Pediatric Mild Traumatic Brain Injury: Transfer Management

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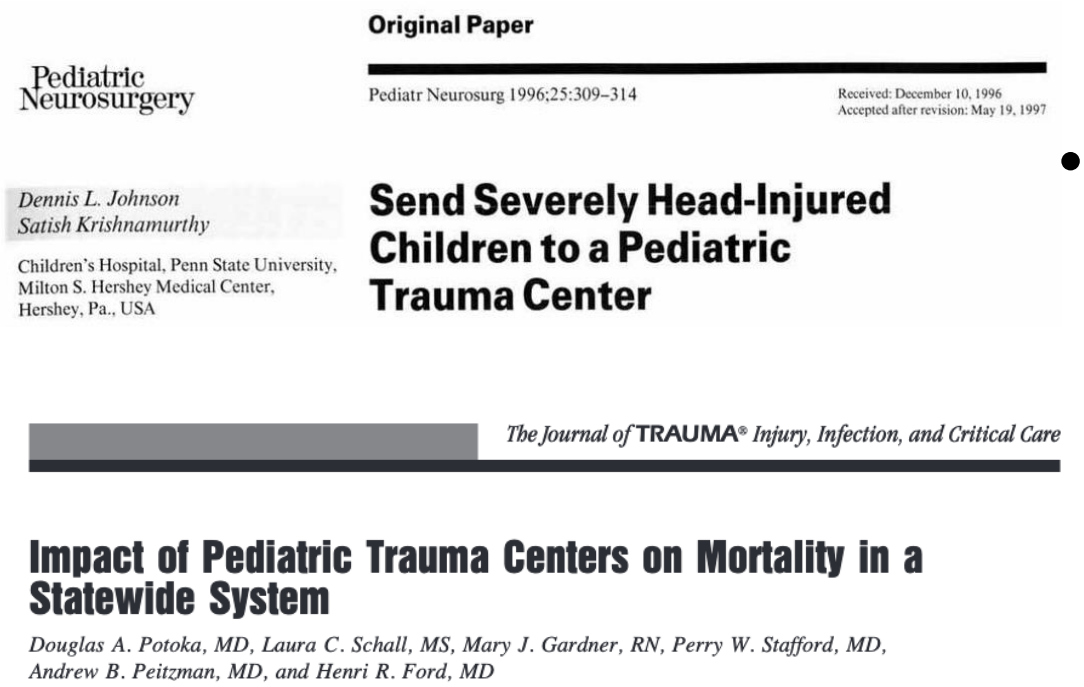
Traumatic Brain Injury

- 475,000 annual pediatric TBI case per year
- 70-90% are discharged with mild injuries
- 37,000 hospitalization
- 2,675 deaths
- Lifelong Disability
  - 61% of children with moderate to severe TBI
  - 14 % with mild TBI
- If presenting with GCS 3-4
  - 56% will die within one year

CDC

Pediatric vs Adult Trauma Centers



Original Paper

Pediatric Neurosurgery

Pediatr Neurosurg 1996;25:309–314

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Accepted after revision: May 19, 1997

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Send Severely Head-Injured Children to a Pediatric Trauma Center

The Journal of TRAUMA® *Injury, Infection, and Critical Care*

Impact of Pediatric Trauma Centers on Mortality in a Statewide System

Douglas A. Potoka, MD, Laura C. Schall, MS, Mary J. Gardner, RN, Perry W. Stafford, MD, Andrew B. Peitzman, MD, and Henri R. Ford, MD

- In 1990s and early 2000 there was improved survival in Pediatric trauma at Pediatric Trauma Center vs. Adult Trauma Centers

Pediatric vs Adult Trauma Centers

ORIGINAL ARTICLE

Big children or little adults? A statewide analysis of adolescent isolated severe traumatic brain injury outcomes at pediatric versus adult trauma centers

Brian W. Gross, Mathew M. Edavettal, MD, PhD, Alan D. Cook, MD, Cole D. Rinehart, Caitlin A. Lynch, Eric H. Bradburn, DO, MS, Daniel Wu, DO, *and* Frederick B. Rogers, MD, MS, *Lancaster, Pennsylvania*

ORIGINAL CONTRIBUTION **Open Access**

Outcomes of pediatric severe traumatic brain injury patients treated in adult trauma centers with and without added qualifications in pediatrics — United States, 2009

Fernando Ovalle Jr[1,2], Likang Xu[1], William S Pearson[1], Bridget Spelke[1] and David E Sugerman[1*]

- Later study showed no difference in mortality between Adult and pediatric trauma centers

Pediatric vs Adult Trauma Centers

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- PA Trauma database- 15-17yo -2003-2015
- 1100 severe TBI
- Adjusted control for (age, shock index, GCS, Trauma center level), case volume and year
  - No difference in mortality or complication between pediatric or adult centers

Pediatric vs Adult Trauma Centers

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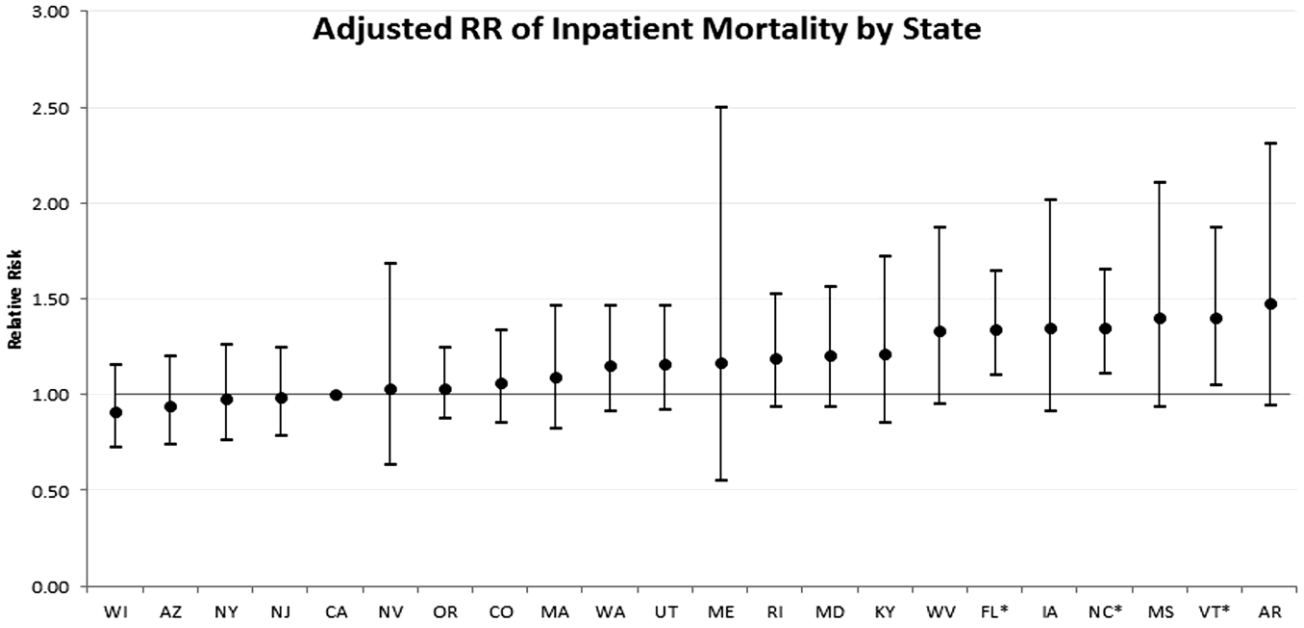
Fernando Ovalle Jr[1,2], Likang Xu[1], William S Pearson[1], Bridget Spelke[1] and David E Sugerman[1*]

- NTDB in 2009 for severe TBI- 7,000 pediatric severe TBI
  - 49.5% at ATC-AQs; 50.5% at ATC
  - Mortality (no difference
    - 8.6% at ATC-Aqs
    - 10.3 % at ATCs
  - Mortality was associated with
    - Age, length of stay, firearm and GCS
    - Uninsured (aOR 2.1)
    - Other injuries (aOR 1.9)

Traumatic Brain Injury

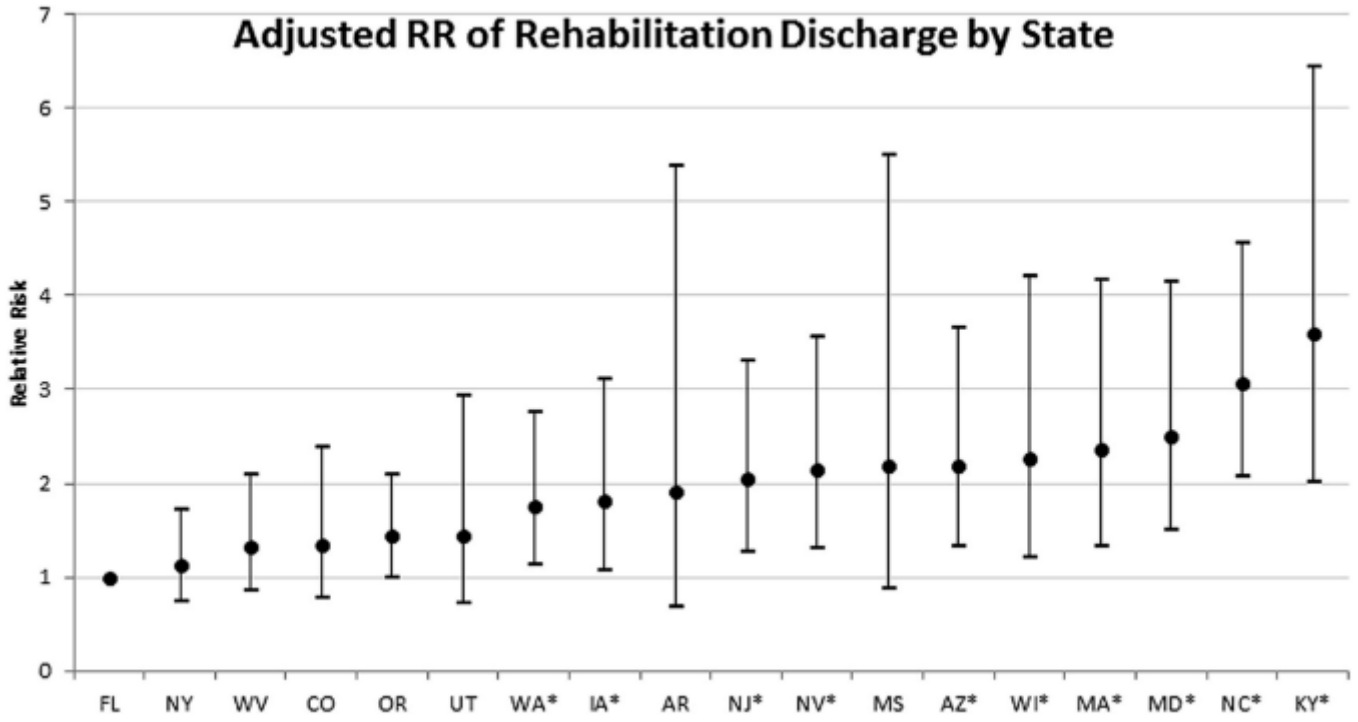
- Variation in Mortality between States



Greene, N.H., Kernic, M.A., Vavilala, M.S., and Rivara, F.P. (2014). Variation in pediatric traumatic brain injury outcomes in the United States. *Archives of Physical Medicine and Rehabilitation* 95(6): 1148-1155.

Traumatic Brain Injury

- Variation in Rehabilitation between States



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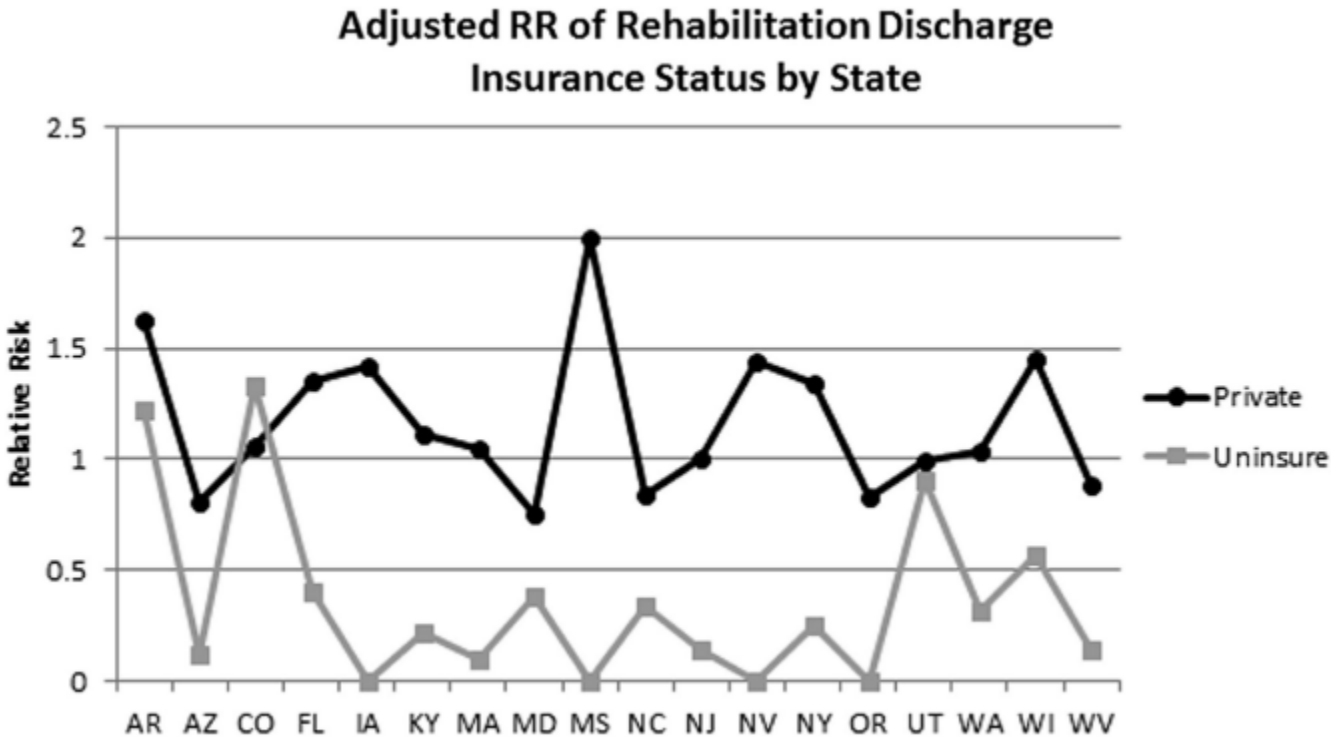
Traumatic Brain Injury

- Great Variation in Rehabilitation between States



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Pediatric Triage

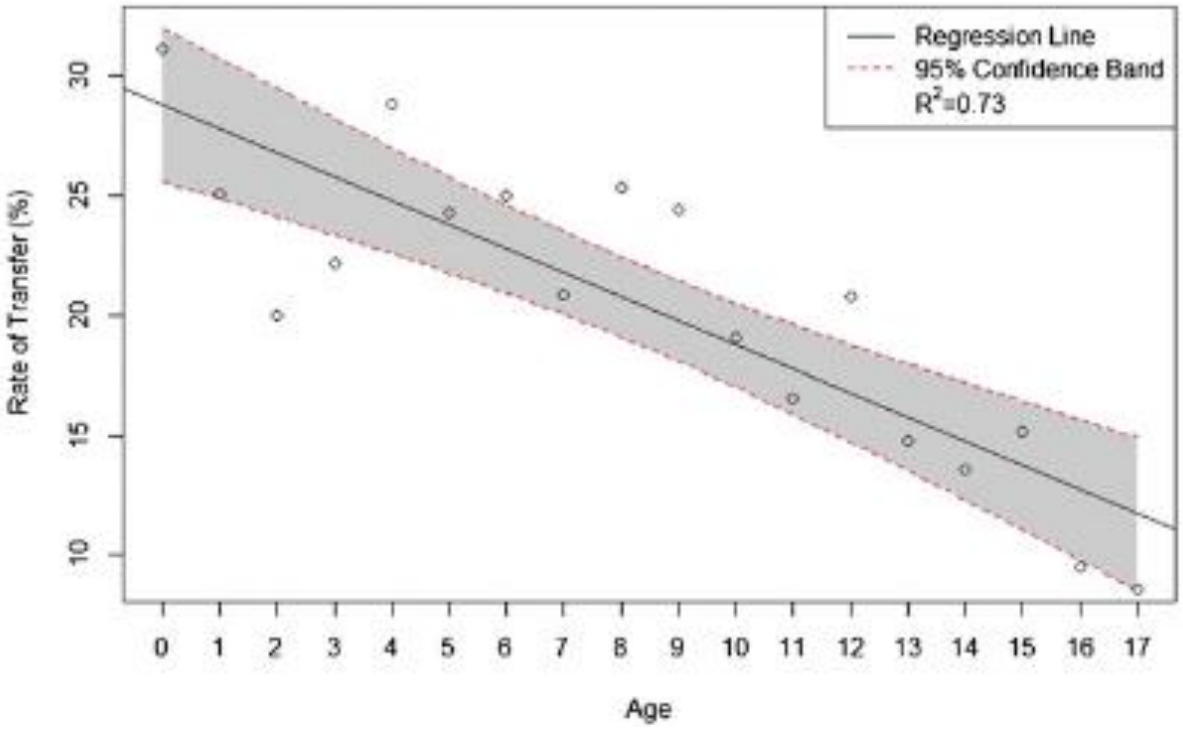
- Primary triage in the prehospital setting is determined by first responders
- Secondary triage is an evaluation regarding the ultimate location of definitive care, made after initial evaluation and stabilization
- National guidelines exist for primary overtriage rates to level I centers to minimize missed injuries but may lead to unintended consequences
  - ACS- COT- rate of primary overtriage between 25 and 35%
- Secondary overtriage does not have a standard definition and is poorly characterized.

Pediatric Triage

Pediatric Secondary Overtriage in a Statewide Trauma System

ALEXANDER LEUNG, M.D.,* PATRICK BONASSO, M.D.,* KEVIN LYNCH, B.S.,† DUSTIN LONG, PH.D.,‡
RICHARD VAUGHAN, M.D.,* ALISON WILSON, M.D.,* JORGE CON, M.D.*

*From the *Department of Surgery, †School of Medicine, and ‡Department of Biostatistics, West Virginia University, Morgantown, West Virginia*



What can we make of all the data

Phases of care

Can we make a difference?

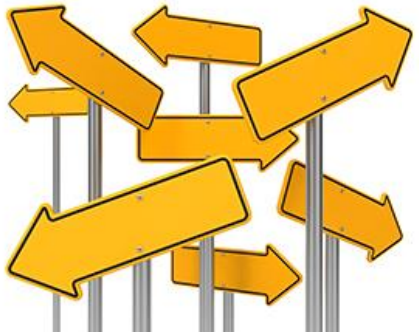
Purpose Statement

- **There is a lack of information and protocols regarding transferring to a pediatric trauma center and hospital admission in mild TBI- GCS >13**
- **Purpose: To define the appropriate transfer guidelines for mild pediatric Traumatic Brain Injury**

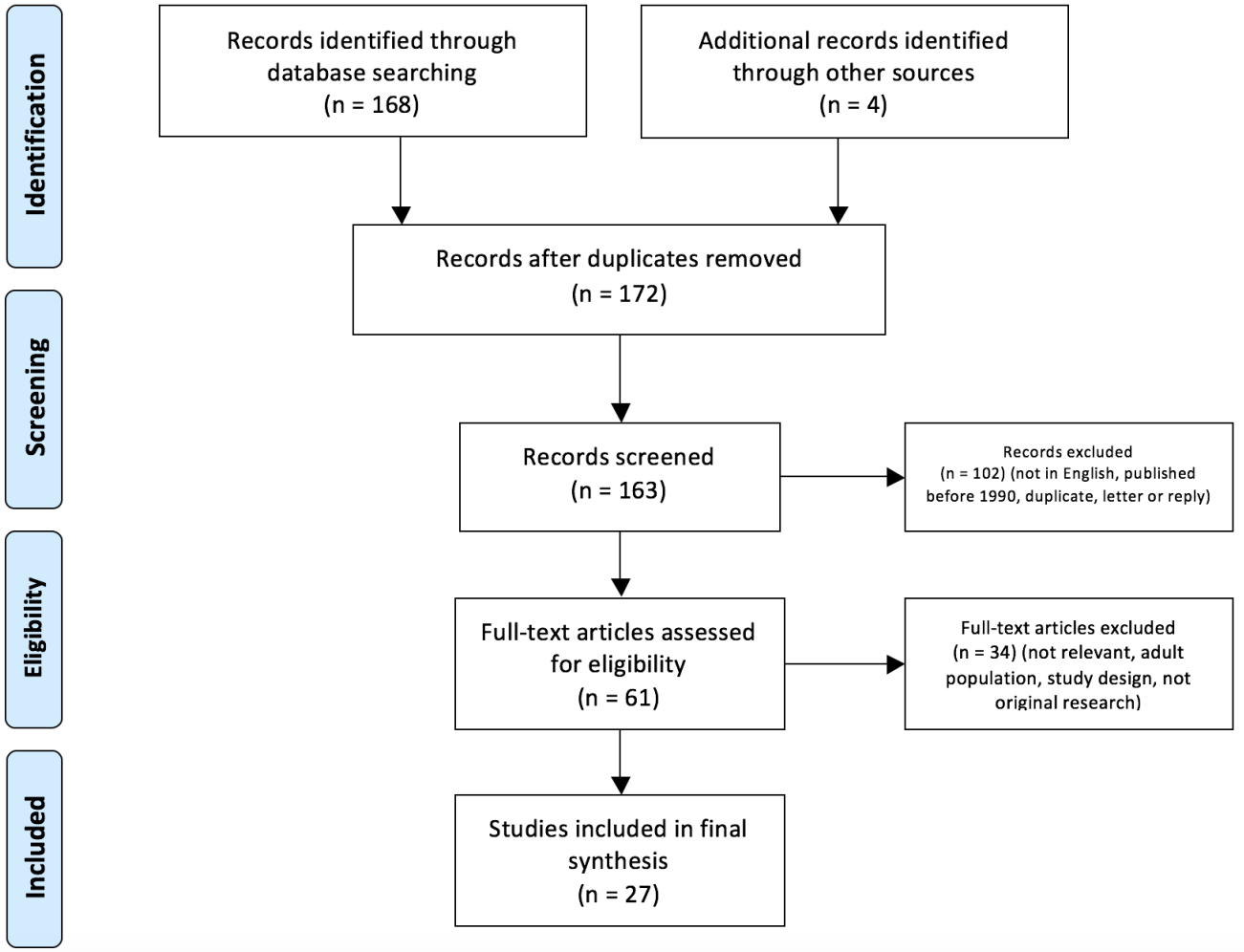
How we got here

- Started with GRADE Guideline
  - PICO Questions
  - In the pediatric trauma patient, does early transfer to designated pediatric trauma centers from adult hospitals improve morbidity and/or mortality?

- Changed course to develop a systematic review with a proposed algorithm
  - Focus on Mild TBI



How we got here



Traumatic Brain Injury: Transfer Management

- Mode of Transport
- Patient Outcomes
- Healthcare Costs

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Traumatic Brain Injury: Transfer Management

- **Mode of Transport**
- Patient Outcomes
- Healthcare Costs

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Mode of Transportation

- Ground vs. Air Transport

Transport Mode to Level I and II Trauma Centers and Survival of Pediatric Patients with Traumatic Brain Injury

Symeon Missios, MD[1,*] and Kimon Bekelis, MD[2,*]

  - NTDB between 2009 and 2011
  - 15,700 pediatric patients
    - 3142 transported via helicopter
    - 12,562 via ground
  - Mortality
    - 7.5% (183) Helicopter
    - 3.8% (337) Ground

Mode of Transportation

Transport Mode to Level I and II Trauma Centers and Survival of Pediatric Patients with Traumatic Brain Injury

Symeon Missios, MD[1,*] and Kimon Bekelis, MD[2,*]

TABLE 3. MODELS DEMONSTRATING THE ASSOCIATION OF HELICOPTER TRANSPORT WITH SURVIVAL OF PATIENTS WITH TRAUMATIC BRAIN INJURY

	OR (95% CI)	p *value*	*ARR (95% CI)*
Level I centers			
Unadjusted mortality	0.49 (0.40–0.58)	<0.001	1.97 (1.30–2.63)[3]
Logistic regression			
Standard	1.76 (1.27–2.46)	<0.001	2.70 (1.64–3.75)
After propensity score matching	1.77 (1.25–2.52)	<0.001	2.73 (1.67–3.78)
Level II centers			
Unadjusted mortality	0.57 (0.41–0.79)	<0.001	1.84 (0.49–3.18)
Logistic regression			
Standard	2.35 (1.30–4.25)	0.005	5.36 (3.06–7.66)
After propensity score matching	2.56 (1.28–5.11)	0.008	6.14 (3.77–8.51)

Mode of Transportation

Transport Mode to Level I and II Trauma Centers and Survival of Pediatric Patients with Traumatic Brain Injury

Symeon Missios, MD[1,*] and Kimon Bekelis, MD[2,*]

37 patients needed to transported via helicopter to save one life When used appropriately air transport increases survival

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Preventable Transfers

Preventable transfers in pediatric trauma: A 10-year experience at a level I pediatric trauma center☆

Stephen J. Fenton [a,*], Justin H. Lee [a], Austin M. Stevens [a], Kyle C. Kimbal [b], Chong Zhang [c], Angela P. Presson [c], Ryan R. Metzger [a], Eric R. Scaife [a]

Variable	All transfers ($N = 6380$)	Preventable ($N = 1699$)	Unpreventable ($N = 4681$)	p-Value
Transfer method				
Ground transfer	3852 (60%)	1332 (78%)	2520 (54%)	<0.001
Air transfer	2528 (40%)	367 (22%)	2161 (46%)	<0.001

Traumatic Brain Injury: Transfer Management

- Mode of Transport
- **Patient Outcomes**
- Healthcare Costs

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Patient Outcomes

Paediatric mild head injury: is routine admission to a tertiary trauma hospital necessary?

Krishna Tallapragada,* Ratna Soundarya Peddada* and Mark Dextert
*Department of Neurosurgery, Children's Hospital Westmead, NSW Health, Sydney, New South Wales, Australia and
†Department of Neurosurgery, Children's Hospital, Westmead Public and Private Hospitals, Sydney, New South Wales, Australia

- 410 children analyzed
  - 380 (93%) managed conservatively
  - 75% of non-surgical patients discharged within 2 days
- Children with small intracranial hematomas and/or skull fractures who need No surgery only require brief inpatient symptomatic treatment and can be managed In the primary hospital

Secondary Overtriage

Secondary Overtriage in Pediatric Trauma: Can Unnecessary Patient Transfers Be Avoided?

Seth D. Goldstein *, Kyle Van Arendonk, Jonathan K. Aboagye, Jose H. Salazar, Maria Michailidou, Susan Ziegfeld, Jeffrey Lukish, F. Dylan Stewart, Elliott R. Haut, Fizan Abdullah

Division of Pediatric Surgery, Johns Hopkins Hospital, Baltimore, MD

Outcomes of pediatric (≤15 years old) patients transferred to level 1 pediatric trauma centers (2008–2011).

	Appropriately triaged N = 112,102	Secondary overtriage N = 32,318	*P*
Required any major procedure (%)	48,761 (43.5)	n/a	
Required critical care (%)	24,970 (22.3)	n/a	
Discharged from ED without hospital admission (%)	2256 (2.0)	12,126 (37.5)	<0.001
Survival to discharge (%)	110,577 (98.6)	32,318 (100)	<0.001

Mild Traumatic Brain Injury

Consequences of pediatric undertriage and overtriage in a statewide trauma system

Hilary A. Hewes, MD, Mathew Christensen, PhD, Peter P. Taillac, MD, N. Clay Mann, PhD, Kammy K. Jacobsen, *and* **Stephen J. Fenton, MD**, *Salt Lake City, Utah*

- Utah's statewide trauma center- 2001- 2013
- 73% of pediatric trauma treated at non-PTC were transferred to PTC
- Head trauma was 5 x more likely to transferred compared to other injuries
- Strongest predictor was hospital practice and not injury, severity or distance to PTC
- Those transferred to PTC- 61% were discharged within 24 hours

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Variable	All transfers ($N = 6380$)	Preventable ($N = 1699$)	Unpreventable ($N = 4681$)	p-Value
Injury type				
Head	3452 (54%)	1082 (64%)	2370 (51%)	<0.001
Chest	574 (9%)	70 (4%)	504 (11%)	<0.001
Abdomen	812 (13%)	77 (5%)	735 (16%)	<0.001
Orthopedic	2596 (41%)	427 (25%)	2169 (46%)	<0.001
Spine	434 (7%)	56 (3%)	378 (8%)	<0.001
Facial	729 (11%)	149 (9%)	580 (12%)	<0.001
Other	2185 (34%)	559 (33%)	1626 (35%)	0.17
Nonaccidental trauma	106 (2%)	10 (1%)	96 (2%)	<0.001

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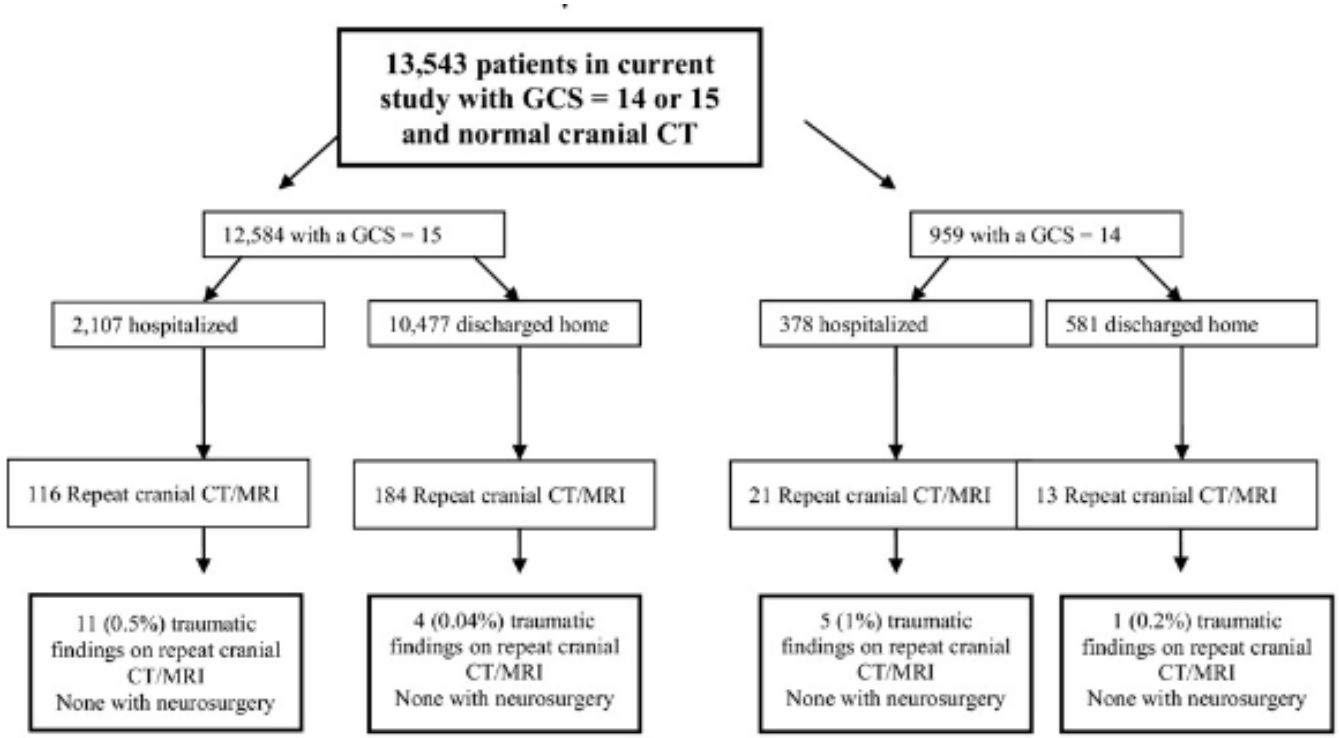
	All transfers	Preventable	Unpreventable
Transfer charges			
Mean	$7991.29	$5204.02	$9073.08
Median	$2423.39	$1839.82	$2812.69
Min	$664.50	$664.50	$664.50
Max	$75,998.37	$47,857.35	$75,998.37
Total	$50,984,457.76	$8,857,246.32	$42,443,846.39

Mild Traumatic Brain Injury

Do Children With Blunt Head Trauma and Normal Cranial Computed Tomography Scan Results Require Hospitalization for Neurologic Observation?

James F. Holmes, MD, MPH, Dominic A. Borgialli, DO, MPH, Frances M. Nadel, MD, MSCE, Kimberly S. Quayle, MD, Neil Schambam, MD, Art Cooper, MD, Jeff E. Schunk, MD, Michelle L. Miskin, MS, Shireen M. Atabaki, MD, MPH, John D. Hoyle, MD, Peter S. Dayan, MD, MSc, Nathan Kuppermann, MD, MPH, and the TBI Study Group for the Pediatric Emergency Care Applied Research Network*



PICU

Preventable pediatric intensive care unit admissions over a 13-year period at a level 1 pediatric trauma center☆

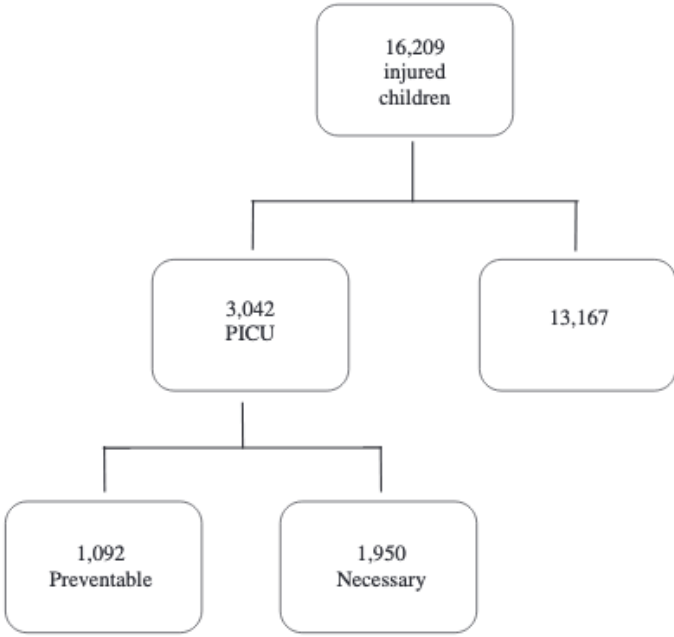
Stephen J. Fenton [a,*], Stephen J. Campbell [b], Austin M. Stevens [a], Chong Zhang [c], Angela P. Presson [c], Justin H. Lee [d]

Multivariate analysis of risk factors of preventable PICU admission.

Predictor	Odds ratio	*P* value
Head injury	9.1 (CI 5.24 ~ 15.82)	<0.001
Face injury	0.62 (CI 0.44 ~ 0.87)	0.006
Chest injury	2.6 (CI 1.76 ~ 3.83)	<0.001
Abdominal injury	10.51 (CI 5.73 ~ 19.28)	<0.001
Extremity injury	0.65 (CI 0.47 ~ 0.9)	0.009

Facility charges.

	All PICU admissions	Preventable PICU admissions	Non-PICU >24 h admissions
Facility charges			
Median	$14,061.04	$8413.29	$6051.90
IQR	($8729.39, $26,985.72)	($4695.70, $9478.21)	($3458.16, $8530.34)
Total	$76,943,512.60	$9,981,454.76	$14,917,595.82



How we feel about transferring…

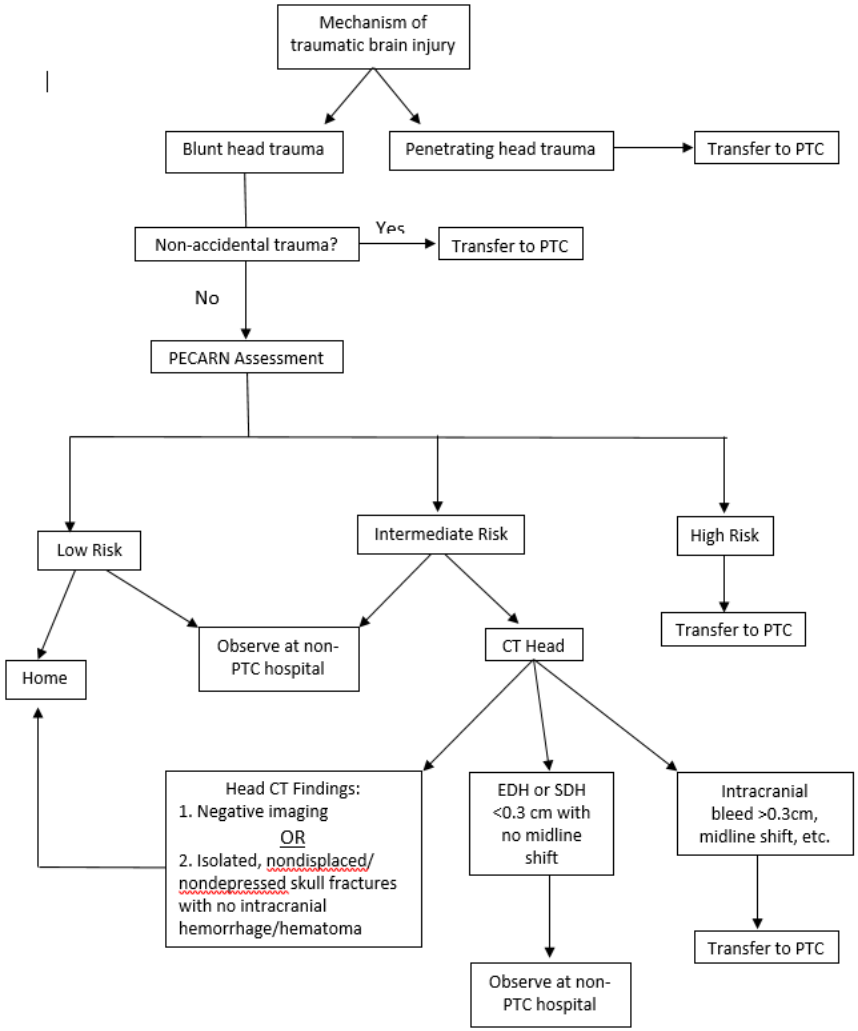
"Who is the right patient?" Insights into decisions to transfer pediatric trauma patients

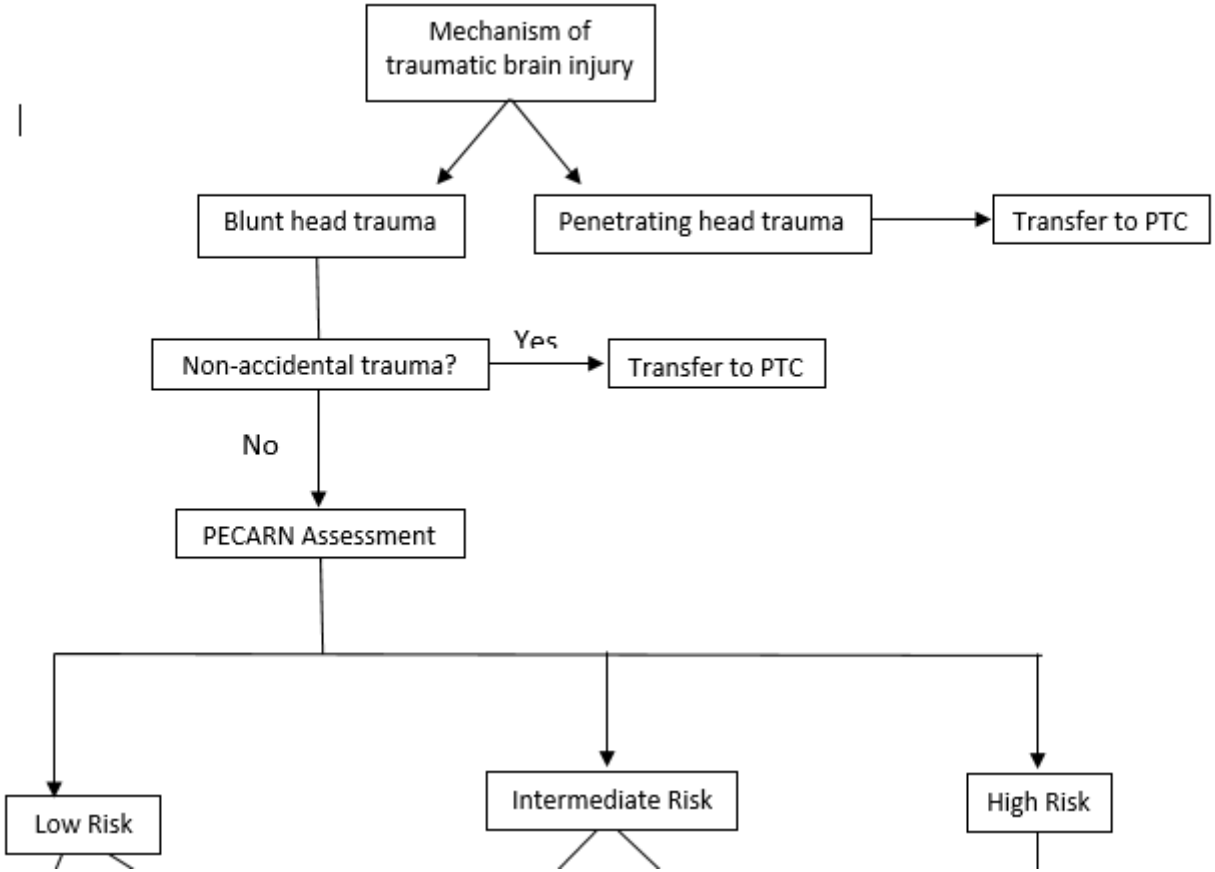
Sydney Candy [a,e], Nadine Schuurman [b], Alison MacPherson [c], Rachel Schoon [d], Kimberly Rondeau [e], Natalie L Yanchar [e,*]

Variable	Reference	Increase of log odds of transfer	Level of significance
PTC physician (versus Level III TC)	Level III TC physician	0.85 +/− 0.41	p = 0.037
Initial hemodynamic instability	Always stable	0.75 +/− 0.28	p = 0.008
GCS 3–8	GCS 13–15	3.27 +/− 0.41	p < 0.0001
GCS 9–12		1.74 +/− 0.32	p < 0.0001
Age 0–3y	Age 9-15y	0.80 +/− 0.34	p = 0.021

Pediatric Mild Traumatic Brain Injury: Transfer Management

- How do we make progress with
  - Proper utilization of resources
  - Decreasing cost
  - Varying practice patterns
  - Varying geographically locations
  - Safety for trauma patients


Mechanism of traumatic brain injury
Blunt head trauma
Penetrating head trauma
Transfer to PTC
Non-accidental trauma?
Yes
Transfer to PTC
No
PECARN Assessment
Low Risk
Intermediate Risk
High Risk
Transfer to PTC
Observe at non-PTC hospital
Home
CT Head
Head CT Findings:
1. Negative imaging
OR
2. Isolated, nondisplaced/ nondepressed skull fractures with no intracranial hemorrhage/hematoma
EDH or SDH <0.3 cm with no midline shift
Intracranial bleed >0.3cm, midline shift, etc.
Transfer to PTC
Observe at non-PTC hospital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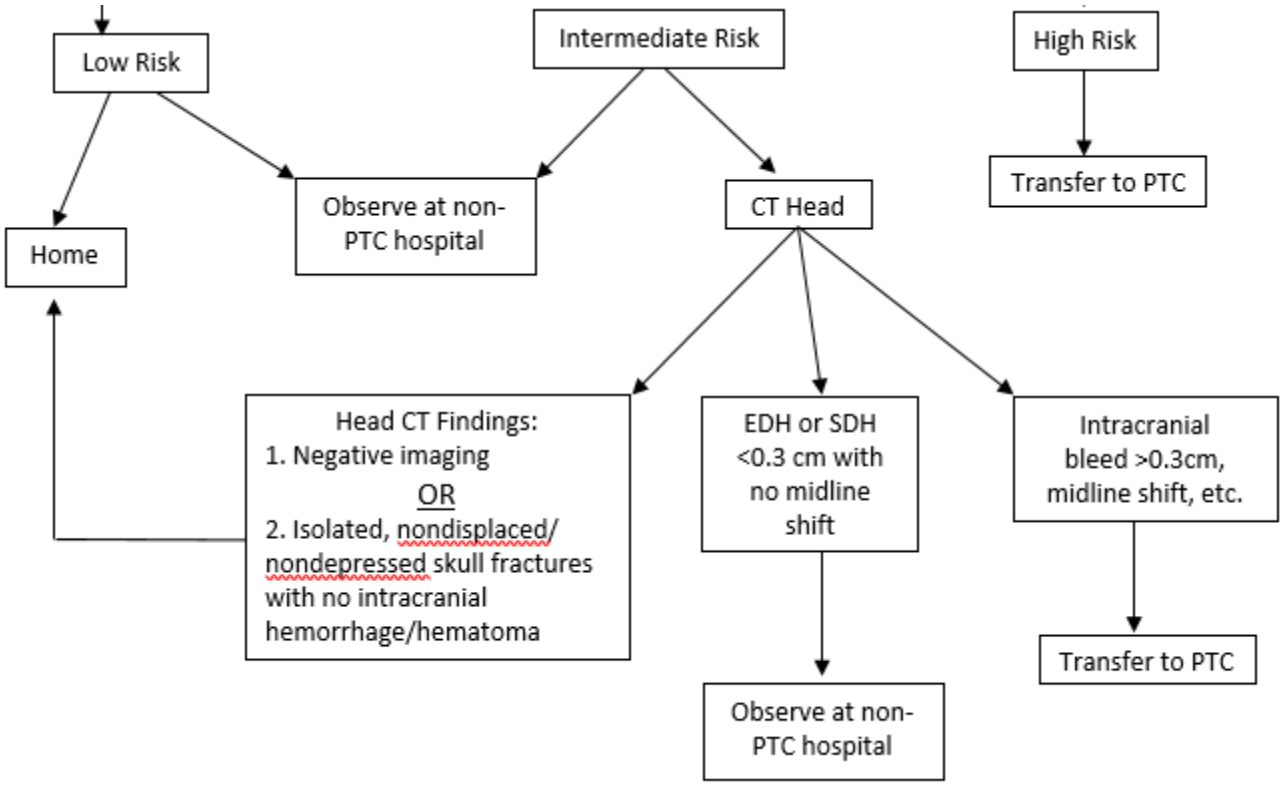
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Next Steps