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

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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
Epidemiologic Model of Injury: Application to Response to Infants

- Unique Anatomy/Physiology
- System Preparedness
- Provider Response
Framework for Categorizing Injury Control Factors

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Haddon. *Journal of Trauma* 1972;12:197-207
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
EMSC Continuum of Care

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

Integrals 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

1 Death
22 Hospital Admissions
1138 Emergency Department Visits

Childhood Traumatic Injuries

- CDC, NCIPC and NCHS
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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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”.
Regionalized Pediatric Trauma and EMS System: An Exclusive Approach
The Golden Hour: Probability of Survival

Survival is related to severity and duration.

Cowley RA. *Md State Med Jour* 1975;24:37-45
Hypovolemic Shock

Fig 3. Model for cardiovascular response to hypovolemia from hemorrhage (based on normative data)."
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
“Age less than 5, ...consider medical direction and transport to the closest, appropriate trauma center”

Maryland Medical Protocols for EMS Providers. MIEMSS, Baltimore 2007
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 80-90cc/kg x 3 kg = 270 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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• “Significantly lower risk of death for injured patients receiving care at designated trauma center hospitals. Further regionalization is needed”.


➢ 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:**

- 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

Journal Trauma 2007;63:suppl
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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.

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**Tackling TBI: Pediatric Rapid Sequence Intubation (RSI)**

MIEMSS Pilot Protocol since 1998

- N = 90 patients [0-17 yrs]

- Mean pre-intervention:
  - GCS = 5.2
  - $O_2$ sat=85.7%

- 96% received endotracheal tubes

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**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 patient.

*Prehospital Emergency Care* 2007;11:102
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.

Maryland Medical Protocols for EMS Providers. MIESSS, Baltimore 2007
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