TOP 5

IMPORTANT PEDIATRIC EM STUDIES

WHY THESE?

- Common presentations
- Well designed studies within the last 2 years
- Have the potential to change practice patterns

CASE #1- THE RED-HOT BABY

- New parents bring their 2 week old baby to your ED because of a fever. The infant's rectal temperature on arrival is 38.6 (101.4).

- Do you need to do a full septic work up?

BACKGROUND

- Febrile young infants can present a diagnostic dilemma to ED physicians
- Management remains an area of considerable debate
- Many algorithms developed prior to widespread use of Hib and Pneumococcal vaccines, maternal GBS screening, and the development of laboratory biomarkers

- What if we could identify a subgroup of febrile neonates at low risk for serious bacterial infection?

FEBRILE INFANT <60 DAYS

- Kupperman, et al. **"A clinical prediction rule to identify febrile infants 60 days and younger at low risk for serious bacterial infections."** *JAMA Peds 2019*

- **Clinical Qu**
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  bacterial infe

FEBRILE INFANT <60 DAYS

- **Design:** Prospective observational multicenter study
  - PECARN study
  - 26 pediatric EDs enrolled febrile infants <60 days of age
- **Goal:** To derive and validate a highly accurate prediction rule to identify infants at low risk for SBI

- **Exclusions:**
  - Critically ill
  - Antibiotics in the preceding 48 hours
  - Premature
  - Other medical conditions
  - Indwelling devices
  - Soft tissue infection

FEBRILE INFANT <60 DAYS

- **1821 infants**
  - Less than 28 days (30.5%)
  - 29-60 days (69.5%)
- Fever defined as 38°C within the last 24 hours
- All patients had blood and urine cultures, CSF cultures done at treating physician's discretion
- SBI in 9.3%
  - UTI 8.3%
  - Bacteremia 1.4%
  - Bacterial Meningitis 0.5%

FEBRILE INFANT <60 DAYS

- Derived the prediction rule on a random sample of 908 infants

PECARN FEBRILE NEONATE DECISION RULE: LOW RISK CRITERIA*
(-) Urinalysis = (-) Leukocyte esterase AND (-) Nitrite, AND Absence of Pyuria (5 WBC/HPF)
ANC 4,090 per microL (to convert to $\times 10^9$ per liter, multiply by 0.001)
PCT 1.7 ng/ml
*All 3 criteria need to be fulfilled in order for the patient to be consider low risk by the rule The authors report a similar sensitivity but lower specificity with rounded values of ANC 4,000 and PCT 0.5 ng/mL

FEBRILE INFANT <60 DAYS

- Rule was validated on a sample of 913 infants
  - Sensitivity of 97.7%
  - Specificity of 60%
  - NPV 99.6%
  - 1 infant with bacteremia and 2 with UTI were misclassified
  - No missed cases of bacterial meningitis

Table 2. Univariable Analysis of Combined Derivation and Validation Cohorts

Characteristic	SBI Status, No. (%)		Difference (95% CI)
	Positive (n = 170)	Negative (n = 1651)	
Age, mean (SD), d	[illegible]	36.4 (14.8)	−3.3 (−5.7 to −0.9)
Age ≤ 28 d	72 (42.4)	483 (29.3)	13.1% (5.4 to 20.8)
Qualifying temperature, mean (SD), °C	[illegible]	38.5 (0.4)	0.2 (0.1 to 0.3)
Duration of fever prior to ED visit, h			
<12	106 (63.5)	1038 (63.3)	0.2% (−7.5 to 7.8)
12-24	49 (29.3)	470 (28.7)	0.7% (−6.6 to 7.9)
>24	12 (7.2)	132 (8.0)	−0.9% (−5.0 to 3.3)
YOS, median (IQR)[a]	6.0 (6.0 to 10.0)	6.0 (6.0 to 8.0)	
Clinician suspicion			
<1%	36 (21.4)	647 (39.4)	−18.0% (−24.6 to −11.3)
1%-5%	75 (44.6)	678 (41.3)	3.4% (−4.5 to 11.3)
6%-10%	27 (16.1)	238 (14.5)	1.6% (−4.2 to 7.4)
11%-50%	20 (11.9)	66 (4.0)	7.9% (2.9 to 12.9)
>50%	10 (6.0)	14 (0.9)	5.1% (1.5 to 8.7)
Urinalysis positive	[illegible]	135 (8.2)	74.8% (69.0 to 80.6)
WBC, mean (SD), /μL	14 300 (6100)	10 000 (4300)	4300 (3400 to 5300)
ANC, mean (SD), /μL	7700 (4500)	3700 (2600)	4000 (3300 to 4700)
PCT, ng/mL, median (IQR)	0.7 (0.3 to 3.4)	0.2 (0.2 to 0.3)	0.5 (0.4 to 0.6)

FEBRILE INFANT <60 DAYS

- **Major Limitation:** Sample included 170 patients with SBI, but only 30 had bacteremia or bacterial meningitis
  - Needs validation of findings in cohorts with greater numbers of invasive infections before implementation

- **Potential Impact: IF VALIDATED BROADLY**
  - Reduce invasive testing
  - Reduce hospital admission
  - Reduce unnecessary antibiotic usage and antimicrobial resistance

FEBRILE INFANT <60 DAYS

- **“Until further validation of the prediction rule, clinicians must remain most cautious with infants younger than 28 days, in whom the risks of bacteremia and bacterial meningitis as well as herpes encephalitis are the greatest."**

CASE #1- THE RED-HOT BABY

- You perform a full septic work up on your febrile 2 week old patient and admit on empiric antibiotics. He does well, cultures remain negative and he is discharged 48 hours later.

CASE #2- THE CROUPER

- A 2yo child is brought to your ED at midnight by his concerned parents. They state he was fine when he went to bed but woke up struggling to breathe with a barking cough. After a careful exam, you diagnose viral croup.

- What steroid, and at what dose, is most effective in treatment of this common pediatric condition?

BACKGROUND

- Steroid use in croup has been shown to significantly decrease:
  - rate of hospital admission
  - length of hospital stay
  - return visits
  - endotracheal intubation
  - ICU admission

- Although different routes of corticosteroid administration have been used (inhaled, IM, IV) the oral route has many advantages and is the preferred route in many centers

BACKGROUND

- But what about dose?
- Early trials demonstrated safety/efficacy of **IM dexamethasone at 0.6mg/kg**

- Subsequent studies revealed efficacy of **0.6mg/kg oral dexamethasone**

PRED VS DEX FOR CROUP

- Parker CM, Cooper MN. **"Prednisolone Versus Dexamethasone for Croup: a Randomized Controlled Trial."** *Pediatrics*. 2019 Sept, 144 (3).

- **Goal:** To compare the traditional, evidence-supported gold standard croup treatment, dexamethasone at a dose of 0.6 mg/kg, with 2 alternate treatments already in widespread use, namely lower-dose dexamethasone (0.15 mg/kg) and prednisolone (1 mg/kg), and assess these treatments for noninferiority.

PRED VS. DEX FOR CROUP

- **Design:** Prospective, double-blinded RCT at 2 separate Australian EDs

- **Inclusion:**
  - Clinically diagnosed croup
  - 6 months or older
  - Contactable by telephone
  - English speaking caregivers

- **Exclusion:**
  - Known allergy to prednisone or dexamethasone
  - Immunosuppressed
  - Steroid use in the last 14 days
  - High suspicion for alternative disease (bacterial tracheitis, epiglottitis, RPA, FB, structural anomaly)

PRED VS. DEX FOR CROUP

- **Outcome measures:**
  - (1) an objective and validated measure of croup severity, the Westley Croup Score (WCS)
  - (2) re-attendance for follow-up of ongoing symptoms.

SCORE	Stridor	Retractions	Air Entry	$Sa0_2$ <92%	Level of consciousness
0	None	None	Normal	None	Normal
1	Upon agitation	Mild	Mild Decrease		
2	At rest	Moderate	Marked Decrease		
3		Severe			
4				Upon agitation	
5				At rest	Decreased

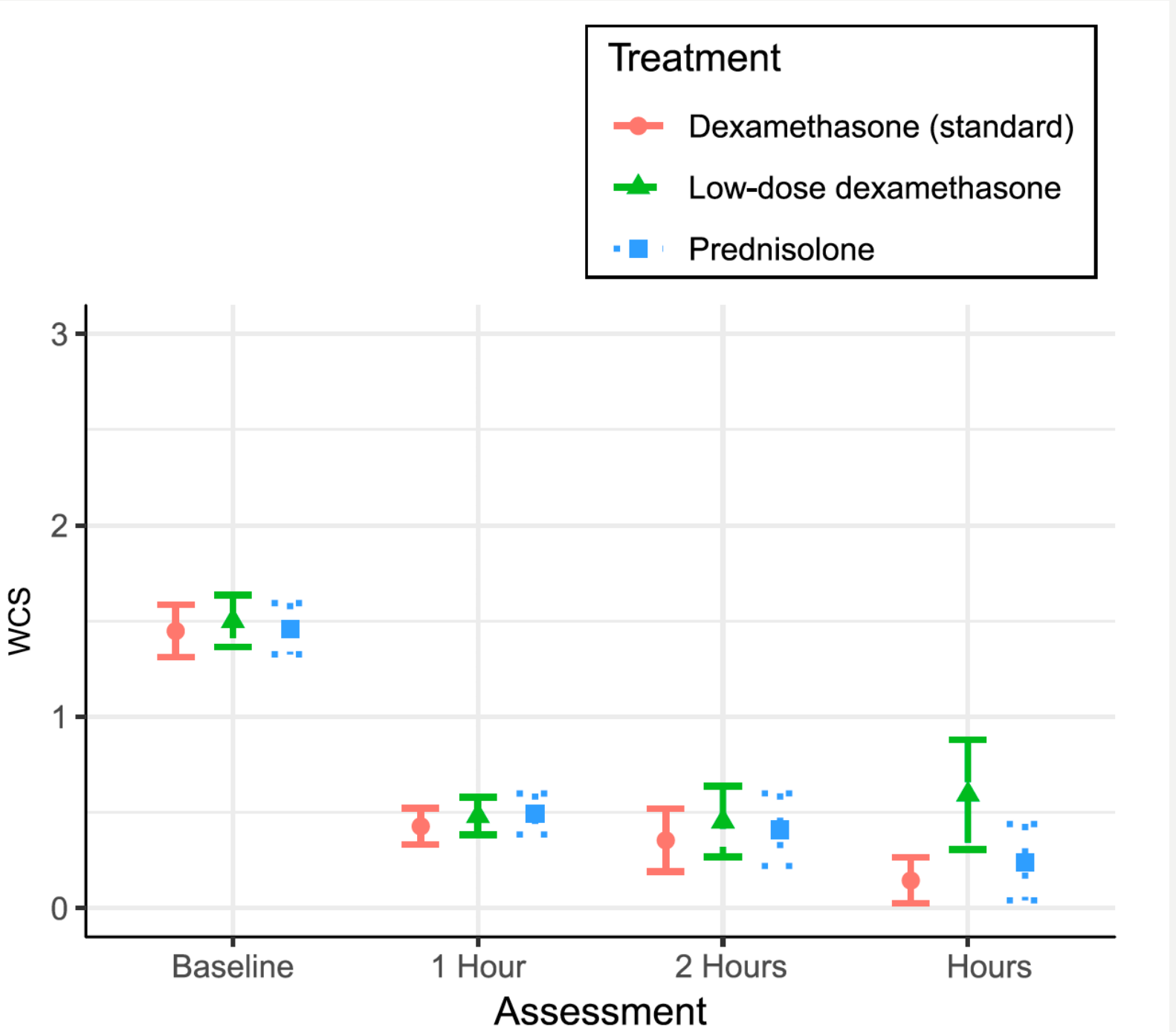
PRED VS. DEX FOR CROUP

1231 Patients randomly assigned

410 patients	410 patients	411 patients
0.6mg/kg oral dexamethasone	0.15mg/kg oral dexamethasone	1 mg/kg oral prednisolone

PRED VS. DEX FOR CROUP

- **Results**
  - No statistically significant difference between the 3 groups for the WCS at the 1-hour assessment
  - Re-attendance rates were modest at 17.8% (dexamethasone), 19.5% (low-dose dexamethasone), and 21.7% (prednisolone)
    - ED re-attendance rates were low at 5.9% (dexamethasone), 8.8% (low-dose dexamethasone), and 7.5% (prednisolone), with no statistical difference between treatment groups


Treatment
Dexamethasone (standard)
Low-dose dexamethasone
Prednisolone
WCS
3
2
1
0
Baseline
1 Hour
2 Hours
Hours
Assessment

PRED VS. DEX FOR CROUP

- **Results**
  - No difference between treatment groups in the need for nebulized epinephrine (2.2%–3%)
  - A repeat dose of nebulized epinephrine was given to 0%, 1.2%, and 1.0% of participants in the dexamethasone, low-dose dexamethasone, and prednisolone groups, respectively
  - One or more additional steroid doses were given to 11.3%, 15.1%, and 18.9% of participants in the dexamethasone, low-dose dexamethasone, and prednisolone groups, respectively

PRED VS. DEX FOR CROUP

- **Limitations:**
  - Only 70% follow up by phone
  - Most but not all of the remaining 30% captured in electronic medical record
    - Missed those who may have returned with a different diagnosis or who returned to another location

PRED VS. DEX FOR CROUP

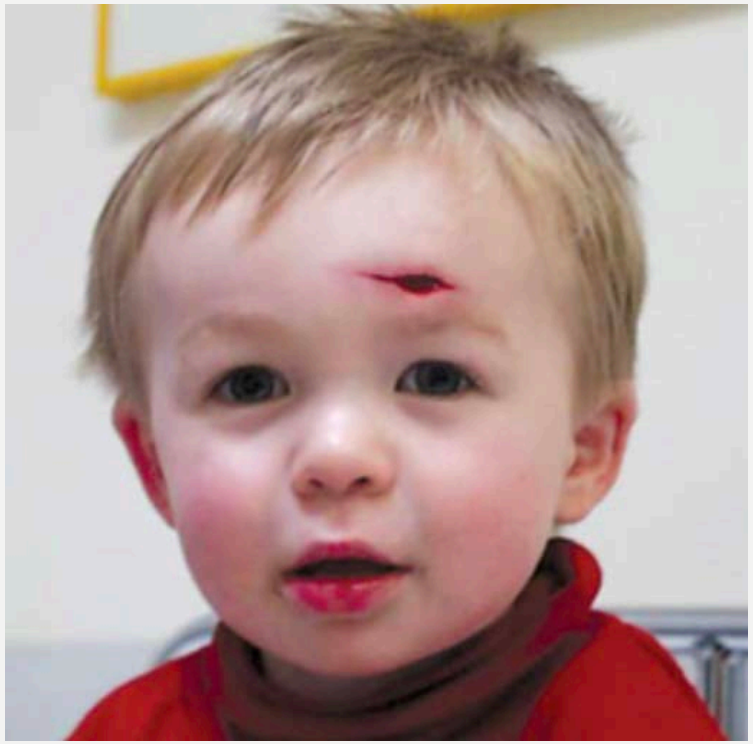
- **Conclusions:**
  - Noninferiority, it is acceptable to use any of the 3 commonly used oral steroid regimes to treat croup in children
  - The vast majority (92%) of patients were successfully treated and discharged within 2 hours, improving from an average WCS of ~1.5 to ~0.5 over the first hour after treatment, with no differences between the 3 groups
  - Children treated with prednisolone initially are more likely to require additional doses to cover the duration of the illness

CASE #2- THE CROUPER

- You administer dexamethasone at 0.15mg/kg, observe the patient and discharge home. He improves over the next 24-48 hours without a return visit to the ED.

CASE #3- THE LACERATION

- A 2yo male presents to your ED after a fall at home. Mother states he was chasing the family puppy and tripped over a toy, striking his forehead on the wooden coffee table. You note an otherwise well appearing, age appropriate child, who has no significant signs of injury except a linear 3cm forehead laceration that will require closure.



- Is there a safe and effective agent that delivers both analgesia and anxiolysis for minor procedures in children?

BACKGROUND

- Pediatric patients often require analgesia or anxiolysis for common procedures.
- Effective analgesia/anxiolysis can increase compliance and facilitate successful completion of the procedure.
- Administration of IV sedation is not always feasible, poses risks, requires increased resource utilization and prolongs length of stay.
- IN medications have been used, but questions remain regarding the proper dose, safety profile, and the degree of monitoring necessary.

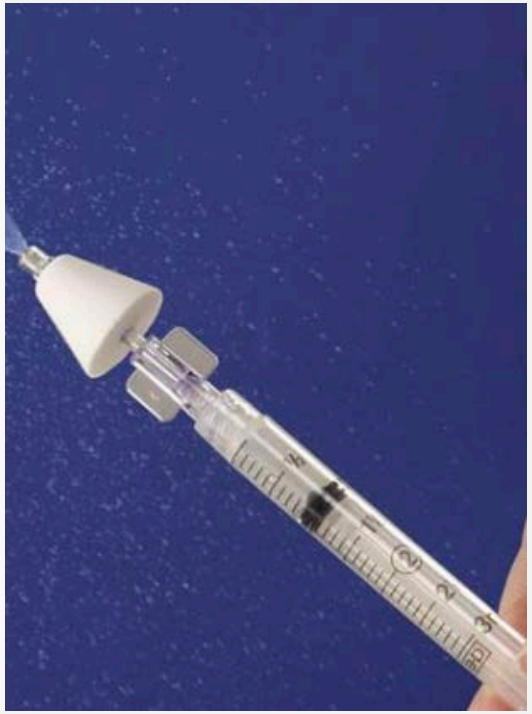
BACKGROUND

- Ketamine
  - A dissociative anesthetic, affects the limbic and thalamic systems
  - Prevents higher brain centers from perceiving pain while preserving some degree of consciousness
  - Appropriate analgesia and sedative properties with minimal effects on respiratory drive

INTRANASAL KETAMINE

- Guthrie A
  Ketamir
  Emerge
  Care. 201

- **Goal:** To
  patient o
  ketamine



INTRANASAL KETAMINE

- **Design:** Prospective survey and retrospective chart review
- **Inclusion:** Pediatric patients 6mos-18 years between Jan 2018 and May 2018
- **Exclusion:**
  - Allergy
  - difficult airway
  - nasal obstruction or trauma
  - Epistaxis
  - Rhinitis
  - altered ciliary function (i.e., cystic fibrosis)

Initial dose of ketamine (100mg/ml) was 2mg/kg to 5mg/kg to a max of 200mg

INTRANASAL KETAMINE

- **Primary Outcome:** Provider satisfaction with use of IN ketamine in pediatric patients for analgesia, anxiolysis, and agitation

- **Secondary Outcomes:** Comparing outcomes stratified by dose, evaluating adverse events, assessing for treatment failure, evaluating ED LOS, and evaluating perceived success of IN ketamine in relation to procedure type

INTRANASAL KETAMINE

Prospective Survey

Provider comfort (0-100)	Provider satisfaction (0-100)	Perception of patient comfort (0-100)
100	90	75

Also asked whether patients would have otherwise required procedural sedation → 59%

INTRANASAL KETAMINE

Retrospective Chart Review

- **Data points collected:**
  - Age, sex, weight
  - Vital signs
  - Indication for procedure
  - Initial pain score
  - Other medications receive before IN ketamine
  - Dose
  - Time of doses
  - Treatment failure (progressed to procedural sedation)
  - Adverse reactions
  - ED LOS

INTRANASAL KETAMINE

- 196 patients
  - All encounters accompanied by provider survey
  - 52 unique survey participants (physicians and APPs)
- Median patient age = 3.8 years
- Most common procedure = laceration repair (42.9), orthopedic procedure (16.3%)
- Median dose = 3.9mg/kg
- Perceived patient comfort maximized using doses between 3 and 4 mg/kg

INTRANASAL KETAMINE

- 7.7% treatment failure
  - 40% orthopedic procedures
  - 73% male
  - Older children
  - Not dose-dependent
- 6% adverse events
  - Nausea, dizziness, drowsiness → did not interfere with procedure or perceived patient comfort
  - **No patients required respiratory support/intubation**
- Discharged 95 minutes faster

INTRANASAL KETAMINE

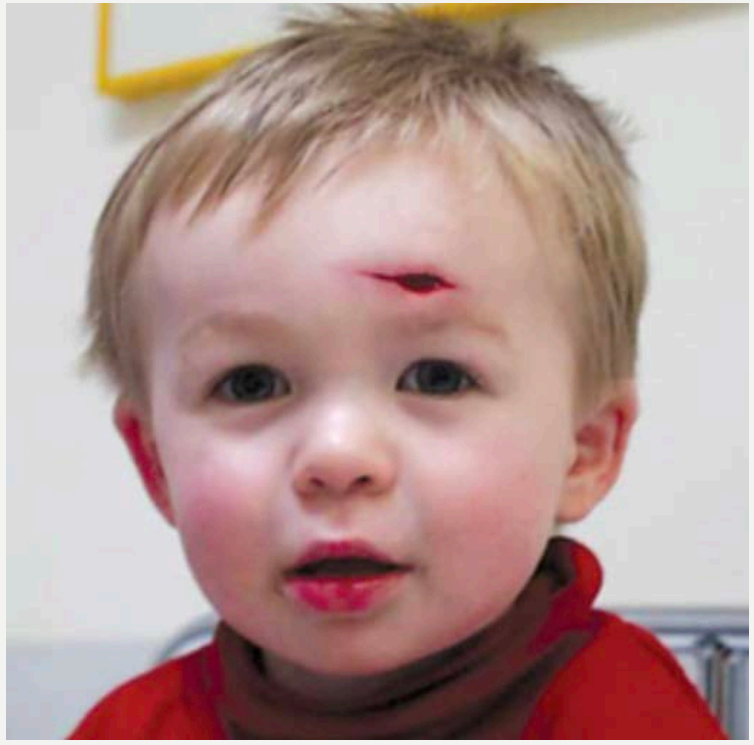
- **<u>Limitations:</u>**
  - Retrospective chart review
  - Relatively small sample size
  - Survey = potential for bias
  - Unknowns remain (time of onset, procedure duration, duration of analgesia/anxiolysis?)
  - Patient/Parent satisfaction not evaluated
  - Rating scale (0-100) is not a validated tool for assessing satisfaction

INTRANASAL KETAMINE

- **Conclusion:** "Intranasal ketamine appears to be effective in providing analgesia and anxiolysis in **shorter procedures** (foreign body removal, laceration repair, and superficial incision and drainage). However, IN ketamine may not have the same degree of success in longer, more painful procedures (eg, orthopedic procedures requiring extensive manipulations or deeper incision and drainages having a longer duration)."

CASE #3- THE LACERATION

- You provide anxiolysis with 4mg/kg of IN ketamine and local anesthesia. The laceration is repaired successfully without adverse events. The ED LOS is <2hrs.



CASE #4- THE DIABETIC

- A previously healthy 11yo girl is brought to the ED by her parents due to fatigue, weight loss, and concern for dehydration. She is thin, tachypneic, has sunken eyes, and prolonged cap refill. She responds to gentle stimuli and answers questions appropriately, but quickly falls back asleep. Her POC BG is 487, and her VBG demonstrates a pH of 7.15 and a HCO_3 of 12.
- At what volume and rate should you administer IV fluids?

BACKGROUND

- The most concerning complication of DKA, and its treatment, is cerebral edema
  - Primary cause of death in childhood DKA
  - Etiology unclear… rapid osmotic shifts?
- Traditionally, cautious approach to fluid administration in pediatric DKA

IV FLUIDS IN PEDIATRIC DKA

- Kupperman, et al. **"Clinical trial of fluid infusion rates for pediatric diabetic ketoacidosis."** N Engl J Med 2018; 378:2275-2287

- **Clinical Question:** In pediatric patients with diabetic ketoacidosis, is the rate and tonicity of intravenous fluid administration associated with an increased risk of poor in-hospital or long term neurocognitive outcomes?

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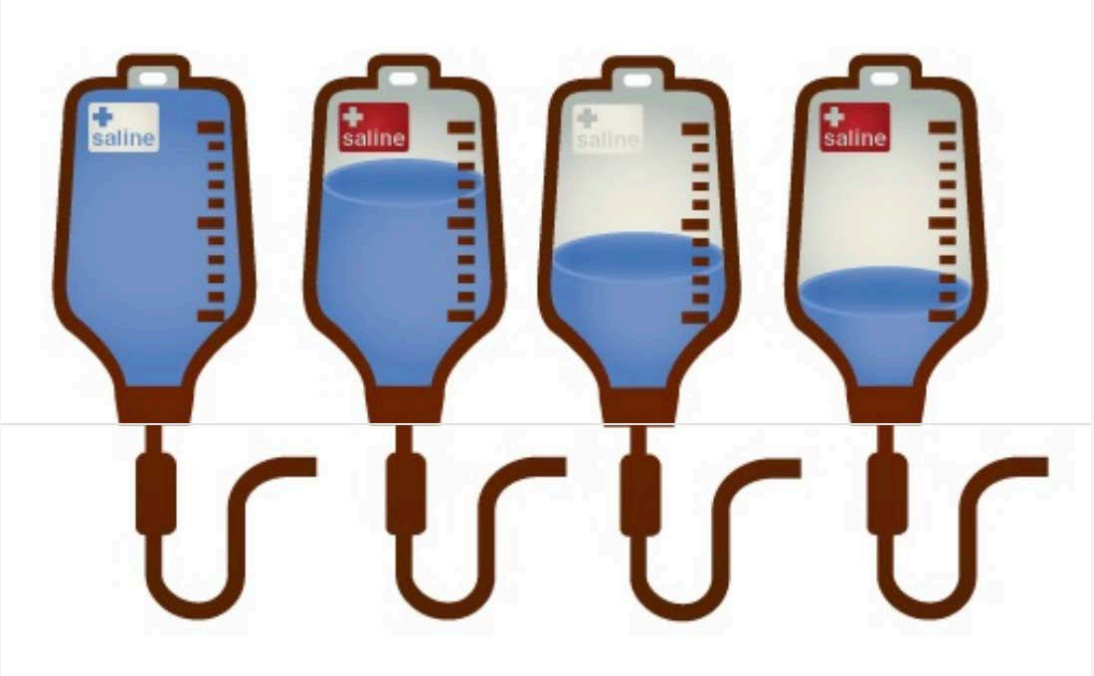
IV FLUIDS IN PEDIATRIC DKA

- **Design:** Randomized control trial
  - Multicenter PECARN study
- **Inclusion:** Children 0-18 years with diagnosis of DKA
  - BG >300
  - pH <7.25 or HCO3 <15
- **Exclusion:** Underlying disorders that could affect neurocognitive testing



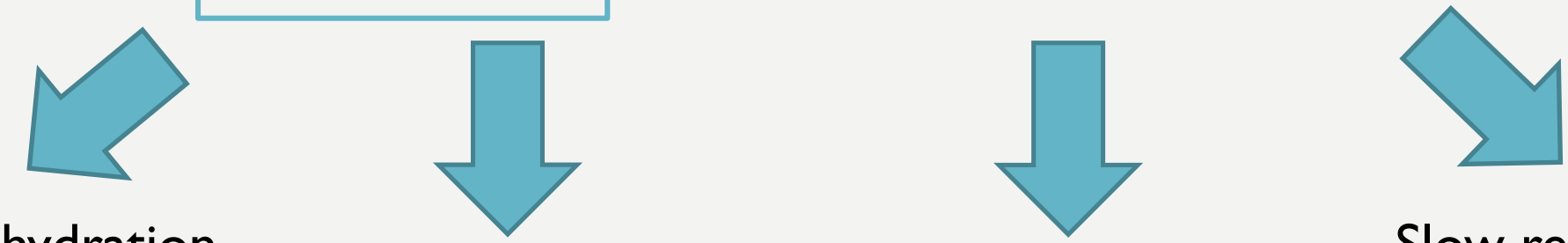
IV FLUIDS IN PEDIATRIC DKA

<u>1389 PATIENT ENCOUNTERS</u>

All patients received an initial bolus of 10ml/kg of 0.9% NaCl

Additional 10ml/kg bolus of 0.9% NaCl

No additional bolus



Fast rehydration with 0.45% NaCl

Fast rehydration with 0.9% NaCl

Slow rehydration with 0.45% NaCl

Slow rehydration with 0.9% NaCl

Treatment for DKA between the 4 groups was otherwise identical

IV FLUIDS IN PEDIATRIC DKA

- **Primary Outcome:** Deterioration of neurologic status as evidenced by 2 consecutive GCS scores of <14 in the first 24 hours of treatment
- **Secondary Outcome:** Short-term memory during treatment for DKA, clinically apparent brain injury (initiation of hyperosmolar therapy, intubation, or death), short-term/contextual memory and IQ 6 months after treatment

IV FLUIDS IN PEDIATRIC DKA

- **Results:**
  - 98% of patients had a presenting GCS of 14 or 15
  - 3.8% of patients had a GCS decline to <14
  - 1.6% of patients declined to require hyperosmolar therapy for suspected cerebral edema
  - 0.9% of patients had clinically apparent brain injury
    - 1 patient died, 11 recovered without overt neurologic deficits

IV FLUIDS IN PEDIATRIC DKA

- **Results:**
  - **No significant differences** among the groups in
    - the percentage of episodes in which the GCS score declined to <14
    - the magnitude of decline in the GCS score
    - the duration of time in which the GCS score was <14
  - **No significant difference** in the incidence of clinically apparent brain injury among the groups
  - **No significant differences** in neurocognitive outcomes after recovery among the trial groups

IV FLUIDS IN PEDIATRIC DKA

- **Limitations:**
  - Clinically apparent brain injury occurs in less than 1% of episodes, making it impractical to design a trial with sufficient statistical power to detect differences in this outcome
  - Would have been helpful to measure inter-rater reliability of GCS scores

IV FLUIDS IN PEDIATRIC DKA

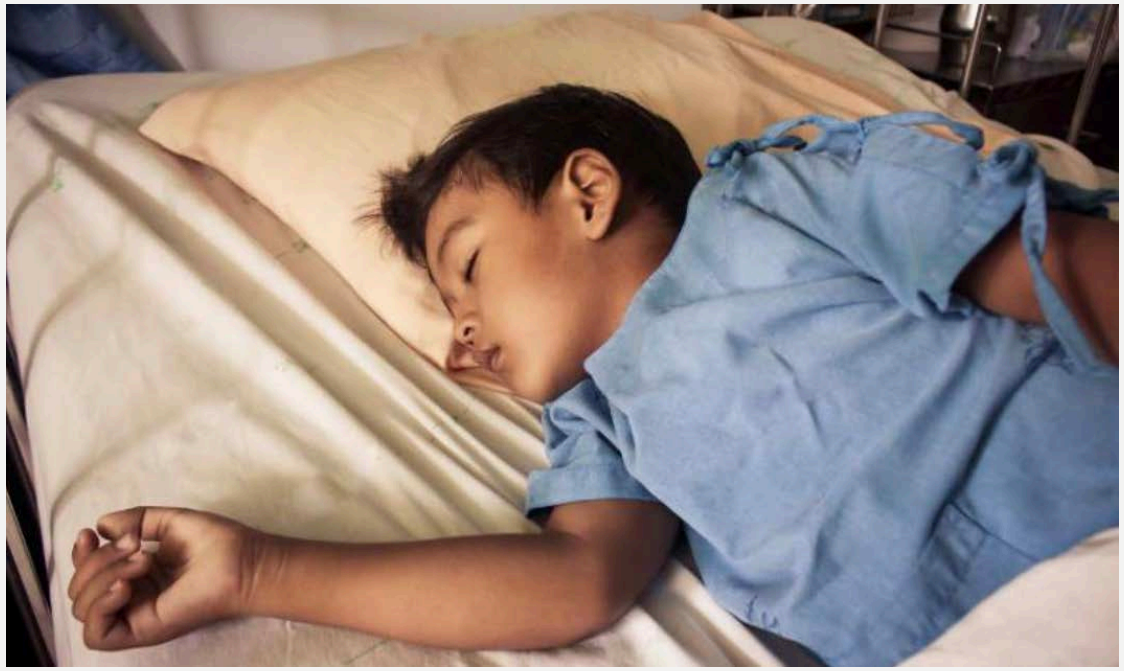
- **Conclusions:**
  - **"…Neither the rate of administration nor the sodium chloride content of intravenous fluids significantly influenced neurologic outcomes of diabetic ketoacidosis in children."**
  - Supports a more recent hypothesis that cerebral hypoperfusion and the effects of reperfusion, along with neuroinflammation, are central to diabetic ketoacidosis–related brain injury

CASE #4- THE DIABETIC

- You administer a 20ml/kg 0.9%NaCl bolus and initiate insulin. With ongoing IVF resuscitation, close neurologic and glucose monitoring, your patient improves.

CASE #5- THE SEPTIC CHILD

- An 8yo boy is brought to your hospital via EMS. He had been febrile for the last few days with cough and poor oral intake. On arrival, he is febrile, tachycardic, tachypneic, pale with cool extremities and decreased responsiveness.



BACKGROUND

- Children account for >30 million ED visits annually (20% in the US)
- Most visits occur in general EDs, not pediatric
- Most children live >30 miles from a facility with a high pediatric readiness score
- The 2013 National Pediatric Readiness Project found the median readiness score to be 69 (scale 22-100)
  - Many hospitals lack core elements of pediatric readiness recommended by national guidelines

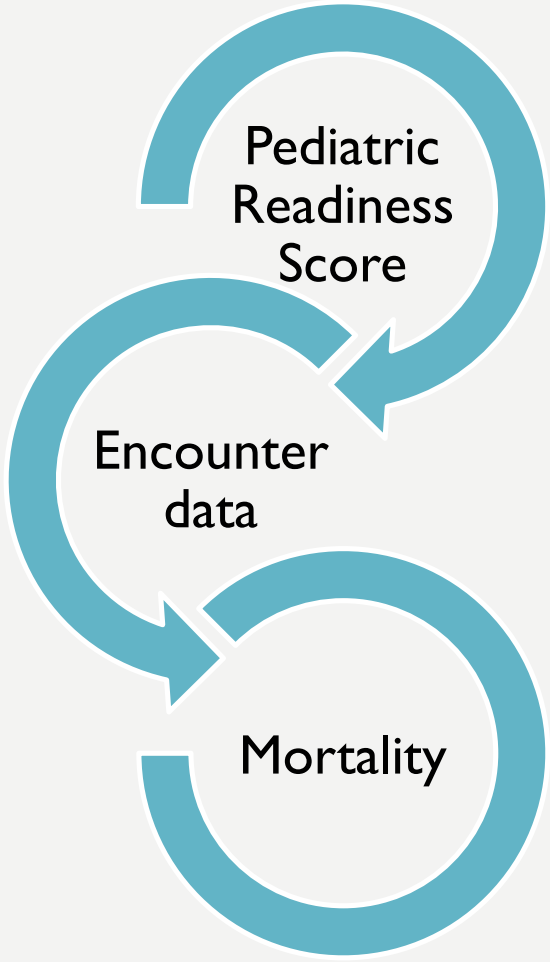
ED PEDIATRIC READINESS

- Ames SG, et al. **"Emergency Department Pediatric Readiness and Mortality in Critically Ill Children."** *Pediatrics*. 2019 Sept, 144 (3)

- **Goal:** To determine the proportion of patients presenting to EDs with various levels of pediatric readiness and to evaluate if ED pediatric readiness is associated with mortality.

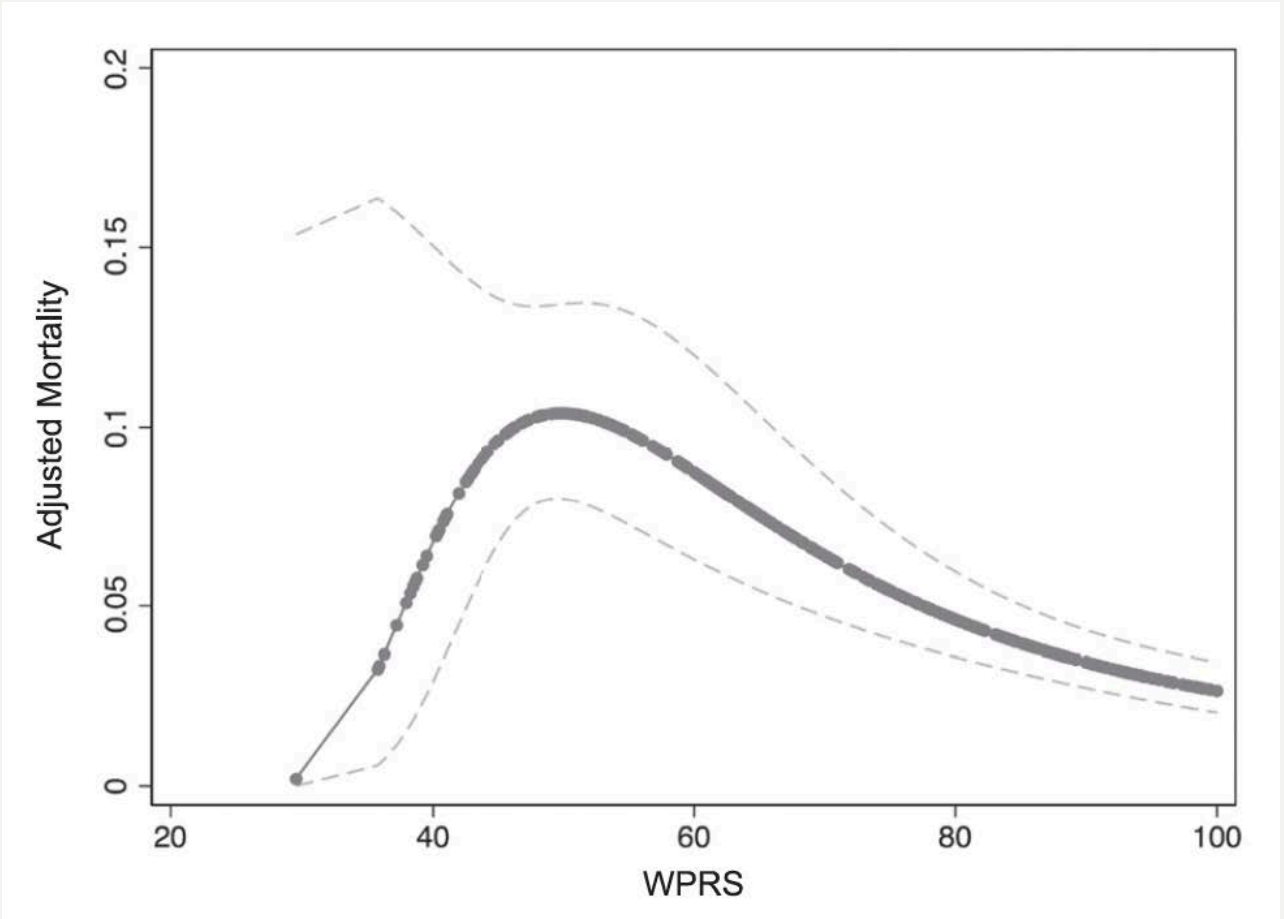
ED PEDIATRIC READINESS

- **Design:** Retrospective cohort study using 2013 data
- **Study Population:** Pediatric patients <18 years presenting to EDs with critical illness
  - Patient-level characteristics included age, race, sex, the presence of complex chronic conditions, and severity of illness.



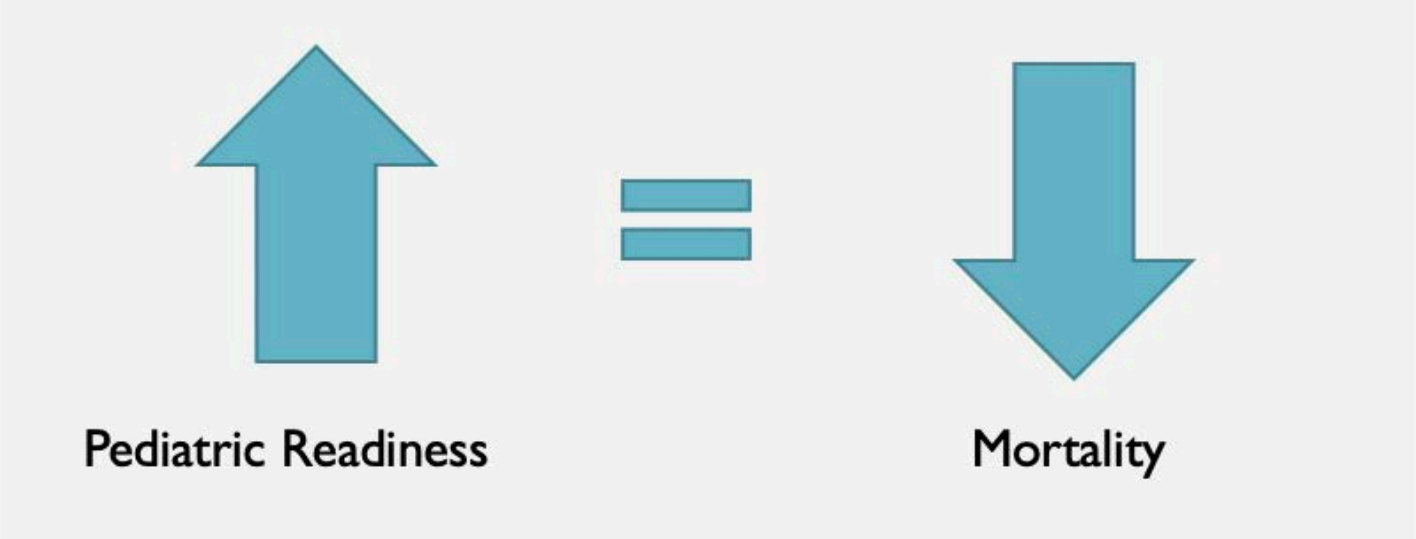
ED PEDIATRIC READINESS

- **Results:**
  - 20, 483 children presenting to 426 hospitals
  - Median Pediatric Readiness score 74.8
  - Subgroup Analysis: cardiac arrest, sepsis and TBI
  - 4x increased odds of death when presenting to hospitals with lower scores



ED PEDIATRIC READINESS

- **Conclusions:** "Primarily, our findings suggest that patient outcomes may be improved by increasing the readiness of hospitals to care for pediatric emergencies."



ED PEDIATRIC READINESS

- Most common reasons for a low readiness score:
  - Lack of implementation of ED policies dedicated to children
  - Lack of quality improvement efforts
  - Absence of a Pediatric Emergency Care Coordinator
  - Lack of Pediatric resuscitation equipment, medication dosing chart and interfacility transfer guidelines

ED PEDIATRIC READINESS

- How to Address?
  - Local/state collaboratives
  - Shared resources, policies
  - QI activities
- Appoint a PECC!
- Regionalized Pediatric Emergency Care
  - Selected children at high risk systematically triaged and transferred to designated centers of pediatric readiness
- Telemedicine

CASE #5- THE SEPTIC CHILD

- Your ED recently completed a quality improvement project to improve timely recognition and management of pediatric sepsis. Immediately, supplemental oxygen is applied to the patient and your team effectively establishes IV access. You estimate the child's weight using your length-based resuscitation tape. Fluid resuscitation begins and you utilize a medication dosing chart to administer broad spectrum antibiotics. You note improved perfusion, and mental status and arrange for timely transfer to the nearest Pediatric ICU.

THANK YOU FOR CARING FOR KENTUCKY'S CHILDREN!

CONTACT INFORMATION

Katelyn Yackey, MD, FAAP

Assistant Professor of Pediatric Emergency Medicine

University of Kentucky and Kentucky Children's Hospital

katelyn.yackey@uky.edu

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