CRITICAL KIDS IN THE FIELD: Initial Assesment and Stabiliization

Robert J. Dimand. MD
Pediatric Critical Care Medicine
Chief Medical Officer, California Children's Services
Professor UCSF-Fresno

CRITICAL KIDS IN THE FIELD:
Initial Assesment and Stabiliization

- Scene vs Interfacility
- Respiratory Distress
- Trauma
- Shock
- Drowning
- Infections
- Non Accidental Trauma

Transport of the Critically Ill Infant or Child

- “Scoop and Run” or “Stay and Play”? Approach to Pediatric Stabilization and Transport
- Different Considerations: Scene vs Interfacility, Often from Facilities with Limited Pediatric Capabilities

Trauma Transports: Hazards

Work Philosophy

Stay and Play

Scoop and Run

Communication Center Call

- Patient arrived to ED with CPR in progress
- Intubated with 3.0 ETT and being bagged
- Epinephrine given X 2
- Atropine given X 2
- Heart rate resumed
- Sodium Bicarb given X 2
- Current vitals: HR-140 RR-40 BP-52/11 Temp- 90F
- Vent settings: FiO2 1.0, Rate 40, PIP 20 PEEP 3
- Pupils 3mm and sluggish
- Cap refill 5 seconds
- ABG 6.93/74.4/259/14.8/-16.9

Case Study

- 2 month old infant found in full cardiac arrest at home
- Paramedics initiated CPR and continued CPR for 10 minutes until arrival in ED

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Family Presence

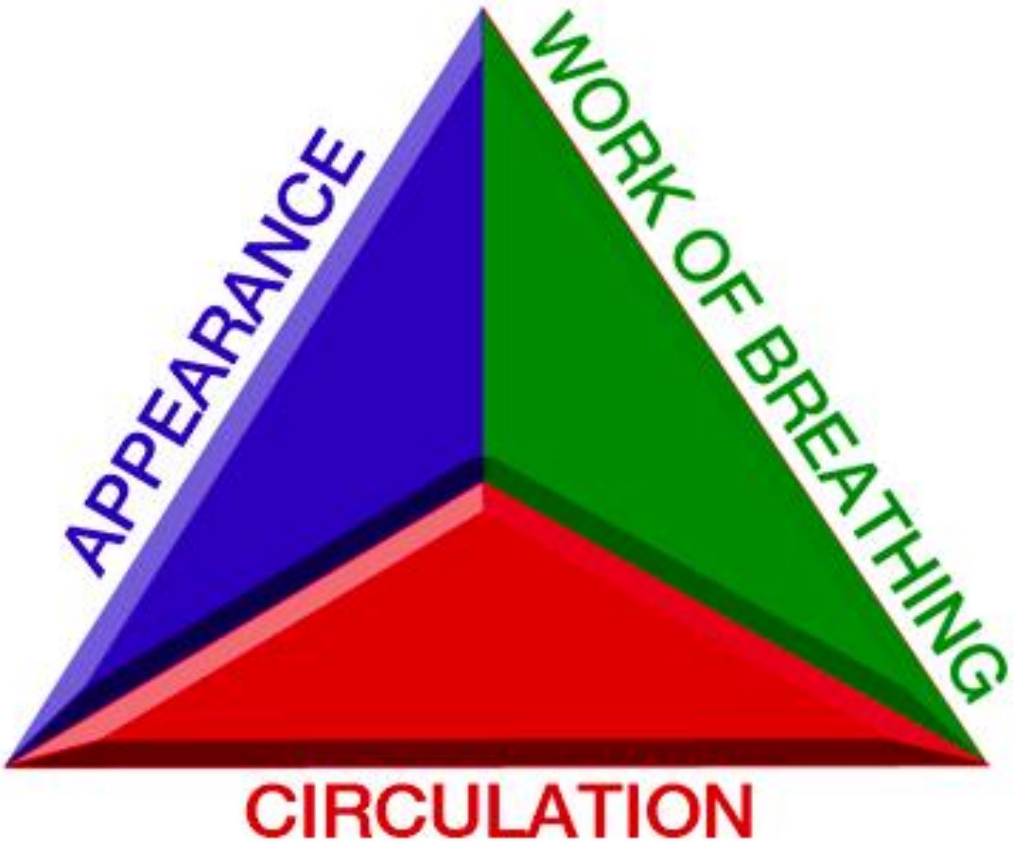
- On transport, the family is almost always present either at the OSH or in the ambulance
- The literature shows that most clinicians are concerned that parents will interfere with care if allowed to be present during resuscitation
- However, this is rarely the case
- In fact, some studies show that care is improved when a parent is present
- There is no evidence to suggest that the legal risk increases with parental presence
- What would you want if it were your child?

Dingeman et al. (2007)

Exposure/Enviornment

- Remember a naked child is a cold child!
  - Check child's temperature
  - Warm IV fluids if possible: room temperature fluids are about 20 degrees colder than normal body temperature
  - Warm blankets for transport
  - Portawarmer mattress: Can use more than one for an older child
  - Place under blanket to avoid burns to skin
- Hypothermia exacerbates acidosis!

CRITICAL KIDS IN THE FIELD
Pediatric Assessment Triangle



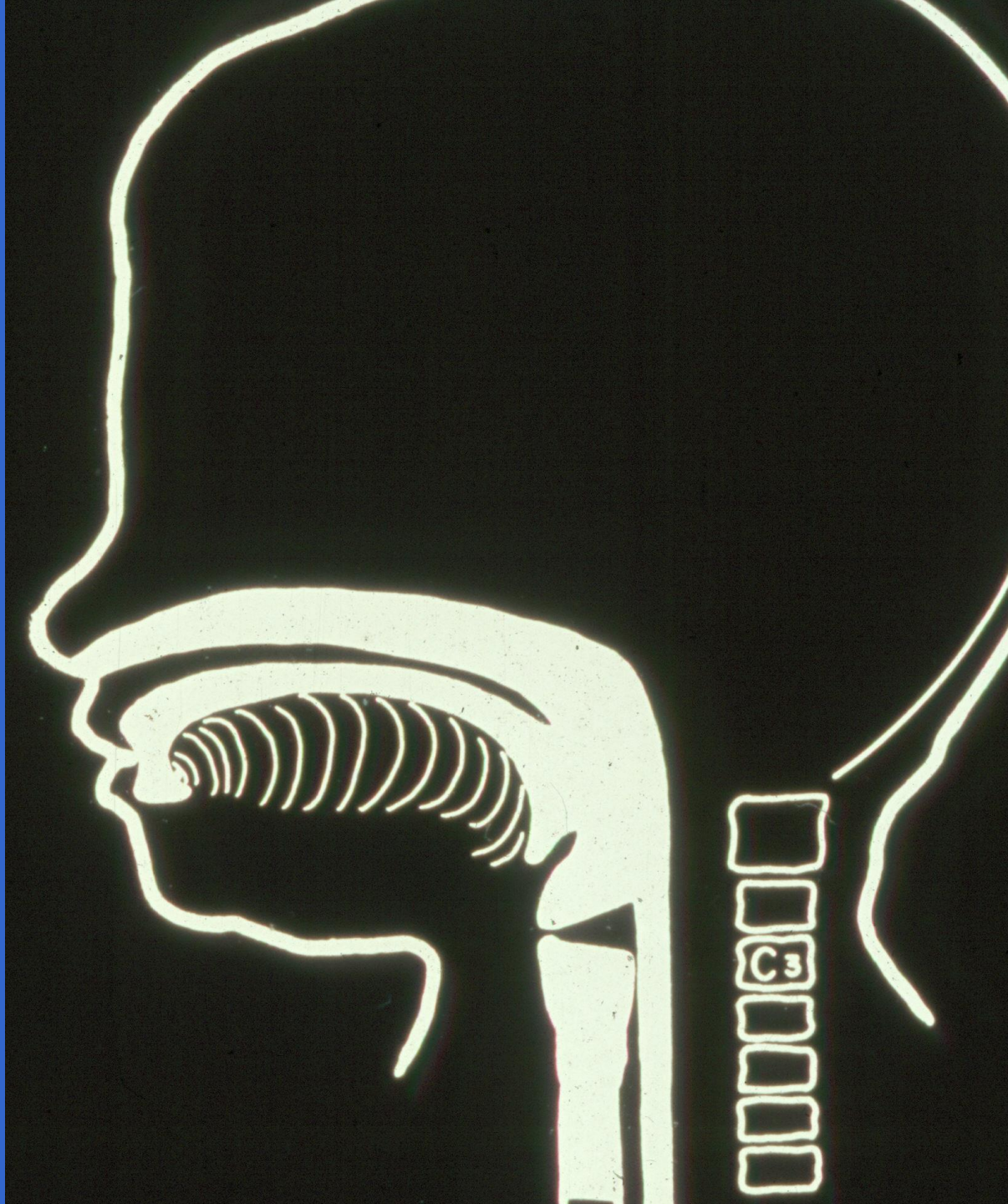
INFANT WITH INCREASED RESPIRATORY EFFORT

Note use of intercostal and accessory muscles

Infant Airway

- Narrow Nares
- Small Pharynx
- Large Tongue

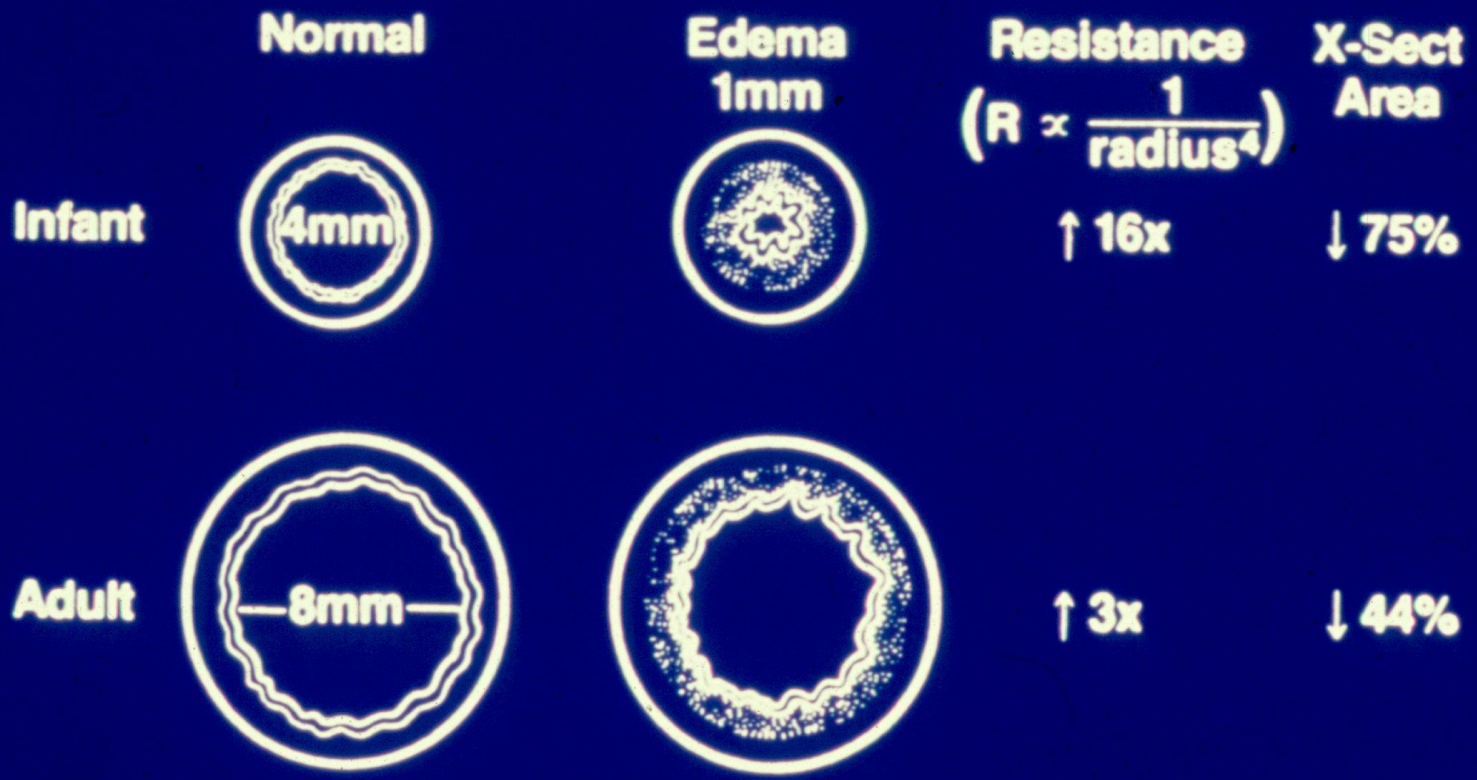
- Larynx
  - High (C3)
  - Anterior
  - Tapered
- Narrowest Part is
  - Subglottic Area



EFFECTS OF AIRWAY EDEMA ON RESISTANCE

1MM CIRCUMFERENTIAL EDEMA

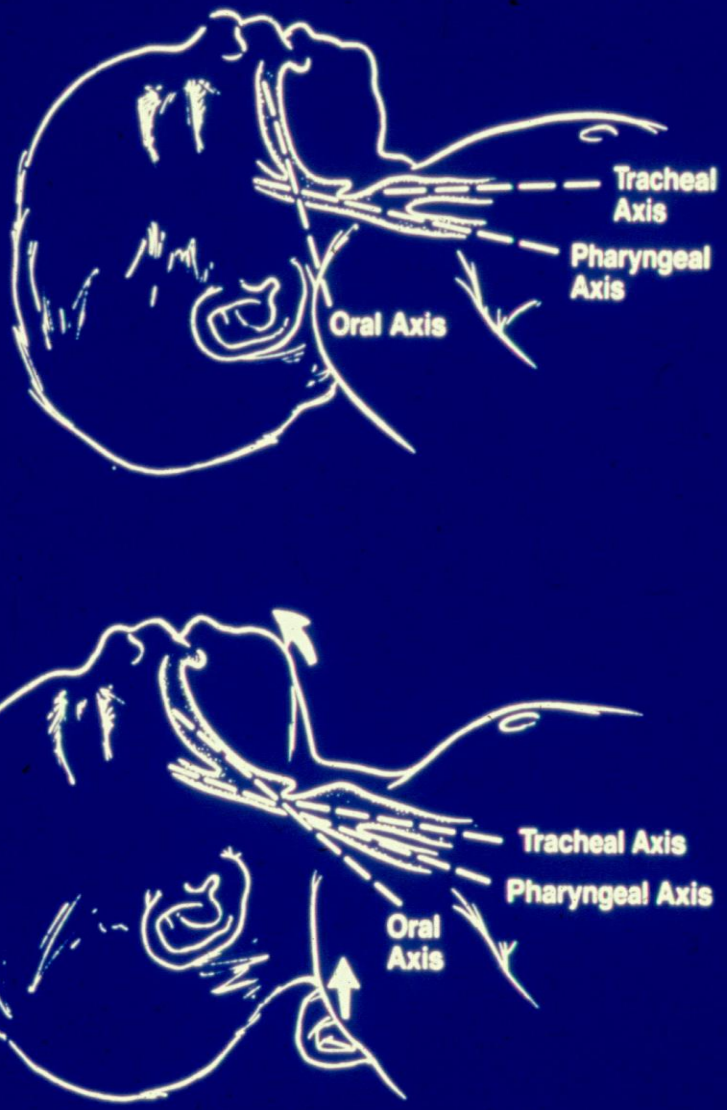
INFANT VS. ADULT



Respiratory assessment and management on transport

- 100% oxygen via NRB mask
  - Wean O2 as patient stabilizes using face mask or nasal cannula
- Provide bag valve mask ventilation for children who are not breathing effectively
  - Unable to maintain O2 sats on oxygen
  - Cyanosis
  - Unable to protect airway
  - Bag with enough force to make chest rise
  - 1 breath every 3 seconds
- CE hand position
  - Do not occlude airway with your fingers!

ENDOTRACHEAL INTUBATION: INFLUENCE OF NECK POSITIONING



Endotracheal Tubes

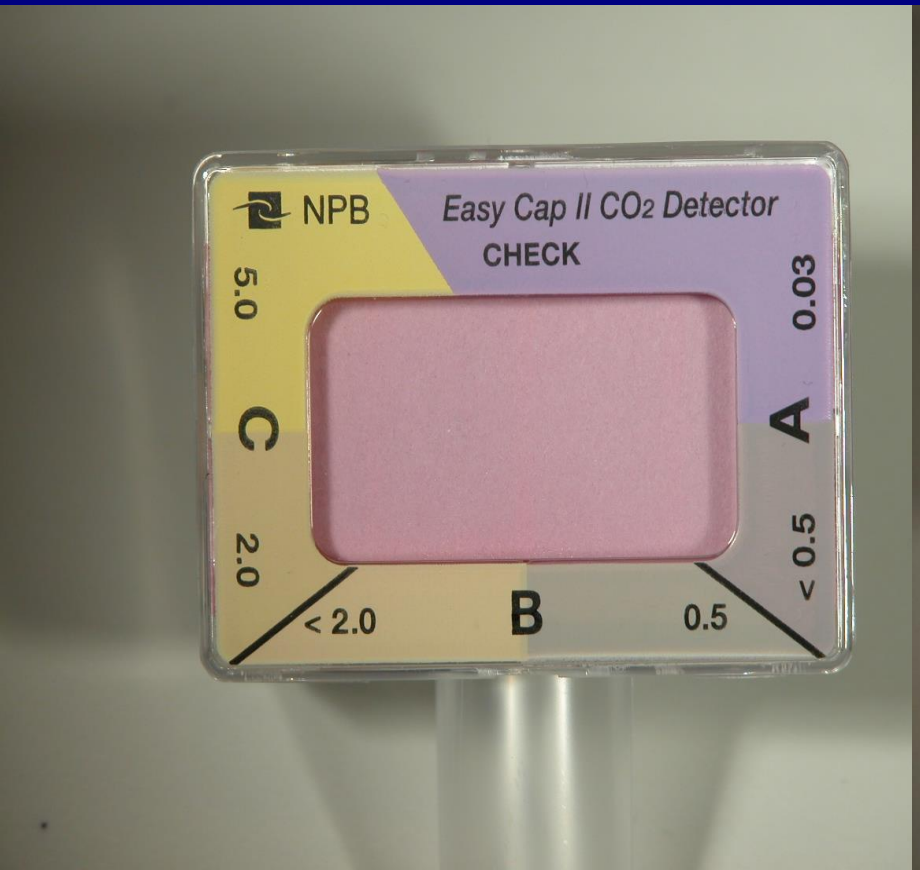
- Length of tube estimated by the following:
  - Children > 1 year of age:
    - 13 plus ½ patient's age
  - Infants < 1 year of age:
    - Estimated 3x ETT size

Rapid Sequence Intubation

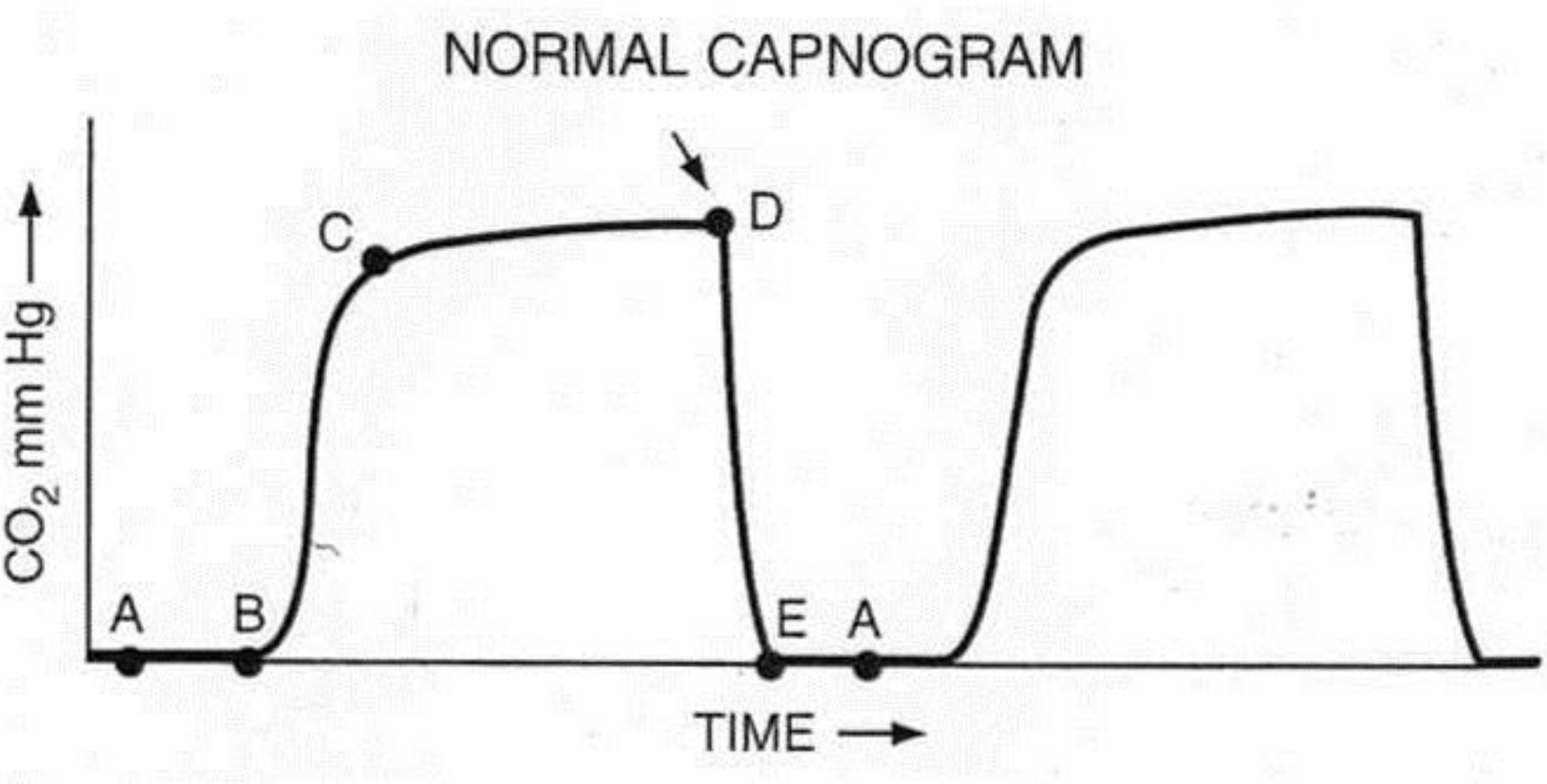
- Procedure
  - Oxygenate with FiO2 of 1.0
  - Administer atropine
    - Prevents vagally induced bradycardia
    - Minimizes secretions
  - Administer an opiate and benzodiazepine
    - Sedation
  - Administer paralytic
    - Relaxes all muscles allowing ease of opening airway and controlling breathing
  - Proceed with intubation

End Tidal CO2 Detection Disposable Device

Baseline CO2 Present



End Tidal CO2 Tracing



Mechanical Ventilation in Infants and Children

- Introduction: Lung Protection/Injury
- Lung Disorders: ARDS, Pneumonia, Bronchiolitis, Asthma
- Goals of Ventilation: Minimize Injury of Lungs, Brain, Organs
- Strategies: Permissive Hypercapnia, Hypoxemia
- Modes of Ventilation: Pressure Control, Volume Control (Pressure Limited), Pressure Support, Volume Support, HFOV

Mechanical Ventilation Induced Injury

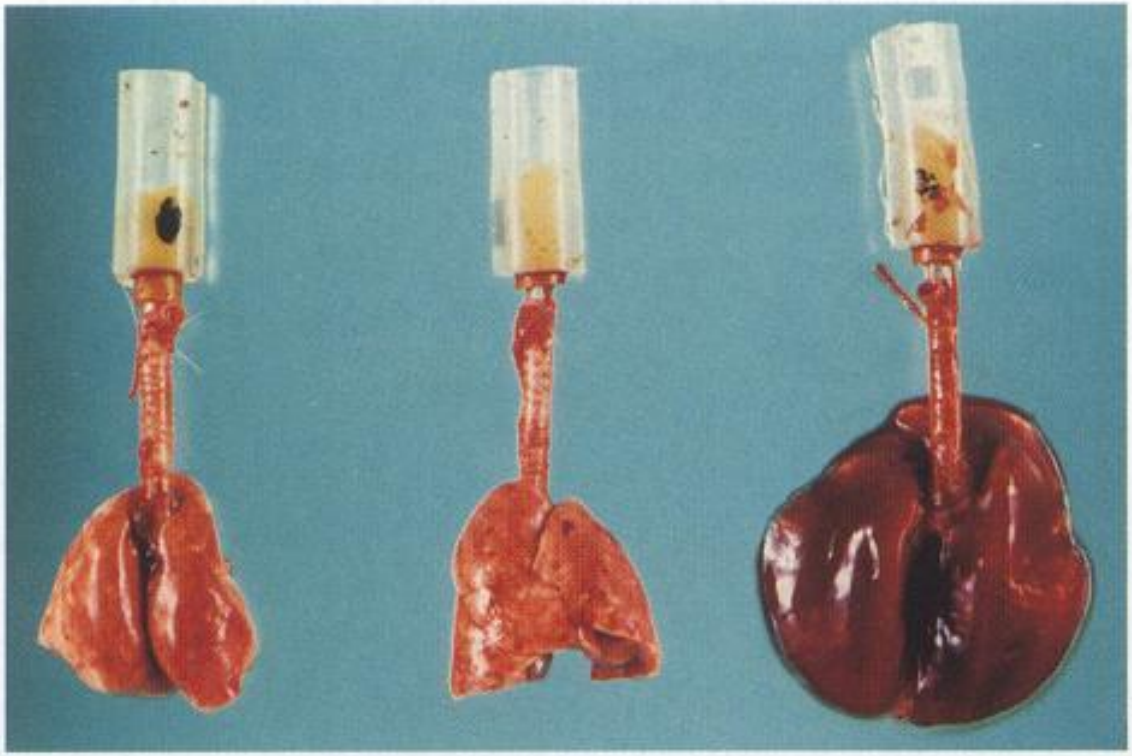


Figure 5. Macroscopic aspect of rat lungs after mechanical ventilation at 45 cm H_2O peak airway pressure. *Left*: normal lungs; *middle*: after 5 min of high airway pressure mechanical ventilation. Note the focal zones of atelectasis (in particular at the left lung apex); *right*: after 20 min, the lungs were markedly enlarged and congestive; edema fluid fills the tracheal cannula.

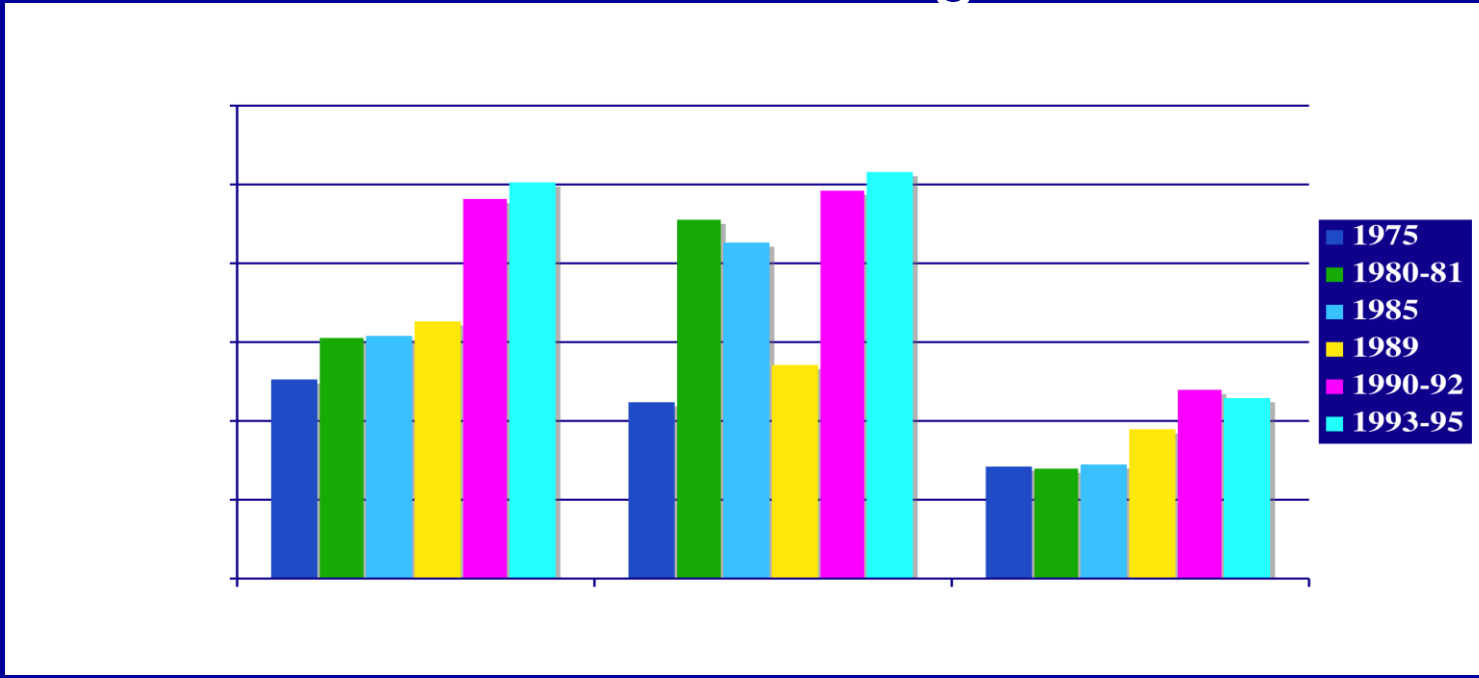
CNS Effects of Hypercapnia: Cerebral Blood Flow

- Acute changes in p_aCO_2 has profound effects on CBF
  - CBF increases 6% per 1 mmHg change in p_aCO_2
  - No additional increase in CBF with p_aCO_2 > 80-120 mmHg
- Increased CBF mediated by both systemic hypertension and cerebral vasodilatation

: Epidemiology

Prevalence

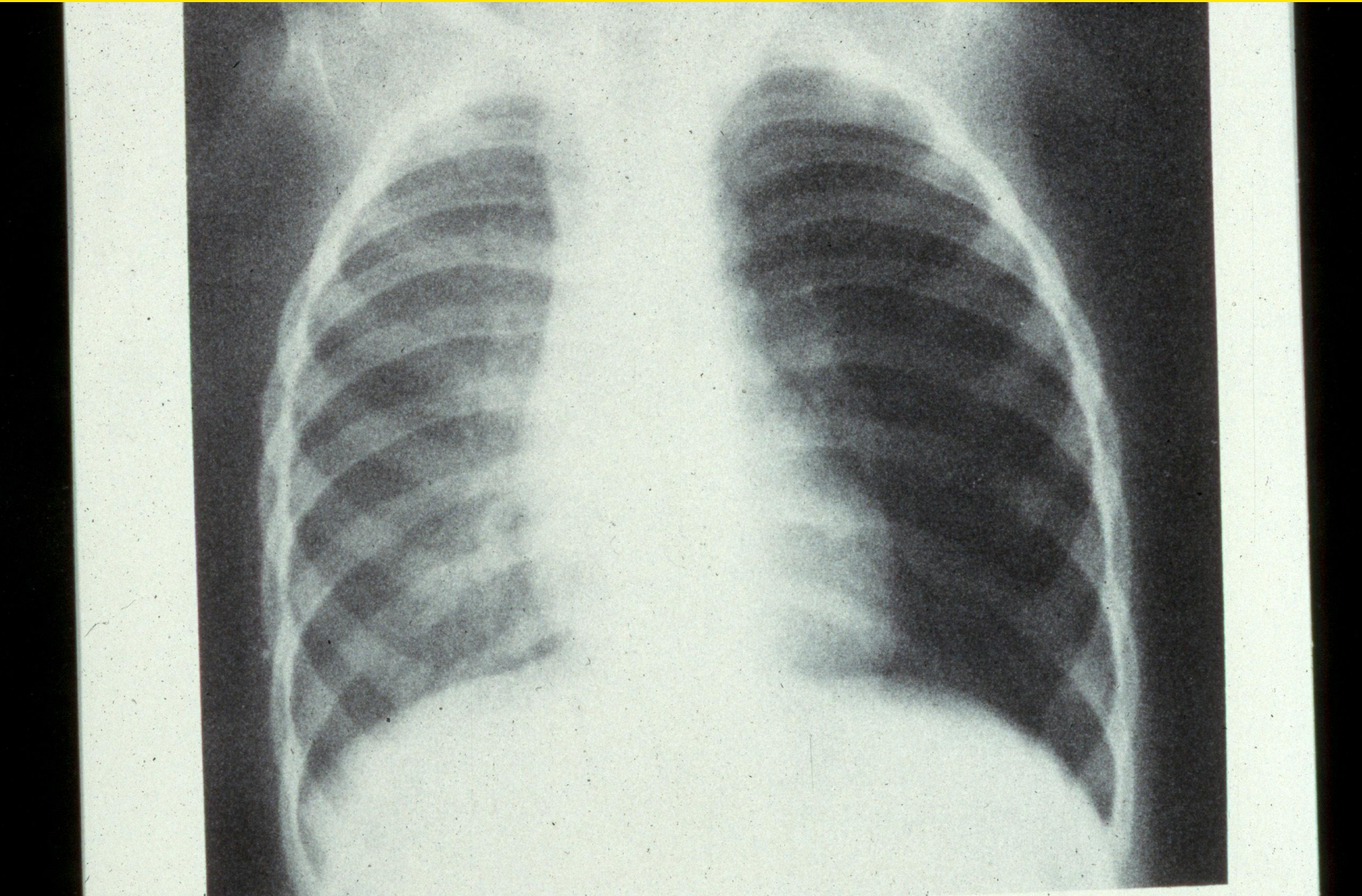
- The prevalence of pediatric asthma in the US is increasing



Rate of self-reported asthma/1,000 population

Mannino DM. MMWR 1998;47(1):1-27

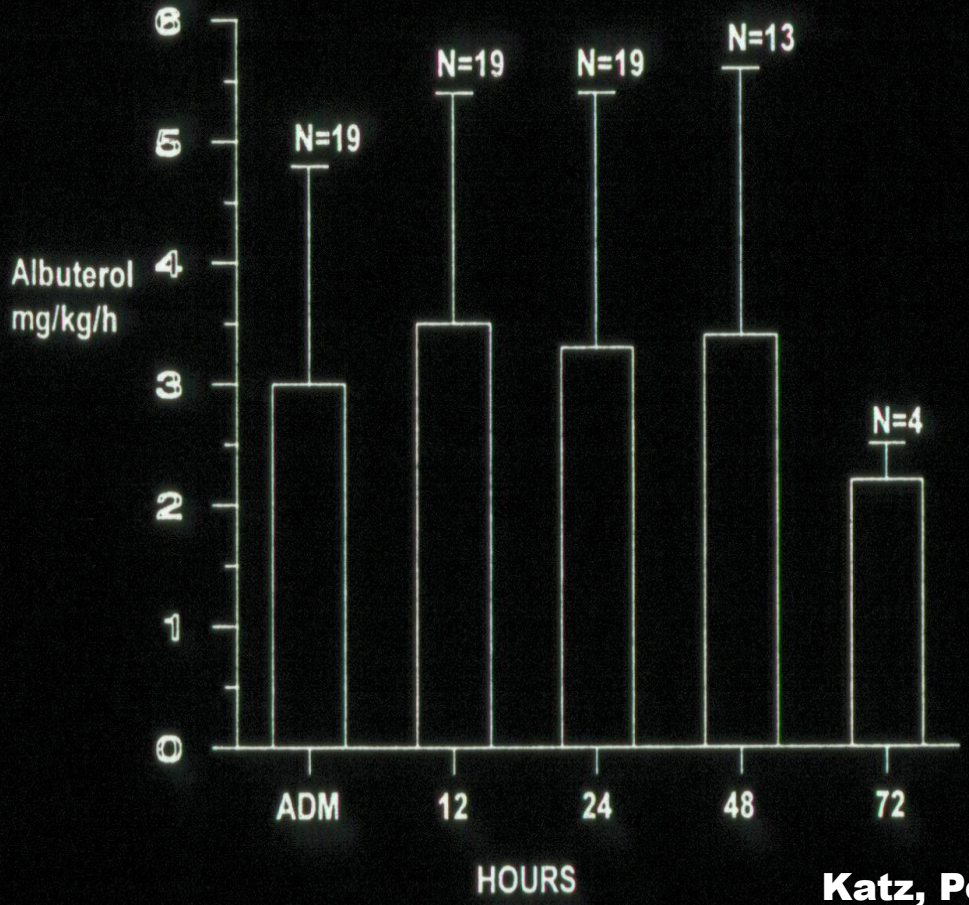
FOREIGN BODY IN MAINSTEM BRONCHUS



HIGH DOSE BRONCHODILATORS PEDIATRICS: SAFETY ISSUES

- Pediatric Myocardium Not Oxygen Limited
- Tolerance of Tachycardia
- Lack of Arrhythogenicity
- Tolerance of Hypokalemia

SAFETY OF CONTINUOUS HIGH DOSE ALBUTEROL IN CHILDREN



Katz, Pediatrics, 1993

: Treatment

ß -Agonists

- Delivery of nebulized drug
  - Only particles between 0.8 – 3 μm are deposited in alveoli
  - Correct gas flow rate is cruci
  - Most devices require 10-12 L/min gas flow to generate correct particle size

INTUBATION IN STATUS ASTHMATICUS IN CHILDREN

- To Be Avoided if Possible, Only for SEVERE Respiratory Failure
- Asthma a Disease of Exhalation, Neuromuscular Blockade, Positive Pressure Worsen Expiratory Flow/Function
- Ketamine May Reverse Hypoxic, Hypercarbic Hysteria
- If Necessary, Slow Rates, Watch for Air Leak, CO_2 Likely To Go Up

Back to the case study

- Current vitals: HR-140 RR-40 BP-52/11 Temp- 90F
- Vent settings: FiO2 1.0, Rate 40, PIP 20 PEEP 3
- Cap refill 5 seconds
- ABG 6.93/74.4/259/14.8/-16.9
- 2 tibial IO's in place bilaterally and one PIV with maintanance and dopamine infusing at 5 mcg/kg/min
- Glucose-47, K-7.0 non-hemolyzed
- Succinylcholine given by ED staff but patient with gasping respiratory effort

What happened?

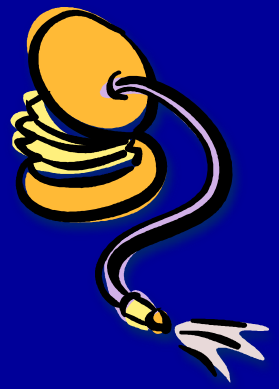
- Patient sedated and paralyzed appropriately
- CaCl and bicarb given as ordered
- Recheck of accucheck after dextrose =112
- Insulin given as ordered
- Accucheck dropped to 42 so D10W repeated
- One IO was infiltrated so new PIV started
- Repeat ABG 6.94/92.1/233/18.8/-13.1
- BP dropped after pavulon, so dopamine titrated up-to 20mcg/kg/min
- Pt diagnosed with Influenza A

Interventions

- Re-tape and pull back ETT 1 cm
- Increase PEEP to +5
- Sedation with Fentanyl 1-2 mcg/kg
- Treat hypoglycemia-2ml/kg of D10W
- Provide adequate paralysis with NMB
- Give Calcium Chloride-Why?
- Give dextrose to increase accucheck to 100, then give regular insulin 0.1u/kg-Why?

Types of shock

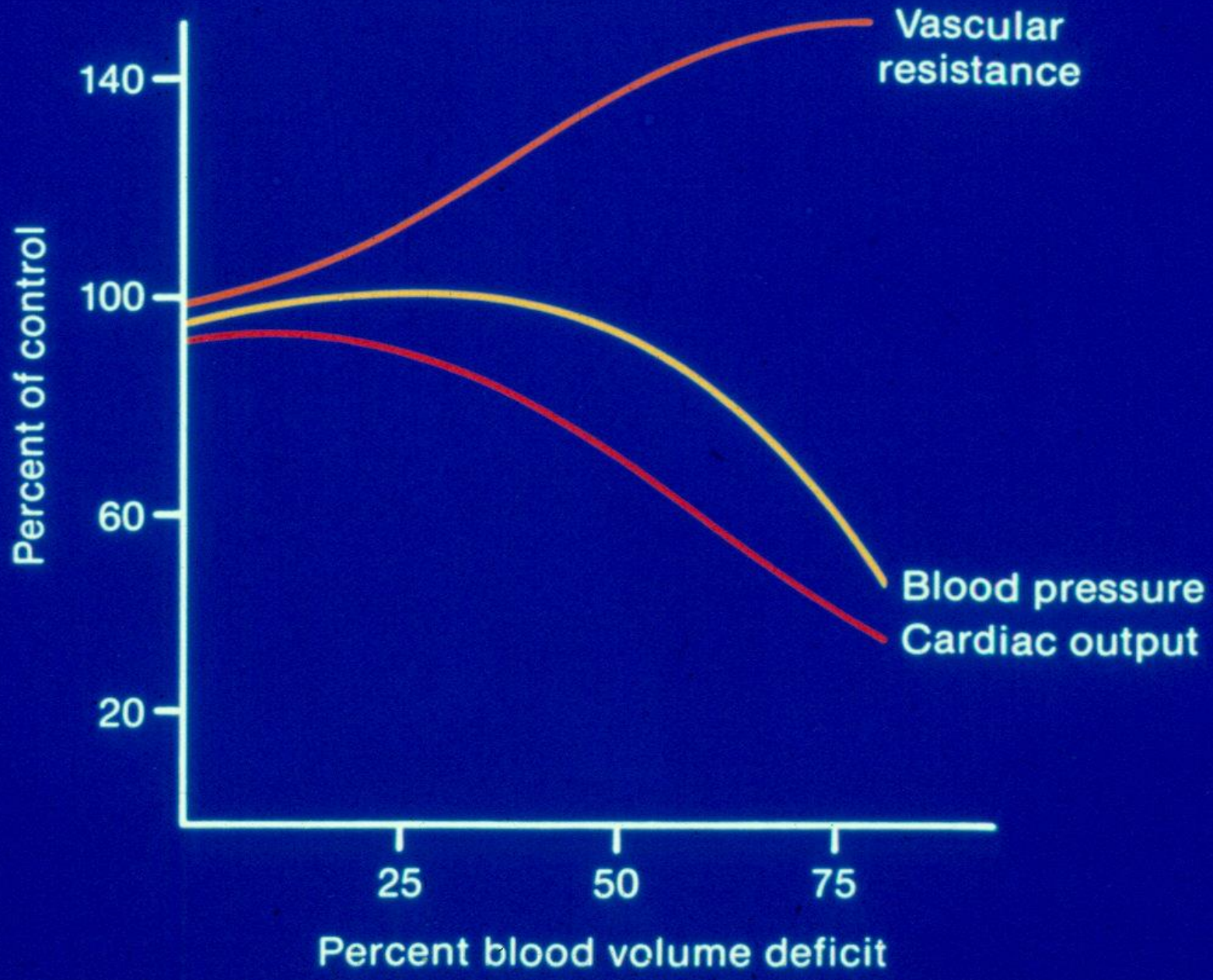
- Hypovolemic Shock
  - Occurs from loss of blood or body fluid volume from the intravascular space
  - Causes can be injury, vomiting or diarrhea
- Cardiogenic Shock
  - Pump Failure
    - Inability of the heart to maintain adequate cardiac output
    - SVT, arrhythmias, cardiomyopathy, heart block
    - Support ABC's
    - Treat the cause



DEFINITION OF SHOCK IN INFANTS AND CHILDREN

- Clinical State Characterized by Inadequate Delivery and Uptake of Blood Flow to Meet Metabolic Demands. May Involve Metabolic Uncoupling (Sepsis). In Children may be Independent of Blood Pressure

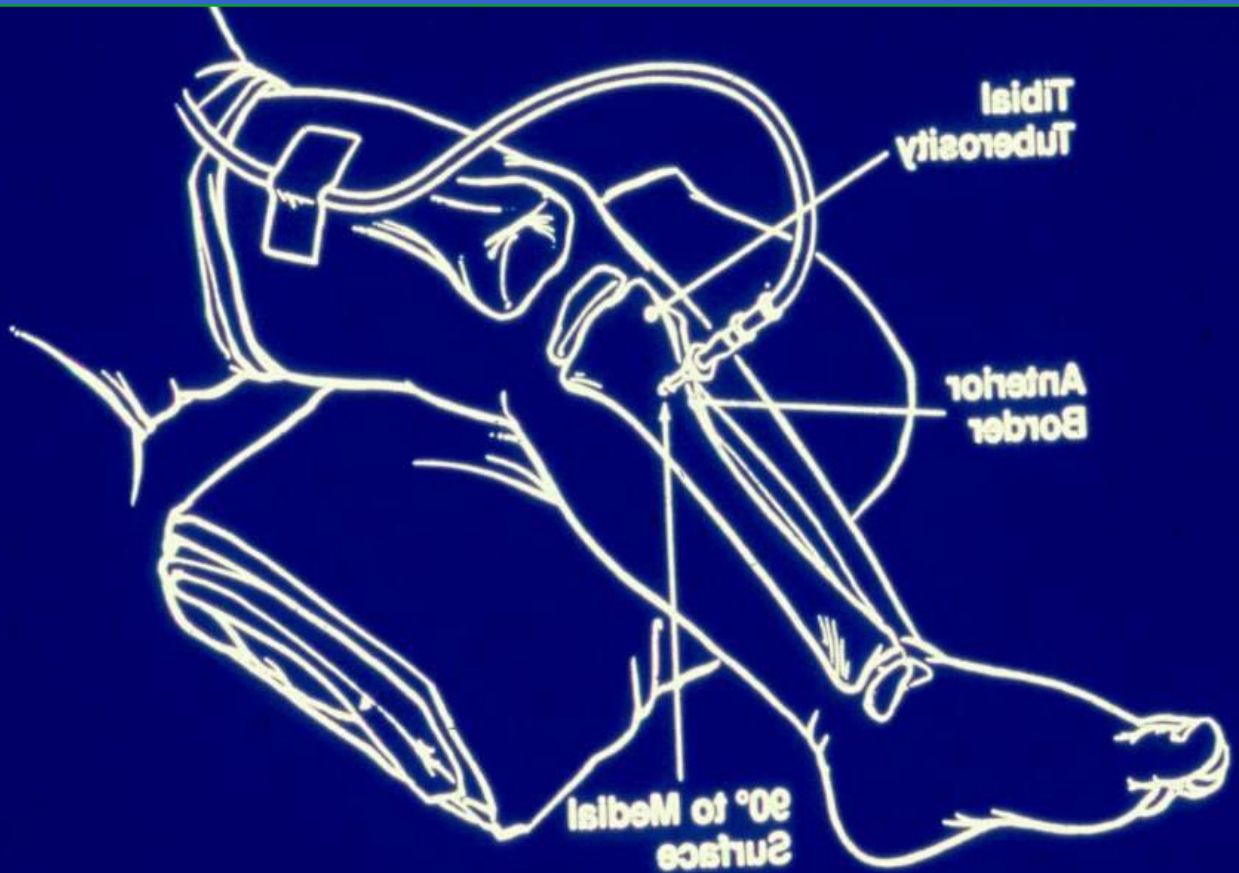
HEMODYNAMIC RESPONSE TO HEMMORHAGE



CAPILLARY REFILL – NORMAL < 2 SECONDS

INTRAOSSEUS CATHETER PLACEMENT

CRITICALLY ILL INFANT OR CHILD



Will feel a “pop” when entering bone marrow space. Fluid will flow freely. Essential not to manipulate catheter, no tape to put tension on catheter, will loosen bone seal

Vascular Access in PICU Patients

Venous

- Femoral - Usually Most Common, Easiest, Least Risky
- Internal Jugular - Ultrasound Facilitates, Experience
- Subclavian - Apex of Lung, Perforation

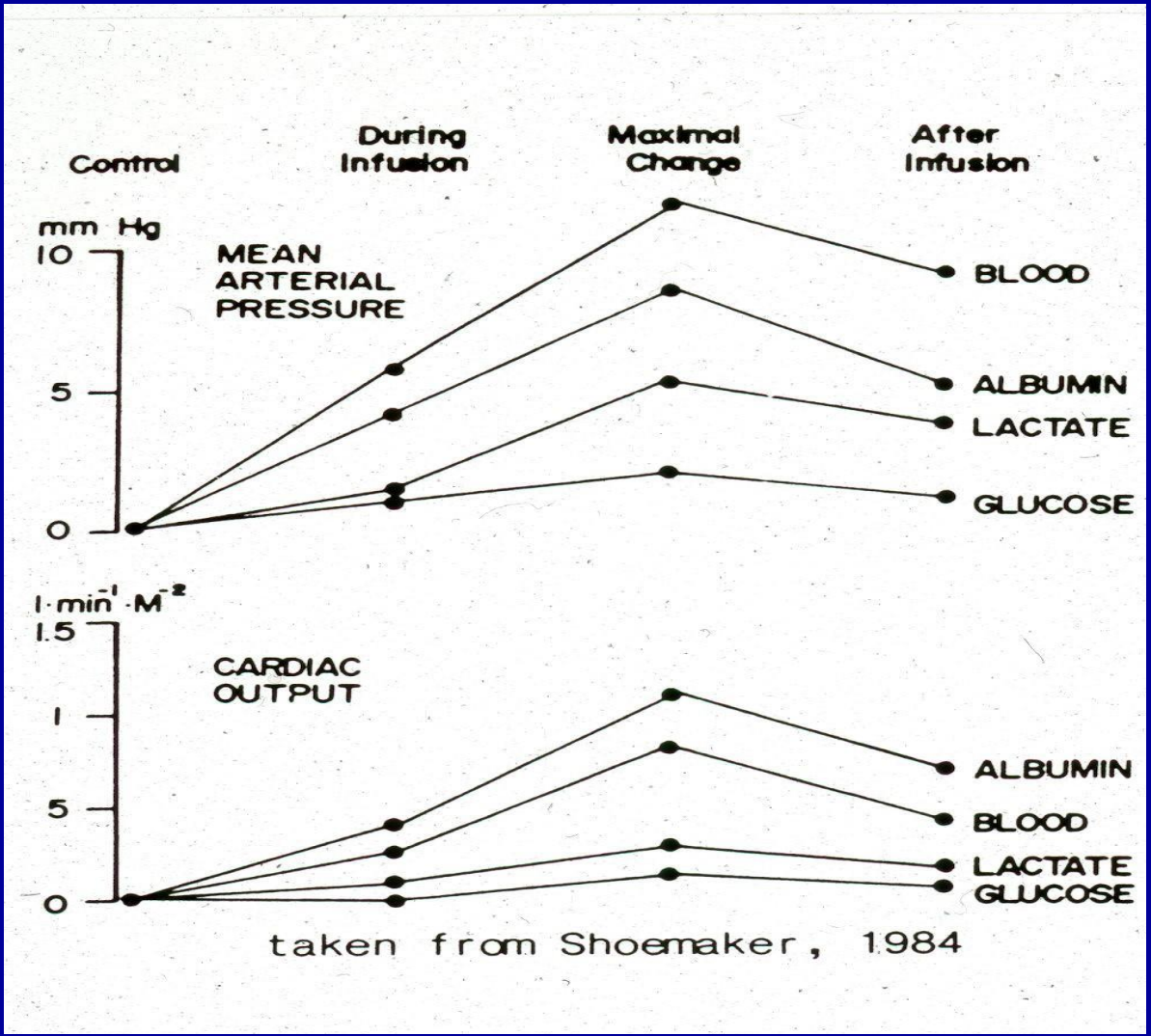
Arterial

- Radial
- Femoral
- Posterior Tibial
- Axillary

DEFINITION OF PRELOAD

- Gold Standard: Left Ventricular End Diastolic Volume. Stretch on Myocardial Fibers. Starling Curve
- CVP – Central Venous Pressure, Right Atrial Pressure. ? Effect of Airway Pressure?
- LVEDP – “Wedge” Left Ventricular End Diastolic Pressure. Occluded PA Balloon, Pressure Column from LV to PA via Mitral Valve. ? Effect of Airway Pressure?
- Echocardiogram: LV Diastolic Volume

EFFECT OF VARIOUS FLUIDS ON BLOOD PRESSURE AND CARDIAC OUTPUT



Comparison of 500 ml Blood, 5% Albumen; 1000 ml Lactated Ringer's, 5% Dextrose

DRUGS USED IN SHOCK IN CHILDREN

DRUG	Dose mcg/kg/min	Mech	Use
Dopamine	2-20	D,B,A	Mild Shock
Dobutamine	5-20	B	Cardiogen.
Epinephrine	.05-3	B>A	Shock
Norepineph.	.05-3	A>B	Shock
Milrinone	.25-1	PDE	Ino, Vasodil
Nitropruss.	.2-5	Dil	Vasodil
Fenoldapam	.2-.8	RBF	Renal Perf
Vasopressin	.5mU	Const	Synergy

Treatment:
Hemodynamic Support

Early septic shock:

- Impaired distribution of O_2 to tissues
- Low SVR
- Often high Q_T
- Hypotension
- Warm extremities
- "Flushed" appearance

- Treatment
  - Volume administration (lots)
  - Epinephrine
  - Norepinephrine

Late septic shock:

- High SVR
- Low Q_T
- Delayed capillary refill
- Cool extremities

- Treatment
  - Optimize preload
  - Inotropic support & afterload reduction
    - Dobutamine
    - NTP or Fenoldapam
    - Milrinone or Amrinone
    - Epi. & NTP
    - NE & phentolamine

Pediatric Trauma

- **Stabilization - Resuscitation**
- **Chest Trauma**
- **Abdominal Trauma**
- **Closed Head Injuries**
- **Cervical Spine Injuries**
- **Trauma Systems**
- **Injury Prevention!!!!!!**

Severe Traumatic Brain Injury Infants, Children, Adolescents

PREHOSPITAL MANAGEMENT

- Hypoxia
- Hypotension
- Mannitol/Osmotherapy: Herniation
- Hyperventilation: Unclear – More Harm than Good

GLASCOW COMA SCALE MODIFIED FOR CHILDREN

		Glascow Coma Scale	Modified Infant Score	
Eye Open.		Spont.	Spont	4
		Voice	Voice	3
		Pain	Pain	2
		None	None	1
Verbal	Resp.	Oriented	Coos	5
		Confused	Irrat, Cons.	4
		Inappropriate	Cries to Pain	3
		Garbled	Moans to Pain	2
		None	None	1

GLASCOW COMA SCALE MODIFIED FOR CHILDREN

Localize Pain	Withdraw to Touch	5
Withdraw to Pain	Withdraw to Pain	4
Flexion Posture	Flexion Posture	3
Extension Post.	Extension Post.	2
None	None	1

The Motor Response is the Most Reliable, Least Subjective. Best for Communication of Severity

Pediatric Trauma
Closed Head Injuries

- Major Cause of Pediatric Morbidity and Mortality
- A Preventable Cause of M & M
- Heterogeneous Disease Process
- ICP (Intracranial Pressure) Management has Evolved over Years, Hyperventilation Not First Line
- Surgical Approach More Aggressive: Ventriculostomy, Decompressive Craniectomy

Severe Traumatic Brain Injury
Infants, Children, Adolescents

Subdural Hematoma
MRI

Immediate Loss of Consciousness
Venous Oozing
Damaged Brain

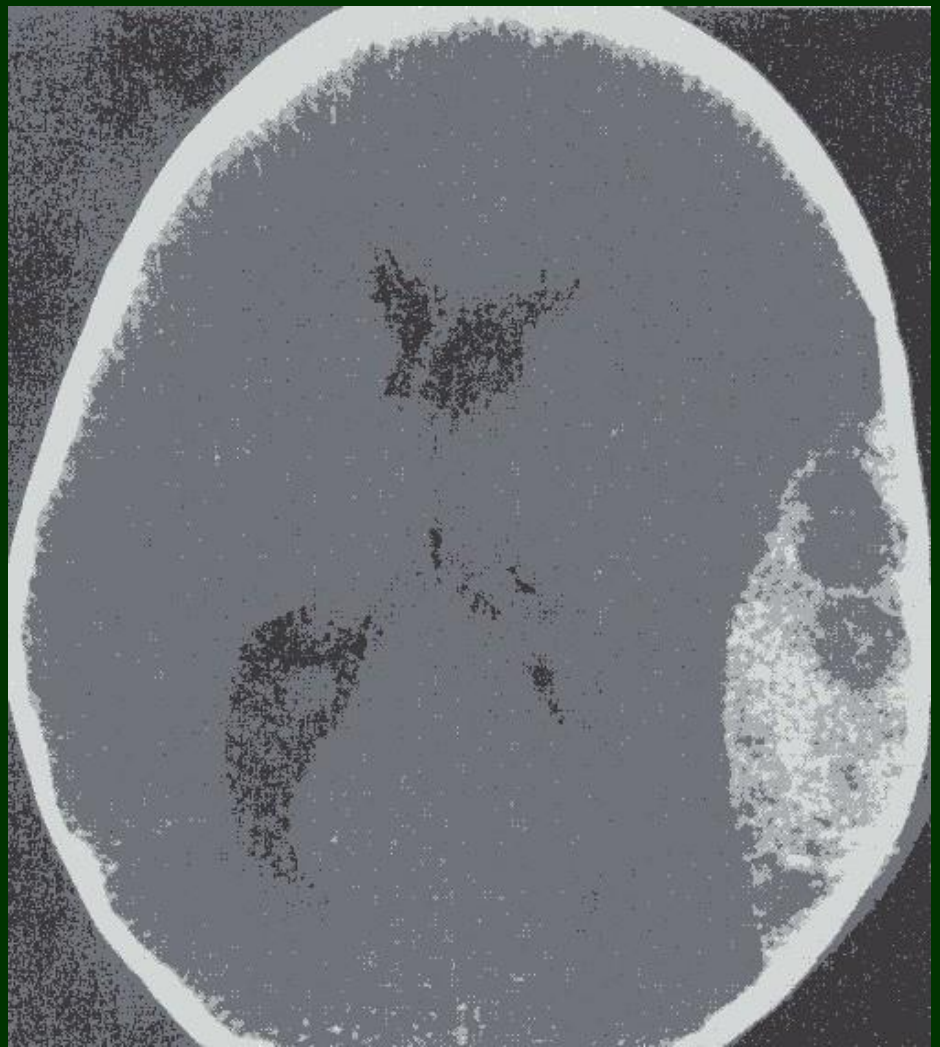
Severe Traumatic Brain Injury
Infants, Children, Adolescents

Epidural Hematoma

Lucid Interval

Arterial Blood High Press.

Compresses Normal Brain



Severe Traumatic Brain Injury Infants, Children, Adolescents

- 9 Studies, 518 Pedi Demonstrated Association ICP and Poor Neuro Outcome &/or Mortality
- 3 Different Strategies Similar Improvements: Decomp. Craniectomy, Hyperosmolar, Hyperventilation
- 2 Prospective Trials Decompression: NAT, P/R Trauma
- 3% Saline 68 Inf/Child, ICP $\leq$ 20: 15% Mort vs Hist 40% (Peterson, Kanna CCM 2000
- 85 Children Hypervent, Barbs, ICP $\leq$ 20: 9% Mort, 87.5% Good Outcome (Bruce Childs Brain 1979)
- Risk Population: 86% Child. GCS $\leq$ 8, ICP > 20.

Severe Traumatic Brain Injury Infants, Children, Adolescents

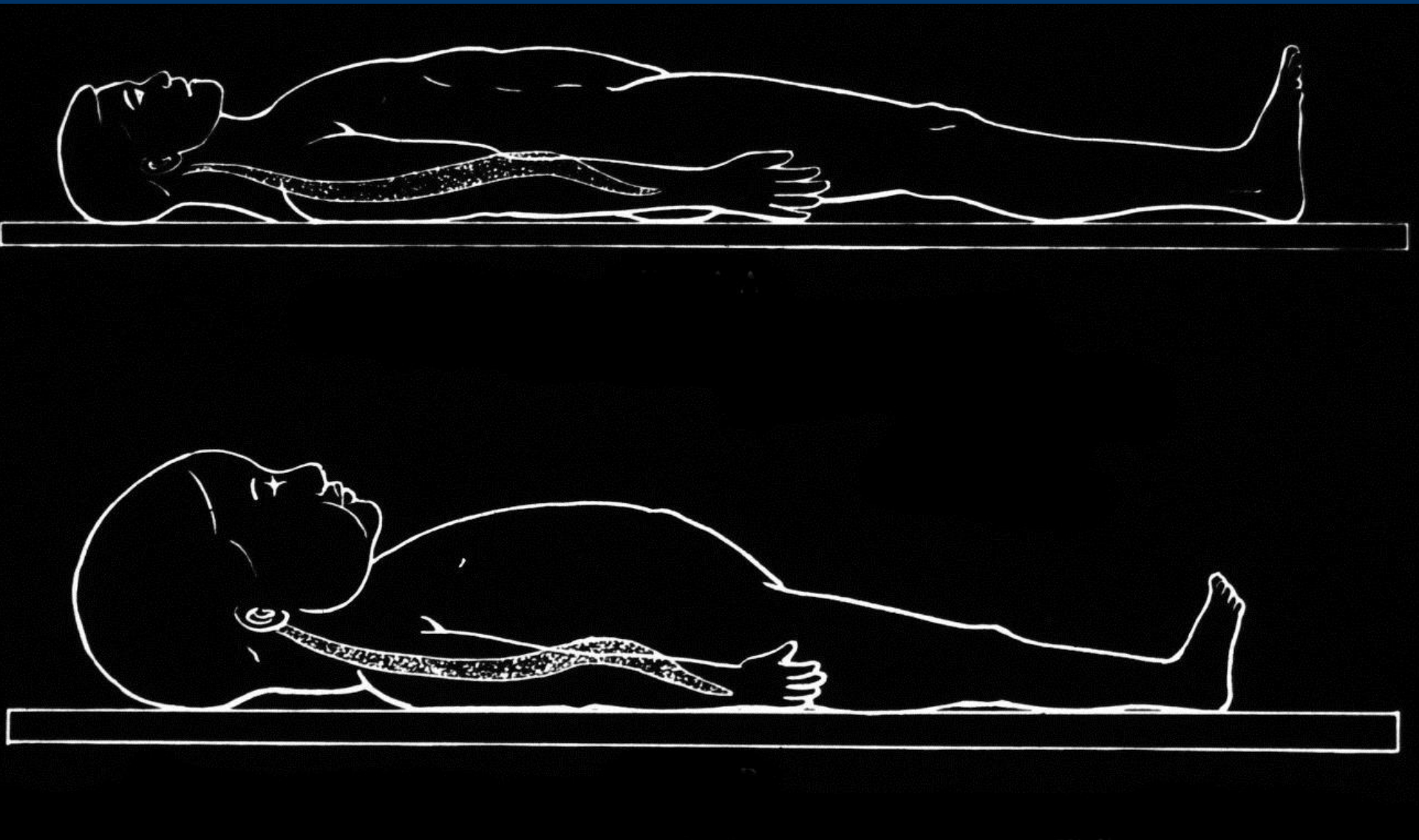
HYPERVENTILATION CONTROVERSIES

- Decreased ICP at Expense of Cerebral Blood Flow, Hyperemia May Be Desired
- Skippen, 1997 CCM, Demonstrated Regional Ischemia 3x with $PaCO_2 < 25$
- Stringer, 1993 AJNR, Hypoventilation Decreases CBF to both Injured and Non-Injured Brain
- Muizelaar, 1991 J Neurosurg, Prophylactic Hyperventilation ($PaCO_2 = 25$) Worse Clinical Outcome in Pts. GCS 4-5.

SCIWORA: **S**pinal **C**ord **I**njury **W**ith**O**ut **R**adiographic **A**bnormality

RELATIVE HEAD SIZE, ANGULATION

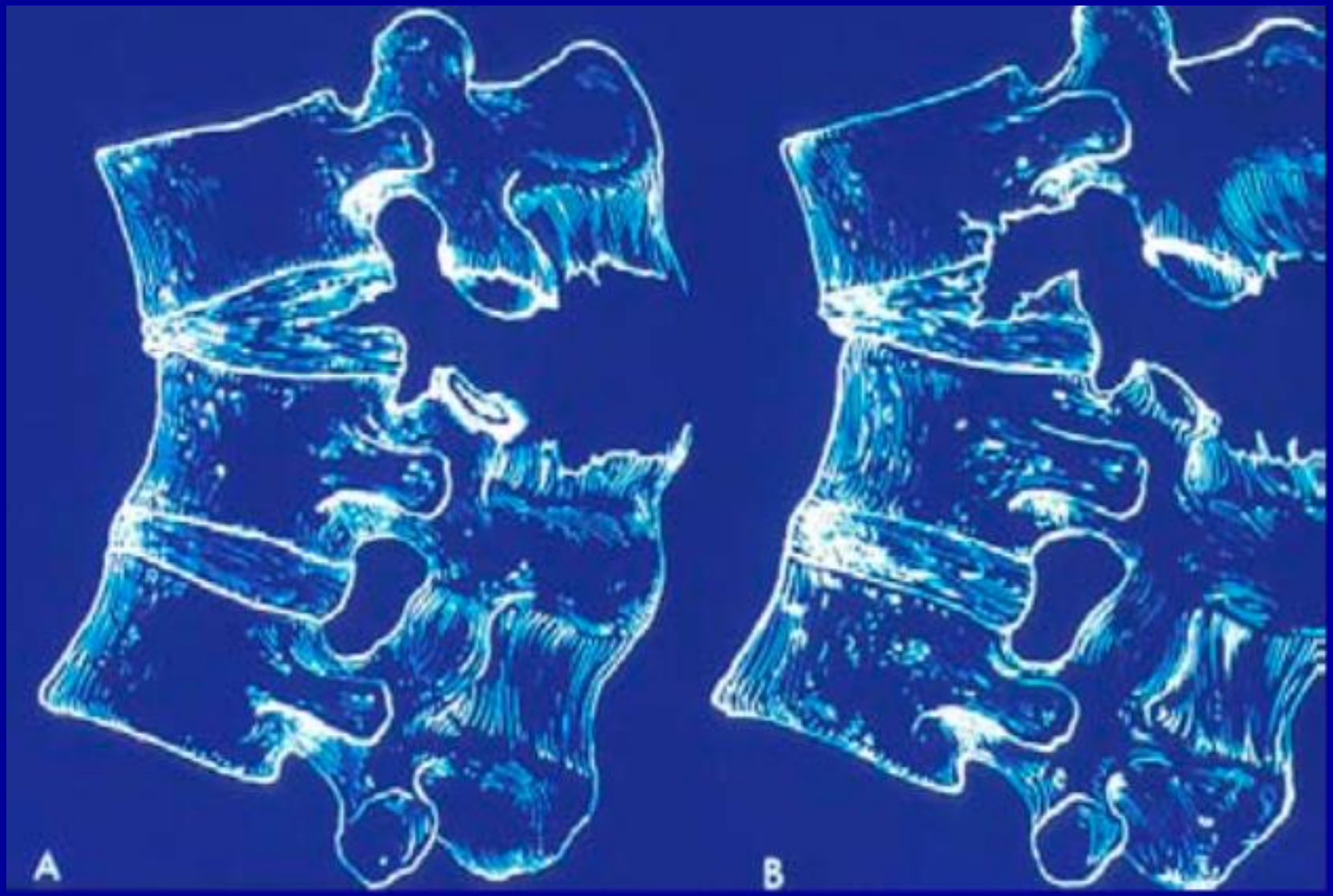
ADULT VS CHILD



SCIWORA Syndrome

- **Originally Described by Pang and Wilberger in 1982.**
- **Closed Spinal Trauma with Significant Neurologic Injury, Normal Spine Xrays**
- **Children at High Risk Due to Ligamentous Elasticity and Laxity, Mass of Cranium**
- **Common in Series of Children with Spinal Cord Injury**
- **Secondary Injury, or Recurrent Injury a Significant Risk, Preventable by Immobilization, Diagnosis**

SCIWORA Syndrome: Ligamentous Injury



SCIWORA: Incidence In Series Of Pediatric Spinal Cord Injury

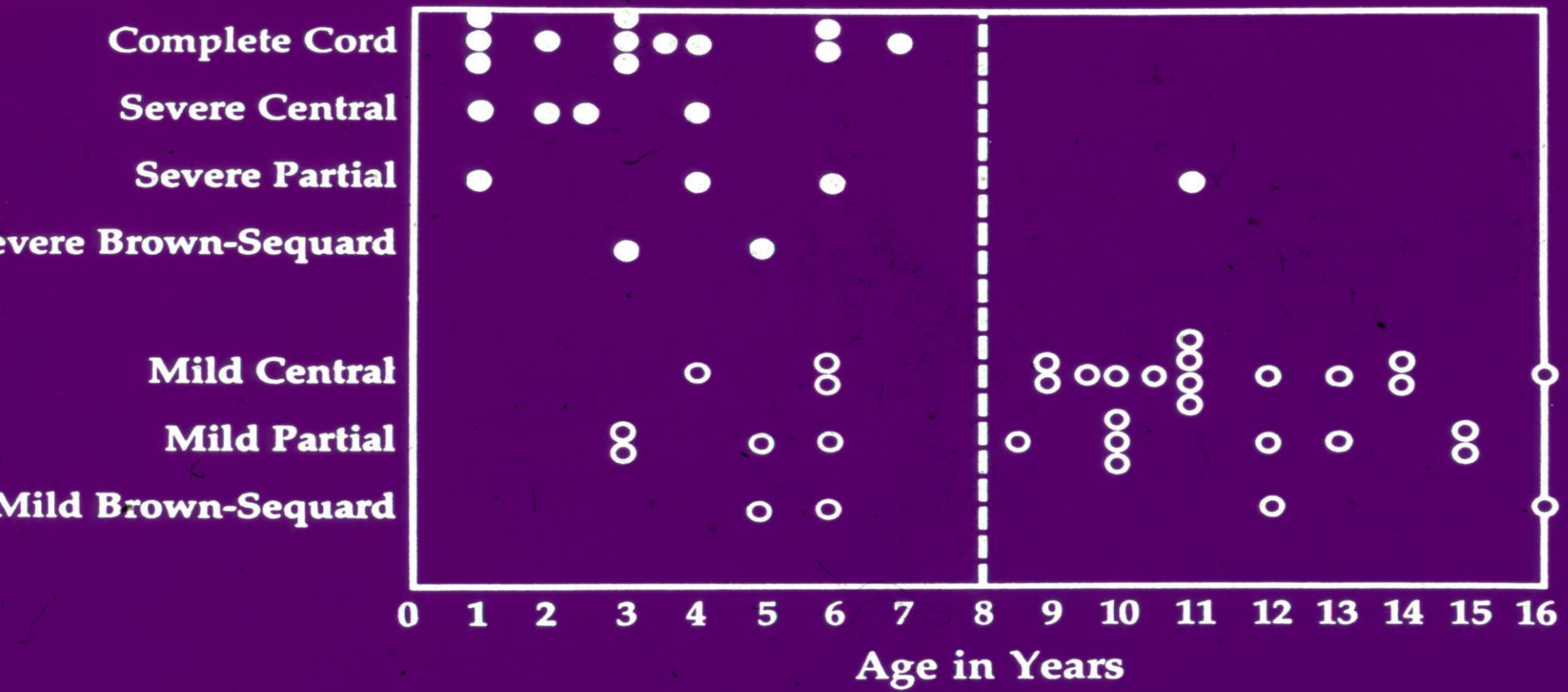
Melzak (1969)(33)	**55%**
Burke (1971)(38)	**50%**
Pang (1982) (36)	**67%**
Baker (1999) (72)	**56%**

Comparison of Children With Radiographic Evident Spine Injury and SCIWORA

- 72 Children, Ages 1 Month to 15 Years, Primary Children's Hospital, 1989 – 1994
- 40 RESI, 32 SCIWORA
- Sports, MVA and Falls Most Common
- Midline Cervical Tenderness Common, in Absence of **Distracting Injury**

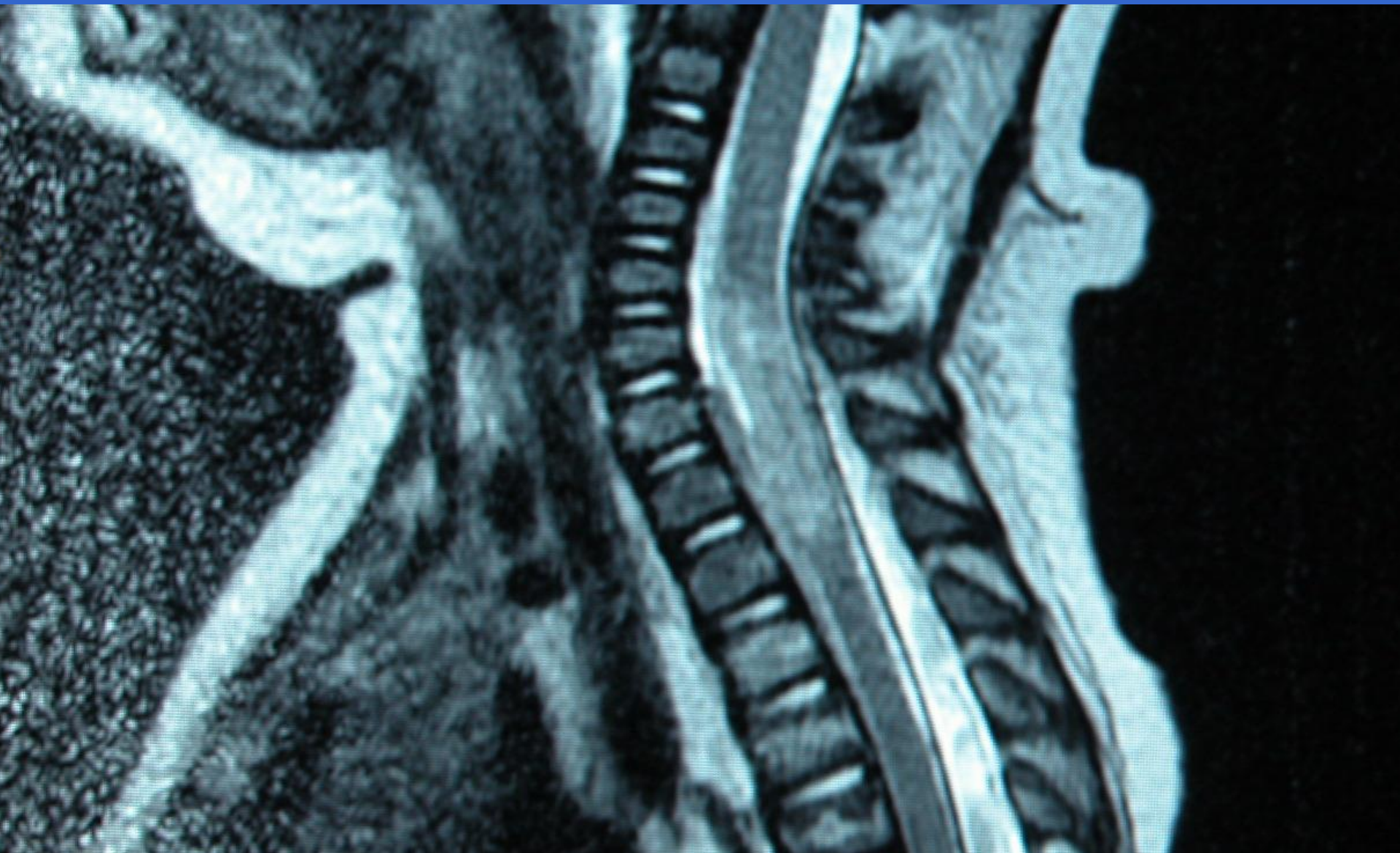
Baker C, et al, Am J Emerg Med. 1999

SCIWORA: Extent of Injury vs. Age



SCIWORA: 1 YEAR OLD, CORD CONTUSION

MRI , C-COLLAR IN PLACE



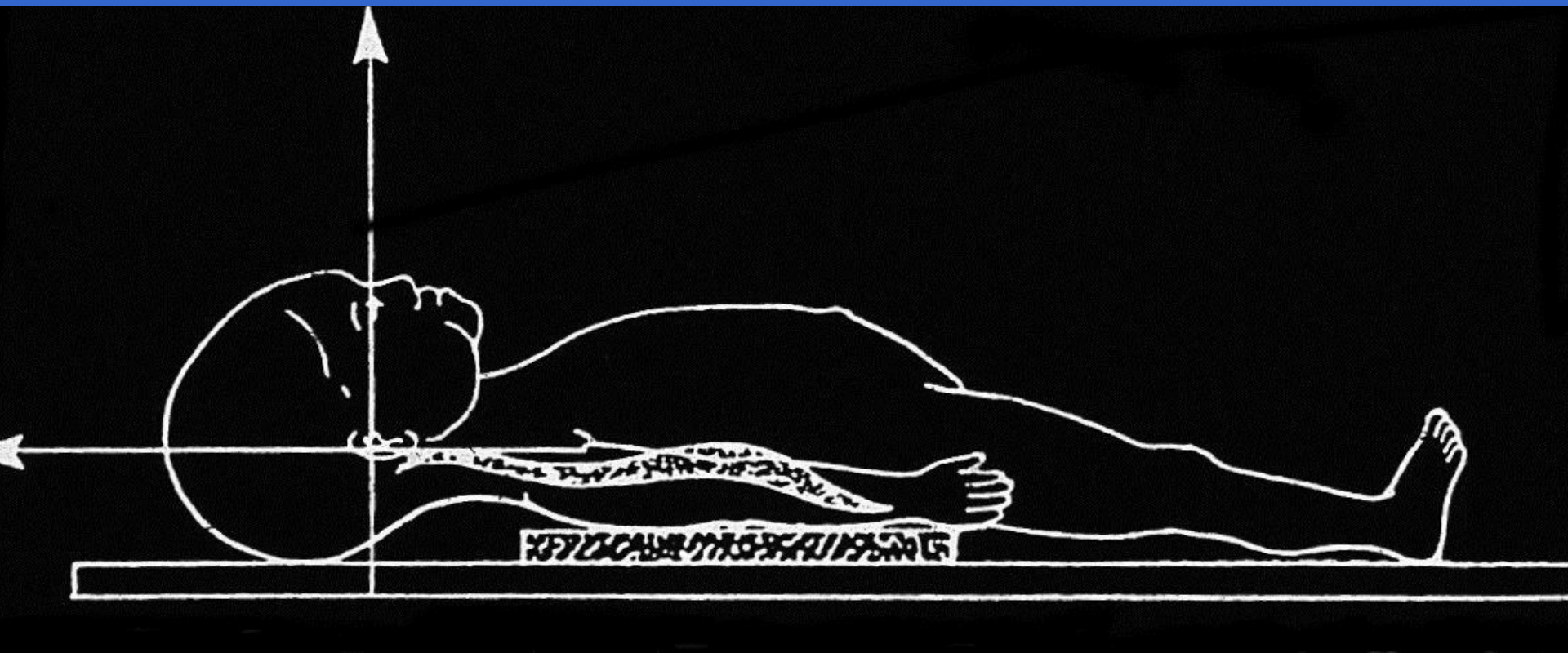
SCIWORA: Delayed Deterioration

- Series of Pang and Pollack, *J. Trauma*, 1989
- 55 Children, 15 with Delayed Deterioration
- 8 Children Suffered “Second” SCIWORA: 3 Days to 10 Weeks After Initial Injury (5 Within 1 Week)

C-SPINE STABILIZATION IN CHILDREN

PROPER ALIGNMENT, BACK ELEVATION

HAVE CHILD GAZE PERPENDICULAR TO BOARD/SPINE AXIS



C-SPINE FILMS IN CHILDREN
IMPROPER ALIGNMENT
RISK OF SECONDARY INJURY

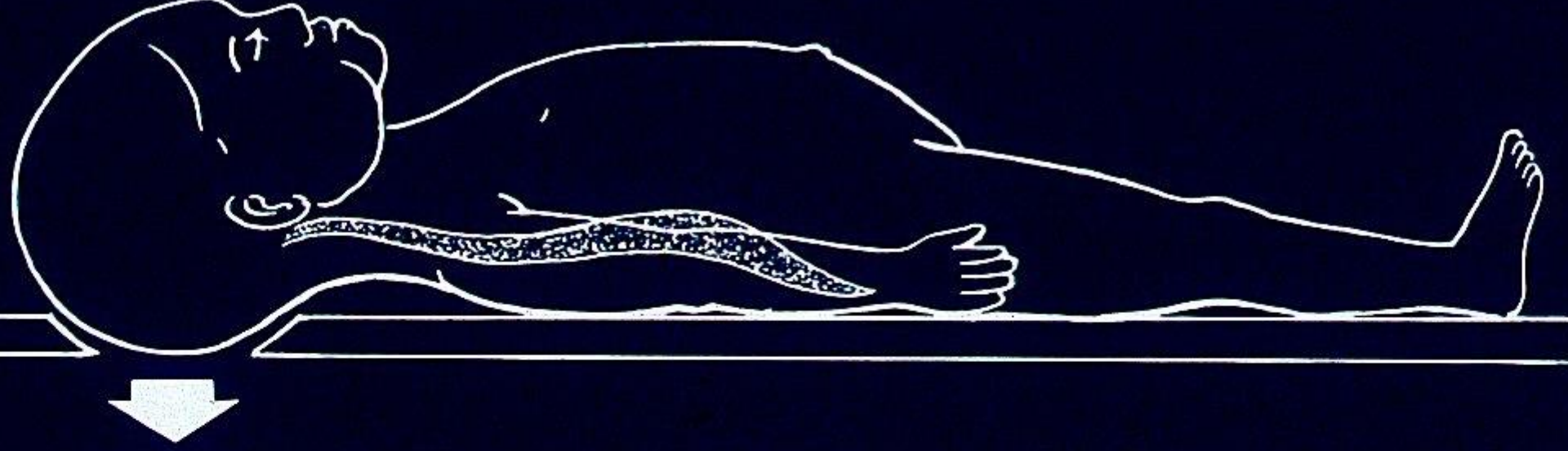


FIG. 6-A

a modified backboard that has a cut-out to recess the occiput, obtaining safe supine cer

FIG. 6-B

C-SPINE FILMS IN CHILDREN PROPER ALIGNMENT, LESS RISK OF SECONDARY INJURY

SCIWORA: Approach

- Key to Diagnosis is Suspicion
- Immobilize All Children at Risk
- Can Not Clear C-Spine Under 8 Years with a Lateral Neck Xray
- Maintain C-Spine Immobilization Until Cleared: Either Clinically, MRI, Flex-Ext Films
- Distracting Injuries Prevent the Clearance Based on Absence of Cervical Tenderness (CLINICAL), or Presence of Pain Meds

PEDIATRIC TRAUMA ABDOMINAL INJURIES

- Approach to Pediatric Abdominal Trauma Based More on Clinical Status than Radiology/DPL
- Free Air
- Specific Patterns: Belt Injury, Handlebars
- CT usually Initial Exam
- Ultrasound

PEDIATRIC TRAUMA
CHEST TRAUMA

- Mechanism: Blunt vs Penetrating
- Hemothorax
- Pneumothorax
- Pulmonary Contusion
- Pericardial Tamponade
- Myocardial Contusion
- Vascular Injuries

Summary

- Transporting critically ill children requires a systematic approach
- Attention to details will help to avoid adverse events
- Be prepared before you move
- Minimize major interventions in ambulance or helicopter
- It’s all about the ABC’s