The Evolution of the ProVent Score from Medical to Surgical Applications

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The ProVent score is a simple, five-variable clinical tool designed to assist clinicians in understanding 1 year survival for patients who receive mechanical ventilation for far longer periods than average. Since the 2008 publication of the original report describing ProVent (1), the phenomenon of prolonged mechanical ventilation, a type of chronic critical illness, has gained significant attention or, rather, more detailed scrutiny. The story is compelling: A group of approximately 400,000 persons a year with high mortality, great physical and cognitive disability, and enormous costs appeared to be growing (2). When combined with the Center for Medicare and Medicaid Services' interest in long-term care facility reimbursement, the introduction of bedside tracheotomy placement, and discussions about the possible discordance of outcomes with patient preferences in a time of increasing awareness of palliative care principles, discussion of this somewhat controversial patient group even began to enter the lay press on a regular basis (3).

At the bedside, however, one real controversy at hand seemed to be: To whom exactly did ProVent apply, and what did it mean? Early in the ProVent experience, one could certainly argue that it was perhaps insufficiently validated outside of five East Coast and West Coast academic institutions. Over time, other studies have been conducted in other regions and nations that have essentially reproduced the initial findings that the model successfully identifies those at high risk for very poor outcomes: the very group on which decisional support should be

focused. Yet in our experience with ProVent during the last 7 years, for no population has there been more resistance to its acceptance than the clinicians who care for surgical patients. Although there has been a sizable number of surgical patients (>400) included in ProVent studies, no single study had been conducted that focused nearly exclusively on such a cohort.

Addressing this important knowledge gap is a new work in this month's issue of *AnnalsATS* by Udeh and colleagues (pp. 1845–1851), at the University of Iowa (4). In a retrospective cohort design among 398 patients, 75% of whom were surgical patients (most of whom were trauma, cardiothoracic, and neurosurgical patients), who were ventilated for at least 14 days, these authors evaluated the performance of the ProVent model both on patients ventilated for 14 or more days and on those ventilated for 21 or more days. They found that the model had good discrimination and accuracy in this group with primarily surgical diagnoses. Further extending their exploration of the model in a Midwestern geographical location in which the model had been previously untested, the authors also found that advanced age, vasopressor use, and new receipt of hemodialysis were the most powerful ProVent predictor variables for those ventilated for 14 or more days, whereas age 65 years and greater and vasopressor use were significantly associated with survival among those ventilated for 21 or more days.

These results complement the ProVent Investigators' recent report of the development and validation of a mechanical

ventilation day 14 ProVent model (5). This model adds an additional variable to the model (nontrauma), recognizing that trauma patients with prolonged mechanical ventilation have better outcomes than nontrauma patients. Given the high number of trauma patients in the Iowa cohort, it is therefore possible that the ProVent 14 model would have performed even better than the original ProVent model that was assessed.

Yet in Udeh and colleagues' thoughtful discussion of their results, they highlight the fact that perhaps the easier part of clinical care is calculating a prognosis. The harder part is understanding what this number means relative to a clinician's instincts and the patients'/families' values, and how to actually apply this information to shared decision making. We think it is also important to consider these researchers' results in the context of a couple inertia-restraining realities unique to the surgical clinician experience. One is the reality of the 30 day surgical mortality public reporting rule, a time frame clearly much beyond the 14 day ProVent window. Although alternatives to this surgical quality indicator have been proposed (6), none has been adopted. We assume that most surgeons focus on delivering care that is concordant with patient values (a palliative care quality indicator) as a metric of success, rather than focusing on an arbitrary time frame of survival, but these metrics may at times create notable conflict.

The second is exemplified by some variation of a legitimate question we are often asked: "How many 75 year-old

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post-partial-hepatectomy patients from rural Nevada were evaluated in your study?”

Actually, we think what the surgeon is really trying to say is: “Listen, I want to advocate for my unique patient and give them the most accurate, personalized information. Are your model’s data sufficiently robust for this task?” To offer yet another retread on the maxim that after a few days of life support, the surgical and medical patient delineation begins to evaporate, we think the general answer to this question is increasingly a “yes,” an answer now based on more than 700 surgical patients in the published ProVent medical literature.

ProVent is not perfect for assessing prognosis for the individual patient, however. There are clearly unique patients whom one would reasonably expect to do much better or worse than the model predicts, based on clinical characteristics that are not included in ProVent (relapsed leukemia, marathon runner, etc.), which is certainly a trade-off of a model that aims to be both simple and easy to apply across broad populations. When a surgeon reflects on a predicted 75% 1 year mortality, for

instance, it is certainly his or her prerogative to frame this information the way he or she feels is most correct: “Listen, I know that based on a limited set of clinical factors, we would expect that about 75 of 100 patients just like your husband would die within 1 year from now. But I think that Jim’s remarkable physical health before his partial colectomy and subsequent sepsis leads me to believe that he is probably going to be in the group of 25 survivors.” Another current limitation of ProVent is its inability to predict outcomes beyond survival that patients and families deeply care about, such as future physical and cognitive function. This is an important focus for future research. Finally, as pointed out by Udeh and colleagues, better defining a reproducible, prescribed shared decision-making approach that integrates objective data such as ProVent with clinician judgment and patient values is much needed. Although interventions such as decisional support tools show early promise for providing this assistance (7), more research is needed to understand their clinical effect.

Recent epidemiological data have shown that the incidence of tracheotomy (an imperfect and incomplete surrogate of chronic critical illness) for prolonged mechanical ventilation has, in fact, fallen lately, after a peak in 2009 (8). This finding is likely a result of a variety of factors, including greater emphasis on intensive care unit-based communication and palliative care, publication of studies showing no advantage to early tracheotomy placement, and possibly the increased focus on this unique patient population. Given intensive care medicine’s technology focus, combined with greater annual numbers of multimorbid patients, what is clear is that the number of patients at risk for prolonged mechanical ventilation and chronic critical illness will remain large for the foreseeable future. For medical and surgical patients alike, clearer clinician judgment, as well as adjuncts such as the ProVent model, may help clinicians, patients, and families more deftly navigate these challenging waters. ■

Author disclosures are available with the text of this article at www.atsjournals.org.

References

- 1 Carson SS, Garrett J, Hanson LC, Lanier J, Govert J, Brake MC, Landucci DL, Cox CE, Carey TS. A prognostic model for one-year mortality in patients requiring prolonged mechanical ventilation. *Crit Care Med* 2008;36:2061–2069.
- 2 Damuth E, Mitchell JA, Bartock JL, Roberts BW, Trzeciak S. Long-term survival of critically ill patients treated with prolonged mechanical ventilation: a systematic review and meta-analysis. *Lancet Respir Med* 2015;3:544–553.
- 3 Kolata G. At these hospitals, recovery is rare, but comfort is not. New York: New York Times; 2014 [accessed 2015 Oct 14]. Available at: <http://www.nytimes.com/2014/06/24/health/life-goes-on-at-long-term-acute-care-hospitals.html>
- 4 Udeh CI, Brent Hadder B, Udeh BL. Validation and extension of the provent score for one-year mortality in patients requiring prolonged mechanical ventilation. *Ann Am Thorac Soc* 2015;12:1845–1851.
- 5 Hough CL, Caldwell ES, Cox CE, Douglas IS, Kahn JM, White DB, Seeley EJ, Bangdiwala SI, Rubenfeld GD, Angus DC, et al.; ProVent Investigators and the National Heart Lung and Blood Institute’s Acute Respiratory Distress Syndrome Network. Development and validation of a mortality prediction model for patients receiving 14 days of mechanical ventilation. *Crit Care Med* 2015;43:2339–2345.
- 6 Schwarze ML, Brasel KJ, Mosenthal AC. Beyond 30-day mortality: aligning surgical quality with outcomes that patients value. *JAMA Surg* 2014;149:631–632.
- 7 Cox CE, Lewis CL, Hanson LC, Hough CL, Kahn JM, White DB, Song MK, Tulskey JA, Carson SS. Development and pilot testing of a decision aid for surrogates of patients with prolonged mechanical ventilation. *Crit Care Med* 2012;40:2327–2334.
- 8 Mehta AB, Syeda SN, Bajpayee L, Cooke CR, Walkey AJ, Wiener RS. Trends in Tracheostomy for Mechanically Ventilated Patients in the United States, 1993–2012. *Am J Respir Crit Care Med* 2015;192:446–454.