Module 4 Advanced: Special Treatment Considerations

Dr: Mohr: Module four, special treatment considerations. We'll talk about threats to the burn patient, discuss special situations pertaining to burn mechanism, escharotomies, adjunctive treatments and laboratory pitfalls, burn shock, burn sepsis, and hypothermia.

Once a patient makes it into medical care, they typically die from one of two causes: early burn shock and failure to resuscitate or multiple organ failure from sepsis, which tends to be the leading cause of late deaths.

Burn shock is multi-factorial. There is a hypovolemic distributive shock component, as well as a myocardial depressant factor which leads to low cardiac output state.

Burn sepsis is a major cause of morbidity and mortality in the thermally injured patient. It typically results in late burn deaths and one of our main ways to prevent this is early excision of the burn. This is not something that will be expected of the burn surge facility, and is something that does not typically develop within the first 72 hours after a burn. It is important to avoid the typical type of critical care associated infections such as central venous catheter associated infections, foley associated infections, and pneumonia.

There are a lot of reasons why burn patients develop hypothermia. Some of them are thermoregulatory changes that occur, but most importantly, it's the damage to the skin that destroys the body's ability to maintain heat within their system. As these areas are excised, the rate of heat loss is even greater. Prevention is the key, heating the rooms to 80 to 85 degrees is important for homeostatis of the patient's temperature. Warming all IV fluid during the first 72 hours and the use of bear huggers or external heating devices may be required to maintain that normal thermea in the first three days.

Some of the special situations pertaining to burns and their mechanisms, we revolve around that of electrical injuries, inhalation injuries, and chemical burns.

Electrical injuries is largely considered an inside-out phenomenon meaning muscle internal compartment damage may be a hallmark. We want to monitor patients for compartment syndrome and rather than doing escharotomies, you have to make certain that you perform what we call fasciotomies and that's relieving the injured muscle bellies from their fascia compartments. You want to monitor CMS checks on all extremities, not just the ones that we believe to be affected as that sometimes we can have exit wounds or entrance wounds from electrical injuries that we do not appreciate. We want you to consider any electrical contact injury, but most notably when we develop greater than a thousand volts that our patients become in contact with. Amperage is actually the part of electricity that is doing most of the damage. However, it's one of those phenomenons or one of those measurements that most people aren't familiar with the amperage that they came in contact with whereas the voltage is something that's a little bit more readily available and more documented.

You want to make sure you monitor all the patients for cardiac abnormalities and arrhythmias. You want to follow troponins and cardiac enzymes. You want to check the patient for CK levels to monitor for rhabdomyolysis and treat these patients with an increased intravenous fluid rate and or plus or minus urinary alkalization.

Patients that are burned often develop or are in closed spaces and can have and develop what we call smoke inhalation injuries, and this is where they've breathed in particles and chemicals that are from the burning combustion of these substances. Most notably, there's a couple poisonous gases that people can breathe in that are pitfalls for burn patients.

Carbon monoxide has a 200 times greater affinity for hemoglobin than oxygen, essentially suffocating us from within. One of the pitfalls here is that we can have a normal SpO2 value despite having a significant exposure to carbon monoxide. The half-life of carbon monoxide, at room air, is typically 250 minutes on 100% FiO2 is 40 to 60 minutes, and in a hyperbaric oxygen chamber at 3 ATMs is roughly 20 minutes. Some of the side effects or symptoms of carbon monoxide exposure is that of headache, vasodilation, pulsating temples, nausea and vomiting, changes in vision, increase in your heart rate. These are all on a continuum and are associated with a greater than 10% percentage of carbon monoxide saturation of your hemoglobin.

Cyanide toxicity is another commonly produced synthetic compound that's developed from burning carpet, other household goods such as vinyl and couches and chairs. Basically, cyanide binds to the cytochrome oxidase of our mitochondrial wall and blocks cellular respiration and also carries a synergy with carbon monoxide exposure. These effects develop within seconds of inhalation, and typically what you see with these patients is a persistent lactic acidosis that's resistant to resuscitation. So, if you see an extremely high lactate in a patient with an inhalation mechanism to be very concerned for cyanide toxicity and always consider this in patients with closed space smoke exposures. There are two sort of treatment modalities, both which are fairly benign and readily available both pre-hospital and inter-hospital and ERs. The old cyanokit, the Lilly cyanide antidote is rarely used anymore and that's a methemoglobin generator. Typically, nowadays, what we use is a hydroxocobalamin or vitamin B-12 precursor in 5 mg vials, and you may repeat this dose more than once. The side effects of this are flushing, hypertension, and lab interference. Also, all of the secretions of the body can turn purple, most notably as seen in our Foley bags turning beet red. Inhalation injury carries a significant amount of morbidity and mortality when combined with a large total body surface area of burn. Typically, it’s involved in a closed environment where escape has been impeded and patients often times have lost consciousness. Your exams should revolve around that of a patient with hoarse voice or changes in their ability to talk, barking coughs, soot in their airways or carbonaceous sputum. You have burns both inside the mouth.

The treatment of an inhalation injury always revolves around securing the airway first is they have a large secretion burden that they're unable to protect their air with. Additionally, there is subsequent swelling or edema that comes along with an inhalation injury that makes it so that the patients cannot protect their airway and essentially can become asphyxiated and suffocate. You want to put patients on what we would consider an ARDS setting meaning 5 to 6 cc per kg of volume for the ventilator settings. You want to have your respiratory therapist perform aggressive pulmonary toilets. You want to engage the patient in inhaled medication such as bronchodilators, heparin nebulization, and acetylcysteine embolizations. You want to use

percussive ventilation to break up some of the particles that may be able to be suctioned and in extreme cases, you may want to consider ECMO and bronchoscopy for both removal of soot and secretions as well as for diagnosing.

Chemical burns is another common injury that patients come to our burn center with and basically these burns begin from the time that the chemical is contact with the skin which in some patients and with some chemicals patients don't realize that they were in contact with at all and can subsequently be deep by the time that they have an opportunity to see you. The first thing you want to do is bush off any dry chemicals that may be remaining. Most notably, this is a problem when people are using cement or dry cement because activating the cement or the chemical within the cement is done by water. So, if you take a dry cement, you make it wet, you then activate the chemical causing or the acid in the chemical causing a burn. So, you can actually make situations worse without removing any of the excess chemical around. You want to remove clothing. You want to wash with soap and water. You want to avoid any acid-based reversals as this can change the integrity of the skin while you're cleaning. Alkaline burns are by far more dangerous and end up with a deeper burn than acid burns, and this is treated with just extensive irrigation. I typically tell people to irrigate for greater than 45 to 60 minutes and then reassess the need for ongoing irrigation. You want to place the dressings and saline dressings and contact your poison center for recommendations.

There's a couple of acids that warrant their own conversation in this module, and the most notable one is that of hydrofluoric acid. One of the main things to consider here is to make sure that you and the patient recognize that there was a hydrofluoric acid exposure. If so, you want to consult the poison center. You want to place the patient in topical and possibly that for IV calcium needs. In some rare, extreme exposures you want to place the patient -- you want to place an intra-arterial catheter with a direct infusion of calcium. You typically treat these patients with calcium until their pain succeeds. To remember to be careful that just because their pain is going away is that a product of your treatment or is that a product of giving them analgesic pain medication? So, you need to be assessing these patients very closely. There can also be electrolyte abnormalities that revolve around particularly the potassium and the calcium. So, you need to monitor these closely. You want to watch them on a cardiac monitor to make certain that they don't develop any arrhythmias. And then of course, you need to once you feel like you've treated the initial exposure, start treating their wounds as these may end up being as deep as fourth-degree burns as talked about earlier and involving the deep underlying tissues. So, hydrofluoric acid is one that carries its own set of circumstances.

In the event of a full circumferential burn or a full circumferential thoracic burn, one needs to consider the need for an escharotomy. I'm going to talk a little bit about the places and the positions of your escharotomy incisions as well as some of the common pitfalls associated with it. Here is a picture or diagram of a chest wall escharotomy that was necessitated by the large edema that was ongoing from the resuscitation as well as that accompanied by eschar. It was impeding the ventilation in the pulmonary mechanics of the ventilator also creating abdominal compartment syndrome. The other image is that of a leg on the medial incision of the full leg escharotomy. These are the proper placements of escharotomies both medial and lateral on the extremities, the abdomen and the chest, and even up under the neck. The common pitfalls on the arms are the ulnar nerves, the radial nerves, and the cephalic veins. You want to watch out for the long saphenous vein on the leg and the posterior tibial vessels. You can also injure

the common peroneal nerve as it dives out of the deep spaces over the femoral head or, excuse me, over the fibular head. You also have the short saphenous vein and the sural nerves to be cognizant of. When performing an escharotomy, you want to make certain that you increase sedation prior to performing the procedure and giving them appropriate pain medication. These can be performed at the bedside or in the operating room. Usually, we prep the eschar with a betadine solution or a chlorhexidine wash before proceeding. We typically perform this with an electrocautery or a scalpel. There can be an associated amount of subcutaneous bleeding, so having the ability to control that blood loss with electrocautery is very beneficial. You want to make certain that you release all of the entire thickness of the eschar down through the dead dermis into the subcutaneous fat. Your release should be greater than approximately 2 cm or approximately an inch. You want to control bleeding again with the electrocautery. You may need to repeat or extend these escharotomies as you need to continue to monitor for profusion to these extremities as the resuscitation continues. Adjuvant treatments that patients may need based around disease processes is that sometimes when they have IVs placed through their eschar or burn, you may need to develop thrombophlebitis. This is just something to be cognizant of. Also, we want to be certain to avoid any of the other common critical care infections such as CLABSI, urinary tract infections and etc.

There's no need to administer prophylactic antibiotics as this just increases microbial resistance. Many times our patients are in the hospital for long periods of time, and they require a considerable mode of antibiotic or antimicrobial therapy and the struggle with resistance microbes throughout. So, starting antibiotics early without an associated or known infection only increases this. You want to make certain that, you know, your CLABSIs or your pneumonias are treated and identified early.

Typically, urinary catheter infections are not an issue in the first 72 hours, but it's something to consider if you're caring for patients in a longer period of time. Patients with burn develop what we stress hyperglycemia as that being burn is considered to be one of the most stressful events that a human body can go through. Essentially, we treat this with subcutaneous insulin or an insulin drip as need to maintain a basal blood sugar level of approximately 100 to 180.
We used metabolic adjuncts and tube feeds for any burn patient with greater than 24% total body surface area. Typically, we start these within 24 to 48 hours. We use high-protein and low-fat formulas and if they have renal disease, to make certain that you're using a renal-based formula. It is okay to feed the stomach, so as long as the residuals are monitored, but however, post-pyloric feeds are preferred.

There are some laboratory pitfalls to consider when caring for patients. Most notably, if we see a falling platelet count, this can be an ominous sign or an onset of sepsis. Overall, a falling platelet count in a setting of a large burn can equal poor prognosis. An elevating hemoglobin or hematocrit can be an example of hypovolemia and is usually present in our early burn shock resuscitation. Persistent lactic acidosis that is refractory to resuscitation is an indication of cyanide poisoning, and you should consider giving the patient a cyanokit. Sometimes patients will come to you with an inhalation injury or a closed space exposure fire, and they will have a normal CO levels. It's important to remember the half-life of carbon monoxide and whether or not the patient is on room air or if they're on a ventilator with 100% because a normal CO level does not rule out carbon monoxide exposure. Low calcium should not be treated unless we've been able to check an ionized calcium level as that we can develop hypoprotein albuminemia

can affect our calcium levels. White blood cells initially elevated and may decline in over 24 to 72 hours and sometimes this results in neutropenia.

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