

= Burn =

A burn is a type of injury to skin , or other tissues , caused by heat , cold , electricity , chemicals , friction , or radiation . Most burns are due to heat from hot liquids , solids , or fire . Among women in many areas of the world the risk is related to the use of open cooking fires or unsafe cook stoves . Alcoholism and smoking are other risk factors . Burns can also occur as a result of self harm or violence between people .

Burns that affect only the superficial skin layers are known as superficial or first @-@ degree burns . They appear red without blisters and pain typically lasts around three days . When the injury extends into some of the underlying skin layer , it is a partial @-@ thickness or second @-@ degree burn . Blisters are frequently present and they are often very painful . Healing can require up to eight weeks and scarring may occur . In a full @-@ thickness or third @-@ degree burn , the injury extends to all layers of the skin . Often there is no pain and the burn area is stiff . Healing typically does not occur on its own . A fourth @-@ degree burn additionally involves injury to deeper tissues , such as muscle , tendons , or bone . The burn is often black and frequently leads to loss of the burned part .

Burns are generally preventable . Treatment depends on the severity of the burn . Superficial burns may be managed with little more than simple pain medication , while major burns may require prolonged treatment in specialized burn centers . Cooling with tap water may help pain and decrease damage ; however , prolonged cooling may result in low body temperature . Partial @-@ thickness burns may require cleaning with soap and water , followed by dressings . It is not clear how to manage blisters , but it is probably reasonable to leave them intact if small and drain them if large . Full @-@ thickness burns usually require surgical treatments , such as skin grafting . Extensive burns often require large amounts of intravenous fluid , due to capillary fluid leakage and tissue swelling . The most common complications of burns involve infection . Tetanus toxoid should be given if not up to date .

In 2013 , fire and heat resulted in 35 million injuries . This resulted in about 2 @.@ 9 million hospitalizations and 238 @,@ 000 dying . Most deaths due to burns occur in the developing world , particularly in Southeast Asia . While large burns can be fatal , treatments developed since 1960 have improved outcomes , especially in children and young adults . In the United States , approximately 96 % of those admitted to a burn center survive their injuries . Burns occur at similar frequencies in men and women . The long @-@ term outcome is related to the size of burn and the age of the person affected .

= = Signs and symptoms = =

The characteristics of a burn depend upon its depth . Superficial burns cause pain lasting two or three days , followed by peeling of the skin over the next few days . Individuals suffering from more severe burns may indicate discomfort or complain of feeling pressure rather than pain . Full @-@ thickness burns may be entirely insensitive to light touch or puncture . While superficial burns are typically red in color , severe burns may be pink , white or black . Burns around the mouth or singed hair inside the nose may indicate that burns to the airways have occurred , but these findings are not definitive . More worrisome signs include : shortness of breath , hoarseness , and stridor or wheezing . Itchiness is common during the healing process , occurring in up to 90 % of adults and nearly all children . Numbness or tingling may persist for a prolonged period of time after an electrical injury . Burns may also produce emotional and psychological distress .

= = Cause = =

Burns are caused by a variety of external sources classified as thermal (heat @-@ related) , chemical , electrical , and radiation . In the United States , the most common causes of burns are : fire or flame (44 %) , scalds (33 %) , hot objects (9 %) , electricity (4 %) , and chemicals (3 %) . Most (69 %) burn injuries occur at home or at work (9 %) , and most are accidental , with 2 %

due to assault by another , and 1 @-@ 2 % resulting from a suicide attempt . These sources can cause inhalation injury to the airway and / or lungs , occurring in about 6 % .

Burn injuries occur more commonly among the poor . Smoking is a risk factor , although alcohol use is not . Fire @-@ related burns are generally more common in colder climates . Specific risk factors in the developing world include cooking with open fires or on the floor as well as developmental disabilities in children and chronic diseases in adults .

= = = Thermal = = =

In the United States , fire and hot liquids are the most common causes of burns . Of house fires that result in death , smoking causes 25 % and heating devices cause 22 % . Almost half of injuries are due to efforts to fight a fire . Scalding is caused by hot liquids or gases and most commonly occurs from exposure to hot drinks , high temperature tap water in baths or showers , hot cooking oil , or steam . Scald injuries are most common in children under the age of five and , in the United States and Australia , this population makes up about two @-@ thirds of all burns . Contact with hot objects is the cause of about 20 @-@ 30 % of burns in children . Generally , scalds are first- or second @-@ degree burns , but third @-@ degree burns may also result , especially with prolonged contact . Fireworks are a common cause of burns during holiday seasons in many countries . This is a particular risk for adolescent males .

= = = Chemical = = =

Chemicals cause from 2 to 11 % of all burns and contribute to as many as 30 % of burn @-@ related deaths . Chemical burns can be caused by over 25 @,@ 000 substances , most of which are either a strong base (55 %) or a strong acid (26 %) . Most chemical burn deaths are secondary to ingestion . Common agents include : sulfuric acid as found in toilet cleaners , sodium hypochlorite as found in bleach , and halogenated hydrocarbons as found in paint remover , among others . Hydrofluoric acid can cause particularly deep burns that may not become symptomatic until some time after exposure . Formic acid may cause the breakdown of significant numbers of red blood cells .

= = = Electrical = = =

Electrical burns or injuries are classified as high voltage (greater than or equal to 1000 volts) , low voltage (less than 1000 volts) , or as flash burns secondary to an electric arc . The most common causes of electrical burns in children are electrical cords (60 %) followed by electrical outlets (14 %) . Lightning may also result in electrical burns . Risk factors for being struck include involvement in outdoor activities such as mountain climbing , golf and field sports , and working outside . Mortality from a lightning strike is about 10 % .

While electrical injuries primarily result in burns , they may also cause fractures or dislocations secondary to blunt force trauma or muscle contractions . In high voltage injuries , most damage may occur internally and thus the extent of the injury cannot be judged by examination of the skin alone . Contact with either low voltage or high voltage may produce cardiac arrhythmias or cardiac arrest .

= = = Radiation = = =

Radiation burns may be caused by protracted exposure to ultraviolet light (such as from the sun , tanning booths or arc welding) or from ionizing radiation (such as from radiation therapy , X @-@ rays or radioactive fallout) . Sun exposure is the most common cause of radiation burns and the most common cause of superficial burns overall . There is significant variation in how easily people sunburn based on their skin type . Skin effects from ionizing radiation depend on the amount of exposure to the area , with hair loss seen after 3 Gy , redness seen after 10 Gy , wet skin peeling after 20 Gy , and necrosis after 30 Gy . Redness , if it occurs , may not appear until some time after

exposure . Radiation burns are treated the same as other burns . Microwave burns occur via thermal heating caused by the microwaves . While exposures as short as two seconds may cause injury , overall this is an uncommon occurrence .

== Non accidental ==

In those hospitalized from scalds or fire burns , 3 ? 10 % are from assault . Reasons include : child abuse , personal disputes , spousal abuse , elder abuse , and business disputes . An immersion injury or immersion scald may indicate child abuse . It is created when an extremity or the lower body (buttock or perineum) is held under the surface of hot water . It typically produces a sharp upper border and is often symmetrical . Other high @-@ risk signs of potential abuse include : circumferential burns , the absence of splash marks , a burn of uniform depth , and association with other signs of neglect or abuse .

Bride burning , a form of domestic violence , occurs in some cultures , such as India where women have been burned in revenge for what the husband or his family consider an inadequate dowry . In Pakistan , acid burns represent 13 % of intentional burns , and are frequently related to domestic violence . Self @-@ immolation (setting oneself on fire) is also used as a form of protest in various parts of the world .

== Pathophysiology ==

At temperatures greater than 44 ° C (111 ° F) , proteins begin losing their three @-@ dimensional shape and start breaking down . This results in cell and tissue damage . Many of the direct health effects of a burn are secondary to disruption in the normal functioning of the skin . They include disruption of the skin 's sensation , ability to prevent water loss through evaporation , and ability to control body temperature . Disruption of cell membranes causes cells to lose potassium to the spaces outside the cell and to take up water and sodium .

In large burns (over 30 % of the total body surface area) , there is a significant inflammatory response . This results in increased leakage of fluid from the capillaries , and subsequent tissue edema . This causes overall blood volume loss , with the remaining blood suffering significant plasma loss , making the blood more concentrated . Poor blood flow to organs such as the kidneys and gastrointestinal tract may result in renal failure and stomach ulcers .

Increased levels of catecholamines and cortisol can cause a hypermetabolic state that can last for years . This is associated with increased cardiac output , metabolism , a fast heart rate , and poor immune function .

== Diagnosis ==

Burns can be classified by depth , mechanism of injury , extent , and associated injuries . The most commonly used classification is based on the depth of injury . The depth of a burn is usually determined via examination , although a biopsy may also be used . It may be difficult to accurately determine the depth of a burn on a single examination and repeated examinations over a few days may be necessary . In those who have a headache or are dizzy and have a fire @-@ related burn , carbon monoxide poisoning should be considered . Cyanide poisoning should also be considered .

== Size ==

The size of a burn is measured as a percentage of total body surface area (TBSA) affected by partial thickness or full thickness burns . First @-@ degree burns that are only red in color and are not blistering are not included in this estimation . Most burns (70 %) involve less than 10 % of the TBSA .

There are a number of methods to determine the TBSA , including the Wallace rule of nines , Lund and Browder chart , and estimations based on a person 's palm size . The rule of nines is easy to

remember but only accurate in people over 16 years of age . More accurate estimates can be made using Lund and Browder charts , which take into account the different proportions of body parts in adults and children . The size of a person 's handprint (including the palm and fingers) is approximately 1 % of their TBSA .

= = = Severity = = =

To determine the need for referral to a specialized burn unit , the American Burn Association devised a classification system . Under this system , burns can be classified as major , moderate and minor . This is assessed based on a number of factors , including total body surface area affected , the involvement of specific anatomical zones , the age of the person , and associated injuries . Minor burns can typically be managed at home , moderate burns are often managed in hospital , and major burns are managed by a burn center .

= = Prevention = =

Historically , about half of all burns were deemed preventable . Burn prevention programs have significantly decreased rates of serious burns . Preventive measures include : limiting hot water temperatures , smoke alarms , sprinkler systems , proper construction of buildings , and fire @-@ resistant clothing . Experts recommend setting water heaters below 48 @.@ 8 ° C (119 @.@ 8 ° F) . Other measures to prevent scalds include using a thermometer to measure bath water temperatures , and splash guards on stoves . While the effect of the regulation of fireworks is unclear , there is tentative evidence of benefit with recommendations including the limitation of the sale of fireworks to children .

= = Management = =

Resuscitation begins with the assessment and stabilization of the person 's airway , breathing and circulation . If inhalation injury is suspected , early intubation may be required . This is followed by care of the burn wound itself . People with extensive burns may be wrapped in clean sheets until they arrive at a hospital . As burn wounds are prone to infection , a tetanus booster shot should be given if an individual has not been immunized within the last five years . In the United States , 95 % of burns that present to the emergency department are treated and discharged ; 5 % require hospital admission . With major burns , early feeding is important . Hyperbaric oxygenation may be useful in addition to traditional treatments .

= = = Intravenous fluids = = =

In those with poor tissue perfusion , boluses of isotonic crystalloid solution should be given . In children with more than 10 @-@ 20 % TBSA burns , and adults with more than 15 % TBSA burns , formal fluid resuscitation and monitoring should follow . This should be begun pre @-@ hospital if possible in those with burns greater than 25 % TBSA . The Parkland formula can help determine the volume of intravenous fluids required over the first 24 hours . The formula is based on the affected individual 's TBSA and weight . Half of the fluid is administered over the first 8 hours , and the remainder over the following 16 hours . The time is calculated from when the burn occurred , and not from the time that fluid resuscitation began . Children require additional maintenance fluid that includes glucose . Additionally , those with inhalation injuries require more fluid . While inadequate fluid resuscitation may cause problems , over @-@ resuscitation can also be detrimental . The formulas are only a guide , with infusions ideally tailored to a urinary output of > 30 mL / h in adults or > 1mL / kg in children and mean arterial pressure greater than 60 mmHg .

While lactated Ringer 's solution is often used , there is no evidence that it is superior to normal saline . Crystalloid fluids appear just as good as colloid fluids , and as colloids are more expensive they are not recommended . Blood transfusions are rarely required . They are typically only

recommended when the hemoglobin level falls below 60 @-@ 80 g / L (6 @-@ 8 g / dL) due to the associated risk of complications . Intravenous catheters may be placed through burned skin if needed or intraosseous infusions may be used .

== Wound care ==

Early cooling (within 30 minutes of the burn) reduces burn depth and pain , but care must be taken as over @-@ cooling can result in hypothermia . It should be performed with cool water 10 ? 25 ° C (50 @-@ 0 ? 77 @-@ 0 ° F) and not ice water as the latter can cause further injury . Chemical burns may require extensive irrigation . Cleaning with soap and water , removal of dead tissue , and application of dressings are important aspects of wound care . If intact blisters are present , it is not clear what should be done with them . Some tentative evidence supports leaving them intact . Second @-@ degree burns should be re @-@ evaluated after two days .

In the management of first and second @-@ degree burns , little quality evidence exists to determine which dressing type to use . It is reasonable to manage first @-@ degree burns without dressings . While topical antibiotics are often recommended , there is little evidence to support their use . Silver sulfadiazine (a type of antibiotic) is not recommended as it potentially prolongs healing time . There is insufficient evidence to support the use of dressings containing silver or negative @-@ pressure wound therapy .

== Medications ==

Burns can be very painful and a number of different options may be used for pain management . These include simple analgesics (such as ibuprofen and acetaminophen) and opioids such as morphine . Benzodiazepines may be used in addition to analgesics to help with anxiety . During the healing process , antihistamines , massage , or transcutaneous nerve stimulation may be used to aid with itching . Antihistamines , however , are only effective for this purpose in 20 % of people . There is tentative evidence supporting the use of gabapentin and its use may be reasonable in those who do not improve with antihistamines . Intravenous lidocaine requires more study before it can be recommended for pain .

Intravenous antibiotics are recommended before surgery for those with extensive burns (> 60 % TBSA) . As of 2008 , guidelines do not recommend their general use due to concerns regarding antibiotic resistance and the increased risk of fungal infections . Tentative evidence , however , shows that they may improve survival rates in those with large and severe burns . Erythropoietin has not been found effective to prevent or treat anemia in burn cases . In burns caused by hydrofluoric acid , calcium gluconate is a specific antidote and may be used intravenously and / or topically . Recombinant human growth hormone (rhGH) in those with burns that involve more than 40 % of their body appears to speed healing without affecting the risk of death .

== Surgery ==

Wounds requiring surgical closure with skin grafts or flaps (typically anything more than a small full thickness burn) should be dealt with as early as possible . Circumferential burns of the limbs or chest may need urgent surgical release of the skin , known as an escharotomy . This is done to treat or prevent problems with distal circulation , or ventilation . It is uncertain if it is useful for neck or digit burns . Fasciotomies may be required for electrical burns .

== Alternative medicine ==

Honey has been used since ancient times to aid wound healing and may be beneficial in first- and second @-@ degree burns . There is tentative evidence that honey helps heal partial thickness burns . The evidence for aloe vera is of poor quality . While it might be beneficial in reducing pain , and a review from 2007 found tentative evidence of improved healing times a subsequent review

from 2012 did not find improved healing over silver sulfadiazine . There were only three randomized controlled trials for the use of plants for burns , two for aloe vera and one for oatmeal .

There is little evidence that vitamin E helps with keloids or scarring . Butter is not recommended . In low income countries , burns are treated up to one @-@ third of the time with traditional medicine , which may include applications of eggs , mud , leaves or cow dung . Surgical management is limited in some cases due to insufficient financial resources and availability . There are a number of other methods that may be used in addition to medications to reduce procedural pain and anxiety including : virtual reality therapy , hypnosis , and behavioral approaches such as distraction techniques .

= = Prognosis = =

The prognosis is worse in those with larger burns , those who are older , and those who are females . The presence of a smoke inhalation injury , other significant injuries such as long bone fractures , and serious co @-@ morbidities (e.g. heart disease , diabetes , psychiatric illness , and suicidal intent) also influence prognosis . On average , of those admitted to United States burn centers , 4 % die , with the outcome for individuals dependent on the extent of the burn injury . For example , admittees with burn areas less than 10 % TBSA had a mortality rate of less than 1 % , while admittees with over 90 % TBSA had a mortality rate of 85 % . In Afghanistan , people with more than 60 % TBSA burns rarely survive . The Baux score has historically been used to determine prognosis of major burns . However , with improved care , it is no longer very accurate . The score is determined by adding the size of the burn (% TBSA) to the age of the person , and taking that to be more or less equal to the risk of death . Burns in 2013 resulted in 1 @.@ 2 million years lived with disability and 12 @.@ 3 million disability adjusted life years .

= = Complications = =

A number of complications may occur , with infections being the most common . In order of frequency , potential complications include : pneumonia , cellulitis , urinary tract infections and respiratory failure . Risk factors for infection include : burns of more than 30 % TBSA , full @-@ thickness burns , extremes of age (young or old) , or burns involving the legs or perineum . Pneumonia occurs particularly commonly in those with inhalation injuries .

Anemia secondary to full thickness burns of greater than 10 % TBSA is common . Electrical burns may lead to compartment syndrome or rhabdomyolysis due to muscle breakdown . Blood clotting in the veins of the legs is estimated to occur in 6 to 25 % of people . The hypermetabolic state that may persist for years after a major burn can result in a decrease in bone density and a loss of muscle mass . Keloids may form subsequent to a burn , particularly in those who are young and dark skinned . Following a burn , children may have significant psychological trauma and experience post @-@ traumatic stress disorder . Scarring may also result in a disturbance in body image . In the developing world , significant burns may result in social isolation , extreme poverty and child abandonment .

= = Epidemiology = =

In 2013 fire and heat resulted in 35 million injuries . This resulted in about 2 @.@ 9 million hospitalizations and 238 @,@ 000 dying . This is down from 300 @,@ 000 deaths in 1990 . This makes it the 4th leading cause of injuries after motor vehicle collisions , falls , and violence . About 90 % of burns occur in the developing world . This has been attributed partly to overcrowding and an unsafe cooking situation . Overall , nearly 60 % of fatal burns occur in Southeast Asia with a rate of 11 @.@ 6 per 100 @,@ 000 . The number of fatal burns has increased from 280 @,@ 000 in 1990 to 338 @,@ 000 in 2010 .

In the developed world , adult males have twice the mortality as females from burns . This is most probably due to their higher risk occupations and greater risk @-@ taking activities . In many

countries in the developing world , however , females have twice the risk of males . This is often related to accidents in the kitchen or domestic violence . In children , deaths from burns occur at more than ten times the rate in the developing than the developed world . Overall , in children it is one of the top fifteen leading causes of death . From the 1980s to 2004 , many countries have seen both a decrease in the rates of fatal burns and in burns generally .

= = = Developed countries = = =

An estimated 500 @, @ 000 burn injuries receive medical treatment yearly in the United States . They resulted in about 3 @, @ 300 deaths in 2008 . Most burns (70 %) and deaths from burns occur in males . The highest incidence of fire burns occurs in those 18 ? 35 years old , while the highest incidence of scalds occurs in children less than five years old and adults over 65 . Electrical burns result in about 1 @, @ 000 deaths per year . Lightning results in the death of about 60 people a year . In Europe , intentional burns occur most commonly in middle aged men .

= = = Developing countries = = =

In India , about 700 @, @ 000 to 800 @, @ 000 people per year sustain significant burns , though very few are looked after in specialist burn units . The highest rates occur in women 16 ? 35 years of age . Part of this high rate is related to unsafe kitchens and loose @-@ fitting clothing typical to India . It is estimated that one @-@ third of all burns in India are due to clothing catching fire from open flames . Intentional burns are also a common cause and occur at high rates in young women , secondary to domestic violence and self @-@ harm .

= = History = =

Cave paintings from more than 3 @, @ 500 years ago document burns and their management . The earliest Egyptian records on treating burns describes dressings prepared with milk from mothers of baby boys , and the 1500 BCE Edwin Smith Papyrus describes treatments using honey and the salve of resin . Many other treatments have been used over the ages , including the use of tea leaves by the Chinese documented to 600 BCE , pig fat and vinegar by Hippocrates documented to 400 BCE , and wine and myrrh by Celsus documented to 100 CE . French barber @-@ surgeon Ambroise Paré was the first to describe different degrees of burns in the 1500s . Guillaume Dupuytren expanded these degrees into six different severities in 1832 .

The first hospital to treat burns opened in 1843 in London , England and the development of modern burn care began in the late 1800s and early 1900s . During World War I , Henry D. Dakin and Alexis Carrel developed standards for the cleaning and disinfecting of burns and wounds using sodium hypochlorite solutions , which significantly reduced mortality . In the 1940s , the importance of early excision and skin grafting was acknowledged , and around the same time , fluid resuscitation and formulas to guide it were developed . In the 1970s , researchers demonstrated the significance of the hypermetabolic state that follows large burns .