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NEUROCRITICAL CARE SOCIETY

INVITED COMMENTARY

Complex Approaches for a Complex Organ

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Do complex systems improve our care of patients with brain injury? It is easy to argue that they do, at least in concept. The brain is the most complex organ of the human body and even more so when injured. A multitude of pathophysiological changes evolve from primary traumatic brain injury (TBI) and many more from secondary insults, developing a vicious cycle of injury that begets more injury. Moreover, all of our well-meaning attempts to avoid or treat secondary injury can create more trouble, sometimes inadvertently causing further injury. For example, raising blood pressure may reduce the risk of ischemia, but it may cause systemic adverse effects and increase intracranial pressure (ICP) if autoregulation is impaired. How does one treat increased ICP when both its causes and the consequences can vary between patients, and even in one patient over time? Perhaps this is why clinical trials in TBI fail—standard interventions applied homogeneously to large groups of patients produce averaged results that do not tell you if an individual patient would benefit because the injury is too complex and heterogenous.

All of this is more challenging in children, an ever-changing population for whom we have less data. Although in adults, anatomy and physiology are largely static, they vary enormously from birth to age 13 [1]. If we cannot agree on what is a sensible cerebral perfusion pressure (CPP) treatment target in adult TBI, how are we possibly going to do this in a 3- or 9-year-old child?

It is tempting to believe that we can match this complexity with some complexity of our own. Maybe we can make more informed and individualized decisions based on a patient's unique set of circumstances using advanced monitoring [2]. To do so we would need more information from a patient and better systems to accommodate and process that information. Maybe then we can select therapies for specific patients and titrate that therapy to find the sweet spot where the intervention is maximally effective and minimally harmful.

Many people are trying to do just that. But does it make a difference? How do we show that it benefits patients?

So with that backdrop, let us turn to the study of Appavu et al. [3] in this issue. The study reports the impact of implementing standardized reporting of multimodality monitoring (MMM) in children with TBI: 18 children underwent detailed MMM reporting in the later part of a larger series of 85 children. The authors used several tools: ICP, invasive and noninvasive brain oxygenation monitoring, autoregulation testing, graphical display of trends, continuous electroencephalography, and more. They also evaluated which components of clinical care were influenced by the MMM data, including therapies, timing of neuroimaging, weaning to extubation, and prognostication. They aimed to evaluate the impact of the implementation of the system, not the outcome (the sample size is too small for that). The implementation of their system was associated with reduced ICP monitoring duration and ventilation times. Attributing a causal effect to this is speculative given the small sample size, but at least it did not show prolonged ICP monitoring or longer ventilation times, which is sometimes a criticism of an MMM approach.

First, the authors are to be congratulated on developing an excellent system of data monitoring and reporting at their institution—a great achievement worth emulating, particularly in the setting of pediatric TBI, the literature for which lags behind that for adult TBI. The article is strongest in the demonstration of a feasible methodology—taking MMM data and creating an integrated system for frequent reporting. The authors list the components of clinical decision-making that were influenced by MMM, but here is where a great deal of subjectivity is introduced, because the ways in which these data were

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used to guide treatment goes "off-road." We still have little agreement as a community for many of these concepts: How do you incorporate autoregulation capacity into therapy? Should one be more tolerant of ICP and CPP thresholds if brain oxygenation appears reasonable? What threshold of brain oxygenation do you target and how do you treat it (and where is the monitor placed)? Is there a benefit (that offsets the risks) of chasing a optimal CPP? To be fair, the authors acknowledge that this was not their goal. The system provided the data reporting; how this was interpreted and responded to would have been at the discretion of the treating clinician. So they have demonstrated feasibility but not what many really want to know: the specific value of the various components of the system. If this system were used elsewhere, would the impact be the same? If it cannot be completely replicated, what are the most useful parts?

The study design (essentially a small sample historical control study) is very often all we have to work with in pediatric TBI. Even in the best of these, in which the introduction of a care package shows a clear outcome benefit, we are still left wondering what component of the package made the difference or the most difference. This will always be a limitation of the study design. Still, one can argue that we have to start somewhere.

So, in summary, the authors give a very nice description of how to make a complex system work in pediatric neurocritical care. Even with its limitations, this work is a great addition to the pediatric TBI literature, and we will all learn from their experience on integrating complex data systems into clinical work. How to use that data is still unclear, though, and maybe this leaves some room open for the art and practice of medicine within a scientific framework. As such, it may be comforting to know that as clinicians, we have added value that cannot (as yet) be replaced by sophisticated computer algorithms. It is perhaps unavoidable that the reader is still left with the question: will this benefit my patient? Personally, I suspect so (that may be my bias), but the limitations of the work (and that of many others, including my own) are that they cannot demonstrate it. Not yet, anyway.

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References

1. Figaji AA. Anatomical and physiological differences between children and adults relevant to traumatic brain injury and the implications for clinical assessment and care. Front Neurol. 2017;8:685.
2. Le Roux P, Menon DK, Citerio G, Vespa P, Bader MK, Brophy G, et al. The international multidisciplinary consensus conference on multimodality monitoring in neurocritical care: a list of recommendations and additional conclusions: a statement for healthcare professionals from the Neurocritical Care Society and the European Society of Intensive Care Medicine. Neurocrit Care. 2014;21(Suppl 2):S282–96.
3. Appavu B, Burros BT, Nickoles T, Boerwinkle V, Willyerd A, Gunnala V, et al. Implementation of multimodality neurologic monitoring reporting in pediatric traumatic brain injury management. Neurocrit Care. 2021. https://doi.org/10.1007/s12028-021-01190-8.