

# State of the Science in Traumatic Brain Injury Rehabilitation

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# Standards of Care

- Through the mid 1990s there was considerable inconsistency in acute care of TBI in the US.
- Differences existed in prehospital intubation, ICP monitoring and management, and use of Head CT.
- Aggressive hospitals had less mortality and shorter LOS but no change in survivor outcome.

- Guidelines for Management of Severe Head Injury, Bullock et al. EJEM 1996



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# Guidelines of TBI Care

- 1995- Survey of 272 randomly selected US hospitals (49% level I, 32% level II)
- 34% had NSICUs
- 28% used ICP monitoring routinely
- 72% used ventriculostomies but only 44% used them to drain CSF



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# Guidelines of TBI Care

- 1995 Survey
  - 83% used hyperventilation and osmotics to control ICP
  - 33% used Barbiturates to induce coma
  - 64% used corticosteroids routinely
    - Ghagar, et al. Crit care Med, Mar 1995



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# Brain Trauma Foundation

- EBM Guidelines established in 1996 and most recently updated in 2007.
- Endorsed by AANS and WHO
- If used would result in a 50% reduction in mortality and 262 million cost savings annually.



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# BTF Guidelines

- GCS – repeatedly after trauma X 48 hours
- Check BP and O2 Sats repeatedly X 48 hours
- Check for pupillary response and symmetry regularly
- Steroids NOT recommended based on Level I evidence with associated higher mortality



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# BTF – Anesthesia

- Prophylactic Barbiturate use NOT recommended but may be used 2-3rd line to decrease ICP (level II)
- Propofol can be used to reduce ICP but does not improve mortality or 6 mo. outcome



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# BTF – ICP

- ICP monitoring in all GCS  $<8$  w/ abnl CT or if CT nl but age  $>40$ , posturing, or SBP  $<90$  mmHg
- Keep ICP  $< 20$ mmHg
- Mannitol works (Level II)
- Not enough evidence for hypertonic saline but optional for GCS  $<8$  and PaCO<sub>2</sub>  $<25$
- Avoid hyperventilation especially in first 24 hrs b/c risk of ischemia



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# BTF – Surgery

- Evacuate EDH if  $> 30 \text{ cm}^3$ , 15 mm thick or  $> 5 \text{ mm}$  shift
- Evacuate SDH if  $> 10 \text{ mm}$  thick or 5 mm shift or if in coma, GCS drops  $> 2$ , or ICP  $> 20 \text{ mmHg}$



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# BTF – Seizures

- Level II evidence that DPH/Valproic Acid NOT necessary beyond one week
- They prevent EPTS but not LPTS



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# BTF – Fluids/CPP

- Avoid fluids and pressors to keep CPP >70 mmHg b/c inc. risk of ARDS
- Avoid CPP < 50 mmHg ( keep >60)



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# BTF – DVT/PE

- ICP Stockings
- LMWH or low dose UFH but insufficient evidence on dose or timing



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# BTF – Nutrition

- Start feeding by day 7 at 100-140% of resting metabolic expenditure



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# BTF – Hypothermia

- Level III evidence for now but studies do show that if you hit target temps (33 C) for 48 hrs survivors had better GOS than normothermic comparisons



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# Neuropharmacology

- No FDA approved drugs for the treatment of TBI
- Only 3 small randomized studies done ( N= 18-30)
- Heterogeneity in injury types, treatment and outcome measurements make forming conclusions difficult.



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# Neuropharmacology

- Improve survival and outcome
  - Progesterone
- Increase arousal, attention and performance
  - Amantadine – meta-analysis of 22 studies and 6400 pts showed improvements in GCS
  - Ritalin – Improve processing speed and attention
  - Aricept – Improved cognitive testing and PET scan



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# Neuropharmacology

- Can it speed recovery and improve outcomes?
- Can it improve cognition, initiation and participation.
- Can it reduce abnormal cortical recovery and improve motor performance.



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# Spasticity

- Definition is controversial
- Measure with...
  - Rating scales – Ashworth / Tardieu
  - Biomechanical tests
  - EMG – multichannel or H-reflex
  - Functional Scales – Barthel / FIM / Fugl-Meyer
- Angle of limb affects central regulation of Stretch Reflex Threshold (SRT) thus linking motor fxn and motor control deficits



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# Robotics and TBI Rehab

- Numerous small studies show benefits of robotics in UE and LE motor scores and function
- Uncertainty remains about dosage, timing and combination with other treatments like medication, e-stim, and sensorimotor training



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# Future of TBI Technology

- Use of robotics to improve wakefulness and arousal in Vegetative States or MCS
- External robotic control of repetitive movements may normalize CPGs and reduce development of abnormal brain response and compensatory mvt. patterns.



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# Future of TBI Technology

- Brain Computer Interface
- Neurobotics
  - “The integration of mechanically engineered human-like hardware (limbs, joints, tendons) with our own body's software – the nervous system.”  
Yoky Matsuoka



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# Thank You



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