

Research

Should invasive airway management be done in the field?

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Traumatic injuries result in more years of productive life lost than any other disease and represent the main cause of death among young people. Despite the public health importance of trauma, there have been few advances in early resuscitative care over the past several decades. In this issue, Stiell and colleagues¹ provide us with an important investigation into the relation between advanced prehospital care and outcomes from traumatic injury.¹ Stiell and colleagues used a before-and-after design to document the change in survival with implementation of an advanced life-support program. Their analysis is part of the Ontario Prehospital Advanced Life Support (OPALS) project, which has emerged as perhaps the most important and comprehensive investigation into prehospital resuscitation yet performed.

Advanced life-support includes the theoretical advantages of advanced assessment, invasive management of airways and administration of intravenous fluids and medications. However, the first OPALS analysis failed to document a survival benefit with advanced life-support among patients with cardiac arrest.² The second analysis documented improved survival following implementation of an advanced life-support program among prehospital patients with respiratory distress.³ In the present analysis, involving trauma patients, Stiell and colleagues found no significant change in overall survival to hospital after implementation of the advanced life-support program (82% among 1373 patients during the basic life-support phase and 81% among 1494 patients during the advanced life-support phase), a finding confirmed by their logistic regression analysis. Furthermore, their planned subgroup analyses showed a significant increase in mortality during the advanced life-support phase among patients with suspected head injury, as defined by a Glasgow Coma Scale [GCS] score of 3–8 (40% with basic life-support v. 49% with advanced life-support).

Stiell and colleagues speculate that endotracheal intubation and positive-pressure ventilation associated with advanced life-support may be partly responsible for the increase in mortality. So, should prehospital intubation in patients with severe traumatic injuries be removed from the paramedic scope of practice?

Although the axiom “GCS 8, intubate” is ubiquitous in

Key points

- The Ontario Prehospital Advanced Life Support (OPALS) project is a comprehensive investigation into prehospital resuscitation in different patient populations.
- In this latest OPALS study, advanced life-support was not found to improve outcomes in patients with traumatic injuries.
- Endotracheal intubation and positive-pressure ventilation, especially in patients with severe head injury, may result in more harm than good.
- It is unclear what elements of complex airway management in vulnerable patients should be modified or performed only in a more controlled hospital setting.

emergency medicine, this concept has little substantive evidence to support such an aggressive approach to airway management. Early animal studies and postmortem pathological investigations revealed ventilatory dysfunction to be an important mediator of morbidity and mortality in patients with head injury.⁴ Observational analyses using large trauma registries, such as the seminal work by Chesnut and colleagues⁵ in 1993, confirmed an association between early hypoxia and death from traumatic brain injury. However, it is less clear that these associations justify early intubation in the presence of traumatic coma.

Several authors have used registry data to explore the relation between prehospital intubation and outcome from traumatic brain injury. Eckstein and colleagues⁶ documented increased mortality among patients with severe head injury who underwent prehospital intubation compared with patients who received bag-valve-mask ventilation before being transported to an urban trauma centre. Murray and associ-

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ates⁷ analyzed data for patients with severe head injury who were taken to 13 different trauma centres in Los Angeles County, California, and observed increased mortality among those in whom intubation was attempted, whether successful or not. Others have since reported similar findings, even after adjusting for multiple covariates in regression models.^{8,9} The only prospective, controlled trial to explore the effect of prehospital intubation was performed in a pediatric population. Gausche and associates¹⁰ used an alternating-day design to compare intubation with bag-valve-mask ventilation in the prehospital management of pediatric patients requiring ventilatory support. They observed no statistically significant difference in survival between the 2 cohorts, although the subset of patients with head injuries was relatively small. Data from our own system in San Diego have shown an association between early intubation and increased mortality.¹¹ Although this was true for all patients with moderate to severe head injuries, as defined by an Abbreviated Injury Score of 3 or greater, neural network analysis as well as a modified approach to calculating the Trauma and Injury Severity Score revealed a subgroup of patients with more severe head injuries who appeared to benefit from early intubation.¹¹

The consistency of the findings from the above studies is compelling and suggests an adverse effect of early intubation on outcomes of patients with head injuries. However, some degree of selection bias was likely present in each study despite the rigorous methodologic approaches to adjust for multiple covariates. A patient in whom intubation can be done without the use of medications almost certainly has a devastating neurologic injury that cannot be fully quantified by a Glasgow Coma Scale score or an Abbreviated Injury Score. The San Diego Paramedic Rapid Sequence Intubation Trial was performed to explore the use of neuromuscular blocking agents on outcome from severe head injury in patients who could not undergo intubation without the use of medications, which theoretically eliminated this selection bias. Although our use of historical controls may have introduced some degree of selection bias, multiple analytic approaches suggested an increase in mortality associated with rapid-sequence intubation by paramedics.¹² Other attempts to explore the use of neuromuscular blocking agents by paramedics have suggested a potential benefit, although these studies suffered from the influence of secular trends and inappropriate controls.^{13,14}

Physiologic impact of early airway events

To understand the apparent discrepancies with regard to the role of intubation, with or without the use of medications, in the early management of traumatic brain injury, it is useful to consider the physiologic impact of early airway events and how they might affect the injured brain. Although early respiratory dysfunction is certainly part of severe head injury, it is unclear whether emergency medical services can perform intubation and reverse hypoxemia before significant hypoxic injury has occurred.⁴ In addition, noninvasive modalities to improve oxygenation may be as

effective as intubation in most patients.¹⁵ Similarly, the loss of airway-protective reflexes is likely associated with severe head injury. However, aspiration events appear to occur immediately following the injury, before the arrival of paramedics, and recent evidence suggests that the presence of an endotracheal tube itself may increase the risk of aspiration pneumonia.¹⁶ Furthermore, the act of performing laryngoscopy may lead to a rise in intracranial pressure that can exacerbate the primary injury.¹⁷

Perhaps the most compelling explanation for why we have been unable to demonstrate a benefit with early intubation in severe head injury concerns inappropriate ventilation strategies by prehospital providers. Multiple secondary analyses from the San Diego Paramedic Rapid Sequence Intubation Trial suggested that hyperventilation, as defined by hypocapnia, was a major contributor to the adverse outcomes associated with the use of neuromuscular blocking agents by paramedics.¹⁸ Subsequent analysis using data from the larger San Diego Trauma Registry confirmed the association between hypocapnia and increased mortality.¹⁹ Of note, this relation existed only among patients in whom intubation was performed, and after adjustment for multiple covariates, hypocapnia was not associated with increased mortality among patients who were breathing spontaneously. Warner and colleagues²⁰ has since confirmed these findings in their own system. Although Stiell and colleagues did not have ventilation data to explore this relation, a substantial incidence of hyperventilation most certainly existed following implementation of the advanced life-support protocols.¹

A less recognized but equally compelling explanation for the apparent adverse effect of intubation on outcome from traumatic brain injury is the potentially harmful effects of supranormal oxygen levels. A recent analysis using data from our trauma registry revealed an association between both hypoxemia and hyperoxemia and increased mortality (unpublished data). This relation was independent of intubation and ventilation status, although the partial pressure of oxygen on arrival was higher in patients in whom intubation had been performed than in patients who did not undergo intubation. Improved equipment, such as the use of quantitative capnometry or mechanical ventilators, may avoid hypocapnia or hyperoxemia. Finally, inadequate training and the relative infrequency with which intubation is performed by prehospital providers has been postulated as an explanation for the apparent adverse effect on survival. How these factors affect optimal performance of the technique or how they influence the frequency of physiologic insults, such as hyperventilation, is unclear.

The way forward

Although the article by Stiell and colleagues represents a provocative challenge to our assumptions about resuscitation, I would caution against concluding that advanced life-support in general — or prehospital intubation in particular — is not beneficial or is innately harmful. Instead, we need to improve our understanding of the mechanisms that ex-

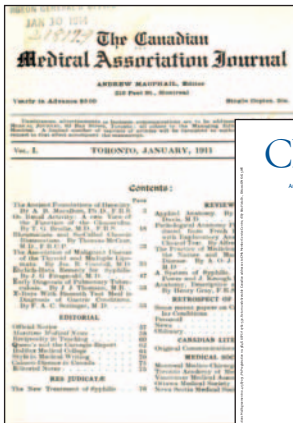
plain these associations and work toward optimizing performance before contracting the scope of practice for our prehospital providers. Perhaps optimizing performance of the technique through better training or limiting the practice to experienced providers can eliminate the adverse impact and allow patients to benefit from definitive airway control and improved oxygenation. Better selection of patients to undergo prehospital intubation may also help avoid unnecessary exposure to a potentially harmful procedure, and improved equipment may help avoid insults such as desaturation or hyperventilation.

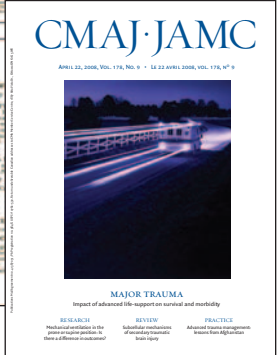
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