Meeting the Challenge of Surgery and Pulmonary Hypertension: How to Manage the "Hemodynamic Environment" to Optimize Outcomes


Richard Channick, MD


Kenneth R. McCurry, MD


Ronald Pearl, MD


Stuart Rich, MD

This discussion was moderated by Richard Channick, MD, Associate Professor of Medicine, Pulmonary and Critical Care Division, University of California, San Diego Medical Center, San Diego, California. Panel members included Kenneth R. McCurry, MD, Assistant Professor of Surgery, Division of Cardiothoracic Surgery, Director, Lung and Heart-Lung Transplantation Programs, University of Pittsburgh Department of Surgery, Pittsburgh, Pennsylvania; Ronald Pearl, MD, PhD, Professor and Chair, Anesthesia Department, Stanford University School of Medicine, Stanford, California; and Stuart Rich, MD, Professor of Medicine, Section of Cardiology, Center for Pulmonary Hypertension, University of Chicago, Chicago, Illinois.

Dr Channick: Good morning, gentlemen. The challenges of general surgery in pulmonary hypertension patients are something all of us face, and we are doing so more and more often. As more patients are surviving longer with medical therapies, many practical issues arise. Let's start with Stuart Rich. As a physician taking care of patients with pulmonary hypertension, very briefly tell us what you feel are the greatest challenges you face with patients being considered for a surgical procedure.

Dr Rich: We're talking noncardiac surgery?

Dr Channick: Yes.

Dr Rich: What we've encountered is undue anxiety over the underlying presence of pulmonary hypertension, especially in stable patients being sent for a surgical procedure, and the problem of what I call "fiddling." Fiddling is having anesthesiologists place a Swan-Ganz catheter into the patients for monitoring during surgery, to monitor the pulmonary artery pressure, which we strongly discourage because the level of the pulmonary artery pressure for all practical purposes is irrelevant. These patients have pulmonary hypertension, and if they are clinically stable, the focus should be on the general clinical parameters, which include blood pressure, heart rate, oxygen saturation, etc. The problem with putting the Swan in is that there is this inclination to try to lower the pulmonary pressure, either because the patients become unstable or because they think they can lower it a bit, and that's where the problems begin. So that's one fundamental problem. One should assume that the pulmonary artery pressure is as good as it's going to get. That's why the patients were referred on therapy for this other procedure. The other category of things to focus on is the nuances that are typical of pulmonary hypertension patients. They tend to get hypoxemic easily when their cardiac output falls. A lot of them have underlying lung disease that is not obvious. They tend to get vagal very easily, so with the occurrence of unexplained hypotension or bradycardia, we advise just giving the atropine first and thinking afterward. And lastly, and this should be obvious, if they have a Hickman catheter for intravenous therapy, it is a dedicated line and should never be interrupted or tampered with for another infusion.

Dr Channick: Do you like to talk to the anesthesiologist yourself prior to any surgical procedure?

Dr Rich: Absolutely. It's really not the surgeon or the procedure that's the problem; it's usually the anesthesiologist who's overseeing the "hemodynamic environment" of the patient where the problems are encountered.

Dr Channick: Excellent. Dr Pearl, as an anesthesiologist, what are some of the mistakes or issues that you see with your anesthesiologist colleagues or that you think about with these patients?

Dr Pearl: A few things. A major problem involves patients who are receiving a continuous intravenous infusion such as epoprostenol (Flolan) for treatment of pulmonary hypertension. When the patients become hypotensive, the anesthesiologists want to decrease the rate of the infusion, and the subsequent increased pulmonary hypertension is frequently disastrous. As a general rule, we never titrate the infusion rate in the perioperative setting, neither increasing nor decreasing the rate. In places that are not used to taking care of patients receiving continuous infusions for pulmonary hypertension, there can be confusion as

to what to do with the infusion in the operating room and how to switch it over to something we may be more used to being able to manage in terms of different pumps and infusion systems. The switch from the patient's chronic pump to the hospital system can cause problems for the team that is not used to doing so. There is a tendency, as was noted, to try to manipulate pulmonary artery pressures in order to make the pulmonary hypertension better than it was before. Anesthesiologists frequently overtreat the patient with stable pulmonary hypertension. On the other hand, these patients do need to be treated much more gently than other patients. They can decompensate very easily, particularly during extubation in terms of worsening pulmonary hypertension as they emerge from anesthesia.

Dr Channick: This is backing up a little bit. We always debate over which type of anesthesia is best or worst in these patients—general versus spinal, certain agents versus others. What is your feeling on that?

Dr Pearl: Over time we have learned that many of these patients will tolerate regional anesthesia techniques. Certainly for peripheral surgery anesthesiologists who are reasonably skilled at nerve blocks can often very effectively provide anesthesia without having to deal with the impact of general anesthesia or the marked hemodynamic changes of spinal-epidural anesthesia. Even patients undergoing a lower abdominal procedure, or patients with pulmonary hypertension who are pregnant, will commonly tolerate epidural or continuous spinal anesthesia. One needs to titrate slowly and allow the physiology to adjust to the changes that occur rather than have rapid changes such as may occur in a typical spinal, which is likely to decompensate the patient. So regional anesthesia works well for many of the patients and avoids some of the problems of general anesthesia but, as in many things with anesthesia, one can be successful with almost any approach. It's much more the way the approach is done than the choice itself.

I think having the presence of pulmonary hypertension qualifies as a Class IV risk. We're sending a lot of patients to bariatric surgery also. Unless the anesthesiologist is experienced, he or she will be very reluctant to do these cases because, at least on paper, they carry an inordinate risk. – Dr Rich

Dr Rich: That's right on the money. I've always felt uncomfortable recommending to anesthesiologists how to anesthetize a patient for a surgical procedure. That's their specialty and really not ours. I think the general principle that allows the patient to have the least stress is probably the one that is in his or her best interest, combined with the surgical technique and the type of anesthesia delivered. I prefer to leave it to their judgment, and I think the points Ron made are right on in terms of having an appreciation for the nuances. And then there's the old rule—that it's always easier to stay out of trouble than to get out of trouble. They can't have too normal a heart rate, too normal a blood pressure. If you pay attention to these signals early on, you can probably avoid getting into a problem, rather than ignoring them and allowing the patient to decompensate.

Dr Channick: Dr McCurry, I assume that as a surgeon you have operated on a number of patients who had pulmonary hypertension. Are there any issues that have come up for you?

Dr McCurry: I'm a cardiac thoracic surgeon and direct our heart-lung transplant programs here, so the majority of the patients I have operated on have been in the setting of replacement and correction of their disease, if you will, with transplantation. I would echo some of the comments Stuart and Ron made because we have had the opportunity to offer nontransplant surgery, either thoracic surgery or abdominal surgery, to some of the patients with either primary or secondary pulmonary hypertension on our lung transplant waiting list. Obviously those are patients whose condition in general was more advanced, who were not responding to medical therapy or had a transient response and then declined and ultimately had been referred to our program for consideration for transplantation. The two main procedures we have offered prior to getting into a transplant are bariatric surgery—we've had a handful of patients with pulmonary hypertension doing bariatric surgery, to try to get them to lose weight prior to transplantation—and the second is in the setting of secondary pulmonary hypertension associated with mixed connective tissue disease, primarily scleroderma. We've done a few esophagectomies preoperatively prior to transplantation in patients with very severe esophageal dysmotility. A lot of the points Stuart and Ron have made are right on with regard to management of those patients intraoperatively and in the postoperative period.

Dr Channick: One of the issues I have dealt with is that it's not easy if patients are getting continuous infusion of prostacyclin, but now a number of our patients are getting intermittent oral therapy or even inhaled therapy. How have you dealt with that intraoperatively? For instance, have you used continuous prostacyclin therapy intraoperatively or nitric oxide during the surgical procedure or in the immediate postop period in these patients who may not be able to take oral or inhaled therapies? How have you dealt with those issues?

Dr Pearl: Patients receiving oral therapy tend to be relatively simple to manage because you can have them take it in the morning. The duration of the surgery is almost always much shorter than the duration of the oral therapy. For patients who are not eating after surgery, you can usually put it down the nasogastric tube. Most of these patients are not undergoing surgery where they can't take medications directly afterward. So that has not been a problem. In general, they also do not have rapid rebound from discontinuing oral agents. We have not had much experience with inhaled iloprost. We're trying to decide what to do. Certainly we have them take it immediately before surgery and we might try to

use nebulized in place of inhaled therapy during or after surgery. I don't know that inhaled nitric oxide would provide necessarily the same benefit as inhaled iloprost. It's something that we would consider if we saw the patients getting into trouble. But ideally we would try to replace it with inhaled therapy at the same time.

Dr Channick: Are you prepared to use intravenous prostacyclin intraoperatively even if patients have not been receiving it, if they get into trouble?

Dr Pearl: Yes, but when you're talking about intravenous prostanoids, one is probably at that point using them for their acute pulmonary vasodilatory effects, which inhaled nitric oxide may adequately replace instead.

Dr Rich: I agree. In patients who become hemodynamically unstable, initiating a prostacyclin at that point is probably not the wisest thing. You just go back to the fundamentals. If they're hypotensive you give them a pressor to raise the blood pressure or cardiac output, etc. On another theme here, and Ron, I don't know if you agree, but the referral centers need to have one or more anesthesiologists designated as the only ones who will do the cases with pulmonary hypertension. That's what we've done at the University of Chicago. We just have a handful of anesthesiologists who are comfortable with pulmonary hypertension because the general anesthesiologists we have encountered are very frightened. I think having the presence of pulmonary hypertension qualifies as a Class IV risk. We're sending a lot of patients to bariatric surgery also. Unless the anesthesiologist is experienced, he or she will be very reluctant to do these cases because, at least on paper, they carry an inordinate risk.

The major set of cases where intraoperative transesophageal echocardiography might be useful is those where there is going to be very large blood loss and where it is often difficult to figure out whether the problems you are getting into are related to lack of intravascular volume versus the pulmonary hypertension versus some cardiac depression. – Dr Pearl

Dr Pearl: I completely agree.

Dr Rich: I would follow with another suggestion. Even community hospital types of procedures belong in a referral center for patients with pulmonary hypertension. I don't care if it's a laparoscopic cholecystectomy or a small surgical procedure, because familiarity is really essential. I can also tell you some horror stories of things that Ron also referred to. They've never seen a CADD pump before, so they switch them to a regular IMED pump. They don't know how to mix the Flolan correctly, so someone in pharmacy is trying to mix it without experience. They see a Hickman catheter in a patient with lousy venous access and they try to drip something else in that. And we've had very tragic deaths occur in patients undergoing minor surgical procedures at community hospitals because of our healthcare system, which puts barriers to having these patients sent to specialty centers.

Dr McCurry: I certainly agree with that. The approach we have taken at our center is primarily to utilize our cardiac anesthesiologists, about four or five members of that group. An important point to extrapolate on is the intraoperative management by a dedicated team. It's also important in the postoperative period in the intensive care units. Certainly in small community hospitals, those that are not nearly as well staffed at night, perhaps, compared with larger centers that are used to dealing with these types of issues, the type of care that is provided there can be equally critical.

Dr Channick: We've had similar horror stories even in our own institution, and if we hadn't intervened, there would have been a bad outcome. In terms of the types of surgery our patients face, you name it, from gall bladder removal to total colectomy, I don't think there is necessarily any particular operation that these patients cannot undergo. One potential issue is bleeding. We generally consider intravenous epoprostenol to have antiplatelet effects. Have you observed that these patients seem to bleed more intra- or postoperatively?

Dr McCurry: That has not been my experience in the setting of transplantation. Certainly you can see some preexisting thrombocytopenia but, in general, bleeding has not been a major problem in these patients.

Dr Pearl: It has not been a problem for us either.

Dr McCurry: Ron, may I ask you about the value of echocardiography, intraoperative transesophageal echocardiography? Do you see a value of that in this patient population, depending on the severity of illness? What do you see as the role there?

Dr Pearl: We commonly do it unless it's a relatively straightforward surgical procedure. However, I don't think we've seen it to be extremely useful in general during surgery. There is obviously always right ventricular dilatation and decreased function. We normally have interventricular dependence, so the left ventricle is small. You can diagnose left ventricular underfilling. But what to do about that is often very difficult, especially when it is due to worsening pulmonary hypertension. The major set of cases where intraoperative transesophageal echocardiography might be useful is those where there is going to be very large blood loss and where it is often difficult to figure out whether the problems you are getting into are related to lack of intravascular volume versus the pulmonary hypertension versus some cardiac depression. And the echo in combination with other aspects of the patient may give you some sense as to what to do in that setting.

Dr Channick: I guess that gets back a little bit to Stuart's point about the dangers of putting in a PA catheter, because you actually may respond to the information in an inappropriate way. One issue that comes up with our patients is

obviously the volume status, and the one thing I talk to anesthesiologists about is paying attention to the volume status so they don't get more concerned about overloading the patients than losing too much. It's a problem on both ends. Theoreticaly, that would be one potential advantage of having some sort of central monitoring, to make sure they are not getting overloaded.

Dr Rich: I hate to be so basic, but lots of times those neck veins are so distended going into the OR that unless they're invisible in the patient, the volume status is more than adequate. The problem that you are alluding to, Rich, the knee-jerk reaction of the inexperienced physician, is that if the blood pressure falls, give fluids. We have people going into the OR with ascites, and the last thing they need is more fluids.

Dr Pearl: The overwhelming majority of the surgical procedures these patients undergo are not large blood-loss procedures, and having to give volume should usually not be an issue. Sometimes they're undergoing major procedures, and there are those where you may have a couple of liters of blood loss. There, the issue of giving volume does come up. That is uncommon.

Dr Rich: Then I would move to my adage that it is easier to stay out of trouble than to get out of trouble. We will tolerate mild anemia going into the OR for a major procedure in normal patients, but in these patients I want the hemoglobin to be above 12 g/dL if there is any concern about blood loss, because they have no reserve. They may tolerate going from 12 to 9 g/dL but they can easily become very ischemic and I want to be very protective and get all those numbers as ideal as I can before the surgical procedure starts.

Dr Channick: Although it is fairly basic, are there any specific pressors you like or do not like to achieve better responses in these patients?

Dr Rich: Our bias has always been toward phenylephrine. I know that is not widely popular. Typically the problem is one of hypotension, which leads to right ventricular ischemia and failure acutely, so simply raising systemic blood pressure with phenylephrine is all that we generally need to do if hypotension is a problem. If it's hypotension with low cardiac output, then we prefer dopamine.

Dr Pearl: I would say that phenylephrine has for two decades been recognized as extremely valuable. Often it tends to be underutilized in this setting because the concept in the physician's mind is that the problem is low cardiac output and we have to do something to raise cardiac output. The right ventricle becomes ischemic very easily. Right ventricular perfusion is highly dependent in pulmonary hypertension on maintenance of systemic blood pressure, so I completely agree with the idea of using phenylephrine to maintain blood pressure. Some institutions might use norepinephrine instead of phenylephrine to try to maintain blood pressure. There are some settings where one needs to do something for more inotropic support. That's more common, for example, when we talk about pulmonary hypertension in the setting of cardiac surgery. Dobutamine is a very good choice in that setting. Outside of cardiac surgery the emphasis probably should be much more on maintaining blood pressure with vasoconstrictors.

Dr Channick: I think we're all in agreement there. I've seen inotropes make people more tachycardic, which isn't a good thing either for these patients. Is there something else that we should be discussing about surgery in these patients that we haven't thought of?

One other thought on the intraoperative management of these patients might be in that subpopulation of patients who might have a patent foramen ovale coexisting and, at least intraoperatively, the risk of a paradoxical air embolus. Those of us who work in the operating room know that it is not uncommon with intravenous lines and everything else in the operating room to get some air on the right side of the heart, particularly in the setting where there might be some intermittent right to left shunt or a positive pressure ventilation, a greater preponderance of left to right shunting. – Dr McCurry

Dr Pearl: Let me say that I do like to use pulmonary artery catheters in the bigger surgical procedures. It's not specifically done to try to reduce pulmonary artery pressures. The value of pulmonary artery pressure monitoring is often seen during the emergence of anesthesia, when patients can develop marked increases in their pulmonary artery pressure, often with increases in systemic blood pressure. That we will sometimes treat. It's not to improve the pulmonary artery pressure from where it began but to prevent decompensation from exacerbation of the chronic pulmonary hypertension. If the patient seems to be decompensating and the systemic blood pressure is good, we will treat that at that point in time. One can make the same decision without a pulmonary artery catheter as well, but it helps us to determine if there is a need to do something. I agree with the earlier comments that, in general, one should avoid intervening if possible. But we have seen patients who develop marked increases in pulmonary pressure during the emergence from anesthesia and who, if allowed to continue on that path, do get into trouble.

Dr McCurry: One other thought on the intraoperative management of these patients might be in that subpopulation of patients who might have a patent foramen ovale coexisting and, at least intraoperatively, the risk of a paradoxical air embolus. Those of us who work in the operating room know that it is not uncommon with intravenous lines and everything else in the operating room to get some air on the right side of the heart, particularly in the setting where there might be some intermittent right to left shunt or a positive pressure ventilation, a greater preponderance of left to right shunting. The risk of shunting some of that air to the left side of the heart to the systemic circulation is not low. So I

(continued on page 96)