Audio Companion for SESAP® 16
TRAUMA — Category 7

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Disaster Management: Triage and Categorization of Patients

For disaster management, the skill set required for triage and the categorization of patients is facing a growing demand. Unfortunately, we have plenty of recent examples in which facilities were called on to respond to a disaster. The key to an effective response to a mass casualty incident or a shooter situation is that the planning and preparation should start well in advance of the incident. To that end, you should have a plan in place to triage these patients and move them along the trauma chain, whether you are a level I trauma center or a community hospital.

**Triage:** The most important part of any massive casualty situation is patient triage. The definition of a mass casualty incident is that the amount of patients overwhelms your system. When this situation arises, you must focus on doing the greatest good for the greatest amount of people. This sometimes means that some severely injured people may need to be listed as “expectant” (no treatment priority) even though they might have had a chance at survival if they were the only patient you had. However, because of the severity of their injuries, their treatment would eat up all your resources, and in triage, you must focus on using your resources to do the greatest amount of good for the greatest number of people. In planning, you should know where your capabilities and resources are at your hospital.

**Triage Categories:** In the military, we have three triage categories: “expectant” (injuries so severe that patient cannot be saved without overwhelming the system), “urgent” (patient needs immediate care and can be handled immediately by your system), and “delayed” (people whose care can be delayed 1 to 2 hours but who will then need immediate care). Patients categorized as “delayed” need periodic reassessment because they can present pretty mildly but may have some devastating injuries. Therefore, another part of triage is re-triaging. After you make your initial assessments and have organized which patients go where, you need to reassess later on. One identified leader must make those types of decisions, and that person cannot be your best most capable surgeon who ought to be in the operating room taking care of patients. Therefore, someone else must lead and direct the triage.

**Keys:** The key topics in preparation for mass casualty incidents are as follows. (1) Know what your assets are locally. (2) Know what your capabilities are locally. (3) Know what your transport chain is out of that particular level of care. If you are in a small community with just three or four ORs, you might do a couple of cases but have that patient transferred on to the next level of care so that more definitive surgery can be done in a timely fashion. Your transport system should need hours, not days, to complete. Both communication and transportation are very key in these situations.

Disaster Care: Security

Whether you are in combat or in mass casualty situations like in the Boston bombing, the area where medical care is provided must first be secured. This is of paramount importance. In the military, we are trained to not provide any care until the situation is secured. This involves communication and coordination with your local police departments or nearby forces, and a leader from that realm should be telling you whether the area is secure. These security forces will do things like secure buildings, secure the area, or ensure the threat is gone before anyone starts to provide care. In the case of a hospital shooter, every hospital has their own protocols and warnings, but people should not be giving care until we get the “clear” from the security forces or the police that the area is okay to enter for providing care. If medical providers become victims themselves, then that makes the whole situation worse. It may even be necessary for forces to accompany medical providers when trying to locate patients or to protect providers as they are doing surgery or providing other care.
Disaster Medicine: Dirty Bombs

A dirty bomb is a radioactive bomb whose victims have radiation exposure issues as well as radiation sickness issues. This is different than many of the bombs we see in the Middle East or during conflict, which are bombs loaded with tools, nuts and bolts, and other things that are meant to cause secondary damage once the bomb explodes.

Radiation Sickness: Like anything with radiation, the more exposure you get, the more devastating or problematic the illness is. Aside from the initial blast, the greater amount of time someone spends exposed to the radiation, the more problems they will have. The symptoms can initially be somewhat benign, such as vomiting, erythema, diarrhea, or nausea. The data show us that patients who start vomiting within 1 hour of radiation exposure are likely exposed to 6 Gray, and with that, they have a ≥50% greater risk of mortality.

Dirty Bombs: Recognizing a dirty bomb is probably not the physician’s area of expertise. Instead, they must rely on police or other law enforcement agencies to inform us of these things. Assuming there is a dirty bomb, triage each incoming patients and try to decontaminate them as much as possible, as well as anyone else who might be exposed to that patient. Next, look for signs of exposure.

Disaster Medicine: Bombings and Blast Injuries

What does a general surgeon need to know about blast injuries and other related effects after a bomb explodes (not a dirty bomb)? Bombs can inflict damage by several mechanisms. The initial pressure wave from the blast can cause a great deal of damage. Any flying debris along with the bomb can cause penetrating and blunt damage. The force of the bomb may throw the victim somewhere, and then landing or hitting somewhere can cause even more damage to the body. The bottom line with blast injuries is that it is rare for a victim to have an isolated injury. Depending on how close the victim was to the bomb, you will typically see a broken leg or maybe a broken arm with a blast injury. In the bombing of the Boston Marathon, patients who died had several injuries, mostly to the lower extremity, but then they also had genitourinary-related injuries and abdominal injuries because of the blast effect. Therefore, blast injuries are generally complex with more than one system injured. Surgeons should be very thorough in looking at all possibilities as they do their primary survey. Not only is the victim likely to have more than one injured area, they may also have delayed injuries after initial resuscitation or even after initial operation is completed. Blast injuries may also be more internal, such as within the lung. The pressure wave can injure the eardrums resulting in hearing loss. The concussive effect that occurs in the lungs may not be apparent until a little later — one of the delayed phenomena. As a result, you may not necessarily see hypoxemia early, but it may occur in the following 24 to 48 hours.

Perioperative Antibiotics: Open Fractures and Penetrating Abdominal Trauma

Case: A patient presents with an open orthopedic fracture. Should we use antibiotics to manage this patient? Recommendations: Yes, I think antibiotics are indicated in open orthopedic fractures. Antibiotic use in open fractures is based on fracture classification. The Gustilo Classification of open orthopedic fractures seems to be very reliable and efficacious. This system uses three classifications, depending on the length of the injury and any associated injuries with the fractures. For type I fractures with a skin injury ≤1.0 cm, gram-positive coverage is recommended, but only for the first 24 hours postop. For type II fractures with a skin laceration >1.0 cm but no extensive soft tissue damage, flaps, or avulsions, gram-positive coverage is also recommended for only the first 24 hours postop. Type III fractures have lacerations >10.0 cm, exposed bones, and missing soft tissues. Type III A fractures have adequate soft tissue coverage; type III B fractures have exposed bone that may require soft tissue transfer for
coverage; and type III C fractures are similar to III B but also have associated vascular injury that requires repair in order to salvage the limb. In these type III fractures, either gram-positive or gram-negative coverage is recommended for 72 hours after closure over the top of the exposed bone. For any injuries that have fecal or potential clostridial contaminations, such as fractures occurring during farm accidents or in more austere environments, I recommend adding anaerobic coverage. The fracture alone, if it is closed however, probably does not need any antibiotics.

**Penetrating Abdominal Trauma:** I recommend giving a prophylactic dose of perioperative antibiotics for a penetrating abdominal trauma. Then, if no hollow viscus injury is present, you can consider discontinuing the antibiotics. Administer the antibiotic that you believe is best indicated and give it within an hour of your incision. Discontinue the antibiotic within 24 hours once you have controlled any potentially contaminating source inside the abdomen, which is typically from a hollow viscus injury. Some studies show that perioperative antibiotics in this setting are associated with reduced surgical site infections, a shorter hospital stay, but no real difference in mortality.

**Transfusion Ratios**

The results of the Pragmatic Randomized Optimal Platelet and Plasma Ratios (PROPPR) trial tested the 1:1:1 transfusion ratio of plasma:platelets:packed red blood cells. How does the military approach the PROPPR trial? During the last 10 to 15 years during wartimes, the U.S. military has gone back and forth about the best way to give transfusions and the best transfusion ratios to use. When the PROPPR trial came out, we believed its transfusion guidelines would decrease early mortality and increase the amount of hemostasis the patient was able to achieve. In the military, we operate typically under their clinical practice guidelines, which are distributed to surgeons who deploy. When you are on the ground, either the forward surgical team or in the combat hospital, you do not always get the direct benefit of seeing how that transfusion ratio works. In other words, we might transfuse the patient at the forward surgical setting, but the patient is going to be transferred to a combat hospital within the few hours, and then the patient will rather quickly transfer from the combat hospital to some place like Germany or Landstuhl. Therefore, we rely on our combat system to tell us ultimately the outcomes associated with our approaches. Some data have come out suggesting that the 1:1:1 transfusion ratio does help, but I do not think it is as beneficial as we thought it was when the trial first came out and made its claims. Nonetheless, the military continues to follow it, or we are still following something similar: we keep it closer to a 1:1:1 approach and transfuse all components all at the same time.

**Data Transferability:** Do you think that some of the transfusion-related data that came from the military trauma studies is more specific to your patient population? Can these data be transferred to our civilian trauma population or, from a health perspective, are the two populations too different? I am not sure if it is a matter of health, but that certainly is something to consider about why these data may not be translatable. We do not get too many patients with single gunshot wounds or stab wounds, instead most of them are relatively devastating injuries. Perhaps for our combat population, that 1:1:1 transfusion population works better. Our combat population typically consists of younger patients who are in better physical shape as opposed to a 40-year-old civilian who may be overweight or obese (the typical U.S. patient).

**Acute Vascular Injuries: Tourniquet Use**

Have we changed the ABC priorities (airway, breathing, circulation) to a new paradigm of circulation first then airway and breathing? Yes, I think this shift has occurred, at least to some degree, especially when someone has major vascular injury and they are clearly bleeding out. In the U.S. military, everyone is trained to carry a tourniquet, each of which is made so that an individual can put it on their arm or leg by themselves when needed. Most surgeons who have been deployed will tell you that
tourniquet is probably the biggest lifesaving piece of equipment that people have in the field, aside from body armor and the ability to transport patients out of the danger area into a definitive care area. I would contrast this to the Boston Marathon bombing, when unconfirmed reports stated that plenty of medical providers were at the scene but there was only one medical grade tourniquet that was used and no tourniquets were available to the EMS-type providers. In a pinch, belts, clean sheets, shirts, etc are used as tourniquets to control hemorrhage. I believe tourniquets are very important, especially in the trauma situation. They allow us to first stop the bleeding and then go on to the airway and breathing, and then your regular primary survey. One of the recommendations from the Hartford conference is that our civilian first responders and maybe our police should carry tourniquets for this purpose.

**Releasing the Tourniquet:** How should we manage the tourniquet once the patient gets to definitive medical care? Eventually, the tourniquet must be released to look at the injury. But, like any trauma patient that comes in, we first do our primary survey and make sure everything else is safe. Then we prepare to look at the injury. We do not want to repeatedly let down the tourniquet (release the pressure) and then put it back up. The surgeon or someone who can definitely manage that should be present and ready to identify the injury. Depending on the source of the bleeding, the patient will likely need an operative intervention to completely control the bleeding. I am not an advocate of releasing the tourniquet every so often just to look at the injury, but instead, I believe we should limit the tourniquet’s release to when a surgeon or someone who can provide definitive care is present to manage it.

Do not be confused — the situation is equally urgent whether hemorrhaging is controlled via a tourniquet or whether someone has their hands in the wound to hold control of the bleeding.

**Acute Vascular Injuries: Temporary Vascular Shunts**

**Case:** A patient presented to the ED with a tourniquet in place to control bleeding from leg trauma. The patient was taken to the OR to repair bleeding from the common femoral artery. The patient also has an associated injury to the abdomen. Would a temporary vascular shunt be helpful in this setting? **Recommendations:** Let me give you a couple of different situations where one might consider doing a temporary vascular shunt. If you are the general surgeon in a small community hospital and a patient is basically bleeding out from this injury, then you must stop the bleeding. To consider salvaging the leg, especially if you do not do vascular repairs to begin with, you do not want to do a bypass or any grafting for this patient. That would take too long, use up too many resources, and probably not result in a good outcome for that patient. Instead, insert a temporary shunt then transfer that patient to some prearranged facility that can provide the care and expertise needed. If, on the other hand, the surgeon intends to do vascular repair, a temporary shunt is certainly advocated as a damage control method for surgery to stop the bleeding and potentially salvage the limb that is otherwise in good shape. I would consider a vascular shunt in someone who is hemodynamically unstable or someone who has active bleeding.

**Shunts:** For a vascular shunt, anything can be used that allows transport of fluid from one end to the other. I use pediatric feeding tubes, but lots of things have been described: IV tubing, chest tubes, etc. Typically, you do not need to have it anticoagulated, not because they will not clot off, but because they will be removed within a few hours at a more definitive level of care or when a vascular surgeon available. These shunts should not be left in place for longer than 24 hours. A temporary shunt may be used for damage control surgery of the patient who needs resuscitation because they are too unstable and may be at a lethal triad with coagulopathy, acidosis, and hypothermia.

**Fasciotomy:** Is a temporary vascular shunt an indication for also doing a fasciotomy on the leg described in the original case above? Absolutely. According to our training, anyone suspected of having vascular compromise distally probably needs a fasciotomy. This may not be on the surgeon’s mind because this typically happens a couple of days after the injury. But yes, when you put a shunt in or do some kind of major vascular repair, that typically indicates the need for a fasciotomy. I always do a two-incision and four-compartment release for the lower extremities.
Morel-Lavallée Lesions: Description and Treatment

We see a fair amount of Morel-Lavallée injuries. Most commonly, we see it with motor vehicle accidents, but sometimes it occurs with the bombing injury or improvised explosive device (IED) blast and the accompanying forces. With these injuries, the skin and subcutaneous tissues get sheared off the underlying fascia and muscle, creating a gap where fluid can collect, such as blood, serous fluid, and lymphatic fluid. If the fluid stays there, the hematoma or fluid collection can start to form a capsule, which compromises the overlying skin to become both infected and necrotic. The fluid itself can also become infected. This can lead to skin loss and delayed infection of the wound. Most commonly, these injuries happen in the proximal thigh just because of the shearing across the trochanter area. It may not present right away, maybe because we are more focused on the bigger injury. Then days to weeks later, you see this ballotable mass. If you scan it, you might see this consistency of blood, fluid collection, and maybe a capsule forming over the top of it. The management is operative, which is basically to evacuate the hematoma, debride all infected necrotic-looking tissue, and planning to re-operate once or twice to ensure that the space is eliminated so that fluid can no longer collect there. The amount of skin loss and infection associated with this lesion can be devastating. When I deal with these lesions, I unroof almost the entire cavity to drain everything out, remove the capsule, and remove all necrotic tissue. The skin loss is usually the biggest problem with these lesions, and unfortunately there is not a great way to predict that except tincture of time sometimes.

Renal Injuries and Retroperitoneal Hematomas: Management

Case 1: A hemodynamically normal patient with blunt renal trauma has, on CT scan, a blush within the renal parenchyma. Does this generally need operative management?

Recommendations: Generally, in hemodynamically normal patients, a blush is something you can watch and it will be self-limited without need for kidney resection, especially in the case of a blunt injury. A grading system is used for blunt renal injuries that is based on the amount of renal parenchyma involved. Grade 4 lesions involve the collecting system and typically a segmental artery or vein. Grade 5 lesions involve the main renal artery or renal vein: these patients are typically not hemodynamically normal. However, in a hemodynamically normal patient with a blunt injury, they can usually be observed, making sure that the patient remains hemodynamically normal. But if they become unstable, and this injury is thought to be the cause of the instability or hemodynamic abnormality, then operative exploration with attempted salvage is warranted. Nonetheless, I think most of these cases end up with total nephrectomies if they are hemodynamically abnormal.

Case 2: A patient arrives with a renal artery injury at 4 hours after a motor vehicle crash. Are we usually successful with renal salvage in such cases?

Response: For hemodynamically normal patients with higher-grade injuries, renal salvage is something you might want to consider. However, because this is a grade 5 lesion involving an injury to the major renal artery or vein, with a delay to initial treatment, being able to salvage the kidney is not expected.

Case 3: A patient presents with a penetrating retroperitoneal wound with hematoma in the renal fossa. How should we manage this patient?

Response: In the management of retroperitoneal hematomas, the biggest determining factor for watchful waiting versus surgical exploration is the patient’s hemodynamic normality. In hemodynamically normal patients, these cases can be watched to ensure that the hematoma is not expanding. As long as the penetrating wound to the retroperitoneum does not involve the peritoneal cavity, observation is based on renal grade and hemodynamic normality.
Pelvic Fractures: Stabilization, Packing, and Prophylactic Binding

For pelvic fractures, I am an early binder or an early wrapper. When you do your primary and secondary survey, look for pelvic instability. If patients are hemodynamically unstable with an unstable pelvis, then I will usually put a binder or a wrap on them as I continue on with the secondary survey. What I use for a binder depends on what we have available. I have been in the field where we have some state-of-the-art binders that you can sequentially put down. On the other hand, I have been in some hospitals where we would use the sheets. The bottom line is that you want to stabilize unstable pelvic fractures until more definitive care can be delivered, which may be operative management with fixation or may be angiography for embolization to stop any bleeding. Management generally involves doing your primary and secondary surveys, resuscitating the patient, correcting any coagulopathies, doing any needed transfusion, and then evaluating any other major vascular injury. When ready to proceed with either angiography or surgery and the patient has been otherwise resuscitated, take the binder down and evaluate the patient to determine what they need. To contain the bleed, then the first step would be angiography. If they continue to bleed after that, then operative intervention for the fracture will be needed. The initial plan may be to pack the pelvis with a plan to go back within 24 hours to do more exploration of the hematoma, to fixate the pelvis along with the assistance of your orthopedic colleagues, or to do something else like an external fixator to provide additional pelvic stability.

Pelvic Packing: For packing the pelvis, the Denver Group has popularized a German technique that utilizes small incisions and retroperitoneal packing for the patient who appears to have pelvic fracture bleeding. Although I have no experience with this technique, the Denver Group certainly subscribes to it as another option in the management of the pelvic fracture bleeder.

Stable Pelvic Fractures: In patients with blunt injury and a stable pelvic fracture, the use of a binder as prophylaxis may be considered in certain situations. If you are in a small community hospital with few nearby resources, placing a binder will not harm the patient. However, if you have orthopedic colleagues or a trauma surgeon available for consultation about the need for a binder, then I would discuss the case with them first before binding the pelvis. I do not think there is too much harm in putting on an early binder, but you need to continue to evaluate the patient while the binder is on.

Colon Injuries: Closure and Damage Control Management

Ultimately, the closure of colon injuries is still okay. The rule that we still follow is bowel closure is okay if $\leq 50\%$ of the circumference of the bowel is injured. I would probably not close the colon if the patient is hemodynamically abnormal, if a lot of contamination/infection is present, if numerous other concomitant injuries are present, or if the patient has had massive transfusions. In such cases, I would favor resection, maybe ostomy placement, and second-look approaches. Our military approach is different than that of trying to salvage as much intestine as possible because we are often in dirty situations and we expect a higher level of infection afterward, and we also expect to do a lot of damage control surgery initially. For example, in a foreign area, we may just primarily sew up some colonic injuries, knowing that they are going to get a second look within 12 to 24 hours. At that point, the injury might declare itself or might be worse than originally thought, in which case they might do a resection and then possibly an ostomy. Another difference with our military approach is based on the fact that the aspects of the injury patterns are different. If the patient is hit with a bomb, for example, the injury is considerably different than getting a single gunshot wound to the abdomen.

Case 1: A patient with a gunshot wound to the abdomen has a couple of holes to the small bowel and has an injury to the right colon that destroys at least 75% of the colon wall. His hemodynamics are okay. In your practice, would you do a resection and primary anastomosis on the colon injury?

Recommendation: I would do a primary repair on this case if everything else were okay. I would probably do a formal right hemicolectomy on that person.
Case 2: The patient presents with the same injury as Case 1, except that the injury is on the left side. Do you do a left colon or you do once again do resection and primary anastomosis?

**Recommendation:** The issue with this case is that the injury involves the left colon, which is a dirtier area than the right colon. I would probably do an ostomy initially and then plan to come back later on. I think your damage control is to do an ostomy on similar cases. While you may do more ostomies than are maybe necessary, but, at the same time, you live to fight another day with the patient.

**Damage Control**

As a military surgeon, I consider “damage control” to be the hallmark of combat surgery. The bottom line of damage control is that you are basically controlling the amount of damage caused by the traumatic injury so that the patient can be better resuscitated before the patient undergoes definitive repair. For example, for colonic injury or extensive intestinal injuries, you may just very quickly resect the injured areas with no attempt at primary repair and anastomosis. Instead, the goal is to resect the injured areas, leave them in discontinuity knowing that they will to be re-operated on in 12 to 24 hours, at which time it can be decided whether an anastomosis is needed. If the patient is acidotic, coagulopathic, and hypothermic, they are not going to heal very well, so these issues must be corrected before any definitive repair is performed. The same thing is true for vascular injuries. A temporary shunt can be done very quickly in an effort to control the bleeding, which is of paramount importance. Then salvaging the leg or arm, which are not as important in the grand scheme of things can be undertaken after the bleeding is controlled and the patient is resuscitated. Therefore, damage control is basically a temporizing measure to control the injury, which I advocate for anyone whose practice is away from a high level of care. Knowing where your evacuation routes are and having a definitive plan in place beforehand are critical for getting definitive care for the patient. Not everyone can have a helicopter that goes to the hospital at a moment’s notice, but the community surgeon can do damage control initially and plan on doing a second-look operation, and hopefully within that 24-hour period, adequate transport has been arranged to get the patient to the next level of care. I believe that damage control is probably the biggest lifesaver that the military does on the battlefield. This enables patients to be stabilized enough so they can handle the transfer in 1 to 2 hours and then get resuscitated so that when they can go to the definitive repair.

**Damage Control: Abdominal Closure and Wound Management**

A million different techniques are available for temporarily closing the abdomen. When doing damage control, I typically pack the abdomen; put a moistened towel over the intestines to keep them from getting too dry; place drains, and then place Ioban™ or something similar to cover the abdomen and close the edges to decrease leakage or sensible fluid loss. Probably one of the more important things to do when you pack an abdomen is to communicate with the next group that receives the patient, or even just yourself, what is still in the abdomen. In the early days of the war, they used to write on the Ioban something like “24 packs inside abdomen,” “three small bowel resections done,” etc, to let the receiving institution know right away what was done.

**Re-Operation:** Regardless of your facility’s location, the most important things are to limit the fluid loss within the abdomen and to close the abdomen so that the bowel is still protected. After this, resuscitation is continued to correct the acidosis and coagulopathy. In battlefield conditions, some patients get two or three operations within 24 hours with a good evacuation. The surgeon in a small hospital with few nearby resources must do damage control, start resuscitating the patient, and then transfer them when stable. The receiving institution may re-operate within the first 24 hours to confirm the injury and provide more definitive care. Or, the patient may need to undergo another operation.
because new injuries occur or the patient is unstable and the receiving group may need to ensure that all injuries are controlled. For the community surgeon who might have direct access to definitive care or the level I surgeon who might receive the transferred patient, the same rules apply. If they receive a patient who is an absolute mess, despite adequate resuscitation, the surgeons may have to re-operate to ensure that all injuries are taken care of. Similarly, the original surgeon may need to re-operate and look for a missed injury when the patient does not improve after resuscitation in their facility. The fact is that these patients need to be periodically re-evaluated for other injuries.

**Case:** A patient with bowel injuries has undergone damage control (two ends of the bowel sewn off) and resuscitation. They now have a positive fluid balance. When you re-operate on them, the bowel edges look viable but the bowel is edematous. Do you do a primary anastomosis or do you leave them open and come back to fight another day?

**Response:** For this patient, I would probably come back to fight another day, as long as they are doing well otherwise. If I went ahead with a primary anastomosis, it would potentially fail because of all the edema and swelling. Therefore, I might come back in 48 hours after trying diuresis or another method of removing some fluid.

**Pregnant Bariatric Patients**

In general, an increasing number of individuals are undergoing bariatric surgery. Patients can and do become pregnant after bariatric surgery. They are counseled that they should not become pregnant during the period of rapid weight loss (first 18 months after surgery). If they become pregnant during this time, it is not a death sentence for the mom or the baby, but it does present more of a challenge to get enough calories into the fetus while the mother continues toward a healthier weight. Assuming they become pregnant after this period, especially after gastric bypass, these patients need to be informed about several important points. (1) They must maintain their nutrition. Because B₁₂ and folate, in particular, are known to cause some neural tube defects, patients should continue their supplements. (2) The amount of weight gain during pregnancy should be based on their BMI when they become pregnant. If the BMI was 20 to 25 (normal range), the patient should gain 30 to 35 lbs during pregnancy. For those whose BMI was 25 and 29 (overweight), weight gain during pregnancy should be 25 to 30 lbs. For those whose BMI was 30 to 35 (Class I patients), weight gain during pregnancy should be 20 to 25 lbs. For BMI >40 (Class III patients), weight gain during pregnancy should be 10 to 15 pounds. Unfortunately, some patients use pregnancy as an excuse to abandon their lifestyle changes and can gain a tremendous amount of weight. The outcomes from pregnancy are generally better after the weight loss: according to mostly retrospective studies, the risk of pre-eclampsia and gestational diabetes and the need for C-section all go down after bariatric surgery. However, small for gestational age and fetal demise are slightly increased in patients who have had bariatric surgery.

**Best Advice:** If a general surgeon is referred one of these patients from an OB who does not know exactly what to tell the patient, the most important thing is to advise the patient how much weight they can gain. By >2 years after a bypass, in particular, the patient can generally tolerate food relatively comfortably, such that they can get the extra 200 to 300 calories they need daily for the fetus, which should result in only a moderate weight gain. But within a couple of years after bypass, people can outeat their bypass, especially if they are eating the wrong types of foods, regardless of the amount and frequency with which they eat. Therefore, warn the patient that, although they may be feeling more comfortable with eating, that they should stick to the general principles (high protein diet, calorie limitation), with the exception of an extra 200 calories for the fetus. Reinforce that they must keep taking their multivitamin supplements so the baby can be as healthy as possible.
Preparing for Mass Casualty Events: The Surgeon’s Role and Damage Control

Any major city and even the small cities should have some kind of trauma massive casualty plan in place. Even if the plan is to say, “All our patients will be transferred to xxx hospital.” That kind of communication needs to be in place. It is becoming increasingly more important for the surgeon and hospitals to know their trauma plan. I believe the general surgeon is probably the best person to run that kind of massive casualty situation — because of our training, we recognize certain injury patterns better and we recognize the need for surgery for certain injury patterns better than some of our colleagues. Not that someone else can’t manage this job, but this task is more in line with a surgeon’s area of expertise. I would certainly advocate for anybody in any hospital to know what your massive casualty plan is for evacuating patients. If you are a “country doctor” in the middle of that situation, your role is damage control, damage control, damage control. This is not the time to worry that the next level of care will criticize you for not doing the primary anastomosis, the bypass, or whatever. If you use up all 50 units of blood on one patient, your hospital could be dead in the water for any other incoming cases. You must do the best you can with the resources you have. Our focus should be on the patients, but you deal with what you can with what you have and damage control is always a good answer. In my practice in the military, especially at the forward setting, I do not even think about closing the abdomen, even if everything is perfect, because we are operating in a tent, which can be a dirty environment. Sometimes only one or two surgeons are in the forward setting, so damage control is the key and is always the best answer, in my opinion.

Penetrating Neck Injuries: Zones of the Neck and Workup of Zone I Injury

The zones of the neck are, to some degree, helpful in the management of patients with penetrating neck wounds. The idea of identifying anatomically where the patient is injured helps set the stage for what the likely injuries are and the modalities that can be used to treat those injuries. Although the zones are relatively well defined, most trauma centers manipulate the zones a bit. At our level I trauma center, zone III encompasses anything above the angle of the jaw, zone II encompasses the region down to either the cricoid or hyoid bone, and zone I encompasses from the bottom of zone II to the thoracic inlet. **Zone I Injury:** How do you manage zone I injuries in a hemodynamically normal patient? The initial history, physical exam, and hemodynamic status of the patient are paramount. On the physical exam, I am vigilant for any hard signs of significant neck injury: shortness of breath, hemothorax, etc. If the patient with a zone I injury is relatively asymptomatic, I think that the type of injury is important. For example, is it a stab wound or a gunshot wound? Does some kind of path need to be identified? Next, I check pulses and look for bruits, hematomas, and airway obstruction. After that, I get the initial chest x-ray. Some studies say that, in a hemodynamically normal patient who is asymptomatic with a normal chest x-ray, the likelihood of finding something significant that requires an operative intervention is quite low. Although an operative intervention cannot be completely ruled out with that initial evaluation, these elements (history, physical exam, initial chest x-ray) are important in the trauma bay. **True Injury:** If the patient has a true injury and a normal chest x-ray in zone I, I generally separate the injuries into stab wounds or gunshot wounds. My next step is to order further imaging. Most centers would probably order a high-resolution CT of the neck with angiography (CTA). This imaging would most likely be ordered for most asymptomatic wounds to the neck in any zone. CTA identifies many things you would not see in a chest x-ray, including aerodigestive injuries and perhaps occult injuries, especially in zone I of the neck. The presence of abnormal air in places where it should not be brings up the spectra of esophageal injury.
Penetrating Neck Injuries: Managing Injuries to Zone I

Case: For a hemodynamically normal patient with a zone I injury, the CT scan shows no hematoma and no bluses in any place through the mediastinum. However, a transmediastinal wound in the thoracic inlet is seen. A few little dots around the esophagus are seen. How should we manage this patient? Any periesophageal air, especially if it is true transmediastinal such as that seen with a gunshot wound, needs a further workup. During the past 15 to 30 years, the evaluation of the esophagus has evolved from primarily relying initially on contrast studies or rigid esophagoscopy to relying on flexible esophagoscopy in all areas except for maybe pediatrics. Most general surgeons feel comfortable performing careful high-resolution, high-definition flexible endoscope, which is indicated to rule out esophageal injury. I think the literature is starting to show that, under these circumstances with a good screen and good imaging techniques, we can get a good look at the esophagus through a flexible endoscope in adults.

Blood: If, on flexible endoscopy, we see a little blood but nothing else, how should we proceed? If I see blood and do not believe there is a full hole in the esophagus, I would ask myself if I see blood related to any kind of defect in the esophageal wall. If I saw just a little bit of blood and air was there, I would be very paranoid. I may get a contrast study with water contrast and, if that did not work, then maybe even barium or some thicker contrast material to diagnose it. If there is a hole and it is in the chest itself (a lot of times those mediastinal holes contain leaks), I begin to consider some operative interventions for that esophagus.

Penetrating Neck Injuries: Managing Injuries to Zone III

Case: A hemodynamically normal patient presents to the ED with a stab wound to zone III in the neck. How should we evaluate this patient?

Recommendation: The initial history, physical exam, and hemodynamic status of the patient are vital. On the physical exam, I am vigilant for any hard signs of significant neck injury, such as pulsatile bleeding. Branches of the external carotid artery can bleed relatively profusely. If the patient is negative for hard signs, then imaging is next. A chest x-ray will not be beneficial since the injury is so high in the neck, and a plain film is of much less use in this region. Therefore, I suggest a high-quality CT scan with IV contrast looking for a bullet track or other injuries. The reason for scanning asymptomatic patients is that the operative exposures in zone II are much harder when you get above the angle of the mandible, particularly if the injuries are close to it and certain operative maneuvers have to be done to access the site or to attempt endovascular control for the purely vascular injury.

Aerodigestive Tract: In most patients with zone III injuries, the aerodigestive tract is usually managed through the mouth or via simple drainage. Because the injury is so proximal, the occult problem of mediastinitis is unlikely, which you might expect to see with esophageal damage associated with zone I or zone II injuries of the neck.

Penetrating Neck Injuries: Managing Injuries to Zone II

Injuries to zone II of the neck seem to be the most controversial of the three zones. Most people equate zone II with penetrating wounds to the neck. To manage zone II injuries to the neck, the initial history, physical exam, and hemodynamic status of the patient are vital.

Hard Signs: On the physical exam, I am vigilant for any hard signs of significant neck injury. From my clinical practice, my hard signs include any voice changes or hoarseness, changes in swallowing, and the presence of large hematomas, bruits, pulsatile bleeding, and pulsatile masses. On radiographic
studies, I look for unexplained air in the neck or physical signs of crepitus. When dealing with a gunshot or a stab wound, I plan the operation, which will be a neck exploration in my hands.

**No Hard Signs:** If no hard signs of significant injury are present, I evaluate these patients with CTA. This decision is somewhat controversial. A body of literature says that patients without any hard signs can be watched clinically if they are completely stable. Again, I would add the swallowing and hoarseness component to this observation if changes were not clear on the initial exam. If the patient remains completely stable with no progression of symptoms and no development of hard signs, then it is quite unlikely that the patient has a significant injury requiring operative intervention and repair. Most physicians lean on the CT/CTA if they elect for nonoperative management.

**CTA:** I order CTAs for zone II neck injuries. I think it is an acceptable means to watch these patients in the absence of hard signs of significant injury. My experience has taught me, occasionally, these patients have occult injuries, especially aerodigestive tract injuries. If I see unexplained air in suspicious places, I would investigate those cases. Usually, I explore that to repair and/or drain any aerodigestive injury.

**Observation:** If I elect to observe a completely asymptomatic patient with no hard findings of significant injury, then I watch them overnight for 12 to 24 hours. Even if the patient has a negative CTA, I tend to let them settle down in an ops unit. Many of these patients are intoxicated, and their status may have influenced my exam. Therefore, I tend to not send these people straight home from the ED without some observation period. I think it is prudent to watch them for some time to make sure they do not develop any kind of hard signs in their necks. We ask them to eat and drink (a PO challenge) during the observation period. As long as they can swallow normally and are talking okay (no voice changes or hoarseness), we feel okay about sending them home in 12 to 24 hours.

**Penetrating Neck Injuries: Surgical Technique**

**Case 1:** A patient presents with a zone II through-and-through neck wound. They are coughing or spitting up blood. Do you subscribe to doing bilateral incisions on the anterior border of the sternocleidomastoid, or do you subscribe to collar incision, raising flaps, and doing a bilateral neck exploration?

**Recommendations:** In an unstable patient, I start where I believe the most significant injury is located because I am worried about bleeding. I do an incision on the anterior border of the sternocleidomastoid muscle on the side that I think is worse. This is the most expeditious way to get to the vessels and control the bleeding. Once that is fixed, then I assess the other side, especially if there is an aerodigestive hole. I tend toward doing an anterior approach on the opposite side if the bullet or knife track lends itself to that. I have made a collar incision after doing the first anterior border incision if the track was coming more anterior and it was coming out more midline on the other side. I have tailored that incision a bit through the platysma and have done the flaps if I thought it was better for exposure. In summary, airway protection is first, then go to the operating room to explore and control the bleeding and repair the aerodigestive tract.

**Case 2:** A patient presents with a stab wound to the trachea somewhere between tracheal rings 1 and 4. A 50% transection is present at the anterior-lateral location. How do you recommend managing this patient?

**Recommendations:** In general at our institution, we traditionally repair the tracheal defect if we can, depending on the neck. Usually a stab wound or a gunshot wound tends to have more destruction and the patient’s primary problem initially is almost always an airway issue. If the wound is located where we would put a tracheostomy, then we must decide what to do with the wound. In this case, we are getting away from doing tracheostomies in light of a tracheal repair in that they can be maintained somewhat with an endotracheal tube. I have tended to put tracheostomy tubes in because I think there is some variable healing with these and it also secures an airway for the patient in a setting in which there may be additional edema and sometimes delayed bleeding. We tend to repair the trachea and establish some sort of surgical airway, and again, that is decided by where we are working between the tracheal rings. Therefore, the tracheostomy tube is sometimes put above the injury with extension of the tube and
balloon below the level of the injury. We have not done much of the nontracheostomy intubation route although several studies suggest that it can be done safely and effectively.

Occult Penumothorax & Retained Hemothorax: Management

Occult hemothoraces and pneumothoraces are not apparent on a chest x-ray but are apparent on a CT scan. Sometimes an occult pneumothorax (PTX) is noticed on a cervical spine CT. If the patient is asymptomatic (breathing fine, etc), I will repeat a chest x-ray to verify that the PTX did not progress. I treat a nonprogressing occult PTX with observation. I do not like prolonged periods of positive pressure ventilation (PPV) with these patients. Therefore, I try very hard to avoid general anesthesia for an asymptomatic patient with an occult PTX seen on CT, opting instead for regional anesthesia if it can be done safely and with good control.

PPV: The literature does not necessarily support that all these patients need a chest tube, but in every series, some patients deteriorate on PPV. Whether progression of an occult PTX is hastened by PPV during a long orthopedic procedure is up to interpretation. If long-term general anesthesia is needed, I tend to put a chest tube in these patients on induction of anesthesia. Not everyone would agree with that decision because some published series show little to no difference between having a chest tube in or not. In addition, the use of PPV did not seem to make much of a difference.

Retained Hemothorax: If the chest x-ray looks okay (even the costophrenic angles look clear) but the CT scan shows a little rim of blood back in the chest cavity, then I watch these cases. Although a little blood does not bother me, I think it has to be followed up by a chest x-ray but not a repeat CT. The risk of long-term sequelae associated with a small hemothorax (HTX) that does not expand is usually quite low. Therefore, for many years, we have managed occult HTX and occult PTX with just chest x-rays.

Occult Hemothorax: Management Via VATS

Case: After inserting a chest tube, some blood and air are drained. Then 24 hours later on a repeat chest x-ray, a retained fluid collection is found, most likely a retained hemothorax (HTX). How do you manage a retained HTX?

Recommendations: The absolute answer to this question is to use video-assisted thoracoscopic (VATS). A second chest tube is usually futile or at least not helpful. VATS is a good way of obtaining a complete resolution of the HTX, and it gives us an opportunity to look around inside the cavity. Patients generally tolerate VATS relatively well. However, if any contraindications to general anesthesia exist, we must counter that. The sequelae of a retained HTX can be quite bad in terms of fibrothorax and empyema, especially without a chest tube in place. Adequate evacuation of the retained HTX can clearly reduce late-term sequelae, and in our hands, the best way to do that is through an early VATS. The retained HTX must be removed by days 1 to 5 before inflammatory reactions occur.

Technique: To perform VATS, we either use the old chest tube site or select a site for the first port. The lung first needs to be selectively ventilated, then we place a second or working port, the location of which is based on the anatomy of the trouble we are dealing with. We try to position the patient at least with some elevation of that chest up. The patient can be positioned in a full turn or less than that if they are stable. If we can place the patient in a full lateral thoracotomy position, it gives us some working space, especially if we drop the lung. We generally drop a lung using a double lumen tube. Selective ventilation is very helpful in this situation. I think it actually shortens the case because it allows us space in which to work.

Chest Tubes: If I feel relatively good about the retained HTX that I was able to clean out and there is no ongoing bleeding, then I put in 1 chest tube. A huge chest tube, such as 40 Fr or 36 Fr, is not needed. Instead, I use a 28-Fr or a 32-Fr chest tube. Although we use only 1 chest tube, I think it is perfectly
acceptable to use 2 chest tubes. Every case is slightly different. Regardless, the patient is followed up postoperatively via chest x-rays and chest tube output.

**Blunt Cardiac Trauma**

Does a blunt injury to the heart create symptoms for our patients? Depending on the exact type of blunt cardiac trauma, patients may or may not be symptomatic. Examples of cases in which the patients are symptomatic include blunt trauma resulting in chamber ruptures or valvular abnormalities (quite rare). The diagnosis of blunt cardiac injury (BCI) has gone through an evolution over the years. At times, BCI was probably over-diagnosed and probably over-monitored. Some of the major trauma institutions have established some good guidelines for the workup of BCI. All patients receiving a high impact to the chest area should get an ECG, and if the ECG is normal and the patient is asymptomatic, the use of troponins remains controversial. If all test results are negative, most patients do not have risk of BCI. Therefore, I believe all patients with blunt cardiac trauma deserve an ECG. If the patient shows hemodynamic instability, then the patient is symptomatic and needs further workup.

**Troponins:** I do not often use troponins to monitor for BCI, although we tend to trend them at our institution. I am not sure what I am waiting for when I trend them, but we do get them. The ECG means more to me than troponins. According to the guidelines, troponins are better if they are negative than if they are positive. I think they have a little more diagnostic value if they are used in conjunction with a normal ECG. I am not sure that troponins are useful in a positive sense because I do not think a troponin level alone changes the treatment plan.

**Penetrating Cardiac Wounds to the Box: Diagnosing Pericardial Effusion**

Like all trauma workups, the evaluation and management of stab wounds to the “box” have evolved with time. US has revolutionized trauma care in this area, and it is actually quite effective.

**Initial Workup:** In cases of stab wounds to the box, we are worried about a pericardial/cardiac injury. The classic scenario is a patient who presents with tachycardia, hypotension, and a little short of breath. As I approach this patient, I wonder if they might have a large pneumothorax (PTX), which can be ruled out with chest auscultation or chest x-ray. If the breath sounds are good, then a large hemothorax (HTX) and a tension PTX are unlikely on whichever side of the box the wound is located.

**Cardiac Tamponade:** If the patient has good breath sounds and the chest x-ray looks relatively normal but the heart looks enlarged, we begin to consider a penetrating wound to the heart with cardiac tamponade. The use of US has made a significant difference in the workup of these cases. As our expertise and technology continue to improve, we can use US to diagnose pericardial fluid quite well in real time in the trauma bay. Visualizing pericardial fluid on US mandates a surgical exploration in a symptomatic patient. We classically used to also look for jugular venous distention (JVD). Not only is JVD difficult to visualize in many necks, but this particular incidental sign is not very helpful. We were also taught to listen for a muffled heart sound, but that is a difficult diagnosis to make when taken in the resuscitation bay with a stethoscope.

**Effusion Plus HTX:** If the patient has cardiac tamponade and a left HTX, I sometimes worry that we are diagnosing a pericardial effusion based on the HTX. Again, the assessment must be individualized. If they have HTX, then we insert a chest tube right away and wait to see if that improves their condition. But if the injury is in the box, their condition does not improve right away, and we get a large amount of blood via the chest tube, then we take the patient to the OR. But if we do not get a lot of blood out of the chest tube, I would put the FAST (Focused Assessment with Sonography in Trauma; synonymous with bedside US) right back on it and look at the pericardium again. I think that, usually, there is always some
HTX even with a pericardial window, although it could be quite small. The bleeding can be almost completely intrapericardial. But if the HTX is large enough, then the patients will go to the OR.

**Penetrating Cardiac Wounds to the Box: Managing Pericardial Effusion**

For the patient with a penetrating cardiac wound to the box and a left hemothorax (HTX), it is often difficult to say where the pericardial stripe is versus a little blood posterior to the heart. What happens when the US looks like a pericardial effusion but the patient responds to a little fluid? A left HTX can confuse the pericardial window. In that setting, I do not want to send the patient to CT. Instead, I determine the patient’s hemodynamic status. If they deteriorate or if the chest tube has a large output, I take the patient to the OR. Alternatively, several different modalities can be used. Some try a transesophageal echocardiogram (TEE), which gives us a pretty good view of the epicardium from the back side with less confusion. Because TEE is relatively invasive, I usually just follow the patient with my US probe as much as I can. If I cannot determine that the patient has any real signs, then they tend to get some individualized operative intervention from me.

**Management:** Is there any role for a pericardial window in these patients, or do you go right to a thoracotomy or median sternotomy? The patient’s hemodynamic status is the determining factor. If the patient is hemodynamically abnormal, both a sternotomy and a left anterior thoracotomy ± sternal extension are acceptable. Surgeons who do not do a lot of thoracic surgery may find this somewhat intimidating/uncomfortable or may not have the necessary equipment immediately available. However, this provides a great incision for access to the cardiac chambers and the very proximal great vessels, and it is preferred, but it takes some expertise and time to do it. If there is any kind of combined injury with an abdominal injury, opening the sternum in a dirty field is problematic. Most surgeons are comfortable doing a left anterior thoracotomy ± extension across the sternum, which is a good approach for relief of tamponade in most anterior wounds, especially in the right ventricle.

**Case:** After draining the hemothorax, the patient’s hemodynamic status is normal but, with US, you cannot determine whether the patient has a pericardial effusion or if they have a little blood lying posterior that has not yet been evacuated. Does a pericardial window enter your decision tree? Absolutely. If that patient is doing better, a traditional subxiphoid pericardial window is worth considering. This involves removing the xiphoid, going underneath it, making the incision, getting above the diaphragm, finding the pericardium and putting two stay sutures in it, and then opening the pericardial sac to see what kind of fluid is present. If a lot of blood is present, then you must be prepared to do a sternotomy (all equipment ready to go on standby in the OR). The tamponade is decompressed, but we must be ready to do that sternotomy or left thoracotomy.

**Blunt Torso Trauma**

**Case:** A patient presents with a high-energy injury with a pelvic fracture. The FAST (Focused Assessment with Sonography in Trauma) shows no blood in the abdomen. Is there a good way to diagnose a blunt diaphragm rupture? In this case, you have the right mechanism, you do not quite like the chest x-ray, you do not quite like the FAST, and you try to figure out what is going on. Two modalities are available to diagnose a blunt diaphragm rupture.

**CT:** Hemodynamically normal patients should undergo CT. For this diagnosis, CT is better than a chest x-ray; it usually shows displacement of abdominal organs into the thorax and sometimes shows the tear in the diaphragm. This is especially true with reconstruction of sagittal and coronal views. As this technology evolves, its ability to diagnose blunt diaphragmatic rupture improves. However, there are many reports in the literature of a CT scan missing a torn diaphragm in the acute setting,
leading to a delay in diagnosis. This is certainly a possibility. But I think CT is a very reasonable first start in a patient who is hemodynamically stable.

**Laparoscopy:** In a patient with a pelvic fracture who is going to the OR, where it was not necessary to get a CT, and the patient is showing other signs, then I think laparoscopy is a good diagnostic tool in a blunt trauma setting. Laparoscopy is even more utilitarian in the penetrating trauma setting because you can see if there is penetration and also you can identify it. Sometimes in the right hands and proper location, the penetrating wound can be fixed via laparoscopy. But with blunt trauma, laparoscopy is a good diagnostic tool for diaphragmatic ruptures. We are looking for blood and for the rupture in the diaphragm, which sometimes requires repositioning the patient. In my hands, if I see the rupture via laparoscopy, then that patient is going to be opened, which in the acute setting is done almost invariably through the abdomen.

**Thoracoscopy:** It is certainly easier to repair the diaphragm through the chest than it is trying to fight through the abdominal viscera. Is it better to do a thoracoscopic exploration to identify and repair diaphragmatic ruptures? Certainly people talk about using thoracoscopic views, but I have very little experience with that. I am concerned about associated abdominal injuries in cases with a ruptured diaphragm. Therefore, I go into the abdomen to assess the rupture. Additionally, in the acute setting, abdominal contents pull down through the diaphragmatic rupture with relative ease, unlike in a chronic setting in which the abdominal contents are incarcerated in some kind of hernia in diaphragmatic areas.

**Penetrating Torso Trauma**

In cases of penetrating torso trauma, the classic wound is the thoracoabdominal stab wound just below the rib cage in which the patient has a negative abdominal exam. Is it better to use laparoscopy or CT to exclude a diaphragm tear in these cases? CT is not useful in most of these cases, depending on where you think the injury is in the anterior abdominal wall. If the patient has an abdominal stab wound (asymptomatic patient, no peritoneal signs, negative abdominal examination), I think this patient can probably be followed clinically. However, if the stab wound is just below the costal margin or even the intercostal space just above the costal margin, this wound lends itself to a laparoscopy. We use 5-mm cameras. Because this is an anterior wound, we can see the wound and penetrate it with the scope, then we can decide whether the injury is in the abdominal wall and/or whether a diaphragmatic laceration is present. We should try to repair every one of these cases. Although the natural history of these injuries is somewhat uncertain, we definitely have seen incarcerated bowel, colon, and/or splenic flexure, etc in those missed diaphragmatic lacerations that turned into hernias. Some of them caused a great deal of morbidity — incarceration in true sense with strangulation. If this diaphragmatic laceration can be diagnosed through the laparoscope on initial exam, that is better than delaying repair because of a missed laceration. You can even repair the tear through the laparoscope, if you have that set of skills.

**Resuscitative Thoracotomy: EAST Guidelines**

The Eastern Association for the Surgery of Trauma (EAST) has issued some new guidelines for the performance of resuscitative thoracotomy (RT) in patients presenting with or without multiple combinations of common survival predictors. The EAST subdivide their indications for RT into 6 patient categories: (1 & 2) thoracic penetrating trauma with or without signs of life, (3 & 4) extrathoracic penetrating trauma with or without signs of life, and (5 & 6) blunt trauma with or without signs of life. The guidelines have a strong recommendation for RT in patients who have signs of life who deteriorate greatly or come in in extremis with penetrating thoracic trauma. However, the guidelines indicate that patients probably will not benefit from RT when they present with blunt trauma and no signs of life. Conditional recommendations for RT are given to all categories in between these two,
which includes penetrating trauma to the thorax without signs of life and extrathoracic trauma or blunt trauma with signs of life.

**Downtime:** In their algorithm of RTs, The Western Trauma Association emphasizes a downtime of 10 to 15 minutes. Downtime can be difficult to determine in the trauma bay in real time. You ask if anyone sees signs of life. Was any palpable pulse found? Was the patient observed trying to take breath (including agonal breaths)? At least for me, it is sometimes difficult to get an accurate time on when signs of life were last seen before the patient’s arrival in the ED. If this time is prolonged, such as a 45-minute extrication after blunt trauma in a car accident, that patient is basically dead on the scene.

**EAST Guidelines:** In our institution, the EAST guidelines for RT are very close to our practice of aggressive RT. We have had survivors from severe femoral artery injuries for whom we have done RT in the ED to re-establish perfusion to the heart, brain, and lungs in patients young enough to recover from that neurologically intact. The percentage of survivors who are neurologically intact is low, but we have had some success stories with aggressive RT. I think it is important that these RTs be done decisively and with the ability, if they are done in the ED, to get to the OR expeditiously.

**Resuscitative Thoracotomy: Technique**

My technique for resuscitative thoracotomy (RT) is as follows. I begin by putting the patient’s arm up as far as possible to get it out of the operative field. Then I perform a left anterior thoracotomy usually at the fourth and fifth intercostal space. I am guessing a little at the time I make the incision below the nipple. I think it facilitates the surgeon to make a hard turn toward the axilla to better follow the ribs.

A mistake is to make the incision too gradual toward the back, when this should be a hard turn toward the axilla. I usually go through the skin and the muscles down to the intercostals with a knife. I sometimes enter the chest with a knife. At other times, I use Mayo scissors between the ribs in the fourth and fifth intercostal space, I put in a rib spreader, and then I assess what is in the chest. If there is bleeding, I evacuate the blood. If something is bleeding right in front, I place some kind of clamp on it. I clamp the hilum of the lung and then assess the heart and pericardium. I think it is very important to open the pericardium in RT if there is penetrating trauma to the chest or any specter of pericardial tamponade. Pericardial tamponade is hard to assess clinically right away, especially if there is a lot of fat around the heart. Also, I cross-clamp the aorta below the heart to restore blood flow, thus reestablishing diastolic root pressure to perfuse the heart, brain, and lungs at the time of the RT. Make the pericardial incision anterior to the phrenic nerve, which you can usually see. Especially at times of tamponade, the pericardium can be difficult to pick up, and Russian pickup forceps can sometimes be helpful. But the pericardium can be tense and difficult to grab. Sometimes I nick the pericardium with a #15 blade to let it decompress so I can grab it with a pair of Russian forceps or something similar, such as a needle driver. Next, I make a small incision in the pericardium, usually using scissors to first go anterior to the phrenic nerve and then parallel to the phrenic nerve, trying not to cut the nerve. I use a generous pericardial incision so I can deliver the heart out to inspect it. Obviously, I react differently if blood is in the pericardial sac, in which case I try to find the source of bleeding.

**Resuscitative Thoracotomy: Clamping the Thoracic Aorta**

During resuscitative thoracotomy (RT), the thoracic aorta is cross-clamped. When I clamp the thoracic aorta, I sweep the lung up with my left hand to expose the vertebral bodies and then, with my right hand, clamp the aorta against the vertebral bodies with a straighter Satinsky clamp. If an NG tube has been placed, it can help you identify the esophagus (which is anterior to the aorta). We always reassess the aortic clamp if we go from RT in the ED to RT in the OR. One of the first things to do is to actually clamp the aorta, but sometimes a different structure has been clamped. The NG tube, if it is in, can be helpful.
You should feel two structures running along the left side of the vertebral column above the diaphragm, and the posterior structure will be the aorta. With the aorta identified, I try to get just a little bit of a rent into the pleura so I can get a better purchase on the aorta with a straight clamp. I prefer to use a straight clamp on either side of the aorta. Keep a firm pressure against the vertebral column as you close the clamp on the aorta, which is often flaccid, and then during the case, reassess the clamps and the aorta. If there is a pulse above it and not much pulse below it, you feel better about where the clamp is placed anatomically. Sometimes it is hard to see, so some of this reassessment is partly by feel, but you will be better able to visualize it if you can sweep the lung up so you can see the vertebral column.

**Extra Tips:** When placing the clamps around the aorta, firmly push that clamp toward the vertebral column as you close it. Otherwise, it will slip right back on you. If the esophagus is mistakenly clamped as the aorta, have someone quickly place an NG tube then feel for it. If RT is started in the ED, then when you move to the OR, one of your early steps is to control bleeding and reassess where the clamp is on the aorta. If the clamp is on the aorta, you must next assess the patient’s physiological response to that clamp because you can cause profound hypertension in the upper body and you can see the heart dilate. You really want to avoid that. But if it happens, you must release the clamp a little bit at a time (a click or two) and put your hand on it to regulate the outflow from the thoracic aorta into the lower half of the body.

**REBOA: A Potential Alternative to Resuscitative Thoracotomies**

In a patient being resuscitated from an abdominal gunshot wound, are there techniques other than cross-clamping the aorta at the level of the diaphragm? Resuscitative endovascular balloon occlusion of the aorta (REBOA) is an alternate technique for applications such as this. Today in 2016, I think the REBOA is an excellent choice for reducing hemorrhage in patients being treated in austere environments, such as military situations or certain rural situations. I also see REBOA as being utilitarian for pelvic fractures: the REBOA can be placed just above the aortic bifurcation in the lower abdominal aorta and basically achieve the equivalent of a bilateral iliac clamp in a short time before doing selective embolization. However, REBOA is not a good choice for thoracic injuries, because resuscitative thoracotomy (RT) allows us to establish control visually, treat tamponade, clamp the hilum of the lung, and do open cardiac massage when necessary. Above the diaphragm, I find REBOA to be less useful in a trauma center where we are capable of doing RTs. If RT is not available and there is bleeding in the abdominal cavity (not pelvic cavity), then the value of REBOA is a little “iffy” in my mind. In the abdominal cavity, the surgeon must be facile with the proper placement of the REBOA so that it is in the right place, but I can certainly see it could be used to control hemorrhage in that way. I think REBOA may have great use in pelvic fractures. Therefore, in facilities where RT is possible, then RT is probably the best approach to thoracic injuries. But certainly in a different environment without the capability of doing RTs, I think the REBOA could have great benefit, especially in austere environments.

**Seatbelt Sign: Patient Management**

**Case:** An intoxicated patient comes in after a motor vehicle crash. They had worn their three-point harness and now they have this huge seatbelt sign that extends from their left shoulder to their right hip. Should we investigate that patient or is the seatbelt sign something that always mandates exploration?

**Recommendation:** I do not think a seatbelt sign on its own mandates exploration, but it is a good indicator that the mechanism of injury was significant. Almost every study to look at seatbelt signs indicates that these patients have an increased risk of both solid organ and hollow viscus (small bowel and/or colon) blunt injuries. Therefore, the “pathophysiology” of a seatbelt raises the chances of there
being internal injuries up to and including hollow viscus injuries or devascularization injuries with the small bowel basically zipped off the mesentery.

**Diagnosis:** For hemodynamically normal patients, I put a FAST (US) on them. Many of these people do not have a lot of fluid in them, and repeating the FAST may be helpful. But, most hemodynamically normal patients will be sent for a CT. CT is not great, but as the technology improves the diagnostic value of CT will increase.

**Helpful Features:** CT scans do have certain features that can help us decide whether we should stick a laparoscope into or explore the patient. First is how the bowel appears on CT. Is it edematous? Is the mesentery badly stranded? These features will push you toward at least looking at it. Obvious CT-related indications are free air or extravasation of oral contrast, but this is relatively rare. It has been described that, occasionally, you can actually see discontinuity of the bowel on CT. Another underplayed CT indication is significant fluid in the abdomen or pelvis without an identifiable source, such as a solid organ injury. If the spleen and liver look completely intact and there is fluid in the pelvis on several cuts, I am likely to put a laparoscope in that patient because I do not know where the fluid came from. Many times this could represent an injured mesenteric vein, something that is ripped, a significant bowel injury, or visceral contents. Again, the physical exam is important, but the intoxicated or obtunded patient can be very difficult to examine. Therefore, the CT can be diagnostically helpful in certain things, but it is not foolproof. I think the good news is that you do have a little time if you are unsure about how to proceed and are waiting for signs. Nonetheless, it is amazing how relatively asymptomatic a patient can be with a little bit of intoxication and an injured small bowel. The seatbelt sign certainly should raise a specter of this when you see it.

**My Approach:** If the CT scan is stone-cold negative, then I would watch the hemodynamically normal patient. Once again, you must rely greatly on your physical exam as you evaluate and talk with the patient and assess their mental status and the reliability of their exam. Nonetheless, I think the one indicator that really draws me toward exploration is the unexplained fluid in the abdomen because I find this to have a high positive predictive value for something that needs to be done.

**Fat Emboli Syndrome**

**Case:** A patient with a femur fracture presents with an occult pneumothorax. A chest tube is inserted. The patient experiences a fair amount of blood loss during intramedullary pinning of the fracture. When the patient is brought to ICU after surgery, he is hypoxic. What is your differential diagnosis for this hypoxic patient?

**Response:** If the patient is still intubated, check that the endotracheal tube is in the right position. Then, on chest x-ray or auscultation, check whether the pneumothorax has expanded or if something else becomes apparent. If everything looks good but the patient is in respiratory distress after repair of multiple long bone fractures or a bad pelvic fracture, then consider a possible fat emboli or transfusion-related acute lung injury (TRALI). Regardless, you will treat the respiratory portion of the patient as needed with supplemental oxygen or eventual intubation using appropriate ventilatory settings to support their oxygenation.

**Fat Emboli:** No uniform diagnostic and clinical criteria exist for fat emboli syndrome (FES). In almost any patient with a long bone fracture or multiple long bone fractures, you could probably find some fat emboli if you sectioned their lungs. Not everyone that has fat emboli gets FES. The clinical scenario of this syndrome is respiratory insufficiency, mental status changes, petechial rash, and thrombocytopenia. In this era, several studies have looked at CT scan findings in cases of FES, and the CTs reportedly showed perihilar and lobular shadows. Keep this in mind if you take another look at the CTs for these patients when ordering a CT for a pulmonary emboli protocol or if the patient is in postoperative respiratory distress. Perhaps this radiological evidence (perihilar and lobular shadows on CT) can provide adjunctive evidence to help make the final diagnosis. Two other possible tests for FES are to
check for fat in the sputum and to check for fat globules in the urine (detected by a “sizzle” test).
I have no experience with either of these tests.

Management of FES: The primary management measure for FES is supportive care for the respiratory component. The best way to treat it is through prevention via early stabilization of the fractures. The early fixation of these fractures is quite important (intramedullary rods far better than traction). Just a note that FES has been described with conditions other than blunt trauma, such as burns and liposuction, but the classic associated condition has always been long bone fractures. No treatment has been shown to make a difference in FES. Neither IV heparin nor steroids have been shown to be clinically effective once FES is diagnosed. The only thing you can really hang your hat on is that you can ameliorate the risk of the syndrome if you fix fractures early. Normally, with proper supportive care and proper tincture of time, most patients recover.

Trauma Resuscitation: Balanced Resuscitation and Permissive Hypotension

The ATLS (Advanced Trauma Life Support) principles of resuscitation have been modified. The old standard that all patients immediately received 2 L of normal saline or lactated Ringer solution for initial resuscitation has been removed from the latest version of ATLS. The newest ATLS guideline is more directed. Not all patients get those 2 L of fluids. Instead, you should have a specific goal that you are trying to achieve during initial resuscitation, and the overall emphasis is on the use of less saline and crystalloid fluids.

Balanced Resuscitation: This new standard is known as “balanced resuscitation.” I think of it as “less crystalloid, earlier use of blood,” because you are primarily treating hemorrhagic shock for most trauma patients.

Permissive Hypotension: Permissive hypotension is the term used for improving trauma patient outcomes by targeting a lower-than-normal blood pressure achieved by delaying the initiation of fluid resuscitation and limiting the amount of fluids/blood products given. I think this approach has some merit, especially in penetrating trauma. The use of permissive hypotension in blunt trauma is a little bit more iffy, especially in patients with potential concomitant head injuries. In head injury patients, episodes of hypotension are definitely not good. But in general, I think the short-term use of permissive hypotension is okay for the awake, alert patient who is mentating and has either blunt or penetrating trauma.

Massive Transfusion Protocols: Hemostatic Resuscitation

In the trauma setting, patients with hemorrhagic shock may require rapid transfusion of large volumes of blood products, which is associated with its own set of complications. The use of a massive transfusion protocol (MTP) is associated with improved outcomes for this group of trauma patients. I believe that MTPs are a bit of a paradox. Our standards have taken us back to the earlier use of blood products in trauma patients. This idea of “hemostatic resuscitation” involves resuscitation with blood components resembling whole blood (blood cells, plasma, and platelets) and clotting factors along with an earlier push toward using this in unstable trauma patients. The thought is that the earlier use of blood results in less bleeding on the back end and less need for transfusion later in the course if you restore the patient’s ability to clot. It is a little bit of a contradiction. In the ICU, we talk so much about transfusion triggers and limiting blood products, but acutely in the ER, the earlier use of blood products, especially in a balanced hemostatic resuscitation, actually results in the reduction of overall volume of blood used.

Transfusion Ratios: The Pragmatic Randomized Optimal Platelet and Plasma Ratios (PROPPR) trial supported the use of a 1:1:1 transfusion ratio of plasma:platelets:packed red blood cells. At your institution, is your MTP consistent with a 1:1 ratio? I think the latest PROPPR study shows probably 1:1 or 2:1 transfusion ratio. Either one is probably fine, and somewhere in that range is probably the right
answer. Most people say you should try for 1:1 because you never get there, and so if you try for 1:1 you probably wind up getting something like 2:1. At our institution, when trauma patients come to the ED, there is an emergency release of blood for our major trauma activations, so we receive 2 units of blood (type O blood) and 2 units of liquid plasma (AB plasma). Platelets are not sent initially. If we then have to transfuse beyond that initial two and two, then we go to our massive transfusion guidelines: 6 units of blood, 4 units of fresh frozen plasma (FFP), and 1 apheresis unit of platelets, which is the equivalent of a “six pack” in the old terminology. It is really like 6:4:6. A unit of apheresis platelets contains about the same amount of plasma as a unit of FFP, so every unit of platelets is effectively another unit of FFP. If you do the math on that, this is very nearly a 1:1:1 transfusion ratio.

Massive Transfusion Protocols: Use of TXA and TEG

**TXA:** At our institution, we are not big users of tranexamic acid (TXA) as part of our MTP. I was recently talking to somebody, and in their emergency release of blood that comes to their trauma activations, they have a little sticker that says, “If you are thinking about using emergency release blood in the ED, should you be getting TXA?” This is an interesting trigger if you are transfusing patients. According to the original study, we should be giving TXA to anybody we think might need a transfusion. But in our practice, we use TXA sporadically. I know that a lot of places administer TXA regardless of whether they actually transfuse or just think they are going to transfuse a patient in the ED. A couple of large studies with a fair amount of data demonstrated that TXA had some benefit, though not a huge benefit, in transfused patients. TXA use does not have a lot of disadvantages, and it is inexpensive. However, the use of TXA never seemed to get traction for some reason.

**TEG:** In your practice, does the use of thrombelastography (TEG) play a role in how you manage blood products in your MTP? We are starting to get more involved with the use of TEG. The use of TEG is often difficult during an acute massive transfusion situation because it does take some time for the numbers to come back and its use is a little labor- and time-intensive. I am not convinced that, in the throes of a massive transfusion, TEG is going to change a patient’s management. If we are following the balanced hemostatic 1:1:1 resuscitation principles, then we will be pretty close to our targeted goals. To me, the greatest utility of TEG is after the massive transfusion. Once they undergo initial treatment, such as packing the liver in the OR, and are taken to the ICU, they are still sick but the dust has settled a bit and they are out of that massive transfusion phase. Now we have the time to figure out where they are at, and then we can be more targeted and get the TEG. Therefore, in the first 4 to 6 hours, we are not really using TEG. We tend to use it more when the patient is taken to the ICU and is in that second phase of resuscitation when we can figure out the exact problem we are trying to fix.

C-Spine Clearance

**Case 1:** A comatose patient presents to the ED and it does not appear like they will wake up in the next 6 to 72 hours. Can we clear the C-spine if they are still comatose?

**Recommendations:** One of my partners once said that our C-spine clearance protocol will never be complete — it will always be in revision. I have looked a lot at the data, and I believe that a high-quality thin-cut CT scan is enough to clear the C-spine in patients who are not at high risk. Obviously, any comatose patient is at high risk. But if the patient has no spine findings at all (cervical, thoracic, or lumbar) and they have a stone-cold normal high-quality CT scan of the C-spine, I will take off their collar. MRI is an option for C-spine clearance, but data demonstrate that taking a trauma patient to MRI is associated with an increased incidence of adverse events, including hypoxic events and pneumonia. Another option is to leave the collar on the patient, but numerous problems are associated with this option. Therefore, I tend to be more aggressive about trying to get the collars off. A new standard for
neurosurgeons recommends MRI in this patient population, although the recommendation is not very strong. The cost of the MRI, not only with regards to the danger to the patient, but the actual expense is not insignificant.

**Case 2:** An alert patient who has been in a car crash presents with a Glasgow Coma Scale (GCS) score of 15. He has a femur fracture but is otherwise okay. Does this patient need imaging before the spine can be cleared?

**Recommendations:** Our group tries to follow the NEXUS (National Emergency X-Radiography Utilization Study) Criteria for C-spine clearance. These criteria state that clinical clearance can be performed for the awake, alert, nonintoxicated, evaluable patient that does not have a painful distracting injury. Only about a third of trauma patients in the ED fit these criteria. For the remaining patients, imaging is required to clear their spines. One of the things we constantly argue about is, what if the patient has a femur fracture? An injury in and of itself is not an exclusion criterion. The fracture must be painful distracting injury before requiring imaging for spinal clearance. Some patients with a femur fracture are in horrible pain and cannot concentrate: these patients are distracted and cannot be cleared clinically. Other patients with a femur fracture are calm and cooperative and can participate in a physical exam: these patients can be cleared clinically.

**Possible C-Spine Fracture: The Use of CTA**

**Case:** A patient presents with an injury that might be associated with a C-spine fracture. Does this patient need to undergo CT angiography (CTA) of the neck to exclude the neck injury?

**Recommendations:** In our practice, we try to follow the Denver criteria. Screening via CTA is needed for any patient who has any signs or symptoms of potential blunt cerebrovascular injury (any external signs of bleeding, cervical hematoma, some bruit, and evidence of a clear infarction in an anatomic distribution on CT scan) and for patients who are at high risk of blunt cerebrovascular injury (Glasgow Coma Scale [GCS] score <6, midface fractures, any cervical fractures or subluxation, or basilar skull fractures). We use the Denver classification system to grade these injuries (grades I through V). For Denver grades I and II, we treat most patients with aspirin but not heparin. For grade III injuries, we also treat most patients with aspirin (not heparin), and I believe some emerging data demonstrate that this is the correct approach for most grade III injuries. We rarely use full anticoagulation. According to the Denver criteria, fully anticoagulating any patient who meets the criteria to get a CTA is challenging, especially in the first day or two.

**Grade 2 Follow-Up:** Most grade 2 injuries are treated with aspirin. We reevaluate these patients because, even at a week after injury, many will have healed or perhaps did not have an injury to begin with. We tend to restudy them early at 7 to 10 days. After dismissal, we ask patients to return in 1 to 2 weeks so that we can restudy them yet again. If the studies are normal, then aspirin therapy can be discontinued at that time.

**Urgent Airway Management: Intubation and Surgical Airways**

At our institution, our emergency medicine physicians have a “difficult airway cart” in the ED that includes fiber optics as well as a videoscope. Videoscopes are helpful, especially in a training center when an emergency medicine resident attempts the intubation. With the videoscope, everyone can see what they are looking at and see the tube go through the cords.

**Intubating Difficult Airways:** Our emergency medicine group has a standardized approach to intubating difficult airways. Basically, you must have a Plan A and a Plan B for oral or nasal intubation. Plan B cannot be to try Plan A again. To increase the odds of success in Plan B, you must make some
substantial change. If Plan B does not work, then Plan C is to go to cricothyrotomy (cric), which is our method of choice for an urgent surgical airway.

**Cric Technique:** When performing a cric for an urgent surgical airway, a couple of technique-related items are important. (1) First, make a vertical incision for the cric. For an elective tracheostomy, I make a transverse incision, but when for an emergency cric, I make a vertical incision. If you incise transversely, you can cut the anterior jugular veins, so I always make a vertical incision. By doing so, if I am off a little, it is easy to extend the incision up or down to get into the correct spot. (2) Stay on the patient’s right side. I put the heel of my left palm on the patient’s chin, and then I use my thumb and middle finger to stabilize the larynx, feel the cricoid with my index finger, and make a vertical incision. Do not be afraid to make a large incision. I next insert a hook and use it to lift the cricoid, then I hand that to my assistant on the left side. Then usually I insert either an endotracheal tube or a small trach tube. Ideally, use a size 6 tube, but a size 4 ought to work if that is all you have. Trying to insert a regular Shiley™ tracheostomy tube is very difficult: the tube’s size, stiffness, angle, flange, etc, all interfere with trying to get the tube into a cric.

**Tracheostomy:** After performing a cric, the patient has done well but they may still need an airway 2 days later. At this point, we generally convert to a formal tracheostomy. Although it is very unusual, some report decannulating them right from the cric. Usually, I will take the patient who needs an ongoing surgical airway to the OR within 1 to 2 days to convert to a formal tracheostomy. Easily 25% of the time, I find something in there that needs repairing, such as a cut cricoid cartilage that needs 1 or 2 stitches.

**Anticoagulation and Injury**

**Case 1:** A patient presents after blunt torso injury. The patient is on warfarin. How should we manage this case? Management depends on what injuries the patient has or what injuries they are at risk of having.

**Warfarin Reversal:** The biggest challenge is the elderly patient on warfarin who falls down and may or may not have a head injury. If we are worried about them and they are on warfarin, we have a rapid warfarin reversal protocol that we use. This protocol largely consists of prothrombin complex concentrate (PCC). I think everyone is now moving toward the 4-component product. If you use the 3-component product, the patient must first be primed with fresh frozen plasma (FFP). Depending on the patient’s actual INR, the treatment is some combination of vitamin K and PCC for correction. Using this protocol, we have had relatively good success with getting patients’ INR down relatively quickly without giving them a lot of volume.

**Case 2:** A patient presents with acute trauma. Their cardiologist has had them on dabigatran (Pradaxa®). How should we manage this case?  

**Recommendations:** Dabigatran has a specific reversal agent — idarucizumab (Praxbind®). This agent has only been available for 6 to 8 months at the time of this presentation. Our group does not have a huge experience with this agent. We probably have had nearly 100 trauma patients on warfarin, and for most, our urgent warfarin reversal protocol was successful. During that time, we have only needed the idarucizumab once or twice in trauma patients.

**Anti-Xa Products:** For trauma patients on anti-Xa anticoagulants (rivaroxaban or apixaban), these cases can be difficult to treat. These drugs have no specific reversal agent. Some data indicate that PCC may be helpful, so we do use that in these patients. But again, we have only done it maybe two or three times in the last couple of months, and there is nothing we can measure to tell whether or not we did any good giving the PCC. We have had discussions with our pharmacists and our blood bank, and because at least some soft data indicate that PCC might be helpful, we are using it basically because we have little else to offer. The Food and Drug Administration is trying to fast-track an antidote for the anti-Xa agents, but it is certainly still in the study phase.
**Trauma & Anticoagulation: Pharmacologic Prophylaxis**

**Case:** A young patient presents with brain injury and long bone fractures. He is going to be at bed rest for some time. Do you start pharmacologic prophylaxis on a trauma patient with a brain injury?

**Recommendations:** Yes, we do. This has been an ongoing negotiation at our institution. We have finally settled on starting chemoprophylaxis for deep vein thrombosis (DVT) at 72 hours after stable head CT. Regardless of stabilization, all patients get mechanical prophylaxis — sequential compression devices (SCDs) are a form of prophylaxis.

**Solid Organ Injuries:** What about chemoprophylaxis for solid organ injuries? For example, a patient has a grade IV liver, but the hemodynamics are okay. When do you start prophylaxis on that patient? We would start acute prophylaxis at 24 hours after the patient has a stable hematocrit.

**Long Bone Fractures:** In your practice, do patients with long bone fractures receive prophylaxis for a full 30 days, or do they receive prophylaxis until they are ambulatory? We generally continue prophylaxis until we think the patient is going to be ambulatory. Unfortunately, prophylaxis sometimes ends when the patient leaves the hospital. But our orthopedics team has gotten more aggressive about continuing prophylaxis after patients leave the hospital. At some institutions, their guidelines state that these patients are to receive prophylaxis until they are fully ambulatory. This is one of the reasons these centers are seeing more use of rivaroxaban and apixaban: it is much easier to give these agents than to ask patients to inject themselves with low-molecular-weight heparin.

**Blunt Aortic Trauma: Intimal Injuries and Pseudoaneurysms**

For blunt aortic injuries, our practice uses a classification system to help us decide what to do with these patients. We actually have a relatively extensive experience with this at our center. We have a long-standing cardiothoracic surgery program with a big interest in aortas and aortic injuries, and they are one of the places that developed an aortic endograft 20 years ago. A number of grading systems for blunt aortic injuries exist. In my mind, I try to classify these injuries as (1) those that have a normal external contour of the aorta (an intimal injury) or (2) those that have an abnormal external contour (pseudoaneurysms [PA]).

**Intimal Injuries:** For intimal injuries, medical management is our preferred approach. We are doing impulse control in these patients (controlling heart rate and blood pressure). The issue is always how long should we continue impulse control. We try to image these patients in the hospital before dismissal. Usually these patients have significant chest trauma, so they are usually in the hospital for some time. Approximately 7 to 10 days before they leave, we get another imaging study. If they still have an intimal injury, then we continue them on anti-impulse therapy. We usually see them at 30 days after dismissal and get another study. Most intimal injuries will heal, so we continue with pressure control and follow-up until the injury heals. We are not using aspirin as part of our protocol.

**Pseudoaneurysms:** Most, but not all, PAs undergo endovascular repair at our center. In the past few years, we have become more aggressive about doing endovascular repairs now that there is a more specific thoracic endograft for these injuries. When we identify a definite PA, then we try to push the endovascular repair because of the risk of rupture and because the overall management of these patients is often challenging. Management is difficult because if the patient has a head injury, neurosurgery wants their mean arterial pressures (MAPs) up, but because the patient also has an aortic injury, cardiothoracic wants their MAPs down. By repairing the PA, the aortic injury is removed from the equation, which helps expedite patient care.

**Endovascular Repair:** At our center, almost 100% of patients with PAs receive a thoracic endograft, even the young adolescent. Covering the subclavian has been less of a problem than before the thoracic endograft became available. When they first started doing them at our center years ago, they would routinely cover the subclavian and then do a little jump-graft afterward. As their experience grew,
they found that it was delayed 1 to 2 days in a few patients, and they were handling it alright. So now, we rarely cover the subclavian, and if we do, we usually just watch the patients to see if they develop any signs of ischemia, which they rarely do.

Aortic Injuries: Should Aortic Injuries Cause Hypotension?

Case: A patient presents with acute trauma and hypotension. They respond slightly to resuscitation. We find that they have an aortic injury. They have blood in their belly and what looks like a splenic injury on their CT scan. Once again, they become hypotensive. Should we rush off to fix the aorta at this point? Lesson: This is one of the classic teachings, and I think it is correct. The aortic injury should not make the patient hypotensive if it is contained. If the aortic injury is not contained, then generally it is lethal. In my entire career, I think I have seen one patient rupture an aortic injury in front of us and survive. Usually hypotension in these patients is caused by one of the “usual suspects.” If the patient is bleeding into the belly, they likely have a pelvic fracture. In such cases, we proceed to the OR and take care of the spleen. The aortic injury should not be making them hypotensive unless they have a free rupture, in which case it is almost always fatal.

Multiple Rib Fractures: Pain Management

Case: An elderly patient presents with multiple rib fractures. What should we use for pain management? Recommendations: We take these cases seriously. According to our trauma guidelines, a patient aged ≥65 years who has >3 rib fractures is admitted to the ICU, even if they look good. The next step in our protocol is to provide 24 hours of stable pain management before they are ready to be discharged from the ICU. Although good data demonstrate that epidurals help in these cases, I think that, practically, epidurals are a big challenge in these cases because they are just often difficult to do. Therefore, at our center, we tend to use lidocaine drips and patient-controlled analgesia (PCA) in these cases. Rib Blocks: We do not use rib blocks, although I believe rib blocks to be an underutilized modality. They really can help these patients. Nonetheless, they are not very sexy, and people do not do them very much anymore. But I believe they can definitely help us get good pain control, especially early on. Ketamine & Lidocaine Drips: We are using ketamine drips and lidocaine drips with increasing frequency for pain control. On my computer, I have little sticky notes for things I am working on, and one of my big things for the coming year is it is basically a nonnarcotic pain control program, especially for the elderly. I think that is going to be a big issue in general, not just for ribs and trauma patients. I believe that in 5 to 10 years, we will not be using narcotics for pain control in most of our trauma or surgical patients. Acute Management: The dose for lidocaine drips that we use is a standard weight-based dose. Lidocaine drips provide good pain relief, although we must monitor the patient’s pain levels. We are also using Neurontin® in these patients, and we can generally get by with a fairly low amount of narcotics. Typically, these people arrive in the ED at 4, 5, or 6 o’clock in the afternoon or in the early evening. To try and get an epidural put in at 7, 8, 9, or 10 o’clock at night is a challenge. At that time, the spines are not cleared, we cannot sit them up, they are in a collar, it is late in the evening, etc. So, we put them on a lidocaine drip, and we give them IV Tylenol® and PCA. The next morning, if they look good, we continue this pain regimen. However, if our regimen has failed to provide good pain control by that first morning, then we get an epidural put in.
**Rib Fractures: To Repair or Not to Repair**

A study was recently published by our Denver colleagues regarding whether we should surgically stabilize rib fractures. This study used a historical control, and the authors concluded that we should be repairing more rib fractures. How do we decide who gets their ribs fixed? First, I believe that an increasing number of rib fractures will be repaired for the simple fact that there is now a CPT code for it, which is new. Reimbursement always affects things. Second, I believe that, right now, the only patient population with a relatively clear benefit for rib fracture repair is patients with flail chest who are on a ventilator. Available data for this patient population support the use of chest stabilization.

**Other Possibilities:** I am convinced that another group of patients would benefit from rib stabilization: patients with rib fractures who return to the office 2 to 4 weeks after their trauma. They are still uncomfortable, they are not back to work, and they are still taking narcotics. We fix every other long bone in the body, right? And the minute we stabilize a forearm or femur fracture, the pain gets instantly better. I am relatively sure that some patients with isolated rib fractures who have a significant amount of pain would probably feel better if we plated their fractures. I just have not yet been able to figure out how to find those patients, and no one has done that study. The question is: would the patient rather have an operation and feel better in 6 or 7 days, or would they rather go home and do medical management with pain medicines, in which case they would feel better in 2 or 3 months. Is early operative stabilization better for the patient overall? How soon do they return to their normal life and/or work? How soon do they get off narcotics? I would love to see that study be done. But without that data, I am a little slow to stabilize these fractures.

**Conclusions:** At our center, we are performing surgical stabilization of rib fractures for patients with flail chest who are on the ventilator and for patients with late nonunions or chest deformities.

**Splenic Injuries: Angiography/Embolization and Meaning of Blush on CT**

Treating splenic injuries used to be relatively easy. When I started practice, we had one option: remove the spleen. As time passed, we began to fix injured spleens. Finally, we began to manage them nonoperatively. Now, a controversy that is emerging regarding splenic injuries: what is the meaning of a blush on CT scan? Can you help clarify all this data for us?

**Response:** Probably not! Some people are now saying that, regardless of blush on CT scan, we must take these cases to angiography and embolization. At our center, we are not big users of angiography and embolization. We actually just reviewed our data for the last several years for high-grade splenic injuries (grades III, IV, and V), and we found that we used angiography and embolization in only 7% of our patients. For those patients who receive nonoperative management, our salvage rate is 95%. One center is advocating angiography and embolization for all high-grade splenic injuries. They use angiography and embolization on 95% of their patients and having the same splenic salvage rate that we are having.

**Management:** In my practice, if a patient presents with a splenic injury and if they have normal hemodynamics, we get a CT scan. Our decision regarding operative versus nonoperative management largely depends on the patient’s hemodynamic stability and response to resuscitation. Not all blushes on CT scans are the same. If an acute trauma patient has a relatively big blush, then I am more likely to operate on them as opposed to trying to embolize them acutely. The patients we embolize acutely are usually those that have some other reasons, maybe a pelvic fracture as well as a splenic injury. We also embolize patients with high-grade splenic injuries (grades III, IV, V) who failed initial nonoperative management. The late failure rate in these patients is not high, but it probably ranges from 5% to 10%.

**CT Blushes:** In the acute phase of splenic injury, blushes seen on CT need to be considered in light of other factors. Is the spleen intact? Is the capsule intact? Is the spleen lacerated? Is this a little tiny blush? Is this active extravasation? I am not aware of any hard and fast grading scale for this, so we must use
some judgment. We are now more frequently ignoring some of the little blushes seen on the initial CTA. If we see a big extravasation, then the patient needs either operation or angiography and embolization. Like I say, we are not big utilizers of angiography and embolization. I just looked at our data last week, and our failure rate for nonoperative management is about 4.6%.

**Splenic Injuries: Nonoperative Management**

**Case:** A trauma patient presents with normal hemodynamics, and CT scan shows a grade III or IV splenic injury. Are there any absolute contraindications to managing this patient nonoperatively?

**Contraindications:** The only absolute contraindication would be that the patient has another reason (other than splenic injury) to operate on their abdomen. For example, you suspect that the patient also has a bowel injury, a pancreatic injury, or a diaphragmatic rupture. Any absolute indication for a laparotomy is the only real contraindication to nonoperative management.

**Bed Rest:** For cases of isolated splenic injury that we treat nonoperatively, the patient is initially kept on bed rest. The classic teaching for how long to keep them on bed rest has been injury grade plus 1 day. We have no data to support this practice. Most data now say that we can probably be more aggressive about getting the patients out of bed. But we usually keep them at bed rest for 24 hours, and then we individualize it. For an isolated grade I/II injury, I might keep them at bed rest for 24 hours then let them up. If they are eating and walking okay, they can go home the next day. For isolated grade III injuries, I would be hesitant about dismissing them that early. For isolated grade IV/V injuries, I would probably keep them hospitalized for several days.

**Repeat CT:** I like to repeat the CT scan before hospital discharge. Most patients with splenic injuries have other injuries, which extend the duration of their hospital stay. For these patients, I try to get a CTA before dismissal because a small number of these cases will demonstrate a real pseudoaneurysm. This is one group of patients who may have a late failure of nonoperative management — they go home and their spleen ruptures. So we try to get a repeat the scan the day before they go home and check for any abnormalities.

**Splenic Injury: Return-to-Play in Athletes**

**Case:** A young athlete injures his spleen about 4 weeks before his team will go to the championship games. His parents and coach arrive in your office for follow-up, and they want to know if he can play. Is that okay?

**Recommendations:** Last year I had two scholarship college athletes and one semipro athlete in my office with the same questions. My response is that if the athlete’s participation is not for the Olympics or some professional endeavor, I am kind of strict. I make them wait at least a full 6 weeks before returning to sports. If the athlete is talking about going back to full contact sports in which the risk of reinjury is real, I will get repeat imaging on them at 6 to 8 weeks before I let them return to play. If I took care of them during the initial event, I also try to get an US as well before they go home to obtain a “baseline study.” Then I can follow up with serial US studies, thus avoiding the exposure of several repeat CT scans. Regardless, I will obtain imaging studies to document healing before I return them to full activities. Approximately 15% of these patients will never have a normal CT scan, even 6 to 8 months or 1 year later. At what point do you say, “Well, now you are okay, you can go back to full activities?” I usually make them wait. I get a study at 6 weeks, and if it is still abnormal, I get one at 3 months. In 3 months, if it is still abnormal but it has not progressed, then I will let them return to full activities.