefit from surgical treatment.

Extravasation of substances must be differentiated from other types of reactions, such as local hypersensitivity reaction to the injected fluid, or local irritant effects of the substance on the wall of the cannulated vein. In these reactions there is usually no oedema or erythema, and the catheter is in the correct position in the vein. Other different reactions include:

- Anthracycline-associated flare reaction – Erythema with or without hives-like skin pain, associated with itching and burning sensation, resolves within one to two hours.
- Vascular irritation – Pain, discomfort and tightness along the vessel where the drug was infused, accompanied by erythema and dark discolouration of the skin, (in extravasation erythema it is often associated with oedema of the tissue surrounding the vein). Another difference is that in the case of extravasation there is little or no blood return through the infusion site.
- Venous shock – Due to administration of very cold agents into the vein – Causes loss of blood return due to spasm of the vessel and is managed by application of warm compresses.

11.3.4. SIGNS AND SYMPTOMS ASSOCIATED WITH EXTRAVASATION ⁽⁸⁰⁻⁸³⁾

The clinical assessment of the cases of contrast or cytostatic extravasation generally require a precise medical history (the same as in any type of burn), paying special attention to the type of agent extravasated and estimate of volume extravasated to guide the severity of the clinical situation. However, what determines the type of treatment is not the quantity of agent extravasated, but the clinical assessment.



Early recognition of the signs and symptoms of extravasation is essential, because it allows us to carry out a rapid treatment plan, reducing the possible associated sequelae. In general, 4.6% of extravasations are associated with tissue damage, with necrosis occurring in 0.24% of cases.

The extravasation of substances takes generally place in the upper limb. The technical examination shall be focused on:

- Observation: Attention should be given to the emergence of signs of skin suffering, such as erythema, oedema, phlyctenas, blisters or necrosis (photo 45).
- In the case of contrast media extravasation, the first sign of extravasation may be the absence of contrast media in the images.



Photo 45. Extravasation of contrast medium (own source)

- Palpation: assess for evidence of compartment syndrome or risk of compartment syndrome. Alarm signs are: pain, pallor, paresthesia, loss of pulse, pressure and paralysis – the 6P's.
 - The confirmation of compartment syndrome is carried out through needle puncture and measuring the intra-compartment pressure. If this is greater than 30 mm Hg, it should alert us.
 - In clinical practice, it is usually not necessary to resort to this measure, since the symptoms of compartment syndrome is an indication of urgent surgical treatment regardless of the measurement of the pressure in the compartment.



Multiple classifications have been published for extravasation-associated injuries, broadly dividing them into mild, moderate and severe:

- Mild – Minimal extravasated volume, with minimal pain and associated oedema, no erythema or blistering.
- Moderate – Small volumes (approximately 5 cc), with local inflammatory reaction less than 10 cm in diameter, moderate pain, with or without erythema, no blistering. No tissue necrosis is observed and pain is controlled with non-opioid analgesics.
- Severe – Extreme localised pain, extending proximal and distal to the point of extravasation. Marked oedema (may be of the entire affected limb), with erythema and blistering in the affected area. May lead to the development of compartment syndrome.

These classifications are indicative when considering treatment and referral for specialist assessment. Generally, plastic surgery assessment is requested in severe cases, if loss of substance is expected, if there is a large area of extravasation or if there is ulceration.

11.3.5 EXTRAVASATED SUBSTANCES⁽⁸⁰⁻⁸⁴⁾

Any substance administered intravenously is susceptible to extravasation. However, the most relevant substances for extravasation are chemotherapeutics and iodinated contrast agents.

• **Extravasation of chemotherapy agents⁽⁸⁴⁾**

- Extravasation occurs in 0.1-6.5% of chemotherapy infiltrations.
- Classically they were divided into two groups (vesicant and irritant substances), but today they are divided into 5 categories, from highest to lowest potential for tissue damage:
 - Vesicant substances – Can cause skin necrosis and/or blistering when extravasated. The agent most implicated in extravasations is doxorubicin, followed by anthracyclines and vinca alkaloids.
 - Exfoliating substances – Cause inflammation and sloughing of the skin without causing deep tissue necrosis, with blistering and peeling. Examples: cisplatin, paclitaxel, docetaxel...
 - Irritants – Cause inflammation, pain and/or irritation at the site of extravasation, without blistering. Examples: bleomycin, carboplatin, etoposide...
 - Inflammatory substances – Produce moderate inflammation and erythema. Examples: methotrexate, 5-fluorouracil...



- Neutral substances – Do not cause inflammation or damage. Example: monoclonal antibodies, rituximab, cyclophosphamide...
- In reality, each substance can behave differently in certain circumstances, especially if a large amount of substance is extravasated, or if several substances are extravasated in combination.
- It is generally recommended to use central routes for the administration of cytostatics to avoid the risk of extravasation from a peripheral route. However, although rare, extravasation from a central line can occur, with very serious consequences (pleuritis, pneumonitis, etc.).

♥ **Extravasation of iodinated contrasts**⁽⁸³⁾

- Occurs in 0.7% of patients receiving contrast agents.
- Clinically, oedema, pain and erythema occur. The appearance of blisters and ulcers is less frequent than with other extravasations, and if they appear it is as a consequence of the inflammatory process after 24-48 hours.

♥ **Extravasation of calcium salts**

- They are associated with tissue damage. They occur mainly in patients admitted to ICU, especially in paediatric patients.
- Calcium deposits typically occur in the skin (calcinosis cutis), and may affect fat and muscle tissue if calcification is deep. May lead to tissue necrosis.

♥ **Extravasation of other substances**

- Any substance is susceptible to extravasation. Apart from those already mentioned, the most common are enteral nutrition, dextrose, saline, vasoactive substances, other drugs...

11.3.6. TREATMENT OF THE EXTRAVASATION⁽⁸⁰⁻⁸⁵⁾

The initial clinical signs of extravasation are oedema, erythema, and/or pain at the puncture site. If any of these appear, extravasation should be suspected and acted upon.

Although there are no random clinical trials for the specific treatment of each extravasated agent, there are guides depending on the extravasated agents, guides that are available in the units where these types of agents are perfused.

GENERAL GUIDELINES FOR THE MANAGEMENT OF MILD EXTRAVASATIONS⁽⁸⁰⁻⁸⁵⁾

Most extravasations resolve with conservative treatment, especially in the case of iodinated contrast agents.



There are a number of general recommendations for the management of extravasations:

- ♦ Stop the infiltration process. Attempts can be made to aspirate through the same catheter that caused the extravasation to remove as much fluid as possible, although this is not usually very effective.
- ♦ If there is clinical suspicion of extravasation of an agent, the infusion must be stopped immediately. It is not recommended that local pressure be applied or the route be washed.
- ♦ The catheter must not be immediately withdrawn, but is maintained to suck up the excess extravasated agent, and for the administration of the possible antidote.
- ♦ Anti-oedema measures – Raise the affected limb above the level of the heart. This decreases the pressure in the capillaries, which facilitates reabsorption of the extravasated fluid. Elevation should be maintained for 24-48 hours depending on the duration of oedema. Elevation of the limb should be done without compromising its arterial supply or venous return.
- ♦ It is recommended that the patient mobilise the joints of the upper limb separately: open and close fingers by mobilising the proximal and distal interphalangeal joints, as well as the metacarpophalangeal joints, mobilising the wrist and also the elbow.
- ♦ The administration of non-steroidal anti-inflammatory drugs intravenously is recommended, to reduce the formation of oedema and local inflammation. Corticosteroids are not indicated, except in the case of extravasations of oxaliplatin.
- ♦ Topical application of heat or cold – Lacks scientific evidence. Heat produces vasodilatation which enhances vascular reabsorption of extravasated fluid. Cold produces vasoconstriction, limits swelling and oedema, and reduces pain. Cold should not be applied directly, but wrapped in cloths or compresses. The reality is that there is controversy about this, as there are studies that do not demonstrate the efficacy of applying either heat or cold.
- ♦ The patient should be monitored – Reassessment in the next 2-4 hours allows us to detect progression to severe lesions and initiate treatment if necessary.
- ♦ Dilutional treatment This involves infiltrating a fluid that dilutes the concentration of the extravasated drug, so that it produces less cytotoxicity. It is not usually performed, because it increases the risk of injury due to the effect of increased volume.



- In the event of there being areas with skin failure, conservative treatment is initially performed with local dressings, using the same criteria as in the treatment of an acute skin failure produced by a burn.

There are a number of ANTIDOTES described, substances that neutralise or diminish the effects of the extravasated drug.

- Hyaluronidase – The most studied and widely used antidote. It is an enzyme that causes temporary dissolution of the interstitial barrier by depolymerisation of polysaccharide acids. It should be infiltrated within the first hour of extravasation. There are studies that demonstrate its usefulness in the extravasation of hyperosmolar contrast media, calcium salts, parenteral nutrition, some chemotherapy drugs (such as vinblastine, vincristine and paclitaxel) ... It is ineffective with doxorubicin and non-hyperosmolar contrast media. Contraindicated in areas with active infection, purulent collections or cancerous areas. Contraindicated in extravasation of vasoactive substances.
- Dimethyl sulphoxide – Applied topically, because it increases the permeability of the skin and facilitates the reabsorption of extravasated substances. It reduces the occurrence of tissue necrosis. It is mainly used for the extravasation of chemotherapy drugs such as doxorubicin, cisplatin, fluorouracil, etc. Its adverse effects are a burning sensation with urticaria and erythema during application.
- Corticosteroids – Prevent necrosis by local infiltration and/or topical application. The most commonly used is hydrocortisone. There is no clear consensus regarding its efficacy as a local antidote.
- Sodium thiosulphate – Has been used as an antidote in cyanide poisoning, as a chemoprotective against carboplatin, cisplatin and mechlorethamine.
- Dexrazoxane – Antidote for anthracycline extravasation if used within 6 hours of extravasation.
- Phentolamine – Antidote of choice for extravasation of vasoactive substances, especially epinephrine and norepinephrine.
- Others – Terbutaline, topical nitroglycerine, papaverine, procaine, etc.

TREATMENT OF SEVERE EXTRAVASATIONS⁽⁸⁰⁻⁸⁵⁾

In addition to the treatments already discussed, severe extravasations may require surgery. Not all patients with extravasation require surgery. It is estimated that 10-20% of all extravasations require surgery.

There are different surgical techniques:



- ♥ Liposuction – Removing the extravasated fluid using cannulas.
- ♥ Gault or flush out technique – 4 incisions are made at the periphery of the extravasated area and saline is infiltrated through each incision so that the fluid drains out through the remaining three holes. There are variants of this technique, widening the incisions, combining the infiltration of hyaluronidase, local anaesthetics, etc.
- ♥ Urgent surgical treatment is indicated in case of compartment syndrome (photo 46). It is suspected by exploring the 6 P's: pain, pallor, paraesthesia, loss of pulse, pressure and paralysis. Compartment pressure can also be measured. Surgery should be performed within 12 hours. A skin incision is made until the muscle fascia is exposed, fasciotomy may be performed if fluid is present within this compartment. The clinical suspicion and the treatment is the same in cases of compartment syndrome produced by burns.



Photo 46. Extravasation of contrast agent on the back of the hand of a newborn. Symptoms of compartment syndrome requiring surgical treatment (own source).

When skin lesions occur, we must also prevent super-infection, with the usual management of skin lesions or burns.



TREATMENT ASSOCIATED WITH EXTRAVASATION⁽⁸⁰⁻⁸⁵⁾

Once extravasation is established, the patient should be closely monitored.

Strict surveillance is recommended for the first 2-4 hours to assess for progression of the lesions.

If no signs of complications have appeared, the patient can be followed on an outpatient basis, with daily assessment or every 2 days during the first week, and weekly thereafter until symptoms resolve.

If the symptoms do not improve, referral for surgical assessment is recommended.

In the first few days there may be an increase in the initial swelling, with increased oedema and pain. Blistering and necrosis may occur after some days or weeks:

- Blisters – Debridement and local dressing is recommended, usually with antibacterial cream to prevent infection.
- In very severe cases, surgical debridement of the affected tissue and coverage with skin grafts and/or flaps may be required.

11.3.7. PREVENTION OF EXTRAVASATION LESIONS⁽⁸⁰⁻⁸⁵⁾

Early detection of extravasation helps prevent lesions.

There are a number of recommendations to try to avoid extravasation:

- The peripheral pathway must be channelled before the start of the infusion, the old route should preferably not be used for the infusion of cytostatic or contrast agents. In order of preference, select forearm, ante cubital fossa, back of hand and wrist.
- A good backflow of blood must be confirmed. Between 5 and 10 ml of saline must first be perfused to verify that the route is permeable.
- Areas with scars, sclerosis or thrombosis, or previously radiated areas should be avoided, as well as limbs with lymphoedema or hypoperfusion.
- The cannula should be secured through the application of a plaster that holds the peripheral pathway.



- ♥ The infusion should be stopped and the patient checked if the patient has any symptoms, such as local pain or paresthesias in the infusion area, or chest pain or shortness of breath in the case of central catheters.
- ♥ Do not use metallic catheters or small veins.
- ♥ Pay special attention to infiltration with infusion pumps.
- ♥ Do not use catheters longer than 24 hours.
- ♥ Do not use veins with repeated punctures.
- ♥ Preferably use a central venous catheter or reservoir systems to infiltrate cytostatics.



12. GENERAL PREVENTION GUIDELINES EVIDENCE AND RECOMMENDATIONS^(1, 12, 17, 86-88)

Burns are preventable, and therefore avoidable.

High-income countries have made considerable progress in reducing burn death rates by combining preventive strategies with better care for those affected. Most of this progress in prevention and care has not been fully implemented in low- and middle-income countries. Increased efforts in this direction would significantly reduce burn-related death and disability rates.

Prevention strategies should address burn injury hazards, education for vulnerable populations and community training in first aid.

An effective burn prevention plan should be multicultural and include broad initiatives aimed at⁽⁸⁶⁻⁸⁸⁾:

- ♦ Raising awareness.
- ♦ Developing effective policies and enforcing them.
- ♦ Describing the burden of the problem and identifying risk factors.
- ♦ Establishing research priorities and promoting promising interventions.
- ♦ Provide burn prevention programmes.
- ♦ Strengthen burn care.
- ♦ Strengthen capacities to do all of the above.

Most of the existing literature on this topic deals essentially with prevention in children, as they are extremely sensitive to thermal injury⁽⁴⁰⁾. It is therefore important to teach the general population to identify risk factors and to provide them with guidelines to avoid them through educational campaigns.

The main general rules of prevention refer to⁽⁸⁶⁻⁸⁸⁾:

- ♦ Not smoking inside the home and much less so in bed.



- ♥ Not overloading power sockets.
- ♥ Not using fireworks or similar.
- ♥ Keeping matches, lighters, chemicals, and lit candles away from children.
- ♥ Fitting plug protectors.
- ♥ Smoke alarms at home are recommended.
- ♥ Placing the TV and music equipment against the wall.
- ♥ Placing screens in front of chimneys.
- ♥ In the bathroom:
 - Water thermostats allow you to adjust the temperature. Temperatures of 54°C can scald a child in 2-3 seconds.
 - When filling the bath, start and end with cold water.
 - Introduce the elbow (adult), to test the temperature.
 - Disconnect all electrical appliances that are not being used
- ♥ In the kitchen:
 - Do not allow children to use walkers in the kitchen.
 - Do not drink hot beverages if you have a child on your lap⁽³⁷⁾.
 - Do not hold a child in your arms while cooking.
 - Do not heat bottles in the microwave⁽³⁷⁾.
 - Keep the handles of pots and pans away from the reach of children.
 - Keep hot foods and beverages out of reach of children⁽³⁷⁾.
- ♥ Adults:
 - Adult burns are associated to the dangers inherent to modern society. People have the same risks, but increased by the loss of reflexes associated with age.
 - Prevention must be associated with the strengthening of the safety standards.
 - Apply safety standards to housing design and materials, and encourage home inspections.
 - Improve the design of kitchens, particularly in relation to stability and preventing access by children.
 - Promote the use of safer cookstoves and less hazardous fuels and provide information on the use of clothing that can catch fire.
 - Reduce the temperature on hot water taps.
 - Promote fire safety education and the use of smoke detectors, sprinklers and emergency exits in homes.



- The home is where the majority of the accidents occur, so it is important to review the installation of gas, electricity, electrical appliances and storage of flammable and corrosive liquids.
- For adults after the home, work is the next scenario where such accidents happen. Occupational safety standards must be followed and strengthened.
- Promote the adoption of and compliance with industrial safety standards and the use of flame retardant fabrics for children's sleepwear.
- Finally, accidents also occur during leisure: motorcycle exhausts, barbecues, sunburn, etc. Here some of the rules previously seen and above all a lot of common sense must prevail.
- Promote laws mandating the production of cigarettes designed to reduce the risk of fire.
- Improve epilepsy treatment, especially in developing countries.
- Promote the further development of burn care systems, including training of health care providers in the proper classification and management of people with burns.



13. EPILOGUE

Everything we have learned in this guide empowers us and provides us with skills for our daily work with people suffering from complex injuries.

But it is the binomial attitude + aptitude that really gives us the necessary qualities to become complete professionals.

Each person will face the trauma suffered in a different way and what happens to them will alter their projects or way of life to a greater or lesser extent. For this reason, individual care with a holistic approach to patients is essential, as is accepting in a kind, empathetic and understanding way the different ways of dealing with their condition.

It is part of the professional competences to acquire not only technical skills, but also non-technical skills that will help us to treat people with dignity and respect⁽⁸⁹⁾.

We must not forget that we are not treating burns, we are treating people.



14. SUMMARY OF EVIDENCE RECOMMENDATIONS

EVIDENCE [E] / RECOMMENDATION [R] / GOOD PRACTICE [GP]		LEVEL / GRADE
[R]	It is recommended to assess the extension of the burn in adults and children using the Lund & Browder template.	B (Yoshino, 2016) C (AUGE, 2016)
[R]	The palm method and rule of nines are recommended as a method for estimating the burned area.	B (Yoshino, 2016)
[R]	Periodic reassessment of burn depth in children and adults is recommended.	C (AUGE, 2016)
[R]	It is recommended to apply the ABC protocol for the initial management of major burn patients.	C (AUGE, 2016)
[R]	The use of running cold water for at least 20 minutes, as soon as possible after the trauma, and up to 3 hours after the injury.	B (AUGE, 2016)
[R]	Do not use ice water for cooling burns.	B (BBA, 2019)
[R]	Use warming measures to avoid hypothermia and perform temperature control during the pre-hospital phase.	C (BBA, 2019)
[R]	Treat chemical burns as soon as possible, and at the earliest opportunity, regardless of delay in application.	D (BBA, 2019)
[R]	Irrigate chemical burns for as long as safely possible.	D (BBA, 2019)
[R]	Use amphoteric solutions, if available, as first aid for chemical burns.	D (BBA, 2016)
[R]	Initiate fluid resuscitation using the Parkland method.	B (Yoshino, 2016)
[R]	In major burn adult patients, volume replacement with isotonic crystalloids (lactated ringer's solution, rather than colloids) is recommended.	A (AUGE, 2016)
[R]	In paediatric major burn patients, volume replacement with crystalloids (physiological solution, rather than colloids) is recommended.	A (AUGE, 2016)
[R]	Calculate and adjust volume replacement appropriately to avoid the complications of over-volumisation.	A (AUGE, 2016)



EVIDENCE [E] / RECOMMENDATION [R] / GOOD PRACTICE [GP]		LEVEL / GRADE
[R]	Initiate fluid resuscitation in burn adults and children with BSA > 20%.	D (BBA, 2019)
[R]	Fluid infusion rate should be adjusted to urine volume, in adults 0.5-1 ml/kg/hr and 1-2 ml/kg/hr in children.	B (Yoshino, 2016)
[R]	Silver sulphadiazine for extensive 3 rd degree burns.	B (Yoshino, 2016)
[E]	Honey-based treatments heal burns better than those treated with silver sulphadiazine.	MODERATE (COCHRANE, 2017)
[R]	To prevent hypothermia, it is recommended to maintain a stable room temperature, close to 26°C for adults and children, rather than lower temperatures.	C (AUGE, 2016)
[R]	Silver sulphadiazine for the treatment of extensive third-degree burns.	C (Yoshino, 2016)
[R]	Dressing materials such as hydrocolloids, hydrogel, polyurethane film or foam, alginate and hydrofibres are recommended as an option for topical treatment of burns.	C1 (Yoshino, 2016)
[R]	Hydrotherapy for minor burns not requiring hospitalisation.	B (Yoshino, 2016)
[R]	Hydrotherapy for severe extensive burns with bath disinfection.	C1 (Yoshino, 2016)
[R]	Assess pain several times a day and during procedures.	A (ABA, 2020)
[R]	Assess pain using patient-reported scales, when possible.	C (ABA, 2020)
[R]	Opioid analgesics should be used in conjunction with non-opioid and non-pharmacological measures.	C (ABA, 2020)
[R]	Ketamine should be considered for sedation during procedures.	C (ABA, 2020)
[R]	Use dexmedetomidine as a first-line sedative in intubated burn patients.	D (ABA, 2020)
[R]	Early provision of oral or enteral nutrition rather than parenteral nutrition.	C (BBA, 2018)
[R]	Perform aggressive, multi-modal pain management at all stages of treatment.	C (AUGE, 2016)
[R]	Add adjuvants to routine pain management in major burn patients.	C (AUGE, 2016)



EVIDENCE [E] / RECOMMENDATION [R] / GOOD PRACTICE [GP]		LEVEL / GRADE
[R]	No systemic antibiotics are administered prophylactically.	C2 (Yoshino, 2016)
[R]	Prophylactic antibiotics administered according to patient condition and situation.	C1 (Yoshino, 2016)
[R]	Preventive intubation when smoke inhalation is suspected.	B (Yoshino, 2016)
[R]	Administration of high-flow oxygen and hydroxycobalamin in patients with altered mental status and/or cardiovascular instability.	D (BBA, 2018)
[R]	For the care of major burn patients, there should be transitional and definitive coverings, and protocols for the management of each of them.	C (AUGE, 2016)
[BP]	Design and implement a comprehensive rehabilitation plan for each major burn patient on admission with the aim of achieving biopsychosocial reintegration.	(AUGE, 2016)
[R]	Perform comprehensive rehabilitation assessment within 24 hours of admission to hospital.	C (AUGE, 2016)
[R]	Perform early mobilisation of the major burn patient on admission to the hospital.	A (AUGE, 2016)
[R]	Perform soft tissue mobilisation and stretching with dressing changes, treatments and procedures on the ward.	B (AUGE, 2016)
[R]	Perform early respiratory kinesitherapy according to the patient's needs.	C (AUGE, 2016)
[R]	It is recommended that functional or anti-retraction positions be favoured, using orthotic treatment when indicated.	C (AUGE, 2016)
[R]	In patients with lower limb burns, it is recommended to use elastic bandages to start walking.	A (AUGE, 2016)
[R]	It is recommended that compressive treatment be tailored to each patient by a competent professional.	C (AUGE, 2016)
[R]	Periodic monitoring of the effectiveness of compression systems is recommended.	A (AUGE, 2016)
[R]	In major burn patients, it is recommended that a physical rehabilitation programme be maintained over time until functionality is restored.	A (AUGE, 2016)
[R]	Do not apply very cold or frozen water (<15°C).	LOW
[R]	Moisturise the skin to restore moisture.	LOW (GPC SAS, 2011)5



EVIDENCE [E] / RECOMMENDATION [R] / GOOD PRACTICE [GP]		LEVEL / GRADE
[R]	Use sunscreen protection products (FPS>15) in epithelialised areas.	MODERATE (GPC SAS, 2011)5
[BP]	Protect from the sun (during 15-30 days).	LOW (GPC SAS, 2011)5
[R]	Rinse with potable water or saline solution.	MODERATE (GPC SAS, 2011)5
[R]	Dry the lesion without rubbing the injured area.	LOW (GPC SAS, 2011)5
[R]	If an antiseptic is necessary, use chlorhexidine digluconate.	MODERATE (GPC SAS, 2011)5
[R]	Debride blisters or phlyctenas.	LOW (GPC SAS, 2011)5
[R]	In second-degree burns without risk of infection it is not necessary to apply topical antimicrobials.	MODERATE (GPC SAS, 2011)5
[R]	There is not enough evidence on the effectiveness of a healing dressing in humid environment over another.	HIGH (GPC SAS, 2011)5
[R]	Use dressings with low and adaptable adherence.	MODERATE (GPC SAS, 2011)5
[R]	Hydrocolloid dressings are suitable for the management of exudate in superficial burns.	MODERATE (GPC SAS, 2011)5
[R]	Hydrocellular dressings have higher absorption capacity than hydrocolloid ones.	LOW (GPC SAS, 2011)5
[R]	Dressings with silicone protect the perilesional and epithelialised skin.	MODERATE (GPC SAS, 2011)5
[R]	The topical antibiotic of first choice in second- and third-degree burns, is silver sulphadiazine.	HIGH (GPC SAS, 2011)5
[R]	In third-degree burns sulphadiazine shall be applied with cerium nitrate.	MODERATE (GPC SAS, 2011)5
[R]	Silver dressings can help reduce dressings and average hospital stay.	MODERATE (GPC SAS, 2011)5
[R]	Silver dressings, compared with sulphadiazine, reduce pain during dressings.	MODERATE (GPC SAS, 2011)5
[R]	Do not use systemic antibiotics preventively in minor burns.	VERY LOW (GPC SAS, 2011)5
[R]	Silver dressings can help reduce dressings and average hospital stay.	MODERATE (GPC SAS, 2011)5
[R]	Clean eyes several times a day.	VERY LOW (GPC SAS, 2011)5



EVIDENCE [E] / RECOMMENDATION [R] / GOOD PRACTICE [GP]		LEVEL / GRADE
[R]	Use chlorhexidine 0.12% as a mouth antiseptic.	MODERATE (GPC SAS, 2011)5
[R]	Use barrier products of the mucosa and protective agents of the mucosa 34.	VERY LOW (GPC SAS, 2011)5
[R]	Assess the state of nutrition individually and continuously until healed.	VERY LOW (GPC SAS, 2011)5
[BP]	It is recommended that the caloric intake does not exceed 200% of the estimated energy expenditure.	VERY LOW (Nut Hops, 2005)36
[R]	Burn patients will receive a high protein intake.	HIGH (GPC SAS, 2011)5
[BP]	The preferential use of enteral nutrition is recommended.	VERY LOW (GPC SAS, 2011)5
[R]	Enteral nutrition should be administered early.	MODERATE (GPC SAS, 2011)5
[BP]	A glucose intake is recommended.	VERY LOW (Nut Hops, 2005)36 (JPEN, 2002)37
[R]	The dressing of the fingers shall be carried out one by one, to avoid the adhesion between them.	LOW (GPC SAS, 2011)5
[BP]	Elastic or cohesive bandages will be used to allow the expansion of physiological oedema. The ideal is elastic tubular mesh 3.5.	VERY LOW (GPC SAS, 2011)5
[E]	Avoid the unsupervised presence of children in kitchens and bathrooms.	VERY LOW (Cochrane, 2004)40
[E]	Store caustic substances in safe places, away from the reach of children.	VERY LOW (Cochrane, 2004)40
[E]	Be careful with the handling of hot liquids in the presence of children.	VERY LOW (Cochrane, 2004)40
[BP]	Increase the dissemination of a culture of prevention in burns.	VERY LOW (Cochrane, 2004)40
[BP]	Mortality is increased in children under three years of age.	VERY LOW (Cochrane, 2004)40



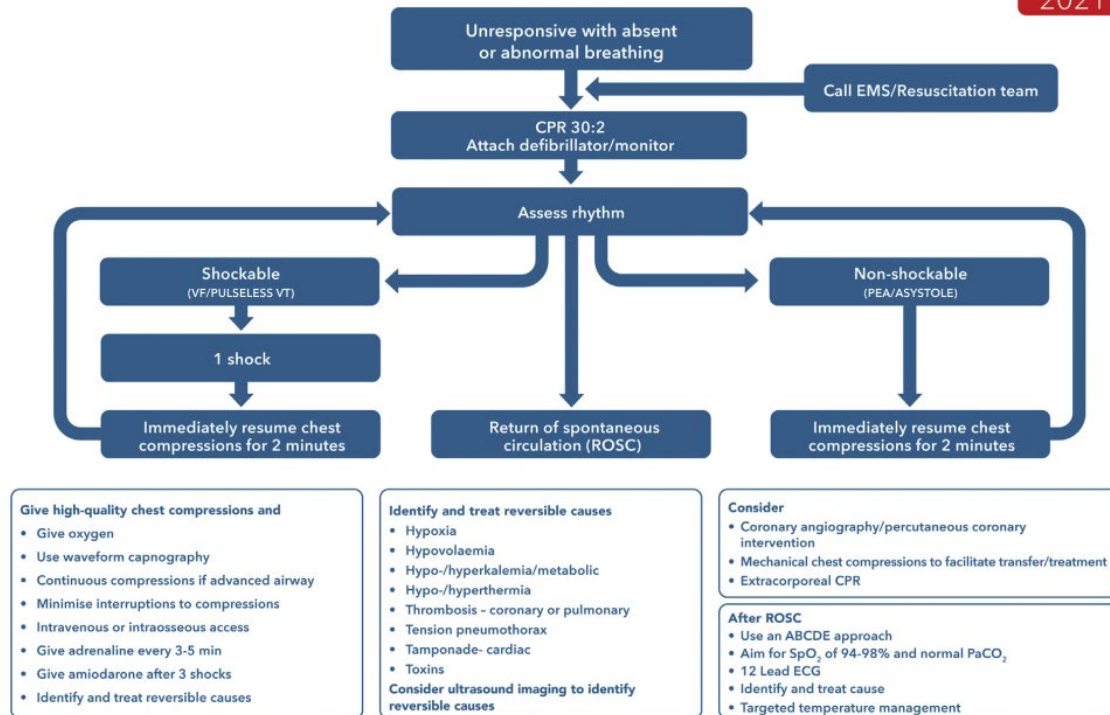
EVIDENCE [E] / RECOMMENDATION [R] / GOOD PRACTICE [GP]		LEVEL / GRADE
[BP]	The most serious damage is by immersion in hot liquids and by fire.	VERY LOW (Cochrane, 2004)40
[BP]	The kitchen and bathroom are the sites where burns most often happen.	VERY LOW (GPC SAS, 2011)5



15. ANNEXES

ANNEX 1

ADVANCED LIFE SUPPORT

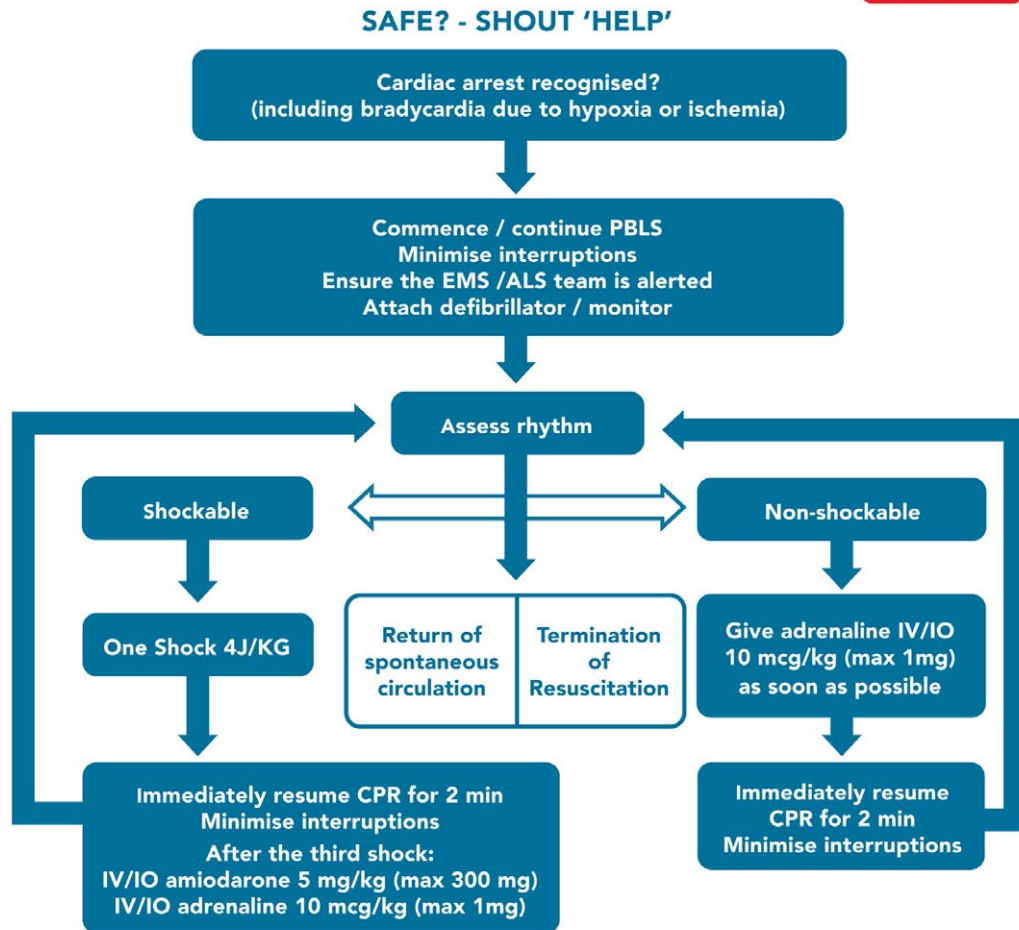


Advanced Adult Life Support Algorithm ERC 2021. Official translation of the Spanish Cardiopulmonary Resuscitation Council (CERCP). <https://www.urgenciasyemergen.com/actualizacion-erc-2021-nuevas-recomendaciones-rcp/>



ANNEX 2

PAEDIATRIC ADVANCED LIFE SUPPORT



DURING CPR

- Ensure high-quality CPR: rate, depth, recoil
- Provide bag-mask ventilation with 100% oxygen (2-person approach)
- Avoid hyperventilation
- Vascular access (intravenous, intraosseous)
- Once started, give adrenaline every 3-5 min
- Flush after each drug
- Repeat amiodarone 5 mg/kg (max 150mg) after the 5th shock
- Consider an advanced airway and capnography (if competent)
- Provide continuous compressions when a tracheal tube is in place. Ventilate at a rate of 25 (infants) – 20 (1-8y) – 15 (8-12y) or 10 (>12y) per minute
- Consider stepwise escalating shock dose (max 8J/kg – max 360J) for refractory VF/pVT (≥6 shocks)

CORRECT REVERSIBLE CAUSES

- Hypoxia
- Hypovolaemia
- Hyper/hypokalaemia, -calcaemia, -magnesaemia; Hypoglycaemia
- Hypothermia - hyperthermia
- Toxic agents
- Tension pneumothorax
- Tamponade (cardiac)
- Thrombosis (coronary or pulmonary)

ADJUST ALGORITHM IN SPECIFIC SETTINGS (E.G. TRAUMA, E-CPR)

IMMEDIATE POST ROSC

- ABCDE approach
- Controlled oxygenation (SpO₂ 94-98%) & ventilation (normocapnia)
- Avoid hypotension
- Treat precipitating causes

ERC 2021 Paediatric Advanced Life Support Algorithm. Official translation of the Spanish Cardiopulmonary Resuscitation Council (CERCP). <https://www.urgenciasyemergen.com/actualizacion-erc-2021-nuevas-recomendaciones-rcp/>



ANNEX 3

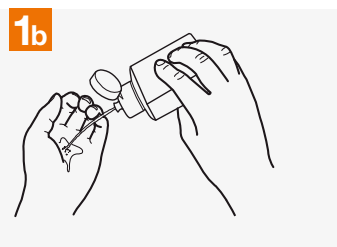
How to Handrub?

RUB HANDS FOR HAND HYGIENE! WASH HANDS WHEN VISIBLY SOILED

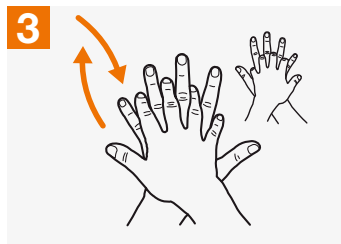
 **Duration of the entire procedure: 20-30 seconds**



Apply a palmful of the product in a cupped hand, covering all surfaces;



Rub hands palm to palm;



Right palm over left dorsum with interlaced fingers and vice versa;



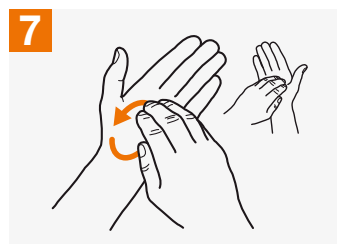
Palm to palm with fingers interlaced;



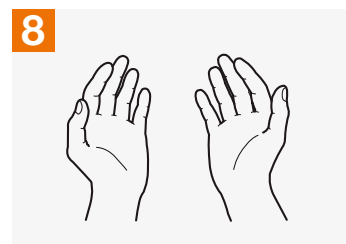
Backs of fingers to opposing palms with fingers interlocked;



Rotational rubbing of left thumb clasped in right palm and vice versa;



Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;



Once dry, your hands are safe.



World Health Organization

Patient Safety

A World Alliance for Safer Health Care

SAVE LIVES
Clean Your Hands

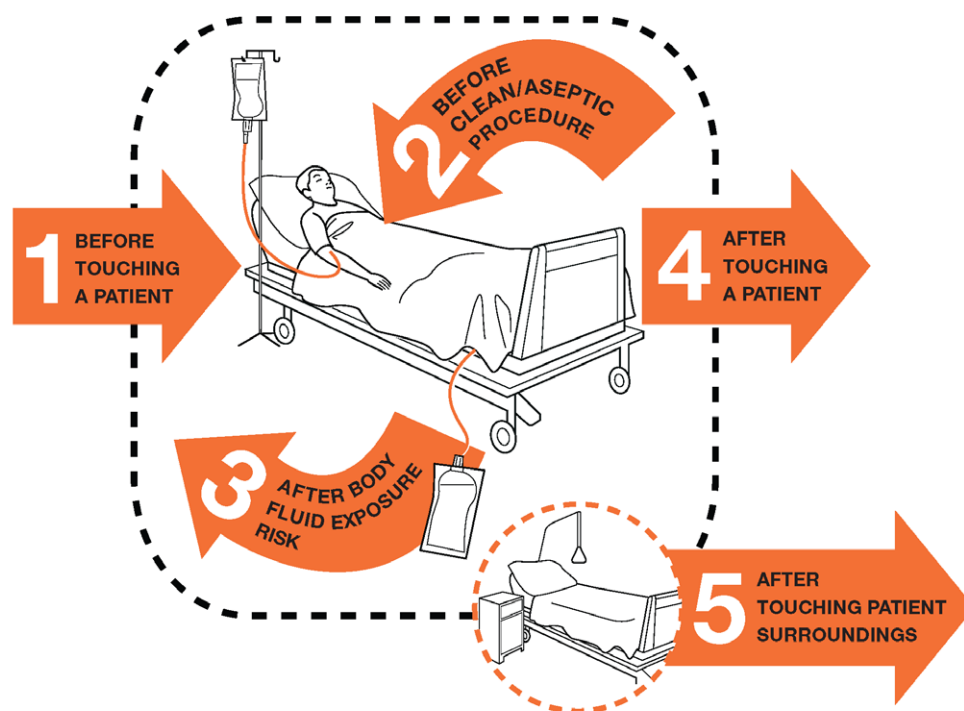
All reasonable precautions have been taken by the World Health Organization to verify the information contained in this document. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall the World Health Organization be liable for damages arising from its use. WHO acknowledges the Hôpitaux Universitaires de Genève (HUG), in particular the members of the Infection Control Programme, for their active participation in developing this material.

<https://www.who.int/publications/m/item/how-to-handwash>



ANNEX 4

Your 5 Moments for Hand Hygiene



1 BEFORE TOUCHING A PATIENT	WHEN? Clean your hands before touching a patient when approaching him/her. WHY? To protect the patient against harmful germs carried on your hands.
2 BEFORE CLEAN/ASEPTIC PROCEDURE	WHEN? Clean your hands immediately before performing a clean/aseptic procedure. WHY? To protect the patient against harmful germs, including the patient's own, from entering his/her body.
3 AFTER BODY FLUID EXPOSURE RISK	WHEN? Clean your hands immediately after an exposure risk to body fluids (and after glove removal). WHY? To protect yourself and the health-care environment from harmful patient germs.
4 AFTER TOUCHING A PATIENT	WHEN? Clean your hands after touching a patient and her/his immediate surroundings, when leaving the patient's side. WHY? To protect yourself and the health-care environment from harmful patient germs.
5 AFTER TOUCHING PATIENT SURROUNDINGS	WHEN? Clean your hands after touching any object or furniture in the patient's immediate surroundings, when leaving – even if the patient has not been touched. WHY? To protect yourself and the health-care environment from harmful patient germs.



World Health Organization

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<http://seehn.org/world-hand-hygiene-day-2021/>



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