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The impact of early flow and brain oxygen crisis on the outcome of patients with severe traumatic brain injury

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Abstract

BACKGROUND: Multimodality monitoring and goal-directed therapy may not prevent blood flow and brain oxygen (Flow/BrOx) crisis. We sought to determine the impact of these events on outcome in patients with severe traumatic brain injury (sTBI).

METHODS: Twenty-four patients with sTBI were treated to maintain intracranial pressure (ICP) less than or equal to 20 mm Hg, cerebral perfusion pressure (CPP) greater than or equal to 60 mm Hg, brain oxygen greater than or equal to 20 mm Hg, and near infrared spectroscopy greater than or equal to 60%. Flow/BrOx crisis events were recorded. The 14-day predicted mortality was compared with actual mortality.

RESULTS: Nonsurvivors had a significantly higher number of crisis events nonresponsive to treatment ($P < .05$). Mortality was 87.5% in patients with greater than or equal to 20 events versus 6.3% in patients with less than 20 events. The predicted mortality was 58%, whereas actual mortality was 33.3% (8/24), yielding a 42% reduction in mortality.

CONCLUSIONS: A multimodality monitoring and goal-directed therapy may decrease mortality in sTBI. However, Flow/BrOx crisis events still occur and predict a poor outcome.

Each year approximately 1.5 million people sustain traumatic brain injury (TBI), 270,000 require hospitalization, and 52,000 die.[1,2] Patients with severe TBI (sTBI) are often treated using the Brain Trauma Foundation guidelines that include a monitoring protocol with described methods of interventions.[3]

There is growing evidence that during the first 48 hours following sTBI, the recommended systolic blood pressure (SBP) threshold of greater than 90 mm Hg is associated with episodes of brain hypoperfusion. The cumulative effect of brain hypoperfusion may lead to increased mortality and a worse functional outcome. As a result, a higher SBP may be necessary to prevent secondary brain injury.[4] However, in the absence of secondary monitoring techniques such as brain oxygen tension ($PbtO_2$), near infrared spectroscopy (NIRS) oxygen saturation, or cerebral microdialysis (CMD), it is unclear whether a higher SBP is beneficial. Theoretically, an

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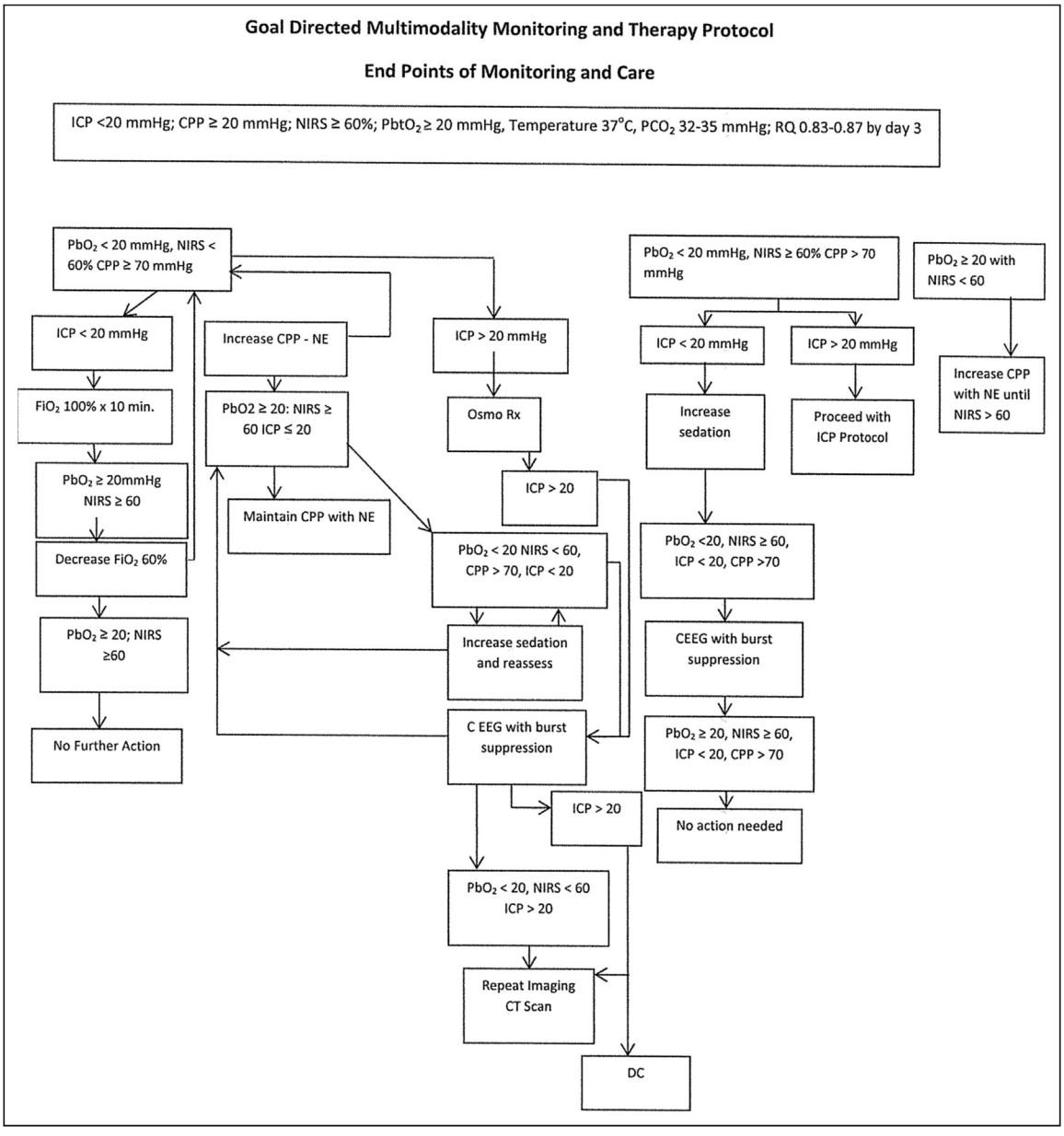

Figure 1 Multimodality monitoring and goal-directed therapy protocol.

increase in CPP may provide the brain with increased oxygen tension and as a result may prevent secondary brain ischemia. To date, the correlation between cerebral blood flow (CBF) obtained by surrogate variables such as SBP, CPP, and NIRS oxygen saturation and the critical threshold of $PbtO_2$ remains unclear. It is within this context that we sought to determine the relationship between early flow and brain oxygen (Flow/BrOx) crisis events on the outcome of patients with sTBI.

Methods

From July 2011 to September 2012, 24 patients with sTBI were treated with a multimodality monitoring and goal-directed therapy (MM&GDTP) for 5 days (Fig. 1). Multimodality monitoring included monitoring of ICP, CPP, $PbtO_2$ (Licox; Integra Life Science, Plainsboro, NJ), NIRS (Covidien, Mansfield, MA), and minute ventilation (Ve). The 5-day targeted therapy protocol included normothermia (37°C) with dry water immersion (Arctic Sun, Medivance, Inc. Luoisville, CO), $PbtO_2$ greater than or equal to 20 mm Hg, ICP less than or equal to 20 mm Hg, CPP greater than or equal to 60 mm Hg, NIRS greater than or equal to 60%, and nutritional support targeted to a respiratory quotient, measured by indirect calorimetry, of .83 by day 3 and positive nitrogen balance (NB) by day 7 with initiation of peptide-based enteral nutrition on completion of the resuscitation phase. All patients were sedated to achieve synchrony with the ventilator, avoidance