Editorial

New Modes of Neonatal Ventilation: Let There be Light

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Neonatal mechanical ventilation has a long history of change by trial and error. From intubated, then nasal CPAP to IMV to high frequency to synchronization and various types of volume targeting, we have adopted changes in our practice based more on the types of technology available than on data generated from large, randomized controlled trials. The reasons are easy to understand. First, during the early years of neonatology as a recognized specialty, mortality was so high as to overwhelm our thoughts, giving us the zeal and desperation to justify trying new things about which we knew little. Then, as we saw improved mortality, we realized that morbidity in our patients was a major problem, and we enthusiastically adopted approaches which held promise in small trials, sometimes without waiting for the larger ones, and sometimes, such as in the case of high-frequency ventilation, in spite of them.[1] We were dazzled by the microprocessor, and by our new ability to measure aspects of pulmonary function at the bedside in critically ill neonates. This new technology was rapidly incorporated into the ventilator platforms and became a part of daily management.[2,3] At the same time, this new technology allowed the ventilator to sense the presence of the patient. Again, this seemed a true advance, though one which has yet to be proven superior by large RCTs.[4,5] Today, we find ourselves surrounded by technologically advanced equipment with a veritable alphabet soup of neonatal ventilatory modes — IMV, synchronized intermittent mandatory ventilation (SIMV), assist/control (A/C), PSV, volume guarantee (VG), PCV, BiPAP, APRV, PRVC — the list goes on. Though there are data to help us, we often find ourselves struggling to integrate what we can potentially do with these devices into what we know of newborn physiology and coming up short.

In this issue of the Journal, two papers shed some light on these problems, one from Georgetown by Abubakar and Keszler,[6] another from Vanderbilt by Guthrie et al.[7] While neither are large RCTs, both evaluate new modes of neonatal ventilatory support carefully and in such a way to both inform the users, who must continue to treat in the absence of more complete data, and to provide a basis for larger trials. Neither study has large numbers, but both use a crossover design in which each enrolled patient serves as his or her own control, greatly increasing the ability of these small trials to detect change.

Abubakar and Keszler compare SIMV to A/C in 12 infants, both using a proprietary volume-targeting system called VG available on the Draeger 8000 + platform. Their main findings are increased work of breathing, lower SpO2, higher pressure requirements and greater variability of tidal and minute volumes during SIMV + VG as compared to A/C + VG. The major difference between these modes is that A/C + VG potentially provides some support above the set PEEP level to all patient-initiated breaths, while SIMV + VG only provides such support for the number of breaths determined by the set SIMV rate. These findings complement and extend earlier studies of these modes with volume-targeting without VG, and add support to the general concept that more uniform support of patient respiratory effort may be beneficial.

Guthrie et al. evaluate a different mode of ventilation called mandatory minute ventilation (MMV), and compared this to SIMV, again using a crossover design in 20 patients. MMV is a mode which requires the operator to determine what the appropriate minute ventilation for the patient should be, and the ventilator then monitors the patient's ability to generate this volume every 7.5 seconds. If the calculation suggests the volume target will not be met, SIMV breaths are delivered at the targeted volume to achieve the desired minute ventilation. A Draeger ventilator, the Evita 4, also provided this mode. They found that, with MMV, fewer mechanical breaths were required as compared to SIMV, without any change in CO_2 values or oxygen levels. In fact, because MMV is a mode in which spontaneous breaths are augmented with pressure support — that is, the infant's spontaneous initiation of a breath has an added positive pressure component to support tidal volume delivery — what the authors actually showed was a decrease in SIMV breaths, not mechanically supported breaths in general. This difference is a subtle one. Pressure-supported breaths are flow cycled, and allow the patient to modulate inspiratory flow and determine the actual duration of inspiration. An SIMV breath has a set inspiratory time, which is not altered by the mechanical characteristics of the infant's lung. Thus, SIMV breaths essentially ''dial the patient out''. The elimination of such breaths then allows the patient to assume another level of respiratory control. The authors suggest that this mode might allow us to more effectively utilize the infant's endogenous respiratory drive to support ventilation, eliminating the ''heavy hand'' of the mechanically imposed breath.

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In addition to the small number of patients studied, the major limitation of both studies is the fact that patients were reasonably healthy when studied. In the Abukabar study, babies were ''clinically stable'', and were 7 to 59 days of age, 690 to 1535 g. In the Guthrie study, babies were even healthier — >33 weeks gestation and intubated electively for medical or surgical procedures, then studies during their post-anesthesia recovery. Because of this, we need to be cautious about generalizing these findings to the patients in whom we are the most interested- the small, the sick, the unstable newborn. But the demonstration that these modes are effective in the recovering infant, and the potential for more physiologic support, certainly should provide stimulus for more studies in smaller, sicker newborns.

It is easy to argue that the many new modes of support available to us are just ''bells and whistles'', since long-term outcomes have not been clearly shown to be improved by their use. While the large multicenter randomized controlled trial remains the gold standard, the absence of such trials must not be an excuse to ignore an opportunity to tailor technology to the critically ill patient. The modes of ventilation studied in these two papers do just that. Because we have the technology to detect patient respiratory effort, to monitor and adjust tidal volumes, to assess and augment minute ventilation, and to allow the recovering patient to interact with the mechanical ventilator, we may increase the likelihood that the delivered support will match the physiologic need. Most neonatologists were trained to adjust ventilator variables manually, with little more than the occasional blood gas and chest X-ray to guide us. We got used to working in the dark. As we are able to make more accurate measurements and to allow the babies to interact more with their technologic support, we should make better judgments. These two studies shed light onto the process of ventilatory support. But the shadows are still long. In this era of molecular mechanisms and genetic mapping, we still need good patient-based physiology research as we study these new technologies.

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