Burn Surgery: Restoring Life to Burn Victims

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With motor vehicle accidents being the leading cause of death in the United States, burn/thermal injuries that require medical treatment affect more than 486,000 people each year.[1] More than 40,000 of these patients require admittance to the hospital, including 30,000 who are admitted to burn centers. The survival rate of thermal injuries has increased to 96.7% over the past four decades as a result of an aggressive multidisciplinary approach to care.[5]

PATHOLOGY

The need for surgical intervention/debridement depends on the depth of the injury. Burn depths can be categorized in three areas: superficial (first degree), partial thickness (second degree) and full thickness (third degree). A patient with full thickness injuries has destroyed all of the dermal elements causing the injured area unable to regenerate skin. Partial thickness injuries have some cell survival in the dermal elements, and have a better chance at repopulating skin.

Local Response

The three zones of a burn are zone coagulation, zone of stasis and zone of hyperaemia. Zone coagulation occurs at the point of the maximum damage, where there is irreversible tissue loss. Zone of stasis is the surrounding area characterized by decreased tissue perfusion and can potentially be salvageable. Zone of hyperaemia is the outermost zone

LEARNING OBJECTIVES

- List the categories of burn depths
- Recall the three zones of a burn
- Examine the role the surgical technologist plays throughout burn surgeries
- Review the steps of skin grafting in relation to burn procedures
- Read about what steps and support it takes to help a patient recover from a burn injury

where tissue has an increased perfusion and likely will recover unless severe sepsis is involved.[3]

Systemic Response

If the total body surface area burned reaches greater than 30%, the body will undergo systemic effects such as cardiovascular, respiratory, metabolic and immunological changes. If these systemic changes occur, the patient can face hypotension, bronchoconstriction and respiratory distress as well as reducing the body's immune response.

Mechanism of Injury

Burns can happen in many different ways, and each mechanism will cause a different reaction from the body. In children, 70% of burns are caused by scalding injuries, while 50% of burns in adults are caused by flame. Scald injuries tend to cause superficial or first-degree burns and flame burns tend to be full thickness or third-degree burns. Contact burns occur when the patient directly touches an object that is extremely hot, or contact with the surface was unusually long. These types of burns are noted in people with epilepsy, which alters their ability to feel the hot object. These burns tend to be deep dermal or full thickness. Electric and chemical injuries also can lead to burns and often are a result of trauma or industrial-related accidents.

Courtesy US Army

Lt Cmdr Christopher Burns, US Army Institute of Surgical Research Burn Center surgeon, center, prepares a wound for surgery, while Col Evan M Renz, burn center director, left, and Spc Dennis Ortiz, operating room surgical technologist, look on during the surgery procedure at the Burn Center OR at San Antonio Military Medical Center.

DIAGNOSTICS/PRE-OPERATIVE TESTS

The most common diagnostic test that will be performed with burn patients is the rule of nines. This helps the physician assess the percentage of burns and design a care plan based on that assessment. This assessment tool varies depending on if the patient is a child or an adult. Each burn patient will undergo a fever workup, including a CBC count, urinalysis and blood, urine and sputum cultures. These tests alert the physician if sepsis is present, and if any other underlying issues need to be addressed. Electrolytes often are monitored with large burns that require aggressive fluid resuscitation. A chest X-ray may be helpful, especially with patients who have suffered inhalation burns as well as skin burns. Burn wounds initially should be covered with dry sterile sheets, and a thorough history and physical examination should be obtained. It is important to keep the patient warm by infusing warm IV fluids and raising the room temperature. These interventions will help to ensure the patient's temperature is maintained.[5]

OPERATING ROOM PREPARATION

Along with the basic setup required for the surgery, the surgical technologist will ensure the room is warmed to an appropriate temperature for the surgical patient, paying close attention to the patients' age, current body temperature and burn percentage, which could alter the required room temperature. The surgical technologist will work closely with the circulating nurse, the patient's floor nurse, the surgeon and the anesthesiologist to determine an appropriate room temperature for the patient. On average, the operating room needs

A skin graft, that will help the skin heal, is placed over the burn site.

to be 85 to 100+ degrees for burn patients, due to the patient having their body exposed in large quantities.

The surgical team will prepare the operating room by placing a fluid warmer on the bed (when applicable) to help with body temperature maintenance, along with an underbody ESU pad. In many cases, patients do not have enough healthy skin remaining on their body to apply an ESU pad and retain a solid grounding contact, so the underbody ESU pad allows this to be omitted. In many procedures, the surgeon will utilize the tumescent administration technique prior to debriding and harvesting skin grafts, which requires the use of an infiltration pump hooked up to nitrogen. The team will need to hook up the machine and test it prior to bringing in the patient. The team also will need to have different positioning equipment available such as pillows, egg crate foam, a bean bag, gel chest rolls and an additional operating room table in case the patient needs to be both supine and prone in one procedure. The surgical team will need to maintain ample amounts of warm fluids close by for anesthesia to have access to throughout the procedure for those patients who need them.

Patients undergoing surgical intervention for burn/thermal injuries will acquire general anesthesia along with the

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INSTRUMENTATION

- Piercing towel clamps
- Hemostats
- Allis
- Currette
- Graft knife with weck blade (with assortment of guards)
- Campbell knife
- Needle holder (Plastic and 6″)
- Suture scissors
- Bandage scissors
- Curved Mayo scissors
- Adson c and c/o teeth
- #3 with 10 and 15 blades
- Dermatome(s)
- Mesher(s)
- Skin graft tray (simply a sterile metal tray to organize meshed grafts)

MEDICATIONS

- 0.25% or 0.5% bupivacaine hydrochloride with epinephrine (smaller burn/graft areas)
- Epinephrine (to add to normal saline irrigation)
- Tumescent - It involves subcutaneous infiltration of large volumes of tumescent fluid containing lidocaine (0.05% or 0.1%), saline, and epinephrine (1:1,000,000) to produce anesthesia, swelling, and firmness of targeted areas
- Fibrin Sealant
  - A sealer protein solution containing human fibrinogen and a synthetic fibrinolysis inhibitor that helps delay the premature breakdown of the clot at the site of application[2]
- Polymyxin ointment
- Mineral oil (for dermatome)
- Liquid adhesive

DRESSINGS

- Interface (coated in Polymyxin ointment)
- Petrolatum dressing gauze rolls
- Cotton bandages
- May need abd's, cotton, towel gauze and anti-sheer wound cover dressings and supplies for splints for some areas

common blood pressure, oxygen saturation and EKG monitoring. The more critical patients may require arterial/femoral lines or PICC lines to assist with the administration of multiple medications as well as blood products.

The required set up usually includes a minor plastic set up, incorporating dermatome(s) and mesher(s). Although not every case requires the same instrumentation, often, a patient will need an emergency fasciotomy or silo procedure or a tracheostomy, so it is advised that the surgical technologist has additional equipment/instruments on standby.

The surgical technologist will need to prepare the back table and Mayo stand, along with draping out a fluid warmer to account for copious amounts of irrigation. In many cases, surgeons prefer to have epinephrine added to the normal saline irrigation to help with hemostasis throughout the procedure. The surgical technologist will need to have an abundance of lap sponges, as they are one of the most common supplies used in burn surgeries. Along with laps, gauze bandage rolls and ace wraps also are used to help apply pressure to the epinephrine-soaked sponge for hemostasis. Most skin or tissue grafts are adhered with staples and, depending on the site, possibly chromic suture. Prior to the start of the case, the surgical technologist will need to make sure their dermatome(s) and mesher(s) are working appropriately; dermatomes are hooked up to a nitrogen hose that will connect to either a tank or outlet on the wall. The surgical technologist will need to test the dermatome and listen for any air leaks within the hose prior to use. Using the surgical consent, the surgical team will need to make sure they have obtained any medication or tissue that will be used in the procedure. Tissue and special sealants come frozen so they require thaw time prior to use.

After setup is complete, the surgical technologist will assist the nurse(s) in getting the patient. Burn patients are commonly hooked up to ventilators and have multiple lines with IV poles, causing transport a challenge if there is not ample amount of staff. A respiratory therapist or anesthesiologist also will be present to help continuous respirations for those patients unable to do so on their own. In all cases, contact precaution measures will be taken when obtaining a surgical burn patient.

SURGICAL INTERVENTION

The surgical team will bring the patient into the operating room and move them on to the table for intubation. Some patients already will be on a vent. The surgeon usually takes time to help the team remove any dressings the patient has

on, and make a game plan for the approach he or she is planning. After the patient is positioned according to the scheduled procedure and the surgeon's preferences, the patient will be prepped with 4% chlorahexadine scrub solution. The affected areas will need to be prepped, as well as donor sites. In some cases, essentially the entire body is prepped for surgery. Most patients will come to the operating room with a Foley catheter already in place, but the circulator may need to insert one with the prep. Meanwhile, the surgical technologist and sterile team will scrub and don sterile gowns and gloves to prepare for draping.

Draping for these types of procedures can be tricky, but ideally the tech will want to square off with towels and utilize ¾ sheets to drape around the patient, keeping as much covered as possible to help with temperature regulation. Often, a warming blanket will be placed on the patient throughout the procedure.

After the timeout is initiated, the surgeon generally starts with a marker and ruler to measure the affected body surface area. This measurement helps determine how much skin will need to be harvested. When a patient's healthy skin is limited due to injury, or is too weak for skin removal surgery, skin from another person, animal or a manufactured skin substitutes can be used. Another possibility is to use cultured skin — new skin grown in a lab from the patient's own skin cells.[6] The surgeon will administer Tumescent into the patient's skin where autografts will be harvested, as well as where the damaged tissue will be removed. This will allow for the area to become firm and limit the amount of blood loss. It is important that the patient's skin is firm and taunt when harvesting grafts so the dermatome doesn't skip and produce low-quality grafts. Prior to using the dermatome, the surgeon will check to make sure the machine is working correctly, and will set the thickness for the desired graft. Dermatomes come with different guards that allow different widths of grafts to be harvested. Guard options range from 1" to 4" and it is common for the 4"-guard to be used for larger surface areas. The surgeon may use saline or mineral oil to help lubricate the surface of the dermatome and skin, which creates a smoother graft harvest. Only the top layer of skin is used for donor skin, and the area the skin is taken from will heal on its own. The assistant will take a dry lap sponge and pull the opposite direction as him or her to keep the skin firm and taunt while he or she uses the dermatome to harvest autografts. Once the graft is taken, the surgical technologist will prepare the skin for transplant. With large burn areas, the patient may not have enough unaffected skin to use, requiring the donor skin to be meshed. This involves a machine (mesher) that will make small slits similar to fish netting in the skin, to allow the skin to stretch to cover a bigger surface area than the piece of skin itself. The skin can be meshed at 1.5:1; 1:1; 2:1; 3:1 or 4:1 with the most common being 1:1. Healing occurs as the spaces between the mesh fill in with new skin growth.[8]

Once the graft is taken, the surgical technologist will prepare the skin for transplant. With large burn areas, the patient may not have enough unaffected skin to use, requiring the donor skin to be meshed.

Preceding the harvest of the skin graft, the surgeon will need to remove the burned and unsalvageable tissue. To do so, a scalpel, a graft knife with a weck blade, Campbell knife or the dermatome will be used. Immediately after the affected tissue is removed, it will be important to gain hemostasis. The surgeon will apply moist laps with epinephrine as well as use the ESU to cauterize any major bleeding. If skin is removed from an extremity, the surgeon also may wrap the limb with the soaked sponges followed by gauze bandage rolls and an ace wrap to apply pressure. By performing this action, the surgeon can work on debriding other areas of the body and keep the anesthesia time limited. After the skin is debrided, the surgeon will take the prepared grafts and apply them to the affected areas. The surgical technologist needs to keep all grafts moist with saline so they don't dry out and to help with the application process. The surgeon may apply a thin coat of a fibrin sealant to the surgical site prior to laying the graft to help with adherence of the graft; staples or suture may be used for additional support. Surgical staples also will be used to secure the edges of a graft to healthy skin and will be removed once the edges have healed together and the graft is stable.[8] Dressings usually consist of interface coated in polymyxin ointment, a petrolatum wound dressing followed by gauze rolls and cotton bandages. It is critical to stabilize the surgical site so the grafts don't shift or tear, affecting the healing process. The application

of cotton, abd's and splints may be necessary to aid in this process. In large areas, such as the torso, the surgeon may ask for the anti-sheer wound cover dressing or towel gauze to lay over top of the interface and the petrolatum wound dressing. Petrolatum dressing and gauze rolls will also be applied to the donor sites, making sure to keep it separated from the grafted areas. Once all grafts are laid, hemostasis will be reached. The patient then will be ready to be extubated (if able) and taken to recovery.

BENEFITS AND RISKS

Assuring that the patient is stable enough to undergo anesthesia is important, although the unsalvageable tissue needs to be debrided as soon as possible. Since burn patients have a weakened immune system, they are more prone to infection, which can also lead to sepsis. Other disadvantages include blood loss and graft loss, but without surgery a patient can suffer from compartment syndrome, as well as infection. There also are cosmetic and life-altering disadvantages of meshing the graft; however, it allows the surgeon to use less donor tissue. Meshing also allows blood and body fluids to drain from under the skin grafts, preventing graft loss, and it allows the donor skin to cover a greater burned area because it is expanded.

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POST-OPERATIVE

Rehabilitation begins with wound coverage to prevent burn scar contracture. Aggressive physical and occupational therapy with exercise and splinting in position of function are the keys to recovery. The use of pressure garments also has been shown to help with healing of wounds more rapidly, but evaluation of its cosmetic and functional advantages currently are still under examination. Plastic and reconstructive surgeons will need to be involved early in patient care for any future needs of contracture releases and related surgeries.[7] Other aspects that will need to be addressed are pain and wound management. Hydrotherapy is highly common to aid in the treatment of a burn victim. Hydrotherapy involves the use of water for pain relief and treatment, using the temperature and pressure of the water to aid in therapuetic care as well as to help stimulate circulation. Patients find that while they are in hydrotherapy they are able to move more without as much pain. Burn victims who suffer from inhalation injuries also will need therapy to help treat their lungs. During treatment in a hyperbaric chamber, oxygen is administered into the pressurized chamber. This greatly increases the amount of oxygen delivered to the tissues throughout the body, which stimulates wound healing, fighting infection and promoting new growth in blood vessels and arteries.[7]

PATIENT CARE – OUTSIDE THE OPERATING ROOM

Burn victims not only undergo changes in their personal health and appearance, but in their social life as well. Special training and education is needed for victims to overcome this transition phase in their life, as well as for the family members who assist the patients during this time. Burn centers are highly recognized around the nation for not only their surgical intervention, but the holistic team approach of care that each and every burn patient receives.

At St Joseph Hospital in Fort Wayne, Indiana, the medical team (specialized in caring for burn patients) meets weekly and thoroughly discusses each patient and the plan of action for their care. During grand rounds, the surgeon (referred to as the bus driver in the care plan), an intensivist, a member from microbiology, trauma therapy (psychology), occupational therapy, respiratory therapy, nursing, as well as a case manager and chaplain are present to review each patient on a case-by-case basis. This approach gives each patient the most holistic and positive outcome possible, and helps assure that each area of their life is being addressed. In addition to the traumatic event itself, some patients are dealing with the loss of a loved one or personal belongings such as a home and may require assistance with the grieving process. The trauma therapy member will help the patient cope with changes that they will not only face in the present but in the future as well. The cosmetic change also can be a huge challenge for patients. Many times, a makeup artist will meet with the patient to help them adapt to the changes so they can find confidence in themselves again. In cases where the victim is a child, a nurse also can accompany them on

their return to the school, allowing a smoother transition for the child. Trauma therapy also can assist in referring victims to outside resources such as SOAR (Survivors Offering Assistance in Recovery), annual burn camps for victims, in addition to seeing the victim for years to come in private practice. There also may be burn centers that offer a place for family and loved ones to stay while the victim is receiving treatment.

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AUTHOR'S BIO

Carrie M Engel, CST, AS, graduated in 2010 with an associate of science degree in surgical technology from the University of Saint Francis. After graduation, she started her career at St Joseph Hospital in Fort Wayne, Indiana. Since St Joe does not have "teams," Carrie has scrubbed every type of surgery, with each day bringing something new and exciting. In 2013, she started teaching clinical sessions for the Department of Surgical Technology, at the University of Saint Francis. In August 2015, Carrie accepted the clinical coordinator/instructor position for the Department of Surgical Technology at the University of Saint Francis, however, she still remains a PRN at St. Joseph Hospital. Carrie will graduate in the spring of 2016 with bachelor's degree in health services. She is also actively involved in the Northeast Indiana Burn Council and serves as Chair of the Burn Buddies Committee for the Family Burn Suites.

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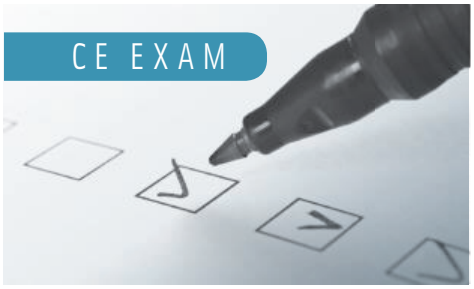

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