


Prehospital Management of TBI

Richard M. Spiro, MD FAANS FACS
Chief of Neurological Surgery
Erie County Medical Center



Epidemiology

Fifty million people suffer from a traumatic brain injury (TBI) worldwide every year (<https://intbir.nih.gov>)

The global incidence rate of TBIs is estimated at 200/100,000 people per year. (www.internationalbrain.org)

In the United States 153 people die *each day* from injuries related to TBIs (www.cdc.gov)

In 2013 there were 2.5 million emergency department visits related to TBI


TBI is the leading cause of death related to trauma

- It is responsible for 30% of all injury related deaths

Target ETCO2 in an intubated TBI Patient


28-32 mmHg	32-35 mmHg	35-45 mmHg	45-55 mmHg
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Main Goal of Pre-hospital treatment of TBI is?



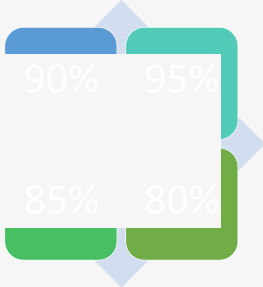
1 Blood glucose >90	2 Maintain SBP > 150	3 Prevent Secondary Brain Injury	4 Provide Positive Pressure Ventilation
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What is the ideal RESPIRATORY rate for intubated TBI patient?



4 BPM	10 BPM
20 BPM	24 BPM

In TBI, pulse oximeter is?



90%	95%
85%	80%

Minimum SBP in TBI patient is?

- 60 mm Hg
- 100 mm Hg
- 120 mm Hg
- 90 mm Hg

SBP for 5 y/o TBI patient should be:

- 60 mm Hg
- 70 mm Hg
- 80 mm Hg
- 90 mm Hg

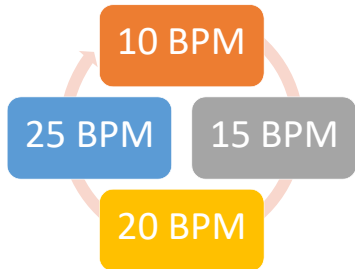
Hyperventilation (Decreasing pCO₂) causes?

- Cerebral Artery Constriction
- Increased Secondary Injury
- Decreased Cerebral Perfusion
- All Of The Above

A SINGLE Episode of Hypoxia in a TBI Patient Results In:

- Increased Morbidity and Mortality
- Bradycardia
- Hypotension
- No Impact on Neurological Outcome

Ideal Rate for Intubated 5yo with TBI is:



If ETCO2 falls below 35 in Intubated Patient, most likely cause is?

- Hypoventilation
- Hypoxia
- Acidosis
- Hyperventilation

Glasgow Coma Scale

EYE OPENING		VERBAL RESPONSE		MOTOR RESPONSE	
Spontaneous	> 4	Orientated	> 5	Obey commands	> 6
To sound	> 3	Confused	> 4	Localising	> 5
To pressure	> 2	Words	> 3	Normal flexion	> 4
None	> 1	Sounds	> 2	Abnormal flexion	> 3
		None	> 1	Extension	> 2
				None	> 1

GLASGOW COMA SCALE SCORE

Mild 13-15 Moderate 9-12 Severe 3-8

MEDIC*TESTS #1 EMT & PARAMEDIC EXAM PREP

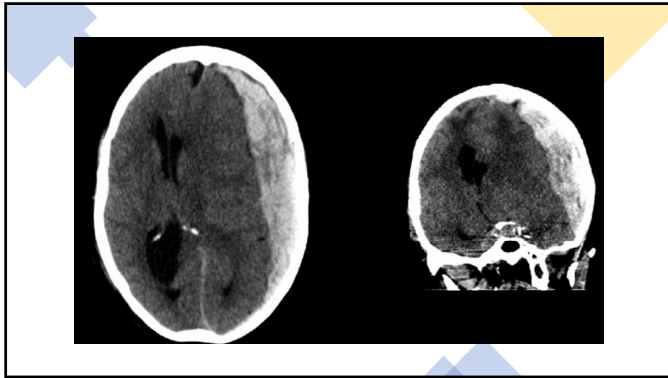
Pediatric GCS

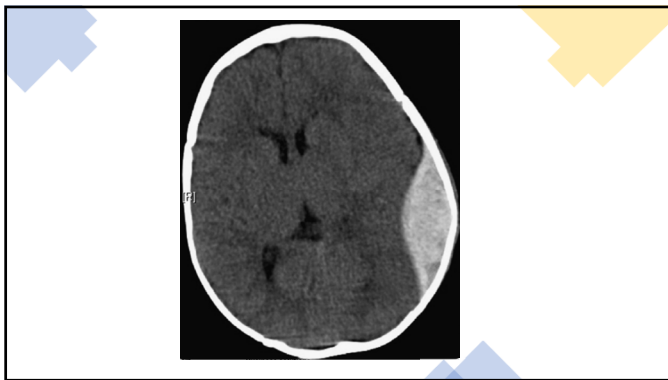
• GCS MODIFIED BASED ON AGE

PEDIATRIC GLASGOW COMA SCALE (PGCS)			
	> 1 Year	< 1 Year	Score
EYE OPENING	Spontaneously	Spontaneously	4
	To verbal command	To shout	3
	To pain	To pain	2
	No response	No response	1
MOTOR RESPONSE	Obeys	Spontaneous	6
	Localizes pain	Localizes pain	5
	Flexion-withdrawal	Flexion-withdrawal	4
	Flexion-abnormal (decerebrate rigidity)	Flexion-abnormal (decerebrate rigidity)	3
	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)	2
	No response	No response	1
VERBAL RESPONSE	Oriented	Appropriate words/phrases	5
	Disoriented/confused	Inappropriate words	4
	Inappropriate words	Persistent cries and screams	3
	Incomprehensible sounds	Grunts, agitated, and restless	2
	No response	No response	1
	TOTAL PEDIATRIC GLASGOW COMA SCORE (3-15):		

Subdural Hematoma (SDH)

- Blood collects between dura and arachnoid
- Torn cortical bridging veins
- 10-20% of all cranial trauma cases
- Demographics:
 - Elderly (60-80y) with brain atrophy,
 - Large intracranial subarachnoid spaces
 - "Shaken baby syndrome"

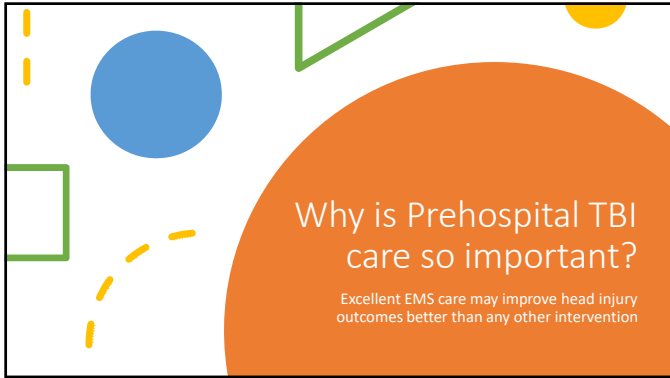




Comparison of EDH and SDH

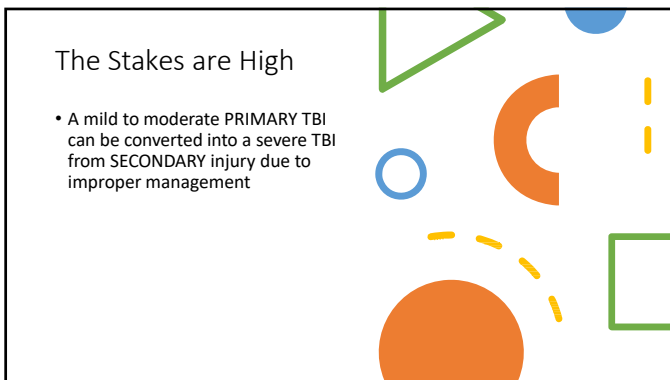
	EDH	SDH
Incidence	1-4% of trauma cases; 10% of fatal trauma cases	10-20% of all trauma cases; 30% of fatal trauma cases
Etiology	a/w fractures in 90% of cases Laceration of MMA/venous sinus	Tearing of cortical veins
Site	Between skull and dura 95% supratentorial	Between dura and arachnoid 95% supratentorial
	Crosses dura but not sutures	Crosses suture but not dura
CT findings	Biconvex (lens) shape Shift grey-white matter interface	Crescentic shape

Diagram from Kumar et al. Basic Pathology 7E



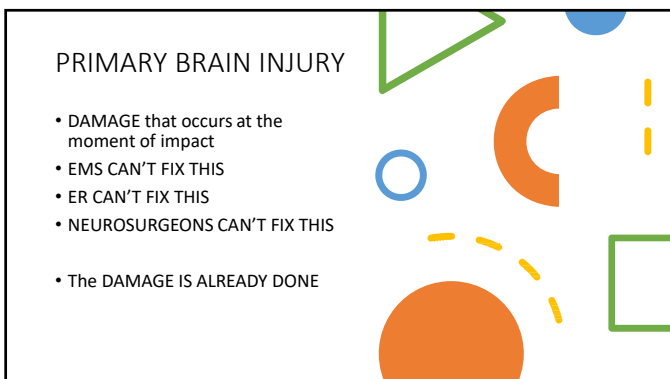
Why is Prehospital TBI care so important?

Excellent EMS care may improve head injury outcomes better than any other intervention



The Stakes are High

- A mild to moderate PRIMARY TBI can be converted into a severe TBI from SECONDARY injury due to improper management




PRIMARY BRAIN INJURY

- DAMAGE that occurs at the moment of impact
- EMS CAN'T FIX THIS
- ER CAN'T FIX THIS
- NEUROSURGEONS CAN'T FIX THIS

- The DAMAGE IS ALREADY DONE


SECONDARY Brain Injury

- Occurs after the initial trauma
- Caused by:
 - Systemic Hypoxia
 - Poor CNS Blood Flow
 - Major Impact in TBO outcome
- GOAL IS TO DO EVERYTHING THAT WE CAN TO PREVENT SECONDARY BRAIN INJURY




WHO ARE THESE PATIENTS

- TRAUMA PATIENTS FROM ANY CAUSE
- GCS 14 or less
- Multi Trauma Patients Requiring Intubation
- Post-Traumatic Seizures




HOW DO I DELIVER A LIVE BRAIN?

- PREVENT/TREAT HYPOXIA
- PREVENT/TREAT HYPOTENSION
- PREVENT HYPERVENTILATION




PARADIGM SHIFT

- THESE ARE SIMPLE CHANGES IN THE WAY THAT WE TREAT TBI PATIENTS
- SIMPLE IS NOT ALWAYS EASY
- REQUIRES A CONSTANT FOCUS TO MAKE THESE CHANGES




USE TOOLS FOR SUCCESS

- VENTILATION RATE TIMER
- PRESSURE CONTROLLED BAGS
- ETCO2 40 (RANGE 35-45)
- VENTILATOR
 - 7CC/KG @ 10 BPM
 - FOLLOW YOUR AGENCIES VENT PROTOCOLS



AVOID THE H-BOMBS

- TBI H-BOMBS
 - HYPOXIA
 - HYPOTENSION
 - HYPERVENTILATION
- A LIVE BODY WITH A DEAD BRAIN IS A DEAD BODY



AVOIDANCE OF HYPOXIA

- Pre-Oxygenate
- High-Flow O2 is the first thing on ANYONE with decreased level of consciousness
- Even with normal mental status and good pulse ox
- Apply O2 before Extrication
- Pre-Oxygenation can PREVENT HYPOXIA in patient who later deteriorate



Advanced Airway Interventions

DO NOT CHANGE DECISION REGARDING THE NEED FOR AIRWAY

BLS AIRWAY/VENTILATION OR BLIND INSERTION (EG LMA) OFTEN IS PERFECTLY ACCEPTABLE AIRWAY

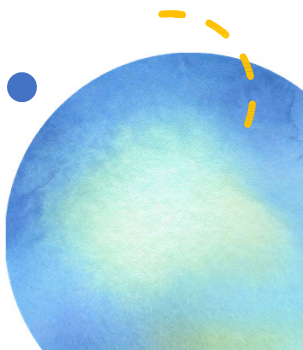
BASIC AIRWAY MANEUVERS ARE ALMOST ALWAYS EFFECTIVE IN KIDS , AND PROBABLY SAFER IN MOST INSTANCES

IF YOU DO INTUBATE THE PATIENT:

- YOU NOW TAKE ON THE RESPONSIBILITY TO METICULOUSLY MONITOR VENTILATIONS
- IF YOU DON'T METICULOUSLY MONITOR VENTILATIONS – YOUR ALS AIRWAY IS ACTUALLY WORSE THAN A BLS AIRWAY



IF YOU DO INTUBATE




OUR WORK IS NOT DONE ONCE INTUBATION IS COMPLETE

THERE IS A GREAT CHANCE OF HARMING OUR PATIENTS WHEN WE INTUBATE AND HYPERVENTILATE


THERE IS GREAT POTENTIAL BENEFIT TO OUR PATIENTS WITH INTUBATION AND PROPER VENTILATION

AVOID HYPOTENSION



1 B/P NEAR OR BELOW 90: INITIAL 1000ML NS BOLUS	2 NO SIGNIFICANT IMPROVEMENT: REPEAT 500ML BOLUS	3 REPEAT TO KEEP SBP AT LEAST 90MM Hg
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CAUTION: SEDATION IN INTUBATION



- MEDS THAT CAN CAUSE RAPID DROP IN BP AND RAPIDLY REDUCE BLOOD FLOW TO THE BRAIN
- MORPHINE
- VERSED
- ATIVAN
- VALIUM
- FENTANYL

USE SEDATION WITH CAUTION

START WITH VERY LOW DOSES

¼ OF USUAL DOSES – 1 MG MIDAZOLAM

WATCH SBP CLOSELY WHEN GIVING THESE MEDS

DON'T GIVE IF THE SBP IS ALREADY LOW OR FALLING!!!

Resource: Medication Formulary Controlled Substances

Medication	Administration Route	Concentration/mL
Fentanyl	IM, IV, intranasal	50 mcg
Ketamine (Access must be restricted to paramedics only)	IM, IV, intranasal	100 mg
Midazolam (Versed)	IM, IV, intranasal	5 mg
Morphine	IM, IV	10 mg

*Not all controlled substances are required; please refer to state and regional policy
The minimum number of medications will be determined by regional procedure*

CAUTION: SEDATION IN INTUBATION

- INTUBATED PATIENTS CAN BE TOO SEDATED!!
- SEDATION CAN RAPIDLY CAUSE HYPOTENSION
- WHEN GIVING THESE MEDS TO SOMEONE IN COMPENSATED SHOCK, YOU MAKE IT HARDER FOR THEIR BODY TO COMPENSATE
- REMEMBER THAT A DROP IN BLOOD PRESSURE IN TBI PATIENTS IS REALLY BAD!!



TWO TYPES OF TBI

- ISOLATED TBI – SELDOM HYPOTENSIVE, USUALLY NORMO/HYPERTENSIVE
- MULTISYSTEM TRAUMA WITH TBI – FREQUENTLY HYPOTENSIVE
 - MORE COMMON THAN ISOLATED TBI
 - TREAT HYPOTENSION AGGRESSIVELY

AVOID HYPERVENTILATION


- THE SINGLE MOST COMMON EMS MISTAKE IS HYPERVENTILATION
- NO JOB IS MORE IMPORTANT THAN THE EMT VENTILATING THE PATIENT
- IF WE AREN'T PAYING CONSTANT ATTENTION TO VENTILATION, WE WILL HARM OUR PATIENT

WHAT ABOUT HERNIATING PATIENT?

- THIS IS RARE IN THE PREHOSPITAL ENVIRONMENT
- MOST SEVERE TBI PATIENTS ARE NOT HERNIATING
- TREAT THE MORE COMMON SITUATION

TBI IN KIDS

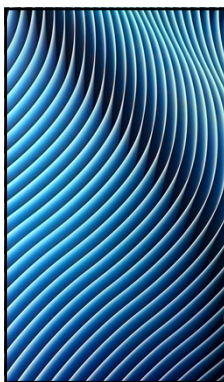
- LARGE NUMBER OF TBI PATIENTS ARE KIDS
- HUGE OPPORTUNITY TO MAKE AN IMPACT
- AVOID THE H-BOMBS FOR KIDS ALSO!



HYPOTENSION IN KIDS

SBP GOALS:

- INFANT 70 mm Hg
- Age 5 80 mm Hg
- 10 and older: 90 mm Hg (SAME AS ADULTS)



HYPOTENSION IN KIDS:

- REMEMBER BP GOALS BY AGE
- INFANT 70, AGE FIVE 80, AGE TEN 90
- INITIAL BOLUS 20ML/KG FOR HYPOTENSION OR SHOCK
- REPEAT BOLUS Q 5 MINUTES TO RETURN TO GOAL BP
- REPEAT TO KEEP SBP IN TARGET RANGE

PEDIATRIC VENTILATION RATES

- INITIAL VENTILATION RATE BY AGE
- INFANTS 0-24 MONTHS – 25 BPM
- CHILDREN 2-14 YEARS – 20 BPM
- AGE 15-17 10 BPM
- USE JUDGMENT AND ETCO2 IF AVAILABLE – IDEAL ETCO2 40 (35-45)

FIVE THINGS TO DOCUMENT

- DO AND DOCUMENT Q 5 MIN
 - SBP, PULSE, RESP RATE, O2 SAT, PUPILS
 - ETCO2
 - GCS – ESPECIALLY MOTOR SCORE
- AT LEAST ONCE: INITIAL BLOOD GLUCOSE, FLUIDS GIVEN AT TIME OF TRANSFER

FOUR THINGS TO REMEMBER:

- HIGH FLOW O2 NOW – KEEP O2 SATS GREATER THAN 90%
- KEEP SBP > 90 ALWAYS
- DON'T HYPERVENTILATE EVER!
- KEEP ETCO2 AT 40 (35-45 RANGE)
