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A SELF STUDY GUIDE

**BURNS – ASSESSMENT
AND MANAGEMENT**

Registered Nurses

OVERVIEW

Injuries due to burns affect millions of people worldwide every year¹. While most of these burns are minor, others require hospitalization and long term treatment plans. In the United States, an estimated 450,000 people will require medical treatment for burns annually. Of these, 40,000 people will be burned seriously enough to necessitate hospitalization.² These injuries can be overwhelming and challenging for the patient, families and the healthcare professionals (HCP) who care for them. With the availability of dedicated burn centers and specially trained HCPs, survival rates from burn injuries have improved but treatment options vary widely, impacting patient outcomes and health care costs. This continuing education activity will present a review of the anatomy of the skin and how burn injuries effect the integumentary system. It will also identify common cause of burn injuries, examine how burns are classified and review the common concerns associated with burn injuries. Finally, this activity will discuss burn wound management and give an overview of common treatment options.

LEARNER OBJECTIVES

After completing this continuing education activity, you should be able to:

1. Identify the different layers of the skin.
2. Discuss the effect of burn injuries to the integumentary system.
3. List the common causes of burn injuries.
4. Categorize different depths of burn injuries.
5. Identify the typical burn life cycle for each burn injury type.
6. Review common concerns associated with burn injuries.
7. Outline general treatment options and dressing choices available for burn injuries.

INTENDED AUDIENCE

The information contained in this self-study guidebook is intended for use by healthcare professionals who are responsible for or involved in the following activities related to this topic:

- Educating healthcare personnel.
- Establishing institutional or departmental policies and procedures.
- Decision-making responsibilities for safety and infection prevention products.
- Treatment and care of burn patients.
- Managing employee health and infection prevention services.

INSTRUCTIONS

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AN 85% PASSING SCORE IS REQUIRED FOR SUCCESSFUL COMPLETION

Any learner who does not successfully complete the post-test will be notified and given an opportunity to resubmit for certification.

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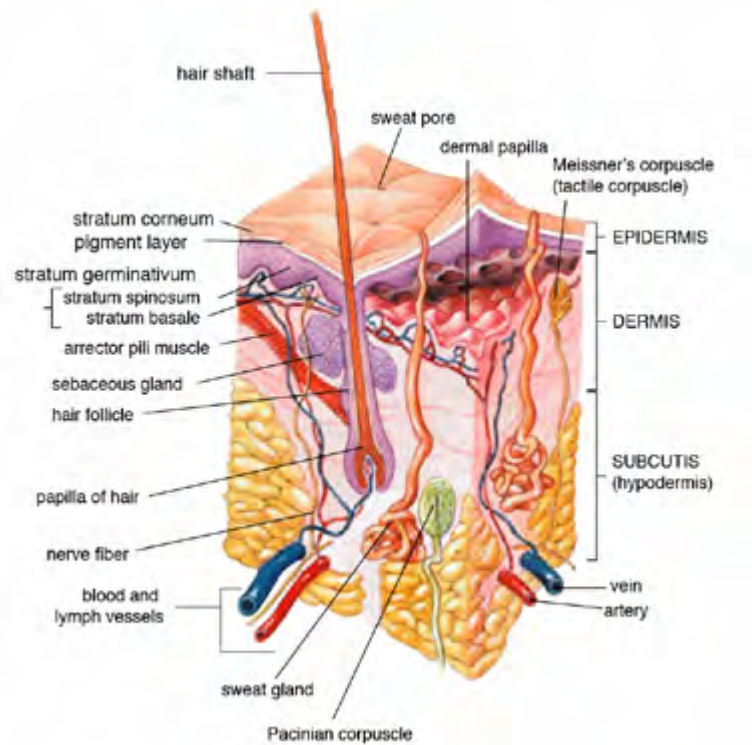
**BURNS –
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INTRODUCTION

Over the past 50 years, outcomes for burn patients have improved significantly.³ With the complexity of treating a burn injury, it is important to approach care from a multidisciplinary standpoint. Without the protection of the integumentary system, burn patients are susceptible to many morbidities and even death. Proper assessment and management, combined with a timely specialist referral, is crucial to the patient healing process. Though morbidity and mortality rates are still substantial, research and new technology has facilitated the progression of optimizing patient outcomes.^{4,5}

THE INTEGUMENTARY SYSTEM

The integumentary system of the human body consists of skin, hair, nails, and exocrine glands.⁶ Though only a few millimeters in depth, the skin, one of the largest organ in the body, protects the human body by creating a physical barrier between the outside world and internal tissue. It consists of two primary layers, the epidermis and the dermis, the skin performs many critical functions, including maintaining and supporting thermoregulation; fluid balance; immunological, neurosensory and metabolic functions.⁷ When the skin is damaged, pathogens, chemicals and other outside elements have a direct route to infiltrate the body and cause illness, infection and possibly death. Understanding the anatomy and physiology of the skin is key in identifying treatment needs of a burn patient.



Skin Layers

EPIDERMIS 8,9,10

Epidermis, coming from the Greek “epi” meaning “over” or “upon,” is the outermost layer of the skin.¹⁰ It forms the waterproof, protective wrap over the body’s surface and is made up of stratified squamous epithelium with an underlying basal lamina. The epidermis is the thinnest at eyelids being approximately 0.1 mm and thickest at the palm or soles, approximately 1.5 mm. The epidermis contains no blood vessels, and cells in the deepest layers are nourished almost exclusively by diffused oxygen from the surrounding air and to a far lesser degree by blood capillaries extending to the upper layers of the dermis. The main type of cells which make up the epidermis are Merkel cells (sensory receptor), keratinocytes (keratin producer), with melanocytes (melanin and pigment production) and Langerhans (immune system activator) cells also present.

The epidermis can be further subdivided into the following strata (beginning with the outermost layer): corneum, lucidum (only in palms of hands and bottoms of feet), granulosum, spinosum, and basale.

The corneum layer of the epidermis consists of 25 to 30 layers of dead cells. This layer regulates water loss and prevents harmful pathogens from entering the body.

DERMIS 11,12,13

The dermis is the layer of skin beneath the epidermis that consists of connective tissue and cushions the body from stress and strain. It is tightly connected to the epidermis by a basement membrane and is structurally divided into two areas: a superficial area adjacent to the epidermis, called the papillary region, and a deep, thicker area known as the reticular region. It also harbors many nerve endings that provide the sense of touch and heat. Additionally, it contains the hair follicles, sweat glands, sebaceous glands, apocrine glands, lymphatic vessels, blood vessels and glycoproteins, which are responsible for cell to cell interactions. The blood vessels inside the dermis provide nourishment and waste removal from its own cells as well as from the Stratum basale of the epidermis. Connective tissue and fibers within this layer are extremely important to maintaining the normal structure of the skin and scar formation after an injury.

HYPODERMIS 14

The hypodermis, though not part of the skin, lies below the dermis and is often discussed in conjunction with the dermis and the epidermis. Its purpose is to attach the skin to underlying bone and muscle as well as supplying it with blood vessels and nerves. It consists of loose connective tissue and elastin. The main cell types are fibroblasts, macrophages and adipocytes (the hypodermis contains 50% of body fat). Fat serves as padding and insulation for the body.

ADDITIONAL TISSUE 15,16

Underneath the hypodermis lie muscle, fascia, tendons, ligaments and bone. Muscle tissue allows the body to have locomotion, the ability to move, in addition to providing protection to nerve cells. Fascia, tendons and ligaments are the “connectors” for the body. These connector tissues are all made of collagen but serve to connect different areas of the body: ligaments connect bone to bone, tendons join muscle to bone and fasciae encompasses muscle and provides a separation between internal organs. Bone tissue functions as protection, structure and aids in locomotion.



SKIN LAYERS

Epidermis	Dermis	Hypodermis
Outermost Layer of Skin (Flakes off)	Second Layer of Skin	Subcutaneous adipose layer (Under the dermis)
Avascular (no blood cells)	Vascular (blood cells present)	Vascular (blood cells present)
Main Service: <ul style="list-style-type: none"> • Waterproofing • Barrier to infection 	Main Service: <ul style="list-style-type: none"> • Location for the appendages of skin (hair follicles, sweat glands, sebaceous glands, apocrine glands, lymphatic vessels and blood vessels) • Cushions body from stress 	Main Service: <ul style="list-style-type: none"> • NOT a true part of skin • Connects skin to body • Insulates and pads body • Helps regulate body weight¹⁷
Essential Cells ¹⁸ : <ul style="list-style-type: none"> • Keratinocytes: produce keratin • Melanocytes: produce melanin (forms a pigment shield that protects the cell nucleus from the UV rays). • Langerhans cells: star-shaped cells from bone marrow. Function to activate the immune system as macrophages. • Merkel cells: function as sensory receptors 	Essential Tissue/Cells ¹⁹ : <ul style="list-style-type: none"> • Collagen • Elastic Fiber • Connective Tissue • Papillae (Touch and Pain Receptors) – form fingerprints 	Essential Tissue/Cells ²⁰ : <ul style="list-style-type: none"> • Connective Tissue • Collagen • Adipocytes

BURN INJURY OVERVIEW

A burn is an injury to skin or tissue caused by heat (thermal), electricity, chemicals, radiation or trauma.²¹ Damage resulting from burns can be minor or can present a life-threatening emergency, depending on the heat's intensity, the total area of tissues burned, and the length of exposure to the skin. Most burns are minor injuries that occur at home or work. Fire or flame injuries and scalds from hot liquids and steam are the most common causes of burns²².

THERMAL BURNS

A thermal burn is an injury resulting from contact with hot items, such as boiling water, steam, hot cooking oil, fire, or other hot objects. In the United States, fire and hot fluids scalds, are the most common causes of burns, accounting for 8 out of 10 burn injuries reported to the National Burn Repository. Water, at 140 degrees F, creates a deep burn in 5 seconds, but at 156 degrees F, it will cause the same injury in 1 second.²³ Circumferential burns should raise suspicion of non-accidental trauma. Scalds are the most common type of thermal burn suffered by children under 5 years old and the elderly, over 65 years of age, but for adults age 18-35, thermal burns are most commonly caused by fire.²⁴ Of house fires that result in death, smoking, at 22%, is the leading cause of fires, with heating devices coming in second at 19%.²⁵ Scalding is caused by hot liquids or gases and most commonly occurs from exposure to hot beverages, high temperature faucet water during bathing, hot cooking oil, or steam. Contact with hot items is also a common cause of burns in children. Usually, scalds are first- or second-degree burns, but third-degree burns may likewise result, particularly with prolonged contact.



Thermal Burn - Scalding caused by a radiator explosion.²⁶

On the off chance that clothing the individual wears bursts into flames, third-degree burns can develop in the matter of just few seconds. Fireworks are also a common cause of burns during holiday seasons in many countries. This cause of injury is a particular risk for adolescent males.

CHEMICAL BURNS

A chemical burn occurs when tissue is exposed to a caustic substance, such as a strong acid or base. Chemical burns can occur through direct contact on body surfaces including skin and eyes, inhalation, and ingestion and may cause extensive tissue damage. The main types of irritant and/or corrosive products are: acids, bases, oxidizers, solvents, alkalis and vesicants. Additionally, chemical burns can be caused by some types of chemical weapons e.g. vesicants such as mustard gas and Lewisite, or urticants such as phosgene oxime.²⁷

Generally, chemical burns do not need a source of heat and may not be immediately noticeable. Tissue injury begins immediately upon contact with the irritant and continues to be damaged as the irritant diffuses through skin layers and begin to destroy structures underneath the skin. This diffusion and damage to the deeper layers, where nerve endings reside, cause this type of burn to be extremely painful. Tissue damage will continue to occur unless the chemical agent is completely removed and possibly neutralized.²⁸



Chemical Burn - Chemical burn caused by exposure to sodium hydroxide solution (lye). Photographed 44 hours after exposure.²⁹

ELECTRICAL BURNS

An electrical burn is a burn that results from an electrical current passing through the body. Nearly 1,000 deaths per year due to electrical injuries are reported in the United States, with a mortality rate of up to 15%. In order to be classified as an electrical burn, the injury has to be directly caused by electricity. For example, burning a hand on a hot, electric curling iron is a thermal burn, not electrical. For an electrical burn, the body comes into contact with an electrical source and becomes part of the electrical circuit. The electrical current creates point of entry in the body, follows the path of least resistance through blood vessels, nerves, muscle, then skin, tendon, fat and bone, leaving the body through an exit point. As a result of this pathway, only the entry and exit wounds are visible, concealing internal damage between the entrance and exit points, making it hard to accurately diagnose the severity of damage.³⁰

Four factors determine the severity of the damage caused by electrical burns: voltage, current, resistance, and frequency. Low voltage injuries, 500 volts or less, usually cause superficial tissue damage. Most commonly, electric injuries primarily damage the outer limbs, but more critical portions of the body may be affected as well causing severe complications. Large current, high voltage injuries, like those accompanying a lightning strike, are usually severe in nature, depending on the pathway the current takes through the body. In extreme cases, electricity can cause shock to the brain, strain to the heart, respiratory paralysis and injury to other organs.³¹



*Electrical Burn – on hand*³²

RADIATION BURNS ^{33,34}

A radiation burn is damage to the skin or other tissue triggered by exposure to radiation. Thermal radiation, radio frequency energy, ultraviolet (UV) light and ionizing radiation are of greatest concern for tissue injury.

The most common type of radiation burn is a sunburn from UV radiation. High exposure to X-rays during diagnostic medical imaging or radiotherapy can also result in radiation burns. As the ionizing radiation interacts with cells within the body, damaging them, the body responds to this damage, typically resulting in erythema, redness around the damaged area. Radiation burns are frequently linked with radiation-induced cancer due to the ability of ionizing radiation to interact with and damage DNA, occasionally inducing cells to become malignant. This damage to cell DNA can cause chronic skin changes and result in significant healing issues, even if cells do not become cancerous.



Radiation Burn – Ionizing radiation burn: Large red patches of skin on the back and arm from multiple prolonged fluoroscopy procedures. ³⁵

TRAUMATIC BURNS ^{36,37}

Friction burn, also termed road rash, is caused when the skin is rubbed briskly over a rough surface causing an abrasion. These burns can be the result of falling on or being dragged over rocks, cement or asphalt. For example, during a motorcycle accident, the rider can be thrown from the bike and dragged across the road due to the momentum. The friction between the body and the asphalt creates a high temperature, which can cause a burn. These friction burns are often accompanied by traumatic injuries, abrasions or skin tears. Friction burns can also occur during sports activities; playing on mats, or on the carpet or the playground when skin rubs against a rough surface. Additionally, these burns can occur during the use of an exercise treadmill from accidental contact with the fast moving, motorized belt.

Friction burns can be quite serious and painful, and result in injury extending through the dermis. Depending on the size and depth of injury, friction burns may be treated conservatively with a dressing and ointments or require skin grafting.



Rope burn (friction burn)

FROST BITE ³⁸

Frostbite is an injury that is caused by exposure of parts of your body to temperatures below freezing point. The cold causes freezing of your skin and underlying tissues. The fingers, toes and feet are most commonly affected but other extremities including the nose, ears, and the cheeks can also develop frostbite. In areas of the body affected by frostbite, ice crystals form and cells and blood vessels become damaged. Like burns, frostbite injuries are classified by the degree of injury. The degree of frostbite basically refers to how deep the frostbite injury goes.



Human toes 3 weeks post frost bite ³⁹



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Types of Burn Injury	
Thermal	<p>Flash – Explosions of natural gas, propane, gasoline and other flammable liquids. Intense heat for a very brief period of time. Clothing is protective unless it ignites.</p> <p>Flame – Exposure to prolonged, intense heat. House fires, improper use of flammable liquids, automobile accidents, ignited clothing from stoves/heaters.</p> <p>Scalds– Burns caused by hot liquids. Water, oil, grease, tar, oil.</p> <p>Contact – Result from hot metals, plastics, glass or coals. Can be very deep.</p>
Chemical	Caused by strong acids or alkali substances. They continue to cause damage until the agent is inactivated.
Electrical	Caused by an electrical current. Current follows the path of least resistance and causes injury in areas other than the contact/entry site. They cannot be judged from the external injury alone.
Radiological	Caused by alpha, beta or gamma radiation. They may need to have some type of decontamination done to stop the injury.
Traumatic	Caused by friction – Motor vehicle crashes, treadmill belts.
Frost Bite	Caused by exposure of parts of your body to temperatures below freezing point.

BURN CLASSIFICATIONS

Burn injuries are categorized according to the range and depth of tissue injury. Burn depths are often underestimated during the initial examination phase. This can often occur when the internal damage is not readily observed. Devitalized tissue may appear viable for some time after injury, and often, some degree of progressive microvascular thrombosis continues. Consequently, the wound appearance may change over the days following injury. Because of this, serial examination of burn wounds can be very useful to correctly determine tissue damage. An accurate estimate of the extent of the burn wound is important in determining the need for hospitalization and the initial and definitive treatment required for the victim.⁴⁰

When classifying the depth of a burn, one system that is commonly used assigns a degree to the injury, first through fourth degree. Though still utilized in some areas, the degree classification system is now being transitioned to a more descriptive classification structure. Using this new system, the exact level of tissue injury can be noted and utilized for development of a treatment plan.

SUPERFICIAL BURN

A superficial, first degree, burn is a painful injury, usually confined to the epidermis. There is generally no breach in the epidermal layer and the skin appears red dry without blisters. When pressure is applied to the injury, the skin easily blanches and maintains swift capillary refill.⁴¹



Sun Burn – first degree burn

SUPERFICIAL PARTIAL THICKNESS

A superficial partial thickness burn may have been classified under the old system as a first or second degree burn. A common example of this is a deep sunburn. This injury is usually extends into to the epidermis, and possibly the papillary layer



2nd degree hand burn⁴³

of dermis, and typically heals without scarring. This injury is painful and the skin is pink, but blanches easily with virtually immediate capillary refill. If blisters are present, they are usually thin and can be addressed with mild debridement.⁴²

DEEP PARTIAL THICKNESS

With a deep partial thickness, deep second degree, burn, tissue injury involves the epidermis, papillary dermis and reticular dermis. Part of dermis may still be intact with this injury, providing a small amount of protection during the healing process. Skin is red to pale pink in color, develops extensive blistering and blanches poorly due to the destruction of blood vessels. If a majority of the dermis has been injured, this deep tissue injury can result in scarring which may cause functional and motor issues, especially if the injury is over a joint area such as the knee.⁴⁴



Deep second degree burn caused by scalding water

FULL THICKNESS INJURY

A full thickness, or third degree, injury involves the epidermis, both layers of dermis and extends across basement membrane into subcutaneous tissue. With this injury, the surrounding zone of injury varies in depth and results in skin color which can range from a dark waxy red to waxy white or black. Injured skin feels leathery to the touch and may not have sensation, depending on the nerve tissue damage. Scarring is common, even after appropriate treatment and care.⁴⁵



Full thickness 3rd degree burn caused by motorcycle muffler

DEEP FULL THICKNESS INJURY

Fourth degree, deep full thickness, burns involve the most tissue damage. These injuries extend past the layers of the skin and subcutaneous tissue and include damage to muscle, tendon and possibly bone. Tissue destruction is obvious and the skin is usually black in color. The surrounding zone of injury is generally large and contains varying depths of tissue destruction. Extensive debridement, considerable tissue reconstruction, like muscle flaps, and often time amputation are all necessary to promote healing.⁴⁶



4th degree burn – fingers⁴⁷

BURN CLASSIFICATION SUMMARY

Classification	Skin Layers Involved	Appearance	Sensation	Healing Time	Prognosis
Superficial (First-degree)	Epidermis	<ul style="list-style-type: none"> • Red - without blisters • Blanches with pressure 	Painful	3-7 days	<ul style="list-style-type: none"> • Heals well • Repeated sunburns increase the risk of skin cancer later in life
Superficial partial thickness (First or Second-degree)	Extends into superficial (papillary) dermis	<ul style="list-style-type: none"> • Redness with small blister • Pink skin • Blanches with pressure 	Very painful	7-14 days	<ul style="list-style-type: none"> • Local infection/cellulitis potential • Possible scar formation
Deep partial thickness (Deep Second-degree)	Extends into deep (reticular) dermis	<ul style="list-style-type: none"> • Dark Pink Skin • Less blanching • Blisters present 	Pressure and discomfort	3–8 week	<ul style="list-style-type: none"> • Scarring • Contractures (may require excision and skin grafting)
Full thickness (Third-degree)	Extends through entire dermis	<ul style="list-style-type: none"> • Stiff skin • Blotchy red/white/ (possibly) black • No blanching 	Can be Painless	Prolonged (months)	<ul style="list-style-type: none"> • Scarring • Contractures • Skin grafting • Amputation
Deep Full Thickness (Fourth-degree)	Extends through entire skin, and into underlying fat, muscle and bone	<ul style="list-style-type: none"> • Skin is usually black (can also be White/ brown) • May be charred with eschar • No blanching 	Painless	Prolonged (months) Requires excision	<ul style="list-style-type: none"> • Amputation • Significant functional impairment • Skin grafting • Potentially fatal

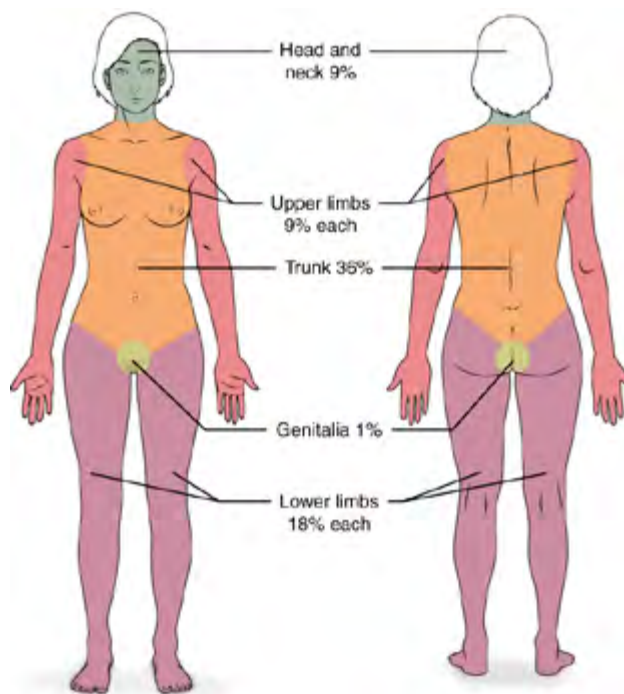


SURFACE AREA ASSESSMENT

The extent of damage is best described utilizing the percentage of the total body surface area affected by the burn. This measurement is imperative for estimating fluid requirements and determining the potential need for transfer to a burns center. For example, large superficial burns, though shallow in depth, have a potential to cause morbidity and mortality, especially in young children and the elderly.⁴⁸

Burn size or extent is expressed as a percentage of the total body surface area (TBSA) and may be estimated in a number of ways. Several studies have compared the various methods of estimating burn surface. Perhaps most accurate is the Lund-Browder diagram, an age-specific chart that compensates for the changes in body proportions with growth. A burn is drawn on a figure, and an associated age-specific table is used to calculate the body surface area involved. Another method of determining TBSA is the Wallace Rule of Nines, which divides the body in areas of nine or multiples of nine percent. The head and arms each count for nine percent, each side of the trunk and each leg count for 18 percent, and the remaining one percent is reserved for the genitalia and the perineum. Rule of Nines is faster and more convenient to use for adult burn patients in emergency situations, however, it is not as accurate for children or for obese people.⁴⁹ For small, incongruent, or extremely large burns, the palmar surface of the patient's hand can be used to calculate small injuries or subtract from the TBSA in massive burn injury. The area of the palm represents 1% of the body surface.

Rule of Nines ⁵⁰



COMMON CONCERNS ASSOCIATED WITH BURN INJURIES

The integumentary system, the skin, performs many different functions for the human body, including protection; immunological assistance; fluid, protein and electrolyte homeostasis; thermoregulation; neurosensory tasks; and metabolic duties. A burn injury, especially if it is deep or widespread, disrupts the ability of the skin to carry out these vital functions and can lead to many complications.

INFECTION

Infection is one complication which can affect any burn injury, no matter the depth. Once there has been a breach epidermal layer, this opening to the underlying tissue creates an opportunity for pathogens to enter the body. These pathogens include bacteria, bacterial spores, viruses, fungi, and prions.

Bacteria are single cell living organisms and do not need a host to survive. They can be categorized as gram positive or gram negative, which makes a distinction regarding the cell wall and permeability. Bacterial spores are an adaptation of bacteria. With this pathogen, the bacteria is in the core, protected by an outer spore. Viruses need a host to survive and learn to adapt to their host, using those adaptations to reproduce. Fungi, like yeasts and molds, and prions, genetically coded abnormal proteins, are also a concern for infection. Damage to the body's immunological response allows these pathogens to reproduce or replicate within the human body, causing illness and disease.⁵¹

Pathogens are ever present in the world. A burn injury patient is susceptible for infection from various sources. Contaminants can come from outside the hospital, such as the accident scene or the patient's own skin, or from inside the hospital due to contaminated surfaces, healthcare worker cross contamination, and from procedural activities. Healthcare associated infections (HAIs) are a huge concern for a vulnerable burn injury victim. According to the Centers for Disease Control and Prevention (CDC), 1 in 25 hospital patients will develop an HAI.⁵² The healthcare team has to take this threat into account when developing treatment plans for a burn injury patient.

Burn wound cellulitis, skin infection, usually manifests with progressive erythema, swelling, and pain in the uninjured skin around a wound. Usually, this is seen in the first few days after the burn occurred. Invasive burn wound infection is a rapid proliferation of bacteria in burn eschar that invades underlying viable tissues.

A change in color, new drainage, and, occasionally, a foul or sweet odor are clinical findings. Depending on the extent of tissue injury, a localized infection can progress to systemic toxicity and sepsis, a life-threatening infection that travels through your bloodstream affecting the whole body, possibly causing shock and organ failure.⁵³

RESPIRATORY PROBLEMS

Damage to the tracheal and pulmonary system can occur when hot air, toxic gases, and associated particulates are inhaled during a burn injury. Inhalation injury is present in 13% of patients with flame burns. With smoke inhalation, the overall mortality rate is 24%, while the mortality is only 3% in those patients without this complication.⁵⁴ The diagnosis of an inhalation injury is based on information about the burn incident and clinical findings, such as burn injury to the face, debris in the mouth and decreasing oxygenation levels. Often the degree of respiratory injury is confirmed by bronchoscopy. Smoke inhalation damages the lungs and can cause respiratory failure, inhibited the body's ability to exchange oxygen and carbon dioxide. Assisted ventilation or intubation may be needed to support the patient's respiratory function.⁵⁵

LOW BLOOD VOLUME (HYPOVOLEMIA)

Burns can damage blood vessels and cause fluid loss. This may result in low blood volume, hypovolemia. Severe blood and fluid loss cause a decrease in cardiac output and prevents the heart from pumping enough blood to the body. Without an adequate blood supply, tissues and cells within the body do not receive the oxygen and nutrients necessary for basic functions and living.

LOW BODY TEMPERATURE (HYPOTHERMIA)

The skin helps control the body's temperature, so when a large portion of the skin is injured, body heat is lost. This increases your risk of hypothermia, when the body loses heat faster than it can produce heat, causing a dangerously low core body temperature.

SCARRING

Burns can cause scars and keloids, ridged areas caused by an overgrowth of scar tissue. This scar tissue can cause motor dysfunction and long term discomfort. Deep burns over joint areas can limit movement due to the destruction of tendons and ligaments in the area. Additionally, scar tissue can form and cause contractures, tightening and shortening of skin, muscles or tendons, permanently pulling joints out of position.

BURN INJURY MANAGEMENT

Treating burns is not a clear-cut or simple process. Treatment strategies and wound care differ greatly internationally, nationally and locally, depending on the knowledge and experience of the health care team.⁵⁶ Although extensive burns can be fatal, current practices and treatments developed since 1960, though varied, have considerably improved patient outcomes.⁵⁷ Using a systemic patient evaluation process is key for promoting positive patient outcomes. Airway support, fluid balance/circulatory stabilization and pain management are essential components of the initial emergency treatment. Preliminary and ongoing assessment of burn wound extent, depth, and circumferential elements is also a critical factor in developing patient treatment plans.⁵⁸

In addition to these essentials, early nutritional support of a burn patient has been shown to impact patient outcomes. After a burn injury, the body goes into a heightened inflammatory state, which can increase metabolism and cause metabolic disharmony within the body. With modern research showing the positive effect of maintaining nutritional balance after a burn injury, many treatment plans now include nutritional interventions, not to stave off malnourishment, but to modulate the healing process.⁵⁹

Decisions regarding the type of monitoring, wound care, nutritional therapy, hospitalization, and transfer will be made based on the information obtained from these initial assessments and interventions.^{60,61}

HISTORICAL PERSPECTIVE⁶²

Records of burn injuries can be traced back to cave paintings from more than 3,500 years ago. In 1500 BC, Egyptian documents by Edwin Smith Papyrus describes treatments using honey and the salve of resin. Many other treatments have been used over the ages, including the use of tincture and extracts from tea leaves by the Chinese documented in 600 BC, pig fat and warm vinegar soaks by Hippocrates in 400 BC and wine and myrrh by Celsus during the first century. During the 1500s AD, Ambroise Paré, barber-surgeon to French royalty, implemented some new burn injury treatment practices and is often associated with the first procedural description of early surgical excision.

In 1797, Edward Kentish, a British Physician, published an essay focusing on relieving burn pain and blisters with the use of pressures dressings. Years later, in the early 19th century, Guillaume Dupuytren, anatomist and surgeon, developed the burn degree classification system that is still in use today. By 1843, Edinburgh Royal Infirmary, the first hospital to treat burns, opened in 1843 in London, England and the development of modern burn care had begun.



Guillaume Dupuytren (1777–1835)⁶³

During World War I, English chemist, Henry D. Dakin, and French surgeon, Alexis Carrel developed standards for the cleaning and disinfecting of burns and wounds using sodium hypochlorite solutions, also known as Dakin's solution, which significantly reduced mortality. In the 1940s, the importance of early excision and skin grafting was acknowledged, and around the same time, fluid resuscitation and formulas to guide it were developed. In 1947, during an ammonium nitrate explosion in Texas City, Truman G. Blocker became a pioneer for burn care and mass casualty treatment. Leading the care of over 3000 victims, Dr. Blocker has been attributed with being the first to use a multidisciplinary team approach for burn injury management. By the 1970s, researchers began looking deeper into the process of healing and demonstrated the significance of the hyper-metabolic state that follows large burns.

SURGICAL INTERVENTION – ESCHAROTOMY

Burn wound repair is an eternal issue for burn treatment. Ischemia and hypoxia caused by stress and wound inflammatory reactions to burn injuries are key factors of sepsis and organ complications. Therefore, the treatment of burn wound is not only relevant to repair of burn wound itself but also for prevention and treatment of complications, such as burn induced compartment syndrome. This is especially true for circumferential, or near-circumferential, burn wounds.

These wounds may cause progressive extremity ischemia or interfere with ventilation as burn wound swelling increases and inelastic eschar, burnt tissue. In such situations, timely escharotomy is essential. An escharotomy is an incision into stiff eschar tissue, which releases the constriction and allows the cutaneous envelope to become more compliant. Hence, the underlying tissues have an increased available volume to expand into, preventing further tissue injury or functional compromise.^{64,65}

EXCISION AND GRAFTING

Wound size is the most important factor in determining the need for early operation because this correlates with the physiologic threat represented by the injury. These operations can be bloody and physiologically stressful, but the blood and stress can be minimized with proper planning and execution. Examination by an experienced burn surgeon remains the most reliable method to assess for surgical intervention, despite the many devices developed to measure burn depth or burn blood flow. The changes in wound appearance over the first few days after injury make serial examinations particularly useful tools in surgical planning.

Patients with small burns rarely develop overwhelming wound sepsis, and burn care providers often have the luxury of time to allow the wound to fully evolve, allowing accurate operative planning. Patients with larger injuries generally do better if their wound is addressed during the first few days after the burn occurred. If an excision is warranted, debridement, removal of necrotic tissue and eschar, is performed until a viable wound bed is reached. Depending on the depth of the wound bed, subsequent grafting may be performed.⁶⁶

There are three types of grafting, autograft, allograft, and xenograft. Autograft requires skin to be taken from somewhere else on the body, the donor site, and placed on the debrided burn wound. If the burn is large it may take multiple surgeries to cover the entire burned area with autograft. Since this graft is from the patient's body, with proper care, rejection of the tissue does not occur. An allograft is a donor skin from another individual. These grafts provide wound protection against infection and fluid loss but generally will be rejected by the patient's body within 7-21 days. Until rejection, the allograft acts as a temporary skin and promotes tissue healing.⁶⁷ Xenografts are skin taken from animals and used as a temporary cover until more definitive care can be provided.

SKIN SUBSTITUTES

With extensive burn injury or other underlying morbidities, some patients may not have an appropriate donor site to be able to provide an autograft. Split thickness human allograft remains the optimal temporary skin cover but coverage of open wounds with reliable skin substitutes is can be an alternative choice. Temporary skin substitutes provide protection from mechanical trauma, a vapor barrier, and a physical barrier to bacteria. They may also allow regrowth of the dermis and decrease scarring. A number of membranes have been developed to effect permanent wound coverage, including epidermal, dermal, and composite substitutes. These can be useful in patients with massive injury, but they are very fragile, expensive, and provide unreliable definitive cover.⁶⁸

MEDICATIONS AND MEMBRANES

The choice of medication or membrane for a burn injury is an ongoing debate. A wide range of topical medications is available, including simple petrolatum, various antibiotic-containing ointments and aqueous solutions, and debriding enzymes. All of them can be effective when used properly by experienced providers in a program of burn care that includes wound evaluation, regular cleansing, and monitoring.

Wound membranes differ from medications and dressings in that they provide temporary physiologic wound closure. These membranes offer some protection from mechanical trauma, vapor transmission characteristics similar to skin, and create a physical barrier to bacteria. These membranes are commonly placed on clean superficial wounds while awaiting epithelialization. These membranes are mostly occlusive; therefore, they must be used with caution if wounds are not clearly clean and superficial. If an occlusive membrane is placed over devitalized tissue, infection can occur beneath the membrane, which can lead to localized and/or systemic sepsis.⁶⁹

WOUND CARE AND DRESSINGS

When choosing a dressing for a burn injury, healthcare providers should consider the five fundamental objectives. First, the chosen dressing should provide a level of protection against wound colonization and infection. Second, the dressing should maintain an optimal wound bed moisture level and prevent wound desiccation. Third, dressings that offer appropriate absorbency and management of exudate are also important in maintaining a clean wound bed and promoting healing. With the prevalence of scar tissue formation, the fourth goal of a burn dressing is to provide compression. Compression has been shown to manage swelling, minimize the effects of scarring and provide some pain relief to the injured area. Lastly, the application and removal process of the dressing as it relates to pain management and additional tissue trauma should be taken into consideration. Dressings that do not adhere to the wound and are easy to apply and remove are optimal for this goal.

Specialized areas of injury, including the face, head, neck, ears, hands, perineum and genitals, require careful consideration. Choosing and applying dressings for these difficult to dress areas can be challenging and complex. For instance, when dressing a facial burn, in addition to the above objectives, the dressing also has to address issues such as the potential presence of assisted ventilation devices or patient anxiety from feeling “closed in” with a thick covering. With burn injuries to the hands and feet, it is recommended to dress each finger/toe separately. Bandaging the whole hand/foot together inhibits normal functioning and mobility and should only be used when necessitated. By bandaging each appendage, mobility, functionality and edema can be better manage. Though best for wound healing, this practice can be time consuming for the healthcare worker and may extend the time of pain for the patient.⁷⁰





**BURNS –
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Wound Care Product Selection – General Overview ^{71,72,73}		
Product	Function	Note/Precautions
Gauze	<ul style="list-style-type: none"> • Can be dry, wet, or impregnated with ointments • Provide vapor and bacteria barrier while allowing drainage • Moistened – non adherent barrier protection 	<ul style="list-style-type: none"> • Can be time consuming to apply, depending on area of injury • May adhere when used as a primary dressing (especially when dry)
Hydrocolloids	<ul style="list-style-type: none"> • Provide vapor and bacteria barrier while absorbing wound exudate • Provides moist wound environment 	<ul style="list-style-type: none"> • Should only be used when surrounding tissue is not compromised
Biologic/ Biosynthetic dressings	<ul style="list-style-type: none"> • Temporary skin cover • Barrier against infection/water evaporation • Bio synthetics: combination of a biologic source and a synthetic 	<ul style="list-style-type: none"> • Expense may be prohibitive • Temporary dressing, body may reject product
Alginates	<ul style="list-style-type: none"> • Maintain a physiologically moist microenvironment • Promotes healing and granulation tissue • Promotes hemostasis 	<ul style="list-style-type: none"> • Do not use on a dry wound or wound with little exudate • Use with third degree burns contraindicated
Foams	<ul style="list-style-type: none"> • Absorbs wound exudate from wound bed 	<ul style="list-style-type: none"> • Avoid use on infected wounds
Antimicrobial Creams/Ointments	<ul style="list-style-type: none"> • Useful in many superficial partial-thickness wounds • Provides antimicrobial protection 	<ul style="list-style-type: none"> • Additional reapplications needed to ensure level coverage • Can be painful to apply to wound
Antimicrobial Fabrics – Containing Silver	<ul style="list-style-type: none"> • Broad Spectrum antimicrobial (inactivates bacteria, viruses, fungi) • Manages exudate formation • Additional functions/feature vary by manufacturer 	<ul style="list-style-type: none"> • Has not been evaluated for use during pregnancy • Fabric may have to cut to size
Outer Dressings	<ul style="list-style-type: none"> • Provides wicking, stretch and absorption for fluid management 	<ul style="list-style-type: none"> • May need frequent changing which can be difficult for the staff and patient
Compression garments	<ul style="list-style-type: none"> • Provides compression after initial healing to decrease long term scarring 	<ul style="list-style-type: none"> • May be expensive and patients often refuse to wear them

REHABILITATION ^{74,75}

Rehabilitation and reconstruction is the final part of burn care. This phase begins during the acute treatment phase with range of motion exercises, minimization of edema and the initiation of case management. This rebuilding phase may last months to years after the injury, depending on the extent of the burn and surgical interventions. As this field has evolve and become highly specialized, the survival has improved and patients have to cope with the effects of their injury, physically, emotionally, financially and psychologically. Rehabilitation is designed to meet each patient's specific needs; therefore, each program is different. The goals of a burn rehabilitation program include helping the patient return to the highest level of function and independence possible, while improving the overall quality of life.

SUMMARY

Most minor burns can be treated as an outpatient and will heal fine without scarring. Extensive burns, severe burns in critical areas, such as the face, genitals, hands, or feet, and burns in infants or the elderly may require hospitalization and care by a specialist in burns. The effective treatment of severe burns is multidisciplinary, involving general practitioners, specialty physicians, nurses, physical therapists, as well as case workers and sometimes organizational purchasing staff. Knowledge of the basic principles of burn management, in conjunction with an understanding of the different treatment options available enables physicians to care for patients with burns appropriately both in the acute setting and long term.





BURNS – ASSESSMENT AND MANAGEMENT

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