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EDITORIAL: The Spaces Between the Notes

Failing to Prepare is Preparing to Fail:
The Known, The Known Unknown, and The Unknown Unknown

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There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know.
But there are also unknown unknowns. There are things we don't know we don't know.
—Donald Rumsfeld

Cardiothoracic surgery residents often enter their training with fairly limited prior exposure to the field. Obviously, they need to master the essential knowledge and skills of the discipline during their training. In addition to following a didactic curriculum of one sort or another, much of the necessary knowledge and understanding will accrue from their experiences caring for and operating on the patients who will be under their auspices, not only during their formal training but also after they finish their training. Some of these cases and situations, such as elective cases, allow for careful preparation, while some more urgent or emergent cases require generic, advance preparation in order to be ready to perform optimally in these cases when they arise. And then there will always be cases for which one will not be able to prepare in any meaningful way, and these types of cases will require creativity and innovation "on the fly." I will describe three cases, which are examples of each of these situations, with suggestions on how to handle each type of situation optimally. I will describe the preparation, such as it was for each, in some detail to help the reader understand how it felt to deal with each of these cases. The technical details of each of these cases resulted in a publication, which will be cited in the references, should the reader want to learn more about them.

A KNOWN KNOWN

He who would do good to another must do it in minute particulars: general good is the plea of the scoundrel, hypocrite, and flatterer, for art and science cannot exist but in minutely organized particulars.
—William Blake

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The first case is one that allowed, and, indeed, required extensive preparation. The patient arrived in my office, after hours, the evening prior to her scheduled clinic visit. I was working late, listening to some loud rock music. I asked the visitor if I could be of help, and she said that she was leaving a note for the surgeon she was scheduled to see the next day. I asked who she had an appointment with, and it turned out her appointment was with me. (I figured she was disappointed that the surgeon she was slated to see was holed up in his office listening to edgy music, but if she was overly concerned, it wasn't evident.) I asked her what she had come to see me about, and she began to tell me her very unusual story. She eventually confessed that she was, herself, an otolaryngologist. She then went on to tell me that she had had a glomus vagale tumor removed from the right side of her neck and that she had two paragangliomas in her mediastinum, one in the right atrioventricular groove and one just beneath the ligamentum arteriosum, both of which needed to be removed surgically. I realized immediately that she had a paralyzed right vocal cord, since the right vagus nerve would have been resected with the glomus vagale tumor, and that she would be at a very significant risk of left vocal cord paralysis if the tumor near the ligamentum arteriosum resulted in injury to or resection of the left recurrent laryngeal nerve. Bilateral vocal cord paralysis would likely require a tracheostomy, possibly a permanent one. What a daunting prospect for patient and surgeon!

I realized that she had flown in from her home in a Western state, and I knew I didn't want to talk about her situation any further that night. So I called my wife and asked if we had enough food at the house to feed two hungry doctors. She said that there was enough to feed us both, so we agreed that we wouldn't talk about the potential surgery again that night and went to my home and ate.

The patient came to clinic the next day for her official visit. We discussed her situation more extensively, of course. She noted that she was visiting a series of prominent institutions to decide where she would have her surgery. I told her, with some trepidation, that I would be willing to do the operation, if, after contemplation, she wanted to have her operation at our institution. In the interim, I began to study up on paragangliomas and some of the issues that might have to be addressed in resecting the two in her mediastinum. Somewhat to my chagrin, about a month later, she called to say that she wanted to have her operation done at our institution.

Now my approach to preparing for this operation had to shift into another gear, as I knew that I needed to take the necessary

time to prepare thoroughly for the particulars of this case. I created a notebook in which to organize all the information I hoped to round up. I started by doing a literature search, but there was very little information in the literature, especially about these particular tumors and their specific locations in this patient. Next, I asked friends and colleagues for suggestions, but, as erudite and experienced as some of them were, they were not able to add much to my preparation. I looked up paragangliomas in the Fascicles of the Armed Forces Institute of Pathology, and, though the pathological aspects of these tumors were well described, there was little information on the challenges of resecting them. I then put the case up on the Heart Surgery Forum List-Serve. It was from this group that I received the most helpful and specific advice. One participant, Guy Fradet from the University of British Columbia, had some specific experiences to share. The founder of the Heart Surgery Forum, Mark Levinson, also had a number of additional suggestions that proved very valuable. (To join this discussion group, you can email the moderator: mmlevinson@hsforum.com)

The paraganglioma in the right AV groove seemed as though it might involve the right coronary artery and possibly the tricuspid valve, the right atrial wall, the right ventricular wall, and even some part of the conduction system. Thus, preparation would have to be made for a coronary bypass (which was indeed required), reconstruction of the right atrium and the right ventricle with prosthetic material, and the placement of pacing wires. The paraganglioma near the ligamentum arteriosum might require reconstruction of the pulmonary artery, the aorta, and the recurrent laryngeal nerve. Homografts and prosthetic grafts needed to be available, and preparation for harvesting a segment of sural nerve for reconstruction seemed prudent. Furthermore, learning about how to actually perform a nerve graft was necessary.

When all of this preparation had been completed, the patient and I scheduled the operation. The operation went along smoothly, and the extensive preparation paid off. Briefly, we did the operation on cardiopulmonary bypass so that the vascular structures and the heart were relatively decompressed and so that the lungs were deflated and out of the way. The technical details of this case were published as a case report, and the patient herself contributed to the paper as a co-author [Kern 1997]. The patient has continued to do well, 20 years after this operation.

The lesson from this case was that one must take advantage, when an elective case permits, to thoroughly research all the issues, including seeking advice from a wide array of trusted sources.

A KNOWN UNKNOWN

The patient's outcome correlates directly with the surgeon's attention to a myriad of minor details. This obsession of doing a lot of little things right is the foundation for good surgical results.

—Hiram C. Polk, MD

The second case illustrates how one must strive to continuously prepare for unexpected situations that might arise without advance warning and, thus, without the opportunity to seek extensive consultation with colleagues or to review the literature.

I had been awake and working for nearly 40 straight hours when I arrived home one mild spring night. My usual practice when tired is to get in a bit of a workout to blow out the cobwebs prior to heading off to sleep. I lifted some weights, grabbed a bite to eat, showered, and headed to bed. The window was open to the mild spring air, the sheets were clean, and I let out a long sigh as I set the alarm on my bedside clock, relieved to see that I would get 5 full hours of uninterrupted sleep, since I wasn't on call that night. It was midnight. I was in full REM sleep about the time that my head hit the pillow. The phone rang, and, as I answered it, I saw that it was 12:05. One of my favorite residents said "I need you in the hospital now. Hang up the phone and start driving." I grabbed the scrubs that I always had set out beside my bed, ran to my car, and as soon as I was on the road, called the resident back. A young woman had presented with hemoptysis, and the team of surgeons and anesthesiologists who were already with the patient (including faculty from both disciplines) were unable to intubate her with a double lumen endotracheal tube. Furthermore, I learned that she had had a coarctation repair as a child and, subsequently, had had as many as five or six additional operations on the coarctation over the years, all done via left thoracotomies.

I told the resident that the patient was drowning rather than exsanguinating and that he needed to get her to the operating room, where we'd get her on cardiopulmonary bypass as expeditiously as possible and then sort out what we might be able to do. I had a vague memory of an article saved in my office files that might provide a solution to this problem. (This case occurred well before the advent of aortic stent grafts, so that approach was not an option.) The article was one that had been sent out by Dr. Donald Doty as part of a loose-leaf textbook of Cardiac Surgical Techniques [Doty 1985].

As my resident and our other colleagues moved the patient expeditiously to the operating room, I rummaged through my files and found the article that I had vaguely remembered. The article described doing a bypass from the ascending aorta to the upper abdominal aorta. I knew we'd be very unlikely to be successful in crashing into what would surely be a "frozen" left chest. And, I knew that if we could depressurize the descending aorta, we might be able to save this young woman's life. So that is exactly what we did, taking a Dacron graft from the ascending aorta to the upper abdominal aorta, emulating the obscure article I had vaguely remembered receiving from Dr. Doty's system. Of course there were some other steps required, such as dividing the aortic arch between the left carotid and the left subclavian arteries, dividing the most distal thoracic aorta, and, at the end of the case, revascularizing the left subclavian artery.

The operative details were reported in a case report [Lawrence 1997]. The patient did very well and had no further problems related to her grafts nor to her prior coarctation repair. She has raised several children and been healthy since.

The lesson from this case was the importance of preparing for unexpected situations (the known unknowns) by paying

attention to articles and ideas that come along regularly and which might come in handy at some later time.

AN UNKNOWN UNKNOWN

I'm not sure this is going to work, but let's try it.
—Prince

The third case illustrates yet another kind of preparation in which we all must engage during our lifelong continuing education, which includes the need to incorporate new techniques from sometimes disparate arenas into our practices, keeping in mind how they might be applied in novel ways.

I had received a call from a dentist in our region saying that a drill bit had broken during a dental procedure being done on a very elderly woman and that a fragment of the bit had somehow been aspirated into the airway. He asked that we accept the patient in transfer with the expectation that we would be able to retrieve the fragment from the airway with bronchoscopy. I told our residents of the case, and I specifically mentioned that we would need to be careful with the woman's neck, which was likely not very flexible. I asked the resident who would be covering the case to call me when the patient arrived in the operating room.

An hour or so later, I was paged and asked to come immediately to the operating room, so I hustled over to the designated room. As I walked in, I was shocked to see blood everywhere, the neck open, and everyone in the room clearly in a state of dismay. The cardiothoracic resident who was there said "don't worry, boss, we have everything under control." I, of course, had no way of knowing at that moment that the patient in this room was NOT the woman with the drill bit in her airway but was a completely different patient, who had been undergoing a transhiatal esophagectomy as part of a resection of a laryngeal cancer that was invading the pharynx. My relief upon realizing that this was not the patient I was expecting was quite transient, as I learned that while doing the transhiatal esophagectomy the membranous trachea had been injured. Worse yet, the anesthesiologist was having great difficulty ventilating the patient because the injury to the membranous trachea extended into the right mainstem bronchus. We had to act quickly and creatively to stabilize the situation and to then figure out how to repair the airway. Briefly, we were able to switch out the anode tube that was in place for a smaller one and to position it, with bronchoscopic guidance, into the left mainstem bronchus, which, at least for the time being, allowed adequate ventilation. Then, a series of ideas, tricks, and techniques from a disparate set of prior experiences were employed. The first key realization was that we needed some vascularized tissue, preferably muscle, to repair the airway. After some contemplation, I realized that the best available vascularized muscle would be the stomach itself. We pulled the gastric conduit up through the mediastinum and into the neck and assured ourselves that it would reach the pharynx as intended.

However, once it was in place, it was apparent that there would be no room to suture the stomach to the trachea. I recalled a technique of manubrial splitting that we had been using for some aortic branch vessel work, and I thought this strategy might afford just enough room to work in the mediastinum from the neck. After all, an old adage, when called to help in a difficult situation, is that one should "always make the incision bigger." Splitting the manubrium did indeed allow just enough room in the thoracic inlet to see the anterior wall of the gastric conduit and the tracheal bifurcation and the proximal right bronchus.

The next challenge was to find instruments that would allow suturing in this deep, very limited space. I called for the HeartPort instruments, which we had obtained fairly recently, as part of starting our HeartPort cardiac surgery program. Next, we had to sort out what suture and suturing technique might be optimal. We had developed a technique of using a long 3-0 polypropylene suture in a running technique for bronchial anastomoses in our lung transplant program. I suspected that this suture would allow me to start a running suture in the right mainstem bronchus to sew the anterior gastric wall to the two sides of the injured airway. This strategy required taking a few stitches on one side and then the other, because, as the stomach was pulled up against the airway, I wouldn't be able to see beyond the sutured area. This approach worked, somewhat to my amazement, and the anterior gastric wall was successfully and securely sutured to the airway all the way up to the site of the planned permanent tracheostomy. We were then able to exchange the ventilating tube back to a larger anode tube. And, miraculously, we were able to ventilate the patient optimally again. We poured saline into the mediastinum to see if there were air leaks, and there were none. The operation was then completed by anastomosing the fundus of the gastric conduit to the pharynx, finishing the permanent tracheostomy, and closing the wound, with drains galore. The technical details of this operation were also reported in detail [Gitter 1999].

Thus, the preparation for this case had to come from a general understanding of how techniques and tools from a myriad of relatively unrelated procedures could be applied creatively to address a completely different, and, heretofore, unknown problem.

THE ROLE OF REFLECTION IN PREPARATION

Experience is communicated by small details intimately observed.
—Ernest Hemingway

An essay on preparation would not be complete without a note on the process of reflection that should occur after cases. It is essential that one learn from each case and every experience. In fact, it has been said that one should dissect one's cases the way people have dissected the famous Zapruder film of the Kennedy assassination, frame by frame [Rosenbaum 2013]. Those who have not made a consistent habit of this practice will likely be astonished by how valuable it can be. Every surgeon, not just trainees, should consider adopting some approach to this type of reflection, whether by dictating notes or by writing them out by hand [Spencer 1979].

I have observed that once such a habit has been adopted it is almost never abandoned [Tribble 2016].

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