Preoperative Pulmonary Function Tests to Predict Postoperative Outcomes: Beware of Confounders!

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ANESTHESIOLOGY IMPERFECTA: A SHORT, ONE-ACT PLAY

Cast of Characters

The Resident: A clinical anesthesia year 3 (CA-3) resident preparing for the anesthesiology boards.

The Attending: A veteran attending pediatric anesthesiologist who has “seen it all,” almost.


The Resident (feeling a little smug): I thought we did all right today. We managed to extubate our 2 patients at the end of their rather long posterior spinal fusion (PSF) operations. Only Kyle, the 5-year-old kid, required precautionary overnight intensive care unit (ICU) observation. I do have a point of observation to make. I hope you don’t mind?

The Attending: Please, feel free to share your thoughts.

The Resident: When we were discussing the anesthetic plan at the beginning of the day, you barely glanced at the pulmonary function test (PFT) results of the teenage girl with idiopathic scoliosis, and only gave a cursory look at the results of the 5-year-old boy with neuromuscular scoliosis. I am currently studying for the anesthesiology boards, and questions about PFTs and their impact on postoperative pulmonary complications feature quite commonly in the examinations. Don’t you believe in the utility of PFTs?

The Attending: PFTs are a battery of cross-sectional tests or maneuvers used to assess lung function.1 Broadly speaking, they assess 3 aspects of the respiratory system: respiratory mechanics, lung parenchyma or gas exchange, and cardiopulmonary interactions—or loosely speaking, they assess 3 aspects of the respiratory system:

1. Insufflation capacity (IC) values <40% of predicted normal and/or maximum inspiratory pressure [MIP] values <30 cm H2O

2. Inspiratory pressure [MIP] values <30 cm H2O

3. Forced vital capacity [FVC] <40% of predicted normal

It is important for you to understand that these tests were neither designed to predict who will need postoperative mechanical ventilation, nor can they reliably predict the need for postoperative ICU admission. When you use a diagnostic test to perform beyond what it was designed to do, it will fail.2

The Resident: So why do we still perform preoperative PFTs on patients? Seems like an awful waste of money, given the limited return on investment.

The Attending: That is precisely the point that Burjek et al3 were trying to make in their article in a recent issue of Anesthesia & Analgesia (A&A). I read their work with considerable interest, and I think they should be commended for taking a stab at providing some insight into the difficult question of predicting postoperative pulmonary complications in pediatric patients experiencing scoliosis. Have you read the article?

The Resident: I’m afraid I haven’t, but I promise to look it up tonight before I go to bed.

The Attending: The overarching objective of the study by Burjek et al3 was to question the utility of routine ordering of PFTs on all patients undergoing PSF at their institution. Theirs was a retrospective cross-sectional study of a large cohort of children (N = 433; 288 with primary scoliosis, and 145 with secondary scoliosis) who underwent PSF between June 2012 and August 2017. The specific objectives of the analyses were to determine whether children with “high-risk” preoperative PFT values (defined as forced vital capacity [FVC] <40% of predicted normal and/or maximum inspiratory pressure [MIP] values <30 cm H2O) were more likely to require postoperative ventilation or ICU admission.

PFTs performed within 1 year of surgery were used for group allocation.

The Resident (with a hint of sarcasm): I bet their results confirmed what is written in many anesthesia textbooks and what shows up frequently in our examinations: high-risk PFT results increase the risk of postoperative pulmonary complications.

The Attending: On the contrary. Interestingly, despite what we teach you and what you will find in comprehensive review articles on the subject,4 the literature is actually unclear about the benefits of PFTs as a predictive tool for postoperative pulmonary complications. Some investigators have reported increased rates of postoperative complications in patients with low PFT values,5,6 while others argue that (despite what we teach you), a low vital capacity does not...
preclude good surgical outcome. It is what I like to refer to as “anesthesiology imperfecta.” We have no clear crystal ball for predicting poor outcome in patients with scoliosis.

The chief findings of the retrospective analyses by Burjek et al were that the majority of children with primary scoliosis were able to produce usable PFT data, but this did not predict postoperative pulmonary morbidity. On the other hand, children with secondary scoliosis (who were sicker) were often unable to produce usable PFT data; and when they did, these results did not reliably predict the need for postoperative ventilation or ICU admission. The authors concluded that “routine pulmonary function testing for all patients with scoliosis may not be indicated for purposes of risk assessment before PSF,” and they suggested a targeted approach that limits preoperative PFTs to patients for whom results may guide preoperative optimization, as this may improve outcomes and reduce inefficiencies and costs.

**The Resident:** Sounds like a reasonable conclusion. We should show this to the spine surgeons and the anesthesia team. It seems that routine ordering of PFTs is a waste of resources, and we should stop this practice as soon as possible. I like simple, observational studies such as this, which have huge potentials for changing clinical practice.

**The Attending:** Not so fast, Mr Hospital Administrator! Despite the underlying wisdom of the message in the study by Burjek et al, I am afraid these findings are not going to change clinical practice by much. First, retrospective studies have many limitations, many of which cannot be corrected by the study design. Also, these findings are not in any way novel, as previous investigators have shown poor association between PFT values and postoperative pulmonary complications. Also, remember that PFTs are usually ordered by the patient’s spine surgeon or the pulmonologist; and in many instances, they are performed preoperatively to document existence of pulmonary dysfunction, especially for patients with thoracic scoliosis, and they serve as a baseline for comparison in the later postoperative period.

In my 23 years of doing this job, I don’t recall a single instance in which I demanded to see a patient’s PFT results before proceeding with anesthesia or canceled a spine case because PFT results were not available! On another note, temporality is one of Bradford Hill’s criterion for determining causality: Can you reliably say that a PFT that was performed nearly a year ago will have anything to do with the patient you’re seeing today? One year in the life of a child experiencing neuromuscular scoliosis could be an eternity with respect to disease progression or lack thereof. So, remember this in your future practice: when trying to predict who is going to need ICU care or postoperative mechanical ventilation, detailed history and physical examination are just as important (if not more important) than the results of the PFT. Personally, I think serial PFTs are more useful for measuring disease progression; cross-sectional PFTs are useless!

**The Resident:** Sounds like you’re not a fan of Burjek et al! Did you find anything else wrong with the article?

**The Attending:** On the contrary, I actually give them a lot of kudos for their addition to the literature on PSF and postoperative pulmonary complications. Unfortunately, their study design has left us with many more questions than answers. For example, the authors found that failure or inability to attempt preoperative PFTs on children with neuromuscular scoliosis was associated with increased odds of postoperative ICU admission and the need for mechanical ventilation. This is a classic case of protopathic bias.

**The Resident (looking slightly confused):** Protopathic bias? Totally new expression to me. Please explain.

**The Attending:** The albatross of every retrospective study is the vexing issue of confounders. Confounding is often simply defined as a confusion of effects. Simply put, a confounder “pulls” the observed association away from the true association, indicating that you can have a positive or negative confounder. A confounder is a variable or variables that correlate with both the exposure (risk factor or x-variable) and the outcome (disease or y-variable). Since confounders are extremely difficult to account for with observational study designs, the investigator must ensure they are accounted for either a priori (preferred) or during the analysis.

Confounding by indication or disease severity is one that occurs from good medical care: physicians’ tendency to choose a medication or a form of intervention for the patients who are most likely to benefit from such intervention. For example, the observation by Burjek et al that children with secondary scoliosis who “failed to perform” on preoperative PFTs were more likely to require postoperative ICU care or postoperative ventilation may simply be an indication of good medical care (these patients were judged to be too sick on clinical grounds, and were kept intubated and sent to the ICU out of abundant caution). This type of confounding by indication leads to protopathic bias, which occurs when an intervention (postoperative ventilation or ICU admission) occurs in response to a symptom of the disease (inability to perform a PFT). Think about it this way: sicker patients tend to go to the ICU postop regardless of the results of a single preoperative test. Indeed, the finding by Burjek et al that high American Society of Anesthesiologists (ASA) functional status was associated with increased odds of postoperative intubation and ICU admission is a good indicator that protopathic bias may be responsible for some of their findings. Many other examples of confounding and bias are detailed in a recent issue of *Anesthesiology*.

**The Resident:** I promise to read up on this. I’m beginning to appreciate the importance of confounding with retrospective studies now. I can see how variables like duration of surgery, number of spinal segments fused, occurrence of intraoperative hypothermia, intraoperative blood loss, and volume of blood transfused can become important confounders. I would imagine that if these variables were all clustered in children with idiopathic scoliosis (very likely) whose physicians failed to attempt PFTs, then one cannot make the argument that failure to attempt PFT is responsible for the outcome. Did the authors control for these variables?

**The Attending:** Very impressive! I’m glad you learned something from the 2 patients we managed today, because we tried to optimize these variables in the intraoperative period. Unfortunately, the report by Burjek et al did not account for many of these variables. You could argue that previous investigators have identified these variables as risk...
factors for postoperative intubation and ICU admission, but you are correct in expecting that they are important confounders that have to be considered in any retrospective analyses of PSF patients. This is why I feel that although they have asked the right question, Burjek et al leave the reader with many more questions than the answers provided. Will these findings convince spine surgeons and pulmonologists to stop ordering PFTs on their patients? I don’t think so. PFTs are primarily used to monitor disease progression. Single, cross-sectional PFTs are rarely used in isolation. They may serve as complementary diagnostic tools for symptoms, signs, and other ancillary tests.

One important lesson from the study by Burjek et al is that anesthesia providers may stop giving undue weighting to preoperative PFTs, especially in children. Among those with idiopathic scoliosis (who are often healthy adolescents), postoperative intubation and ICU admission are extremely rare events regardless of the PFT findings. Relatedly, among children with neuromuscular scoliosis, many were unable to produce usable PFT data, and of those who provided usable data, there was no demonstrable association with postoperative ventilation or ICU admission. Who knows? One of the options to “board type” questions on the utility of perioperative PFTs in the near future may include “none of the above.”

The Resident (Looking up at the clock): Gee! Dr T, where did the time go? We’ve been talking for almost 2 hours! I have to go and preop my patients for tomorrow. Thank you so much for all the teaching today. I learned a lot.

The Attending: I know! Time flies when you’re having fun! Good luck with “the boards.” Remember not to argue with the multiple-choice questions! ☝️

DISCLOSURES
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