

# Pulmonary Roundtable – Bariatric Surgery and the PAH Patient

As guest editor of this issue on perioperative issues in PAH patients, Sean Studer, MD, MSc, convened a group of experts to discuss the implications of bariatric surgery for the pulmonary hypertension patient. Given the prevalence of obesity and its sequelae related to PH patients, it's not an uncommon topic. The approach to patient counseling, minimizing surgical risks, and working with the interdisciplinary team were addressed among the wide range of topics by clinicians on the front lines. Taking part in the conversation were Michael Mathier, MD, Assistant Professor of Medicine, Director, Pulmonary Hypertension Program, and Associate Director, Cardiovascular Fellowship Program of the University of Pittsburgh Medical Center; Dana P. McGlothlin, MD, Medical Director of Combined Heart-Lung Transplantation and Mechanical Circulatory Support, Medical Director of the Cardiac Intensive Care Unit, and Associate Director of the Pulmonary Hypertension Program at the University of California, San Francisco; Ramesh C. Ramanathan, MD, is a surgeon specializing at the University of Pittsburgh Medical Center. Deborah J. Levine, MD, Associate Professor, Pulmonary Disease and Critical Care Medicine, Director, Pulmonary Hypertension Clinic, University of Texas Health Science Center, San Antonio, added comments from the pulmonary perspective to the transcript of the discussion.

**Dr Studer:** The purpose of today's roundtable is to gain an interdisciplinary perspective regarding the topic of weight loss surgery in the setting of pulmonary hypertension. Our experts discussants include Dr Michael Mathier (cardiologist), Dr Ramesh Ramanathan (bariatric surgeon), Dr Dana McGlothlin (cardiologist) and Dr Deborah Levine (pulmonologist). Dr Levine's comments were included following our initial live conversation to include a pulmonary perspective. To begin the discussion, I will ask the participants to comment on the prevalence of obesity in their patient population and their perceptions of its impact on the course of their underlying pulmonary hypertension.

**Dr Mathier:** I think that obesity is a prevalent issue in pulmonary hypertension (PH) and it's an increasingly prevalent issue. I think that as we have seen a broader population of patients diagnosed with PH, a subset of whom will be proven to have pulmonary arterial hypertension. We're seeing more patients who are older, more patients who have the co-morbid conditions that come with age, and obesity is certainly in the mix.

While I have not done a formal calculation of this in my own practice, I would estimate that probably a third of the patients that I see have an element of obesity and probably half of those have a degree of obesity that I think significantly impacts their functional status. And you know it may well directly impact the phenotype of their pulmonary vascular disease. Metabolic abnormalities seen in obesity have recently been demonstrated to affect pulmonary vascular structure and function.

**Dr McGlothlin:** I agree with Mike. I would estimate that about a third of the patients with PAH in my practice have significant obesity as a comorbid condition, similar to what has been shown in the contemporary multicenter, observational, US-based REVEAL registry of PAH patients. And I see obesity in the young patients as well as the old patients, but definitely I would agree that I see it as a more common comorbidity in patients who are older. I also think that it does significantly impact their symptoms of pulmonary hypertension such as functional capacity. I think, Mike, you have some data about

the potential impact obesity may have on the pulmonary vascular disease itself. I must admit I know less about that relationship, but perhaps you can share some of what you are learning about obesity and pulmonary vascular disease?

**Dr Mathier:** It's very rudimentary at the present time. What we've been able to observe is that in a couple of patients who had morbid obesity and clearly diagnosed PAH and were struggling with advanced symptoms despite very aggressive PAH therapy, aggressive weight loss measures markedly improved both functional capacity and to a somewhat lesser extent—but still I think in a meaningful way—their hemodynamics. This was accomplished through bariatric surgery which we'll discuss as the conversation goes on. I know that the Vanderbilt group has been looking at a more mechanistic understanding of this and there appear to be some very intriguing links between the metabolic changes that are known to occur after dramatic weight loss accomplished through bariatric surgery and subsequent changes to pulmonary hemodynamics. That's something that I think is going to bear more exploration as we go forward so we can really understand the relationship between obesity and PH.

Disclosures: Dr Studer receives research support and has received honoraria from Actelion, Gilead, and United Therapeutics. He has received consulting fees from Bayer, Actelion, and United Therapeutics. Dr McGlothlin has received grant or research support from Actelion and United Therapeutics. Drs Levine, Mathier and Ramanathan report no potential conflicts.

**Dr McGlothlin:** Yes, I think it's an interesting relationship and as we've seen in the literature on left heart failure, these patients with obesity can have lipotoxicity in the myocardium. I have seen also patients who are obese tending to have more right-sided heart failure with their pulmonary arterial hypertension. And recently at the International Society for Heart and Lung Transplantation, Dr Roham Zamanian presented his data. I know the Stanford group has been interested in insulin resistance and its link to pulmonary arterial hypertension. Interestingly, he found, based on several studies, that it didn't look like the relationship bore out with regard to its impact directly on the pulmonary vascular disease or the myocardium. But I think the jury is still out. It's an interesting correlation.

**Dr Studer:** Do you counsel patients in detail regarding obesity before and at the time of consideration of bariatric surgery? Do you consider weight loss goals pre-op or how we might counsel patients afterward?

**Dr Levine:** The patient is counseled on their obesity at the time of initial visit and at every visit after that. We have a dietitian at our clinic who not only visits with the patients when they are at clinic, but also keeps up with the patient by phone and by email or Facebook to see how their attempt at weight loss is progressing, including both diet and exercise. The dietitian will give our team an update on this at regular intervals. Having this resource has been very beneficial to our patients. Goals of weight, goals of exercise, and ambulation are discussed by the team, including the dietitian, every visit.

**Dr Mathier:** I think it's worth pausing here to recognize that the interrelationship between obesity and pulmonary hypertension is a really complex one. And even if we don't stop to consider the as-of-now somewhat inscrutable mechanistic aspects, we know that obese patients have a physiology that can lend itself to the development of pulmonary hypertension. And that pulmonary hypertension can have any of a number

of different kinds of hemodynamic subsets. So we can see in these patients, of course, that they have a diastolic abnormality of the left ventricle with subsequent elevation of left heart pressures and then a secondary form of pulmonary hypertension, what we term WHO Group 2. We know that they can have relatively high cardiac output so that they may end up on hemodynamic assessment having a high transpulmonary gradient but a normal pulmonary vascular resistance. Most of us would not think of that as pulmonary arterial hypertension. We know of course that they can have hypoxemia via either sleep-disordered breathing or the obesity hypoventilation syndrome and that can have an effect on pulmonary pressures where they might be considered a WHO Group 3 patient. And there is a whole host of other things—even short of the kind of well-known metabolic disturbances that occur in obesity—that can play into the development of PH and into the specific phenotype of that PH. So that has to be carefully considered in every patient we see who has the combination of obesity and pulmonary hypertension.

**Dr Ramanathan:** Both of you said the prevalence of obesity in patients with PH is about one-third. Do you think there are two distinct populations of patients with pulmonary hypertension, with obesity linked to the etiology of PH in one-third and a different mechanism in the other two-thirds?

**Dr Mathier:** I think that's too simplistic. I think we honestly don't know. It is possible for this relationship to exist in either direction. I think there are patients who develop significant PAH and it compromises their functional status so much that they develop obesity over time. In which case the obesity will certainly contribute to their functional limitation, but probably shouldn't be thought of as potentially causative. But then we also know that people can develop obesity and, through many of these mechanisms that I just spoke about, will develop secondary forms of pulmonary hypertension. Most of us in current PH practice will see the whole spectrum of patients with the combi-

nation of obesity and pulmonary hypertension. I think what we have to do is just a very, very careful diagnostic assessment so we can understand as well as possible the relationship between the two.

---

**Metabolic abnormalities seen in obesity have recently been demonstrated to affect pulmonary vascular structure and function.**

—Dr Mathier

---

**Dr Studer:** Let me ask from that point—as it sounds as if everyone agrees that the problem is increasingly prevalent of obesity in pulmonary arterial hypertension patients and that the relationship between the two is quite complex—when you consider referral to bariatric surgery for these do you look to something like the NIH Guidelines for a body mass index >40 or >35 with comorbidities? Or is it a much more detailed assessment that would lead you to decide who you're going to ultimately refer for bariatric surgery?

**Dr Mathier:** Well, I would say the guidelines apply. I don't think that we should be referring for bariatric surgery patients with more modest obesity simply because they have pulmonary hypertension. We all have to take a breath and realize that if we are going to consider bariatric surgery that there is significant risk in pulmonary hypertension patients. I think an assessment has to be made about whether or not we have truly maximized PAH therapy. That has to be a prerequisite. I think we have to do a careful assessment of that patient's ability to potentially lose weight through more conservative means. That's part of the normal bariatric surgery evaluation that Ramesh can expand upon. And then we have to do a really careful risk assessment. We need to make sure that this patient has—while it will undoubtedly be a somewhat elevated risk of a perioperative complication—as low a

risk as possible before we can really consider referring them for surgery. I think.

**Dr Levine:** Patients who we have referred are those morbidly obese patients (usually with a BMI >40) suffering from significant comorbidities from their obesity; for example, diabetes, OSA, OHS, atherosclerosis, hypertension; and who have had less severe PAH or those who may have PH Group 2 with stable right heart function. The patients we have referred have had good functional capacity that they are able to at least do some ambulation.

For patients who have other types of PH (WHO Group 3) with other lung disease, we need to look at other considerations, in terms of their other lung disease. We will also need to make sure that all lung diseases are appropriately treated prior to this surgery.

The patients we have referred have, of course, been referred only after all other avenues of weight loss had been exhausted.

**Dr McGlothlin:** I think the question of referring patients for bariatric surgery, particularly in my mind, relates to referring patients with Group 1 pulmonary arterial hypertension for bariatric surgery. While undoubtedly I think losing the weight after bariatric surgery would help the patient's condition, I think that these PAH patients are at particularly high risk from the surgical standpoint and so I take pause in referring patients who have more advanced pulmonary arterial hypertension, particularly those with right-sided heart failure. I think that the preoperative evaluation is of paramount importance. I just saw a recent study that looked at 185,000 patients who were referred for bariatric surgery and out of all the comorbidities, pulmonary hypertension was the number one risk factor, the greatest risk factor for peri- or postoperative mortality. And so it is an important risk factor. While I think we need to consider bariatric surgery in obese patients based on guidelines, I think that we do need to do our due diligence in assessing the patient's perioperative risk prior to sending them for surgery.

**Dr Levine:** Additional assessments for patients with other lung diseases include the full preoperative testing (ie, all the pulmonary function tests, etc). All of their medications (PAH and medications for other lung diseases) need to be continued throughout the perioperative period. Patients with OSA need to make sure they are extubated to CPAP after the surgery.

**Dr Mathier:** We have to walk a very fine line here because on the one hand we can never lose sight of the fact that especially the type of PH patients that Dana described—a Group 1 patient with significant disease who is on aggressive therapy maybe with borderline right heart function—those patients are always going to have an elevated surgical risk and we have to be very, very cautious about considering doing any elective or quasi-elective surgery on them. On the other hand, I think we need to recognize that in selected patients who have severe functional limitation that may be largely contributed to by their obesity; they may in fact be acceptable surgical risks. And we have to really try to delineate these two groups so that people are referred when they can be safely operated on and where the surgery is judiciously avoided in those where the risk is simply too high. I'll echo what Dana said. In my mind, while there is some unpredictability to this, I think that the severity of right heart dysfunction is the key determinant here. In patients with preserved cardiac index and relatively low right-sided filling pressures who have reasonable functional status, you know not fully Class 4; these are folks who I think can be considered. But in folks who have very high right atrial pressures and very poor cardiac index I think this kind of surgery should be avoided because the risk is really excessive.

**Dr Studer:** Ramesh, I'm curious what you think when you get these patients in referral in terms of initial risk. Are there certain additional criteria you would apply beyond what the PH clinician in their office would be concerned about when considering the surgery?

**Dr Ramanathan:** I would definitely

---

...as we've seen in the literature on left heart failure, these patients with obesity can have lipotoxicity in the myocardium. —Dr McGlothlin

---

have a detailed discussion with the patient and the family regarding perioperative risks including mortality. The 30-day mortality after bariatric surgery has decreased significantly over the last several years and ranges from 0.1% to 0.5%. But patients with PH are extremely high risk. Most of them are female, have a very high BMI, and have multiple comorbidities including obstructive sleep apnea. And when you combine their poor cardiopulmonary functional status, they are probably in the highest risk category of all bariatric surgery patients. I quote a mortality risk of around 5% to 10% for this specific group of people. But by the time they come to my office, they've come to the realization that if something is not done, they are going to die soon. Their life expectancy is measured in terms of months or a few years if untreated. So when I say "you could die from this operation", they all respond "If I don't do anything, I'm going to die soon anyway." Fortunately, we've been lucky so far in our program. It is largely due to the multidisciplinary approach to these patients with a coordinated care among specialists with expertise in cardiac anesthesiology, cardiology, pulmonology, critical care, and bariatric surgery. So you really want to do this in a tertiary care center that has all the specialties available to monitor and treat them appropriately.

I have a question for the cardiologists. By the time, some of these patients get to see the surgeon to discuss bariatric surgery, they are extremely high risk. They have been managed with medications for years and years and their functional capacity is sometimes being able to walk only a few steps. Is there a way to identify a certain group of

patients with PH who have a better functional status and where we think obesity is specifically contributing to or accelerating their deterioration in functional status? We could possibly intervene earlier with bariatric surgery.

**Dr Mathier:** I think that's a good point, Ramesh. There is definitely an argument to be made that waiting too long to pursue a surgery like this is going to leave you with a patient who has worsened to the point that their risk becomes certainly higher and potentially prohibitive. I think that we work hard to identify patients who are in the proper window for this type of procedure. If they are "too well," if you will, and we feel that they can make progress with more conservative efforts at weight loss because they still have very good functional capacity, then certainly you don't want to send them to surgery prematurely. On the other hand, as you point out, it doesn't do them any good for us to wait until they can barely move to consider a surgery like this because their risk is likely to be too high. So I think we're always looking for that window where they're at a stage where their surgical risk is acceptable and they have clearly shown us that they're not going to have any success with more conservative measures and that their functional status is not going to be acceptable to them moving forward. That's the kind of patient in my mind who we can really consider for this kind of surgery.

**Dr Ramanathan:** What criteria do you evaluate before referring a patient for bariatric surgery? I know it's kind of subjective, but is there any one particular parameter that you look for in the cardiac catheterization that would determine the eligibility or risk status of a patient to undergo an operation.

**Dr Studer:** That's what I was going to lead into. He mentions the catheterization, but maybe functional status or certain echocardiographic parameters are also factors. For those who are considering referral, are there specific triggers that would either say "this is time" because the severity is met or possibly "this patient is a little too ill and I need

to optimize them better". Dana, would you start with that please?

**Dr McGlothlin:** Sure. I would say a patient with right-sided heart failure, as indicated by elevated right atrial pressure, especially patients with a right atrial pressure above 15 mmHg, and particularly those in whom the cardiac index is low, less than 2.2, are going to be at significant risk of perioperative hemodynamic compromise. In that patient, I really would be hesitant. And you notice I'm not even talking about the pulmonary artery pressure. To me, I think that the key is the status of the right heart as the main marker of how patients might do with this sort of surgery. In terms of indications for the surgery, as Mike already mentioned, if we think that the patient's obesity is significantly contributing to their symptomatology and disease process, then it may justify a going forward despite a relatively high risk. For instance, if the patient with PH has obesity hypoventilation syndrome contributing to their PH and they have significant symptoms and they do not have significant right heart failure, that would probably be an appropriate patient in whom to move forward with bariatric surgery. But if that patient had severe pulmonary hypertension and right-sided heart failure, we should be very cautious. I think at the minimum we would want to optimize their hemodynamic status by whatever means we could prior to surgery. And, then, if they do actually improve with pulmonary vasodilator therapy, with diuretics, and so forth, then that might be a better situation. You know the surgery itself is—and Ramesh can comment on this in more detail—by and large a laparoscopic surgery which is often considered lower risk compared to open surgeries, but the hemodynamic effects of anesthesia can cause vasodilation, hypotension, and have effects on the myocardium that can worsen right-sided contractility. And mechanical ventilation can increase right ventricular afterload. It has effects on pulmonary vasoconstriction that can lead to decompensation of the right heart during surgery. Also, the laparoscopy requires insufflation of the abdomen

with CO<sub>2</sub>. That carbon dioxide not only increases intra-abdominal pressure that can compress the vena cava and aorta, but can also increase intrathoracic pressures, making it harder to mechanically ventilate; and this further increases RV afterload. There can also be some subcutaneous emphysema from carbon dioxide that can leak into the bloodstream and worsen pulmonary vasoconstriction and pulmonary hypertension. So there are many ways in which the surgery itself can worsen right heart failure due to its direct effects on the myocardium and the pulmonary vasculature. However, I think it's worth the risk in the PH patient who has significant symptoms associated with their obesity but who has less advanced disease without significant right heart failure.

---

**Goals of weight, goals of exercise, and ambulation are discussed by the team, including the dietitian, every visit.** —Dr Levine

---

**Dr Mathier:** If I could just make one additional point about assessing a patient and assessing their suitability for the surgery. You know one of the things about our field that really is an art form is that we are constantly integrating different markers of risk or prognosis in our assessment of the patient. So it's not simply about hemodynamics or simply about functional status. We're really looking at maybe 10 or 12 different markers to give us an integrated sense of where that patient sits in terms of the risks they're facing or what kind of prognosis they may have. Or whether or not our therapy is adequate or whether we need to be considering intensifying therapy. So it's very difficult because we haven't put this integration of all these different markers into any kind of an equation like you see in certain other fields. And instead what we do as individual care providers is with each individual patient we try to integrate these things in our own minds and I very much do that when I'm considering these patients for surgery.



**Dr Ramanathan:** And we see that variability in how bariatric surgeons' approach these patients as well. There may be surgeons who would say that a diagnosis of pulmonary hypertension is an absolute contraindication to bariatric surgery.

**Dr Studer:** Do you think there is any consensus, that a certain procedure is safer or better suited to these patients, since there appears to be a number of options that these patients can go through in terms of type of bariatric surgery?

**Dr Ramanathan:** I think it's evolving and I don't think we have a consensus on the most appropriate bariatric surgical procedure in these very high risk patients. A few years ago we had the option of either the gastric bypass or the laparoscopic adjustable gastric banding. The benefits of the lap band are that it is less invasive with very low perioperative risks. It is also quicker and we can get them off the operating table sooner which would be very desirable in these patients due to the adverse hemodynamic effects of anesthesia and laparoscopy. But the amount of weight loss is lower compared to the gastric bypass and it takes 2 to 3 years to achieve that weight loss. So the question is whether they are going to lose enough weight quickly to benefit their functional status in a meaningful way? On the other hand, the gastric bypass is considered a lot more invasive with a longer operating time and a higher risk of postoperative complications. The advantage is that they could lose a lot of weight (up to 60 to 70% of their excess weight) in the first 6 months to a year and that could have a significant beneficial effect on their functional status. I tended to favor the gastric bypass over the lap band because I thought if you're going to put them through the risk of an operation you might as well get the best bang for the buck. Now, there is one more option, the laparoscopic sleeve gastrectomy. It is a restrictive type of operation, where the stomach is converted into a long narrow tube along the lesser curve removing more than two-thirds of the stomach, preserving the

pylorus and without any intestinal malabsorption. And the weight loss results, at least in the short to medium term, seem much better than the lap band and maybe slightly lower than the gastric bypass. So nowadays, in these high risk patients, I would prefer to do the sleeve gastrectomy rather than the gastric bypass because it's quicker, has a lower risk of perioperative and long-term complications with an acceptable amount of weight loss.

**Dr Mathier:** Ramesh mentioned this briefly earlier, but I think it deserves some expansion. I think to try to maximize the outcomes in these patients it's really critical that a carefully orchestrated multidisciplinary approach is taken. And it's not simply a matter of having a surgeon and a pulmonary hypertension physician. You need a pulmonologist who can focus on the sleep apnea or hypoventilation aspect of the patient's disease; typically an endocrinologist who can manage diabetes or other metabolic abnormalities. It's very important to have either a dietitian or another behavioral modification person involved. Most bariatric programs integrate this so that the patients' habits can be changed for the better following the surgery. I think it's critical that especially the surgeon and the pulmonary hypertension specialist speak with the anesthesiologist ahead of time so that we can go over aspects of intraoperative care that may be important including hemodynamic monitoring if necessary, including the possibility of using inhalational therapy through the surgery if necessary. We have as a rule admitted these patients to the cardiac care unit where the nurses I think have much better facility with pulmonary hypertension therapies immediately postoperatively and we've gotten good results with that because we can more carefully monitor hemodynamics, monitor fluid shifts, and adjust pulmonary hypertension therapies and other vasoactive medications accordingly. So that kind of a truly integrated multidisciplinary effort I think is mandatory if you're going to have good outcomes with these patients. They cannot be approached in the same way that you

would approach a patient who doesn't have a severe comorbidity like PH.

**Dr McGlothlin:** I agree with what Mike just said. I think the perioperative or the multidisciplinary planning is critically important and you know these patients actually don't usually die in the operating room. They die postoperatively. So that piece is at least as important as what happens in the operating room. Because, just as Mike mentioned the fluid shifts, there are all kinds of conditions postoperatively that lead to changes in pulmonary vascular resistance and the status of the right ventricle. And there's a risk of infection and bleeding and all of those hemodynamic factors and physiologic factors can lead to a decompensation in the postoperative period. So it's important to have a good hand off between the anesthesiologist, the surgeon, and the PH specialist and the critical care team after surgery. And then close monitoring, usually at least with central venous pressure monitoring, if not a PA catheter. Definitely not everyone needs a pulmonary artery catheter, but I think we can all agree that central venous monitoring along with arterial hemodynamic monitoring is very important in these patients to really capture changes that are occurring to institute therapies that can prevent a downward spiral postoperatively.

---

I think that we work hard to identify patients who are in the proper window for this type of procedure.

—Dr Mathier

---

**Dr Mathier:** One perhaps obvious point is that you know these patients are going to have an interruption in their ability to take oral medications and so you have to plan ahead for that. Depending on how smooth the postoperative course goes and when they can start taking pills again, that could be a headache or potentially might not be much of an issue. But it should be thought of ahead of time.

**Dr McGlothlin:** Good point. Do you all frequently use inhaled nitric oxide for these patients intraoperatively and postoperatively?

**Dr Mathier:** Yes, I would say both. We anticipate that we will use nitric oxide intra- and postoperatively. I think that it's smart to have it available. It's smart to make sure that your Pharmacy and Therapeutics committee or your pharmacy is going to sign off on it because, as you know, it's quite expensive. But it can be really an invaluable sort of bridging agent in a patient like this.

**Dr McGlothlin:** That's my experience as well.

**Dr Studer:** How often do you have these patients that you're sending over on parenteral therapy? And are there any specific concerns you have in that population?

**Dr Mathier:** You know we've had patients who go on parenteral therapy. As you know by definition this usually identifies a more advanced population and so you might argue that you know it's a somewhat higher risk population. On the other hand, having them on parenteral therapy means that there is no interruption of the treatment perioperatively and also it gives you a little bit of titrate-ability according to what the hemodynamic needs are. I think it really gets down to how beneficial a hemodynamic effect you have been able to achieve with your therapy, whether it is parenteral or not. And does the patient on their therapy fall into an acceptable risk category as we discussed earlier?

**Dr Studer:** Ramesh, does it have any specific concerns for you when a patient is receiving parenteral therapy? Is that someone you're likely to feel is managed in a way that creates risk or maybe mitigates it?

**Dr Ramanathan:** I think, like Mike pointed out, they've already reached a more severe form of the disease. The management of the medication postoperatively is easier because you don't have to

deal with oral intake. Some patients after bariatric surgery have a prolonged period of nausea and vomiting with difficulty tolerating oral medications. But clearly you are dealing with a much higher risk patient once they have reached the point where they require parenteral therapy.

**Dr Studer:** Are there any specific comments about the postoperative period you think we haven't covered? We talked a bit about monitoring. Are there any other aspects of the postoperative management for those who haven't had management experience in bariatric surgery patients that you give as things to look for?

**Dr Ramanathan:** One of the issues is most of these people are on Coumadin or some sort of anticoagulation. Is that right, Mike?

**Dr Mathier:** Many are, yes. And warfarin would be the typical medicine we would use.

**Dr Ramanathan:** So we have to transition them over to Lovenox before surgery for a few days after stopping the Coumadin. Then postoperatively the question is how soon to restart anticoagulation? Especially when you're doing a procedure like sleeve gastrectomy or gastric bypass, there is a lot of mesenteric dissection with staple lines and anastomosis, postoperative bleeding is definitely a concern. The timing of when to restart their anticoagulation can be crucial, because if you end up with bleeding, you may have to take them back to the operating room. But I would like to know from Mike or Dana, how long can you delay the anticoagulation?

**Dr Mathier:** The good news is that this is not what I would consider a hard indication for warfarin so we have time on our side and we're generally happy to wait as long as it takes for there to be surgical certainty that it's acceptable to resume anticoagulation.

**Dr Ramanathan:** All these patients are transferred postoperatively to the intensive care unit on a ventilator and so the question is when to extubate them

and when to do the upper GI study. We usually do an upper GI study the next day after bariatric surgery in other patients to rule out anastomotic or staple line leaks before starting them on oral intake. So transferring these patients to the radiology suite while they're on a ventilator and have multiple monitoring catheters can be difficult. So we wait for a couple of days to wean them off all of these and then do the upper GI study.

**Dr Mathier:** Although I would say that the extubation issue more commonly has to do with the patient's tendency to have obesity hypoventilation than it does with their PH, *per se*. My approach to patients with pulmonary hypertension who are intubated, especially electively intubated, is that the sooner they're extubated the better. Just as a kind of guiding principle. But that's where the pulmonary consultant comes in—whether that's the actual PH provider or not—where they can help with safe and timely extubation in somebody who you know may have a tendency toward hypoventilation.

**Dr Studer:** Dana, did you have any other comments based on that postoperative piece that Ramesh and Mike were discussing?

---

...largely due to the multidisciplinary approach to these patients with a coordinated care among specialists with expertise in cardiac anesthesiology, cardiology, pulmonology, critical care, and bariatric surgery. —Dr Ramanathan

---

**Dr McGlothlin:** Yes, I agree that in general we like to extubate patients with pulmonary hypertension as soon as possible with the caveat being that these patients might be at greater risk for hypoxic pulmonary vasoconstriction after extubation because of sedation and hypoventilation. I think that does have

to be considered for these patients. But in general the sooner you can extubate them the better. I would say that it's not very uncommon for a patient with pulmonary hypertension to have some decompensation in ventricular failure related to the fluid shifts and perioperative stressors, and at times we need to use inotropic therapy such as dobutamine or norepinephrine. Those are common drugs used perioperatively for patients who develop right-sided heart failure. Some patients develop infection reduced systemic vascular resistance either from infection or from the anesthetic agents while they're on mechanical ventilation and in those patients vasopressin is a very good pressor agent. It tends to cause some nitric oxide release in the pulmonary vasculature that can lead to some degree of pulmonary vasodilation and decrease in the pulmonary vascular resistance to systemic vascular resistance ratio. Sometimes, although sometimes it is necessary to administer a little volume occasionally in appropriate situations, particularly in patients with bleeding, it is probably more common that we need to diurese gently for those patients who develop right-sided volume overload from fluid shifts and so forth. So the postoperative management period—especially within the first couple days after surgery—is an important time period for patients with PH undergoing surgery. And you know for those patients who are on nitric oxide, there is the issue of weaning off the nitric oxide. We tend to want to do that slower rather than faster because there is some degree of rebound PH in some patients. So we don't want to just want to wean it off quickly. Sildenafil can help wean PH from nitric oxide. That may be beyond

this discussion but there are those issues postoperatively that require a lot of attention.

**Dr Studer:** Thank you. I just wanted to sort of wrap up with the question, based on the experience you've all had with these patients in bariatric surgery and the concern that the prevalence of obesity as a co-morbid factor is increasing, what do you see as some of the future developments or referral patterns for bariatric surgery? Do you think the role of it is increasing?

**Dr Mathier:** I think it is increasing in the sense that we've come to recognize that when the proper approach is taken, the surgery can be offered to a broader range of patients than we initially thought. Those success rates, as Ramesh indicated, have improved. But at the same time I think we have to recognize that we shouldn't get complacent and fall into a pattern where we have bariatric surgery as some kind of a safety net and stop trying to energetically encourage patients to lose weight through more conventional means. Or better yet to prevent them from gaining weight to the extent where they become morbidly obese and have such severe limitation in their functional capacity. So one of the educational things I think we can do in pulmonary hypertension patients, especially because there are a large number of them who are young, is to institute very good habits in terms of diet and physical activity emphasizing the importance of avoiding the progression on to obesity.

**Dr McGlothlin:** Absolutely. And then I would just make another comment

about obesity as it relates to candidacy for patients with pulmonary arterial hypertension or who are failing medical therapies and may otherwise need to be considered for lung transplantation. This would be a significant barrier to their being able to have the next step in terms of life-saving treatment for their pulmonary arterial hypertension. It's a very important issue for these patients, particularly those who are not responding to medical therapy. So I always counsel my obese patients with Group I pulmonary hypertension who have significant disease even at earlier stages of their disease. If they're significantly overweight, they need to start working on it immediately with diet and as much regular exercise as they can safely tolerate so that that doesn't become the barrier to lung transplantation should they need it down the line.

**Dr Studer:** Ramesh, any final thoughts that you have . . .

**Dr Ramanathan:** Well, I think educating the patients about the risks and benefits of bariatric surgery is extremely important. Weight regain is a constant battle that we face in follow up. They have to understand that long-term successful weight loss requires significant and permanent changes to their lifestyle along with bariatric surgery. Especially in this patient population, where their physical activity is limited due to their cardiopulmonary status, the changes in their dietary habits have to be really dramatic.

**Dr Studer:** Those are excellent points. I thank all of you for your thoughtful contributions to this roundtable.