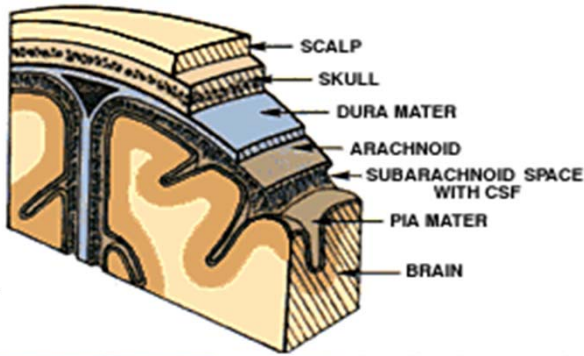


Traumatic Brain Injury and Respiratory Care

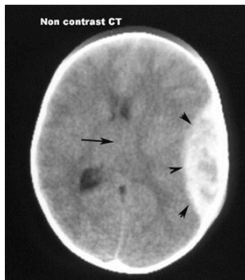
Damien Beilman, RRT
Adult Clinical Specialist
Wesley Medical Center



Basic Brain Anatomy

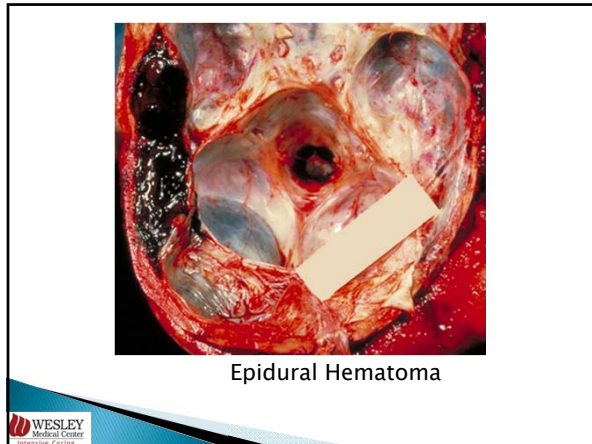


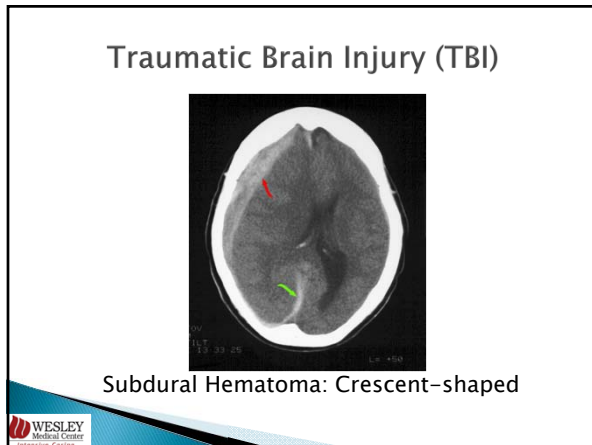
Traumatic Brain Injury (TBI)

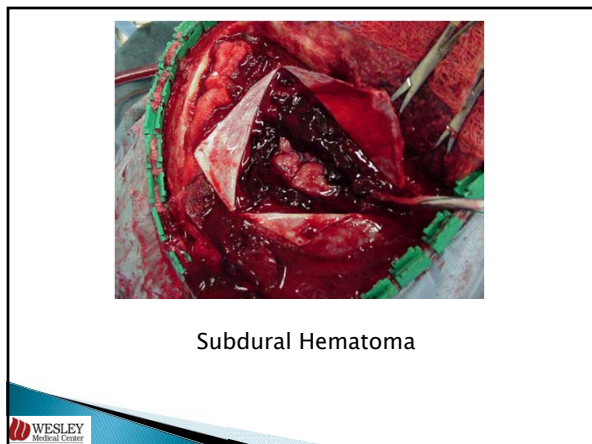


Epidural Hematoma: Lens Shaped.









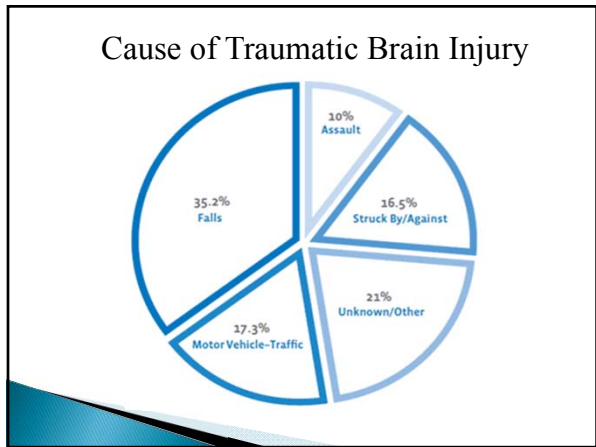


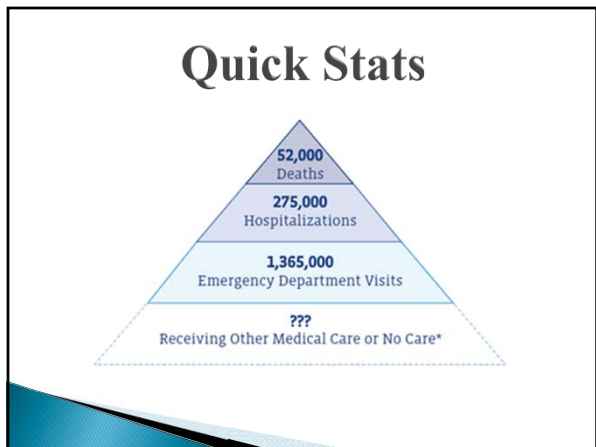
Traumatic Brain Injury (TBI)




Cerebral Contusion








Secondary insults that occur later that do the most harm.



Secondary Insults


- ▶ Hypoxia
- ▶ Hyper- and Hypocarbica
- ▶ Increase intracranial pressures (ICP)
- ▶ Low mean arterial pressure (MAP)
- ▶ Low Cerebral perfusion pressures (CPP)
- ▶ Increased temperature (>38°C)

Respiratory Therapists have an impact!



Objectives

- ▶ Basic neurophysiology lesson
- ▶ Respiratory Care
 - Minute ventilation
 - Managing hypoxia
 - Chest physical therapy/Suctioning
 - Traveling
 - Extubation



Basic Neurophysiology Lesson

Intracranial Pressures (ICP and CPP)

Blood Flow Autoregulation

Cerebral Perfusion Pressures

Measuring Oxygenation



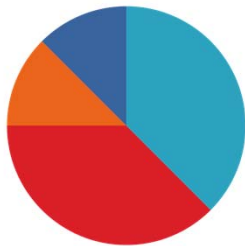
Intracranial Pressure



- Brain
- Blood
- CSF
- Interstitial Fluid



As the Brain Swells... something has to give



- Brain
- Blood
- CSF
- Interstitial Fluid


If this fails to occur... intracranial pressure rises



High Intracranial Pressure (ICP) Is that a Problem?

Increase in ICP
(normal < 10-15 mmHg)

Mass Effects & Herniation Impaired Perfusion




Is the ICP the only concern?

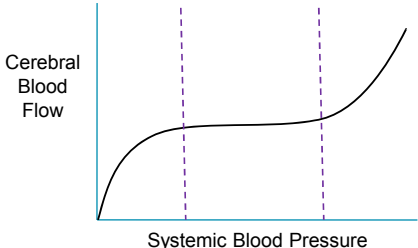
CPP

Cerebral = Mean - Intracranial
Perfusion Arterial Pressure
Pressure Pressure Pressure

Goal CPP: ≥ 65 mmHg




Regulation of Blood Flow

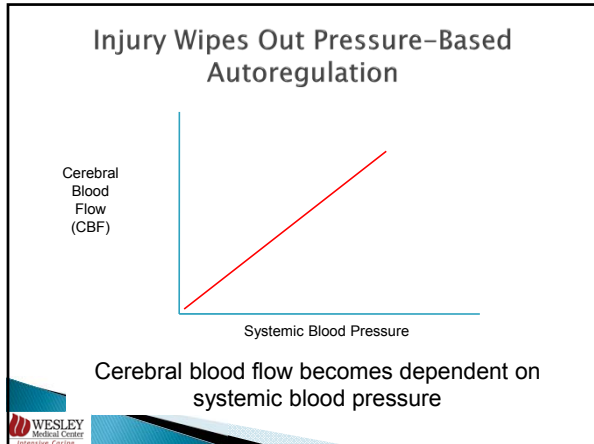


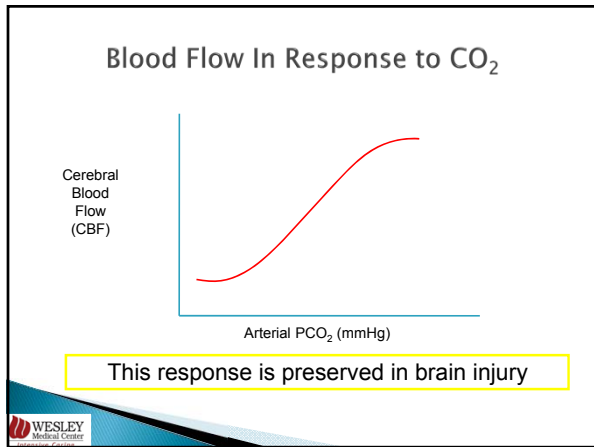
Cerebral Blood Flow

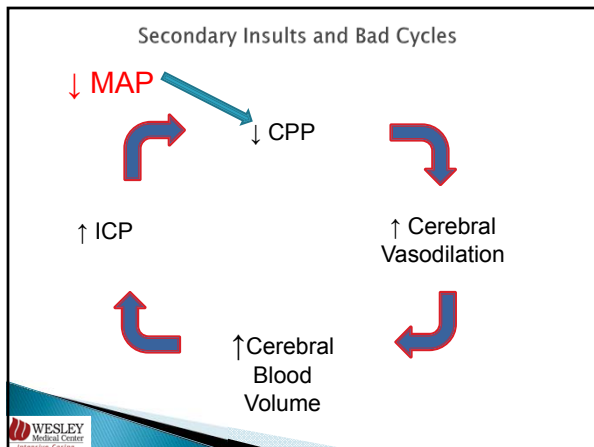
Systemic Blood Pressure

Normal Cerebrovascular Autoregulation









$P_B O_2$ and $S_j O_2$

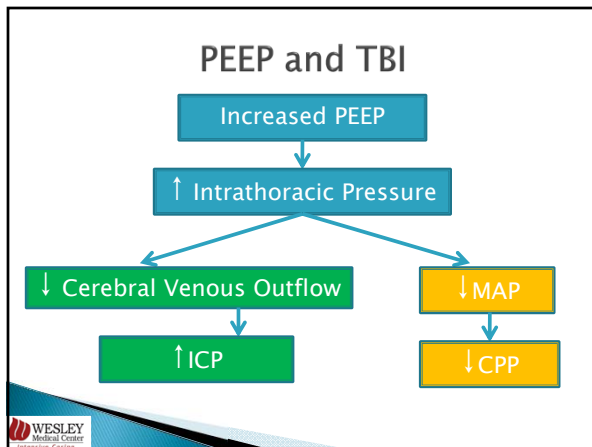
$S_j O_2$ $P_B O_2$ $S_a O_2$

$S_j O_2$ is akin to $S_v O_2$ and reflects balance of oxygen delivery and utilization in the brain

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Uh, Oh!
Show me a TBI and I will show you ARDS.

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Does PEEP Effect ICP/ CPP?

- ▶ PEEP has minimal effect on ICP
- ▶ Cerebral venous outflow acceptable if PEEP < ICP
- ▶ Cerebral hemodynamics effects not seen in patients if:
 - Respiratory system compliance is low
 - The patient is euvolemic
 - Mean arterial pressure is maintained



Lowe G., Ferguson N. Curr Opin Crit Care, 2006. 12:3-7.
 Muensch E. et al. Crit Care Med. 2005 33:10. 2367-72.

What About Other Strategies?

Study	Strategy	ICP	CPP
Bein et al. 2002	Recruitment Maneuvers	↑	↓
Thelandersson et al. 2006	Prone Ventilation	→	→
Reinprecht et al. 2003	Prone Ventilation	↑	↓
Salim et al. 2004	High Frequency Percussive	↓	No Data

Alternative Treatment for Severe ARDS



- ▶ Increased PEEP
- ▶ Proning
- ▶ Recruitment Maneuvers
- ▶ High Frequency Ventilation



Salvage Therapies

The ATS is providing this information about salvage therapies that are available as a resource for those interested in this information, but it is important to note that none of these therapies have been shown to improve survival for patients with ALI/ARDS and that the ATS is not recommending the use of these therapies.

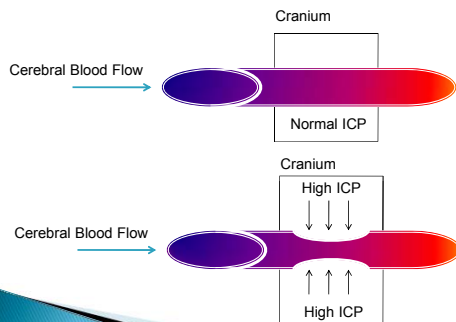


P_aCO₂- Ventilation

“Hyperventilating TBI patients with elevated ICP will bring down the ICP by decreasing cerebral blood flow”



How Does Happen and Is This a Good Thing?



Hyperventilation Impairs Oxygenation

Parameter	Observed Change
Intracranial Pressure (ICP)	↓
Cerebral Blood Flow (CPP)	↓
Jugular Vein Saturation (SjO ₂)	↓
Brain Tissue PO ₂ (PBO ₂)	↓

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Stocchetti et al. Chest 2005

The Take-Home Messages on CO₂ Targets in TBI

- ▶ Target PaCO₂ should be 35–40 mmHg with TBI &/or increased ICP
- ▶ Hyperventilation is reserved for emergent situations:
 - Acute Herniation
 - Crash to the OR or CT scanner

WESLEY Medical Center

Patients Often Arrive in the ED With Bad PaCO₂ Levels

Distribution of Arrival pCO₂

Category	Percentage
Hypocapnea	17%
Target Ventilation	47%
Mild Hypercapnea	26%
Severe Hypercapnea	10%

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Warner et al. J Trauma 2008

The Glasgow Coma Score

Eye Opening	Motor Response	Verbal Response
1- None	1- None	1- None
2- To Pain	2- Extensor	2- Sounds
3- To Voice	3- Flexor	3- Words
4- Spontaneous	4- Withdraws	4- Sentences
	5- Localizes	5- Oriented
	6- Obeys	

Glasgow Coma Score (GCS): sum of the score on each variable (Maximum = 15)

Outcomes

Patient Group	Reintubation Rate
No Extubation Delay	17 of 99 (17%)
Delayed Extubation	7 of 37 (19%)
GCS ≤ 8	10 of 49 (20%)
GCS ≤ 4	1 of 11 (9%)

Patients with delayed extubations had more pneumonia and longer ICU and hospital stays

Coplin et al. AJRCCM 2000

More Outcomes

EXBUTATION DELAY AND OUTCOME

	No Delay	Extubation Delay	p Value
Factor, n (%)	99 (73%)	37 (27%)	
Pneumonia, n (%)	21 (21.2%)	14 (37.8%)	0.048
Intensive care unit length of stay, d	3 (1-15)	8 (3-22)	< 0.001
Hospital length of stay, d	11 (1-39)	17 (3-61)	0.009
Cost, \$ (range)	41,824 (6,576-165,994)	70,881 (27,051-193,109)	< 0.001
Mortality, n (%)	12 (12.1%)	10 (27.0%)	0.04
Tracheotomy, n (%)	4 (4.0%)	0 (0.0%)	0.6

* Data are presented as medians with ranges shown in parentheses, except when specified.

Coplin et al. AJRCCM 2000

Low GCS Alone Should Not Preclude Extubation

- ▶ Good Cough?
- ▶ Gag?
- ▶ Low Sputum?
- ▶ Low Viscosity?
- ▶ Low Suction Frequency?

Summary

- ▶ Respiratory Therapist and the care they provide can impact outcomes.
- ▶ Target PaCO₂ 35–40 mmHg
- ▶ PEEP and suctioning can be safe
- ▶ Use a transport ventilator and monitor EtCO₂ during transports.
- ▶ A low GCS should not preclude extubation.

Any Questions??
