Audio Companion for SESAP® 16
PROBLEMS IN RELATED SPECIALTIES — Category 10

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The following faculty report no relevant financial interests: Drs David A Bull, Casey M Calkins, and Richard PM Koehler.
Preventive Measures in Pediatric Trauma: Carseats, Bicycle Helmets

As a pediatric surgeon there are 2 major prevention areas — carseats and bicycle helmets.

**Carseats:** Pretty much on a daily basis, we deal with the use of carseats and the heightened awareness of efforts to make carseat fitting a natural part of the landscape. When you deliver a baby in any hospital in the Milwaukee area, it is mandatory to have a carseat fitting by a certified technologist prior to discharge. I think that is an enormous effort, and I would like to think it has made a tremendous difference in terms of how children are secured in automobiles to try to prevent motor vehicle crash morbidity and mortality.

**Carseat Fitting:** In our hospital, fitting is done by specially trained personnel. Other institutions and hospitals in our region have different practices with regard to who does it, but it has to be an individual certified in safety devices. What parents do with the information after they leave obviously is another thing entirely, but at least we are trying from the outset to encourage families to use carseats appropriately and to be able to fit them in a way that is meaningful for their children.

**Bicycle Helmets:** In the State of Wisconsin, there are no state laws for the use of bicycle helmets, but when I ride around my neighborhood, it is nice to see most children wearing one. I know there are states that do have laws, Washington comes to mind, and that many other counties in Washington have made bicycle helmets mandatory for children. The data not surprisingly delineates that helmet use has dramatically decreased the consequences of bicycle crashes compared to not wearing them.

Pediatric Nonaccidental Trauma, Shaken Baby Syndrome

Nonaccidental trauma or NAT is basically a fancy word to describe child abuse. Unfortunately, we see a fair amount of this. During the course of my training and now being in practice, the incidence has not really changed anecdotally, and I know that is substantiated by data as well. The key thing, at least for me as a physician, is to be suspicious when the story does not fit the injury pattern.

**Signs of NAT:** The classic thing in our practice is the child who does not walk or crawl that has bruises — that obviously does not fit and should raise a red flag about the potential for abuse. That is not a child with hemophilia; that is a child that has been abused until proven otherwise. Probably the most common presentation is repetitive trips to the emergency department for injuries. Obviously, if you are doing radiographic work-up on a child with fractures in various stages of healing, that is pretty classic, or patterns of burn injury that do not fit with a story. Submersion burns are fairly common in which a child is unfortunately placed underwater against his or her will and has submersion injuries to lower extremities with clear cut offs between the burned and the nonburned skin. Those patterns of injury should raise suspicion. As a physician, you are never going to be chastised for at least calling the social worker in your ER and raising suspicion for injury that does not fit with the story.

**Shaken Baby Syndrome:** This term implies that a child has been shaken, and the typical injury is subdural hematoma. These babies generally present with lethargy and obvious neurological symptoms not compatible with normal. The typical scenario is unfortunately the mom brings her child in and he or she has been watched for by another caregiver, and that caregiver has shaken the baby to the degree to where the baby has a subdural hemorrhage. As a result, the neurologic status is anywhere from waxing and waning to obviously a lateralizing injury with hemiparesis, etc. It can vary in terms of presentation, but that is the general story we usually get in our emergency department.

Substantiating Non-Accidental Injuries

One of the luxuries of working in a large Children’s Hospital is that not only do we have social workers and people that have a heightened sense of the potential for nonaccidental trauma, but we also have a
specific subset of pediatric practice called the Child Advocacy Team. These are pediatricians who have gone through a specialized fellowship training program to be able to recognize patterns of injury and do all the diagnostic testing and necessary medical-legal workup for those patients. They are always asking us to get CT scans of the abdomen when we feel the potential for an intraabdominal injury is not very high. It is not that they would change what we would do clinically but instead because it is important in the court of law to document all the injuries. Bone scanning also is one of those tests that can help prosecute potential abusers when nonaccidental trauma is suspected. So, a lot of the testing we do does not necessarily make a whole lot of sense clinically, but it is important from a medical-legal standpoint.

**Burn Patterns Important in Determining Cause**

When a child pulls a pot of hot water off the stove, there is a typical pattern of burn. First, obviously it has to be a child that is mobile. The 6-month old that is not able to pull the pot of water off the stove raises concerns. The 2 year old that is in the exploration stage is obviously prone to that, and you would expect there to be a pattern of injury that is commensurate with that. Water spilling down the front of her chest or splash marks on the face are things that would imply a dramatic event that goes along with pulling a pot of boiling water off the stove. The whole hand being burned without any splash marks implies the hand has been placed in hot water under duress, so there are 2 different obvious patterns of injury. One that implies a true unfortunate incident versus an obvious abuse-type situation where a patient’s hand is being placed under water.

**Children With Special Needs:** The other population in our world that is vulnerable is obviously the children that have special needs. They are still lumped into this category.

**Principles to Manage Splenic Injury after Blunt Abdominal Trauma**

Handling a splenic injury after blunt abdominal trauma in a child is probably not a whole lot different than doing so for an adult. The biggest issue is whether or not the patient is hemodynamically normal. In children, obvious hypotension is something we do not often see until it is too late, so if patients have significant blunt abdominal trauma, we would go through the steps that a lot of other adult centers would go through. We start with ABC survey and a FAST exam, and if there is a bunch of blood in the peritoneal cavity suggestive of a splenic injury, it really comes down to whether or not you feel you can treat the patient non-operatively. This is no different than an adult. Tachycardia is probably the biggest issue we face in children. At the end of the day, if you feel you can get away with managing a patient non-operatively, we do that. In splenic injury in children, 90–95% can be managed without surgery. You have to use your judgement based on physiologic parameters, and there is no cut off per se for blood transfusions. Another hot topic is how much blood is too much blood when you take a spleen out. Thankfully, we do not face that situation very frequently. The other thing unique about children is if you do get a FAST exam and the patient is hemodynamically normal to the point you are able to get a CT scan and document a splenic injury, surgery is still not mandated. The blush on a CT scan that normally in an adult might heighten your need for angioembolization or surgery, in children a lot of those injuries will actually go away without doing anything. A blush is not a necessary mandate to go to the angio suite per se. That is one of the differences in children and adults, but by and large the management principles are pretty much the same. In many cases, we do not have to do an operation in order to remove the spleen or take out part of it.
Amount of Bedrest Needed Following Splenic Injury

**Case:** You have a 10 year old who fell on her bike, hit her handlebar, and has a grade 3 splenic injury. She is hemodynamically normal, and got 1 transfusion of blood products. What do you do for bedrest with them, or what happens after the trauma room exit?

**Recommendations:** When the guidelines were originally proposed and written, bedrest days were essentially grade of injury +1. So, for the child you are describing, it would be 4 days of bedrest. At our institution as well as others around the country, this recommendation is becoming more liberalized. At our institution, grade 1 and 2 injuries are maintained on bedrest overnight, and then they are able to get out of bed the following day. For grade 3 and 4 injuries, we estimate that at 2 days. Again, this is predicated on the fact that patients are hemodynamically normal and have an adequate response to non-operative management. Then, once patients are discharged to home, we have not changed our restrictions on activity — grade of injury plus 2 weeks. For that 10 year old with a grade 3 injury, we limit her ability to play soccer for 5 weeks total.

**Case Continued:** So, she is the star on the team. The coach and parents are in your office a week after discharge, and they say the championship game is coming up. What do you do?

**Recommendations:** We do not have good data to say that number has been well studied. These guidelines were put in place many years ago. They seemed to have worked, but we have not studied whether or not 3 weeks or 2 weeks or 1 week is any better than 5 weeks. So, I give the parents and coach my recommendations about what I would do. But at the end of the day, it is a free country and people are going to do what they are going to do. I tell them I think the risk of recurrent bleeding is higher in higher-grade injuries but that I do not know that for certain. My recommendation is to always follow the guidelines. Some people listen to me, and some people do not.

**Rescanning:** We generally do not rescan, but this might be a scenario where if the parents were really pressing me to know more information, an ultrasound might be of value. If on ultrasound you do find a pseudoaneurysm per se, that might steer me to say, “Hey, you know we really ought to wait longer in this particular child because the findings an objective study has shown what we talked about.” But, by and large, it usually does not happen. Most people are apt to listen to what we say.

Occasions for Partial Splenectomies

**Case:** A 13 year old does not stabilize with blood transfusion and is still hypotensive. You go to the operating room, and he has a lower pole that is macerated, but the rest of the upper pole and the hilum seemed to be spared. He is just bleeding from this lower pole piece of the spleen. Do you ever just do a partial splenectomy?

**Recommendations:** On occasion, I have done a partial splenectomy. It has got to be the right patient. The principles still remain — you have to have a patient that is hemodynamically able to tolerate general anesthesia and an operation that is going to take a little bit longer than just simply doing a total splenectomy. If I am able to do the operation quickly and effectively, then I certainly would make an attempt to try to either fulgurate ongoing bleeding — ligate the lower pole vessels. Those would be the 2 things that would come to mind I can do quickly to try to ascertain whether or not that would be successful. Then if that is successful, the next question is what to do with that piece of dead tissue. Again, I would say that would depend on the situation, but just leaving it alone and allowing it to involute would probably be just fine rather than do something heroic and removing it.
Advantages, Methodology of Performing Partial Splenectomies

**Case:** A patient presents with hereditary spherocytosis. Is a partial splenectomy something that can be done there to salvage some of the spleen?

**Recommendation:** It can, and it has. A partial splenectomy has been described in other rare splenic condition, but hereditary spherocytosis (HES) is the most common. Obviously, the potential benefit is there — you do away with the problems as a results of the hereditary spherocytosis — so the hope is to increase red cell half-life and increase hemoglobin levels while preserving splenic function. Essentially, you divide the main blood supply to the spleen and leave behind a small remnant of the superior pole on those short gastrics, which can be done open or laparoscopically. The downside of it is the spleen typically regrows after about a year, but a majority of patients actually do have relief in terms of increased hemoglobin level, etc, when you do that operation, while hopefully preserving some of the splenic function.

**Controlling Bleeding:** There are a variety of ways to control bleeding. I have found a LigaSure device to be helpful. When I do it laparoscopically, then I fulgurate the remaining pulp with argon beam, and I have had pretty good luck with that. You want to cut across the parenchyma in the ischemic part. Probably the best trick is dividing most blood vessels; you will get a clear demarcation of what is going to live and what is not, and coming through that ischemic part with a LigaSure has worked well for me in the couple of cases that I have done.

**Should a Pancreatic Duct Injury Be Treated With Surgery?**

Obviously, if you have a child that is 5 days out after an injury and has a large peripancreatic fluid collection, that is probably not someone on whom you want to operate. Instead, to try to temporize things with drainage — either internally or externally — is probably the way to go. But for the patient who is 24 to 48 hours after injury who has a complete ductal transaction and is an otherwise-healthy 8 year old, that would still be a patient on whom I would operate. Because the ease of the operation oftentimes is usually a crack right down the body of the pancreas, you can usually fairly easily do a distal pancreatectomy and preserve the blood supply to the spleen. I have been faced with this scenario a couple of times and have had pretty good luck. So ERCP and drainage for a patient like that typically requires long periods of TPN and complications that go along with internal drainage procedures and the potential for the distal pancreas to become ischemic, etc. My personal thought is just to do the operation that I know how to do, and that usually works pretty well.

**Posterior Bleeds:** I am a LigaSure freak, so I use this quite frequently. Or I use ties — ties are not a bad thing. On little things, I would use small little LigaSure. If there is a larger branch, I will tie it.

**Managing the Cut Edge:** To manage the cut edge, I usually use an Endo GIA stapling device reinforced with Gore-Tex. If I am worried about the duct or the integrity of the cut edge, then I will oversew it — I could use PDS® or Maxon™ or some type of braided suture material.

**Is a Child Too Young to Repair Hernia?**

The most common reason we see patients in the office is for hernia, both umbilical and inguinal hernias. For umbilical hernias, we generally wait until patients are pre-school age before we entertain the idea of fixing them. We start to think about doing that at the age of 2, although my practice has changed over the last couple of years. Because of the potential heightened awareness of the problems with general anesthesia in children, I usually wait until kids get to be about 3 or 4 years of age before entertaining fixing them. Many umbilical hernias will close on their own without surgery. In fact, about 85% to 90% will. The challenging patient is the 1 year old that has what I like to call the proboscis-like hernia,
the elephant trunk that you know for certain is never going to close. I would still like to wait, not only for the anesthetic considerations but also because we do not generally use mesh to close these. Anecdotally, it is a lot easier to sew the fascia that is a little bit more robust than a 1 year old’s fascia is. So for those 2 reasons I wait, and the risk of incarceration from an umbilical hernia is so infinitesimally small that waiting is reasonable.

**How Young Is Too Young for Anesthesia?**

There are a number of observational studies in humans that suggest there might be detriment of anesthesia in the first couple of years of life with regards to neurodevelopmental outcome, school performance, ADHD, etc, later in life. But they are observational studies, and the right thing to do is still quite controversial.

**SmartTots:** There is an organization called SmartTots composed of a host of people from multiple groups including the American Academy of Pediatrics and American Society of Anesthesia. They have gotten together and released a consensus statement that essentially says if you do not need surgery in the first 4 years of life, it is probably reasonable to entertain delaying an operation. Umbilical hernia is a great example of that. On the other hand, if the risks of waiting to do an operation outweigh the potential detriment of anesthesia, you should have the operation done. There was a trial published recently in the *Lancet*. It was mainly conducted overseas. They randomized patients undergoing inguinal herniorrhaphy in the first 6 months of life to either regional anesthesia or general anesthesia and are continuing to follow the patients. Interim analysis was just published in the *Lancet*. At 2 years of age, in patients who have a sevoflurane anesthetic for less than an hour, which is what you would expect a straight-forward inguinal hernia for general anesthesia, there is no difference in neurodevelopmental outcome — mind you — between the general group and the regional group thus far. As these patients are followed, there might be a difference when you hit 5 or 6 years of age. That is encouraging evidence to suggest an anesthetic delivered by a practitioner with expertise in pediatric anesthesia is probably no different than a regional anesthetic for short-duration case, but there is a lot more work to be done in this area.

In my practice, I try to wait if I can based on these concerns.

**Ease of Anesthesia:** If you have a Board-certified pediatric anesthesiologist and surgeon who know what they are doing, regional anesthesia on a small child is quite attainable. There have been people who have done pyloric stenosis operations under regional anesthesia. We do not advocate doing that here, but it has been done. Our hospital benefits from using anesthesiologists specifically trained to care for children, and I think that makes a huge difference.

**Diagnosing an Inguinal Hernia**

**Case:** Diagnosis of inguinal hernia is made by the parents bringing a child in and saying there is a hernia or the referral of a pediatrician. When the child presents to your office, you cannot find the hernia. **I:** At some point you rely upon your knowledge of the pediatrician or the referring provider. I kind of know who to trust and who not to trust, and I am sure that occurs all over the country. If parents are reliable, you can usually sense that pretty quickly. They may describe a bulge right here that comes in and out or the bulge is right here all the time. That is a pretty good story for an inguinal hernia. Unfortunately, there is no radiographic study to help you to identify a hernia. If it is not out, it is very difficult to identify a patent processus vaginalis by ultrasound, CT, or MRI. So, I base a lot of what I end up recommending on my gestalt — the referring provider, the parent and then if you believe in spermatic cord thickening, which is where you take either a gloved finger or a lubricated finger and try to examine the inguinal canal. And I am probably about 50:50 on this. If you feel spermatic cord thickening, that is
suggestive of a patent processus vaginalis. It is not going to steer me one way or the other to operate, but it gives me a little bit better credo with regard to whether or not I am going to operate.

Incarceration a Risk in Infants

Lately, incarceration risk has been downplayed in the adult inguinal hernia literature, but it still a problem in the infant. We see patients in the emergency department that either have a known hernia and are waiting to get it fixed or they do not have a known hernia but present that way. Our literature says the risk of incarceration is similar, 15–20%. Antidotally, that seems like a high number, but this is what has been published. It is a real risk, and it is one of the driving forces for most pediatric surgeons to still recommend elective herniorrhaphy when you have a hernia, especially in a premature infant. Obviously, if you have clinical hernias in both sides, then you repair both sides at once. If a child has a unilateral hernia and no evidence of a clinical hernia on the other side, this is an area of controversy. Especially in a premature infant or anybody less than 2 years of age, I offer contralateral inguinal exploration for diagnostic purposes with the intent to identify processus vaginalis for treatment of the contralateral side and go ahead and fix that while the patient is under the same anesthetic if it is found. The other interesting thing about the anesthesia data is a lot of people think it is repetitive exposure to anesthesia that may be the problem. But basically, the more anesthetics you have, the higher the risk of potential damage to the developing brain. The way I sell this to parents is that, even though I do not know if the processus vaginalis is patent and going to become a hernia, it is of potential benefit to be able to avoid another anesthetic in the future by fixing it now. This is especially true in the premature infant with a left inguinal hernia. Generally, a right inguinal hernia is more common than a left inguinal hernia; if he has a left inguinal hernia, the chances of him having a processus vaginalis that is patent on the right side is very high. These are patients who will truly benefit from a contralateral exploration.

Laparoscopic Repairs in Young Children

When talking about doing laparoscopy on a child, most general surgeons know that we are not talking about doing TEP repairs in a 2 year old. Obviously, we do not use mesh because these were not direct hernias or indirect hernias by and large. But there is a movement in pediatric surgery to do intracorporeal laparoscopic repairs to close the processus vaginalis, and there are a couple of different ways to do this. You basically take a suture and close the internal ring. People are doing this in our specialty from the infant period and up in patients who have an indirect hernia. The benefits are that you make an incision at the umbilicus then usually make a couple of very tiny stab incisions to put instruments into the abdominal cavity and close the hernia laparoscopically. Personally, I have not adopted this practice, mainly because the earlier reports of those procedures demonstrated just slightly higher risk of recurrence. People that are starting to do this now and some of the emerging data would suggest the recurrence rates are actually not a whole lot different than the open standard repair. The other benefit is it allows you to identify the contralateral side if in fact there is a patient that only has a unilateral hernia clinically.

Majority of Neck Masses Are No Cause for Concern

The most common neck masses we see are a dermoid cyst or a cyst in the midline. **Midline Neck Masses:** These are usually above the sterna notch, not up in the neck by at cricoids cartilage but rather lower down in the neck. Even though they tend to occur in the midline, they do not vary with swallowing. They are stationary, they are mobile, and they can generally be simply removed.
by excisional biopsy. Differentiate between that and the thyroglossal duct cyst, which occurs higher in the neck around the cricoid cartilage, varies with swallowing, and is an entity that is a developmental problem or a leftover — so to speak — that connects to the foramen cecum at the back of the tongue. Those should be removed because they are prone to get infected. Since the setting of infection increases the risk of recurrence, the neck mass in the midline that the general surgeons see in the ER that is red and inflamed is probably a thyroglossal duct cyst. Those patients need to be treated with antibiotic therapy plus or minus drainage with a needle. Treatment should allow the infection to be “cooled down.” An elective resection should be undertaken at a later date, and the resection for that is a Sistrunk procedure where you remove the entire cyst, follow the fistula up to the foramen cecum and take a portion of the hyoid bone as well. If you do not do that, then the risk of recurrence is much higher. **Lateral Neck Masses:** The lateral neck masses are the branchial cleft remnants, and those can be of 3 different entities. The most common reason why I see a child in the office with a “neck mass” is lymph nodes. Most are benign. A child who has had a recent upper respiratory tract infection or ear infection presents with a bunch of bulky nodes in his neck, and his parents are concerned he has lymphoma, which quite frankly for a 4 year old who is otherwise healthy is not common. You have to resist the temptation to take out lymph nodes in children when the parents or the pediatricians are clamoring for doing so in your office. Most of those reactive lymph nodes will go away with time, so you have to be patient.

**Medullary Carcinoma Should Be Taken Seriously**

Thyroid nodules in young children are very uncommon. If you have a patient <13 years of age with a thyroid nodule, the risk of malignancy is very high, near 25–30%; therefore, most pediatric surgeons would recommend lobectomy for those types of patients. A solid thyroid nodule in a 10 year old ought to heighten your concern for carcinoma. I approach these patients by saying, “You know, we can do an FNA, etc., but oftentimes it is nondiagnostic, and then you really have not done anything with that information.” I think it is important for a surgeon to understand where we are now in terms of MEN 2A and B screening, as it has probably changed since residency. This is information I did not know until a couple of years ago, so I thought it was helpful. The specific codon mutations guide the way you would talk to a family about prophylactic thyroidectomy. While I do not expect most general surgeons to do a prophylactic thyroidectomy in a 1 year old, all should be aware of it because they are probably seeing patients that do have a history of MEN 2 that may or may not have had their thyroids removed. They probably have occasion to see those people back or those people might be pregnant or having children, so I think it is important for surgeons to understand there is a lot more robust way of evaluating patients with MEN 2 syndromes. If there is any concern about MEN 2 syndromes or a familial medullary carcinoma, which is in that same realm, then the family should most definitely get genetic testing. I think genetic evaluation is readily available and should be undertaken.

**Batteries Cause Corrosive Esophagitis and Perforation when Ingested**

Ingested foreign bodies, specifically little “button” batteries, are a problem these days. There is very little argument about what the right thing to do is. Because of the alkaline nature of the discharge of the battery, button battery ingestion can cause a corrosive esophagitis and perforation. This can happen pretty rapidly, so I consider this to be a surgical emergency. There are very few surgical emergencies in pediatric surgery, but I personally consider this to be 1 of them. This mandates immediate removal with endoscopy. You do not want to try to pull back with a Foley technique because, sometimes even after just an hour or 2, you can have erosions into the mucosa or the wall of the esophagus. I recommend rigid esophagoscopy and removal under direct vision.
**Gripping the Battery:** A good pair of grasping forceps is the best way to grip the battery. There are a number of forceps that we use. Probably the best one is called alligator forceps. They have serrated edges, so they can really grip on to that entity. Unfortunately, if the battery is stuck and you cannot get it out with endoscopy — thankfully this happens infrequently — you probably want to commit to a thoracotomy for removal. I have had occasion to see 2 now in my career of tracheoesophageal fistulas that have occurred as a result of button batteries being lodged in the esophageal wall.

**Danger Arises when Multiple Magnets Are Ingested**

Small toy magnets are still a problem. The issue arises when someone ingests more than 1. If a patient has swallowed magnets and they are proximal to the pylorus — either in the esophagus or in the stomach — get the magnets either with rigid esophagoscopy techniques or with aid of a gastroenterologist who has all kinds of tricks for putting those things in baskets and removing them by flexible endoscopy. If they are past the pylorus, then the issue is what to do. Recommendations vary. We generally recommend a GoLYTELY purge like a bowel prep and following the progress of the magnets in the hospital with x-rays, intervening if the patient should develop any symptoms of a bowel obstruction or peritonitis, which is what happens in this situation. You have 2 magnets that meet up between the walls of 2 separate lumens of the small intestine that lock and create a fistula and peritonitis. Then you are forced to do something operatively. To try to avoid this, we basically bowel prep patients and try to move these magnets as rapidly as possible. If the magnets stop, not moving for 6 to 12 hours, and the patient is still not symptomatic, get a CT scan. If the magnets stopped but are joined and they are intraluminal, obviously you do not have to do anything about those. But a CT scan will tell you if the 2 magnets have met between the walls of the intestine, in which case I would do diagnostic laparoscopy, identify what the problem is, and correct it.

**Appendicitis: Surgery or Antibiotics?**

When it comes to the treatment of appendicitis with antibiotics, pediatrics is lagging behind a little bit. We are part of a multi-institutional Parent’s Choice trial to examine this very issue, and I think one of the questions in SESAP refers to this. It has to be the right patient to treat with antibiotics — a patient with early onset of symptoms, they cannot have peritonitis, they cannot have a fecolith, and their white count has to be <18,000. So for those patients, the trial has been pretty interesting actually. You give the parents the objective evidence that exists for operative intervention, which is very good. I would like to think we do a pretty good job with taking the appendix out in an otherwise-healthy 12 year old. The existing data on antibiotic therapy is not very good, which is 1 of the reasons we are doing the trial. Parents then choose whether or not they want to proceed with surgery or oral antibiotic therapy. I think we have enrolled over a dozen patients now, 6 in each arm. So far, we have only had 1 out of the 6 fail, and that patient actually failed before going home. This goes along with the observational data — if you treat a patient with antibiotics that has early appendicitis, there is about a 15% to 20% failure rate in the first year. Of course, this is different for a 90 year old than it is for a 9 year old. The real issue for me when I talk to parents is this — what are the chances of your child getting appendicitis when they are 12? I cannot give answers to these families, so I am torn. I am a surgeon — laparoscopic appendectomy for me is extraordinarily straightforward in the majority of patients, especially in those patients where it is early. But now we are seeing a furor of patients interested in pursuing nonoperative management.
Preparing a Case of Gastrochisis for Transport

If you are a general surgeon in a small town and a baby is born with an abdominal wall defect, there are a couple of pretty simple caveats. First, you have to protect the intestine. Gastrochisis is a defect that occurs in the abdominal wall. It is now usually noted prenatally with good prenatal care. The defect usually is pretty much always to the right of an intact umbilical stalk. The bowel is usually dilated and macerated, probably owing to the fact there is a small hole and you have venous congestion of the bowel. As a general surgeon, you want to decompress the GI tract with an OG or NG tube. You want to protect the bowel from the environment in terms of temperature loss, and it is pretty simple — you just put the patient in a bowel bag from the waist down to try to prevent some of that heat loss. If you are out in the middle of nowhere and are transferring the baby and the aperture of the hole is really, really tight and the bowel is becoming ischemic in front of your eyes, the 1 thing you can do is open the fascia. This is as simple as just taking a pair of scissors and opening the fascia to make the apertures bigger to allow that bowel to be healthy for the purposes of transport to a higher level of care. These are kind of the initial principles of gastrochisis and then the neonatology stuff such as intravenous fluid resuscitation and the antibiotics are obviously important, but for the general surgeon these are the things you can do to temporize the situation until the baby can get to a pediatric facility. With gastrochisis, most of those babies — even though they are premature — generally do not have anything else wrong.

Preparing a Case of Omphalocele for Transport

With gastrochisis, most babies do not have anything else wrong with them. Then omphalocele is different. It is a defect of the umbilicus where babies have an essentially large umbilical ring defect. There are different gradations of severity from a very small, almost glorified umbilical hernia to a true giant omphalocele where the majority of the liver and intestinal tract is out that is covered by the amnion. This is 1 of the distinguishing characteristics between omphalocele and gastrochisis, and patients with omphalocele generally tend to have more concomitant congenital defects such as heart defects, renal defects, etc. For the general surgeon faced with omphalocele that is covered, which is the standard one, the best thing to do is to put on a non-adherent dressing, decompress the GI tract with an OG tube, and send the baby on to a higher level of care. The conundrum comes in when that amniotic sac is ruptured, and what I would tell a general surgeon is to treat that baby like you would one with gastrochisis. Leave the amnion alone; do not do anything with it because we can actually use it. It is almost like a silo if it is reasonably intact. Then put the baby in a bowel bag, and send the baby to higher-level care. For the general surgeon, these are salient principles of what you need to do and how to recognize the differences between the 2.

Correcting Gastrochisis Without Sutures

Correcting abdominal wall defects without sutures is something I have learned in the last couple of years, and my practice has dramatically changed. Recently, a baby was born at 34 weeks. I saw the baby in the nursery. The bowel appeared to be viable. The baby was awake and thriving, not on a ventilator, and had just had an IV. Five years ago, we would have taken that baby to the operating room and, under general anesthesia, reduced the bowel back into the abdominal cavity, closed the fascial defect with sutures, and tried to make a new belly button. Today, what I did with this baby — what we have done with a lot of these kids now — is put the bowel back in like we would do in the operating room. Then, instead of trying to do fascial closure with sutures, you take the umbilical stalk, and put all the bowel back in so long as it goes back in, and we use all the same parameters. Hopefully, the obstetrician has left the umbilical cord long; you may have to educate obstetricians. Now that we have educated our
obstetricians, the cord is left about 10 feet long. This is all done without general anesthesia but rather with the neonatologist at the bedside providing sedation, usually with a little bit of morphine and a small dose of Versed. The baby is awake and breathing spontaneously. We want to make sure the baby is breathing comfortably. We use NIRS monitoring, which is a regional oximetry monitoring of the back to try to get a sense of whether or not it is too tight, so to speak. We do all those same things. As the baby tolerates this bowel replacement, we use the piece of umbilical stalk and basically fold it over the defect. You can do 1 of 2 things — you can just cut the stalk short enough and cover with a Tegaderm so that is truly sutureless closure, or you can take a couple of chromic sutures and just tack the cord down to the skin around the defect so it stays there. I am pretty anal, so I do the second. The way I do it is not really sutureless, but it is pretty close. So, you do not do anything about the umbilical fascia. And just like an umbilical hernia, some of those will close without surgery, and we have seen that already in some of our patients. We started doing this a couple of years ago and have found that, even though you leave them with an umbilical hernia defect, it closes just like an umbilical hernia would. This is pretty slick. It is one of those things that has really changed in our specialty over the last couple of years. The obvious benefit is you avoid anesthetic at a potentially vulnerable time in the patient’s life. If it does not work, you are back to going to the operating room or just putting silo on. The silo is the chimney-like housing we use. It has a spring on the bottom of it that you, basically for lack of a better term, stuff in the abdominal cavity and temporarily house the bowel in that silo until you can gradually, over the course of several days, close up.

**Management Techniques for Meconium Ileus**

A meconium ileus is typically associated with a cystic fibrosis (CF). It is a defect in the processing of the meconium as a result of a gene defect that goes along with CF. A meconium is normally kind of thick and viscous in a normal baby; in a baby with CF, it is like tar. And as a result, they get stuck in the terminal ileum, so patients have an intraluminal obstruction essentially with tar. This meconium is horribly abnormal, and this really causes an obstruction. Historically, it is called meconium ileus, but it is really an intraluminal obstruction. It usually presents within the first day of life because babies will not tolerate feedings. A classic example is a plain radiograph with dilated loops of small intestine, a decompressed colon, and a ground-glass appearance in the right lower quadrant where the meconium, once it gets static, can develop calcifications, etc.

**Past Management:** Management has also changed since I was a resident, and I am not that old. You know, traditionally, this was long time ago, this was the so-called Bishop-Koop operation where they would take that baby to the operating room and make a distal enterotomy in the terminal ileum so you would have 2 ends of the ileum staring you in the face. You would evacuate all that meconium with saline, an acetylcysteine, or an agent that would dissolve the meconium. Then you make kind of a chimney-like anastomosis, so you bring the distal end out as an stoma, an end stoma, and then anastomose the proximal ileum to the side of the terminal ileum with the hope that you can irrigate through there, and continue to wash things out. This was before the days we had enzymatic replacement for patients with CF, so just doing that operation was not the end of it. You could use that as a way to continue to evacuate the meconium out of those babies.

**Current Management:** But today we have enzymatic replacement, so once you get rid of the meconium you do not usually need a stoma. Generally, you do not need to operate on patients with uncomplicated disease. By way of a combination of antegrade substance — we like to use dilute NS acetylcysteine or Mucomyst, the stuff that smells like rotten eggs — and doing enemas from below, you can oftentimes dissolve the meconium to the point to where you do not need to operate. If you do need to operate, you can irrigate the ileum out by making a small enterotomy, and then you do not have to create a stoma. That management in uncomplicated disease has definitely changed since some of your SESAP readers may have been in residency. Complicated disease patients are those with perforation or a
meconium pseudocyst, and those are a lot more difficult patients. Thankfully, these are a lot rarer, but these are generally patients that require operative intervention because of a perforation and a stenosis or they have a pseudocyst, where they have had an intrauterine perforation and they have meconium peritonitis, which is a bad problem.

**Indentifying and Treating Malrotation Quickly is Essential**

Again, there are few pediatric surgical emergencies, but a baby with bilious emesis is another one of them. Every newborn infant who has bilious emesis should be assumed to have malrotation and midgut volvulus until proven otherwise, which has not changed for decades. I always tell our residents, if they learn one thing on our service, it ought to be that. The question about what you should do is pretty simple — you need to have a heightened degree of awareness about the problem, and you need to make the diagnosis expeditiously. The best way to do that is with an upper GI. An upper GI will show either obstruction at the level of the duodenum or the classic hook screw down the right lower quadrant, which is where the bowel is twisting around itself. You might have a scenario where the ligament of Treitz is not on the patient’s left side but the right side. The contrast still kind of trickles through. Anything that says malrotation in a baby with green vomiting ought to expedite an operation.

Now, if you are a general surgeon and you do not know the operation to do and you are in a scenario where you could get that patient out, that should be like a level 1 trauma. In fact, I was just up at one of our outside facilities. At 2 a.m., I had an 8 year old who had a similar story. She was totally healthy until a couple of hours ago and presented with green emesis, and the ER physician was estute enough to get a CT scan because he could not get an upper GI.

**CT Scan:** The CT scan showed what we see in malrotation with a CT scan. The mesentery will swirl, and it is pretty obvious. In this particular girl, it was very obvious. You do not need to be a radiologist to figure it out. If you get delayed images on CT, the orientation between the SMA and the SMV are reversed. Those are backwards, and if those are backwards and you get that swirl sign in a girl with green emesis, that should prompt an immediate transfer to a higher level of care where you have a surgeon that can deal with the problem. In the interim, the best thing you can do is fluid resuscitation, start an IV, and place an NG tube to decompress the proximal GI tract. The general surgeon needs to be able to recognize it. Of all the kids we get that have a history of green emesis, we probably do 4 upper GIs to diagnose 1 patient with a problem, so we do a lot. We have a short fuse for doing a study in the middle of the night to make sure they do not have that particular entity because it is a life-saving operation when you can perform it in a baby with volvulus.

**Treating Adults with Abnormal Anatomies**

The classic patient with malrotation is usually less than a year of age. The 8-year-old girl I described to you before is an anomaly, but and I have had occasions in which I operate on older folks. They generally present not with an acute presentation but rather years worth of intermittent abdominal pain, weight loss, bloating — those types of symptoms. For these patients, I have offered a laparoscopic Ladd’s procedure, which is where you do a couple of things — you assess the rotation of the bowel; not all of them are going to have this very narrow pedicle of mesentery, but many of the older patients will have pretty significant Ladd’s band. Those are the bands that emanate from the cecum or the right colon over the duodenum or proximal intestine, and they can cause obstructions. A lot of these patients have these vague symptoms, probably because those bands have been a problem for them for many years.

Reorient the bowel in ways where the mesentery is wide. For most patients, that means if you divided the bands, you want to straighten the duodenum on the right side so it has a downward trajectory almost towards the right leg. Widen the mesentery and then place the cecum in the left upper quadrant.
This usually gives you a reasonable repositioning of the anatomy, so to speak. A lot of parents ask us if it is necessary to tuck the bowel down. This has been tried and probably acts as more of a point for obstruction rather than doing anything formidable. Tucking the bowel varies in adults. One month, tucking is preferred; 1 month not tucking is preferred.

**Removing the Appendix:** Taking the appendix out is obviously part of the Ladd’s procedure because most of those patients have an appendix that now lives in the left upper quadrant. This idea might change now that the antibiotic option is out there, but we still recommend taking the appendix out when it is going to be in an abnormal location. With adults, the big issue is usually revision of those bands. Once you get rid of those, a lot of these patients actually do have a reasonable amount of relief. Many of these patients have been what I like to call GI institutionalized; they have had problems for many years. But, in my limited experience in dealing with older patients, they definitely do have relief.

**Determining and Treating Meckel’s**

The usual presentation for a Meckel’s in a child is painless bleeding. The vast majority of these patients are between 2 and 5 years of age. Today, we still rely on scintigraphy to determine Meckel’s. It is a little bit easier sell for parents if we have an actual diagnosis before going to the operating room. For the patient who has uncontrolled bleeding and you do not know where it is coming from, this is a little bit different scenario. However, this is not generally how most patients with a Meckel’s will present. They present with voluminous bleeding that stops, and it is usually because of an ulcer of the ileum that bleeds and then stops and bleeds and then stops. Most of the time, we are in a scenario that you are not going to the operating room emergently because of a Meckel’s diverticulum that is bleeding. So, we rely on the results of this Meckel’s scintigraphy. The issue then becomes what if this is negative. This is pretty common, and the patient has had an upper and lower endoscopy and those were all normal and there is no anal fissure and there is no sigmoid polyp or there is no other reason for the child to have a bleeding episode. These are patients I would counsel the families about the potential benefit of diagnostic laparoscopy, and that is what I will offer, especially when somebody has had more than 1 episode. If they have had more than 1 episode and the diagnosis is still in question and the Meckel’s scan is negative, then I would most definitely offer diagnostic laparoscopy.

**Case 1:** When you are in there, you see a Meckel’s, it has got a wide base, what do you do?

**Recommendation:** For the patient that is symptomatic, I do a segmental bowel resection and primary anastomosis. I think that is still the conservative and safe answer. In a patient that has had a bleeding episode, taking the Meckel’s out does away with the ectopic mucosa that has caused the ulcer, but you have not done anything about the ulcer. Presumably, if you take the ectopic mucosa out, the ulcer might go away. But the way I was trained and I think the safest thing is to do a segmental bowel resection, get rid of it, do a primary anastomosis. I identify the area laparoscopically and make a small incision in the umbilicus. I would bring that area out. I do everything extra corporeally and dunk it back in, and that is a minimally invasive operation. In my experience, most of those patients have done exceptionally well.

**Case 2:** You are doing an appendectomy and find a Meckel’s. What do you do?

**Recommendations:** What to do is an area of controversy in our world. In my patient with appendicitis, I would not do anything because you are there for another reason, but it is safer unless you are doing an inguinal hernia or if you find one, you come back and take it out, you know it is broad based. Those are issues that I think are still unresolved and by in large up to the surgeon and their judgment if there is a right or wrong answer.
Esophagus: Ingestion of Acid or Alkaline

The initial management differs for the ingestion of acid versus the ingestion of alkaline. Alkaline ingestion is more common than acid ingestion. The two major groups at risk are children aged <5 years (typically accidental poisoning) and adults (typically intentional ingestions as part of a suicide attempt).

Pathology: Alkaline ingestions are associated with injuries to the oropharynx but exert most of their damaging effects on the esophagus, producing a form of liquifactive necrosis. Because of their liquid nature, acid ingestions often do most of their damage in the stomach, inducing a form of coagulative necrosis.

Diagnosis: At our center, we first obtain a CT of the chest and abdomen as part of the diagnostic workup. This helps assess whether a transmural injury has occurred and whether esophageal perforation is a concern. If neither of these injuries has occurred, then we go to endoscopy. We find that CT can be as reliable as endoscopy to rule out the presence of a transmural injury and to detect the possible presence of perforation in a way that is not as easily done with endoscopy. If esophageal perforation is present, then we will likely be headed for an operative intervention, a washout of the mediastinum, and, though unusual, an esophageal resection. Once esophageal perforation and transmural injury are ruled out, then the patient would undergo endoscopy to assess the site and extent of the endoluminal injury to predict the likelihood that a stricture will eventually form.

Grading System: The grading system we routinely use for esophageal injuries like this ranges from Grade 0 to 4. Grade 0 indicates that normal mucosa is present. Grade 1 indicates that superficial mucosal erythema/edema is present. Grade 2 indicates mucosal and submucosal ulceration (2a: superficial ulcerations; 2b: deep circumferential ulcerations). Grade 3 indicates transmural ulcerations with necrosis (3a: focal necrosis; 3b: extensive necrosis). Grade 4 indicates esophageal perforation.

Management: Grade 0 lesions require no intervention, while Grade 4 lesions need operative intervention. Patients with a Grade 1 lesion should not require a great deal of resuscitation, have a good prognosis, and need weekly follow-up endoscopy to ensure that the injury has not progressed. The Grade 2 and 3 subgroups need the greatest attention to reduce the complications or sequelae associated with these burns. Once the burn injury has set in, we have not yet found a reliable means to keep it from progressing. Steroid therapy has been commonly used based on the notion that it would decrease the inflammatory response and subsequent stricture formation. However, no prospective trial has confirmed that steroids are a reliable intervention in this circumstance. As strictures form, balloon dilatation is effective. Patients with Grade 3 lesions will need repeated endoscopy, repeated dilatation, and, if they cannot be managed with balloon dilatation alone, they may require operative intervention, including esophageal resection and reconstruction of the stomach.

Esophagus: Iatrogenic Perforations

Esophageal perforations typically occur in the distal third of the esophagus just above the gastroesophageal junction. This is the most common site with endoscopy-related perforation and also spontaneous perforation that typically follows vomiting. Injuries related to esophagogastroduodenoscopy typically are self-limited and often heal with conservative management. Esophageal perforations resulting from vomiting (classic Boerhaave perforations) typically are associated with significant soilage of the mediastinum and are much more likely to require urgent operative intervention. The relationship between a Boerhaave perforation and a Mallory-Weiss tear is strictly anatomic. A Mallory-Weiss tear typically involves the mucosa of the distal esophagus and proximal stomach, and Boerhaave perforations tend to involve the distal third of the esophagus. These are two distinct entities. Mallory-Weiss tears can often be managed nonoperatively through endoscopy and clipping or direct intervention through the endoscope. However, a Boerhaave perforation usually requires operative intervention. In the past, people were taught that extensive esophageal resection was required to manage a Boerhaave perforation. But with experience, we found that the esophagus can typically be salvaged, especially if you operate
early and perform a patch repair to the perforation site, wash out the mediastinum, and ensure that there is no ongoing contamination. This intervention can save the esophagus, especially if there is no underlying pathology present (stricture, tumor, or mass obstruction).

**Stents:** Stents may play a role in the treatment of a Boerhaave perforation. Usually, covered stents are useful for smaller perforations that do not have extensive soilage of the mediastinum. To use a covered stent when there is a question of soilage of the mediastinum, then a mediastinal washout should be performed. For a true Boerhaave perforation that has significant disruption of the distal esophagus, patients are better managed with operative intervention, washing out the mediastinum, and a direct patch closure to the area of direct repair rather than placing a stent in what is likely a contaminated field.

**Surgery:** For perforations in the distal third of the esophagus, my surgical approach is through a left posterolateral thoracotomy. It allows good exposure of the distal third of the esophagus, allows full mobilization of the esophagus onto the stomach, and provides a good view. For perforations that occur in the middle third of the esophagus, my surgical approach is through a right posterolateral thoracotomy, which often offers a better approach because you do not have to deal with the aorta.

**Patch:** In the OR, I know that I am dealing with a perforation, so I harvest and mobilize an intercostal muscle flap in the fifth intercostal space along the superior border of the sixth rib. If the perforation is a little lower, then we will go to the sixth intercostal space to mobilize the intercostal muscle. The idea is to rotate the intercostal muscle to help patch the esophagus. Other alternatives patches include pleura, pericardium, and omentum.

**Esophagus: Squamous Cell Carcinoma**

Typically, squamous cell carcinomas are located in the middle or distal third of the esophagus. Adenocarcinoma tends to be in the distal third of the esophagus and is more commonly associated with reflux disease. In the past, the treatment regimen for squamous cell carcinoma of the esophagus was a straight surgical approach. But this has changed. Patients who demonstrate any evidence of disease involvement extending through the mucosa into the muscularis are better treated with neoadjuvant chemotherapy prior to an operative intervention. Patients who have disease isolated to the mucosa can undergo an endoscopic mucosal resection, although in some circumstances, a surgical resection is required. **Invasive Disease:** Do all cases with evidence of disease involvement extending through the mucosa into the muscularis require resection after neoadjuvant therapy? We are finding that a significant number of these patients will have R0 disease (no evidence of disease) following resection. This has led to the question of what to do with a patient who, on repeat endoscopy, does not have evidence of disease. That is still an open question. I think a combined assessment is made between the patient, oncologist, and surgeon as to whether the patient can tolerate a resection. My view is that there is likely microscopic disease left behind. If the patient can tolerate esophagectomy, that is the way to ensure that their recurrence rate is going to be significantly lowered. **Outcomes:** With the neoadjuvant approach to this disease process, have the outcomes changed from a relatively dismal outcome to an improved outcome? I think the outcomes are beginning to improve. Esophageal cancer, because it is typically diagnosed late, still has a poor prognosis. However, for cases detected at an earlier stage of disease (stage I or II), the outcomes are improving and are likely to be reflected in new data in the coming 5 years or so.

**Chylothorax After Esophagectomy: Occurrence and Management**

Chylothorax is a problem after esophagectomy. It can occur as a result of direct transection of the thoracic duct, in which case the patient typically will have a high-output leak (>1000 mL/day). Chylothorax can also occur as a result of a minor injury through a branch off of the thoracic duct rather
than the thoracic duct, in which case the patient will have a low-output leak (<500 mL/day).
The distinction between high-output and low-output leaks is important because their management differs significantly. A low-output leak can typically be managed conservatively with nonoperative intervention: the patient’s diet is changed to a low-fat or non-fat, medium-chain triglyceride diet, effectively shunting material out of the thoracic duct and allowing the injury to close on its own. A high-output leak is very unlikely to respond to conservative management and requires some type of intervention to close that leak.

**Percutaneous TDE:** The intervention classically has been surgery, but we have gone to a percutaneous thoracic duct embolization (TDE). This procedure is typically performed by interventional radiologists, and our success rate for that in the University of Utah is approximately 80%. We use percutaneous TDE as our first intervention for a patient who has a high-output leak. The procedure is typically done through a pedal access (or somewhere in the lower extremities around the feet), and then the lymphatic system is accessed. Because this can be technically challenging, a newer method has been to access the lymphatic system through the inguinal nodes, which seems to be subject to less technical and anatomic variation. Once the lymphatic system is accessed, and then a wire is passed and material used to occlude or embolize the thoracic duct is applied to seal the leak. After the procedure, even if embolization is successful, we typically maintain the patient on a medium-chain triglyceride diet for several weeks so as to not unduly stress the thoracic duct and cause a leak to re-emerge. It is not done in isolation, but it can be a very useful intervention and hopefully prevent the patient from having to undergo a thoracotomy and open ligation of the thoracic duct. The material we typically use material to occlude the duct is a Gelfoam® thrombin, although they sometimes insert very small plugs. The thoracic duct is not a large structure, so options for occlusion are limited based on the size of the vessel.

**Lung Cancer: Screening and Dealing With False-Positive Results**

Results of the National Lung Screening Trial using low-dose CT scanning for smokers demonstrated that screening with low-dose CT scan can reduce the risk of death from lung cancer, especially in patients aged 55 to 74 years who have at least a 30-year smoking history. At our institution, we routinely screen for lung cancer in patients with a 20- to 30-year history of smoking, and we are detecting an increasing number of stage I lung cancers. The dismal prognosis of lung cancer is mainly due to the fact that disease is detected a later stage (stage III or IV) when most interventions are no longer effective. By detecting patients at an earlier stage (ideally stage I) with an isolated mass lesion, they should be able to undergo operative resection and enjoy a good long-term prognosis.

**False-Positive Results:** For every 5 low-dose CT screening exams, 1 will yield a false-positive result. That patient will need to have a follow-up with at least 1 more CT scan, but approximately 5% of false-positive cases will require evaluation with invasive biopsy or surgery. If the lesion regresses on subsequent scanning, it was not a malignancy. If it does not change in size on subsequent scanning, it needs to be followed up. We must be aware that false positives occur and that we should not jump to perform an intervention the first time a lesion is detected.

**Follow-Up:** If the patient’s original scan shows a mass lesion >1 cm in diameter with a spiculated margin, I am more likely to regard that as a true-positive case and proceed accordingly. But if the original scan shows a lesion <1 cm with smooth margins and no other evidence of disease, then I am likely to follow up with a repeat scan in 4 months. If at 4 months the lesion’s size is unchanged, we will repeat the scan in another 4 months. If the lesion’s size remains unchanged on that scan, then the follow-up interval is extended to 6 months and then 1 year, especially if the patient is continuing to smoke.

**Smoking:** Lung cancer screening is not a single test: it is process that involves counseling to stop smoking and requires annual testing. The best treatment for preventing lung cancer is to stop smoking.

**Screening Creep:** For breast cancer detection, a “screening creep” has been observed in which, over time, younger, lower-risk populations begin to be screened. I suspect that a similar creep may
eventually be seen with lung cancer screening using low-dose CT. If we detect a sufficient number of stage I cancers, I think it is likely that the screening threshold may move from a smoking history of 30 years to 25 years to 20 years. At some point, an analysis will be done to determine the number of smoking years at which positive results will begin to be seen.

Lung Cancer: Treatment

The optimal treatment for patients with stage I lung cancer is a video-assisted thoracoscopic surgery (VATS) lobectomy combined with a mediastinal lymph node dissection. Even for stage I patients, I perform a mediastinoscopy at the time of the procedure. If the mediastinoscopy is negative, I perform a VATS lobectomy and then a mediastinal lymph node dissection. The same treatment is also appropriate for patients with stage II disease. If, at the time of mediastinoscopy, a patient is positive in 2 lymph nodes, I do not proceed with a VATS lobectomy. Instead, I have that patient seen for chemotherapy or radiotherapy, and then restage them after they complete that regimen.

N2 Disease: Once a patient has N2 disease with lung cancer, their long-term survival is not good being approximately 20% at 5 years. Therefore, once such patients complete chemoradiotherapy, they would rarely be considered for a possible intervention. I occasionally have those patients, but usually patients with N2 disease will undergo definitive chemoradiotherapy with the understanding that the 5-year survival is poor.

Chemo Drugs: For lung cancer chemotherapy, the workhorse drugs are typically platinum-based carboplatin and Taxol®. New immunotherapies are on the horizon as are targeted inhibitors of epidermal growth factors that are present in 7% to 8% of patients. As these drugs become available, a more personalized approach will be explored in many centers, which will be facilitated by next-generation sequencing on resected tumors.

Survival vs Neoadjuvant Therapy: Has the use of neoadjuvant therapy improved the survival outcomes of patients with N2 disease? Most patients with N2 lung cancer will not undergo chemotherapy and radiotherapy followed by resection. Most of these patients will be treated with definitive chemoradiotherapy. I do not know that we are ready to say we have made significant progress in patients with N2 disease. What does appear to improve long-term survival is our ability to use cancer screening to detect stage I cancer in asymptomatic patients who can undergo operative resection. Earlier detection should lead to significantly improved survival: approximately 80% at 5 years.

Pulmonary Metastases: Primary Sources, Metastasectomy, and Recurrences

The most common cancer that I see that metastasizes to the lung is breast cancer. Unfortunately, in most cases in patients with breast cancer, multicentric disease is present in both lungs and is often also present in the bone. Therefore, this type of metastasis typically is not amenable to surgical resection. Among lesions that are amenable to surgical resection as an isolated metastasis, the most common lesion I see is metastatic colorectal cancer, followed by renal cell carcinoma and sometimes prostate cancer. Metastatic renal cancer and colorectal cancer tend to be multicentric. Prostate cancer can present as an isolated lesion, but the lesion that I most commonly see that is amenable to surgical resection is metastatic colorectal cancer. Metastatic colorectal cancer most commonly metastasizes to the liver, but after the liver, the next most common organ for metastasis is the lung.

Recurrences: After metastasectomy of isolated colorectal cancer metastases to the lung, the 5-year survival rate is approximately 50% to 55%. This outcome is good for those select patients undergoing metastasectomy as compared those receiving palliative chemotherapy. Colorectal cancer metastases to the lung tend to be multicentric. Therefore, after the initial metastasectomy, a recurrent lesion can sometimes be treated via another metastasectomy. After a pulmonary metastasectomy, the recurrence
rate for colorectal cancer is reported to approach 70%. Because recurrence is very common, patients need to continue with active aggressive surveillance/screening via CT scans on a yearly basis to rule out the presence of any recurrent disease. With the first metastasectomy, we often perform a VATS wedge resection, ensuring that we get clear margins. However, lesions can recur often in the same area even though patients had clear margins. Because a fairly wide resection was performed initially, that repeat operation may require a lobectomy. I am usually very conservative about performing lobectomies, but if significant involvement of the pulmonary vessels or a lobar segmental bronchus is present, then lobectomy may be the only available option.

**Aortic Stenosis in Patients Presenting to General Surgeons**

**Case:** A patient presents with aortic stenosis (AS) and cholelithiasis. What does the general surgeon need to know about operating on patients with AS?

**Recommendations:** The surgeon needs to perform a history and physical to determine whether the patient is symptomatic for AS (angina, syncope) or congestive heart failure (shortness of breath, dyspnea on exertion, fatigue, and malaise). On physical exam, if a murmur is identified in the region of the left ventricular outflow tract, the patient should get an echocardiogram before they undergo surgery for their gallbladder disease.

**Severe AS:** Severe AS is classified as an aortic valve area <1.0 cm² typically associated with normal left ventricular function and a gradient >40 mm Hg. If that patient is also symptomatic, I recommend that the AS be addressed before going on with elective surgery.

**Asymptomatic AS:** For the general surgeon, the more difficult scenario is when the patient is asymptomatic, has a valve area <1.5 cm², and has a gradient of 30 to 40 mm Hg. For these patients, knowing exactly how to proceed becomes more difficult. If time is available, the best thing to do is to perform an exercise stress test or exercise tolerance test if the patient can exercise or to perform a stress test with dobutamine to determine if the gradient increases and the heart function declines. If this occurs, then I recommend intervention on their aortic valve before undergoing the general surgical procedure.

**Unmasking AS:** The concern about AS in surgery involves the patient who is fairly well compensated, especially if they are asymptomatic. This means that their systemic vascular resistance (SVR) has increased over time to compensate for the increased gradient across the aortic valve. As long as the volume status remains reasonable, then the patient will do fine. However, for this same patient, as they undergo general anesthesia, their SVR may suddenly drop quite significantly because of the inhaled anesthetic. Their volume status, filling to the heart, central venous pressure, and blood pressure fall because volume is pooling in the periphery. Suddenly, the heart is underfilled and the gradient is increased, meaning that the heart is now very stressed, which can lead to cardiac arrest in extreme circumstances. This is what makes the decision about going to surgery a challenge: you may unmask previously undiagnosed AS when the patient goes to sleep, especially if you are not monitoring the patient via an intraoperative continuous online transesophageal echocardiogram.

**Summary:** Going back to the original history and physical, if you detect a murmur and the patient is symptomatic, the decision about what to do next is relatively straightforward. An echocardiogram should be obtained. The echocardiogram findings are used to indicate the need for an intervention before the general surgical intervention.

**Aortic Trauma: Surgical Approach vs Coexisting Injuries**

**Case:** A 15-year-old hemodynamically normal presents with a Grade III injury to his aorta. Is management different in him versus a 45-year-old versus a 75-year-old with that same injury?
**Recommendations:** Treatment of Grade III aortic injuries depends on several factors. The primary factor to consider is the presence of coexistent injury. Patients that typically are not going to be do well with an immediate operative intervention are patients who have a significant head injury, cerebral contusion, diffuse axonal injury, subdural hematoma, epidural hematoma, coexistent lung injury, significant pulmonary contusion, or coexistent abdominal injury. Instead, these patients would likely be candidates for a thoracic endovascular aortic reconstruction (TEVAR) or placement of a stent graft within the lumen of the proximal descending thoracic aorta. However, for patients with an isolated injury (no coexistent injuries), we have gone back to doing more of those procedures open. This is because a 15-years-old student with a TEVAR/endograft will require annual follow-up for the rest of their lives, which will entail a lot of radiation over the course of a lifetime. These young patients are also susceptible to graft infection, endoleaks, device migration, etc. So for younger patient who has an isolated aortic injury, we would be more likely to intervene with open operative intervention. If they have multiple coexistent life-threatening injuries, then we would offer TEVAR. In older patients for whom the long-term follow-up and consequences of repeated annual imaging are not significant, then we would be much more likely to do a TEVAR, especially in the presence of coexistent medical morbidity.

**Devices:** A variety of excellent devices are available from device manufacturers. I believe that these devices yield more durable and reproducible outcomes. So I think TEVAR is increasingly becoming a preferred option again in a multiply injured trauma patient.

**Zone I and Mediastinal Injuries: Surgical Approaches**

**Case 1:** A patient presents with a gunshot wound to the left infraclavicular area. The patient is bleeding from the wound and is not really responding to fluid that well, although you can maintain their blood pressure. How should we approach that patient?

**Bleeding Subclavian Injury:** This patient has a zone I injury and I would perform immediate sternotomy and then do a trapdoor incision on the right or left side, depending on the side of injury. Therefore, I make a T incision into the thoracic space on the involved side, attempting to gain control of the vasculature through that approach. The trapdoor can be difficult in terms of exposure, but we do have self-retaining retractors that usually afford us a relatively good view of the right and left side. In general, the left side can be more challenging just in terms of where the subclavian is located, but if necessary, we may need to make a coexistent supraclavicular incision as well if we need to go further out on the vessel.

**Non-Bleeding Subclavian Injury:** Recent articles in the trauma literature recommend that, for subclavian injuries that are not exsanguinating, we should no longer be performing a subclavian operative intervention. Instead, these injuries should be repaired endovascularly. For example, if the patient has a hematoma in Zone I and CT angiography does not show active bleeding, I believe these patients are better treated with placement of the stent to isolate the lesion. After that, the stent can cover the area of injury effectively, isolate it, and effectively treat a laceration of the subclavian artery or vein.

**Case 2:** A patient presents with a mediastinal gunshot wound that traverses the upper mediastinum, How does a thoracic surgeon approach that scenario?

**Recommendation:** If the patient is hemodynamically unstable, they need to go to the OR for a median sternotomy or a right or left posterolateral thoracotomy. If they are not hemodynamically unstable, the patient should undergo CT if there is an opportunity. If the CT scan does not show any evidence of injury, then the patient should undergo a bronchoscopy and esophagoscopy or esophagogastroduodenoscopy (EGD) to rule out any injuries to the important structures in those areas, assuming that the CT scan included a CT angiogram (CTA) of the aorta and the pulmonary artery. Therefore, the treatment approach depends on the patient’s hemodynamic status. If the patient is hemodynamically normal and has been adequately resuscitated without excessive volume requirements, then I think imaging can be successful in ruling out the presence of significant injuries. If the CTA is totally normal, I would still
obtain a bronchoscopy and an EGD as well because I believe there can be occult injuries that are not necessarily obvious on a CT scan, especially to the trachea, mainstem bronchi, or esophagus.

**Anticoagulation in AF: Dosing for Frequent Fallers and Preop/Postop Regimens**

In our practice, we are seeing an increasing number of elderly patients with atrial fibrillation (AF) who are either not placed on anticoagulation or removed from it if they are a frequent faller. Typically, an assessment is made as to the patient’s overall risk for stroke with AF. If they have had difficulty with falling and are considered to be at high risk, then their anticoagulation may be scaled back (not necessarily stopped). Alternatively, they may be moved off of Coumadin® and placed on 1 of the newer anticoagulants, such as Pradaxa®, although these agents are not without their own risk of bleeding.

**CHADS Score:** When making the decision about the risk of stroke in AF, we use the CHADS (congestive heart failure, hypertension, age >70 years, diabetes mellitus, stroke) score. A score of ≥2 usually indicates some need for anticoagulation.

**Bridging:** For patients who must come off Coumadin before surgery, it often must be discontinued 5 days in advance. Then the patient may be bridged with low-molecular-weight heparin, such as Lovenox®. Alternatively, the patient may be hospitalized, placed on IV heparin, undergo surgery after the heparin is turned off, restarted on IV heparin, postop, and then ultimately restarted on Coumadin 48 hours later. Bridging with heparin can be quite cumbersome, whereas bridging with the newer anticoagulants, such as the direct thrombin inhibitors (DTIs), is easier. Typically, DTIs can be stopped 24 hours in advance for relatively minor procedures, or 48 hours in advance for procedures associated with a higher risk of bleeding. Then 24 hours after surgery, DTIs can be restarted in patients with low risk for repeat bleeding based on what happened in the OR. For patients with a low daily risk for stroke (CHADS score of ≤2), the ongoing debate at our institution is whether the full 5-day pre-op regimen to discontinue Coumadin followed by heparin bridging and then restarting the Coumadin postop is necessary. For many patients, a good option is to discontinue Coumadin 5 days in advance and transition them to a low-molecular-weight heparin, such as Lovenox (assuming renal function is stable, predictable), to achieve predictable dosing without running into over-anticoagulation with Lovenox. Then, hold the Lovenox 12 hours before surgery, operate on the patient, restart Lovenox 12 hours later (keep them hospitalized because they are getting subcutaneous injections), and then resume their Coumadin as an outpatient. However, patients with prior cardiac surgery and mechanical heart valves cannot be off anticoagulation for any time, so they are probably best served by being hospitalized and put on IV heparin before surgery.

**Nutritional Support of Critically Ill Patients**

Most patients in the ICU with a normal body mass index (BMI) or body surface area (BSA) require about 30 kcal/kg nutritional support. During the last 10 years, we have gained an appreciation for the fact that we cannot use that same measure for an obese patient because we can easily end up overfeeding the patient. For example, we do not want to calculate the caloric needs of a patient who weighs 150 kg using the 30 kcal/kg formula. Instead, we must adjust the formula based on their lean body weight or BMI. Studies have demonstrated that hypocaloric feeding in obese patients can actually improve insulin sensitivity, decrease insulin requirements, decrease the length of stay on the ventilator, and decrease the length of ICU stay overall. Therefore, at the University of Utah, we target the caloric intake of patients with a BMI >30 to about 60% to 70% of their target energy requirement. For most obese patients (BMI >35 or 40), this means that their actual intake is approximately 11 to 14 kcal/kg of their actual body weight per day.
Chemically Paralyzed Patients: The baseline requirement for most patients with sepsis, trauma, burns, multiorgan system failure, etc is 30 kcal/kg per day. However, a patient who is sedated and mechanically ventilated has a lower expenditure of energy, and we target 25 kcal/kg per day. In somebody who is mechanically ventilated and paralyzed as an adjunct to their mechanical ventilation, they have a still lower expenditure of energy and typically require only 20 kcal/kg per day. Therefore, to determine the appropriate nutritional support, we must look at the patient and make an overall assessment on where they are in terms of their overall recovery so that we can ensure they are receiving adequate nutritional supplementation such that they are anabolic and not overfed. The exact number of calories can be a moving target, depending on where the patient is on the course of their treatment. But for a patient who is chemically paralyzed as an adjunct to the mechanical ventilation, we typically provide 20 kcal/kg per day of nutritional support.

Metabolic Cart: At our center, we use metabolic cart for our critical care patients. For patients who are mechanically ventilated, we do indirect calorimetry twice a week (Tuesdays and Fridays). We want to make sure that whatever target nutritional intake we selected is appropriate. Indirect calorimetry gives an estimate of the patient’s energy expenditure, and then we adjust the caloric supplementation twice a week.

Aortic Stenosis: Transcatheter Aortic Valve Replacement

A revolution is going on now in the treatment of aortic stenosis (AS). Transcatheter aortic valve replacement (TAVR) is now available to many of patients with previously undiagnosed AS who otherwise require general surgery. We perform TAVR at our center for patients who require general surgery, such as a ventral hernia repair or colon resection, but are found to have previously undiagnosed significant AS. These patients can be treated with a TAVR, typically through a transfemoral arterial approach. The catheter is placed through the right or left common femoral artery, and under fluoroscopy, the valve is guided into position. A new valve is placed to the side of the prior valve, which is pushed to the sidewalls of the aorta, and the AS is functionally released. Because these patients do not have a median sternotomy, they have not had to be on cardiopulmonary bypass. Recovery from TAVR is much faster than if a median sternotomy had been performed. Typically, if required in the opinion of general surgeon, the patient can then, several days later, go to the OR with adequate antibiotic coverage to have their general surgical procedure done, thus having it done during the same admission. TAVR is an option for many patients. Therefore, the diagnosis of AS does not mean that the patient is committed to a pathway of sternotomy and open heart surgery, only to return 3 or 4 months later for the general surgery procedure.

Durability: The durability of the transcatheter valves is reported to be good for about a mean of 8 years, but this is followed by a rapid deterioration of the valves. These data were released at a European cardiac meeting in the spring of 2016. This 8-year durability is about 50% shorter than that for an open surgical valve. Most of these patients are poor operative risks for numerous reasons, including frailty, multiple medical comorbidities, severe end-stage chronic obstructive pulmonary disease, renal failure, wheelchair bound, or important comorbidities and/or general surgery issues. Therefore, for most patients undergoing this procedure, their life expectancy is calculated to be within that 8-year window. Because TAVRs may not be appropriate for better-risk patients with a much longer anticipated life expectancy, these patients should undergo open operative replacement of their valve. The transcatheter valve should be reserved for patients with a limited lifespan, such as those with malignancy, renal failure, other organ system dysfunction, or those who have urgent or emergent situations going on in the abdomen or elsewhere that cannot wait for them to recover through an open valve replacement with cardiopulmonary bypass.
Infection Formation in Thoracic Procedures

Some thoracic procedures are more commonly associated with the formation of infection within the pleural space — right pneumonectomy followed by left pneumonectomy, then bilobectomy, and then probably just single lobectomy would be the decreasing incidence of those. In right pneumonectomy, infection is 1 of the largest preoperative concerns. It is a big enough concern that I try to mitigate the risk. Certainly, after pneumonectomy, irrigation with antibiotics is not uncommon. There is no science behind it, but you are trying to do everything you can. Then, closing the bronchial stump and covering the bronchial stump with whatever is nearby in terms of taking it as high as you can and letting it retract into the mediastinum and then covering it with an intercostal flap or even filling space with something like a latissimus flap are some of the other considerations. Certainly, in a pneumonectomy, a lot of times you put in a chest tube but very transiently, again, because you do not want to infect that space. Once you keep a chest tube in for more than a week, you start worrying about it infecting a space. Since you are not expecting a lung to reexpand after a pneumonectomy and it is going to be filled with fluid, you basically just want a tube in there to make sure there is no bleeding initially and then you get that out as soon as possible. This usually happens within the first 24 or 48 hours.

Closure of the Stump: There have really been no data to say that suturing versus stapling makes a significant difference. I tend to staple my bronchial stumps with the plain staple, and then bury it in the pericardial fat or at least put in an intercostal flap and then kind of tack that down over it. Covering with something is kind of a key — something living, preferable to just fat.

Treatment Options for Empyema in the Pleural Space

Here at 8,000 feet, we are blessed with very low infection rates. We do have some community MRSA. We are not seeing much of drug-resistant strains. We have C. diff and the standard stuff, but empyema tends to be polymicrobial. It tends to be aspirated flora, so it is kind of the common stuff that is in our aerodigestive tract to begin with. I have done a number of things to treat an empyema in the pleural space. I had a patient with an empyema following surgery for a prolonged air leak and then he had gotten talced. When he came to see me, he had a very hostile chest that had been partially talced but was also now infected. In that situation, there was a localized area. Interventional radiology placed drains above and did an antibiotic irrigation. As we pulled the tubes, we just filled it with antibiotic irrigant. I have done a kind of washout procedures. The standard for a post pneumonectomy space infection would be something like an Eloesser flap, basically taking a square of ribs out and suturing skin to pleura to make a pleural space that you can then pack. That is a very long and time-intensive recovery, as you can imagine. When you have a big wound you are waiting to heal secondarily when it is your entire hemithorax, this can take a long time. I have had a plastic surgery colleague help to mobilize a latissimus flap and then drop that into the chest space to kind of close the dead space and also bring a vascularized pedicle to bring antibiotics. Most of the time, some sort of a long-term drainage and/or flap is necessary. Then you have to figure out how to close the bronchial stump if that is a sizable defect. I had a patient who had had a pneumonectomy elsewhere and came and saw me and had a large pleural space infection. I went down and took the main stem, kind of flush with the carina, in order to get back to viable, healthy tissue and then brought in the muscle flap and then did some drainage for a while. Eventually, that healed through secondary means, but the bronchial stump was finally closed. I used endobronchial valves in those situations, trying to occlude things from the inside. Some try fiber and glue, and squirt things in it. Those tend to be kind of less reliable. Also, the Eloesser flap is still something that will get you out of a big problem; you do not like to pull it out unless you have to, but it certainly should be in your armamentarium.
Solutions for Thoracic Duct Injuries

Certainly if you are not careful during esophagus surgery, you can injure the thoracic duct. The LIMA harvest is still a frequent offender as well as the right lower lobectomy when immobilizing the inferior pulmonary ligament. Management depends where you are. Certainly, NPO plus TPN or elemental tube feeds for at least a week takes care of the majority of issues. If you are still dealing with a high-output chylothorax, then you have to start thinking of duct ligation, whether you do it through an open approach or a VATS approach.

**Embolization:** Embolization depends on your local interventional radiologists (IRs). I have been in cities where nobody does lymphangiograms anymore with embolization, and then in Seattle we had a couple of really good IR docs who would help us, and they would get us out of trouble occasionally by embolizing. So, I think it kind of depends on your local expertise. Other countries tend to be much more surgically aggressive, and a visiting surgeon from Belgium told us if they have a chylothorax following thoracic surgery, they go in on postop day 1 and just duct ligate, whereas I would say we have a 60–75% chance — if not higher — of getting things to close just by doing NPO or mid-chain fatty-acid feeds and kind of nothing by mouth for a week or so.

**Identifying the Duct:** When I am looking for the duct to ligate it or I know there is a problem, I have anesthesia give a bunch of creamer through an NG tube. Most of the time for a routine elective surgery, I do not do any kind of intraoperative maneuvers and just try to avoid the duct. If you do see the thoracic duct, take it with impunity; just do not injure it. In my experience, it was probably a side branch leaking, and I think those are the ones that probably do well with conservative management. I think the other thing that I do intraoperatively is to liberally use clips when I am in those higher-rent districts. Cautery does not seal structures like that, so I think using a lot of microclips to take down structures is a safer way to proceed. Despite the fact we all have increased our use of electric cautery for numerous reasons, we still have not found an electrosurgical instrument that seals lymphatics.

Minimizing Risk of Gastric Outlet Obstruction

The occurrence of gastric outlet obstruction after esophageal pull-up can certainly be an issue. There are centers that do maneuvers, pyloroplasties, and Botox injections at the time of surgery to minimize that risk. Personally, I found with a narrow conduit that was well verticalized I had very little incidence of it, so I did not do any preventative maneuvers. I do have to dilate patients. Once you have suspicion of that, you want to confirm it with a swallow. Then, either yourself or a trusted GI colleague should go in and do a dilation. You could consider Botox but, again, most of the time I think that can be prevented with meticulous adherence to surgical technique. Other than in training when dictated by the attending surgeon in my practice, I never did a pyloroplasty.

**Botox Injections:** If it not a mechanical issue, I think transiently Botox might help. I have colleagues at various centers who at the time of their surgery will do a Botox injection to relax things to facilitate conduit drainage, but this is not something that I have done.

Hemothorax that Will Not Drain: Start with VATS

The trauma literature currently is favoring early VATS every time you have a retained hemothorax. This is my approach as well. If it is not being adequately drained with tube thoracostomy, then an early VATS is reasonable. Here I see ski trauma not just in the acute setting. For example, somebody falls and 10 days or 2 weeks later comes in with a sizable effusion. I will often put in a tube; if I do not get complete evacuation immediately, I will take them for an early VATS. So, I think the approach is similar between the thoracic and the trauma communities.
Case 1: You have 1 tube in. The first day you have pretty good expansion and pretty good evacuation, but the next time you get a chest x-ray you have a little fluid that is collecting, most likely at the base but sometimes elsewhere. Do you ever ask your IR folks to do an image-guided drainage of that fluid collection? **Recommendation:** If I think it is fluid and it is in a spot that is separate from the chest tube, I would attempt to percutaneously drain it. As for the hemothorax component, if it is clotted blood, getting a pigtail or a chest tube placed interventionally — whether it be a solid or semisolid gelatinous material — is not going to do much. You really have to think, *Does it layer?* Sometimes I will do positional x-rays to see if it layers. I think you have to use good clinical sense of whether it is liquid or solid, and if there is a sizable component that is fluid distinct from my chest tube, yes, I would ask IR person to help me in that situation.

**Case 2:** A patient comes in late after having an undiagnosed hemothorax. You put the tube in; you do not get much out. On the CT scan, it even looks like it is loculated. Do you still start with a VATS approach, or are there some patients that it is just not worth starting that way and you just do it open? **Recommendations:** I would start that patient VATS, even complicated loculated empyemas that have been there a long time. Stick to your goals — expansion of lung, debridement, and thorough cleanout. I have done a number of complex drainage procedures, and I would just do it through the VATS approach. If you take your time and do not cut any corners, most things can be tackled through VATS. Within reason, I use as many ports as necessary using those principles. I tend to drain those people with a couple of chest tubes, a straight and an angled. That takes care of 2 of your VATS incisions. If you have 2 or 3 more incisions to facilitate it — or even if you needed a minithoracotomy — it is easier to heal from non rib-spreading procedures most of the time compared to putting in a rib spreader. So, even if you need a larger utility incision, you can do that. As you see from the lobectomy experience, we are getting better and better at taking out more complex things through smaller and smaller incisions. I would say that the pleural space things are analogous and that we are taking care of more complex things.

**Treating Spontaneous Pneumothorax**

**Case:** A young healthy male, asthenic, comes in with a first spontaneous pneumothorax as best you could identify. There has been no trauma. What do you? **Recommendations:** I would put in a chest tube, meaning anything from a percutaneously placed chest tube to a standard small tube or a surgically placed thoracostomy tube. My goal is 100% expansion. Once I see good expansion on my follow-up film, I monitor the air leak. If I have a persistent air leak, that is going to start pushing me into a potentially surgical approach. If I have good expansion and no air leak, I follow-up with a chest x-ray on water seal, then hopefully get the tube out and get the patient home. If we have persistent air leak, at some point we are going to be discussing with the patient that, if this does not go away, we are going to pick a point to operate.  
**Case Continued:** The air leak goes away in 48 hours, lung is up, tube is pulled, lung stays up, and everybody is happy. The patient goes home, and a month later they are back with another spontaneous pneumothorax. **Recommendations:** A lot of times I would not even put in a chest tube. I would just take him right in for a VATS at that point. I would be there at induction and make sure that the anesthesiologists understands we do not want a lot of positive pressure until we isolate that lung. I know a lot of times the mentality is, “Oh, you have to put in a chest tube”. But, if you are going to be taking them to surgery within an hour or so, why put them through the pain and trauma of another tube when you can just do it all at once? So, a lot of times I would not even get a chest CT because it is going to show a collapsed lung. I do the inner tube test where I just instill irrigation and then have the anesthesiologist gently inflate that lung while I am kind of holding it under water to find any air leaks that way. I do this minimally invasive as well.  
**Case Continued:** You have a bunch of blebs up at the apex. Do you need more than a pleurodesis approach? Do you need a resection approach?
**Recommendations:** If it was bubbling under water, I would certainly resect that segment if that appears to be the culprit. Again, it is also going to depend on the lung. If you have a young healthy kid, the tendency is to have 1 area that I can take out with 1 or maybe 2 wedge resections. A lot of times if I am worried about that leaking, I will strip some of the pleura off the apex, kind of the pleural tent, and bring that down to lay and buttress the staple line, and then do a mechanical pleurodesis as well. You are well started because you have kind of stripped the pleura off the apex anyway, and then you can just do a mechanical abrasive pleurodesis, and you can always add talc if you really want to get an inflammatory reaction.  

**Talc Use:** When it comes to talc use, I tend to be more of a mechanical abrader. The next step depends on my assessment of the risk for recurrence. The guy with terrible COPD, terrible bullous disease — you obviously want to do as much as possible in that situation. You are also thinking about whether or not the patient will ever be a candidate for a lung transplant, so you might not want to completely get rid of that space. The young healthy athlete I treat tends to say that they never want this to come back, so I at least do a mechanical and then talk to them about the talc. I do not tend to use talc with really young kids because we are unsure what it does after 40 or 50 years in the chest. I do not want to put something foreign in for that long, whereas I would tend to do mechanical and talc in a 50-year-old spontaneous patient.

**Typical Patient Profile for Lung Abscess**

The classic patient profile for lung abscess is someone with poor oral and dental hygiene and alcoholics who pass out and aspirate. These are the people who present with an abscess. The major cause is aspiration from oral cavity. Because of that, the flora tends to be polymicrobial — anaerobes and aerobes. The classic anaerobes can be bacteroides and Peptostreptococcus, and then aerobes include staph aureus and also MRSA, strep pyogenes, and klebsiella. Antibiotics are going to be your first line of attack, and then you are going to have to see if there is clinical improvement. If you do not see improvement within 4 to 7 days, you should start thinking about why it is not getting better. At this point, consider the secondary causes — bronchial obstruction, tumors, foreign bodies, etc. A patient with coexisting lung disease, 1 with CF, or a terrible smoker with emphysema — these are the patients in whom you should worry more about a secondary abscess because of underlying lung pathology. They talk about 2 phases, the acute phase lasting less than 6 weeks and chronic lasting longer than 6 weeks, but by and large you should start to see improvement on antibiotics. If you do not, you should start considering things like coexistent lung disease or an associated tumor. You should start considering bronchoscopies and CT-guided drainage. Only in very rare situations — probably less than 10% of the time — is surgery going to be required because most of the time a percutaneous drain is going to get you out of trouble if it does not resolve with antibiotics. As a general rule, 6 cm is kind of the threshold — >6 cm things do not tend to work out well without drainage below. They tend to do much better with just antibiotics alone.

**Determining Cause when Patient Does Not Respond to Antibiotics**

**Case:** You are seeing a patient for the first time. Do you use a plain x-ray to diagnose, or do we need CT imaging to be sure with what we are dealing?  

**Recommendations:** In thoracic, we are now probably going to get a CT scan. She is being treated as a pneumonia; it is not getting better. At some point imaging is going to be important, ultimately to determine whether this is a pleural space infection, an empyema following a pneumonia, or a lung abscess. This kind of delineation is best identified on CT scan. To exclude or prove some of those other causes, I wait until the patient has been treated a while with antibiotics. If there is no response, I start doing other diagnostics tests.
Drainage: Certainly endobronchial drainage has been done. Some of the problems you run into are that it can contaminate other sections of the lung when you drain it through the bronchus, so you can actually spread the infection to other areas. If there is an associated lung cancer and you can do some sort of an endobronchial ablation and reestablish that airway, I think that makes sense. Otherwise, if you have a segment that you are not aerating and are just percutaneously draining, you are going to be worse off than if you can drain it endobronchially.

Repairing Lacerations: Approach Depends on Location

Case: A patient presents with a simple laceration through the lateral third of the left diaphragm. You are in the belly. How do you go about fixing that?
Recommendations: If it is large, I would fix it with interrupted pledgeted Ethibond sutures, using a large braided Ethibond as the bonder. I tend to do pledgets just to prevent it from ripping through, especially if there is already a laceration. I do worry about the innervation of the diaphragm for future respiratory function, but if the laceration did not injure the nerve it is unlikely the pledgeted repair is going to do it.
Case: Same case, but you are in the chest.
Recommendations: I have fixed a couple of these thoracoscopically. It depends on the location. It depends on how you can accomplish your goals of the operation. If it is very close to the rib margin, sometimes your angles for getting a needle driver in there can be a little more difficult. A lot of these are diagnosed late. I have had a number of patients who came in with giant hernias that, on careful questioning, the patient reveals a snowmobile accident when he was 12 or some previous trauma. Now in their 30s, they have problems. One patient had almost his entire liver up in his chest and another gal had basically everything that was not retroperitoneal in her belly up in her chest — her stomach, colon, and small bowel and she had a loss of intra-abdominal domain. I repaired that through a thoracoabdominal incision and then used Gore-Tex to reconstruct the defect because it was so large. We did a concomitant component separation to give her abdominal domain because she had lost so much of it. It had been such a chronic, longstanding issue, and I worried about compartment syndrome after repair.

Incising the Diaphragm: When you have to go through the diaphragm for whatever reason, the central tendons are the area of most concern. A radial incision in the diaphragm is always going to be safer than an elliptical or 1 that mirrors the chest wall because of the innervation coming out centrally. If you are cutting between the spokes in the wheel, you are probably going to be okay, whereas if you cut across the whole thing, then your chances of injuring it is much more. If you are worried about a diaphragm injury, plicating at the time of repair would be a reasonable thing. If it is longstanding injury, you can always do a fluoror sniff test and see if their diaphragm is moving beforehand. If it is not, I would plicate it at the time of repair. Otherwise, you are just leaving the patient with a big floppy sail instead of a tight sail.

Reattaching the Diaphragm

Case: There is 1 injury that always is a bone of contention when we are presented with it as to how to fix it. It is where that diaphragm is just ripped off the lateral thoracoabdominal attachments. It almost always involves the lower ribs into the abdomen. Do you have any tricks on how to reattach the diaphragm when it has been ripped off the chest wall in any way, shape, or form?
Recommendation: As described, these are complex and difficult to fix. I take a small orthopedic drill, like the hand surgeon’s drill, and just drill small holes through the rib. Then you can pass sutures through that and use that as an anchoring point. In the case you described, I would do an interrupted pledget repair. Again, I use a large suture, and a lot of times I stick an 18-gauge hypodermic needle through the drill track that I made. Then I can easily pass the suture through that and tie it on the outside without
strangulating the neurovascular bundle of that rib. As general surgeons and thoracic and trauma surgeons, we do not often use drills, but if you think about it, that is a way to relatively easily attach something to the ribs, and it works pretty well. I use this in trauma situations as well as elective situations with big resections for tumors and in complex reconstructions after removal of part of the diaphragm.

**Serious Injuries for Thrill-Seekers**

Mammoth Mountain has lift-accessed mountain bike terrain, and some of the trails have gap jumps. These are wooden jumps in which you have to clear a certain amount of air — say 10 feet of air — to hit the landing. There are also areas that have 10- to 12-foot rock drops or cliff jumps. Fortunately, these kids tend to be wearing full-face helmets, shoulder pads, kneepads, and protection, but the injuries that we still see are blunt abdominal injuries. One of our most devastating injuries was a kid who split his pancreas in half and fractured his liver and spleen. Our hospital has about 8 units of blood, and that is it. In this case, we did a damage-control laparotomy, took his spleen out, packed his liver, packed his abdomen, and got him stabilized — stopped the hemorrhage — then sent him off to our nearest level 1 trauma center. Here, we are 300 miles from the nearest major medical center. Helicopters do not tend to fly given the distance and altitude, so most of our transports are fixed wing. This means taking an ambulance down to the airport. Whether our airport is flying or not depends on the ceiling. If it is not, our local airport then is 40 miles down the hill. You are talking about a 2-hour ER-to-ER transport time in the best-case scenario.

**Types of Injuries:** We certainly see some head injuries. We see spine injuries. The orthopedists are obviously the busiest with all the forearm fractures and clavicle fractures. I do not think many wear the chest armor, and I personally do not think the chest armor is that good. The professional motocross race they have here is our busiest week with chest trauma. We see a lot of 6, 8, 10 ribs, flail segments, big pulmonary contusions, hemopneumothoraces. We have the same kind of stuff in winter. Recently, the pros had to make it 110 feet if they were going to hit the transition for the landing, and a number did not. We saw a C-spine fracture, a posterior acetabular fracture, a blowout fracture of the basically posterior aspect of the pelvis, and then chest injuries as well.

**Surgical Care in a Rural Setting**

We are fortunate here. We have full-time OB coverage, so they do prenatal care. There are a number of factors that weigh into whether somebody is going to deliver here. We do not have a neonatal ICU, and the elevation precludes kids with major deformities. High-risk people — even if it is just because of the age of the mother — are shipped out and told to deliver at sea level. A lot of times it is not figuring out what I can do so much as it is determining what our local infrastructure can handle and what is the safest for the patient. For things such as common pregnancy-related general surgical issues such as appendicitis and cholelithiasis, our approach is one of caution. If they are late in their third trimester or there is a chance of preterm delivery, the patient sometimes will be transferred out, figuring a 2-hour delay in transfer is better than getting us into something here that we cannot handle. The data on laparoscopic versus open for both appendicitis and cholecystectomy are interesting. There are a number of meta-analyses showing higher miscarriage rates for lap versus open in appendicitis, but the opposite is true in cholelithiasis. There are certainly a lot of contradictory data. We do have an MRI machine so, to try to avoid the radiation dose, getting a pelvic MRI is something I do a fair bit.

**C-Sections:** OBs will call for help in difficult C-section situations — if they are dealing with hemorrhage, reoperation, or if they are concerned about concomitant intra-abdominal problems. When we work in disaster and mass casualty situations, we do C-sections as well. We did C-sections in austere environments in the Philippines, so having already done them in normal situations with the OB has allowed me to be
of better help in the field as well. Certainly, doing anything on an elective basis or a routine basis is helpful if there is a disaster. I am more familiar with the operation, so I never mind doing them.

Nonoperative Management of Appendicitis

When it comes to nonoperative management of appendicitis with antibiotics, I bring it up to patients. A large majority of the patients that we see here are from more than 300 miles away, and all they want is to get home. When you offer to take out the appendix or stay in the hospital on antibiotics for 5 days, most of the time they want their appendix out. So I have, in the appropriate setting — without appendicolith, without an abscess, kind of the clear-cut features — begun to offer this, but I have not had anybody take me up on it yet.

Compiling a Trauma Team in a Critical Access Hospital

We have an amazing staff of ER docs here, and they are good at identifying what they can manage and work-up and then just call the general surgeon. Our trauma team is myself, an ER nurse, an ER doctor and, if necessary, anesthesia. The most common things we see are abdominal pain, low blood pressure, and left upper quadrant pain or something similar. Doctors will often get word from ski patrol or the paramedics. The ER docs will call and tell me they have a hypotensive patient with left upper quadrant abdominal pain after hitting their handle bars or hitting a tree or whatever. This is kind of how informally our team operates. Or, if there was a multicar accident with a fatality or fatalities, again, the ER staff would call me as the ambulance was extricating those patients and just say, “Rich, come up here. It sounds pretty bad.” So, they try to give me a heads up. I will come in and, if there is an airway issue, designate a few people. We had a guy who was mountain biking without a full-face helmet. He completely crushed his face. I sat with the ER doc and the anesthesia doc. When the patient arrived, we had a discussion right then and there. It is important to get your resources mobilized as best you can in terms of who the key players are. Then, when you as a surgeon make a decision, it has already been talked through.

How to Determine When to Transport from Remote Hospital

You also have to consider what the hospital can handle. How much blood do we have here? How can I stabilize this patient? Basically, if anybody gets transfused a significant amount, we do have a massive transfusion protocol. The actual flight crew that brings the plane to get this patient brings the blood, platelets, and products. It used to be that highway patrol would drive up to Reno and then drive the blood back. By that time the blood arrived, the plane was taking the patient or was already back to Reno. Because we were missing the opportunity, we tried to orchestrate the details to work with our remote geography. We have also worked with our neurosurgeons at the institutions where we send patients and came up with a head injury protocol that we use as general surgeons. If the patients have a small amount of blood, their GCS is 15, and everything else points in a favorable direction, then we do not send all of those people. Instead, we offer them the opportunity to transfer to a higher level of care and to see a neurosurgeon, but for the vast majority of these, nothing happens. You check a CT in the morning, and if it is fine you send them home. In the past, patients were getting transported via a $40,000 medi flight up to Reno and then sent home the next day without a car there. They were 300 miles further from their home. I guess as a small institution we try to protocolize and engineer it so that we do what we can do and get accomplished, and then facilitate a smooth transfer if that is the ultimate destination. Communication is always key to the best care, and early identification of the patient who is beyond our
capacity is important because it does take 2 hours door to door once we have the team rolling them out of our ER. This is a long transport time, so I tend to let the team know what reasons this patient looks like they are going to need a higher level of care. We then call the medi-flight, that way we can put the chest tube in and do the scans or whatever we need to do to take care of them in the initial hour, but the transfer is not delayed.

**Preparing for a Disaster**

An orthopedic surgeon here was 1 of the first 3 physicians at Ground Zero after the September 11 attacks and realized he had received no formal training in triage, mass casualty, and disaster medicine. We live in a rural area and are sitting on 1 of the more seismically active geologic regions in the country. We are a tiny population flanked by San Francisco, which is 6 hours away, and LA, which is also 6 hours away. If a disaster happens that affects the coast, we are a statistical anomaly in terms of when they are going to get to us. As a means of self-preservation, this surgeon started the Mammoth Mass Casualty conference. It has morphed into the nonprofit I work with — the Mammoth Medical Missions. I started running it a couple of years ago, and now we have speakers come to talk about their experiences — speakers from the World Health Organization down to individual nonprofits that provide medicine. Our goal is to try to train people how to interact in those situations and how to work in those environments. We also respond to international disasters as necessary. A lot of the big organizations take 72 to 100 hours to get in, and our thought is that there are a lot of life- and limb-preserving procedures you can do after disasters within those first 100 hours.

**Continuing to Practice Skills Is Important for Rural Surgeons**

The main challenge of this job is that, living in a basically healthy town full of fit young people, the routine elective volumes are not that high. You hear there are some complex injuries and surgical problems, yet skill set erosion and kind of loss of skills, I think, is 1 thing unique to this kind of a rural practice. I have always envisioned going to take call at LA County Hospital for a week or working with the trauma team there, operating a ton to kind of bolster my trauma skills. While SESAP and things for the educational component are brilliant, ultimately I think the adult education component of surgeons needs to include a skills component as well. As you are certainly aware, volume outcome relationships with complex surgery and even from a medical-legal standpoint, they are starting to define low-volume cases, high-volume cases, and in-between. If you are not doing a high volume of complex cases, then you should not, which is going to potentially continue to erode rural surgeons’ skill sets. Having a way to, say, go to work with the biliary guy for a week each year and do a dozen gallbladders or, if you have not done a left colon in a while laparoscopically, go hang out with the guru of left colons to supplement your skill set as necessary, I think, is going to be critical to guys like me. From a hospital perspective, 1 of the biggest barriers is, unfortunately, related to malpractice and the legal environment. Visiting surgeons can come and watch, they can come and observe but to do is usually something that just we have not been able to solve all of the legal battles that seem to occur when somebody wants to do this with us.