BREATHING PATTERNS AS WEANING PREDICTORS

by John Marini MD

Premature extubation is a setback that increases the cumulative duration of machine dependence and poses an increased mortality risk. On the other hand, delaying extubation entails unnecessary discomfort and exposure to the hazards of ventilatory support. The importance of timely ventilator withdrawal has been recognized in the widespread adoption of weaning protocols, whose key elements are guided by quantitative indicators of the reloading process. By following such protocols, nurses and respiratory therapists often make important observations and are empowered to implement care decisions heretofore made only by the physician. Patient care protocols have been implemented for many common tasks related to critical care in an attempt to standardize, routinize, and streamline management. Using them, personal judgments are intentionally kept to a minimum. Their contributions to everyday practice are beyond reasonable doubt when the objective, the evaluation criteria, and the interventions are unquestioned. A good example here is the reminder for sedation to be lightened on a daily basis so that only enough drug is given to assure comfort without unnecessary and unnoticed suppression of consciousness. It seems certain that potentially costly and high risk days on ventilator have been reduced by implementing rule-based sedation monitoring and management. With limited resources, and the varying education and experience of the increasingly turbulent caregiver pool, eliminating undesired variability in common tasks helps to expedite care, improves safety, and makes sense--doesn't it? Ironclad rules can be applied by caregivers of varying ability and work well for the majority of patients. But not all, unfortunately. Although strong advocates of protocolized care believe that we should approach even complex problems in this fashion. Protocols are no substitute for experience; inherently complex problems, such as graded ventilator withdrawal /extubation ("weaning") cannot easily be put on autopilot.

Although RSBI is an excellent weanability predictor, experience shows us its imperfections

Patients may remain ventilator-dependent for a variety of reasons, including intolerable hypoxemia, cardiac instability, or inability to protect the airway. Likewise, reintubation may be required for reasons unrelated to breathing demands and capacity to sustain them. Yet in an alert patient ventilated for an extended period, the commonest cause for weaning failure remains the presence of a demand for breathing power disproportionate to work capacity and endurance. Of the elements "hard wired" into most weaning protocols, none is more pervasive than the rapid shallow breathing index (RSBI) calculated during spontaneous breathing or minimal machine assistance. There is good reason for its favorable reception into daily practice. This simple index allows the patient to integrate respiratory stress and capability into a telltale response that often—but not infallibly—predicts "weanability."

Despite substantial predictive utility, such "snapshot" indicators may be less reliable than measures that track the variation of breathing pattern over time. Increased variability of minute ventilation, its subcomponents of frequency and tidal volume,and I:E ratio, is a highly favorable sign. On its surface, superiority of such variation indices to the RSBI may seem surprising, but it is fully consistent with examples from scientific fields within and outside of medicine. In health, dynamism is an innate property of human biology. Robust homeostasis implies the existence of some baseline variation and of the reserves to respond to a challenge. Examples abound in our surrounding inanimate world (e.g., weather, the turbulence of running water), and some can be found in the field of critical care medicine, as well. Except in extreme circumstances, it is hazardous to predict the overall response of a biological system to stress from any single observation of its regulated output (such as frequency, tidal volume, or their quotient, RSBI).

Although the metabolic demand and chemical set points (pH, Pco2, Po2) normally regulate the level of ventilation, the pattern selected to do so integrates many more inputs. Baseline variation of breathing pattern is characteristic of both healthy and diseased lungs. Under stress, minimizing the work of breathing assumes such a high priority that the respiratory integrator will seldom drive the system into exhaustion, even under conditions of near catastrophic loading. To meet a changing ventilatory requirement, the subject may vary frequency, tidal volume, or alter one or more chemical set points. Characteristically, frequency increases disproportionately to tidal volume when approaching the limits of compensation. Such reasoning may account for an increasing RSBI and a declining variability of tidal volume as adaptive exercise responses.

Analyses of variation—of minute ventilation, tidal volume and I:E ratio--are not only noninvasive and risk-free, but the otherwise tedious process of tabulation, trending, and analysis can

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Another important source is a book from the Best Publishing Company entitled "Hyperbaric Nursing". This is an excellent resource to use for writing the required department interventions that guide staff in managing patient care practices for situations and events that arise. As an example, an intervention is a step-by-step set of instructions on how to manage a hypoglycemic patient, confinement anxiety, or an assortment of emergency procedures. This book also includes an in-depth examination of patient assessment methods as related to nutrition, pain and others. Patient education is another important area surveyor's review, which this book addresses. Do you have discharge instruction information for patients with decompression sickness and carbon monoxide poisoning and are they in printed in multiple languages that reflect your community?

Once you purchase your accreditation survey manual and review its contents you will have a better idea of what is expected and the preparation time needed. It could range from three months to a year to get everything in place and the survey team will want to see some existing evidence of compliance prior to their visit. The survey itself is usually a two-day process although it may be extended and the team usually consists of three surveyors; an experienced hyperbaric physician (the Team Chief), a Certified Hyperbaric Registered Nurse (CHRN), and a Certified Hyperbaric Technologist (CHT). There are three levels of accreditation awarded; full accreditation, full accreditation with distinction, both of which are for a period of three years, and deferred accreditation, which is good for up to 12 months, in which time the center must successfully address specific issues identified during the survey. As with any accreditation survey, there is a great deal of preparation time and energy spent to achieve a successful outcome. There is also the satisfaction and pride received when the goal of accreditation is achieved.

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now be conducted effortlessly by computer-aided tracking of the variables already measured by the ventilator. Protocols that depend on observation and feedback from trials of spontaneous breathing must be informed by reliable indicators. When first described 15 yrs ago, the RSBI was clearly a step forward in extracting information that reflects the demand/capability balance. However, although very useful, experience has shown us the imperfection of its predictive power. By helping noninvasively to evaluate the flexibility and reserve of the ventilatory pump, the variation data suggest another avenue toward improved predictors of extubation success. Just as importantly, we now have the capacity to effortlessly and noninvasively evaluate variation of key ventilation pattern components. Aided by modern technology, numerous important and unsolved problems we confront in daily practice should yield to careful observations by the clinician and to insightful physiologic reasoning.

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