Dr Batirel. Atelectasis and pneumonia were the most significant.

Dr Seeley. If you were to design a randomized controlled trial around your investigation, how would you design it?

Dr Batirel. We should only focus on certain postoperative complications, namely atelectasis and pneumonia. We had 2 patients who had kidney failure after surgery secondary to low infusion rate during surgery, but both were temporary. I would probably determine a value, which is likely to be 5 or 6 mL, and a relatively liberal, like 8 to 10 mL, and then look at the postoperative pulmonary complications.

Dr Daniel L. Miller (*Marietta, Ga*). I enjoyed your presentation. Someone is finally putting some objective numbers on the operating room experience for fluids. These are very long procedures, and 2100 cc actually is not a lot of fluid. But the big thing I think you are getting into trouble with is within that first 48 hours. You are still giving patients intravenous fluid a lot of times. At my institution, we are on the Epic medical record system (Epic Systems Corporation, Verona, Wis); we have an automatic discontinuation of intravenous fluid at 12 and 18 hours. So we have really cut down the fluid immediately after surgery.

Also, we do not allow patients to eat unless they have been seen by a speech pathologist—not on the straightforward lobe but if a patient has had neoadjuvant treatment, induction therapy (a pneumonectomy especially), is older than the age 70 years, or has a history of head and neck cancer. We get them involved very early; the family feeds them ice chips and water, which is the worst thing to aspirate. What's very important in that whole picture is that first 24 to 48 hours.

Dr Batirel. Dr Miller, thank you very much for your comments. Fifty-five of our patients went to the intensive care unit, so typically even patients undergoing pneumonectomy go to the ward. If we believe they don't have any recurrent laryngeal nerve palsy at all, we start oral feeds 6 to 8 hours after surgery, and we don't offer intravenous fluids >1 L in the first 24 to 48 hours. If it's not a patient undergoing pneumonectomy we don't limit oral fluid intake because we believe oral intake is different than intravenous fluid administration.

Dr Batirel. Dr Miller, thank you very much for your comments. Fifty-five of our patients went to the intensive care unit, so typically even patients undergoing pneumonectomy go to the ward. If we believe they don't have any recurrent laryngeal nerve palsy at all, we start oral feeds 6 to 8 hours after surgery, and we don't offer intravenous fluids >1 L in the first 24 to 48 hours. If it's not a patient undergoing pneumonectomy we don't limit oral fluid intake because we believe oral intake is different than intravenous fluid administration.

EDITORIAL COMMENTARY

A dry lung is a happy lung: More supporting evidence

Eric J. Seeley, MD

See related article on pages 314-21.

Emerging data from multiple subspecialties, including surgery, medicine, and anesthesia, suggest that even mild fluid overload has adverse physiologic effects on lung function and leads to worsened pulmonary and nonpulmonary outcomes after surgery and during the resolution phase of acute respiratory distress syndrome (ARDS).^{1,2} The study conducted by Arslantas and colleagues³ and published in this month's edition of the *Journal of Thoracic and Cardiovascular Surgery* adds to the body of literature supporting a fluid conservative approach during lung resection. The counterargument to a

fluid conservative approach to medical or operative management of fluids is that inadequate right atrial filling pressures lead to a decrease in stroke volume, with a subsequent decrease in cardiac output and mean arterial pressure. Prolonged subnormal cardiac outputs and hypotension may cause decreased oxygen delivery to the kidneys, which may in turn lead to renal ischemia and acute kidney injury. Thus fluid administration in any setting, from the operating room to the intensive care unit, requires a fine balance between fluid overload and renal hypoperfusion.

Unfortunately, the current toolbox for hemodynamic measurement is not sufficiently sophisticated to allow clinicians to find the sweet spot in this balance between lung and kidney. In addition, studies within the last 8 years, most notably the Fluids and Catheters Treatment Trial,⁴ which was a randomized trial of fluid therapy in patient with ARDS after the resolution of shock, suggests that a fluid conservative approach may actually decrease the risk of continuous renal replacement therapy, rather than increasing it. The observational study conducted by Arslantas and colleagues supports the concept that we should err on the side of keeping patients dry to preserve lung function and decrease postoperative complications in patients undergoing lung resection.

The study by Arslantas and colleagues is notable for several reasons. First, they initially used a univariate

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comparison to show a correlation between several variables, including smoking and intraoperative infusion rate, with postoperative complications. To substantiate these findings further, Arslantas and colleagues used multivariate stepwise logistic regression to assess for independent predictors of pulmonary complications and found that the only modifiable factor that remained significant in stepwise comparison was intraoperative fluid infusion rate. Although these data suggest that intraoperative fluids may lead to postoperative pulmonary complications, this illustration of correlation certainly does not prove causation. For example, other variables unaccounted for, such as intraoperative hypotension, both would require increased intravenous fluids and could potentially lead to future pulmonary complications. Furthermore, intraoperative tidal volumes, a potential determinant of post-operative ARDS, were not included in the analysis.

To answer definitively the question of how much intraoperative fluid is enough but not too much, a large multicenter randomized controlled trial of conservative

fluid therapy versus standard practice during lung resection powered for a less complex end point, such as the development of postoperative ARDS or mortality, would add clarity and potentially provide evidence for a causal relationship between intraoperative fluid therapy and outcomes during lung resection. It seems that there is now ample evidence to design and execute such a trial.

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