



Infant Morbidity and Mortality: The Role of Regionalized EMS and Trauma System Response

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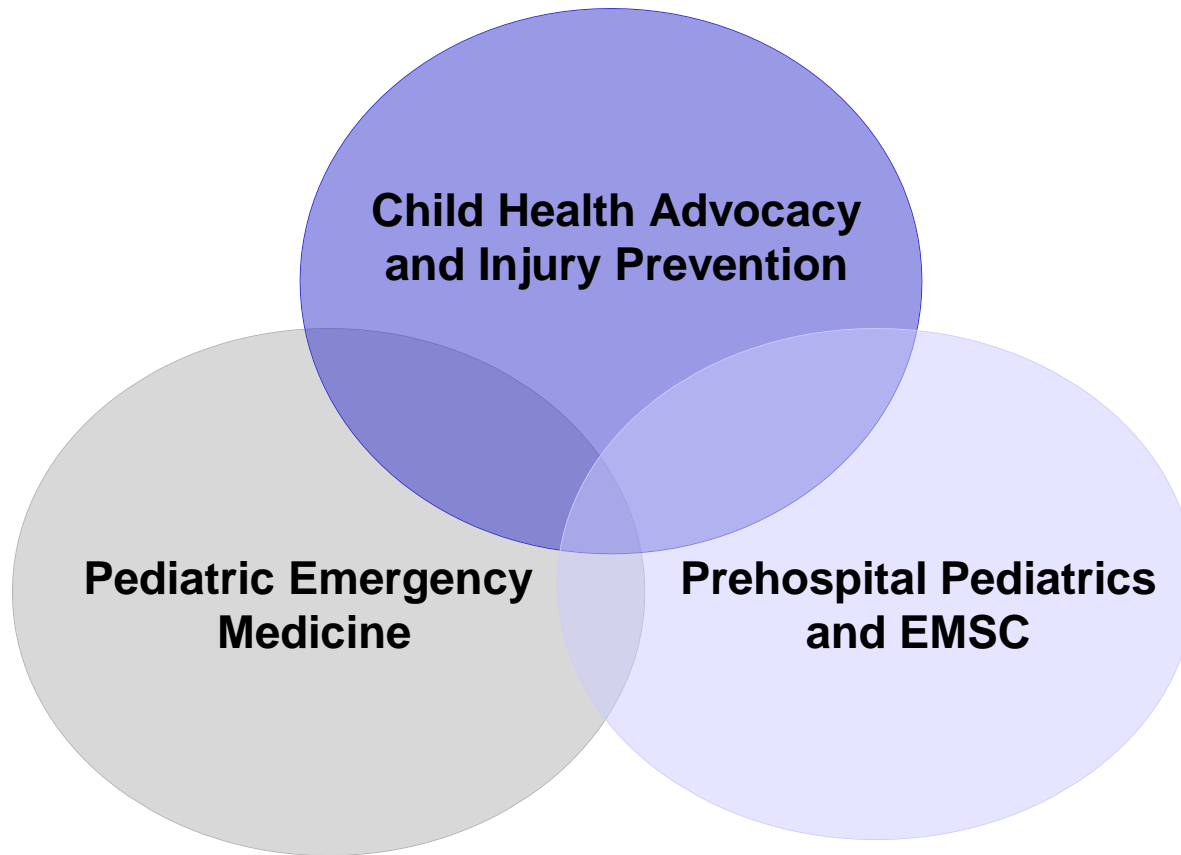
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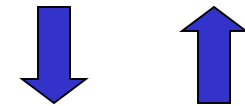
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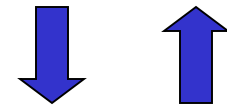
Role of Regionalized System Response: Context and Acknowledgements



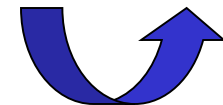
- Emergency Medicine and Trauma Center @ Children's National Medical Center



- Maryland Institute for Emergency Medical Services (MIEMSS)



- Child Health Advocacy Institute and the Emergency Medical Services for Children (EMSC) program



Role of Regionalized System Response



- **Definition(s)**
- **Case Example**
- **Evidence**
- **Protocols**



Skylar Grayce Jarreau



- “In September of 2003 my 8 month old child, Skylar Grayce, sustained an abdominal injury as a result of an adult tripping and falling on her. Shortly after the accident Skylar began demonstrating signs of shortness of breath. I immediately took her to our pediatrician. He examined her briefly and requested she be directly admitted to our local hospital for observation and x-rays...we [eventually] learned that Skylar sustained an internal abdominal injury requiring surgical repair. Our local hospital did not have pediatric surgeons on staff nor a pediatric intensive care unit. Therefore, it was decided that it would be in Skylar’s best interest to transfer her to a hospital with resources that could better accommodate her unique pediatric needs...I never fathomed that our local hospital would not be equipped to provide my child with the appropriate life sustaining treatment necessary for her to overcome injuries sustained in an accident. However, it was a lack of planning and preparation that ultimately cost my daughter her life...Skylar’s death did not result from the accident. It was the result of precious time lost in her treatment. She died of heart failure caused by the stress placed on her heart when her body went into septic shock during the ten hour wait for treatment. This loss of life could have been prevented had Skylar received the proper medical care in a timely fashion”.



- Melanie Grayce, MBA

Chair, Louisiana EMSC Advisory Council

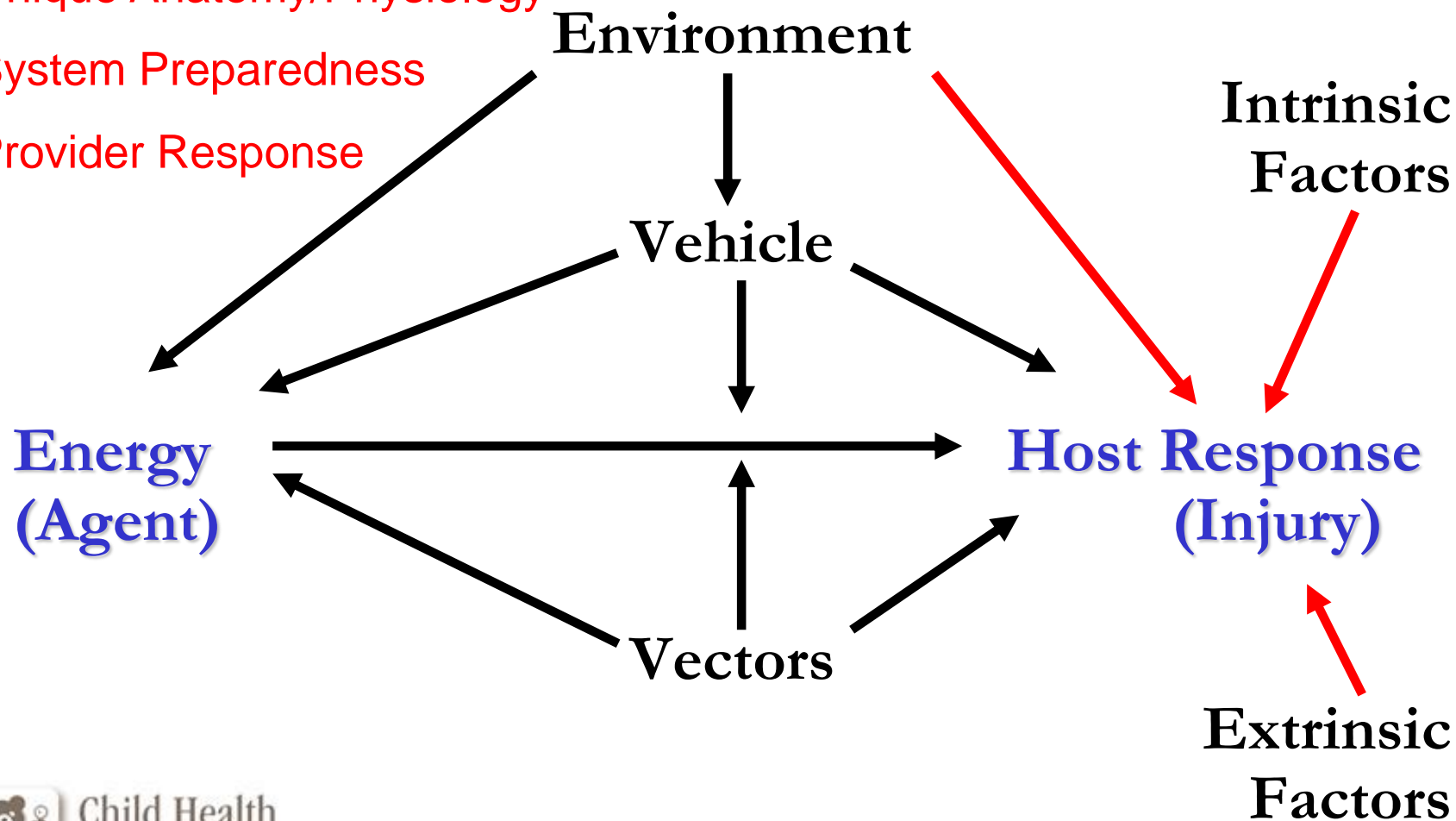


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Epidemiologic Model of Injury: Application to Response to Infants



- Unique Anatomy/Physiology
- System Preparedness
- Provider Response



Framework for Categorizing Injury Control Factors



	Host	Agent	Physical Env't	Social Env't
Pre-Event				
Event				
Post-Event				Emergency Medical Response

Haddon's Matrix

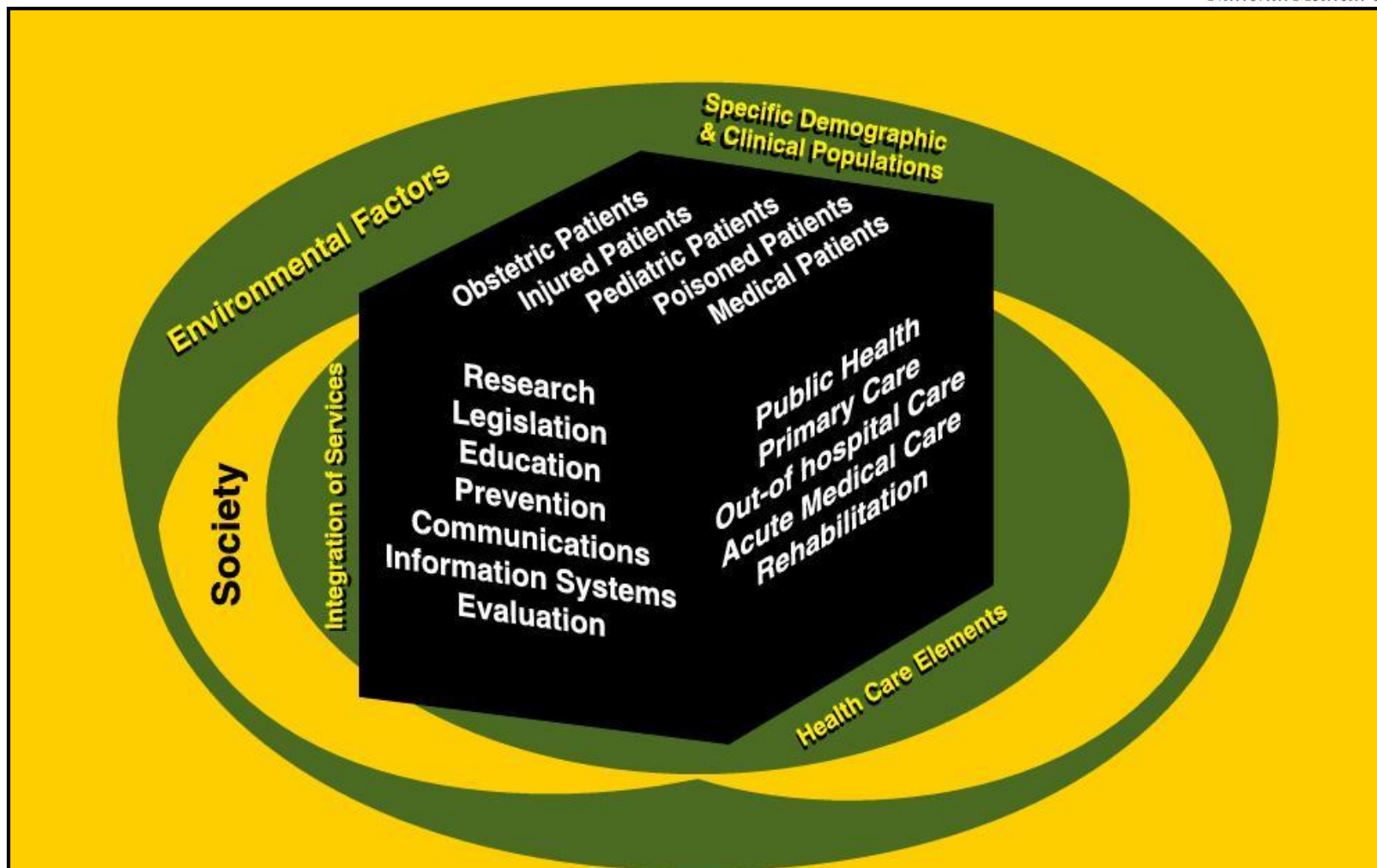


Technical Strategies for Injury Control



- **Begin to counter the damage already done by the environmental hazard; e.g. “Place emergency response teams near areas with high injury rates”**

Emergency Medical Services: Part of the Public Health System of Care



EMS: Part of the Health Care System



EMSC Continuum of Care

- *Prevention*
- **Bystander**
- **Prehospital**
- **Transport**
- **Definitive Care**
- **Rehabilitation**
- *Postvention*



Prehospital Pediatrics



- The goal of prehospital care is to minimize further systemic insult or injury through a series of well-defined and appropriate interventions, and to embrace principles that ensure patient safety.
- Integral to this process is medical oversight of prehospital care by preexisting evidence-based protocols (indirect medical oversight) or by physician via voice and/or video communication (direct medical oversight).



Regionalization



- **Geographically organized system of services that ensures access to trauma care at a level appropriate to patient needs, while maintaining efficient use of the available resources.**
- **An *inclusive* trauma system refers to a model in which all acute care hospitals participate in providing care to all injured patients. An *exclusive* system limits treatment of seriously injured patients to a restricted number of centers.**



Ten Leading Causes of Infant Death



- Congenital Anomalies 20.1%
 - Short Gestation 16.6%
 - SIDS 8.0%
 - Pregnancy Comp. 6.1%
 - **Unintentional Injury** 3.8%
 - Unknown Cause 3.7%
 - Placenta/Cord/Memb. 3.7%
 - Respiratory Distress 3.1%
 - Bacterial Sepsis 3.0%
 - Neonatal Hemorrhage 2.2%
- }
- **Transportation-related**
 - Drowning
 - Bites/stings by animals
 - Fire and burns
 - Poisoning
 - Environmental exposures
 - Inhalation of gastric contents
 - Inhalation of food/obstructive objects
 - Other obstructions of respiratory tract
 - Caught, crushed, jammed or pinched

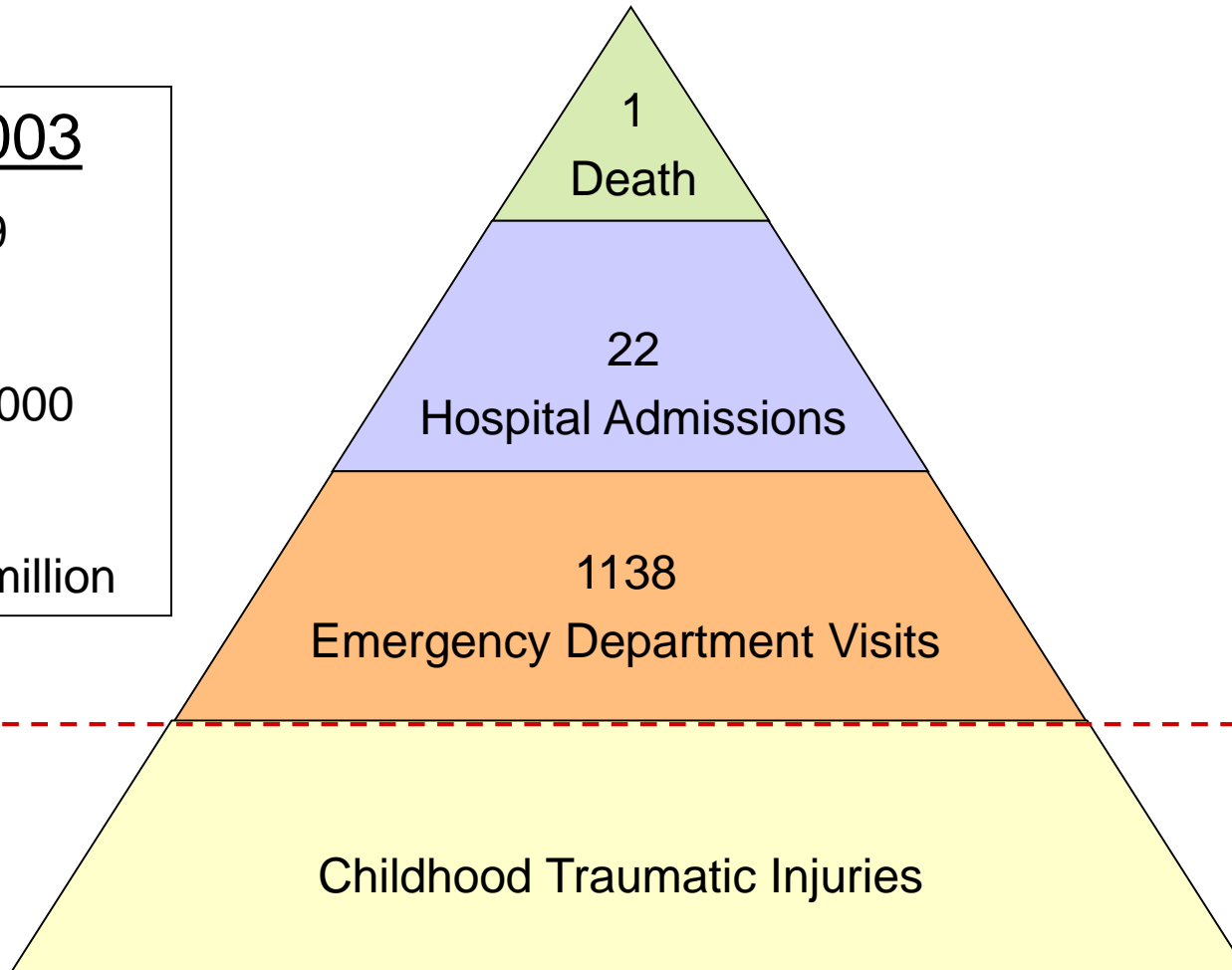


Traumatic Injury and Children



2003

- 7469
- 161,000
- 8.5 million



Injury Rates 0-17 years: ICD9-CM codes 800-959

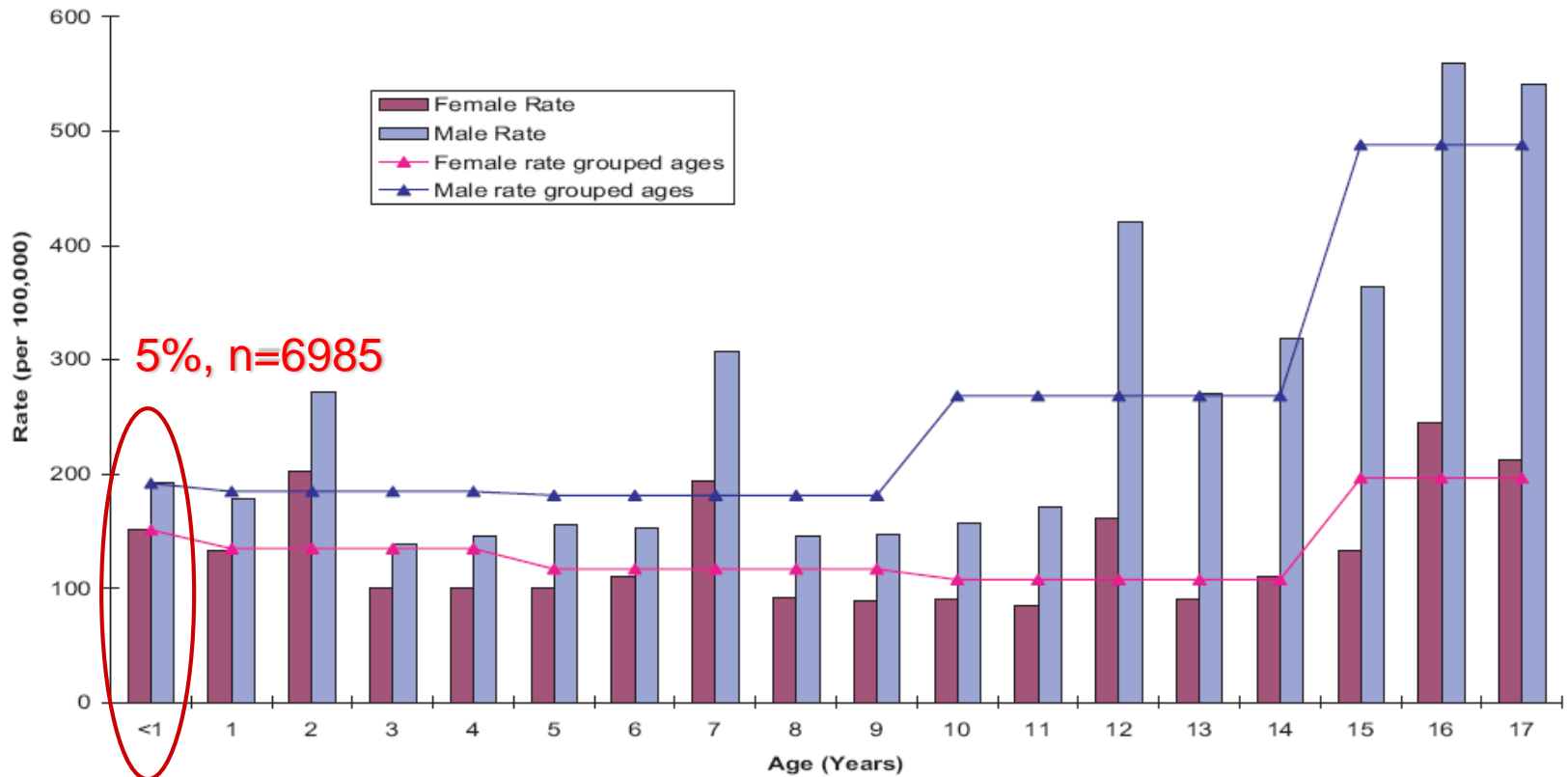


Fig. 1. Rate of injury by sex and age.

Guice, et al. *Jour Trauma* 2007;63:S68-S80



Unique Infant Head and Neck Anatomy

- Large head, thin skull
- Incomplete uncinate processes
- Flat horizontal vertebral facets
- Elastic supporting ligaments
 - Hypermobility
 - High fulcrum, i.e. C2-C3
 - ↑ Energy transfer to brain, i.e. TBI



Central Nervous System Trauma drives Injury Severity in Infants

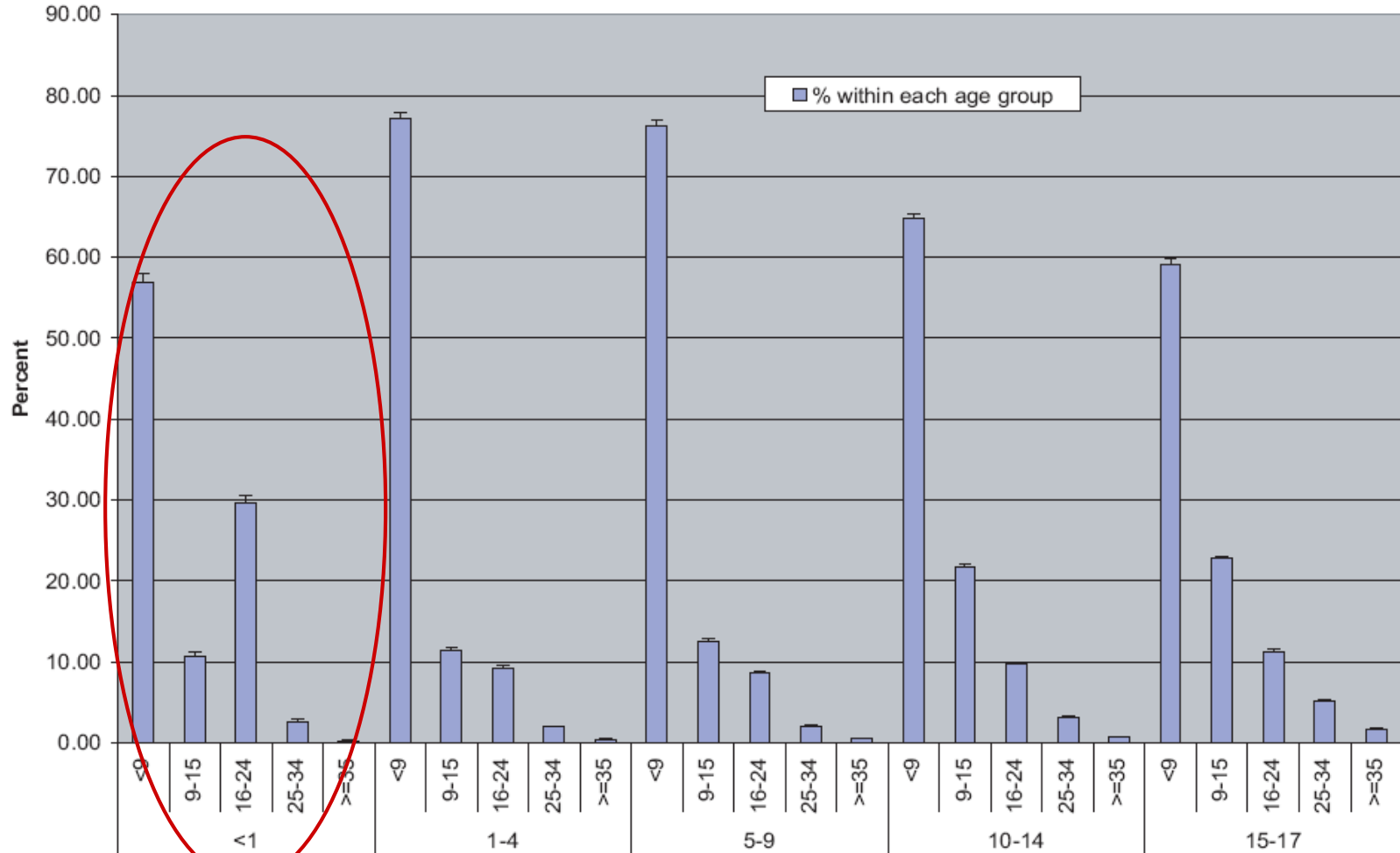


Fig. 3. ISS by age group.

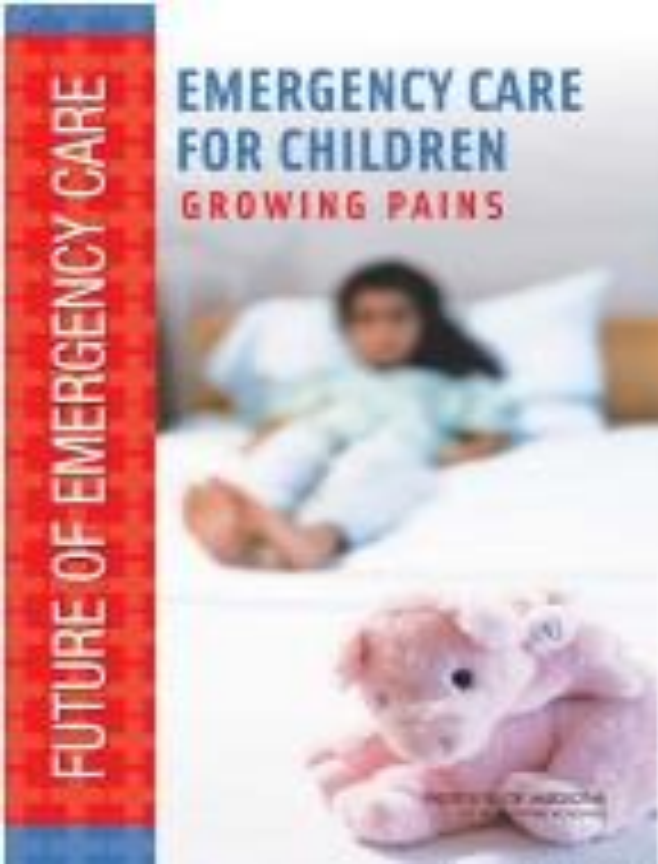
Guice, et al. *Jour Trauma* 2007;63:S68-S80

Role of Regionalized System Response



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Institute of Medicine 2006

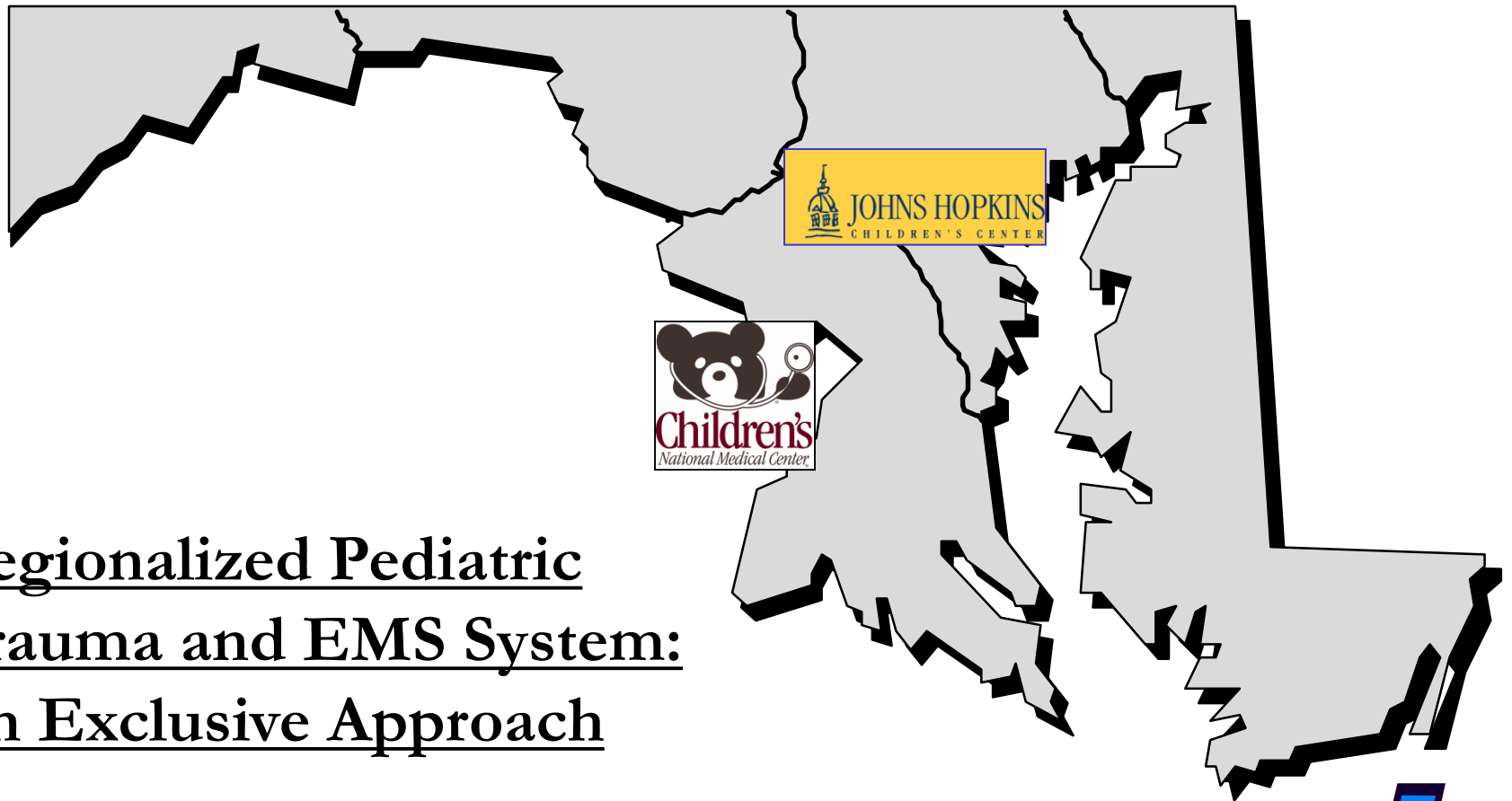


Overarching Recommendation: Incorporation of Pediatric Concerns

- “Congress should establish a demonstration program, administered by the Health Resources and Services Administration, to promote regionalized, coordinated and accountable emergency care systems throughout the country”.



Maryland Institute for Emergency Medical Services Systems (MIEMSS)



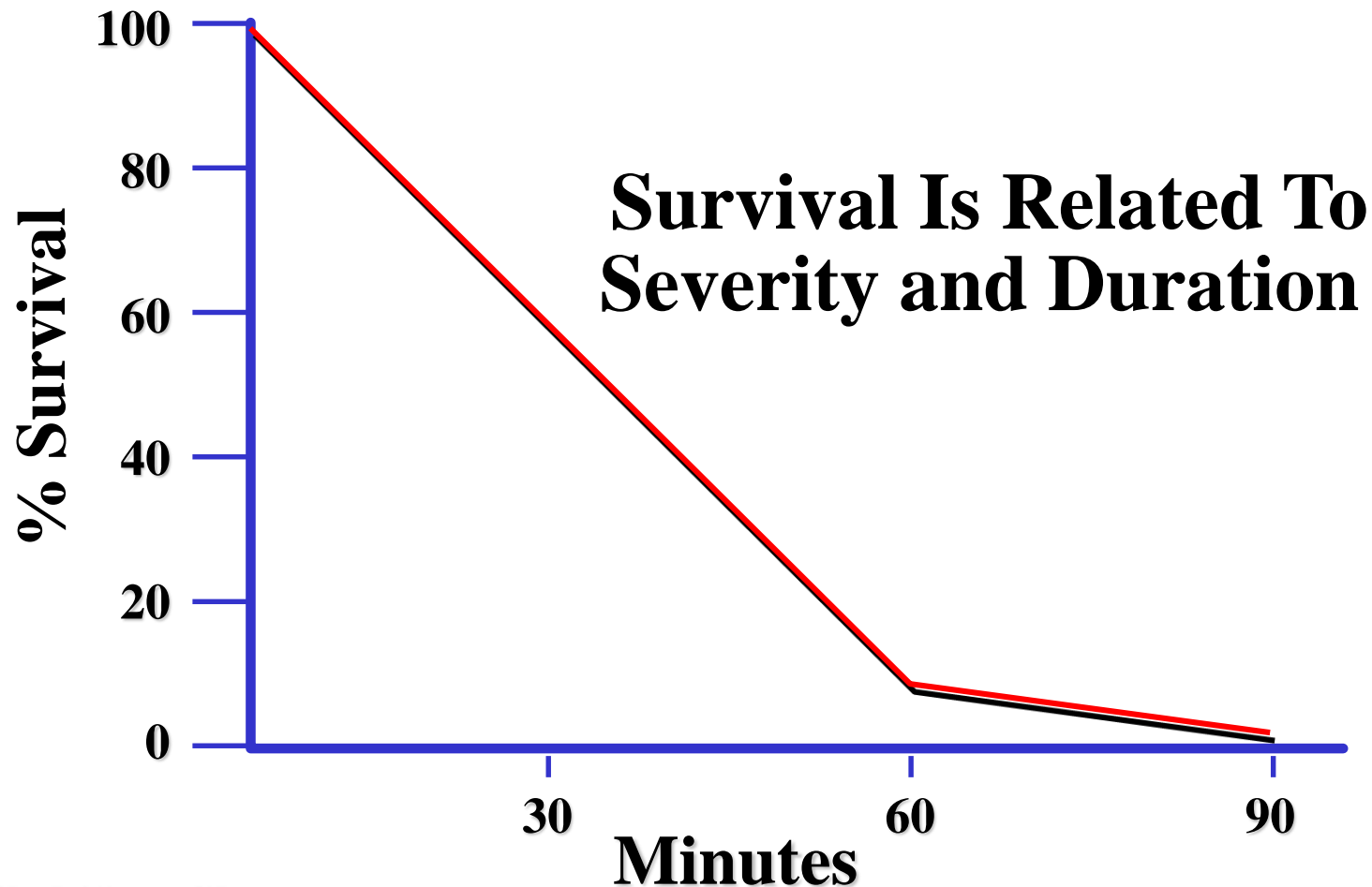
Regionalized Pediatric
Trauma and EMS System:
An Exclusive Approach



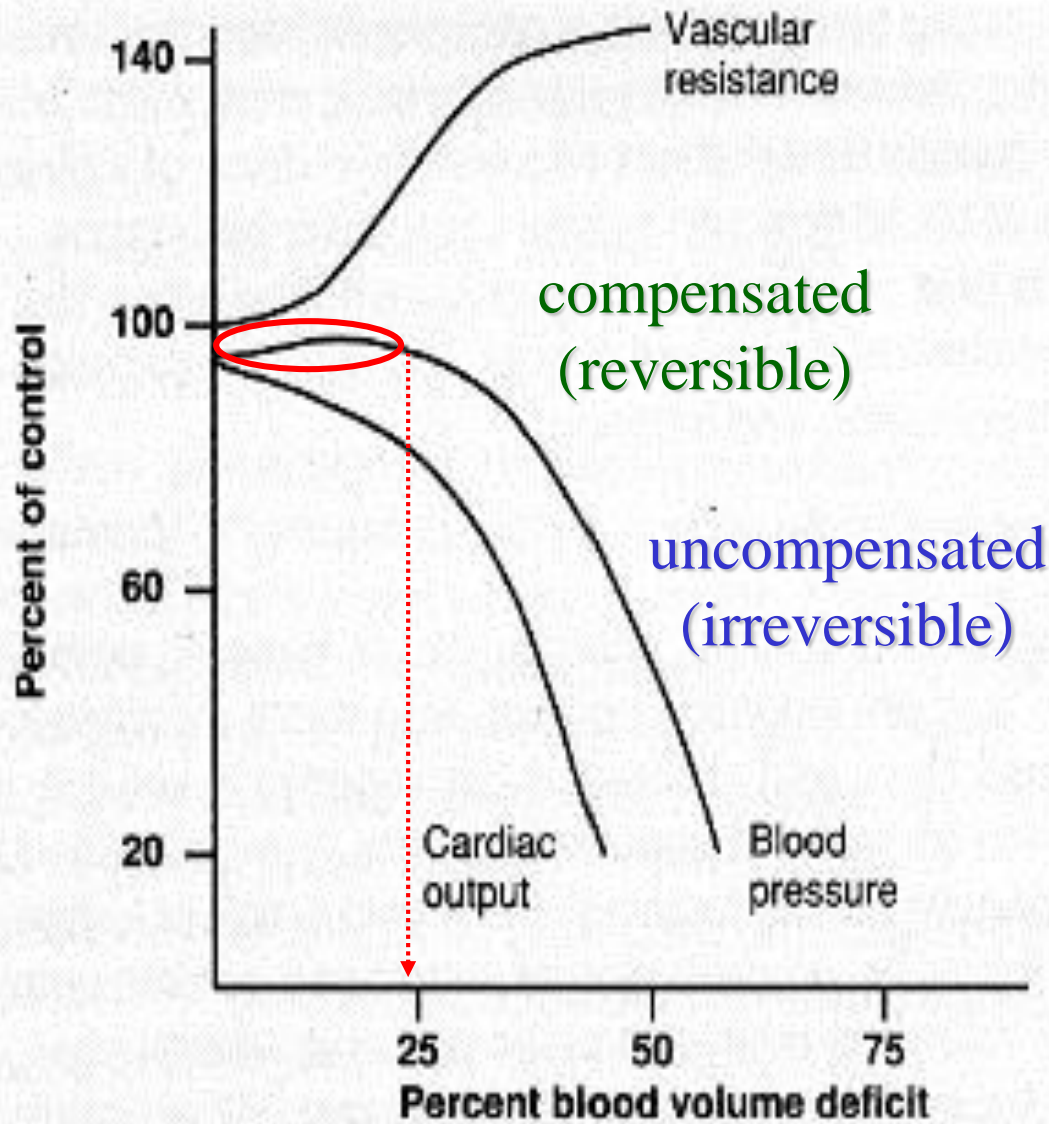
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The Golden Hour: Probability of Survival



Hemodynamic Response to Hemorrhage



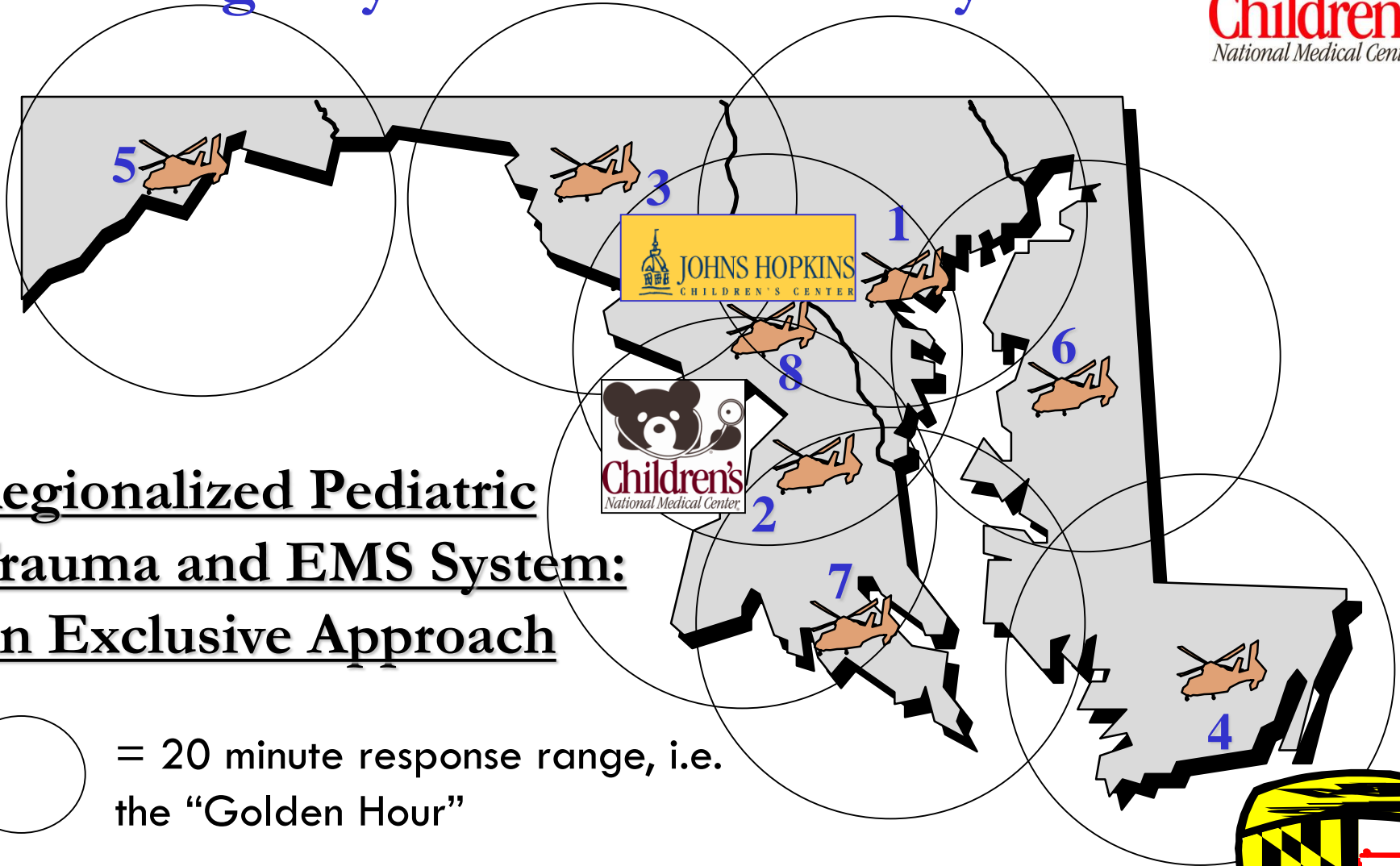
Hypovolemic Shock



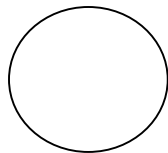
Schwaitzberg, et al. *J Pediatr Surg* 1988;23:605-9

Fig 3. Model for cardiovascular response to hypovolemia from hemorrhage (based on normative data).¹⁰

Transport Approach: Maryland Institute for Emergency Medical Services Systems



Regionalized Pediatric Trauma and EMS System: An Exclusive Approach

 = 20 minute response range, i.e. the "Golden Hour"



MIEMSS: Pediatric Transport Experience



- **Infants represent 10% of ~40,000 annual EMS pediatric transports**
- **Infant transports are 75% medical; injury-related transports are led by:**
 - **Motor Vehicle Crashes - 7% (of total infant transports)**
 - **Falls - 6% (of total infant transports)**
- **In 2007, 52 of 149 (35%) trauma transports of infants to the EMTC at CNMC had severe head injury**



Case Example: EMS called...



- “My one month old baby was bitten about the scalp by one of our dogs” (a dachshund)
- Scene Assessment: Alert, Awake, crying
 - A: Open, patent
 - B: Spontaneous
 - C: Strong, palpable pulse, color pale
- Estimated blood loss approx 100cc



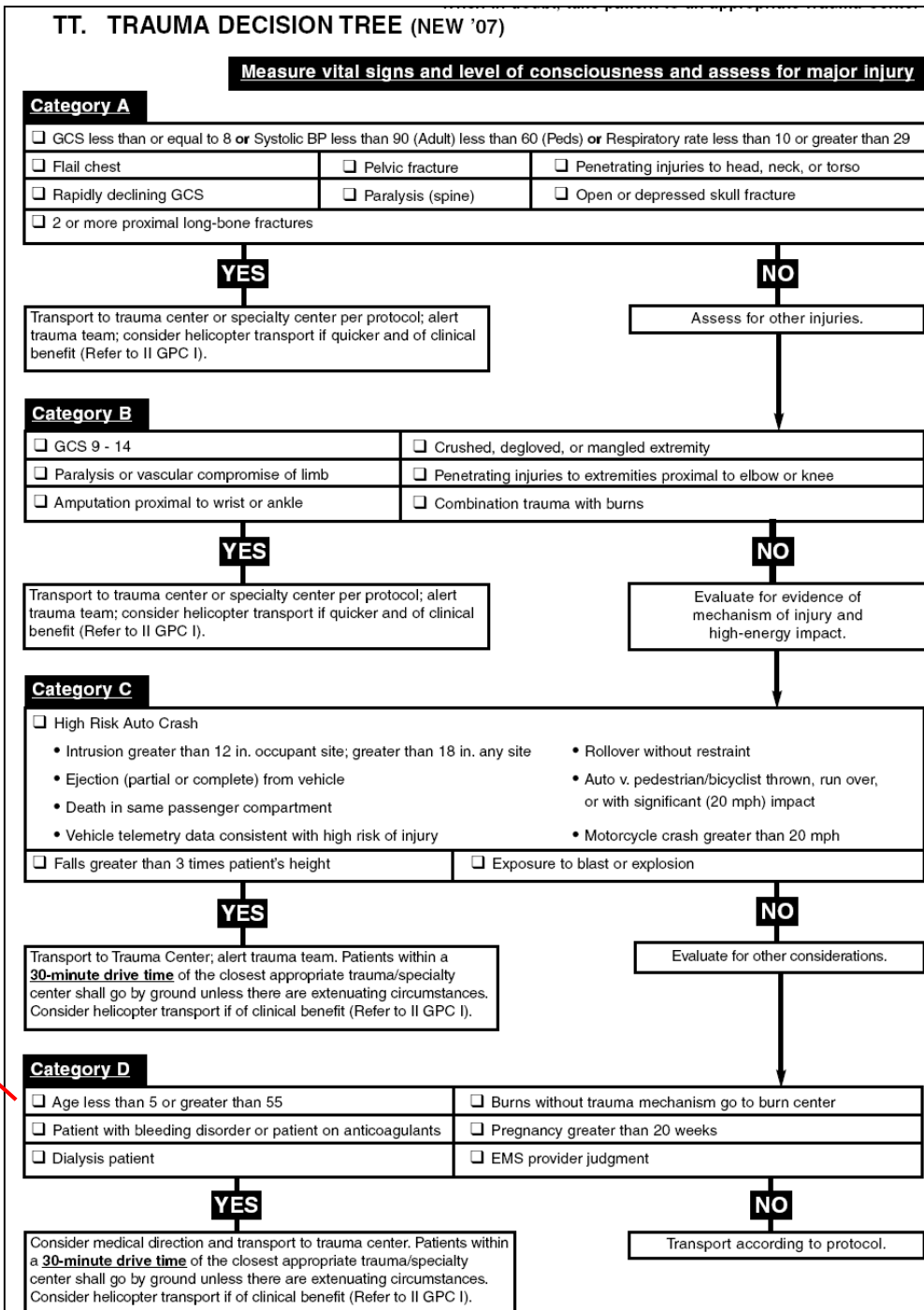
Case Progression

- **Pediatric Trauma Center consulted**
- **Helicopter dispatched**
- **Ongoing Assessment:**
 - Looking around
 - Breathing spontaneously
 - Circulation - HR 150-160s



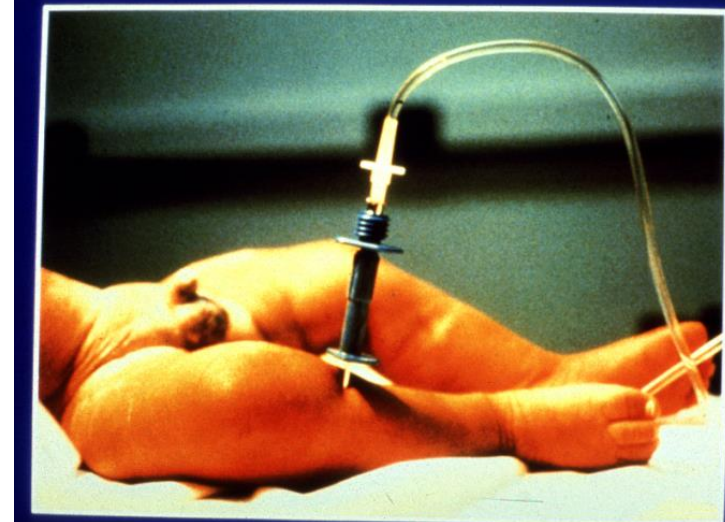
Trauma Decision Tree: Infants a “no-brainer”

“Age less than 5,
...consider medical
direction and transport
to the closest,
appropriate trauma
center”



Sudden Slide Down the Slippery Slope

- Change in condition on helipad; trauma team waiting in code room
 - Reassessment: weight = 3 kg
 - A: Intubated
 - B: no spontaneous RR
 - C: HR 66, BP 33/16
-
- ✓ No palpable pulses, CPR
 - ✓ Epi given via endotracheal tube
 - ✓ Intraosseous access established
 - ✓ Volume and Epi #2 given via IO
 - ✓ Return of Spontaneous Circulation



Denouement: Unique physiology



- Hypovolemic shock from scalp lac (contrary to popular ATLS belief); i.e. infant blood volume $80\text{-}90\text{cc}/\text{kg} \times 3 \text{ kg} = 270 \text{ cc}$
- Intense peripheral vasoconstriction challenges intravenous vascular access; IO placement an acquired skill
- Loss of chronotropic-dependent compensatory mechanisms; limited ventricular compliance of immature myocardium



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National Study on Costs and Outcomes of Trauma (NSCOT)



- “Significantly lower risk of death for injured patients receiving care at designated trauma center hospitals. Further regionalization is needed”.

MacKenzie EJ, Rivara FP, et al. *N Engl J Med* 2006;354:366-78

- Analysis limited to patients age 18 to 84
- Survival the principal outcome measure



Skamania Conference 1998: Academic Symposium to Evaluate Evidence Regarding the Efficacy of Trauma Systems



- **Regionalized trauma systems reduce risk of mortality from motor vehicle crashes (MVC) by 9%.**
- **Age stratified analysis reveals most beneficial effect of trauma system presence conferred upon 0-14 year age group, i.e. 17% MVC mortality reduction.**
- **Statistically significant declines not realized until at least 13 years of system maturity.**

Journal Trauma 1999;47:suppl



Regionalized Pediatric Trauma Systems: Do they make a difference?



- Reviews:

- Wright J, Klein B. *Clin Pediatr Emerg Med* 2001;2:3-12
- Morrison W, Wright J, Paidas C. *Crit Care Med* 2002;30:S448-56
- Junkins E, O'Connell, Mann N. *Clin Pediatr Emerg Med* 2006;7:76-81

- Injured infants and children treated at pediatric trauma centers appear to have better outcomes and overall survival rates compared to adult trauma centers, particularly for isolated head injury and in the youngest age groups.

However, the evidence is neither conclusive nor methodologically rooted in functional outcomes that may be most germane to pediatric quality-of-life.



Pediatric Trauma Care: Defining A Research Agenda



- **Consensus conference sponsored by AHRQ and HRSA/MCHB/EMSC, March 2007**
- **Proceedings published in December 2007
Journal of Trauma supplement**
- **Focus on appropriate outcomes and design for a pediatric NSCOT-like study:**
 - Measures of morbidity
 - Functional outcomes following TBI
 - Family level quality-of-life measures



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Prehospital Pediatrics: Medical Oversight



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Tackling TBI: Pediatric Rapid Sequence Intubation (RSI)



20. A PROSPECTIVE EVALUATION OF THE ABILITY OF PARAMEDIC RAPID SEQUENCE INTUBATION (RSI) TO CORRECT PEDIATRIC HYPOXIA AND HYPOVENTILATION Morgen J. Bernius, Doug J. Floccare, Jeremy T. Cushman, *University of Maryland Medial System, Baltimore, Maryland*

Introduction: The purpose of this study is to evaluate the effectiveness of paramedic RSI as a tool for treatment of respiratory insufficiency in children. There have been a number of studies performed to evaluate the effect of paramedic RSI on mortality. The immeasurable confounding factors in these outcome studies make it difficult to clearly assess the role of RSI in prehospital care. Our study evaluates protocol-driven RSI as a tool to facilitate both placement of an artificial airway and to ensure adequate oxygenation and ventilation in the hypoxic or hypoventilated pediatric

- **MIEMSS Pilot Protocol since 1998**
- **N = 90 patients [0-17 yrs]**
- **Mean pre-intervention:**
 - GCS = 5.2
 - O₂ sat=85.7%
- **96% received endotracheal tubes**

Apparent Life Threatening Event (ALTE)

- The history of an apparent life threatening event (ALTE) must always result in transport to an emergency department regardless of the infant's appearance at the time of EMS assessment.



D. APPARENT LIFE-THREATENING EVENT (ALTE)

1. Initiate General Patient Care.
2. Presentation
An episode in an infant or child less than 2 years old that is frightening to the observer and is characterized by some combination of the following:
 - a) Apnea (central or obstructive)
 - b) Skin color change: cyanosis, erythema (redness), pallor, plethora (fluid overload)
 - c) Marked change in muscle tone
 - d) Choking or gagging not associated with feeding or a witnessed foreign body aspiration



MOST PATIENTS WILL APPEAR STABLE AND EXHIBIT A NORMAL PHYSICAL EXAM UPON ASSESSMENT BY RESPONDING FIELD PERSONNEL. HOWEVER, THIS EPISODE MAY BE THE SIGN OF UNDERLYING SERIOUS ILLNESS OR INJURY. FURTHER EVALUATION BY MEDICAL STAFF IS REQUIRED AND IT IS ESSENTIAL TO TRANSPORT ALL PATIENTS WHO EXPERIENCED ALTE.

3. Treatment
 - a) Perform an initial assessment utilizing the Pediatric Assessment Triangle.
 - b) Obtain a description of the event including nature, duration, and severity.
 - c) Obtain a medical history with emphasis on the following conditions:
 - (1) Known chronic diseases
 - (2) Evidence of seizure activity
 - (3) Current or recent infections
 - (4) Gastroesophageal reflux
 - (5) Recent trauma
 - (6) Medications (current or recent)
 - d) Apply Oxygen.
 - e) Be prepared to assist with ventilation if this type of episode occurs again during transport.
 - f) Assess environment for possible causes.



- g) Place patient on cardiac monitor.
- h) Consider initiating an IV/IO of LR KVO.



IF THE PARENT OR GUARDIAN REFUSES MEDICAL CARE OR TRANSPORT, PROVIDER SHALL CONTACT A **PEDIATRIC BASE STATION PHYSICIAN**.

The Role of Regionalized EMS and Trauma System Response: Observations



- The epidemiologic impact of traumatic injury in infancy is not trivial; there is a disproportionate burden of severe CNS injury.
- Unique anatomic and physiologic attributes render infants at particular risk for adverse outcomes in systems of response inadequately prepared to address these special needs.
- Per the IOM, the HRSA/MCHB/EMSC program is suitably positioned to advocate for research & evaluation, infrastructure development and policy support to ensure the proper care and safety of infants in the national EMS system



Thank You



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