Appendix 1: Ketamine for Intubation in Closed Head Injury

SUMMARY/RECOMMENDATIONS:
* Consider ketamine for RSI in a patient with suspected ICP elevation and normal blood pressure or hypotension.

BACKGROUND
Traditionally trauma literature has listed closed head injury or syndromes with increased intracranial pressure (ICP) as a major contraindication to using ketamine. The support that ketamine increases intracranial pressure comes from small studies during the 1970s that published:

(1) the observation of increased ICP and decreased cerebral perfusion pressure (CPP) during studies involving administration of ketamine to patients with VP shunts who had CSF outflow obstruction (not patients with closed head injury)\(^1\)\(^2\) and
(2) observation of increased cerebral blood flow in healthy volunteers who were given ketamine.\(^1\)\(^3\)

RECENT EVIDENCE
However several recent studies have challenged the assertion that ketamine is unsafe in patients with head injury. When interpreting the evidence, it is important to remember that one single episode of hypotension can double mortality in patients with severe brain injury, and that reduction of secondary brain injury by prevention of hypotension is critical in the emergency department. Additionally, cerebral perfusion pressure (CPP) and cerebral blood flow (CBF) are what affect the damage—not ICP alone. And by increasing cerebral perfusion, ketamine may actually benefit patients with a neurologic injury.

- One prospective study documented no adverse outcomes when ketamine was used to intubate trauma patients in the pre-hospital setting (including those with head injury).\(^5\)
- Also as compared to infusions of midazolam/fentanyl or sufentanyl, infusion of midazolam/ketamine had no significant change in CPP but did have reduced vasopressor requirements in two other studies.\(^6\)\(^7\)
- A recent small study of patients with brain or spinal cord injury investigated ketamine bolus followed by infusion in the neuro-intensive care unit for intubation or painful procedures demonstrated a lack of the sympathetic stimulation of vital signs as compared to the general population.\(^8\)
- Cerebral metabolism (CRMO\(_2\)) was generally thought to be increased with ketamine, which is another argument against the use of ketamine in head injury. However, this has not been found to be true. Studies have demonstrated that ketamine does not interfere with cerebral metabolism and does not increase cerebral oxygen consumption or reduce regional glucose metabolism.\(^9\)\(^10\) Plus addition of ketamine to head injury patients on a propofol infusion decreased ICP and EEG activity without affecting CPP in another study.\(^11\)
- Finally, ketamine can also offset any decrease in mean arterial pressure induced by fentanyl, which is often used in trauma patients.\(^6\)
CONCLUSIONS

- Himmelseher et al. concluded in a recent review that level II evidence supports that in brain injury ketamine does not increase intracranial pressure when on ventilation, when infused with a GABA agonist (e.g., midazolam), and when used without nitrous oxide. They also concluded that level II and III evidence exists that ketamine may improve hemodynamics and cerebral perfusion, which may possibly “make the drug a preferred choice in sedative regimes after brain injury.”

- Filanovsky et al. similarly concluded after a literature review of ketamine, “Based on its pharmacological properties, ketamine appears to be the perfect agent for the induction of head-injured patients for intubation.”

- And, as of September 2012, Up to Date reads, “On balance evidence suggesting ketamine elevates ICP is weak, and evidence that harm might ensue is weaker. We believe ketamine is an appropriate induction agent for RSI in patients with suspected ICP elevation and normal blood pressure or hypotension. In patients with hypertension and suspected ICP elevation, ketamine should be avoided because of its tendency to further elevate blood pressure.”

References:
4. ATLS manual