

MCEMS Trauma Protocol 2026

Brain Injury

Hypertonic Saline alternative

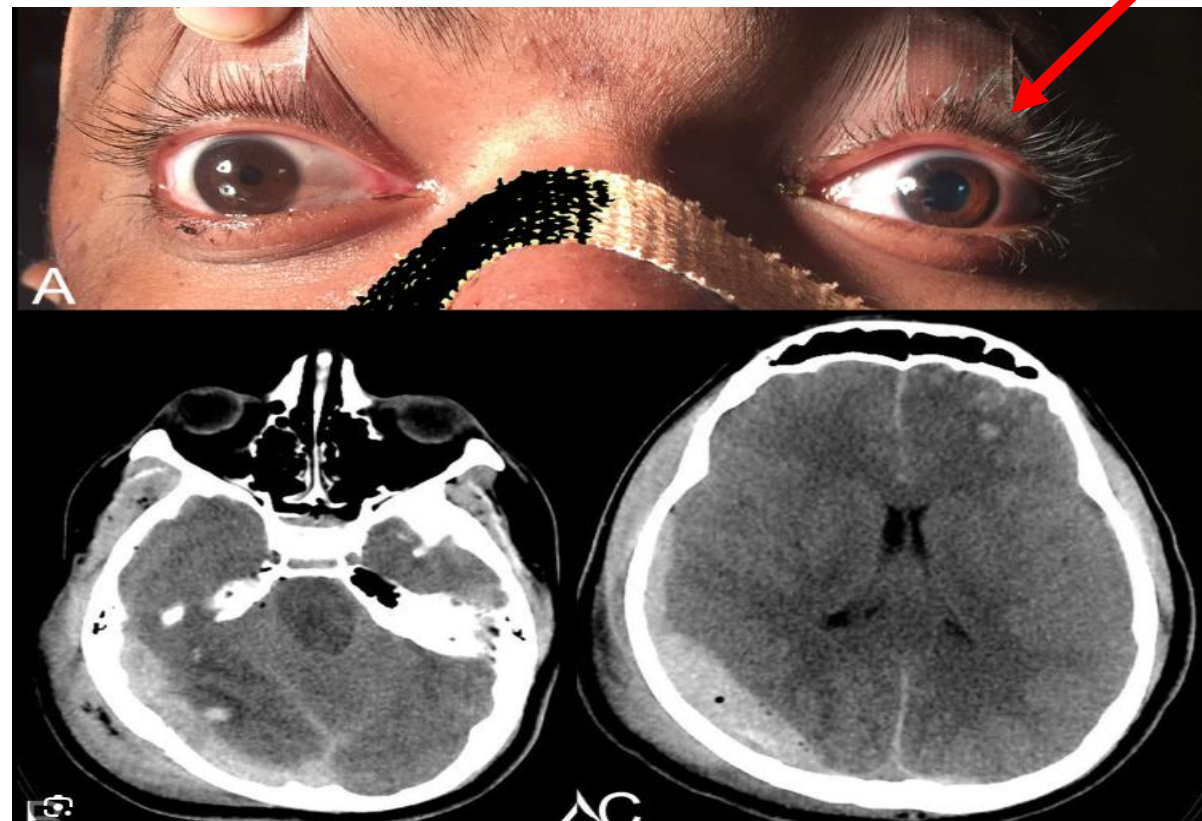
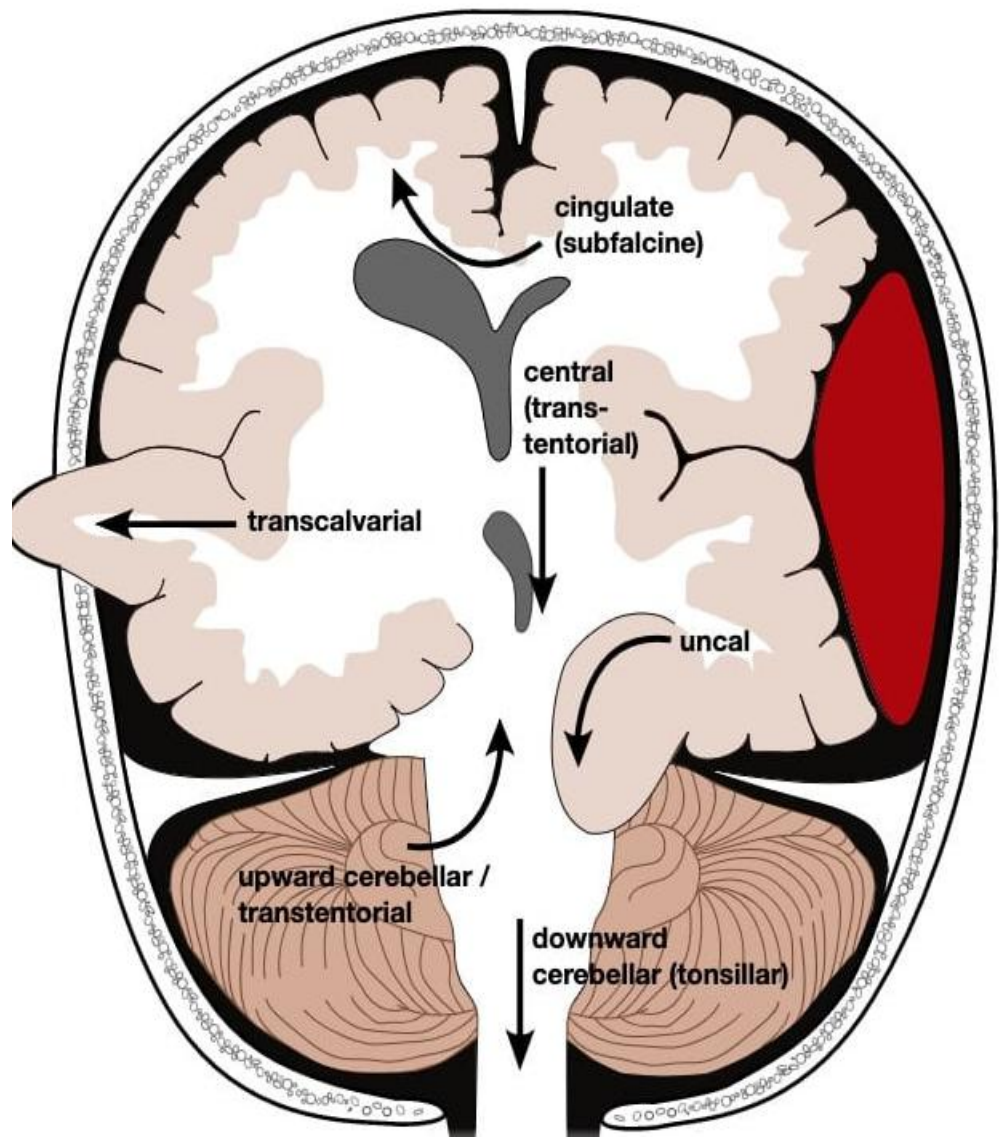
Special mention Dr. Matt Neth

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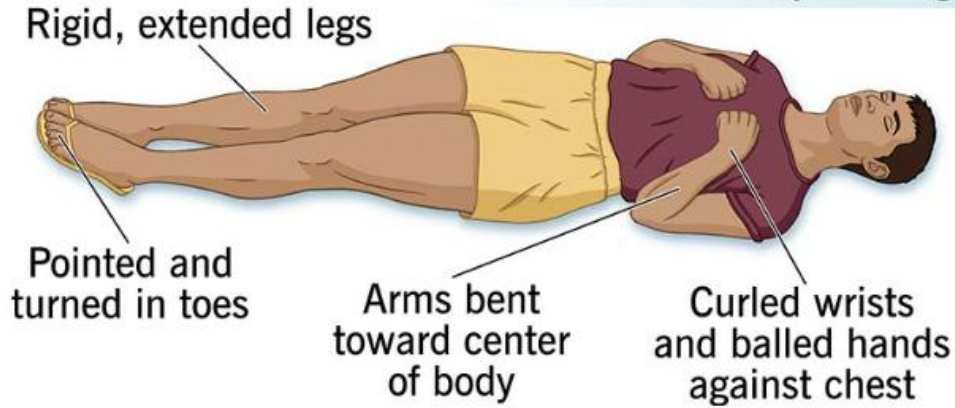
Concerns with Current Protocol

- Limited options for our EMS clinicians to manage patients with **suspected cerebral herniation**
- Need to update EtCO₂ goals to align with guidelines

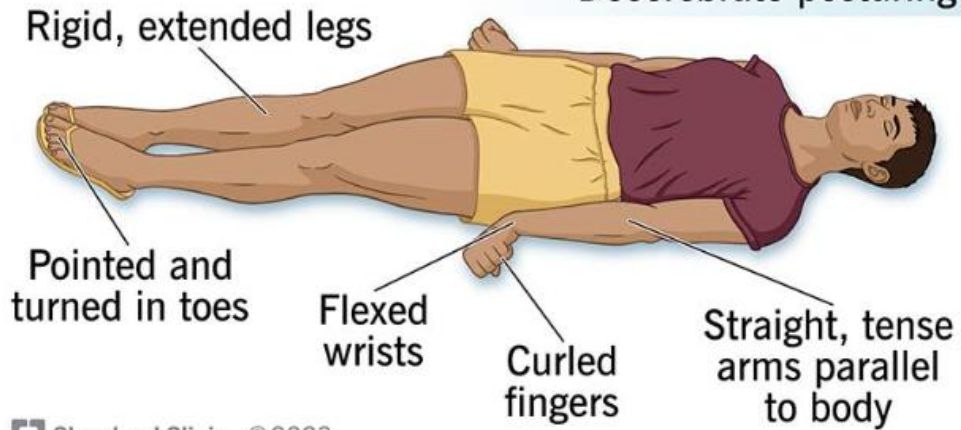


Decorticate Posturing

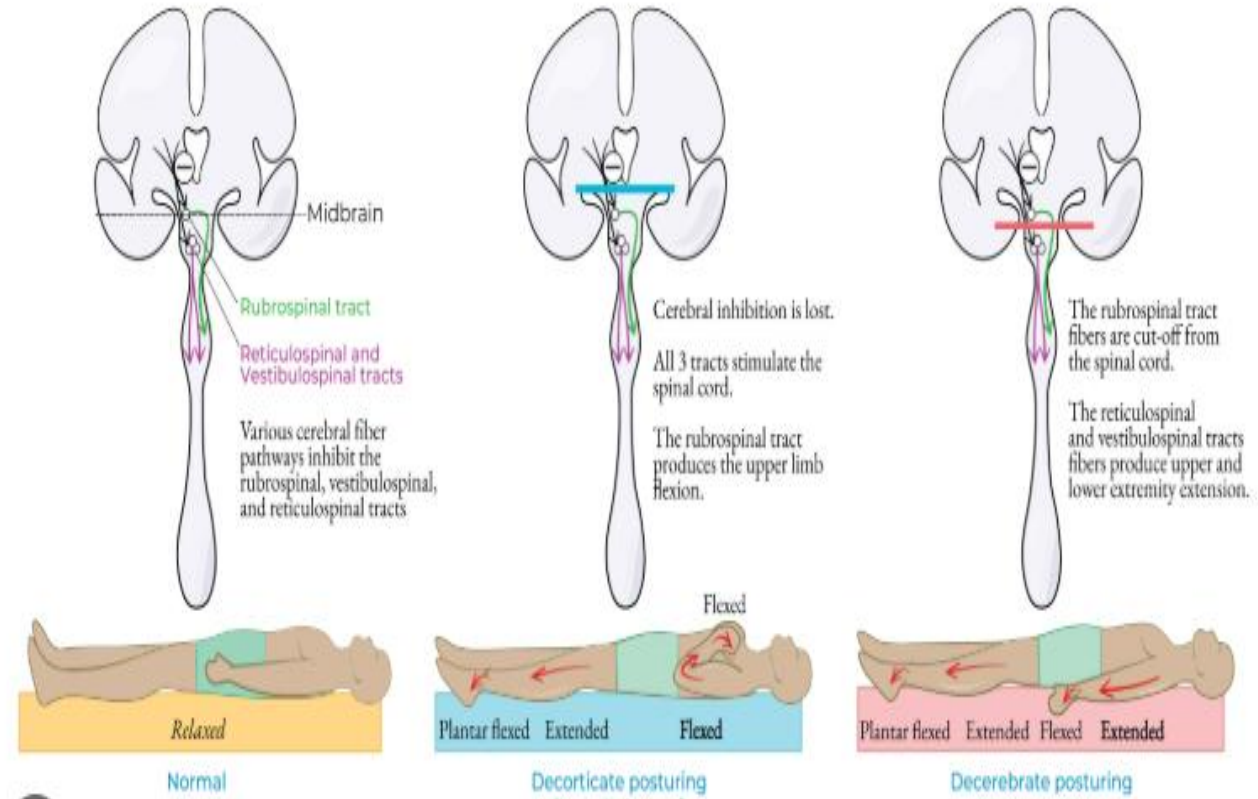
Decorticate posturing



Decerebrate posturing



DECORTICATE & DECEREBRATE POSTURING



**Guidelines for Prehospital
Management of Traumatic Brain
Injury 3rd Edition: Executive
Summary**

Ventilation strategies should target eucapnia and avoid hypocapnia (ie, ETCO₂ of 35-40) and be monitored using capnography

Strong

When used to address signs of active and imminent herniation, hyperventilation should target an ETCO₂ of 30–35 mm Hg using capnography

Strong

[Guidelines for Prehospital Management of TBI, 3rd Edition](#)

Hypertonic fluid resuscitation may be administered to patients with a GCS <8 in whom increased ICP is suspected in the prehospital setting

Weak

Proposed TBI Protocol Update

- Adult patients with a TBI *AND* suspected brain herniation (GCS ,8, blown pupil(s), posturing):
 - Administer **Sodium Bicarbonate 1 mEq/kg IV/IO**
 - Continue **to ventilate with a goal EtCO₂ 30-35**

Bicarb Potential Benefit

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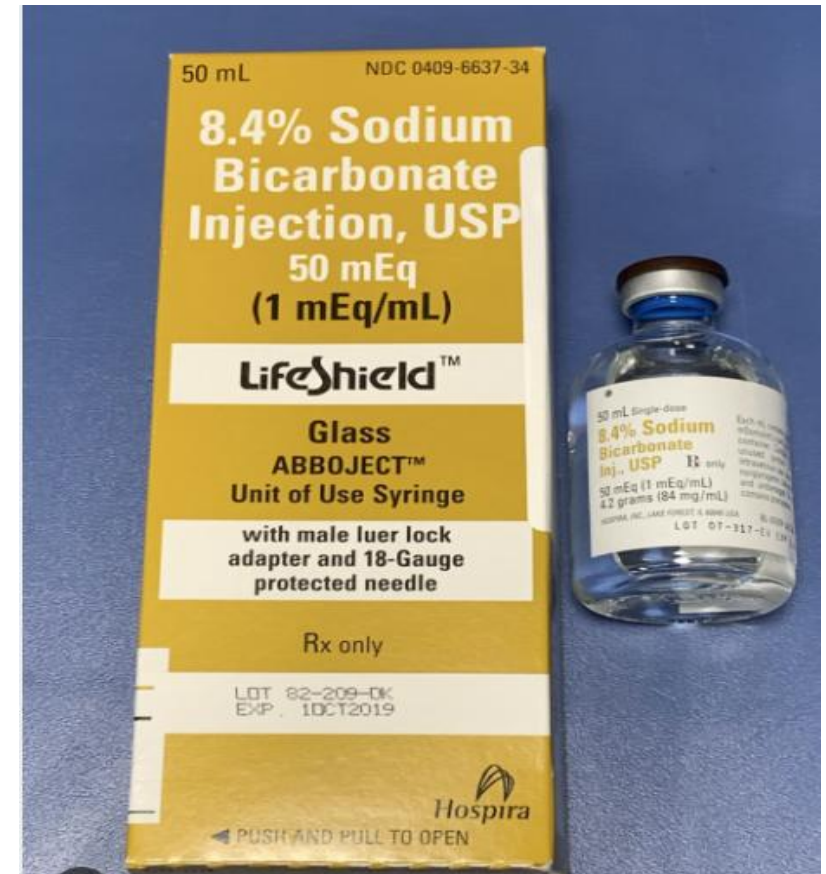
ICP Reduction

Bourdeaux, 2010, Neurocrit Care

- [Pro Obs] 10 episodes of unprovoked ICP rise treated with 85 ml of 8.4% sodium bicarbonate over 30 minutes
- A single dose of 8.4% sodium bicarbonate is effective at treating rises in ICP for at least 6 h

Intervention

- A bolus of 85 ml of 8.4% sodium bicarbonate was administered over 30 min via a syringe driver through a central venous catheter

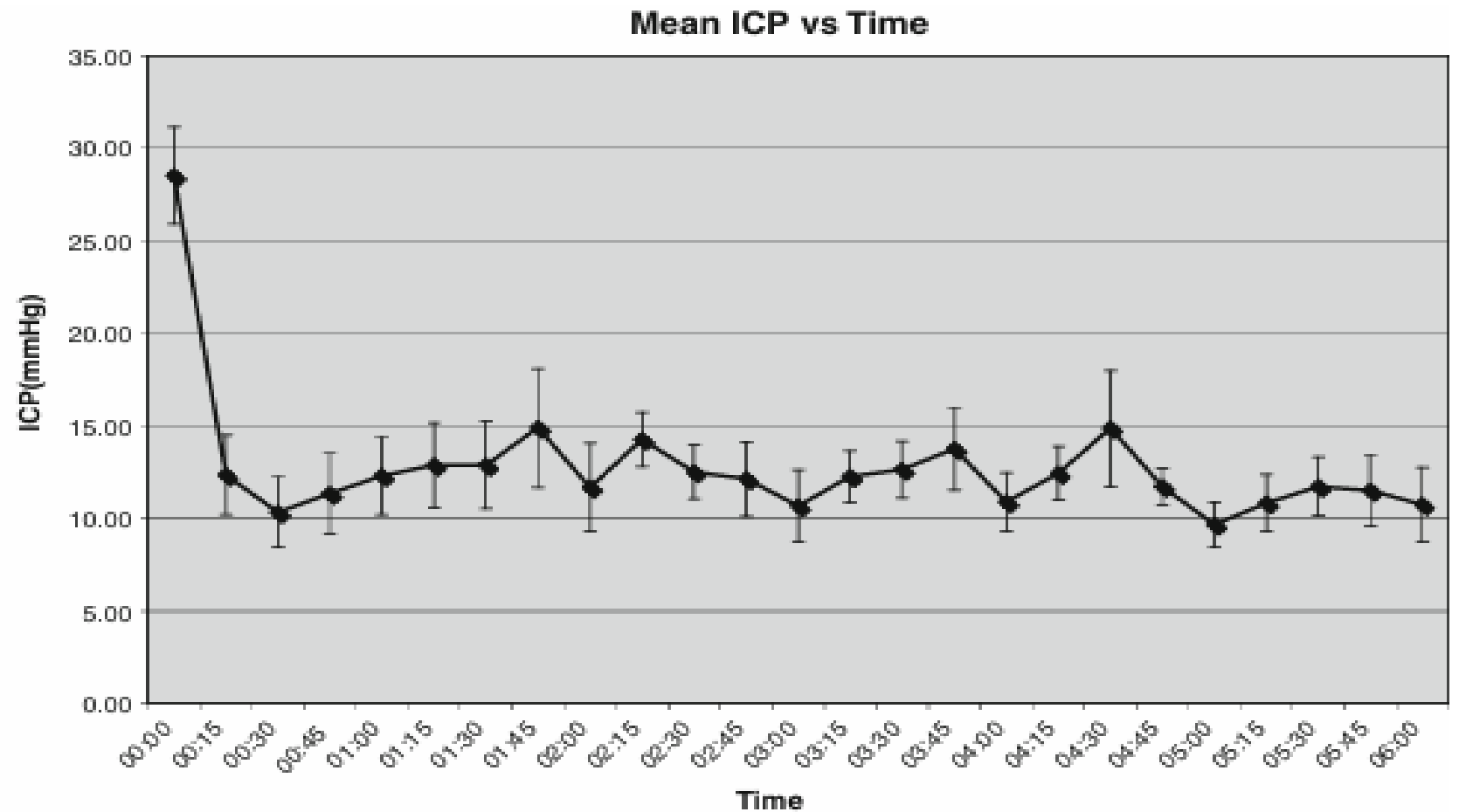


Patients

- N=7, All GCS < 8
- Clinical
 - 4/7 had subdural hematomas
 - 3/7 contusions
 - Only 1 patient required pre-dose

Mean ICP Post Infusion

Fig. 1 Mean ICP (\pm SEM)



Conclusion

- This study demonstrates that an infusion of 8.4% sodium bicarbonate is effective for the reduction of raised ICP in patients who are sedated and ventilated in intensive care with a severe TBI.

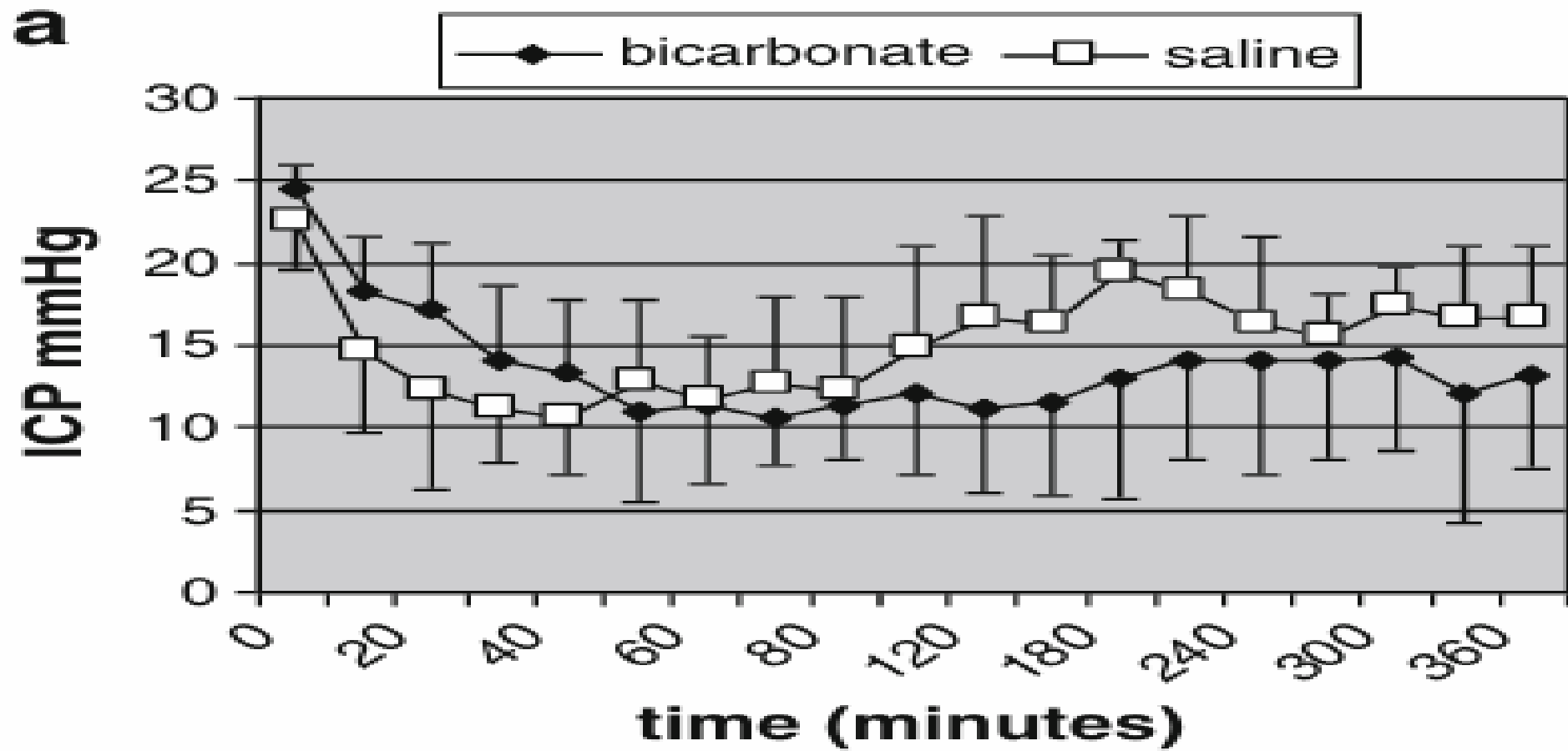
Bourdeaux, 2011, Neurocrit Care

- Randomized Control Study
- Sodium Bicarbonate vs 5% hypertonic saline

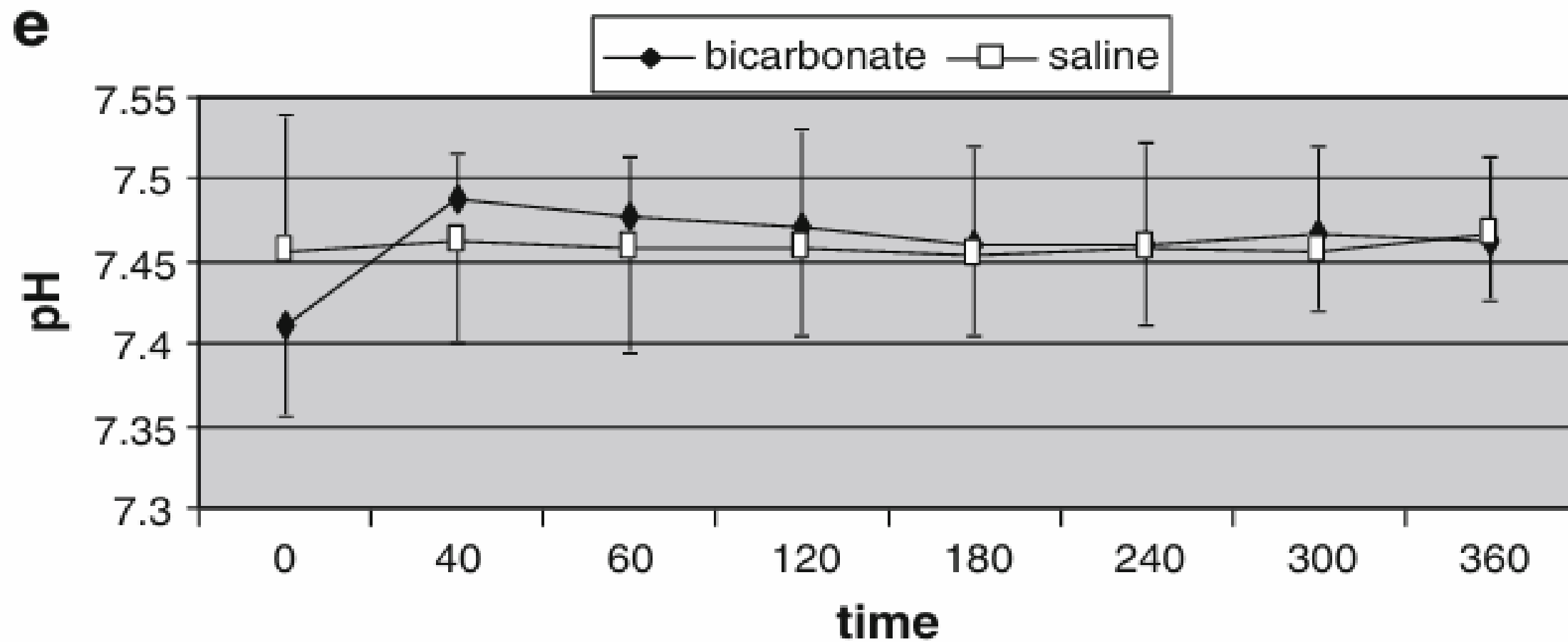
Bourdeaux, 2011, Neurocrit Care

- [RCT] For each episode (20 total) of intracranial hypertension, patients with severe TBI were randomly allocated to receive either:
 - 100 ml of 5% NaCl
 - 85 ml of sodium bicarbonate 8.4%

ICP



pH



Results

- 20 episodes of intracranial hypertension in 11 patients.
- Treatments with 8.4% sodium bicarbonate and 5% sodium chloride reduced raised ICP effectively with a significant fall in ICP from baseline at all time points ($P < 0.001$).
- There was no significant difference in ICP with time between those episodes

Conclusion

- Infusion of 8.4% sodium bicarbonate is as effective as 5% NaCl for reduction of raised ICP after traumatic brain injury when infused over 30 min

Zeiler, 2018, J Neurosurg Anesthesiol

- [Systematic review] IV sodium bicarbonate for ICP reduction (31 episodes total)
- All elevated ICP episodes treated with sodium bicarbonate solution demonstrated a significant drop in ICP, without an elevation of serum partial pressure of carbon dioxide

Potential Harms of Sodium Bicarbonate in Severe Head Injury

Potential Harms

- Metabolic alkalosis: *potentially leading to suppressed breathing and impaired oxygen delivery*
- Fluid overload and edema?
- Tissue injury?
- Electrolyte disturbances?
- Distraction for other patient care (airway, ventilation, TXA, bleeding control, MAP goals)

Bicarb Safety in TBI. (Faiver)

* 299 administrations of 23.4% NaCl (242 central and 57 peripheral)

- No documented occurrence of soft tissue injury or necrosis in any patient

Bicarb Safety in TBI (Zeiler)

- 31 episodes of sodium bicarbonate
8.4% administration for elevated ICP
- No significant complications were
described
- (Zeiler, 2018, J Neurosurg Anesthesiol)

Prehospital Evidence?

Prehospital HTS for Hypotensive TBI

(Cooper, 2004, JAMA)

- Double-blind, RCT of 229 patients with TBI who were comatose (GCS <9) and hypotensive (SBP <100 mm Hg)
- December 14, 1998, and April 9, 2002, in Melbourne, Australia

Prehospital HTS for Hypotensive TBI

(Cooper, 2004, JAMA)

- Rapid intravenous infusion of:
 - 250 mL of 7.5% saline (n = 114)
 - 250 mL of Ringer's lactate solution (n = 115; controls)
- 1° = Neurological function at 6 months (GOSE)

Prehospital HTS for Hypotensive TBI

(Cooper, 2004, JAMA)

- Patients with hypotension and severe TBI who received prehospital resuscitation with HTS had almost identical neurological function 6 months

Summary

- Sodium bicarbonate 8.4% may be a viable alternative to hypertonic saline in isolated life threatening head injuries
- Dose 1 mEq/kg IV/IO

The END