Mind the Gap – From Big Data to Physiology (and Back)

The management of acute respiratory failure has improved in many respects throughout the last decades. On the basis of large-scale observational data and our continuously improved understanding and monitoring abilities of respiratory mechanics, it is no surprise that lung-protective ventilation strategies have routinely been implemented around the globe.[1] Besides these positive developments in the acute setting with relatively strict target ranges for almost anything that one can adjust, more research is needed with regard to long-term sequelae and outcome. One important aspect of this is the transition from lung-protective ventilation strategies in acute settings to the later weaning process and its relation to critical illness associated neuromuscular deconditioning. Obviously, injury (active or passive) to the diaphragm, our major respiratory muscle, is of utmost importance in this context, but its assessment is not implemented in daily routine. Bedside ultrasound provides both qualitative and quantitative assessment of its contractility and longitudinal assessment of atrophy. In general, the technique is certainly fun and has additional value for the aficionado, but in light of its difficulties (eg, inter- and intra-observer variability), its broad use is still limited. It would be desirable to study optimal target ranges of easily reproducible and accessible routine parameters of respiratory mechanics to guide the weaning process and to reduce neuromuscular deconditioning.

Literally all ventilator adjustments during the weaning phase are not based on evidence but rather on physicians' individual decisions that by themselves depend on their personal clinical expertise. Standardized and reproducible algorithms with clearly defined treatment targets would help with these complex decisions, particularly at a time when ICUs around the world are burdened with an unprecedented accumulation of demanding weaning decisions during the COVID-19 pandemic.[2]

In the current issue of Respiratory Care, Urner et al[3] accept the challenge, implementing several routine parameters from their patient data management system in a "big data" approach to answer these physiological questions. In any contemporary ICU setting, thousands of data points are generated in a single day per individual patient, carrying the potential to reveal information that is not readily apparent.[4]

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Nevertheless, at first the authors used ultrasound as the accepted standard to establish a competitor for the computed algorithms. They confirmed that a single initial measurement of diaphragm thickening fraction can stratify the risk of subsequent diaphragm atrophy. They thus show that an additional parameter directly related to the physiological function of the diaphragm, assessed at the beginning of ventilation, may hold information that could prove prognostically relevant and eventually could help guide therapeutic decisions.

For the "big data" approach, the authors did not include all available parameters, instead choosing a (pre-)selection of parameters, thereby introducing, at least to some extent, an unknown bias. In sum, it is fair to state that their analysis did not confirm any connection between the combination of tested clinical variables and diaphragm contractility, nor could those parameters predict diaphragm atrophy. Their results serve as an important reminder that these computational analyses and algorithms are only as good as the data that they are provided with. By reporting these results that are negative only at first glance, the authors succeed in emphasizing that, next to advancing computational methodologies to uncover information contained within the aggregated treatment data, the solution to the problem might depend on balancing these methods with the use and discovery of parameters that are more closely related to the physiological processes in question. The possibility of uncovering information hidden in any combination of the former, or the lack thereof, needs to be weighed against the additional resources needed to collect the latter. The quest for a solution to this problem inevitably catapults the avid clinician between the fronts of advanced machine learning techniques and basic physiological research. By demonstrating the predictive potential of early diaphragm ultrasound regarding the development of diaphragm atrophy, the authors show that the combination of these approaches could eventually help predict the impact of early management decisions on long-term outcome.

In many areas of critical care medicine, the "big data" approach has advanced significantly in the last decade. Its

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potential to further improve not only the initial management of respiratory therapy, but also the transition to weaning and long-term outcome, could help sustainably improve the quality of life of survivors of critical illness. Most importantly, we are just now opening the door to a world where we can optimally balance the integration of available information with the development and collection of new ways to measure the underlying physiology of disease to make truly informed and individualized treatment decisions.

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