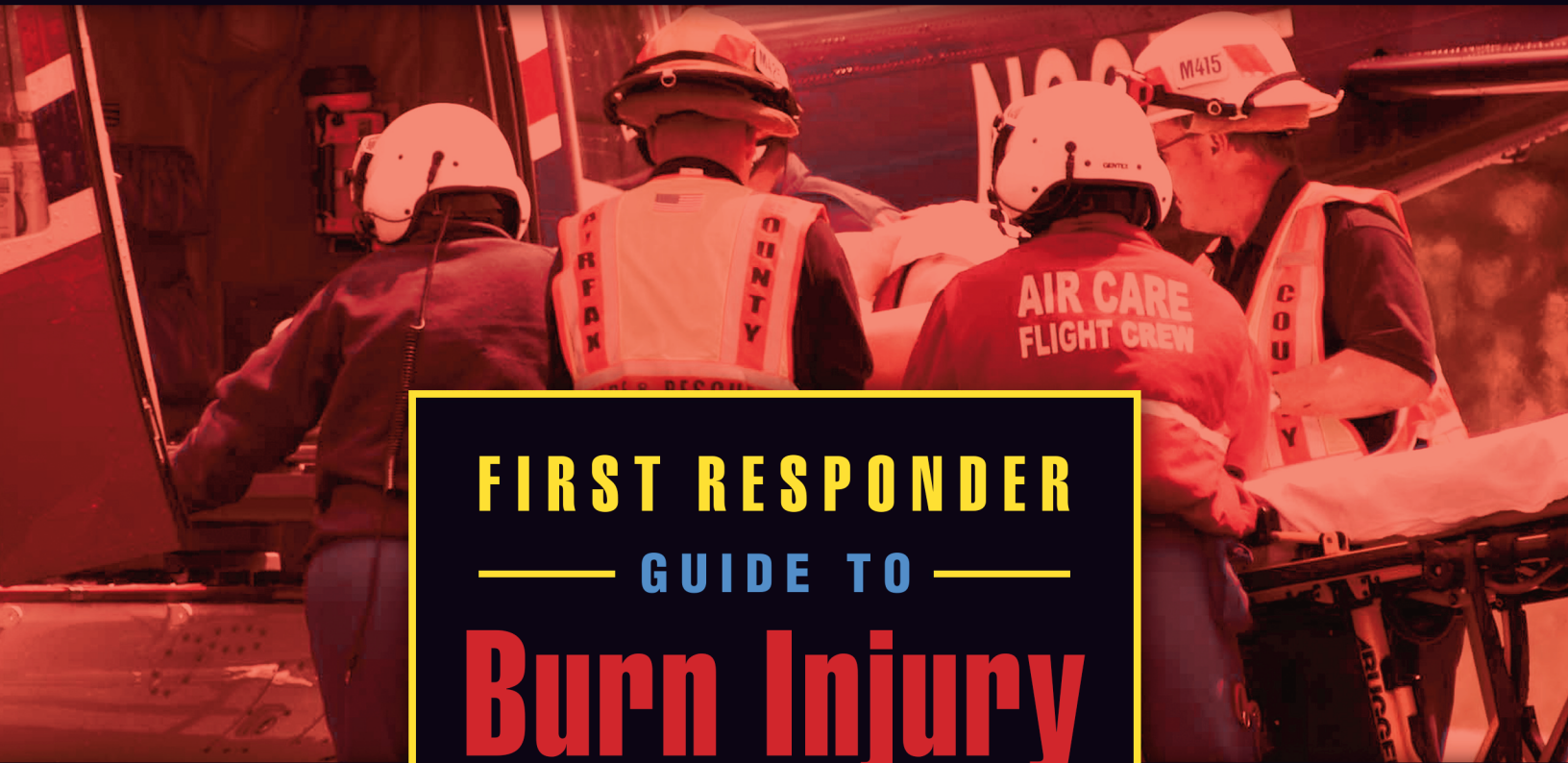




The International Association of Fire Fighters
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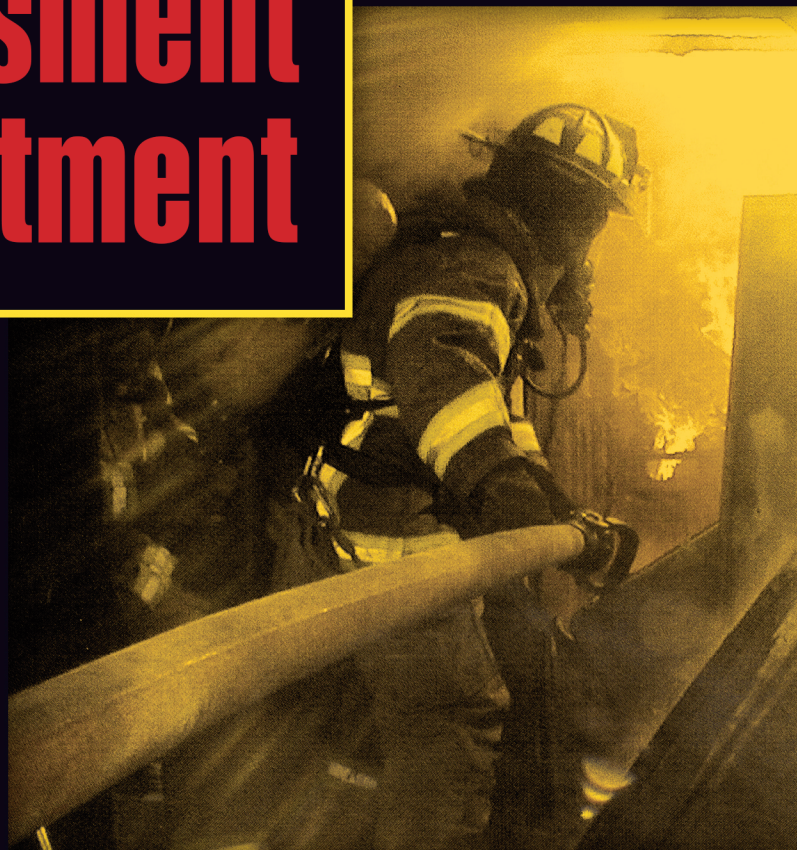
American Burn Association



FIRST RESPONDER

— GUIDE TO —

Burn Injury Assessment & Treatment





The International Association of Fire Fighters
Foundation

American Burn Association



FIRST RESPONDER
— **GUIDE TO** —
**Burn Injury
Assessment
& Treatment**

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International Standard Book Number: 0 -942920-X

FOREWORD

The International Association of Fire Fighters (IAFF) Foundation Burn Fund has partnered with the American Burn Association (ABA) to develop this manual to provide first responders (fire fighters and emergency medical providers) with the basic training and knowledge necessary to effectively assist those who have suffered a burn injury or cold exposure.

This manual provides a comprehensive, general overview of burn and trauma injuries. It takes readers through each step of a response, providing them with simple explanations and classifications of injuries, depictions of the physiological effect these injuries have on the body, initial injury assessment and on-scene management guidelines, as well as basic treatments to administer during the first minutes of a response.

The ultimate goal of this project is to help ensure that all first responders are more fully capable of assessing and managing a burn injury. When first responders are prepared, those who have sustained a burn injury are provided with the best possible treatment, and the chances for patient survival and recovery are greatly increased.

The IAFF Foundation Burn Fund sincerely thanks the American Burn Association for their contributions to this project and wishes to acknowledge that significant material for this First Responder Burn Manual has been drawn from the “Advanced Burn Life Support Course (ABLS) Handbook,” copyrighted by the American Burn Association (ABA) 2011, and reprinted here with the permission of the ABA. Additional material of interest to first responders is contained in the ABA’s web-based course “ABLSNow©” and the ABA’s live ABLS courses. More information can be found on the ABA’s website at www.ameriburn.org.



The IAFF Foundation Burn Fund is dedicated to burn prevention, research and education. Since its inception in 1982, the Foundation has funded nearly \$2.5 million in burn research grants, which have directly improved the life for burn survivors throughout the United States and Canada. More information on the activities of the IAFF Foundation Burn Fund can be found at IAFF.org/burn-fund.

Production of this manual was funded through a Fire Prevention and Safety Grant awarded through the Assistance to Firefighters Grant Program. Special thanks are given to the Office of Grants and Training at the U.S. Department of Homeland Security.

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First Responder Initial Assessment and Management Procedures

Section 1



Step 1: Stop the Burning Process

The first step in managing burns and thermal injuries is to stop the burning process. The manner for accomplishing this will vary depending on the mechanism of injury:

Thermal/Flame Burns

- Eliminate any ongoing burning (i.e. extinguish/remove burning clothes).
- Cool synthetic materials, which can retain heat, by applying water.
- Cover the burned area with dry, clean sheets.

Chemical Burns

- Chemicals will continue to burn as long as they are in contact with the skin.
- Remove chemically contaminated clothing to reduce skin contact.
- Continuously flush the burn area with water to neutralize the reaction (see **Section 4** for more information).

Electrical Burns

- Eliminate the source of electricity before contacting the victim.
- Manage the visible burns according to protocols.
- Recognize that there will likely be internal or “hidden” burn injuries. (see **Section 5** for more information).

Step 2. Initial Patient Assessment (The ABCs)

The objective of initial patient assessment is to identify and address life-threatening problems first before dealing with burns and other injuries. Once the burning process has been stopped, one method of performing an initial patient assessment is to use the A-B-C-D-E-H approach:

Airway maintenance with C-spine protection

Breathing and ventilation

Circulation, cardiac status

Disability (assess any neurological deficit in the victim)

Expose (undress) the burned area and examine the burn victim

History (of the burn event and any prior medical issues affecting the victim)

Burn injuries are assessed only after the ABCs have been completed!

A – Airway Maintenance with C-Spine Protection

Airway problems can occur in a burn patient, especially when the patient is exposed to smoke and/or fire gases or when they have evidence of facial burns. Use the following guidelines to maintain the patient’s airway:

- Assess the adequacy of the patient’s airway.
 - Is airway obstructed?
 - Is patient having trouble moving air?

- Control a compromised airway using any of the following techniques, as required.
 - Chin lift.
 - Jaw thrust.
 - Insert an oral or nasal pharyngeal airway in an unconscious patient.
 - Assess the need for endotracheal intubation.
 - Protect the cervical or C-spine from movement if there is a risk of a C-spine injury.
 - Avoid flexion or extension until the neck is stabilized.
 - Perform endotracheal intubation, if indicated (per protocol).

Oxygen Therapy

Oxygen is necessary with any major injury. Consider oxygen therapy for all burn patients. Oxygen therapy is especially crucial if there has been any exposure to smoke or carbon monoxide.



This burn patient also suffered a thoracic-spine (vertebral) burst fracture after jumping from a second floor.



A compromised airway may require endotracheal intubation.

B – Breathing

Breathing problems frequently occur in the burn patient. Breathing problems are especially likely if:

- The patient's level of consciousness is altered.
- There is a deep-chest burn preventing chest expansion.
- There is trauma to the chest wall, such as rib fractures, impeding breathing.

- Assess adequacy of the patient's breathing.
 - Look for chest wall movement.
 - Signs of labored breathing, strain and/or wheezing.
 - Consider breathing support measures if they are indicated.

Local protocols for supported breathing may vary, but both endotracheal intubation and using a bag valve mask for ventilation should be considered and implemented, if the need is indicated.

C – Circulation

The human body attempts to cool burned areas by sending fluids to the area. The loss of the plasma-like fluid sent to the burn injury will eventually lead to a shock state for the victim of a large burn injury, although evidence of shock is usually not present in the first several hours. Other traumatic injuries, such as fractures resulting in hemorrhage, can cause early shock that will be worsened by the burn injury. Constricting objects, such as rings or other jewelry, will restrict local blood flow to the fingers and toes as swelling develops. These objects need to be removed as soon as possible before swelling occurs. Perform the following during the assessment:

- Assess the status of circulation by observing the patient's color, skin condition, and temperature.
- Measure the patient's vital signs. The pulse should be monitored, if at all possible, through a burned area. Edema may make pulse assessment more difficult, so when necessary the femoral or carotid artery may be used.
- Take the patient's blood pressure on an unburned extremity, if possible.
- Use cardiac monitoring, especially if a heart rhythm disturbance is present or if the patient has had exposure to smoke or to an electrical shock, according to local protocols.

Fluid resuscitation is usually not necessary in burn patients during the first hour after injury, unless there are other fluid or blood losses. However, fluid infusion is indicated in the following circumstances:

- Burns covering more than 20 percent of body surface, with transport to a definitive care facility taking more than 60 minutes.
- Presence of hypovolemic shock, decreased blood pressure.
- There is a need for intravenous medications.

When fluid infusion is indicated, start one large bore IV catheter in an unburned area. Infuse with lactated Ringer's solution. The flow rate guidelines for major burn patient during scene stabilization and transport are as follows:

- 150 ml/hr for patients under five years of age.
- 250 ml/hr for patients five to 15 years of age.
- 500 ml/hr for patients over 15 years of age.

Don't delay transport if IV access is not readily achieved!

D – Disability (Brain Function)

If the burn patient is not alert and oriented, then look for another associated injury or condition such as carbon monoxide toxicity, a closed-head injury, alcohol or drug impairment.

A – Alert

V – Not alert, but responding to Verbal command

P – Responding only to Painful stimuli

U – Unresponsive

E – Expose

In order to reduce the effects of the burning process and minimize further injury, the burned area should be exposed and protected from further damage. The following are some steps that can be taken to achieve this:

- Remove burned clothing, unless it is adhered to the burn area.
- Cut around adhered portions of clothing to remove the loose parts.
- Look for signs of other traumatic injury.
- Release or remove constricting objects such as jewelry or melted clothing.
- Briefly assess the burn injury.

H – History

The first responder should obtain as much information as possible regarding the mechanism of the accident and the patient's medical history from patient, family or bystanders. The first priority is to determine the mechanism of injury for each victim. Fire Fighters should try to verify the events related, or leading up, to the accident, such as:

- How did the burn occur?
- Was a chemical agent involved? Which one?
- If the patient was scalded, what type of liquid was involved and what were the circumstances?

- If electricity was the cause of the burn, what kind was involved, what was the voltage, and what was the duration of contact?

First responders should also try to determine any pertinent medical history or pre-existing illness that the patient(s) may have. This information may be available from family or friends on the scene, by medical alert jewelry, or other means.

Step 3. Management of the Burn and Burn-Related Problems

Once the burning process has been stopped and the initial assessment has been performed, qualified medical personnel must treat the patient's burn injuries and burn-related problems. The following guidelines may be used to accomplish these tasks.

Cooling Burns

The following procedures should be accomplished once the burning process has been stopped, clothing and restricting items have been removed, and an initial assessment has been performed:

- Cool burns, regardless of degree, with tepid water and then cover with a clean, dry sheet.
- Add a blanket for a large burn to avoid a decrease in body temperature.
- Avoid cold surfaces that will increase heat loss.
- Once remaining heat is neutralized, DO NOT apply any further cold water or ice.
- DO NOT apply ointments or creams.
- Do not wrap burns with dressings, as unwrapping will be necessary upon hospital arrival.
- Elevate burned arms and legs to decrease swelling.

Maintain Body Temperature

Burned skin loses the ability to retain body heat. This loss of body heat will have an adverse affect on the patient. Loss of body heat can be minimized by the following actions:

- Use dry sheets or blankets to cover burn patients.
- Avoid wet dressings, especially in large burns.
- Expedite removal of the patient from cold environment.
- Maintain a warm environment during transportation.

Pain Control

Victims of burn injuries can suffer extreme pain, especially in the more superficial (first and second-degree) burns. The following measures can be taken to manage pain in burn patients:

- Covering the burn will provide some comfort as air exposure can accentuate the pain process.

- Give pain medication intravenously to patients with major burns.
- Use other pain medication as dictated by local Advanced Life Support (ALS) protocols.

Step 4. Further Patient Management

The following additional procedures should be used to treat burn patients.

Patient Monitoring

- Continue to assess the patient's state/level of consciousness.
- Continue to assess the patient's vital signs during transport to the appropriate medical facility.
- Check during scene management and transport for decreasing blood flow in burned extremities, especially to hands and feet with deep circumferential burns.
 - The edema or swelling in the deep burn tissue can act like a tourniquet and impede blood flow.
 - A history of a decreasing pulse strength or progressive skin coolness is valuable information for the emergency department or burn center, as an incision through the burn (escharotomy) may be needed.

Stabilization

- Stabilization is managed by both on-scene providers utilizing pre-hospital medical protocols and by medical control personnel providing directions to on-scene personnel.
- Pre-hospital protocols should prescribe the degree of field stabilization and resuscitation to be initiated. Airway maintenance, breathing, and oxygen delivery would be the top priority.
- Burn patients without other severe injuries do not develop shock within 60 minutes of injury, thus decreasing the need for on-scene fluid resuscitation.
- Stabilize any associated traumatic injuries:
 - Spine stabilization.
 - Splints.
 - Direct pressure on bleeding wounds.

Transportation

- EMS dispatch determines patient distribution to appropriate medical facilities.
- If more than 60 minutes from a burn center, patients should be transported to the nearest, most appropriate hospital where resuscitation can be initiated. Following stabilization, the patient can then be transferred to a burn center.
- Aeromedical transport to a burn center should be considered.

Step 5. Transport and Transfer

Transport decisions for all burn patients and burn patients with associated injuries should be made in consultation with on-line medical control or pre-established EMS protocols. Any patient meeting American Burn Association (ABA) criteria should initially be transferred to a burn center, if that transfer can be safely accomplished within 60 minutes of the time of injury. If transport to a burn center will require more than 60 minutes from the time of injury, the patient should be transported to the nearest appropriate hospital with an emergency department. In multiple-casualty situations, the EMS communication system should be used to determine patient distribution to the appropriate medical facilities.



Courtesy of the
American Burn Association
Advanced Burn Life Support
Learn more about the ABA and ABLS at www.ameriburn.org

Burn Center Referral Criteria

A burn center may treat adults, children, or both.

Burn injuries that should be referred to a burn center include:

1. Partial thickness burns greater than 10% total body surface area (TBSA).
2. Burns that involve the face, hands, feet, genitalia, perineum, or major joints.
3. Third degree burns in any age group.
4. Electrical burns, including lightning injury.
5. Chemical burns.
6. Inhalation injury.
7. Burn injury in patients with preexisting medical disorders that could complicate management, prolong recovery, or affect mortality.
8. Any patient with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality. In such cases, if the trauma poses the greater immediate risk, the patient may be initially stabilized in a trauma center before being transferred to a burn unit. Physician judgment will be necessary in such situations and should be in concert with the regional medical control plan and triage protocols.
9. Burned children in hospitals without qualified personnel or equipment for the care of children.
10. Burn injury in patients who will require special social, emotional, or rehabilitative intervention.

*Excerpted from Guidelines for the Operation of Burn Centers (pp. 79-86),
Resources for Optimal Care of the Injured Patient 2006, Committee on
Trauma, American College of Surgeons*

Severity Determination

First Degree (Partial Thickness)

Superficial, red, sometimes painful.

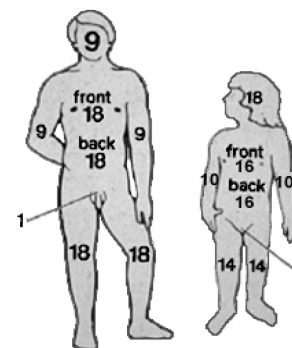
Second Degree (Partial Thickness)

Skin may be red, blistered, swollen. Very painful.

Third Degree (Full Thickness)

Whitish, charred or translucent, no pin prick sensation in burned area.

Percentage Total Body Surface Area (TBSA)



Step 6. Management of Multiple-Burn Casualties

A disaster is an emergency situation, which stresses the EMS system and definitive care resources because multiple casualties are present and require care. For pre-hospital care to be effective, an organized plan must be present which includes *triage*, a process that establishes priorities for provision of care based on the level of injury to the various patients.

The triage area is usually established in a safe area near the scene where the sorting process can occur. A staging area should also be established for available ambulances, and it should be located away from the triage area. Once patients are triaged, EMS units are called to the triage area to accept and transport patients from this location. If the number of patients exceeds immediately available transport and care resources, prioritizing decisions must be made based on the urgency of required medical care and the patient's prognosis for survival. In general, use the following guidelines:

Triage Sorting Guidelines

- The most critical patients, with a good likelihood of survival, are in the top priority.
- Patients requiring emergency care soon, but not urgently, and have a good chance of recovery are in the next group.
- Minor burn patients who can wait for care and the most critical patients with the least likelihood of survival are placed in the delayed categories.

Triage Colored Tag Guidelines

As patients are triaged, they are tagged with color tags to identify their category of care. Subsequent transport and definitive care are based on the category noted on the tag. The following criteria are common to triage tagging systems:

Immediate Care (Red)

- Inhalation injury.
- Burns of more than 20 percent TBSA in patients between ages 10 and 50 years (burns exceeding 20 percent can and will need fluid resuscitation).
- Burns of more than 10 percent TBSA in patients age less than 10 or greater than 50 years.
- Chemical injury.
- Electrical injury.
- Associated, life-threatening injuries.

Delayed Care (Yellow)

- Burns of less than 20 percent TBSA in patients between the ages of 10 and 50 years.
- Full thickness burns of less than 5 percent.

Delayed Care (Green)

- Minor injuries — not in need of emergency care (e.g., 2nd degree burn to arms).

Delayed Care or Terminal (Black)

- Survival unlikely (e.g. massive burns in very elderly people).

Conclusion

Effective initial assessment and treatment of burn patients by Fire Fighters and other first responders dramatically increases the survival and recovery of those patients. All personnel should be trained in these procedures and local protocols so that proper care can be administered to burn patients. This training becomes increasingly important when dealing with multiple casualties requiring a triage operation.

Characteristics of Burn Injuries

Section 2



A *skin burn* is the damage to the skin caused by heat or caustic materials. The most immediate and obvious burn injuries are those caused by heat. Excess heat causes rapid protein denaturation and cell damage. The depth of the burn is dependent on the temperature of the heat insult, the duration of the contact time and the medium (air-water). Wet heat (scald) travels much more rapidly into tissue than dry heat (flame). A surface temperature of over 156°F (68°C) produced by wet heat causes immediate tissue death as well as blood vessel clotting. A higher temperature would be required with dry heat (flames). Caustic materials (chemicals) destroy skin by chemically killing the tissue. In addition, the thickness of the skin layer is critical, as the thinner the skin, the deeper the burn. Children and the elderly have very thin skin. The dead tissue on the surface of a burn injury is known as *eschar*. A clear understanding of alterations in skin function will greatly assist first responders in the initial management of a burn patient.

Skin Properties

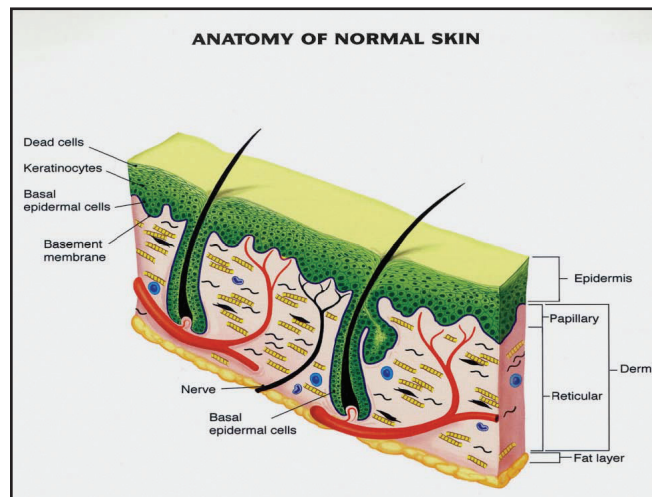
Healthy skin is the body's largest organ. Skin is also a very complex organ with a wide variety of properties, mainly protective barriers,

which are critical to survival. Loss of these barrier functions occur when skin is burned (or otherwise compromised).

Skin Layers

Though the skin is comprised of numerous components, Fire Fighters who will need to treat burn patients need to be concerned with three primary layers of components.

Epidermis



The *epidermis* (outer layer) protects the body from bacteria and toxins in the environment from being absorbed causing infection or illness. This layer also prevents excessive water evaporation, preserving body fluids.

The outer, thinner layer of skin is composed mainly of epithelial cells. The deepest epidermal cells are immature cells, which are continually dividing and migrating toward the surface to replace lost surface cells.

(e.g. after an injury). The same types of regenerating epidermal cells are found in hair follicles and other skin appendages, which are anchored in the dermis. As the cells mature and migrate to the surface, they form keratin, which becomes an effective barrier to environmental hazards such as infection and excess water evaporation.

Functions of the Epidermis (outer layer)

- Protection from drying.
- Protection from bacterial entry (infection).
- Protection from toxin absorption, such as chemicals on the skin.
- Fluid balance maintenance (avoids excess evaporative water loss that would cause dehydration).
- Neurosensory functions (touch, pain, pressure, sensation).
- Social-interactive functions (visible portion of the body covering).

Stratum Corneum

The *stratum corneum* is the “outer most” layer of the epidermis, consisting of several flattened layers of dead keratinocytes as well as keratin. This layer protects against the entry of bacteria and toxins into the body. The epidermal layer regenerates every two-to-three weeks but regeneration requires the presence of the dermis.

Dermis

The **dermis** (inner layer) controls body temperature, avoiding a decrease in temperature with cold exposure or increase with heat exposure. In addition, flexibility is also provided by the dermis. The nerve endings in the dermis provide the sense of touch, temperature, pressure, and pain. The blood vessels transport oxygen and nutrients to the skin and remove carbon dioxide and metabolic waste products.

The dermis is the deepest layer of skin responsible for skin durability and flexibility. The nerves for touch and pain, blood vessels, and hair follicles are present in the dermis. The dermis is responsible for reforming the outer epidermis. So, if the outer layer is burned, the wound can heal as long as there is dermis. If the dermis is totally destroyed, the burn cannot heal.

Functions of the Dermis (inner layer)

- Regulation of body temperature to avoid hypothermia with cold air exposure or high body T° with exercise and a hot environment.
- Prevention of excess loss of body heat.
- Protection from injury because of the properties of elasticity and durability.

Skin's Response to Burn Injury



The photographs above show examples of burn injuries resulting in compromised barrier protection. Photo number one shows a deep burn of the hand.

The possible outcomes of this injury could include the following:

- Increased risk of infection.
- Increased pain and risk of scar formation.
- Increased risk for loss of skin elasticity leading to disability.

The second photo shows a patient with serious chest and arm burns. The possible outcomes of this injury could include the following:

- Increased risk of severe heat loss or hypothermia.
- Increased evaporative water loss with dehydration.
- Increased pain and risk of infection.

Burn Severity

Severity of a burn is determined by the depth, size, and location. It is now known that toxic agents released by inflammation, which are activated with the burn, cause much of the tissue damage after the burn, especially in the deeper burns. It is important for the first responders to know that a burn can become deeper due to any continued exposure to the heat source, any degree of shock, or a later infection.

Degrees of Burn Injury

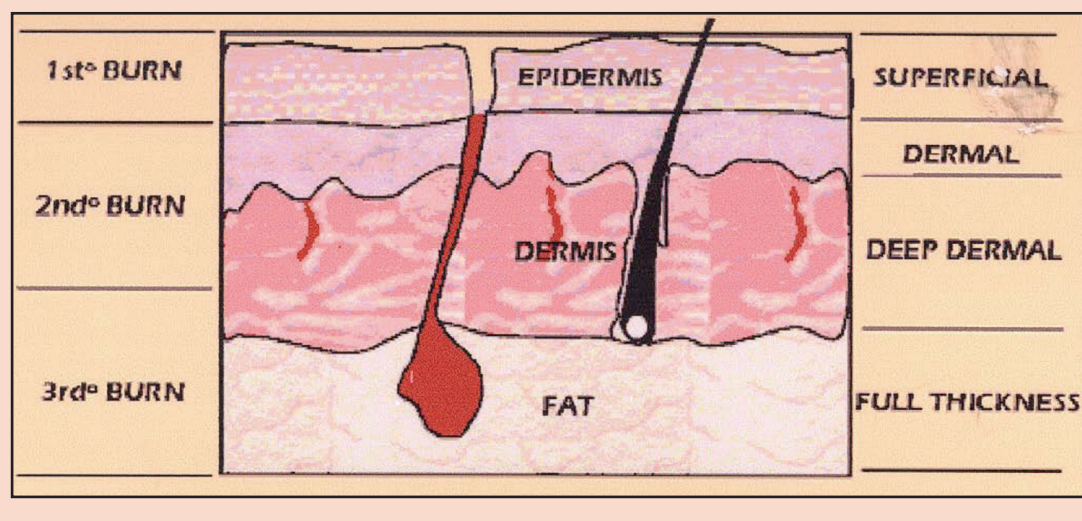
First-Degree: The burns are confined to the outer layer only.

Second-Degree: These burns also involve part of the dermis.

Third-Degree: These burns involve destruction of both skin layers.

Partial-Thickness Burns: A second-degree burn consisting of injury to part of the dermis.

Full-thickness: A third-degree burn consisting of injury to both skin layers.



Burn Depth: How Deep Is the Burn?

Burn depth is defined by how much of the two skin layers are destroyed by the heat source. Only burns extending into the second layer (the dermis) are considered significant. Burns are categorized either by degree or thickness.

Burn injuries can be visually deceiving. The depth can often be underestimated on first appearance. After the wound is gently washed and debrided, the size and depth of the burn is more clearly defined. Some burns caused by contact with flames, extremely hot temperatures, or explosions look less-deep than they really are. The cause should alert the evaluator that the burn is likely deep.

First-Degree Burns

A first-degree burn is confined exclusively to the outer surface and is not considered a significant burn. No bodily barrier functions are altered by this level of burn. The most common form of a first-degree burn is sunburn, which heals by itself in less than a week without scarring.

Second-Degree Burns

Second-degree burns destroy the epidermal layer and portions of the dermis. Since it does not extend through both layers, it is termed a partial-thickness burn. There are a number of depths of a second-degree burn typically used to characterize the partial-thickness burn. Each corresponds with a predictable healing time, treatment modalities and outcomes. It is not necessary to make these distinctions as a first responder, but more knowledge is always better.

Superficial Second-Degree

Superficial second-degree burns involve the entire epidermis and no more than the upper third of the dermis is destroyed. Rapid healing occurs in one-to-two weeks because of the large amount of remaining skin and good blood supply. Scarring is uncommon with these burns. Initial pain is the most severe of any burn, as the nerve endings of the skin are now exposed to the air. The following are characteristics of superficial second-degree burns:

- Confined to upper-third of the dermis layer.
- Usually caused by hot liquids (scalds).
- Blisters, wet pink, painful.
- Low risk of infection.
- Heals in 10-12 days without scar.



A superficial second-degree scald burn to a child.

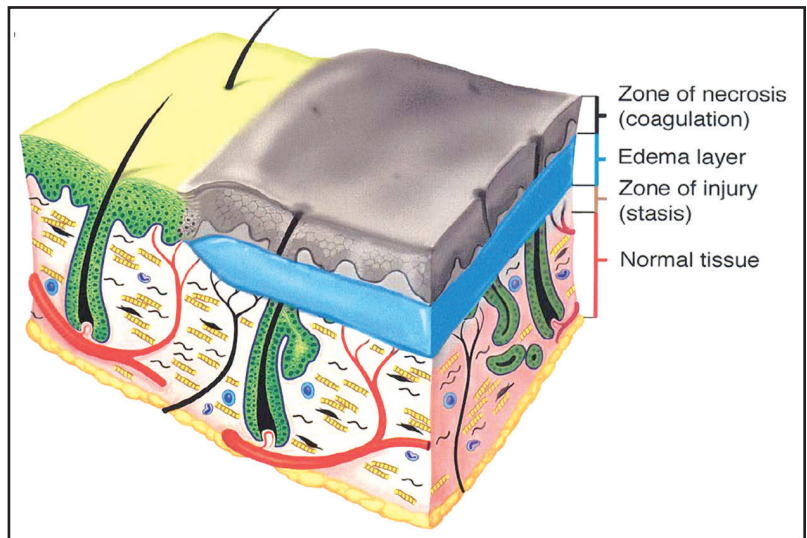


Diagram of a superficial second-degree burn.



Superficial second-degree burn with plasma leaking into wound (note blisters).

Deep Second-Degree Burn (Deep Partial-Thickness)

Deep second-degree burns destroy most of the skin except for a small amount of remaining dermis. The wound looks white or charred indicating dead tissue. Pain is much less as the nerves are actually destroyed by the heat. Usually, one cannot distinguish a deep-dermal from a full-thickness (third-degree) by visualization. The presence of sensation to touch usually indicates the burn is a deep partial injury. Characteristics of deep second-degree burns include the following:

- Involves majority of the inner dermal layer of skin.
- Usually caused by flames.
- Dry, white, or charred skin.
- Minimal pain.
- High risk for infection.
- May heal in 2-3 months.
- Readily converts to a full thickness burn.

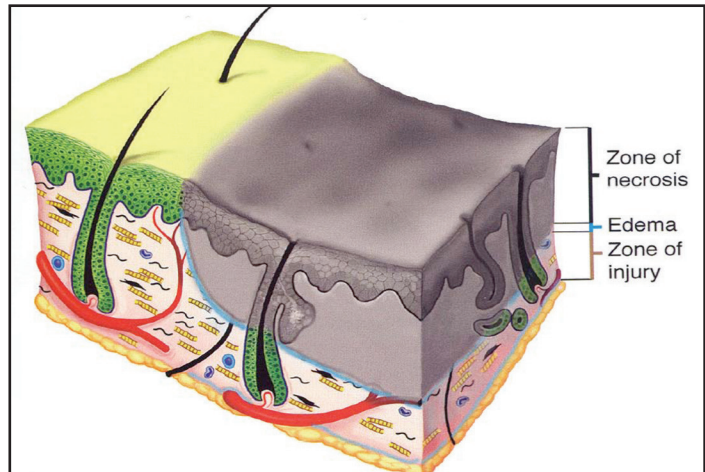


Diagram of a deep second-degree burn.



A deep second-degree burn. Patches of white are the deep-dermal burn surrounded by a more superficial burn.



A deep second-degree burn to the forearm. Note the patches of white indicating a deeper burn. Less pain is usually present in the deeper burn.

Third-Degree Burn (Full-Thickness)

When a patient suffers a third-degree (full-thickness) burn, both layers of skin are completely destroyed leaving no cells to heal. Any large burn of this nature will require skin grafting. Small burns will heal with scarring. The following are characteristics of third-degree burns:

- Complete destruction of both layers of skin.
- Burn appears white or charred.
- Painless.
- High risk for infection.
- Needs to be excised and skin grafted.

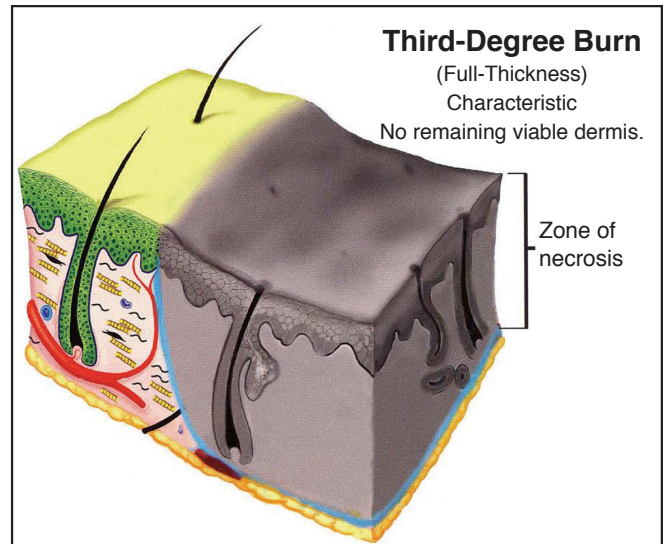
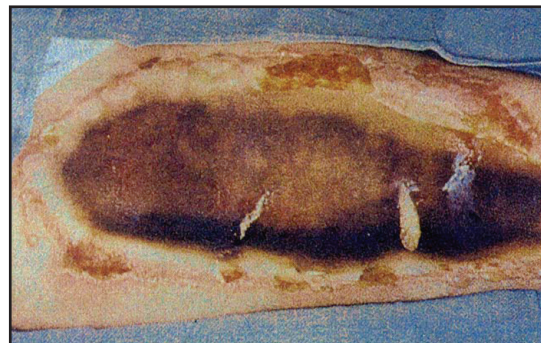


Diagram of a third-degree burn.



This third-degree burn is hard, dry, nonpliable and painless. Veins are clotted. Long-term disability is inevitable.



A third-degree burn to a back. The area is charred and painless.

Burn Depth and Outcome Relative to Cause

Burn	Cause	Appearance	Pain	Healing	Scar
2nd-Degree Superficial	Hot liquid, short exposure	Wet, pink blisters	Severe	10-14 days	Minimal
2nd-Degree Mid-Dermal	Hot liquid, hot grease, or flash flame with longer exposure	Less wet, red blisters	Moderate	2-4 weeks	Moderate, may need a skin graft depending on the location
2nd-Degree Deep-Dermal	Chemicals, direct contact with flames	Dry, white	Minimal	3-8 weeks	Severe, usually needs skin graft
3rd-Degree (Full-Thickness)	Chemicals, flames, explosion with very high temperature	Dry, white or char	None, except surrounding area that is not a third-degree burn	Needs skin graft	Mild to severe, depending on timing and type of graft

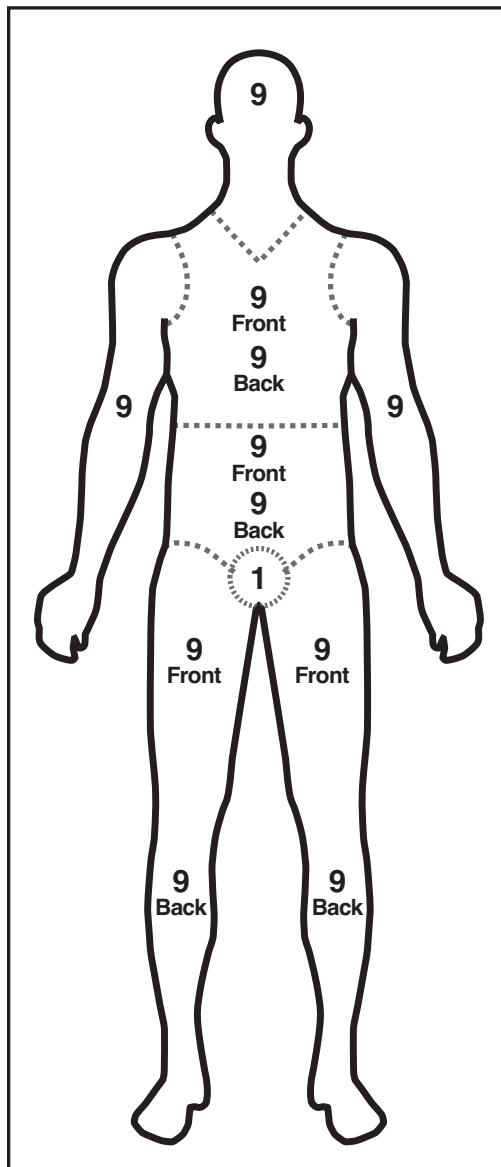
Burn Size: How Big Is the Burn?

Burn size is defined as what percent of the body's total skin is burned. In the adult the **"Rule of Nines"** can be used:

- Each arm is nine percent of the total.
- Each leg is 18 percent of the total.
- Back is 18 percent of the total.
- Chest and abdomen are 18 percent of the total.
- Head is nine percent of the total.

For assessing scattered areas, one percent of body skin surface is equivalent to the patient's palm size. Modifications are made when evaluating a child because of a larger head surface area relative to total body area.

Rule of Nines



The surface area burned is 18 percent for each leg, equaling 36 percent of total body surface.



This burn is to one-half of an arm (9 percent) or 4.5 percent of total body skin.

Body's Response to Burn Injury

In response to a burn injury, a layer of protein-rich edema fluid inevitably develops between the heat-destroyed skin layer and the heat-injured blood vessels. The fluid leak is most prominent in the first 8-12 hours following the injury, but it can persist for days. In the



Burn edema in deep injury about 18 hours after the event.

superficial burns, the edema physically separates the living and dead tissue, producing blisters. In deep burns the edema occurs throughout the injured tissue. However, the dead skin remains physically adhered to the living tissue beneath. The edema process, which peaks at 18-24 hours, can lead to severe complications, especially airway compromise and a tourniquet like constriction of a burned arm or leg.

The burn injury causes the blood vessels in the damaged skin to lose large amounts of body fluids, mainly plasma, into the burn area. This process can lead to sufficient fluid loss to produce hypovolemia and in a large burn, to a shock state. The degree of fluid loss from a burn injury is easy to underestimate, as opposed to other trauma where blood loss is evident. The plasma is not lost from the body but is hidden within the burned skin.

Large amounts of a crystalloid, mainly lactated Ringer's solution, is required to keep up with the fluid losses. It usually takes several hours for burn shock to develop as opposed to minutes after blood loss from trauma.



A circumferential deep burn of the lower arm. As the edema or fluid collection develops underneath the burn, a tourniquet effect results and blood flow to the hand is decreased.



The fluid beneath the burn is released by an incision called an escharotomy. Note how far the wound gapes open, reflecting the degree of pressure beneath.

Burn Severity and Patient Outcome

A burn is without a doubt the worst traumatic injury the body can withstand. Factors affecting burn severity and outcome include the following:

- Burn depth into the skin.
- Amount of skin burned measured as percent of total skin.
- Age (very young and very old patients are at a higher risk).
- Chronic illness and poor overall health condition.
- The part of the body burned.
- Presence of smoke inhalation injury.

Burn survival has markedly improved in recent years when optimum care is provided from the injury scene to discharge from a medical facility. The burn size, as percent of total body, which achieves a 50 percent survival rate, compared with the patient's age is shown on the following chart. Smoke inhalation injury will decrease the survival rate for each group.

Survival Rate from Burn Centers (Data Obtained from Specialized Center for Mean Survival Rate (%) Comparing Age and Burn Size)

	Age (years)						
Burn Size (%) of total skin	0-1	2-4	5-34	35-49	50-59	60-74	>75
1-10	>95	>95	>95	>95	>95	>95	>90
10-20	>95	>90	>95	>90	>90	>70	>60
20-30	>90	>90	>90	>90	>75	50	25
30-40	75	80	90	80	70	40	>20
40-50	50	65	80	60	40	10	>10
50-60	50	60	70	60	40	>25	>5
60-70	40	50	60	40	25	>10	0
70-80	35	40	45	30	25	0	0
80-90	30	35	30	30	30	0	0
90-100	20	20	20	15	0	0	0

Note that survival is very high for even massive burns (over 75% of the body) in older children and young adults. Survival decreases in the elderly due to the presence of pre-existing disease and inability to withstand severe stress. Survival is also less for babies and toddlers for the same size.



Burn on 15 percent of the body in a 12-year-old female. Her chance of survival exceeds 95 percent.



Burns on 20 percent of the body in a 40-year-old male. His chance of survival exceeds 90 percent.

Conclusion

Because the skin is our body's largest organ, any significant injury to the skin places the patient in serious danger. The seriousness of the burn injury will be dependent on the type, depth, and size of the burn. The patient's age and pre-injury physical condition will also have a bearing on how severely they will be affected by the burn. Fire Fighters and other first responders should be familiar with the types and mechanisms of burn injuries. This will allow them to initiate proper treatment and to provide better information to medical facility personnel.

Smoke Inhalation Injuries

Section 3



The leading cause of death in fires is caused by smoke inhalation—not the burns. Death or disability at the scene from smoke is caused by toxins, especially carbon monoxide and lack of oxygen. Exposure to fire gases can lead to a variety of severe complications in the burn victim as well as the Fire Fighter.

It is also important to note that the airway damage caused by smoke toxins can lead to airway obstruction several hours later. Damage to the lung itself is a leading cause of disability and death in the hospitalized burn patient.

Components of Smoke

When considering the composition of smoke, one thing of major importance is the fact that smoke from different environments varies dramatically in component makeup and toxicity. While all smoke is bad and should not

be inhaled, some smoke is worse than others. Examples of extremely toxic smoke include smoke from burning automobile interiors, upholstery, and chemical factories in which hydrocarbons are a major component.

Components of Smoke: Effect and Onset of Injury

Compounds	Source	Effect	Timing
Ammonia Sulfur Dioxide Chlorine	Clothing, furniture, wool, silk	Eye and nose irritation; coughing, increased sputum	Early onset (first several hours)
Hydrogen Chloride (Hydrochloric Acid)	Polyvinyl chloride, Furniture (wall, floor coverings)	Severe airway damage with ulceration and swelling	Delayed often 1-2 days
Acetaldehyde Formaldehyde Acrolein	Wallpaper, lacquered wood, cotton, acrylic	Severe airway damage with ulceration and swelling	Delayed often 1-2 days
Cyanide Carbon Monoxide Poisoning	Polyurethane, upholstery, nylon (any combustible substance)	Lack of oxygen to body	Immediate

Components of a Smoke Inhalation Injury

The following are three major components associated with a smoke inhalation injury:

Carbon monoxide toxicity, which is an immediate onset disability.

Upper airway obstruction/damage, in which the onset may be delayed for several hours.

Lung damage, which may not be evident for hours.

Components of Smoke Inhalation at Onset of Injury

Problem	Time of Onset of Symptoms
Carbon monoxide toxicity and cyanide gas toxicity	Immediate (at time of smoke exposure)
Upper airway obstruction from heat and chemicals in smoke	Delayed by several hours from time of exposure
Lung damage from chemicals in smoke	Delayed often by hours from time of exposure

Carbon Monoxide (CO) Poisoning

Carbon monoxide (CO) toxicity is one of the leading causes of death in fires. Carbon monoxide is a byproduct of incomplete combustion of cellulose products – wood, paper and cotton. This odorless and colorless gas binds to hemoglobin to produce Carboxyhemoglobin (COHgb). COHgb binds oxygen with an affinity 200 – 220 times that of hemoglobin; therefore, the oxygen is circulated but not released to the tissue. The result is a major impairment in oxygen delivered to the body. An oxygen deprivation or hypoxia results in all organs, especially the brain.

Symptoms of Carbon Monoxide Poisoning

At high concentrations, CO directly poisons the cells, especially those in the brain. Symptoms of CO poisoning correspond with the amount or percent of the hemoglobin bound by CO, which is measured as the *carboxyhemoglobin* level (CO Hgb). Confusion and disorientation are the most common symptoms with mild to moderate CO toxicity. A coma may occur when more than 50 percent of the hemoglobin is bound with carbon monoxide. Cardio-respiratory arrest is also common beyond that point. The presence of a good pulse with dilated pupils and an unresponsive state support the diagnosis of severe carbon monoxide poisoning. Carbon monoxide poisoning should be suspected of any patient with a history of smoke exposure and an impaired state of consciousness.

Symptoms of Carbon Monoxide Poisoning

CO Hgb*-%	Symptoms
0-5	Normal value
5-15	Decreased exercise tolerance, shortness of breath during exertion, tightness across forehead, flushed skin
15-20	Headache, confusion, fatigue
20-40	Hallucination, combativeness, fatigue, nausea, visual changes
40-60	Hallucination, combativeness, coma
60 or above	Cardiopulmonary arrest, mortality rate of 50% or more

Treatment of Carbon Monoxide Poisoning

Treatment of carbon monoxide poisoning consists of the early displacement of carbon monoxide from hemoglobin by the administration of oxygen. A carboxyhemoglobin level is needed to determine carbon monoxide toxins. The half-life of carboxyhemoglobin in a patient when breathing regular air is about 4 hours. Whereas, the half-life when breathing 100 percent high flow oxygen is 45 minutes. The concentration of carboxyhemoglobin is reduced by 50 percent every 45 minutes when an oxygen concentration of 90 percent to 100 percent is administered. Oxygen administration is required for all major burns until carbon monoxide toxicity can be ruled out or carboxyhemoglobin levels return to normal.

Treatment Procedures

- Administration of 100 percent oxygen therapy by non-rebreather mask.
- Endotracheal intubation and use of 100 percent oxygen with mechanical ventilatory assistance is indicated for those patients who are unresponsive at the scene.
- Continue 100 percent O₂ administration at the scene and during transport to hospital.

Often the burn victim will respond quickly to oxygen. It is important to continue the oxygen administration at the scene and during transport to hospital care.

Hyperbaric Oxygen Therapy

The role of hyperbaric oxygen therapy is controversial. It appears to be most effective in patients with severe neurological compromise, with a carboxyhemoglobin of >50%, no major burns or severe pulmonary compromise. If hyperbaric therapy is to be used, do not delay initial treatment while arranging transfer to a facility with a chamber. **Consult the local burn center for further information and care.**

Upper Airway Injury (Above the Vocal Cords)

The upper airway is defined as the mouth, larynx and airway above the vocal cords. Breathing in hot air and toxic chemicals from smoke can lead to damage of the lining or mucosa of the upper airway, causing swelling and eventual airway obstruction. Although the damage is present immediately after smoke exposure, evidence of airway obstruction may not be present for 12-18 hours, as a result of progressive airway swelling. Deep burns to the face, mouth and neck can also lead to swelling that obstructs the airway and causes progressive difficulty in breathing.

Symptoms of an Upper Airway Injury

The following factors, when present, should trigger the Fire Fighter or other first responder to the possibility of an upper airway injury:

- Stridor or labored breathing.
- No symptoms until just before obstruction.
- Upper airway noise indicates an altered airflow, often precedes actual obstruction.
- High index of suspicion: facial burn, soot, cough, wheezing, oral or deep facial burn.

Treatment of Upper Airway Injury

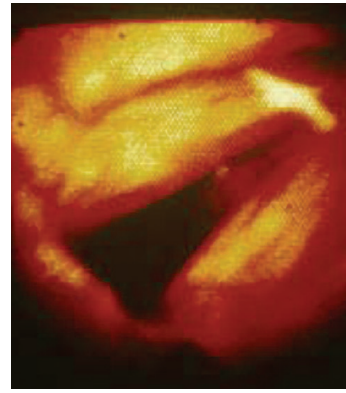
An upper airway obstruction usually takes several hours to develop. Initial airway problems in patients encountered by Fire Fighters at the scene of an incident are more likely due to an unconscious state from carbon monoxide poisoning, head injury and/or drug and alcohol abuse. Standard treatment procedures for the scene and during transport to a medical facility would be as follows:

- All patients should be given 100 percent oxygen by non-rebreathing mask.
- If the patient is unconscious, use one or more of the following airway maneuvers:
 - Chin lift.
 - Insertion of an oral airway.
 - Suctioning of secretions.
- If there are symptoms of an airway obstruction:
 - Insert an oral airway.
 - Perform respiratory support by mask ventilation.
 - Perform an endotracheal intubation per protocols.



A patient with facial burn 24 hours after the injury. Note marked facial and oropharyngeal distortion caused by the resulting tissue edema.

Swelling in the upper airway. Note the redness and swelling of the airway tissue and vocal cords. Normal cords are almost transparent. Progression of edema can lead to obstruction.



- If an airway obstruction is present and intubation is unsuccessful, consider needle cricothyroid ventilation per medical control procedures.

Lower Airway Injury

This aspect of an inhalation injury is often an extension of an upper airway injury, but it is generally much more serious than that produced by heat alone. Toxic gases contained in smoke as well as carbon particles coated with irritating aldehydes and organic acids can result in injury to both upper and lower airways. The location of injury will depend on the duration of exposure, the size of the particles and the solubility of the gases. Often peak symptoms of lung damage occur several days after injury. The degree of injury is often underestimated initially.

Symptoms of a Lower Airway Injury

The initial response to any smoke exposure is usually intense airway irritation and airway swelling that may also include increased sputum production and/or wheezing. The onset of a lower airway injury is often delayed for hours to days following the exposure/injury although some initial coughing and wheezing is common.

Treatment of a Lower Airway Injury

Treatment begins with recognition that a smoke exposure has occurred and then continues as follows:

- Remove the patient from the smoky environment.
- Provide 100 percent oxygen by non-rebreathing mask.
- Encourage coughing and deep breathing.

If there is evidence of an airway problem or obstruction, complete the following steps:

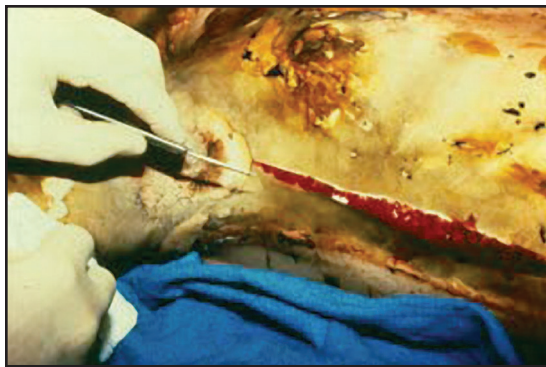
- Suction oral secretions from the airway.
- Perform airway maneuvers (chin lift, jaw thrust), as required.
- Insert an oral airway.
- Support respirations with a bag valve mask ventilation, if needed.
- Perform endotracheal intubation per protocol.

Deep Chest Burns—Impact on Patient Breathing

Breathing can be impaired by a deep burn to the chest, especially if the burn involves the entire chest from side to side. The deep burn tissue is very rigid and doesn't stretch like normal skin so that moving the chest in and out is hampered and the work required to breathe rapidly increases. The process worsens as swelling occurs and the patient can no longer breathe adequately. The problem usually takes a few hours to develop, but when it does it can be recognized by the following:

Symptoms of a Deep Chest Burn

- An obvious, deep burn to the entire chest.
- Rapid, short breaths.
- Inability to effectively cough or take a deep breath.
- Progressive fatigue.



An escharotomy performed at a definitive care facility to improve breathing.



Chest escharotomy incisions are done on each side of the chest, with a connecting incision across the middle.

Treatment of a Deep Chest Burn

The initial treatment of one of these patients by Fire Fighters and other first responders will include oxygen therapy and may also include ventilation assistance via a bag valve mask ventilation device. This patient will require expedient transport to a proper medical facility. In order to correct the constriction, an incision through the burn called an escharotomy may be necessary once in the burn center.

Inhalation Injury in Children

Infants and children are very susceptible to all the components of smoke inhalation injury, as children are likely to seek safety within the burning building rather than try to escape. When a child is suspected of suffering from smoke inhalation or an inhalation injury, the requirements for 100 percent oxygen support are the same as those

for adults. Quicker airway maintenance is often needed as a child's airway more easily obstructs than an adult's.

Performing endotracheal intubation on a child is more difficult than on an adult. Only the most experienced personnel on the scene should attempt this procedure. If intubation cannot be accomplished, consider performing needle cricothyroid ventilation using a large needle through the cricothyroid membrane, if allowed by your local medical protocols.

Initial Assessment and Management of Smoke Inhalation Injuries

As with any patient in an EMS setting, initial assessment of the possible smoke inhalation patient is a crucial first step. This section provides guidance for performing this assessment.

History of Events

The history of events surrounding the incident should raise the index of suspicion of inhalation injury, including:

- A smoke condition in an enclosed space.
- An explosion.
- Combustion products of wood, cotton, paper, petroleum products and plastics in any setting.
- Possible drug or alcohol use by the patient.

Symptoms of Smoke Inhalation

Smoke inhalation is likely if:

- Any of the events in the previous section are present.
- The patient displays an altered state of consciousness due to carbon monoxide inhalation, head injury, drugs or alcohol impairment.

Other physical findings suggestive of a possible smoke inhalation injury are as follows:

- Facial burns.
- Singed nasal hair.
- Soot on the face and tongue.
- Burns to the mouth.
- Carbon particles (black) in sputum.
- Coughing.
- Wheezing.



Treatment of Smoke Inhalation

If smoke inhalation is suspected, the following treatment should be initiated:

- Remove the patient from the smoky atmosphere.
- Clear the patient's airway by suctioning, if necessary, and encourage coughing and deep breathing.
- Administer 100 percent oxygen by non-rebreathing mask to treat carbon monoxide toxicity.
- Maintain an open airway.
 - Swelling can compromise airway.
 - Use standard protocols to restore airway patency.
 - Insert an oral or nasal airway, if needed.
 - Perform endotracheal intubation if allowed per protocol.
- Assist breathing if indicated.
 - Administer oxygen.
 - Suction soot from airway, if indicated.
 - Consider respiratory support via bag-valve mask ventilation.
- Assess and support circulation (see **Section 1**)

In addition to assessing the possible smoke inhalation injury, Fire Fighters should also deal with other potential injuries that may be likely in a fire event, including performing an assessment and initial management of burns and/or other traumatic injuries.

Transport

Transport all smoke inhalation patients to an appropriate medical facility. During the transport, use the following procedures:

- Continue administering 100 percent oxygen.
- Continuously monitor vital signs.
- Continue airway management and breathing support.
- Inform emergency room personnel of the presence of a smoke injury and status of airway and breathing.

Conclusion

Ensuring that a patient has an adequate respiratory effort is one of the most basic, essential functions of the delivery of emergency medical services. Because fire and smoke typically go together, responders who are treating burn patients typically must also deal with the symptoms of smoke and heat inhalation injuries. The proper diagnosis and response to these symptoms and injuries are vitally crucial to patient survival and recovery.

Chemical Burns

Section 4



Chemical burns are sometimes seen in the home, but they are especially common in industrial settings. Initially, chemical burns often look less severe than they really are because the skin is destroyed mainly by chemical reaction. Without intervention, the chemical burn will continue to get deeper, and its later appearance is usually worse than the initial appearance. Chemical toxins such as phenol or hydrocarbons like gasoline may cause only skin irritations, but absorption through the skin can lead to internal poisoning. With the exception of fuming sulfuric acid, heat and thermal injuries play a minor role in chemical burns.

Chemical Classification

The most common categories of burn-producing chemicals are acids, alkalis and organic compounds. These chemicals can produce local tissue injury, and some have the potential to be absorbed into the body resulting in internal poisoning.

Acids

Acids are prevalent in industry and may be found in many household products. Hydrochloric acid is the active ingredient in many bathroom

cleansers. Oxalic acid and hydrofluoric acid are commonly utilized in rust removers. Concentrated hydrochloric and muriatic acid are the major acidifiers for home swimming pools. Concentrated sulfuric acid is utilized in industrial drain cleaners. Acids are found in household products such as rust removers, drain cleansers and swimming pool chemicals.

Alkalis

Alkalis are present in both home and industrial cleansers, including drain cleansers, oven cleansers and swimming pool chemicals. Other compounds containing alkali include fertilizers, cement and concrete products and some paint removers.

Organic compounds

Organic compounds, including phenols, creosote, and petroleum products, produce contact chemical burns and systemic derangements. Phenols are prevalent in a variety of chemical disinfectants. Petroleum, which includes creosote and gasoline, is commonly used in the home, industry and recreation. Organic compounds cause cutaneous damage due to their fat solvent action (cell membrane solvent action).

Chemical Forms

Toxic chemicals can be in the form of gases, liquids or solids. Similar to smoke exposure, the gaseous forms typically cause injury through breathing. The liquid and solid forms are more likely to cause chemical burn damage to the skin.

Types of Chemical Injuries

Petroleum (Hydrocarbon) Exposure

These chemicals carry the risk of not only a skin injury from exposure, but the exposed patient may also be highly flammable. As well, these chemicals can be rapidly absorbed leading to a life threatening poisoning. Chemicals that fall into this category include gasoline, diesel fuel, solvents and phenol.

Treatment Procedures

When handling a patient who has been exposed to one of these chemicals, it is important to provide them protection from any sparks or flame source. Initial skin burn from these chemicals is often superficial. Early removal of chemically exposed clothing and copious irrigation is needed to treat these patients. A small exposure to water can actually spread the agent and lead to further damage.

Hot Tar Burns

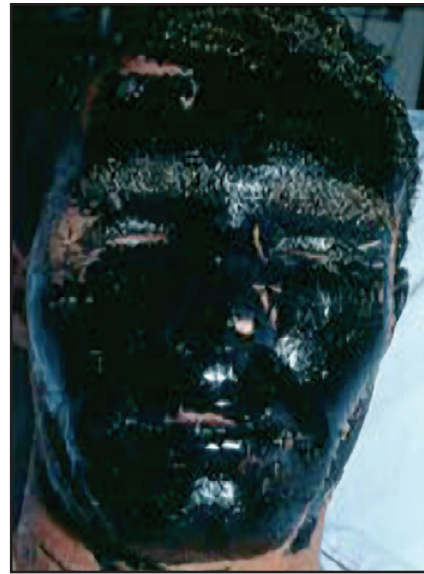
Tar in its liquid form is superheated and; therefore, any direct contact will usually lead to a deep burn. These injuries are most commonly incurred by roofers and highway workers. Initially, the pain may be minimal, as the burn is deep, and underestimation of the degree of the burn is common. The tar typically remains adherent to the skin once it contacts it. A secondary exposure, such as stepping on already poured but still sticky tar, will likely produce a more superficial, but still significant burn.

Treatment Procedures

- Cool the tar using copious amounts of water to decrease the retained heat.
- Do not attempt to remove the tar in the pre-hospital setting, as this will further damage the skin burn.
- Cover the burned area with a clean, dry sheet or cloth.
- Removal of adhered tar can be done in a treatment center using emulsifiers such as Neosporin ointment or mineral oil, but not flammable solvents.



Deep hot tar burns to a hand. Note the white area in the exposed wound, indicating the burn to be very deep. Pain is minimal and injury can be underestimated. Definitive burn management is required.



This skateboarder encountered partially cooled tar. The burn was partial thickness. Initial management is cooling the tar with water and transport.

Chemical Injuries to the Eye

Chemical injuries to the eyes are relatively common. Permanent eye damage can often be prevented by expedient, copious, continuous irrigation of the eye(s) using water, saline or lactated Ringer Solution. If the patient is wearing contact lenses, they should be removed. Then hold the eyelids apart and begin gentle, continuous irrigation. Use of an IV bag and tubing provides continuous controlled irrigation to the eye and lid.



An eye injury caused by a splattered alkali. Proper treatment is continuous water irrigation.

Another alkali burn to the eyes. Delayed treatment resulted in permanent corneal damage.



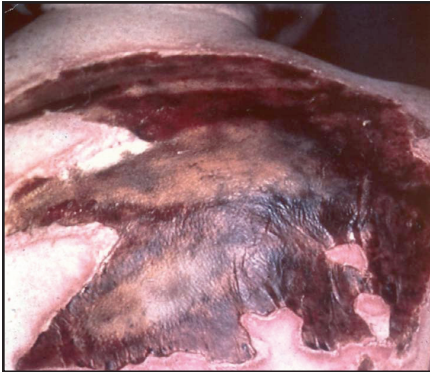
Symptoms of Chemical Burns

The skin appearance of a chemical burn is often brown to gray as opposed to the typical white or char with a thermal burn. Severe, persistent pain is often present and it is indicative of ongoing skin damage.

Initial Assessment and Management of Chemical Burns



A strong sulfuric acid burn. This is a full-thickness burn. Note the brownish-gray appearance, characteristic of a deep skin burn from a strong acid or alkali. Persistent pain is present. The wound usually looks deeper after 24 hours. Initial treatment includes removal of clothing and water irrigation.



A full thickness sodium hydroxide burn to the back, at 24 hours past the injury. This patient did not seek medical attention for 24 hours after the exposure. The brownish dry appearance indicates the burn's full thickness.



A deep lime powder (alkali) burn to lower leg. Lime powder at a construction site entered the patient's boot. The deep burn was noted when pain developed. Initial treatment is water irrigation.



This burn was caused by a nitric acid spray. A brown discoloration is characteristic. Persistent pain is present. Initial treatment is water irrigation.

- The initial treatment of chemical burn patients should include a rapid assessment of their airway condition, breathing and circulation. It may be necessary to support the airway using standard protocols if the chemical involved in the burn was a fuming variety. These chemicals may cause damage to the airway and lungs by either absorption or inhalation. If the chemical exposure was a result of an explosion, traumatic injuries impairing breathing could also be a factor. Any compromise to the respiratory system must initiate airway support and breathing assistance measures.
- Following airway and breathing assessment, assess the adequacy of circulation in the patient using vital signs, skin color and temperature. Hypovolemic shock is usually not present in the immediate post-burn period. Depending on local protocols and the training of the care provider, an intravenous catheter should be inserted mainly for the administration of medications. Ensure that local circulation to appendages is maintained by removing constricting objects, like jewelry, before tissue swelling begins. Deep chemical burns can produce constriction of local blood flow similar to thermal burns.
- Assess the patient's level of consciousness and ability. Absorption of some chemicals can lead to impaired brain function, seizures and an unconscious state. Use the A-V-P-U method to assess and document the level of consciousness. Altered consciousness may not be a result of the chemical burn injury, but it can also be due to head injury (such as in the case of an explosion). Any signs of an altered level of consciousness should be managed based on local protocols.
- Remove any clothing items the patient is wearing that may have been exposed to the chemical causing the burn. Otherwise the chemicals absorbed into the clothing may continue to injure the patient or the care providers who come in contact with them.

Diluting a Chemical Burn

Initial management of the chemical burn injury has a major impact on patient outcome.

- The solution to pollution is dilution.
- Do not attempt to neutralize acids with alkali or vice versa, just apply copious amounts of water to the exposed area.
- Continuous water irrigation of the area should be initiated immediately to reduce the effects of the chemical on the skin. Most workplaces that handle hazardous chemicals have emergency showers that can be used to provide large quantities of water over a patient who has been exposed to a hazardous chemical.
- When neutralizing a burn with water, use tepid water if possible and avoid long exposure to cold or hot water. The irrigation time for a patient exposed to a strong acid or alkali is 30-60 minutes. Similar irrigation procedures should be used for eyes that have been exposed to hazardous chemicals.
- If the offending chemical is in a solid form, first brush it off the patient. Wear appropriate protective clothing and equipment when doing this.
- Irrigation at the scene markedly decreases the morbidity.
- Once the solid material is off the patient, follow the same irrigation procedure previously described for liquid chemicals.
- If possible, continue irrigation through transport, while trying to maintain the patient's bodily temperature appropriately. Once the irrigation has been completed, cover the patient with a clean, dry sheet or blanket.

Chemical Hazards Identification

If there is any doubt as to the properties of hazards associated with an identified chemical, responders can contact **CHEM-TREC** for more specific information. This 24-hour service, established in 1971, provides information to emergency responders responding to chemical emergencies and can provide direct contact with the chemical company in many cases. The contact information for **CHEM-TREC** is 1-800-424-9300 or www.chemtrec.com.

History of Events

Details as to history of the event must be obtained in order to provide proper care and treatment for the patient. Helpful information includes:

- Place of exposure—was it enclosed?
- Nature of the exposure (spill, fall, explosion, etc.)
- Duration of chemical exposure before treatment was initiated.
- Chemical or chemicals involved.
- Specific toxic properties of the chemical(s).
(This information is usually readily available at an industrial accident.)
- Other relevant patient history outside of the burn injury.
- Patient's current symptoms.

Pain Management of Chemical Burns

Victims of chemical burns can be in varying levels of pain. Water irrigation of the injury site should begin to decrease pain level fairly quickly. Beyond that, pain medications may be given to the patient per local protocol and the level of training of the care provider.

Summary of Chemical Burns

Agent	Pathophysiology	Treatment
General Acids	Deep skin burn caused by tissue desiccation and protein denaturation. Injury may extend well below skin with concentrated acids. Acids such as sulfuric, nitric, and hyperchloric cause local damage. Appearance is tan to gray discoloration with extreme pain, a common finding.	Vigorous water irrigation up to 60 minutes after injury using warm water with extensive exposure to avoid hypothermia. Treatment should be based on the assumption that the burn will be much deeper than initial appearance indicates. Standard fluid resuscitation principles.
Hydrofluoric Acid	Deep skin burn usually on the the fingers can be extensive. Systemic effects are due to hypocalcaemia as a result of removal of tissue calcium by the fluoride. Cardiac arrest can occur.	Vigorous water lavage, local injection of calcium gluconate as well as topical use of 2.5% calcium gluconate gel. Zephryn solution is also helpful. Endpoint of local wound, calcium is relief of pain.
General Alkalis	Deep skin burn caused again by tissue and protein desiccation and protein denaturation from chemical reaction of alkali exposed to hydrated tissue. Alkali burns tend to be worse than acid burns, but systemic effects from absorption are not common. Appearance is tan to gray surface discoloration with characteristic extreme pain.	Vigorous water lavage for at least 60 minutes after injury and longer for lye burns, avoiding hypothermia during the lavage. Treatment should be based on the assumption that the burn will progress in depth. Standard fluid resuscitation principles.
General Category Organic Components Gasoline immersion	Superficial skin injury, erythema, systemic poisoning from absorbed hydrocarbons	Water irrigation plus aggressive maintenance of hydration and pulmonary support
Phenol	Partial-thickness burn: dull tan to gray color. Systemic injury from absorption, which is usually rapid with the rate and amount being directly proportional to surface area of exposure	Spray or pour large volumes of water on surface. Do not swab or use small amounts of water, which will only increase surface area exposure. After lavage, use a quick skin wipe with polyethylene or propylene glycol.
Tar	Superficial to deep skin burn, depending on temperature of the tar once skin contact occurs. No systemic absorption is present.	Removal of tar at a medical facility to allow wound care. Neosporin contains the emulsifier Tween-80 which is useful in dissolving the tar.



Electrical Burns



Section 5

The extent of an electrical injury depends on the type of current, the pathway of flow, the local tissue resistance, and the duration of contact. Unlike with other burn patients, victims of an electrical injury are more likely to have serious internal injuries that are not immediately visible to Fire Fighters or other care providers.

Principles of Electricity

In order to understand electrical current injury, familiarity with the principles of electricity—particularly of voltage and amperage is necessary.

Voltage:

The electrical or energy potential. It is the electromotive force generated by the power source. Measured in *volts*.

Amperage:

The intensity of the current or the amount of the current flowing, per unit time. Measured in *amps*.

$$\text{Amperage} = \frac{\text{Voltage}}{\text{Resistance}}$$

Resistance:

The current's tendency to lose power as it flows through a medium. Fire fighters could compare it to friction loss within a hose. Measured in *ohms*.

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Amperage}}$$

Common Voltage Settings

Typical voltages associated with particular settings are as follows:

- Household current = 110 to 220 volts
- Residential area transmission line current = 5,000 to 10,000 volts
- High tension transmission wire current = up to 100,000 volts
- Lightning current approximately 20 million volts

Joules

The electrical current produces heat when it meets a resistance to flow. This process is defined by Joules law with the heat production defined in term of *Joules (J)*:

$$J = IRT$$

where:

J = Joules

I = Amperage

R = Resistance

T = Contact time

Types of Electrical Current

The type of current may also have a bearing on the severity of the injury. There are two types of electrical current: alternating current (AC) and direct current (DC).

Alternating Current (AC)

Alternating current is the most common form of electricity. This type of current is most commonly associated with fixed electrical services. AC current flows back and forth from the power source until the victim is disconnected. The alternating current can produce muscle spasm and the inability to let go of a power source. Complications caused by AC current may include the following:

- Ventricular fibrillation.
- Cardiac arrest.
- Burns and damage below the surface.
- Brain and nerve damage.

Direct Current (DC)

Direct current initially passes through the body but does not alternate. Common sources of DC current are lightning and batteries of any type. Complications caused by DC current may include the following:

- Cardiopulmonary and neurological damage.
- Burns and current damage are less common.

How Electricity Injures the Body

The following are several possible ways electricity can injure the body.

Current

The current generates intense heat often in excess of 2,000°F along its path through the body, which can lead to severe muscle, nerve, and blood vessel damage. Muscles and nerves may also be damaged by the electrical current itself.

Arcing

Ionization of air particles associated with a voltage drop is called *arcing*. The heat generated in the arc can be as high as 4,000°C and can vaporize metal. This process frequently causes a patient's clothing to ignite and causes flame burns.

Flames

A flash can result from the power source causing the ignition of clothing or nearby materials. A flame burn can occur without a current passing through the victim.

Components of Electrical Burn Injuries

An electrical current will produce an array of injuries if the current passes through the body. Most of the damage is beneath the skin surface, and therefore the actual injury can easily be underestimated. Electrical current produces tissue damage in two ways:

- Local generation of heat during the passage of the current.
- Direct tissue damage by the current.

Effect of Electrical Current on Severity of Injury

Current in Milliamps	Effect
High Tension Source 1,000 or more	Severe tissue destruction from heat and coagulation Cardiopulmonary failure
Household Source	
60	Cardiac Fibrillation
30	Respiratory muscle tetany: suffocation
5	Pain

Tissue Injury

The severity of injury to tissues is dependent on the amperage, (i.e., the actual amount of current passing through the tissues). It is impossible to know the amperage because the variability of resistance and exposure time at the accident. However, one can infer amperage from the voltage of the source, at least as to high or low. A low-voltage source is capable of producing major cardiopulmonary complications and death, if a sufficient current passes across the chest to initiate ventricular fibrillation.

The degree of tissue injury is dependent on the following:

- Voltage of the source.
- Amperage of current passing through the tissues.
- Resistance of tissues traversed by current.
- Duration of contact.
- Pathway of the current.
- Type of current: alternating (AC) or direct (DC).

Muscle Spasm

Traumatic injury can be caused by the intense muscle spasm that results from the current or from a fall. Fractures and dislocations can occur. There is also a variety of cardiac, lung muscle, nerve and internal organ injuries which can occur, some being immediately life threatening.

Tissue Resistance

Electric current entering the body follows along the path of least resistance. Since resistance is an integral part of the pathophysiology of the electrical injury, differences in tissue resistance to current flow help explain the observed changes following electrical trauma.

Tissue resistance progressively increases from nerve to blood vessel, muscle, skin, tendon, fat and bone. Bone has high resistance because of its density. Consequently, more heat is generated to adjacent tissue in the area of the bone leading to greater muscle damage deep to the surface. The electrical current itself also destroys tissue along its course, especially muscle and nerves.

The resistance of tissues to the passage of current is in large part dependent on water content in the tissues, as water is a good conductor. The following lists the resistance of human tissues from high to low (decreasing order):

- Bone.
- Fat tendon.
- Skin.
- Muscle.
- Vessels.
- Nerves.

However, with high-voltage injuries, the current readily passes through all tissues indiscriminately.

Skin resistance is also dependent on skin moisture content. A moist hand has a resistance to passage of current 10 to 100 times lower than a dry hand. Heat produced as the current passes is proportional to tissue resistance ($\text{Heat} = \text{amp}^2 \times R$). Local heat generated

along bone from a high-voltage source can be of sufficient degree (more than 1000°C) to cause bone destruction and total destruction of surrounding tissues. Similarly, the heat produced as current enters and exits the body leads to complete destruction of the skin and underlying tissues.

Contact Points of Injury

The terms entrance and exit sites were commonly used to describe the damage at a contact point with the electricity. These terms are really a misnomer when describing a high-voltage AC current injury as the current is actually passing back and forth between contact with electricity and grounding site on the body, thus technically both sites are both entrance and exit sites. Low-voltage injuries usually only have a small burn (or no damage) at the point of contact.

The presence of contact (entrance and exit) points indicates the passage of a current. Therefore, the patient must be transferred to a hospital, preferably a burn center.

Pathway of Current

The pathway of current through a human body is unpredictable, but it generally passes from a contact point through the body to a grounded site. The reason it seeks the grounded source is because it has a lower resistance to flow when compared with the air (a poor conductor) that surrounds the person. Extremely high voltage sources usually exit multiple areas, often in an explosive fashion. Current passing from hand-to-hand or hand-to-thorax has a high risk of producing cardiac fibrillation when compared to hand-to-foot passage. Passage through the head is likely to cause an initial respiratory arrest and subsequent severe neurologic impairment.

High-Voltage Electrical Injuries (Greater than 1000 Volts)

A high-voltage injury can be defined as exposure to a voltage of 1000 volts or greater.

- The injury is caused by passage of current.
- Flashes or flames from electrical source can cause severe skin burns.
- Damage beneath the surface should be suspected.
- Explosive force and falls can cause blunt trauma.
- Cardiac, neurological and other injuries occur.

A high-tension source is usually required to produce any tissue destruction characteristically seen along the path of the current. High-voltage injuries characteristically occur in an outdoor environment near power sources and lines. Electrical current can arc (jump) one inch from a power source or line for every 10,000 volts being carried, so that a person does not actually have to touch the source to sustain injury.

The degree of resistance of tissues to passage of current directly correlates with the heat produced by the current. The resistance of dry skin is high, resulting in severe

Common Complications of Electrical Injuries

Ventricular Fibrillation	Muscle necrosis
Other rhythm abnormalities	Fractures
Respiratory arrest	Hemolysis
Seizures/Coma	Renal failure
Mental changes	Hemorrhage
Hypertension	Limb loss
Retinal detachment	Anemia
Cataract (delayed)	Paresis/paralysis and other neurologic (delayed)

local injury, often mummification, at the contact site followed by damage along the current's path. Temperatures of several thousand degrees can develop. A wet hand will allow passage of current with little resistance, and the contact site may look quite benign while the damage caused by the current may be worse, as more current passes.

Tissue Injury (Contact Points)–High-Voltage

The determination that an electrical current injury to underlying tissue may be present is the finding of contact point sites. Its presence is diagnostic of an electrical injury beneath the skin. The heat generated at the skin surface is dependent on the local resistance, which in the dry hand can be sufficient to generate heat in excess of 1000°C with high-voltage sources. This will lead to local mummification at the site. The skin appearance at the site of contact is often that of a well-defined charred wound that is depressed due to loss of tissue bulk. The wound may sometimes appear like a typical deep flame burn, except in this case the injury extends deep into the surface.



A contact point from a high-voltage source. Hands are typical locations for contact points with the energized source. Note there is a burn to the hand from generated heat. The entrance site is the blackened area on the wrist where there appears to be a defect, as the water in the skin and beneath has vaporized.



This injury is a result of contact with 10,000 volts. There is obvious mummification or total destruction of the hand. The wrist is fixed in flexion as the tendons and muscles of the forearm have been destroyed. The loss of water in the tissue shortens the now dead tissue. The wound at the elbow crease resulted from the heat of the current as it traveled up the arm.



A more dramatic grounding contact point “blowout” type wound is shown where the fourth and fifth toes are destroyed.

An injury at the contact point with the grounding site. The site where the passing current reaches the surface can often look like holes and appear innocuous. However, these wounds are deep as the current is coming from the inside out. A wound such as this, commonly seen on the foot, clearly indicates passage of a high voltage current through the body.



The arc burn is basically a thermal burn caused by the intense heat generated from an arc of current passing from an area of high resistance to low. Tissue appearance at the contact point of the ground varies considerably. With moderate exposures, the appearance is often that of small skin ulcerations with a depressed center and heaped up edges. With passage of a large current, multiple sites are frequently seen along the route of the current. The appearance is often that which would be expected from an explosion, because pieces of cutaneous tissue are often absent, having been blown out by the immense energy of the current.



An arc burn to an arm. Intensive heat is generated when the high-voltage current jumps to the victim from the source. This heat will cause deep surface burn. Clothes often catch fire as well.

Muscle Damage–High-Voltage

Electrical burns more closely resemble a crush injury than they do a thermal burn. The damage below the skin where the current passes is usually far greater than the appearance of the overlying skin would indicate. The immediate damage to muscle is caused by the



An electrical burn with dead muscle. The pale looking dead muscle is beneath normal skin, near the mummified foot (contact point). An incision has been made to avoid the pressure of swollen muscle from damaging nerves and remaining living muscle.



The dark, nearly black urine on the left is caused by the muscle damage and pigment release created by a high-voltage injury. The urine gradually gets clearer over 24 to 48 hours with fluid resuscitation; however, kidney failure can result anyway.

heat, which is usually patchy in distribution along the course of the current, often most severe near the bones.

Within minutes of injury the dead muscle releases its red pigment, myoglobin, into the blood stream. The muscle rapidly swells, compressing local nerves and blood vessels. An incision through the overlying layers of skin, fat, and muscle cover (fascia) is called a fasciotomy and is needed to release the pressure.

Heart and Blood Vessel Injury

Immediate cardiac arrest is the most common cause of death after high-voltage electrical injury. The process is due to both the direct alteration of the heart rhythm by the electrical current. This can lead to fibrillation or to the depression of respiration and subsequent hypoxia. Hand-to-hand passage of a high-voltage current has a reported immediate mortality rate of 60 percent. The initial heart problems are often reversible with CPR.

Lung Injury–High-Voltage

Impairment of the brain center that stimulates breathing and severe damage to other parts of the central nervous system will lead to lack of breathing, which is frequently the cause of immediate death. Decreased muscle activity in the chest wall can be caused by a nervous system injury, muscle damage, or blunt traumatic injuries, and can markedly impair breathing.

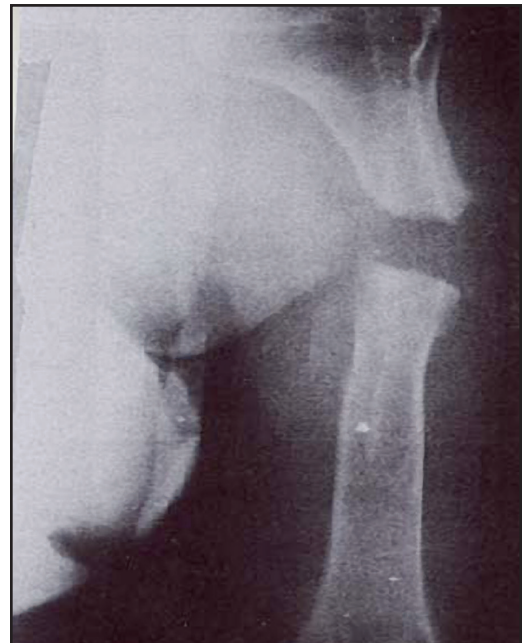
Neurologic Injury–High-Voltage

Acute central nervous system damage with coma, seizures, motor and, to a lesser extent, sensory deficits are common with high-voltage injuries. Many of these abnormalities are permanent.

Orthopedic Injury–High-Voltage

Orthopedic injuries associated with high voltage electrical injuries occur as a result of one or more of three processes:

- The shock causes a severe muscle spasm, strong enough to induce fractures and dislocations. This is the most common orthopedic injury associated with electrical injury, often causing spasms severe enough to produce long bone fractures and dislocation at major joints.
- The heat of the current causes localized bone destruction.
- Devascularization of the bone.



A humerus fracture caused when the muscle went into intense spasm with contact with the electrical current.

Eye and Ear Injuries

Be alert for the presence of conjunctival and corneal burns, as well as ruptured ear drums, in high-voltage shock patients.

Low-Voltage Electrical Injuries (up to 1000 volts)

A low voltage injury is defined as exposure to less than 1000 volts. Local heat damage from these incidents is usually evident, such as burns at the edge of the mouth in a child who bit an electric cord. Low-voltage current is not sufficient to cause tissue damage along its course, except at the contact site. Cardiac problems, such as ventricular fibrillation, are common with low-voltage exposures.

Low-voltage injuries occur characteristically in a home or residential environment. Electrocutions in bathtubs and by electric hair dryers are the most common causes of low-voltage deaths.

Though often not as dramatic as high-voltage injuries, low-voltage electrical injuries can also be serious and even fatal. These are the types of burns commonly encountered in household or commercial settings. Though they do occasionally happen, burns and tissue damage are typically not as serious a complication with these types of injuries.

Cardiac Injury–Low-Voltage

The most severe low-voltage injury responders may encounter occurs when a household current is applied to wet skin, or an electrical device and the person contact each other in the presence of water. This current (as little as 60 milliamps is required) is sufficient to cause ventricular fibrillation and cardiac arrest. Other cardiac rhythm disturbances can also occur.

Muscle Spasm–Low-Voltage

Tetany and spasm can also develop during contact with a low voltage. The “can’t let go” current can be as low as 30 milliamps. In these situations the spasm in the flexor muscles of the hand and forearm prevents the victim from letting go. Suffocation can also occur if the chest muscles go into spasm and the victim can’t breathe. This problem is most commonly seen with electrical shock during immersion in water, for example, in a bathtub.

Low-Voltage Electrical Burns in Children

Low-voltage electrical shock is the leading cause of electrical injury in children, especially one- to five-year olds. Sucking an extension cord is responsible for more than half of the injuries, and biting an electric cord accounts for another 30 percent of the injuries. The most common mechanism of injury is the production of an electrical arc by the bared wires and conducted by the child’s saliva. Intense local heat is generated, producing severe local destruction of mouth tissues.

Oral Burns

The local mouth burn is characteristically grayish-white in color and indented at the center due to tissue necrosis.

Severe swelling then develops a venous thrombosis which impedes blood return.

The oral burn may involve lip, tongue or oral mucosa, and underlying bone. The most frequent site is the lip, in particular the commissure area between upper and lower lip. The swelling of the lips may

be intense, impairing control of saliva. Swelling subsides over the next 5 to 10 days and local necrotic tissue begins to slough. Bleeding from the artery at the edge of the mouth is a common occurrence (20 percent of the time) during the period of slough (7 to 21 days) and should be anticipated. Pressure control of bleeding will be necessary.



The typical appearance of an electrical cord burn to a child's mouth.

Lightning Injuries

Be aware of the following facts when considering the impact of injuries incurred from a lightning strike:

- Lightning strikes with a force of about 20 million volts of DC current.
- The mortality rate of a direct strike on a human is about 30 percent.
- Lightning tends to produce primarily nervous system injuries.
- Permanent sequelae, mainly neurological in nature, are present in 60 percent of direct strike patients.
- Loss of consciousness is common in all forms of lightning injuries.
- The type of injury predicts the prognosis and treatment.
- Serious body burns are uncommon because of the very brief contact time of the strike.
- The person struck is not “charged” with electricity and there is no risk when touching the victim.

Types of Lightning Injuries

The following are the five general types of lightning injury:

Direct Strike

A direct strike occurs when the patient is outside and comes in contact with the lightning bolt. The person is the major grounding site. The head is the most likely place for the entry contact point; yet only a small burn on the scalp may be present. In many cases the patient will be found unconscious and in need of CPR. The mortality rate associated with direct contact injuries is very high.

Flash Discharge

Flash discharge injuries occur when lightning is deviated from another object to the victim. It is the most common form of lightning strike. These injuries can be severe, but they are usually not as bad as a direct strike.

Ground Current

Ground current strikes result when the lightning bolt strikes the ground near a person. The current then travels to the grounded person. This injury is less severe than a direct strike and is usually not fatal.

Shock Wave

Shock wave injuries occur when the victim is near the point of a violent lightning strike that produces a concussive force similar to a large explosion. The patient can be thrown a significant distance, and tissue trauma from the transmitted energy is common.

Flashovers

Flashovers occur when the lightning current travels along the outside of the conductor, namely the victim. The victim's clothes are destroyed, but the person struck is usually not injured, except for the noise damage to the ears and superficial burns.

Symptoms of Lightning Injuries

The following initial symptoms may be noted in a direct lightning strike:

- Unconsciousness.
- Respiratory arrest (can be prolonged due to a temporary chest wall paralysis).
- Cardiac dysfunction (usually asystole rather than fibrillation).
- Autonomic nervous system instability.
- Seizures.
- Intense headache.
- Tinnitus (ringing in ears).
- Musculoskeletal pain from initial current induced tetany (a fracture may also be present).

Symptoms Not Seen:

Burns are common but often superficial. They may be due to the direct contact of lightning or by secondary heat generated. Lichtenberg figures, fernlike patterns in the skin, are not burns but a discoloration that is pathognomonic for lightning strikes and lasts for several hours to a few days. As well, muscle damage, as seen with prolonged high-voltage electricity, is not usually seen with lightning strikes either. Patients who are simply blown away by the concussive force of a nearby strike are most likely to have blunt force trauma injuries, as well as eardrum damage.

Treatment of Lightning Injuries

Treatment for victims of any lightning injury is the same as that described earlier in this section for high-voltage electrical injury patients.

Initial Assessment and Management of Electrical Burns

In general, the procedures that Fire Fighters and other first responders use to treat patients of electrical shock and subsequent burns follow the guidelines provided in **Section 1** of this manual. However, there are a few specific items to remember that may be more likely with electrical incidents than other types of burn injuries.

- Be sure the scene is safe from electrical current.
- Assess patency of the airway patient's airway. If the airway is impaired, initial airway maneuvers should be undertaken, with consideration given to cervical spine protection, as secondary trauma is common in electrical shock patients. Consider the presence of smoke inhalation injury and carbon monoxide toxicity if smoke is present at the scene (see **Section 3**). Endotracheal intubation may be performed based on established protocols.
- Assess the adequacy of the patient's breathing effort. Note if there is labored breathing or wheezing. Remember that the electrical current can impair the ability to breathe, so be prepared to initiate respiratory assistance, if needed. CPR may be needed if respiratory arrest is present.
- Assess the adequacy of the patient's circulation. Initiate IV placement and fluid administration per local protocols. In general, the need for IV therapy is indicated by:
 - Hypovolemic shock.
 - Low blood pressure.
 - A long transport time to a medical facility.
- The following other procedures may need to be initiated, depending on local protocols and the level of training by the emergency providers:
 - Administration of various medications IV.
 - Cardiac monitoring, there is a high probability for cardiac disruption with electrical injuries.

First Responder Safety

First and foremost is the safety of the Fire Fighters and other responders present at the scene.

- Do not touch the patient until the source of electricity has been eliminated. To do otherwise might expose the care providers to a potentially serious injury or death.
- Secure a safe site for patient assessment and initial management of injuries before starting the treatment.

- CPR and defibrillation per diagnosis and protocol.
- Remove potentially constricting objects, such as jewelry, before swelling occurs.
- Monitor pulse in extremities possessing contact point burn or thermal injury looking for impairment to local circulation.
- Try to determine if the exposure was to a high-voltage source.
- History of electrical contact including voltage source and exposure time.
- Presence of contact point burns.

Treatment of Electrical Burns

As with other types of burns, the next step is stop the burning process by neutralizing the heat source.

- Apply copious amounts of water to the injury site. Because of water's conductivity, this can only be safely accomplished when the electrical source has been controlled. Victims of high-voltage electrical shock will often have their clothing ignited.
- Remove the smoldering clothing if it has not adhered to the patient's skin.

Maintaining a reasonable body temperature is also important. If the patient is in a cold environment, he or she should be moved to a warmer one, if possible. If it is not possible to move the patient to a warmer environment, place blankets over the clean sheets protecting the wounds to maintain body heat in the patient.

Disability

The next step is to determine whether the electrical shock has resulted in a brain or nerve deficit, as this is a common problem with this type of injury. Determine the patient's state of consciousness and treat accordingly (using the AVPU process). One excellent indicator will be to see if all four extremities are moving.

Expose and Examine

The next step is to expose and examine any burns that are present. The presence of contact point burns indicates the need for the patient to be transported to a hospital, preferably a burn center due to the risk of the "hidden" injury. Also try to assess and expose flash or flame burns to the skin and other traumatic injuries.

When contact point wounds are found, they should be treated just like any other burn. Do not apply ointments or other agents to the burns. Cool the burn and cover with a clean, dry sheet or dressing.

Pain Management

These patients may be in a state of serious pain. Follow local protocols for pain management. In no case should the use of oral analgesics be allowed.

Conclusion

When approaching a patient who has received an electrical injury, it is important that responders ensure that the patient is no longer in contact with the energized source, as this could gravely endanger the responders. Once the patient is free of the source or has been struck by lightning, the person does not remain electrically charged. Patients of electrical shock are likely to have cardiac issues that need to be addressed immediately. Standard, local protocols for treating these symptoms should be followed.

Scald Burns

Section 6



Scalds are one of the most common types of significant burn injury for all people, and they are the most common burn injury seen in children. Scalds are burns produced by hot liquids. Heat is transmitted from water to skin 100 times more efficiently than from heated air to skin. This is the reason why the temperature of a liquid required to produce a burn is very modest compared to burns by fire or heated air.

Types of Scald Burns

The most common types of scald injuries can be summed up in five different types:

Hot Liquid Spill Scalds

The hot liquid spill incident is the most common type of scald injury. This may come from contact with hot coffee or other liquids, usually in the kitchen. Freshly brewed coffee is usually at about 180°F (82°C) in the pot.

Contact with hot, but not boiling, liquid typically results in a superficial, partial-thickness burn. The liquid cools somewhat in the distance it falls between the container and the patient. If the liquid is boiling (212°F or 100°C), it almost always causes a deep burn. The most common location for these burns on toddlers and other small children is the head and neck, as they typically are injured when they pull a container off a counter or cooking surface.

Hot Grease Scalds

Hot grease burns are fairly common and typically incurred while cooking at home or in a restaurant. Grease hot enough for cooking is hotter than boiling water, with a temperature of 350°F (177°C) or greater. Grease also retains heat longer and adheres to the skin longer than water. Thus, a burn caused by grease is typically deeper than one from hot water. Direct exposure to flaming grease (in excess of 450°F or 232°C) leads to an even deeper burn.

Immersion Scalds

An immersion scald is a burn in which a part or all of the body is immersed in hot water. If hot water contact is prolonged, a deep burn results. This process is characteristically seen in the elderly or in young children who cannot escape the hot water. Because of water's efficiency in transferring heat, the tissue is injured deeper than with



This burn occurred when boiling water on a stove was spilled on the patient. The water temperature was probably 140-150°F (60-68°C) when it contacted the patient. The blisters that are present are characteristic of a superficial second-degree burn.



This child was burned by a spilled cup of hot coffee. The burn is wet and pink in appearance, characteristic of a superficial second-degree burn. It is likely to heal, with little or no scarring, in 10 to 14 days.



This burn was caused by spilling a pot of cooking grease. Note the whitish areas on the back of the hand indicating a deeper burn. A skin graft will be needed.



This injury was caused by near boiling water falling from a picnic table onto the patient's back. Most of the burn is partial thickness, but some whitish patches indicate that the burn is not all superficial.

a flash flame of short exposure. Though the water temperature is usually not hot enough to immediately coagulate vessels, the wound may look red like a superficial burn, but soft tissue injury can be severe and the burn can be very deep. Bathroom scalds are the most common example of immersion scalds. The most common parts of the body that suffer immersion burns are the feet and buttocks. Both of these locations are high-risk burn requiring specialized care.

SIGNS OF FORCED IMMERSION OR ABUSE

Forced immersion or abuse must be considered when encountering patients with an immersion scalding. Children and the elderly are particularly vulnerable to abuse. Some characteristics of intentional immersion scalds include the following:

- A bathtub burn which appears to have a uniform depth.
- Sharp demarcations between burn and non-burn areas.
 - This finding is not possible if the patient was moving or attempting to escape.
 - This indicates a forced immersion where victim cannot move.
- Absence of splash marks.
 - There are less-deep scald burns with splash marks if the victim is moving.



This is an intentional scald burn on a child. Note the perfect border between the burned and unburned skin. This indicates that the child was not moving. The red, dry appearance caused by a prolonged exposure to the hot liquid is indicative of a deep burn. Burn center admission is needed.

Burns Due to Steam Exposure

There are two types of burns that occur as a result of exposure to steam. The first is the large live steam injury, typical to industrial accidents such as a ruptured steam line. In addition to a large deep burn, there is often an inhalation injury component with burns to the mouth and upper airway. The second and more common burn is caused by steam used in cooking. The temperature of the steam and the exposure time of these burns are both less than those of the industrial variety.

With cooking steam burns there is usually no airway injury and the burn is less-deep.

The treatment for steam burns generally follows those for other types of burns. See **Section 1** for details.



This burn was caused by a hot liquid spray that was released when removing the cap from an overheated car radiator. The burn is a superficial second-degree burn, as water cooled somewhat along the course from the radiator to the face. The exposure time was probably 1-2 seconds. All face burns are major burns and should be managed in a burn center. This burn will heal in 10 to 14 days with proper treatment.

Characteristics of Steam Burns

Industrial Steam Burns	Home Cooking Steam Burns
<ul style="list-style-type: none"> • Caused by superheated steam under pressure • The burns usually cover a large area • Long exposure time leads to deep injury • Airway burns are common • Invariably a major burn 	<ul style="list-style-type: none"> • Short exposure time • Hands and face burns are common • Airway burns are rare • Burns are usually superficial

Severity of Scald Injuries

The severity of the scald burn is dependent on the temperature of the liquid and the duration of exposure, typically measured in seconds. The Table below provides some figures related to scald injuries. As shown in the Table, a long exposure to moderately hot water, as seen in bathtub scalds, can produce a deep burn. A scald burn can occur even if the hot water is set at a safe level (below 120°F or 49°C), if the exposure time is long enough.

Exposure Time to Receive a Severe Burn

Celsius (C) Temperature	Fahrenheit (F) Temperature	2 nd Degree Burn	3 rd Degree Burn
45°	113°	2 hours	
47°	116.6°	20 minutes	
48°	118.4°	15 minutes	
49°*	120°*	8 minutes	20 minutes
51°	124°	2 minutes	5 minutes
55°	131°	17 seconds	25 seconds
60°	140°	3 seconds	5 seconds
63°	150°	1 second	2 seconds
68°	156°		1 second

*120°F (49°C) is considered to be the safe maximum water temperature for domestic use.

High-Risk Populations for Scald Injuries

While anyone could potentially be the victim of a scald injury, there are certain groups of people who are more susceptible than others. These groups include the following:

- Children under 5 years old.
- Adults over 65 years old.
- People of any age with disabilities.

Initial Assessment and Management of Scald Injuries

As with other types of burn injuries, the first step in treating a scald patient is to stop the burning process.

- Safely remove the patient from the heat source, or vice versa. It is generally possible to immediately neutralize the effects of the scalding liquid by a short-term exposure to cool water.
- Once this has been accomplished, the standard life support and ABCs described in **Section 1** of this publication may be initiated. Keep in mind when assessing the airway and breathing that depending on the circumstances, the victim may have inhaled superheated steam and could have burn damage to the airway.
- Remove any wet clothing from the patient.
- Use the **Rule of Nines** to perform a rapid burn assessment. The patient must also be assessed for other forms of trauma.

Treatment of Scald Injuries

- Cover the burned area on the patient with a clean, dry sheet.
- Try to maintain a normal body temperature in the patient. Analgesics may be administered for pain, according to local protocols.

History of Events

The following pertinent pieces of information relative to the injury should be obtained, if possible:

- Exact circumstances of the injury.
- Type of liquid and its temperature.
- Exposure time.
- Patient's age (typically the very young or very old will have deeper burns).

Conclusion

Scalds and steam burns are common in both industrial and residential settings. Burns caused by high pressure, superheated steam in an industrial setting are likely to be more severe than those from residential cooking steam accidents. Scalds are common in both these environments as well. Scalds in residential settings are more likely to occur in very young and very old people. Responders should be alert to the potential of abuse when dealing with scald burns in a residential setting. Any suspicion of abuse should be reported to medical and law enforcement personnel according to local policies and procedures.

Burns to High-Risk Areas

Section 7



All burns are not equal in nature. Burns to certain parts of the body are more problematic than others. Small burns to certain portions of the body are of a higher risk because of their potential for a severe disability. These burns require more specialized care than do similar burns to less-critical areas.

High-Risk Areas

High-risk portions of the body include:

- Facial areas.
- Ears.
- Hands.
- Feet.
- Perineal and genital areas.

Burns in these areas are considered serious for the following reasons:

- The importance of function for those body parts.
- The importance of appearance to most people.
- An increased risk of infection in these areas.
- Increased pain and disability in those areas.
- Difficulty in burn management for high-risk areas.

Facial Burns

Facial burns require considerable care to avoid infection, ensure optimal healing, and minimize scarring. A careful assessment of burn degree and severity is needed by someone experienced in burns, and an optimal treatment plan needs to be initiated to avoid, if possible, long-term problems like scarring. Facial burns also often occur in conjunction with smoke inhalation.



A partial-thickness facial burn 12 hours after the injury. It was caused by a short exposure to flames. Note the degree of swelling at 12 hours after injury. Swelling is particularly severe and rapid onset with facial burns. Topical antibiotics and frequent cleansing are required.



This facial burn was caused by a flash flame created by using a flammable liquid to start a grill. Note the singed eyebrows and hair. The burn depth can't be assessed without a thorough cleaning. The airway condition needs to be assessed.

Perineal and Genital Burns

Perineal and genital burns are at high risk for infection and require frequent cleaning and reapplication of antibiotics. Admission to a burn center is always required for deep burns.



Partial-thickness perineal burns caused by a hot grease spill. Admission is required preferably, to a burn center.

Hand Burns

Hand burns are high risk for two reasons:

- The risk of the burn becoming more severe by excess edema from lack of elevation or by infection is high. Often the discomfort from cleaning decreases the quality of wound care at home and admission to a hospital is necessary.
- A decrease in activity, due to pain, will result in a rapid decrease in strength and decrease in hand motion. Early physical therapy is necessary.

Deep hand burns require admission to an appropriate medical facility. As well, extensive superficial burns will benefit from short-term admission. Close follow-up as an outpatient is required by a burn experienced observer.



This mid-partial thickness or second degree burn to hand and arm was caused by live steam from a ruptured pipe. This burn requires admission in a burn center so that long-term disability can be prevented.



Note the dry, white appearance indicative of a deep-partial or full-thickness burn. This burn was caused when hot grease caught fire on the hand. This burn will require skin grafting, and there may be some long-term disability.



This flame burn extends into the tendons and muscle. Note the incisions that have been made along the fingers to release the pressure beneath the burn and improve blood supply. Some permanent disability will occur.



This partial-thickness palm burn was caused by a firecracker exploding in the patient's hand. The burn is not extremely deep. Note the red, wet appearance. Extreme pain is present. Treatment will consist of cleansing, a topical antibiotic, and a dressing to protect the burn and decrease the pain, as well as initiating early hand therapy.



This mid partial-thickness or second-degree burn was caused by hot wax spilled from a large candle. The burn is not extremely deep. Note the red, wet appearance. Treatment will consist of cleansing, a topical antibiotic, an occlusive dressing and hand therapy.

Foot Burns

Foot burns have a high risk of becoming deeper if initial management is not proper. Excessive swelling due to walking or sitting will further decrease blood flow to the area, increasing the risk of infection. Deep foot burns are often considered major burns and require admission to a burn center for elevation and early surgery.



A partial-thickness foot burn in a child caused by hot water. Note the blister formation indicating that the burn is partial-thickness. Because of the site and the patient's young age, this child requires assessment and likely admission to a medical facility, preferably in a burn center.



These burns were caused by inadvertently walking onto hot coals at a campfire. The burns are partial-thickness but extremely painful and totally disabling. Complete healing is expected if optimum care is provided, preferably in a burn center.



The burned feet from above, three weeks after the injury. The burns are nearly completely healed.



A partial-thickness ear burn caused by a flash flame. The ear has been gently cleansed of any dead skin and dirt. The burn now needs to be treated with topical antibiotics. Note rapid onset of swelling. Admission to the hospital was required.

Ear Burns

Ear burns are notoriously undertreated. Part of initial management is recognition that ear burns are a high-risk injury. The ear is mainly made of cartilage covered with a layer of skin. Since there is a low blood supply, the risk of infection is high. Infections are easier to prevent than to treat.

Pressure on the burned ear needs to be avoided until the burn has healed. Avoid dressings or lying on pillows. Damage to the cartilage will lead to loss of cartilage and an ear deformity.



A healed ear burn with cartilage damage. Note the deformity of the ear caused by an infection with resulting cartilage damage.

Conclusion

Fire Fighters and first responders must recognize that burns to the face, ears, hands, feet and perineal/genital areas are more serious than to other portions of the body. Burns that otherwise would not necessarily require extended treatment or transport to a medical facility will require both when located in these areas. It is vitally important that first responders and medical personnel recognize the hazards of burns in these high-risk areas. The American College of Surgeons recommends that these burns are referred to a burn center.

(The Burn Center Resource Directory can be found on the ABA website at www.ameriburn.org)

Pediatric Burns

Section 8



Burns are the second leading cause of accidental death in children. The vast majority of burns occur in the home where they are the leading cause of death of children in the one- to 14-year-old age group. Twenty percent of all hospitalized burn patients are children. The majority of burns in children occur under five years of age. Many childhood burns are the result of abuse or neglect.

Types of Burn Injuries in Children

Scald Injuries

Scald injuries are the major cause of burn injury in children under three years of age and usually occur in the kitchen or bathroom. Unfortunately, water heaters are frequently maintained at temperatures in excess of 120°F (49°C), and hot tap or bath water can cause a severe burn.



This photo shows a burn caused by hot coffee spilled from a cup. The burn is wet and pink characteristic of a superficial second- degree burn. It is likely to heal in 10-14 days.



This photo shows a deep flame burn. The third-degree burns to the shoulder with charred skin occurred when the back of the child's shirt caught on fire while close to fireplace.

Contact Burns

Contact burns occur frequently in crawling infants and toddlers as a consequence of contact with irons, heaters, oven doors or fireplaces.

Flame burns

Flame burns are more commonly seen in children over five years usually due to careless contact with flammable liquids.



This photo shows a child who was burned by grease that fell from a stove. Note the burn is deep compared to hot water as reflected by whitish areas.

House Fires

House fires frequently trap children because of their inability to escape. Smoke exposure would likely occur under these circumstances.

Mouth Burns

Mouth burns occur from chewing on household electrical cords.

Components of Pediatric Burn Injuries

There are important differences between how an adult and a child's body responds to a burn injury. These differences include the following:

Skin Thickness

The skin of infants and toddlers is very thin relative to that of adults. Therefore, a third-degree burn can be produced by the same insult that produces a much more superficial burn in the adult. For example, severe burns in a child can occur with less than a 10-second exposure to 130°F (54°C) water. Adults would need to be exposed to the same water for at least 30 seconds to get a similar injury.

Burn Appearance

Because of the near transparency of a small child's skin, a deep arm burn looks red rather than white.

Temperature Regulation–Cold Injuries

Infants and young children conserve body heat less well than adults. Intrinsic heat generation by shivering is hampered by a relatively small muscle mass. Temperature regulation in infants less than six months depends less on shivering and more on the environmental temperature. Children older than this can generate heat by shivering. Hypothermia can occur rapidly in a small child, especially if the skin is wet or exposed. Attention to conservation of heat is a high priority.

Skin Surface Area

When compared with adults, the infant and young child have a relatively greater surface area of skin per body weight. As a consequence, the child is more in contact with the environment and has relatively greater fluid needs per unit of weight than the adult.

SPECIAL CONDITIONS FOR PEDIATRIC PATIENTS INITIAL ASSESSMENT AND MANAGEMENT

In many cases, the procedures for treating infants and children differ from those for adults.

As with adult patients, the first step is always to stop the burning process. This can be done by removing clothes that contain heat, as long as they are not melted to the skin.

Airway Assessment

The basic principles of airway, breathing and circulation for adults also apply to children. Be sure to assess for airway obstruction if there was any exposure to flames and/or smoke. Infants have a small airway that is susceptible to early obstruction by any airway swelling from the burn injury. Provide oxygen with pediatric equipment and initiate standard airway support, as needed.

Endotracheal Intubation

You may perform an endotracheal intubation per protocol, if required. When doing so, keep in mind the following:

- The glottis of an infant is higher and nearer to the base of the tongue, requiring a modification in the technique of endotracheal intubation.
- The size of the tube should be gauged by the child's external nares or the diameter of his or her little finger.
- An uncuffed tube should be placed in the trachea and well secure.
- An experienced person should attempt intubation.

IV Fluid Administration

The general guidelines for IV fluid administration are as follows:

- If the travel time to the receiving hospital is greater than 60 minutes from the time of injury, an intravenous line should be established and fluid therapy should be initiated at a rate of 250 ml per hour for children five to 15 years of age. For a child under five years of age, the rate is 150 ml per hour (preferably lactated Ringers).
- Starting an IV in children can be very difficult and attempts to do so must not delay transfer to the receiving hospital. If IVs are needed in the child five to 15 years old, the preferred site is the arm at the level of the elbow.
- Intraosseous (IO) infusion may be a lifesaving alternative in the severely burned infant prior to inter-hospital transfer but is indicated only when intravenous line placement has been unsuccessful.

Wound Care

Wound care for pediatric burn patients is as follows:

- Cover the burn with a clean, dry sheet and/or blanket.
- Do not apply ointments or other medication.
- Do not apply cool liquids or ice to avoid hypothermia.
- Keep the patient warm during transportation.

Pain Management

- Do not treat painful burns in infants and children under five-years old with cool compresses during transport (unless the burns are quite small), due to significant risk of hypothermia.
- All medications should be given intravenously.
- Perform administration of pain medication per local protocols.
- Control pain in the pediatric population by applying clean sheets and blankets, keeping the patient warm and avoiding air currents and drafts

Transport

- It is particularly important to maintain body temperature in an infant and a child.
- Elevation of burned extremities during transport will help prevent swelling.
- Elevation of the head in an infant will help prevent brain edema and seizures.

Indicators of Abuse

Child abuse should be suspected if any of the following indicators are noted:

- The patient history is not consistent with the nature or severity of the burn.
- The account of the injury is vague or changes.
- The child or a sibling is accused of neglectful behavior or intentional injury.
- There has been a significant delay in seeking help for the burned child.
- Symmetrical burns are present on the hands, buttocks or legs with no splash marks, indicating forced immersion.
- There are isolated burns of the buttocks due to immersion injury.

History of Events

Obtaining an accurate history is particularly important in the child who may not be able to communicate with accuracy the events leading to the burn or is fearful of reporting abuse. The history of events surrounding the burn can be obtained from first responders, bystanders, relatives or neighbors. Valuable information can be obtained relating to the mechanism of the burn and where the child was found.

Conclusion

People who provide emergency medical services must be familiar with the differences between how infants or children and adults respond to a burn injury. In many cases the procedures for treating infants and children differ from those of adults. Familiarity with these differences can make a significant impact on the recovery of the patient.

Cold Injuries

Section 9



Cold injuries can have many of the same impacts on a victim as burn injuries. Hypothermia and frostbite are two injuries that can be sustained when the body is exposed to cold. Hypothermia is a condition that involves the function of all systems in the body. As the body's temperature continues to drop, body functions begin shutting down to preserve heat. In addition, tissue damage from freezing will occur and the heart will eventually stop and death will occur.

Frostbite is a localized injury. Frostbite involves the freezing of skin and muscle. Frostbite often occurs in a hypothermia victim, but a person does not necessarily have to be hypothermic to have a serious frostbite injury.

Hypothermia

Hypothermia occurs when the body core is cooled to below 95°F (35°C). It can be caused by exposure to cold, snow or ice.

The body's initial response to a dropping temperature is to produce more heat by shivering. Shivering is the body's attempt to increase body heat by muscle activity. Shivering will be impaired by fatigue, especially if no food is available. As body temperature falls further, shivering stops and

heat production is decreased to preserve remaining body heat. Unconsciousness, drugs and alcohol suppress shivering and lead to a more rapid drop in temperature.

As body temperature falls further, the need for oxygen decreases, the heart rate falls, breathing decreases and brain function diminishes leading towards an unconscious state. However, as body temperature continues to fall, tissue damage from freezing will occur and the heart will eventually stop and death will eventually result. Cold exposure is magnified by moisture and wind. The chilling effects on the body are the same for exposure of 20°F (-7°C) air with a 40-mile per hour wind and zero degrees with a 2 mile per hour wind. Moisture or any wetness of the body will increase the rate of heat loss by 100 times. Hypothermia in cold water can occur in seconds compared to minutes to hours with cold air.

The patient may appear dead when his or her body core temperature drops below 90°F (32°C), as pulse and respirations will be difficult to detect.



Types of Hypothermia

There are several types of hypothermia. They are as follows:

- **Acute hypothermia** can occur from several minutes to a few hours. In these situations there is a large difference between body core and outside temperatures. Subacute hypothermia occurs in several hours up to a day.
- **Chronic hypothermia** occurs over a period of one or more days. In subacute and chronic hypothermia, the difference between body core and outside temperature is decreased.
- **Immersion hypothermia** is usually acute or subacute and results from immersion in cold water. A similar hypothermia can be due to exposure to cold rain and high winds.
- **Field hypothermia** occurs in previously healthy individuals such as skiers, climbers, hunters and hikers. It may accompany injuries occurring outdoors in cold weather.
- **Urban hypothermia** occurs in individuals with a physical predisposition, disability, or illness. Predisposing conditions include those which increase heat loss (in infants and newborns with relatively large surface areas), or interference with production (i.e., the elderly with impaired circulation.)

- **Primary hypothermia** is due to an overwhelming exposure to cold air or water in a previously healthy person (not common).
- **Secondary hypothermia** occurs when a milder cold exposure is combined with an impairment in the patient's ability to generate body heat, such as:
 - Other injuries, trauma, burns.
 - A pre-existing illness.
 - Elderly adults and small children.
 - Use of drugs and/or alcohol.

Degrees of Hypothermia

When a patient is being treated for hypothermia, medical personnel will need to determine the extent of the exposure. The following guidelines may be used:

- **Mild hypothermia** is defined as a body temperature between 90-95°F (32-35°C). Its usual characteristics include:
 - Shivering.
 - Anxiousness, unless there is another factor altering consciousness.
 - Increased pulse.
 - Normal to increased respiratory rate.
 - Skin cool.
 - Appearance overall may be normal.
- **Moderate hypothermia** is defined as a body temperature between 86-90°F (30-32°C). Characteristics may include:
 - Shivering is depressed or has ceased.
 - Somnolent, disoriented.
 - Normal blood pressure.
 - Lower than normal respiratory rate.
 - Pale to gray appearance.
- **Severe hypothermia** is defined as a bodily temperature below 86°F (30°C). Characteristics may include:
 - Unconsciousness.
 - Slow pulse, often less than 10 bpm or non-palpable.
 - Low or unobtainable blood pressure.
 - Breathing may appear absent.
 - Appearance is gray to cyanotic.
 - Skin is very cold, mottled.

- **Fatal hypothermia** is very difficult to determine death in the hypothermic patient. Patients who appear to have suffered a cardiac arrest from a low body temperature should not be pronounced dead until they are re-warmed. The exception would be a pre-existing fatal event (i.e. massive head injury) with no functions prior to development of hypothermia. There is an old saying used by care providers that a hypothermic patient isn't dead until they are warm and dead.

Symptoms of Hypothermia

- Shivering.
- Altered state of consciousness, ranging from disoriented to unconscious.
- Physical findings indicating cold exposure.
- Low pulse.
- Cool skin.
- Gray to cyanotic appearance.

Risk Factors for Hypothermia

The following people or situations should be considered high risk for possible hypothermia:

- Elderly adults or small children due to thin skin.
- Cold environmental conditions.
- Wet skin or clothes in moderately cold conditions.
- Cool water exposure (heat is lost 100 times faster if skin is wet).
- Patients with alcohol or drug impairment, increasing the risk of exposure and decreasing shivering.
- Unexpected, prolonged exposure by first responders wearing wet protective clothing.

Initial Assessment and Management of Hypothermia

The initial assessment of hypothermia patients should begin with a review of the conditions in which the person was found or exposed. Determine whether the victim had been in a cold air or cold water environment. In either case, knowing the length of the exposure is also important information. Also, be alert for symptoms such as the following:

When evaluating a possible hypothermia victim, remember that the range of a normal thermometer does not go below 90°F (32°C). If the person is severely hypothermic, his or her body temperature may be below the registerable range on the thermometer.

Treatment of Hypothermia

The most critical phase of treatment for a hypothermia patient is the initiation of measures to avoid a post-rescue collapse of the patient's condition during the first 30 minutes following rescue and during transport. Survival of hypothermic patients can be expected in 50 percent of the patients whose core temperature drops below 90°F (32°C). Coexisting diseases (e.g. stroke, neoplasm, myocardial infarction) are common complications and increase the death rate to 75 percent or more. Survival does not correlate closely with the lowest absolute temperature reached. Death may result from pneumonitis, heart failure or renal insufficiency. The following initial steps should be taken before other assessment procedures:

- Remove wet garments.
- Protect against further heat loss and wind chill using blankets and other insulating equipment.
- Maintain the patient in a horizontal position to protect against the development of shock.
- Avoid any rough handling or excess movement — the cold heart is very irritable and any jolting could initiate a cardiac arrest.
- Avoid a further drop in body temperature during rescue:
 - Avoid muscle activity of the hypothermic victim as this can pump cold peripheral blood from the arms and legs into the main circulation further decreasing temperature.
 - If ventilatory assistance is required, don't use cold ambient air, if possible. Ten to thirty percent of heat loss comes by way of an exchange in the lungs.
 - It is best to first move the patient to a warmer environment.
- Monitor core temperature using a rectal or esophageal probe. Either must have a low range thermometer.
- Monitor cardiac rhythm.

Assessing the ABCs

Airway

- Follow standard airway management procedures.

Breathing

- Assist breathing if the effort is inadequate.
- Perform endotracheal intubation per local protocols.
- Provide supplemental oxygen.

Circulation

- Obtain vital signs.
- It is often difficult to palpate a pulse due to vasoconstriction.

- Do not assume the victim is dead until re-warmed. (They're not dead until they're warm and dead.)
- Check the patient's EKG for presence of rhythm.
- In the presence of a stable heart rhythm, CPR is not necessary and may actually initiate ventricular fibrillation.
- In the absence of a stable or adequate rhythm, initiate CPR.
- Continue CPR until the patient is re-warmed.
- Initiate IV access and fluid therapy per local protocols.

Special Conditions for Cardiac Arrest in Hypothermic Patients

Management of cardiac arrest due to hypothermia is quite different from management of normothermic arrest. The hypothermic heart may be unresponsive to cardioactive drugs, pacemaker stimulation and defibrillation. Drug metabolism is reduced. Administered medications, including epinephrine, lidocaine and procainamide can accumulate to toxic levels if used repeatedly in the severely hypothermic victim.

Disability

- Evaluate brain and nervous system function using A-V-P-U.
- Look for other causes for disability, such as trauma, illness, drugs and/or alcohol.

Re-Warming

Passive re-warming is initiated in all patients to avoid any further heat loss. This approach is provided in the field and is effective for body temperatures above 92°F or 34°C, if further heat loss is prevented. Active re-warming is added in definitive care at a medical facility.

Passive re-warming procedures include:

- Removing the patient from the cold environment.
- Keeping the patient dry.
- Replacing wet clothing.
- Applying external heat to both sides of the patient using whatever heat is available. This can include the body heat of the rescuers.
- Keeping the patient in a warm environment.
- Monitoring core temperature, respiration, and pulse.
- Transporting the patient quickly and carefully to a medical facility.

Active re-warming needs to be added for patients with body temperatures at or below 92°F or 34°C. Active external re-warming procedures include placing the patient in bath water of 105-110°F or 40-42°C.

Frostbite and Related Cold Injuries

Frostbite involves the freezing of tissues. Ice crystals form in or on the tissue leading to damage. Skin and muscle are considerably more susceptible to freezing damage than tendons and bones, which explains why the patient may still be able to move severely frostbitten digits.

Frostbite is caused by cold exposure and its effects can be magnified by moisture or wind. For example, the chilling effects on skin are the same with an air temperature of 20°F (-7°C) and a 30-mile (48 km/h) per hour wind as with an air temperature of 0°F (-18°C) and only a 2-mile per hour (3 km/h) wind. Skin contact with metal or any solvent such as gasoline in very cold weather can cause virtually instantaneous freezing. Skin will often stick to metal and be lost. The risk of frostbite is increased by generalized hypothermia, which decreases skin blood flow as part of the mechanism for preservation of core body temperature. Two related injuries, trench foot and immersion foot, involve prolonged exposure to wet cold above freezing temperatures (for example 50°F or 10°C). The resulting tissue damage is produced by ischemia.

Children are at greater risk for frostbite than adults because their skin is thinner and less weathered. Also, children lose heat from the skin more rapidly.

Degrees of Frostbite

Frostbite can not be definitively classified until after re-warming has been performed. Once the affected part(s) has/have been re-warmed, frostbite injuries are defined as follows:

- **First-degree** characteristics are redness and swelling without skin breakdown.
- **Second-degree** characteristics are large, clear blister formation accompanies the edema with partial-thickness skin loss.
- **Third-degree** characteristics are full-thickness skin and fatty tissue destruction occurs commonly with hemorrhagic vesicle formation.
- **Fourth-degree** characteristics are full-thickness skin destruction including muscle and bone with gangrene.



Blisters typically occur after re-warming. Initial appearance would be white and not blanching.

Types of Frostbite

There are several types of frostbite and related local cold injuries. They are as follows:

Frost Nip

A transient blanching and numbness of exposed parts that may progress to frostbite if not immediately detected and treated. It often appears on the tips of fingers, ears, nose, chin or cheeks and does not lead to skin loss if re-warmed.

Superficial Frostbite

Only the skin and fat below the skin are frozen. Tissues beneath the skin are still compressible with pressure.

Deep Frostbite

Skin, fat, and underlying tissue (like muscle) are all frozen. The extremity or body part has a hard “woodlike” feeling. Likely a third- or fourth-degree injury.

Cold Immersion

This describes a nonfreezing injury of the hands or feet, typically in soldiers, sailors or fishermen, resulting from chronic exposure to wet conditions and temperatures just above freezing, (i.e. 35°F to 50°F or 2°C to 10°C). Although the entire foot may appear black, deep tissue destruction may not be present. The damage may turn out to be skin alone after re-warming.

Chilbain or Pernio

This is mainly a skin manifestation of chronic repetitive damp cold exposure, as might occur in fishermen, or chronic dry cold exposure, as might occur with mountain climbers. It typically occurs on the face, skin, back of hands and feet and areas poorly protected or chronically exposed to the environment. It is characterized by itching and red-purple skin lesions. With continued exposure, skin ulcers appear and progress to scarring with itching replaced by tenderness and pain.

Risk Factors for Frostbite

- Extremes of age.
- Homelessness.
- Immobilization.
- Exposed skin in harsh conditions.
- Exposure to water or dampness.
- Working outdoors in the cold.
- Outdoor winter activities.
- Inadequate or tight-fitting clothes.
- Fatigue.
- Altered mental status.

- Use of nicotine or other vasoconstriction drugs.
- Mountain climbing.
- High altitudes.
- Previous cold injury.

Symptoms of Frostbite

Frostbite of varying degrees looks quite similar when first seen. The magnitude of damage becomes evident with re-warming and time to demarcation. The following are some of the classic signs and symptoms:

- Reddened, blue or pale cold skin.
- Puckering and painful with superficial frostbite.
- Blistering.
- Painless, numb with white waxy appearance with deep frostbite.
- Gangrene with prolonged exposure.

The most common locations for frostbite to occur include:

- Hands.
- Feet.
- Skin.
- Cheeks.
- Nose.
- Ears.
- Corneas.

Initial Assessment and Management of Frostbite

While the affected body part is initially nearly always hard, cold, white and anesthetic, the appearance of the lesion changes frequently during the course of treatment. Additionally, the initial treatment regimen is applicable for all degrees of injury, and the initial classification is often not prognostically accurate. The degrees of damage are comparable to the degrees of burn injury, as opposed to a burn. However, the final degree of tissue destruction is usually less with cold injuries than initial findings indicate. Some of the initially damaged tissue recovers whereas with a burn, what you might see initially usually gets worse over time.

Treatment of Frostbite

The prognosis for a superficial frostbite injury is excellent, if appropriate treatment is provided. Favorable prognostic signs include early sensation to a pinprick, healthy appearing skin color and clear rather than blood-filled blebs. Some tissue loss is likely with deep frostbite. Poor prognostic signs include cyanosis (blue-gray color), bloody blebs or blisters that do not extend to tips of digits and a frozen appearance.

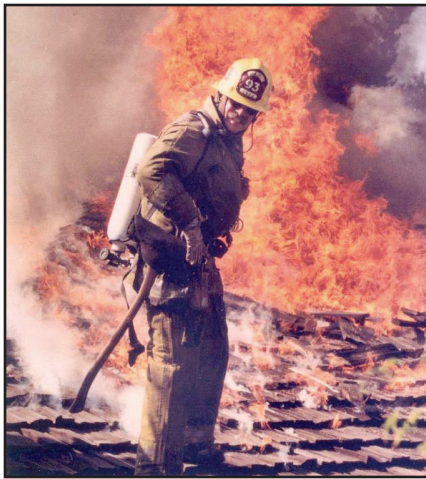
The following procedure should be used to treat frostbite:

- Remove the patient from the cold environment.
- Manage the ABCs.
- Look for other injuries or illness.
- Begin to treat any hypothermia.
- Remove damp or constricting clothing and replace with loose garments.
- Avoid rubbing the affected area with warm hands or snow, as this can cause further injury.
- Avoid applying pressure to the frostbitten area.
- Cover blisters and injured areas with a soft dressing.
- If the affected body part is an extremity, wrap it in a blanket for mechanical protection during transport.
- Avoid any medication which can enhance heat loss and impair shivering.
- In the absence of a life-threatening problem, such as severe hypothermia, it is better to walk with frozen feet to a safe environment than attempting to re-warm in a cold environment. Once removed from the cold, elevate the injured area to reduce any developing swelling.
- During long transport (60 minutes) in a warm air environment:
 - Begin to re-warm by immersion of the frostbitten area in water 100-105°F (38-41 C°).
 - Do not use dry heat as the risk of compounding the injury is great with any method of thawing other than immersion in warm water.
 - Process of re-warming may take 30-45 minutes.
 - Return of color and sensation indicates thawing.
 - Once thawed, the patient cannot walk on cold, injured feet.
 - Elevate the injured area.

No attempt should be made to re-warm the frostbitten area in a cold environment. Do not attempt any re-warming if there is a danger of re-freezing.

Conclusion

First responders who work in areas susceptible to cold temperatures must be familiar with the signs of hypothermia and local cold injuries and the appropriate treatments when they are encountered. With appropriate treatment, the recovery from these injuries is likely to be successful.



Heat Emergencies

Section 10

Heat-related illnesses are often preventable and certainly treatable conditions. However, they have significant consequences, including death, if not prevented and left untreated. The illnesses are traditionally divided into two main categories: *heat exhaustion* and *heat stroke*. These conditions can overlap and exist on a continuum of severity. As a patient's body temperature rises, heat exhaustion can rapidly progress to heat stroke.

Normally, a human's body temperature is maintained at around 98.6°F (37.5°C). Excess heat is dissipated, avoiding body temperature from rising excessively. However, just as *hypothermia* is dangerous, so is any significant increase in body temperature above normal. This elevated temperature is known as *hyperthermia*. A temperature exceeding 104°F (40°C) can damage internal tissues, especially in the brain, and also lead to liver and kidney damage and muscle breakdown.

Types of Heat-Related Illnesses

There are several types of heat-related illnesses with which Fire Fighters and medical personnel must be familiar.

Heat Exhaustion

Heat exhaustion is a milder form of heat-related illness that can develop after short periods of physical exertion in high temperatures or even after several days of simple exposure to high temperatures and inadequate or unbalanced replacement of fluids. Those most prone to heat exhaustion are elderly people, people with high blood pressure, and people working or exercising in a hot environment. Symptoms may include weakness, headache, or nausea.

Heat Stroke

Heat stroke occurs when the body is unable to regulate its own temperature. The body temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. The body's temperature may rise to 106°F (40°C) or higher within 10 to 15 minutes. Heat stroke can cause death or permanent disability, especially if emergency treatment is not provided.

Exertion Heat Stroke

Exertion heat stroke occurs when someone is usually exercising in excessively warm conditions. The body cannot manage the heat produced by the physical activity and the hot environment together.

Classic or Sedentary Heat Stroke

This form of heat stroke is often seen in the elderly or debilitated people who are in warm environments for too long. The elderly are especially vulnerable to the heat, as the body is less and less able to handle heat as it ages. Elderly people may also take medications that impair heat release. Epidemics of heat stroke in elderly people can be predicted when the ambient temperature surpasses 90°F (32°C) and the relative humidity reaches 50 to 76 percent.

Other Heat-Related Disorders

Persons with any of these symptoms should be examined further for signs of more serious heat injury.

- **Heat syncope** occurs when a person overheats and then faints.
- **Heat edema** is characterized by swelling in the arms and legs because of the heat.
- **Prickly heat** is a rash that is red and very itchy.

Heat Cramps

Heat cramps usually affect people who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture. The low salt level in the muscles causes painful cramps. Heat cramps may also be a symptom of heat exhaustion.

Risk Factors for Heat-Related Illnesses

The locations and situations in which an excessive body temperature can occur include:

- Hot environment.
- Intense exercise.
- Illness.
- Taking certain medications.
- Any combination of the above.

Symptoms of Heat-Related Illnesses

There are a variety of symptoms associated with heat-related illnesses. Heat exhaustion patients may have complaints of symptoms that come on slowly. On the other hand, the transition from heat exhaustion to heat stroke can occur quickly.

Signs and Symptoms of Heat Exhaustion

- Headache.
- Weakness.
- Light-headedness.
- Muscle aches.
- Muscle cramps.
- Agitation.

Signs and Symptoms of Heat Stroke

- Symptoms of heat exhaustion, plus:
 - Confusion, hallucinations.
 - Bizarre behavior.
 - Seizure.
 - Coma.
 - Lack of sweating (a late condition).
 - Shortness of breath.

Heat stroke can be diagnosed by Fire Fighters or other medical personnel by recognizing any of the following indicators:

- The person experiences sudden disorientation while in a hot environment.
- The onset is sometimes preceded by dizziness, headache, nausea, and chills.
- Often there is no warning except weakness.
- The skin is pink or ashen; it may also appear dry in the presence of fever.
- In athletes or other people in very good physical condition, profuse sweating may precede the deterioration.
- The patient's body temperature (measured rectally) is usually above 104°F (40°C).
- The heart rate may be 140 to 170 beats per minute.
- The blood pressure is variable.
- Shortness of breath with rapid respiratory rate is common.

Initial Assessment and Management of Heat-Related Illnesses

Proper initial assessment and patient management are crucial to minimizing heat-related illnesses and preventing heat exhaustion from transitioning to heat stroke. The first step is to remove the person from the hot environment or have the person stop any physical activity. If the patient has additional trauma (accident, fall, fight, etc.) standard stabilization measures are required before moving the patient. Provide oxygen to the patient and perform the following measures to check the patient's ABCs:

Airway

The airway may be compromised if the patient is unconscious.

- Restore and maintain the airway per local protocols.
- If the patient is vomiting, protect the airway by turning the victim on his or her side and use suction equipment, if available.

Breathing

The patient's breathing will likely be rapid.

- Remove any constrictive clothing.
- Assist breathing as indicated.

Circulation

- Remove constricting clothing.
- Assess vital signs.
- Initiate CPR if needed, as indicated per protocol.

Disability

Assess the patient's level of consciousness using the AVPU system:

A – alert

V – responds only to verbal command

P – responds only to pain

U – unresponsive

Sometimes a victim's muscles will begin to twitch uncontrollably as a result of heat stroke. If this happens, keep the victim from injuring himself, but do not place any object in the mouth and do not give fluids.

Treatment of Heat-Related Illnesses

When encountering a possible heat-injury patient, the same basic steps will begin the treatment process, regardless of the magnitude of the injury. The first thing to do is to have the patient stop any physical activity and move the person to a cooler place. Prioritize and treat any other noticed major injuries first. Obtain the patient's body temperature to determine the magnitude of his or her fever. The rectal temperature is the most reliable.

If the patient is alert and absent of other injuries, provide him or her with cool (not very cold) water, clear juice or sports beverage to drink. Do not allow the patient to return to strenuous activity for a few hours after the cramps subside, temperature is normal and the person is rehydrated because further exertion may lead to heat exhaustion or heat stroke.

Seek further medical attention for heat cramps if they do not subside in 1 hour.

Special Conditions for Treating Heat Exhaustion

Use the following measures for treating a patient suspected of suffering from heat exhaustion:

- Remove heavy or constricting clothing.
- Stop all activity and move the person to a cool place.
- Provide cool water, juice or sports drink if there are no other injuries and the patient is alert and not vomiting.
- Cool the patient's body:
 - Use a cool water spray on skin.
 - Put the person in a cool shower, if available and the patient is alert with no other injuries.
 - Wrap in cool wet sheet.
- Transport the person to the nearest appropriate facility if the:
 - Patient is elderly and/or chronically ill.
 - Symptoms are severe.
 - Patient has a history of heart problems or high blood pressure.

Special Conditions for Treating Heat Stroke

Use the following measures for treating a patient suspected of suffering from heat stroke:

- Remove the victim from the heat (after trauma assessment).
- Cool the victim rapidly using whatever methods you can. For example, immerse in a tub of cool water, spray with cool water, sponge with cool water; if humidity is low, wrap the victim with a cool wet sheet and fan him/her vigorously.
- Monitor the patient's body temperature and continue cooling efforts until the body temperature drops to 101-102°F (38-39°C).
- **Do not** give the victim fluid to drink as vomiting and a mental status ranging from disorientation to coma are likely present.
- Start an IV per local protocols.
- Transport to nearest appropriate facility ASAP.

Prognosis for Heat-Injury Patients

Bad prognostic signs for injury patient's are a body temperature of 106°F (42°C) or more, a coma lasting over two hours or shock occurring during the first 24 hours. The death rate is about 10 percent in patients who are correctly diagnosed and treated promptly. Deaths in the first few days are usually due to cerebral damage; later deaths may be from bleeding or due to cardiac, renal or hepatic failure.

Conclusion

Fire Fighters should be particularly alert for signs of heat-related illnesses, as they are common among fire fighters themselves. The heavy exertion performed by Fire Fighters, wearing heavy clothing and equipment often in heat environments, makes them highly susceptible to these types of injuries. Proper recognition of these hazards and simple preventive measures can reduce the risk of these injuries. Aggressive treatment can lessen their effects when they do occur.



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