Section on Emergency Medicine

Characterizing Respiratory Syncytial Virus (RSV) Infections Before and During the COVID-19 Pandemic

10/20/2023

Oral Presentation

Saamia Masoom, MD[1]; Gina Aloisio, MD, PhD[1]; Elizabeth A. Camp, PhD[2]; James Dunn, PhD[3]; Sarah Meskill, MD[1], (1) Baylor College of Medicine/Texas Children's Hospital, Houston, TX, (2) Baylor College of Medicine, Houston, TX, (3) Texas Children's Hospital, Houston, TX

Background: Following the onset of the COVID-19 pandemic, RSV infections deviated from a previously reliable epidemiologic pattern of presentation. To investigate whether this change in RSV seasonality resulted in a change in frequency and severity of RSV infections, this single center retrospective study compares demographic and hospital factors during RSV seasons prior to and after the onset of the COVID-19 pandemic.

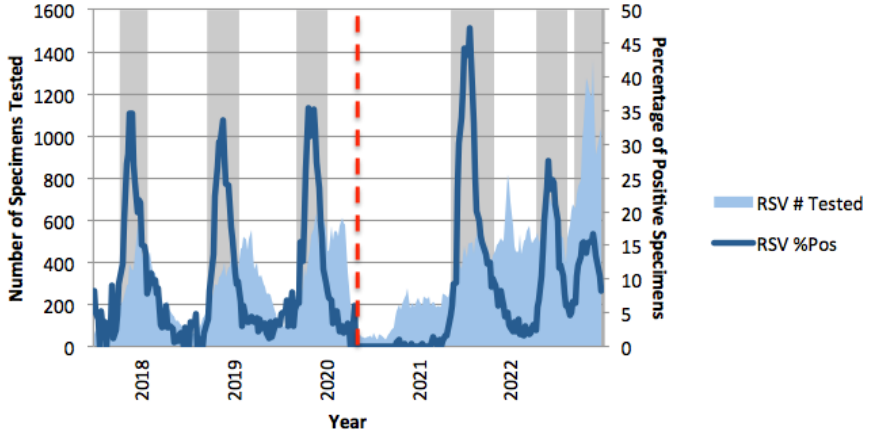
Methods: Included were patients under age 5 years who tested positive for RSV by RT-PCR in our pediatric emergency departments during the last three RSV seasons before the onset of the COVID-19 pandemic in spring 2020, as compared to the first three seasons after the pandemic started. RSV seasonality was defined as periods in which greater than 10% of all RSV RT-PCR tests sent resulted positive. Patients with tracheostomies were excluded, as were duplicate tests performed in the same patient within 1 day. Demographic data obtained included patient age, sex, and weight. Hospital factors obtained were inpatient admission and length of stay (LOS), intensive care unit (ICU) admission and LOS, respiratory support during the encounter, and mortality. A planned subgroup analysis isolating the first RSV season after the pandemic's onset was performed. Mann-Whitney and Pearson Chi-Square testing were used for comparison of continuous and categorical variables, respectively. Significance was set at $p < 0.05$.

Results: RSV seasons were identified as in Figure 1, with 7592 cases meeting study criteria (2770 cases before the pandemic's onset and 4822 cases after). Table 1 displays the comparison of RSV seasons before and after the onset of COVID-19, as well as a subgroup analysis with the first RSV season after the pandemic's onset. While there were more RSV cases following the onset of COVID-19, testing also increased during this period. Patients in seasons after the onset of COVID-19 were significantly older than those in seasons before. They were significantly less likely to be admitted to the hospital, though ICU admission rates did not change significantly. Both inpatient and ICU LOS decreased significantly. Admitted patients were significantly more likely to require respiratory support, with more requiring BIPAP and fewer requiring intubation.

Conclusion: During the first three RSV seasons after the onset of the COVID-19 pandemic,

our pediatric emergency departments saw more RSV positive patients than prior seasons. These patients were significantly older and less likely to be admitted, which may be partly due to increased respiratory viral testing during the pandemic. However, shorter LOS and decreased intubations despite increased respiratory support among admitted patients may indicate a paradigm shift in emergency department and inpatient management of severe RSV infections, perhaps encouraged by practice changes and resource limitations due to COVID-19. This information may better guide institutions in predicting resource needs after large-scale infectious disease outbreaks in the future.

Figure 1: Defining RSV seasons



Seasonality was defined as calendar weeks during which the number of RSV tests resulting positive was greater than 10% of all RSV tests obtained. The first week of COVID-19 testing at our institution is demarcated with a dashed red line, and periods meeting seasonality criteria are shaded in gray.

Table 1: Comparison data

	RSV seasons prior to COVID-19 *N = 2770* N (%) or Median (IQR)	RSV seasons after onset of COVID-19 *N = 4822* N (%) or Median (IQR)	P-value	First RSV season after onset of COVID-19 *N = 2009* N (%) or Median (IQR)	P-value
Patient Demographics					
Age (years)	0.56 (0.19, 1.39)	0.83 (0.30, 2.00)	<0.001	0.75 (0.25, 1.84)	<0.001
Male sex	1568 (56.6)	2666 (55.3)	0.27	1113 (55.4)	0.41
Weight (pounds)	17.24 (11.70, 24.08)	20.06 (13.80, 27.34)	<0.001	19.50 (13.12, 26.46)	<0.001
Hospital Factors					
Inpatient admission	1522 (54.9)	2259 (46.8)	<0.001	970 (48.3)	<0.001
Inpatient LOS (hours)	64 (35, 117)	60 (35, 100)	0.01	61 (35, 103.25)	0.13
ICU admission	474 (31.1)	744 (32.9)	0.25	317 (32.7)	0.42
ICU LOS (hours)	88.5 (45, 241.5)	68 (43.25, 143)	<0.001	74 (45.5, 150.5)	0.04
Required respiratory support (admitted patients)	1316 (86.5)	2010 (89.0)	0.02	852 (87.8)	0.32
Max support: *Nasal cannula*	465 (35.3)	714 (35.5)	0.91	316 (37.1)	0.41
HFNC	375 (28.5)	610 (30.3)	0.25	252 (29.6)	0.59
CPAP	188 (14.3)	266 (13.2)	0.39	109 (12.8)	0.32
BIPAP	107 (8.1)	228 (11.3)	0.003	89 (10.4)	0.07
Intubation	181 (13.8)	192 (9.6)	<0.001	86 (10.1)	0.01
Deceased	1 (0.0)	2 (0.0)	1.00	1 (0.0)	1.00

Comparing patient demographic data and hospital factors used to extrapolate disease severity between cases during the last three RSV seasons prior to the onset of the COVID-19 pandemic vs. first three RSV seasons afterward. A subgroup analysis comparing pre-COVID-19 RSV seasons vs. the first RSV season after the pandemic's onset is also shown. (HFNC = high flow nasal cannula, CPAP = continuous positive airway pressure, BIPAP = bilevel positive airway pressure.)

Pediatric Firearm Injury Emergency Department Visits During the COVID-19 Pandemic: A Multicenter Study

10/20/2023

Oral Presentation

Jennifer A. Hoffmann, MD, MS[1]; Camille P. Carter, BS[2]; Cody S. Olsen, MS[2]; Pradip P. Chaudhari, MD[3]; Sofia S. Chaudhary, MD[4]; Susan Duffy, MD, MPH[5]; Nicolaus Glomb, MD, MPH[6]; Monika K. Goyal, MD, MSCE[7]; Jacqueline Grupp-Phelan, MD MPH[8]; Maya Haasz, MD[9]; Bijan W. Ketabchi, MD, MPH[10]; Nicole Kravitz-Wirtz, PhD, MPH[11]; E Brooke Lerner, PhD[12]; Bashar S. Shihabuddin, MD, MS[13]; Wendi Wendt, MD[14]; Lawrence J. Cook, PhD[2]; Elizabeth R. Alpern, MD, MSCE[15], (1) Ann & Robert H. Lurie Children's Hospital of Chicago, Northwestern University Feinberg School of Medicine, Chicago, IL, (2) Department of Pediatrics, University of Utah, Salt Lake City, UT, (3) Children's Hospital Los Angeles, Los Angeles, CA, (4) Emory University School of Medicine, Children's Healthcare Of Atlanta, Decatur, GA, (5) Hasbro Children's Hospital at Rhode Island Hospital, Providence, RI, (6) UCSF, San Franciso, CA, (7) Children's National Hospital, Washington, DC, (8) UCSF Benioff Childrens Hospitals, Mill Valley, CA, (9) University of Colorado School of Medicine, Aurora, CO, (10) The Children's Hospital of Philadelphia, Philadelphia, PA, (11) University of California Davis School of Medicine, Sacramento, CA, (12) University at Buffalo, Buffalo, NY, (13)

Nationwide Children's Hospital/ OSUCOM, Columbus, OH, (14) Medical College of Wisconsin, Mequon, WI, (15) Ann & Robert H. Lurie Children's Hospital, Chicago, IL

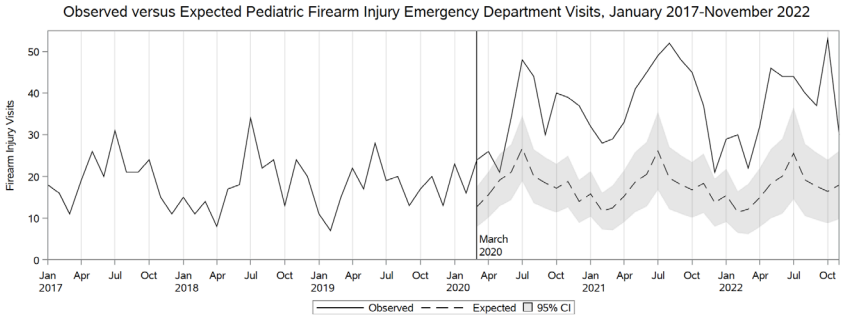
Background: Firearm injuries among children increased during the COVID-19 pandemic, but recent trends in firearm-related emergency department (ED) visits have not been well described. We sought to assess how the pediatric firearm injury ED visit rate during the COVID-19 pandemic differed from expected rates based on pre-pandemic trends.

Methods: We conducted a retrospective cross-sectional study of ED visits for firearm injuries by children under 18 years old at nine hospitals participating in the Pediatric Emergency Care Applied Research Network Registry from January 2017 to November 2022. We compared sociodemographic and clinical characteristics of firearm injury ED visits before the pandemic (January 2017-February 2020) and during the pandemic (March 2020-November 2022). To estimate the expected ED visit rate per 30 days during the pandemic, we calculated prediction estimates and intervals from pre-pandemic ED visit data using multivariable Poisson regression models, accounting for seasonal, geographic, and temporal trends. We calculated the rate ratio (RR) of observed to expected firearm injury ED visits per 30 days, overall and stratified by sociodemographic characteristics.

Results: During the study period, 1902 pediatric firearm injury ED visits occurred at participating hospitals (694 visits pre-pandemic; 1208 visits during the pandemic). Of these, 52.3% were 15-17 years old, 80.0% were male, 63.5% were non-Hispanic Black, 81.1% were publicly insured, and 63.8% were from zip codes with a very low Child Opportunity Index. Triage category level 1 (highest acuity) visits increased from 38.5% pre-pandemic to 46.4% during the pandemic (P=0.027). The percentage of injured children who died in the ED or hospital increased from 3.1% pre-pandemic to 6.1% during the pandemic (P=0.007). Before the pandemic, there were 18.0 firearm injury ED visits per 30 days, which increased to 36.1 visits per 30 days during the pandemic (Figure 1), with an observed to expected visit RR of 2.09 (95% CI 1.63, 2.91). During the pandemic, firearm injury ED visits per 30 days were higher than expected for children 10-14 years old (RR 2.61, 95% CI 1.69, 5.71), 15-17 years old (RR 2.09, 95% CI 1.51, 3.38), males (RR 2.00, 95% CI 1.53, 2.86), females (RR 2.46, 95% CI 1.55, 6.00), Black non-Hispanic children (RR 1.88, 95% CI 1.34, 3.10), and Hispanic children (RR 2.30, 95% CI 1.30, 9.91) (Figure 2). Firearm injury ED visit rates did not differ significantly from expected for children 0-4 years old, 5-9 years old, or for White non-Hispanic children.

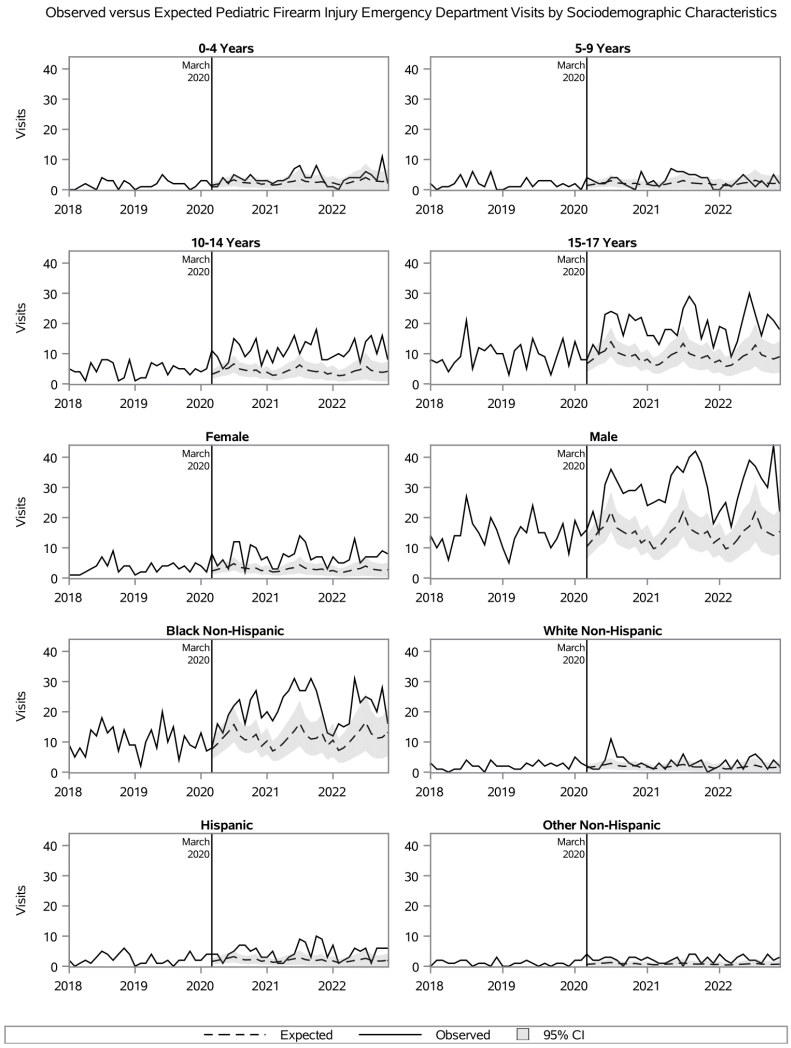
Conclusion: Firearm injury ED visit rates by children during the COVID-19 pandemic exceeded twice the rates predicted by pre-pandemic trends. Visit rates were higher than expected for Black and Hispanic children, widening injury disparities that preceded the pandemic. These findings may inform pediatric firearm injury prevention efforts, including during future public health emergencies.

Figure 1. Observed versus Expected Pediatric Firearm Injury Emergency Department Visits, January 2017-November 2022



Pediatric firearm injury emergency department visits increased significantly above expected visit numbers from July 2020 through November 2022.

Figure 2. Observed versus Expected Pediatric Firearm Injury Emergency Department Visits by Sociodemographic Characteristics



"Less Ouch IV": Minimizing Pain for Non-critical Ivs in a Pediatric ED

10/20/2023

Oral Presentation

Daniel Ichwan, MD[1]; Amy W. Bryl, MD[2]; Daniel Roderick, MSN, RN, CNL, CPEN, TCRN[3]; Karen Yaphockun, DO[3]; Aislinn Mooney, CCLS[3]; Michele McDaniel, MD[3], (1) Rady Children's Hospital - San Diego, Division of Pediatric Emergency Medicine, Pasadena, CA, (2) RCHSD, San Diego, CA, (3) Rady Children's Hospital - San Diego, Division of Pediatric Emergency Medicine, San Diego, CA

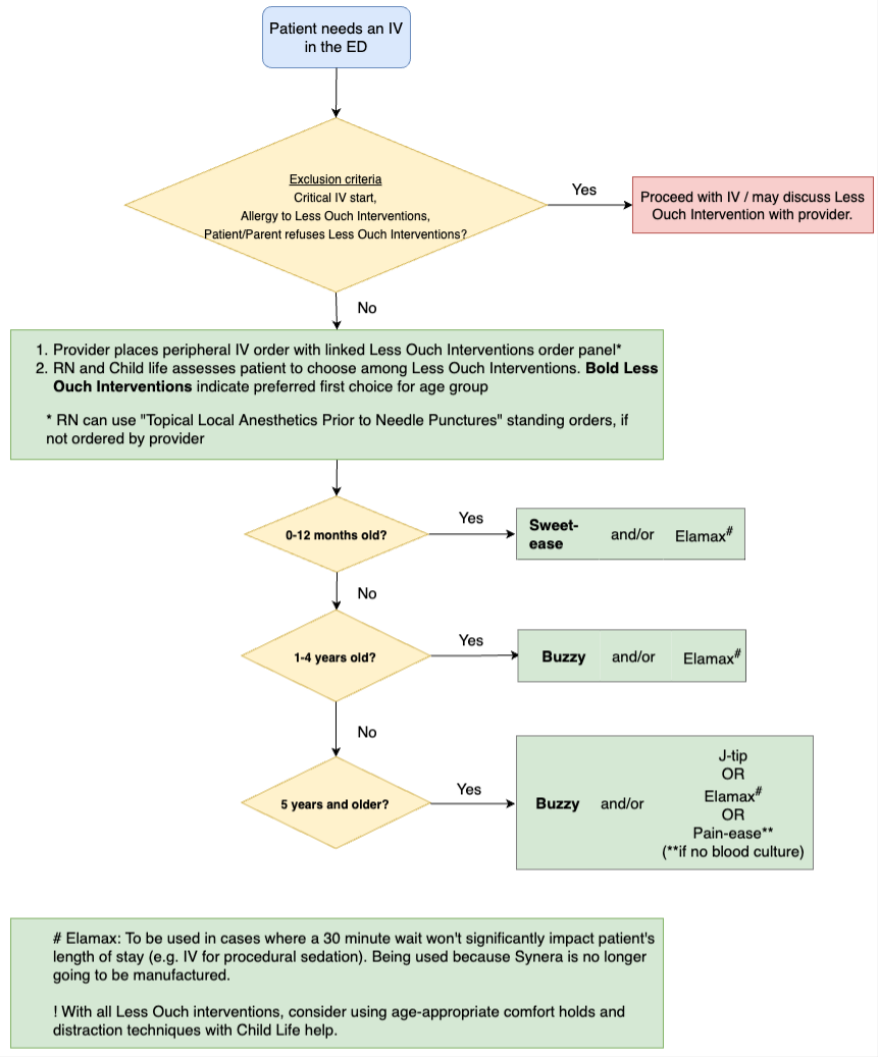
Purpose/Objectives: Peripheral intravenous (IV) line insertion is a common pediatric procedure performed in the emergency department (ED). At an early age, painful IV experiences can have a long-term impact, leading to needle phobia, decreased medical adherence, and negative nurse and physician satisfaction. Fast-acting interventions to reduce IV insertion pain are available. We aimed to decrease pain associated with non-critical IVs without increasing time to IV insertion in our pediatric ED. Our primary aim was to increase the proportion of “less ouch” IVs from a baseline of 8% to 50% within 12 months.

Design/Methods: A multidisciplinary team of pediatric ED nurses, physicians, child life specialists, and pharmacists created an evidence-based pain reduction algorithm for IV insertions (Figure 1). The algorithm is age-based and prioritizes fast-acting interventions, such as oral sucrose for patients under 1 year old and Buzzy® (a vibratory device) for patients over 1 year old. All IVs placed in the pediatric ED were included in the initiative. The initiative excluded IVs ordered as “critical IVs” and IVs placed in patients with an Emergency Severity Index of 1. An IV was considered “less ouch” if an age-appropriate pain reducing intervention from the algorithm was documented. Initial interventions included the introduction of the algorithm at nursing and physician meetings. An IV order panel replaced the “insert IV” order on the ED preferred order list. This order panel bundles the “insert IV” order with the recommended PRN pharmacologic orders and a nursing communication order recommending use of non-pharmacologic interventions. “Buzzy® Hives” were implemented to house these devices in each nursing zone for easier visibility and use. Monthly PDSA cycles were performed with nursing and physician feedback incorporated. Subsequent interventions included posters near IV insertion supplies, team reminders during meetings and in newsletters, and order set integration of the IV order panel. The balancing measure was the average time from IV order to insertion. We used statistical process control to examine changes in measures over time.

Results: From October 2022 to March 2023, the proportion of ED IV insertions using a “less ouch” intervention increased from 8% to 15% (Figure 2). The average time from IV order to insertion remained stable at 48 minutes.

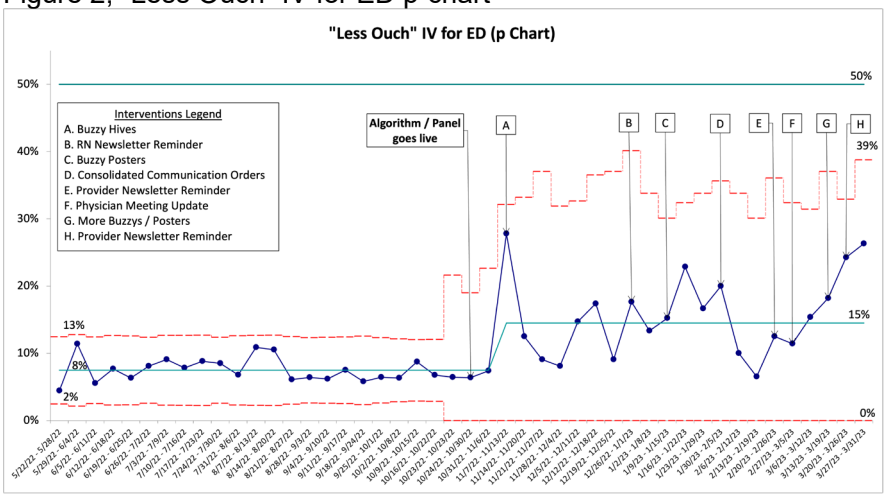
Conclusion/Discussion: We increased the proportion of non-critical IVs placed using age-appropriate pain reducing interventions without increasing time to IV insertion through implementation of an age-based algorithm, IV order panel, and periodic education. Future efforts will focus on increasing and sustaining adherence.

Figure 1, “Less Ouch” IV Algorithm



An age-based algorithm for pain reduction interventions for non-critical IV placement

Figure 2, “Less Ouch” IV for ED p-chart



Proportion of non-critical IVs using age-appropriate pain-reducing interventions during the baseline period (5/22/22-10/23/22) and after the initiative was introduced (10/24/22-3/31/23)

Identifying Pediatric Patients at Risk of Developing Severe Complications from sars-cov-2 Infection – Harnessing the Power of Artificial Intelligence-driven Predictive Models

10/20/2023

Oral Presentation

Oluwakemi Badaki-Makun, MD, PhD[1]; Scott Levin, PhD[2]; Jeremiah Hinson, MD, PhD[1]; Aria Smith, MSc[3]; Xihan Zhao, BSc[1]; Deborah Persaud, MD[1]; Bryan Lau, PhD[4], (1) Johns Hopkins University, Baltimore, MD, (2) Johns Hopkins University; Beckman Coulter, Baltimore, MD, (3) Beckman Coulter, Baltimore, MD, (4) Johns Hopkins School of Public Health, Baltimore, MD

Background: At initial evaluation in the Emergency Department (ED), it is not known which children infected with SARS-CoV-2 might be at risk of severe outcomes. Our objective was to derive and validate models for predicting the development of severe complications of SARS-CoV-2 in children in the ED using electronic health record data and artificial intelligence-based machine learning methods.

Methods: This was an observational study of one academic and two community hospitals. ED encounters from patients aged 0-21 years were included if patients underwent SARS-CoV-2 testing between March 2020 and December 2022. Primary outcomes were: need for general inpatient care (cardiovascular or respiratory dysfunction, or readmission within 72 hours) or critical care (intensive care admission, need for vasopressors, need for ventilatory support, or death). Predictor variables were chosen based on existing literature and univariable analyses. Models were derived using predictors available at various time points during the ED visit: at triage (A), once labs were obtained (B), once any respiratory support was given (C), and at ED disposition (D). Models were trained and internally validated on electronic health record data from the academic hospital and externally validated on data from each community hospital. Data were analyzed using descriptive statistics and random forest supervised machine learning (ML) analyses.

Results: For the 42490 ED visits included, median age was 4.0 years (interquartile range [IQR] 1.0 – 11.0), females accounted for 48.6% of visits, 45.5% of patients were Black, 23.0% White, and 18.9% were Hispanic. The most common chief complaints were fever (26.2%) and respiratory symptoms (26.9%). A need for inpatient care occurred in 5181 visits (12.2%) and for critical care in 1758 visits (4.1%). The area under the receiver operating characteristic curve (AUC) for time points A, B, C and D were 0.84 (95% confidence interval [CI] 0.83 – 0.85), 0.85 (95%CI 0.84 – 0.85), 0.85 (95%CI 0.84 – 0.86), and 0.85 (95%CI 0.84 – 0.86), respectively for predicting need for inpatient care, and 0.87 (95%CI 0.86 – 0.88), 0.88 (95%CI 0.87 – 0.89), 0.88 (95%CI 0.87 – 0.89), and 0.88 (95%CI 0.87 – 0.89) respectively for predicting need for critical care in the internal validation dataset. Figure 1 depicts corresponding AUCs for the external validations at each community hospital.

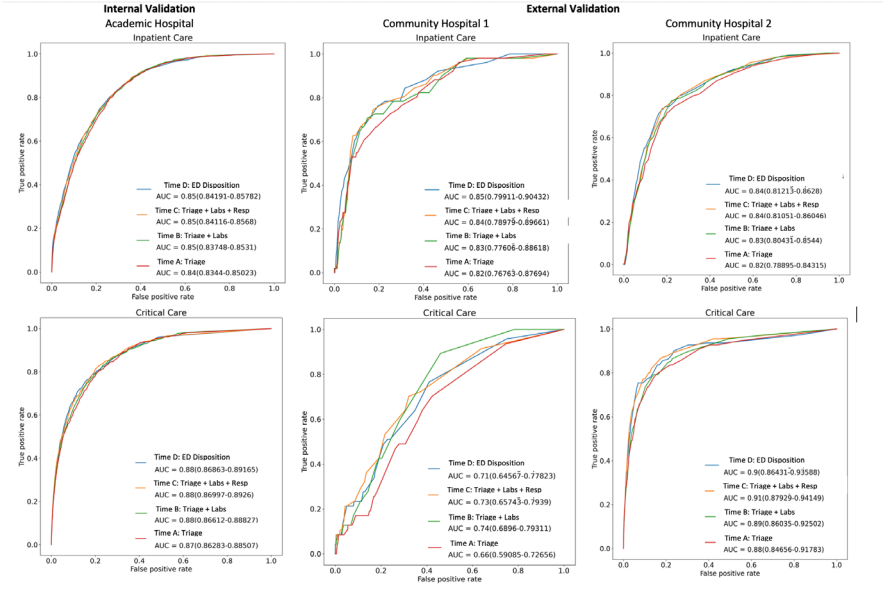
Conclusion: Machine learning models using data obtained during an ED visit accurately predicted need for inpatient and critical care in children with SARS-CoV-2. Models using variables available at triage (demographics, past medical history, chief complaint, and triage vital signs) performed as well as those adding data collected during the rest of the ED encounter. Similar methods could be applied to other disease processes to accurately predict

risk of decompensation at presentation to the ED.

Table 1. Patient Demographics, Chief Complaints, and Primary Outcomes Stratified by Hospital

Variable	Total Cohort	Community Hospital 1	Community Hospital 2	Academic Hospital
PED Visits	42490	5665	11520	25305
Demographics				
Age, median(IQR)	4.0(1.0, 11.0)	3.0(1.0, 7.0)	4.0(1.0, 11.0)	5.0(1.0, 12.0)
Sex, Female, N(%)	20648(48.6%)	2732(48.2%)	5433(47.2%)	12483(49.3%)
Black, N(%)	19352(45.5%)	1378(24.3%)	3944(34.2%)	14030(55.4%)
White, N(%)	9787(23.0%)	3156(55.7%)	2654(23.0%)	3977(15.7%)
Other, N(%)	11300(26.6%)	1051(18.6%)	3650(31.7%)	6599(26.1%)
Hispanic, N(%)	8042(18.9%)	2681(47.3%)	2079(18.0%)	3282(13.0%)
Top 5 Chief Complaints, N(%)				
Fever	11147(26.2%)	2224(39.3%)	3572(31.0%)	5351(21.1%)
Lower Respiratory Complaint	4566(10.7%)	1023(18.1%)	1314(11.4%)	2229(8.8%)
Shortness Of Breath	4228(10.0%)	384(6.8%)	1082(9.4%)	2762(10.9%)
Nausea/Emesis/Diarrhea	3734(8.8%)	479(8.5%)	878(7.6%)	2377(9.4%)
Upper Respiratory Complaint	2627(6.2%)	316(5.6%)	783(6.8%)	1528(6.0%)
Top 5 Co-morbid Conditions, N(%)				
Gastrointestinal	11152(26.2%)	1092(19.3%)	1655(14.4%)	8405(33.2%)
Pulmonary	10267(24.2%)	1048(18.5%)	1634(14.2%)	7585(30.0%)
Endocrine	8785(20.7%)	974(17.2%)	831(7.2%)	6980(27.6%)
Other Systemic Condition	8566(20.2%)	619(10.9%)	983(8.5%)	6964(27.5%)
Neurologic	8497(20.0%)	732(12.9%)	995(8.6%)	6770(26.8%)
Outcomes, N(%)				
Inpatient Care	5181(12.2%)	176(3.1%)	721(6.3%)	4284(16.9%)
Critical Care	1758(4.1%)	79(1.4%)	309(2.7%)	1370(5.4%)

Figure 1. Receiver Operating Characteristic Plots for the Two Primary Outcomes: Inpatient and Critical Care Need



Receiver operating characteristic plots for models evaluating the two primary outcomes using data from each of the four time points: Timepoint A = data available at triage (demographics,

past medical history, chief complaint, and triage vital signs); Time point B = data available at triage + initial labs; Time point C = data available at triage + initial labs + any respiratory support; Time point D = data available at triage + initial labs + any respiratory support + Emergency Department disposition vitals and vital sign trends. *Of note, models predicting the critical care outcome in Community Hospital 1 were less precise given the small number of critical care outcomes at that hospital (79 vs. 1370 at the academic hospital).

Racial/ethnic and Language Disparities in Electronic Health Record-embedded Behavioral Health Flag Use in a Pediatric Emergency Department

10/20/2023

Oral Presentation

Gia M. Badolato, MPH[1]; Meleah Boyle, PhD, MPH[2]; Monika Lemke, MSN, MPH, RN[3]; Danielle Foltz, BA[1]; Asha Payne, MD MPH[4]; Meghan Schott, DO, FAPA[5]; Theresa Ryan Schultz, PhD, MSN, MBA, RN, NEA-BC[4]; Monika K. Goyal, MD, MSCE[1], (1) Children's National Hospital, Washington, DC, (2) Children's National Hospital, Rockville, MD, (3) Children's National Hospital, Westminster, MD, (4) Children's National Hospital, Washington, DC, (5) Children's National, Washington, DC

Background: There are racial disparities in the management of youth presenting with mental health concerns (MHC) to the emergency department (ED), with minoritized youth experiencing higher rates of chemical and physical restraints. Behavioral health flags (BHF) in the electronic health record (EHR) alert providers of the potential risk of harmful or violent encounters. Racial and ethnic disparities in BHF use have been demonstrated in the adult population, but little is known about their use in the pediatric population. The objective of this study was to investigate the presence of racial, ethnic, and language disparities in the use of BHFs among youth presenting to the ED with MHC.

Methods: Cross-sectional study of visits from January 2020 through December 2022 with an ICD code related to MHC (F90-F99) in an urban pediatric ED. We extracted patient and visit level data from the EHR. Race and ethnicity were categorized as non-Hispanic (NH) white, NH Black, Hispanic and NH other, and preferred language was categorized as English, Spanish and Other. Multivariable logistic regression used to examine racial, ethnic and language preference differences and the presence of BHFs. Models were adjusted for age, sex, and insurance. In a subpopulation of patients with the BHF, we examined the differences in being flagged as high risk of aggression vs moderate and low risk.

Results: There were 3074 visits representing 2369 unique patients with MHC. The majority of patients were male (56.3%), NH Black (58.5%), and publicly insured (63.8%) with a mean age of 13 (+/- 3.9) years (Table 1). BHFs were present in 41.8% of the visits. NH Black patients had higher odds of having a BHF compared to NH whites (47.4% vs 33.2%; aOR:1.7; [95% CI 1.4, 2.2]). Compared to patients who preferred English (43.5%), patients who preferred Spanish (30.1%; aOR: 0.5; [95% CI 0.4, 0.7]) or another language (30.0%; aOR: 0.6 [95% CI 0.4, 0.8]) had lower odds of having a BHF. In patients with BHFs (n=1286), the majority were marked as low risk of aggression (55.1%), followed by high risk (26.2%), and moderate risk (18.7%.) NH Black patients had higher odds of being flagged as high risk than NH white patients (29.8% vs 17.2%; aOR: 1.8; [95% CI 1.2, 2.8]). Patients who preferred a language other than English had higher odds of being flagged as high risk of aggression when compared to patients who preferred English (41.2% vs 26.1%; aOR: 2.0; [95% CI 1.1, 3.5]) (Table 2).

Conclusion: These findings suggest that disparities exist in the use of BHFs, with minoritized youth more likely to be affected. Multi-center studies are needed to confirm these results and inform interventions to standardize the use of BHFs as well as create institutional changes to address structural racism in mental health care.

Table 1: Select Characteristics of Study Population

Table 1: Characteristics of Study Population

Characteristic	N=3074
Mean Age in years (SD)	13.0 (3.9)
	N (%)
Race and Ethnicity	
non-Hispanic (NH) white	630 (20.5%)
NH Black	1799 (58.5%)
Hispanic	372 (12.1%)
NH Other+	137 (4.5%)
Missing	136 (4.4%)
Preferred Language	
English	2695 (87.7%)
Spanish	209 (6.8%)
Other++	170 (5.5%)
Male Sex	1732 (56.3%)
Insurance Status	
Private	1026 (33.4%)
Public	1961 (64.0%)
Self-Pay	54 (1.8%)
Not Documented	33 (1.1%)
Emergency Severity Index (ESI)	
2	839 (27.3%)
3	1985 (64.6%)
4	232 (7.6%)
5	18 (0.6%)
Disposition	
Home	1566 (50.9%)

+Non-Hispanic Other consists of person who identify as American Indian or Alaska Native Asian, Multiple, or Other

++Other Language consists of persons who speak Amharic, Arabic, Dzongkha, Faroese, French, Portuguese, Sign Language or Other

Table 2: Mental Health Care Outcomes by Race, Ethnicity and Language

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	Behavior Health Flag n=1286/3074 (41.2%)	Behavior Health Flag	High Risk of Aggression n=337/1286 (26.2%)	High Risk of Aggression
Race and Ethnicity	n (%)	aOR (95% CI)*	n (%)	aOR (95% CI)*
NH-White	209 (33.7%)	Referent	36 (17.2%)	Referent
NH-Black	852 (47.4%)	*1.7 (1.4, 2.2)*	254 (29.8%)	*1.8 (1.2, 2.8)*
Hispanic	119 (32.0%)	0.9 (0.7, 1.3)	19 (16.0%)	0.9 (0.4, 1.6)
NH-Other+	51 (37.2%)	1.2 (0.8, 1.8)	10 (19.6%)	1.2 (0.6, 2.7)
Preferred Language				
English	1172 (43.5%)	Referent	306 (26.1%)	Referent
Spanish	63 (30.1%)	*0.5 (0.4, 0.7)*	10 (15.9%)	0.5 (0.3, 1.1)
Other++	51 (30.0%)	*0.6 (0.4, 0.8)*	21 (41.2%)	*2.0 (1.1, 3.6)*

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*Models adjusted for age in years, patient sex and insurance status
+Non-Hispanic Other consists of person who identify as American Indian or Alaska Native Asian, Multiple, or Other
++Other Language consists of persons who speak Amharic, Arabic, Dzongkha, Faroese, French, Portuguese, Sign Language or Other
Italics represent significance at the p <0.05

Adolescent Relationship Abuse Prevention in a Pediatric Emergency Department: Preliminary Findings from a Pilot RCT

10/20/2023

Oral Presentation

Lenore R. Jarvis, MD, MEd[1]; Elizabeth Miller, MD, PhD, FSAHM[2]; Gia M. Badolato, MPH[1]; Summer Khalefa, MS[1]; James M. Chamberlain, Chamberlain, MD[3]; Monika K. Goyal, MD, MSCE[1], (1) Children's National Hospital, Washington, DC, (2) UPMC Children's Hospital of Pittsburgh, Pittsburgh, PA, (3) Children's National Hospital and George Washington University, Gaithersburg, MD

Background: Adolescent relationship abuse (ARA) affects millions of adolescents annually and is associated with negative health outcomes. We leveraged community collaborative input for

adaptation of existing evidence-based ARA interventions for the pediatric emergency department (PED) setting.

Methods: Pilot randomized controlled trial (RCT) designed to assess feasibility, acceptability, and effectiveness of an ED-based ARA intervention in an urban PED. From February 2023 (and ongoing), adolescents 13-18 years old completed an electronic survey evaluating acceptability attitudes, self-efficacy, recognition of ARA, importance of healthy relationship characteristics, ARA victimization, partner access to firearms, knowledge and use of ARA resources; and receive institutional resources and have opportunity to request social work consultation. The intervention group receives universal ARA education, a healthy relationship quiz (if in a relationship), and QR code access that contains local and national resources (websites with chat options, click to call phone numbers, and texting) through an electronic tablet. The intervention group also answers questions about the intervention effectiveness and QR “hits” are tracked. We calculated feasibility based on adolescent study completion. Acceptability was assessed using 4 Likert-style questions to assess the acceptability of ARA being addressed in the ED setting. Secondary outcome measures include preliminary intervention effectiveness will be further assessed through a future 1-month follow-up survey.

Results: Study enrollment is ongoing. Of 107 (intervention=50, control=57) patients currently enrolled, the mean age was 15.5 (SD +/- 1.5), the majority were female (55%), Black (56%), heterosexual (71%), identified as single (66%), and not sexually active (62%). Over one-third (36%) have experienced some form of ARA (5% physical abuse, 10% sexual abuse, 5% reproductive coercion, 33% cyber abuse). At least 18% (6 of 33 adolescents in a relationship) reported that their dating partners had access to firearms. Of the adolescents randomized to the intervention group who are currently in a relationship, the majority (13/21 (62%)) scored as “definitely warning signs of an abusive relationship” on the healthy relationship quiz. Preliminary intervention results demonstrate high feasibility (97% baseline study completion), acceptability (majority of study participants report “it is helpful for healthcare providers to talk about healthy and unhealthy relationships to adolescents” (91%) and that the “ED is an acceptable place” (74%)), and effectiveness (majority of adolescents in the intervention group report increased understanding about healthy and unhealthy relationships (88%) and how to help someone being hurt by a sexual partner or in an unhealthy relationship (84%)) (Table 1).

Conclusion: This ongoing pilot RCT supports feasibility and acceptability of an ED-based ARA intervention for adolescents in a PED. Over one-third of our adolescents have experienced ARA and the majority of adolescents who took the healthy relationship quiz intervention have signs of an abusive relationship. One-month follow-up surveys will continue to assess preliminary intervention effectiveness.

Table 1: Feasibility, Acceptability, and Preliminary Effectiveness of an ED-based, Adolescent Centered ARA Intervention (enrollment ongoing)

Table 1: Feasibility, Acceptability, and Preliminary Effectiveness of an ED-based, Adolescent Centered ARA Intervention (enrollment ongoing)			
Feasibility	**Overall Study Population (N=107)**	**Intervention Group (n=50)**	**Enhanced Care (Control) Group (n=57)**
Completed the study.	104 (97%)	49 (98%)	55 (96%)
Acceptability (agreement with the following statements) Strongly Agree/Agree vs Not	**Overall Study Population**	**Intervention Group**	**Enhanced Care (Control) Group**
It is helpful for health care providers to talk about healthy and unhealthy relationships to adolescents.	96 (91%)	46 (94%)	50 (89%)
The emergency department is an acceptable place for health care providers to talk about healthy and unhealthy relationships to adolescents.	78 (74%)	37 (76%)	41 (73%)
Emergency department staff care about their safety.	99 (94%)	45 (92%)	54 (96%)
People/staff in the emergency department would know what to do if they were in an unhealthy relationship.	73 (70%)	38 (78%)	35 (63%)
Preliminary Effectiveness (agreement with the following statements)	**Overall Study Population**	**Intervention Group**	**Enhanced Care (Control) Group**
The intervention increased understanding about health and unhealthy relationships.	n/a	44 (88%)	n/a
The intervention increased understanding about how to help someone being hurt by a sexual partner or in an unhealthy relationship.	n/a	42 (84%)	n/a
Universal education was helpful.	n/a	39 (78%)	n/a
The healthy relationship quiz was helpful.	n/a	17 (81%)	n/a
QR code “hits”/clicks.	n/a	28 hits	n/a
Asked to speak to a social worker.	2 (2%)	0 (0%)	2 (2%)
Recognition of ARA. (Not Abusive (1) to Extremely Abusive (5))	item median = 4.0 IQR = 0.9	item median = 4.1 IQR = 1.0	item median = 4.0 IQR = 0.9
Recognition of reproductive coercion. (Not Abusive (1) to Extremely Abusive (5))	item median = 4.5 IQR = 0.75	item median = 4.5 IQR = 0.81	item median = 4.5 IQR = 0.75
Importance of healthy relationship characteristics. (Not Important (1) to Very Important (3))	item median = 2.7 IQR = 0.55	item median = 2.8 IQR = 0.80	item median = 2.7 IQR = 0.30

Comparison of C-spine CT Decision Rules for Children After Blunt Trauma

10/20/2023

Oral Presentation

Lois K. Lee, MD, MPH[1]; Caleb E. Ward, MB BChir, MPH, FAAP[2]; Lorin R. Browne, DO[3]; Monica L. Harding, MS[4]; Lawrence J. Cook, PhD[5]; Kathleen M. Adelgais, MD MPH FAAP FAEMS[6]; Rebecca K. Burger, MD FAAP FACEP[7]; Alexander Rogers, MD[8]; Leah Tzimenatos, MD[9]; Lauren C. Riney, DO[10]; Kenneth Yen, MD, MS[11]; Julie C. Leonard, MD, MPH[12], (1) Boston Children's Hospital, Harvard Medical School, Boston, MA, (2) Children's National Hospital, The George Washington University School of Medicine and Health Sciences, Washington, DC, (3) Medical College of Wisconsin, Milwaukee, WI, (4) University of Utah, Jacksonville, FL, (5) Department of Pediatrics, University of Utah, Salt Lake City, UT, (6) University of Colorado School of Medicine, Aurora, CO, (7) Emory University School of Medicine/Children's Healthcare of Atlanta, Atlanta, GA, (8) University of Michigan, Ann Arbor, MI, (9) University of California, Davis, School of Medicine, Sacramento, CA, (10) Cincinnati childrens hospital medical center, Cincinnati, OH, (11) University of Texas Southwestern Medical School, Dallas, TX, (12) Nationwide Children's Hospital, Columbus, OH

Background: Several clinical decision rules, derived primarily in adults, were developed to assist in guiding imaging decisions for cervical spine injury (CSI) evaluation. Comparing the diagnostic accuracy for these rules in identifying children at high risk for CSI will inform best

practices for imaging after blunt trauma. The objectives of this study were to compare the test characteristics and projected imaging rates between three CSI clinical decision rules: Pediatric Emergency Care Applied Research Network CSI decision rule (PECARN CSI rule), Canadian C-spine Rule (CCR), and the National Emergency X-Radiography Utilization Study (NEXUS).

Methods: We conducted a planned secondary analysis of a multi-center, prospective observational study of children (0-17 years old) presenting after blunt trauma to 18 PECARN emergency departments from December 2018-October 2021. We included all children enrolled in the primary study (to develop and validate the PECARN CSI rule). Study data on injury mechanisms, predisposing conditions, neck and neurological symptoms, and physical examination findings were applied to the three different CSI rules. We calculated the test characteristics with 95% confidence intervals (sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV)) and created Receiver Operator Curves for the detection of CSI for the three rules. We also estimated the projected c-spine imaging rate (x-ray or CT) based on criteria for each of the three rules.

Results: There were 22,430 eligible children enrolled and 1.9% (433) had CSI. C-spine imaging was performed in 56.9% (12,768): 39.7% (8912) with only x-rays and 17.2% (3856) with CT. The sensitivity of the three rules was: PECARN CSI rule 93.3% (95% CI 90.9, 95.7); CCR 75.3% (95% CI 69.9, 80.7); and NEXUS 76.7% (95% CI 72.7, 80.7) (Table). The NPV of the three rules was: PECARN 99.8% (95% CI 99.7, 99.9); CCR 97.8% (95% CI 97.3, 98.4); and NEXUS 99.4% (95% CI 99.3, 99.5). The Area Under the Curve for the Receiver Operator Curves was: PECARN 0.77, CCR 0.56, and NEXUS 0.76 (Figure). Strictly applying each rule resulted in projected imaging frequencies of: PECARN 41.1%, CCR 79.1%, and NEXUS 25.2%.

Conclusion: The PECARN CSI rule had the best sensitivity and NPV for identifying children at low risk for CSI after blunt trauma. Application of the PECARN CSI rule in our study population could have reduced c-spine imaging in these patients. The PECARN CSI rule has the best diagnostic accuracy for the evaluation of those at risk for CSI among pediatric trauma patients.

Table. Comparison of C-Spine Imaging Decision Rule Test Characteristics

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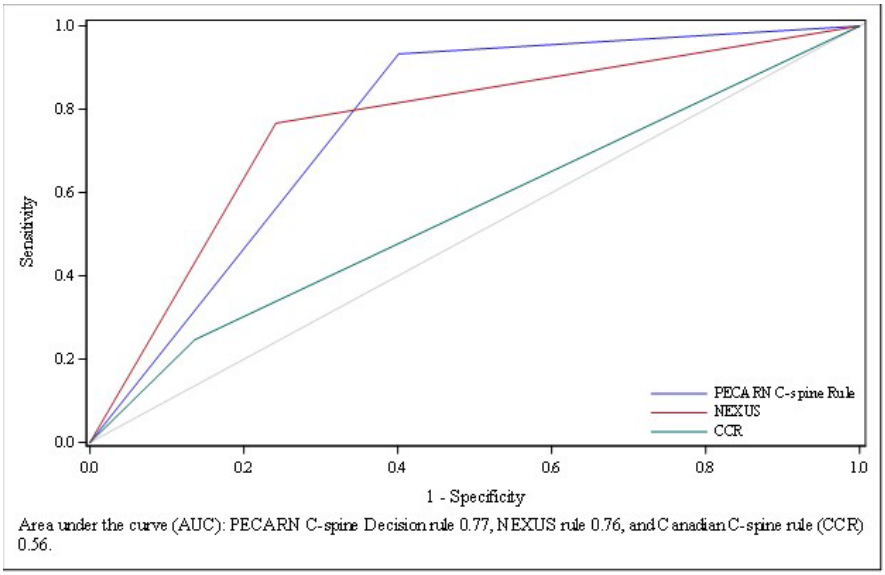
	PECARN C-Spine Decision Rule (95%CI)	Canadian C-Spine Rule* (CCR) (95%CI)	National Emergency X-Radiography Utilization Study (NEXUS) Rule* (95%CI)
Sensitivity	93.3% (90.9, 95.7)	75.3% (69.9, 80.7)	76.7% (72.7, 80.7)
Specificity	59.9% (59.3, 60.5)	13.6% (13.2, 14.1)	75.9% (75.3, 76.4)
Positive Predictive Value	4.4% (4.0, 4.8)	1.0% (0.9, 1.2)	5.9% (5.3, 6.5)
Negative Predictive Value	99.8% (99.7, 99.9)	97.8% (97.3, 98.4)	99.4% (99.3, 99.5)

*Data from the PECARN CSI rule study were adapted to the CCR and NEXUS rules; however, not all elements in these rules precisely matched what was available from the PECARN study.

Figure. Receiver Operator Curves of C-Spine Imaging Decision Rules



Area under the curve (AUC): PECARN C-spine Decision rule 0.77, NEXUS rule 0.76, and Canadian C-spine rule (CCR) 0.56.

Racial and Ethnic Differences in ED Analgesia Among Injured Children Transported via EMS

10/20/2023

Oral Presentation

Sarahjean Kerolle, MD, MS[1]; Lorin R. Browne, DO[2]; Ruta Brazauskas, PhD[3]; Manish I. Shah, MD, MS[1]; Kathleen M. Adelgais, MD MPH FAAP FAEMS[4]; Christyn F. Magill, IV, MD[5]; Daniel K. Nishijima, MD, MAS[6]; Geoffrey S. Lowe, MD[7]; Kunal Chadha, MD[8]; Natasha Gill, MD, MPH[9]; E Brooke Lerner, PhD[8]; Julie C. Leonard, MD, MPH[10]; Hamilton P. Schwartz, MD[11]; Jonathan R. Studnek, PhD[12]; Corrie E. Chumpitazi, MD, MS[13], (1) Baylor College of Medicine/Texas Children's Hospital, Houston, TX, (2) Medical College of Wisconsin, Milwaukee, WI, (3) Division of Biostatistics, Milwaukee, WI, (4) University of Colorado School of Medicine, Aurora, CO, (5) Atrium Health Carolinas Medical Center and Levine Children's Hospital, Charlotte, NC, (6) University of California at Davis Medical Center, Sacramento, CA, (7) UT Southwestern Medical Center, Irving, TX, (8) University at Buffalo, Buffalo, NY, (9) Children’s Hospital Los Angeles, Los Angeles, CA, (10) Nationwide Children's Hospital, Columbus, OH, (11) Cincinnati Childrens Hospital Medical Center, Cincinnati, OH, (12) Mecklenburg EMS Agency, Charlotte, NC, (13) Duke School of Medicine/Duke Children's Hospital, Durham, NC

Background: Pain management remains suboptimal across the continuum of emergency care in both the prehospital and the emergency department (ED) settings. This is amplified in minority populations. Racial and ethnic disparities in the timing of analgesia administration among children who are transported to EDs via emergency medical services (EMS) have not yet been well characterized. The objective of this study is to investigate whether racial and ethnic differences exist in pain management among injured children transported by EMS to pediatric EDs.

Methods: We conducted a secondary analysis of a multicenter prospective observational study of children ages 0 to 17 years transported via EMS to 10 pediatric EDs from July 2019 to April

2020. Timing of ED analgesia (minutes from ED arrival to administration) for patients presenting with an injury were analyzed by race and ethnicity. Race and/or ethnicity were categorized as non-Hispanic White (NH-White), non-Hispanic Black (NH-Black), Hispanic, and Other Race/Multiracial. ED analgesia included opioids, non-opioids, nonsteroidal anti-inflammatory drugs, and other analgesic medications by all routes of administration and were stratified by type.

Results: Among 480 injured children, 353 (74%) received pain medication in the ED after EMS transport (Table 1). Although most patients received pain medication while in the ED, the time to pain management varied greatly (median time 39 minutes; range 2 minutes to 6 hours). The median time to pain medication in the ED was longer for Hispanic patients (55 minutes vs. 38 minutes for NH-Black, 37 minutes for NH-White, and 32 minutes for Other Race/Multiracial children, p=0.015). The median time to ED opioid administration for all groups was 28 minutes (range 2 minutes to 3 hours). Approximately 30% of NH-Black patients, 26% of Hispanic patients, and 14% of Other Race/Multiracial children were treated with opioids in the ED, while 38% of NH-White patients were treated with opioids (p=0.0234). Patients who had broken long bones, had a higher pain score upon arrival to ED, and those who received opioids with EMS were more likely to receive ED opioids. Both the cumulative analgesia and opioid administration across racial and ethnic groups over time in the ED is shown (Figure 1).

Conclusion: Among children transported by EMS to a pediatric ED for an injury, Hispanic patients were less likely to receive timely analgesic medication and were less likely to receive opioids at all. Differences exist in the timing of analgesia administration in the ED by ethnicity. Those of Other Race/Multiracial groups were less likely to receive analgesia but when received was at the quickest rate. In order to improve health equity in pediatric emergency care, further research is needed to understand and mitigate potential root causes of these disparities.

Table 1: Patient Demographics by Race and Ethnicity

Table 1: Patient Demographics by Race and Ethnicity

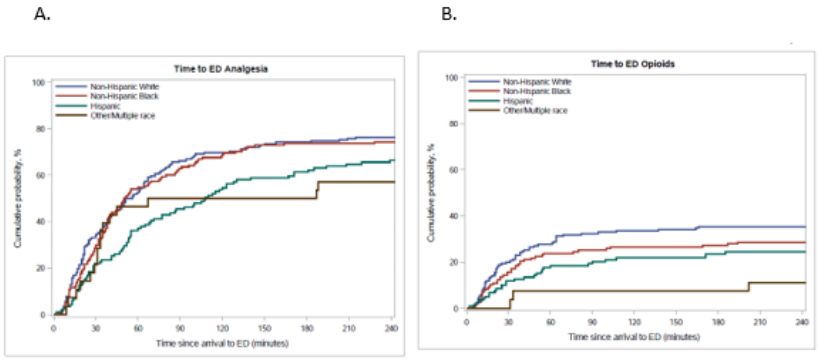
	Total N=480	NH-Black N=150	NH-White N=180	Hispanic N=122	Other/Multi-racial N=28	P-value
Age in years (Mean ± SD)	10.4 ± 5.1	10.4 ± 5.4	10.9 ± 4.8	10.0 ± 5.1	9.0 ± 5.7	*0.3461* [K]
Female	195 (40.7)	55 (36.7)	77 (43.0)	57 (46.7)	6 (21.4)	*0.0563* [C]
Broken bone	91 (19.1)	25 (16.9)	45 (25.3)	17 (13.9)	4 (14.3)	*0.0605* [C]
Initial ED pain score (0-10) (Mean ± SD)	4.9 ± 3.5	5.2 ± 3.7	5.0 ± 3.3	4.7 ± 3.5	4.1 ± 3.9	*0.4297* [K]
Pain score value						*0.4570* [C]
No Pain (0)	97 (22.8)	32 (24.4)	30 (19.5)	25 (22.3)	10 (35.7)	
Low Pain (1-3)	50 (11.8)	10 (7.6)	19 (12.3)	18 (16.1)	3 (10.7)	
Moderate Pain (4-6)	113 (26.6)	33 (25.2)	46 (29.9)	28 (25.0)	6 (21.4)	
Severe Pain (7-10)	165 (38.8)	56 (42.7)	59 (38.3)	41 (36.6)	9 (32.1)	
Missing	55	19	26	10	0	
Any pain meds in ED	353 (74.0)	115 (77.2)	139 (77.7)	83 (68.6)	16 (57.1)	*0.0460* [C]
Time to ED analgesia median (min-max) if received	39 (2.0 - 379.0)	38 (4.0 - 379.0)	37 (4.0 - 345.0)	55 (2.0 - 369.0)	32 (9.0 - 188.0)	*0.0148* [K]
ED opioids	150 (31.3)	45 (30.0)	69 (38.3)	32 (26.2)	4 (14.3)	*0.0234* [C]
Time to first opioid median (min-max) if received	28 (2 - 202)	27.5 (4 - 194)	22 (4 - 166)	34 (2 - 185)	33 (31 - 202)	*0.3270* [K]
Child language						*<0.0001* [C]
English	395 (89.4)	127 (98.4)	168 (100.0)	79 (65.3)	21 (87.5)	
Spanish	42 (9.5)	0 (0.0)	0 (0.0)	42 (34.7)	0 (0.0)	
Other Language	5 (1.1)	2 (1.6)	0 (0.0)	0 (0.0)	3 (12.5)	

ED: Emergency department | NH: Non-Hispanic

[C]Chi-square test | [K]Kruskal-Wallis test | SD: Standard Deviation

Figure 1: The Cumulative incidence of administration from ED arrival by time in minutes by race and ethnicity of A. ED Analgesics and B. ED opioids

Figure 1. The Cumulative incidence of administration from ED arrival by time in minutes by race and ethnicity of **A.** ED Analgesics and **B.** ED opioids



The BRACHA – Is It Able to Assess Risk of Agitation in the Pediatric ED?

10/20/2023

Oral Presentation

Bijan W. Ketabchi, MD, MPH[1]; Wendy J. Pomerantz, MD, MS[2]; Lynn Babcock, MD, MS[3], (1) The Children's Hospital of Philadelphia, Philadelphia, PA, (2) Cincinnati Children's Hospital, Cincinnati, OH, (3) Cincinatti Children's Hospital, Cincinatti, OH

Background: Rates of children presenting to the pediatric emergency department (PED) for mental and behavioral health (MBH) concerns are increasing. Although agitation among MBH patients poses a significant safety risk, early prediction of unsafe behaviors may help ameliorate this risk. The BRACHA is a validated 14-question assessment performed in the PED that is predictive of aggression in the inpatient psychiatry setting; however, no such tools exist for prediction of unsafe behaviors in the PED. The purpose of this study is to assess the discriminative ability of BRACHA to predict agitation requiring intervention (ARI) within the PED among patients presenting for MBH concerns.

Methods: This was a retrospective cohort of patients 5-18 years old, presenting with MBH concerns to two PEDs affiliated with a tertiary care children's hospital over a 9-year period. All patients had a BRACHA completed by trained personnel. Demographic, assessment, and intervention data abstracted from the electronic medical record were used to characterize the cohort. Primary outcome was ARI in the PED defined as an episode of agitation or unsafe behavior requiring physical (i.e., physical hold or mechanical restraint) and/or pharmacologic intervention. Analysis focused on patients requiring both physical and pharmacologic intervention—those deemed at highest risk of injury. Receiver operator characteristic (ROC) curves were used to evaluate the discriminative ability of the BRACHA to predict ARI within the PED. The patient population was divided in a randomized manner into two cohorts—Derivation and Validation—in a 7:3 ratio, respectively. The Youden J Index was used to determine the optimal cutoff score for identification of patients at highest risk for agitation requiring both physical and pharmacologic intervention. Performance characteristics using the determined cutoff are described for the Validation cohort.

Results: During the study period, there were 32,905 MBH encounters with documented BRACHA scores. A total of 3,526 patients had at least one episode of ARI in the PED—2,027 required pharmacologic intervention and 2,250 required physical intervention. The area under

the ROC for BRACHA as a predictor of agitation requiring both types of intervention was 0.83 and 0.82, in the Derivation and Validation cohorts, respectively. A BRACHA of ≥ 6 was identified as the optimal cutoff. This provides a sensitivity of 84.8%, specificity of 66.4%, PPV of 5.6%, and NPV of 99.5% in Validation cohort. Patients with a BRACHA ≥ 6 had odds ratio 12.0 (95% CI: 9.7, 14.7) for requiring both pharmacologic and physical intervention in the PED, compared to those with lower BRACHA scores.

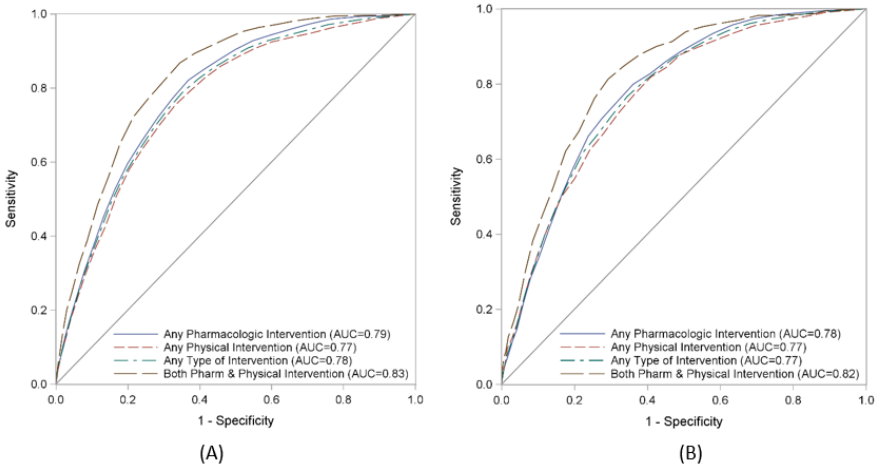
Conclusion: BRACHA score is significantly associated with ARI within the PED and is most predictive of agitation requiring both physical and pharmacologic interventions. Patients with a BRACHA score ≥ 6 are at significantly increased odds of having ARI in the PED.

Table 1

	Patients not Requiring Intervention for Agitation n-=29,379	Patients Requiring Intervention for Agitation n=3,526	All Patients n=32,905
Mean Age in Years (SD)	13.5 (2.8)	12.2 (3.3)	13.4 (2.9)
Sex, n (%)			
Male	12,583 (42.8)	2,269 (64.4)	14,852 (45.1)
Female	16,796 (57.2)	1,257 (35.6)	18,053 (54.9)
Race, n (%)			
White	19,848 (67.6)	1,861 (52.8)	21,709 (66.0)
Black	7,053 (24.0)	1,332 (37.8)	8,385 (25.5)
Other/Unknown	2,478 (8.4)	333 (9.4)	2,811 (8.5)
Ethnicity, n (%)			
Hispanic	927 (3.2)	75 (2.1)	1,002 (3.0)
Non-Hispanic	28,313 (96.4)	3,439 (97.5)	21,752 (96.5)
Unknown	139 (0.5)	12 (0.3)	151 (0.5)
Mode of Arrival, n (%)			
Self-presentation	23,868 (81.2)	2,331 (66.1)	26,199 (79.6)
EMS/Air	3,615 (12.3)	800 (22.7)	4,415 (13.4)
Police	1,896 (6.5)	395 (11.2)	2,291 (7.0)
Mean BRACHA Score (SD)	4.1 (3.2)	7.4 (2.9)	4.4 (3.3)

Patient demographics and ED care descriptors of MBH patients in the PED

Figure 1



(A) (B)

Area under receiver operator characteristic curve for various intervention outcomes within the A) Derivation and B) Validation cohorts

Use of Home Nonpharmacologic Interventions for Long Bone Fracture Pain After Emergency Department Discharge

10/20/2023

Oral Presentation

Alexandria J. Wiersma, MD[1]; Blake Nielsen, MSTAT[2]; Michael W. Webb, MS[3]; Elizabeth R. Alpern, MD, MSCE[4]; David Brousseau, MD[5]; James M. Chamberlain, Chamberlain, MD[6]; Joseph J. Zorc, MD, MSCE[7]; Lynn Babcock, MD, MS[8]; Bradley J. Barney, PHD[9]; Amy L. Drendel, DO MS[10], (1) Children's Hospital Colorado, Denver, CO, (2) University of Utah, Sandy, UT, (3) University of Utah, Woods Cross, UT, (4) Ann & Robert H. Lurie Children's Hospital, Chicago, IL, (5) Nemours Children's Health, Wilmington, DE, (6) Children's National Hospital and George Washington University, Gaithersburg, MD, (7) Children's Hospital of Philadelphia, Wynnewood, PA, (8) Cincinatti Children's Hospital, Cincinatti, OH, (9) University of Utah, Salt Lake City, UT, (10) Medical College of Wisconsin, Milwaukee, WI

Background: Nonpharmacologic interventions (ice, elevation, distraction and other techniques) are recommended for the treatment of acute pain after emergency department (ED) discharge. However, the frequency of use and use in relation to analgesics have not been investigated. Objectives: For home nonpharmacologic interventions used after ED discharge, 1) determine the types/duration of use, 2) describe the relationship with analgesics, 3) identify variables associated with use.

Methods: This was a secondary analysis of the IMPROVE study, a multi-site prospective observational cohort study of children 4-17 years discharged with an isolated long bone fracture between 2019-2021. Parents reported daily about nonpharmacologic and analgesic use for pain via text. Demographic and injury data were abstracted from a linked electronic health record (PECARN) registry or provided by the parent/guardian via a text. Univariable Firth's logistic regression with multiple imputation was used to identify characteristics associated with nonpharmacologic use.

Results: 1,819 children were included, ages 4-< 8 years (38%), 8-< 11 years (25%), 11-< 14 years (24%) and 14-< 18 years (13%). Most were male (62%), had an upper extremity fracture (90%). Many had a reduced fracture (47%) and reported moderate/severe pain at discharge (46%). 96% used nonpharmacologic interventions during the first week for a median of 6 days (3, 7 IQR). Distraction (87%) and elevation (85%) were the most frequently and consistently used nonpharmacologic interventions, while ice (42%) and other nonpharmacologic interventions (31%) were also used (Figure 1). Analgesia was used in combination with nonpharmacologic methods in 92% during the first week for a median of 3 days (2, 6 IQR); 3% used only analgesics. From day 1 to 7, the proportion using only nonpharmacologic interventions increased from 9% to 27% while the proportion using both nonpharmacologic interventions and analgesics decreased from 83% to 27% (Figure 2). By day 7, 36% were using neither a nonpharmacologic nor an analgesic. Children ages 11-< 14 had increased odds of nonpharmacologic use in the first week compared to 4-< 8 years (3.7 OR 95% CI (1.4, 9.8)). Children with moderate/severe pain at discharge from the ED were also more likely to have nonpharmacologic use than those with none/mild pain (2.1 OR 95% CI (1.1, 3.9)). Home analgesic use on any particular day was predictive of any nonpharmacologic use (e.g., Day 1

analgesic use (yes vs. no) had 3.9 OR 95% CI (2.2, 7.1)). Other patient characteristics/injury variables were not associated with increased nonpharmacologic use.

Conclusion: After ED discharge, children with an isolated long bone fracture frequently use nonpharmacologic interventions, including distraction and elevation, for a longer duration than analgesics are used. Patient and fracture characteristics such as age and pain severity at discharge are also associated with increased use. Interventional studies to evaluate effectiveness are needed to optimize ED discharge recommendations.

Figure 1: Use of nonpharmacologic interventions

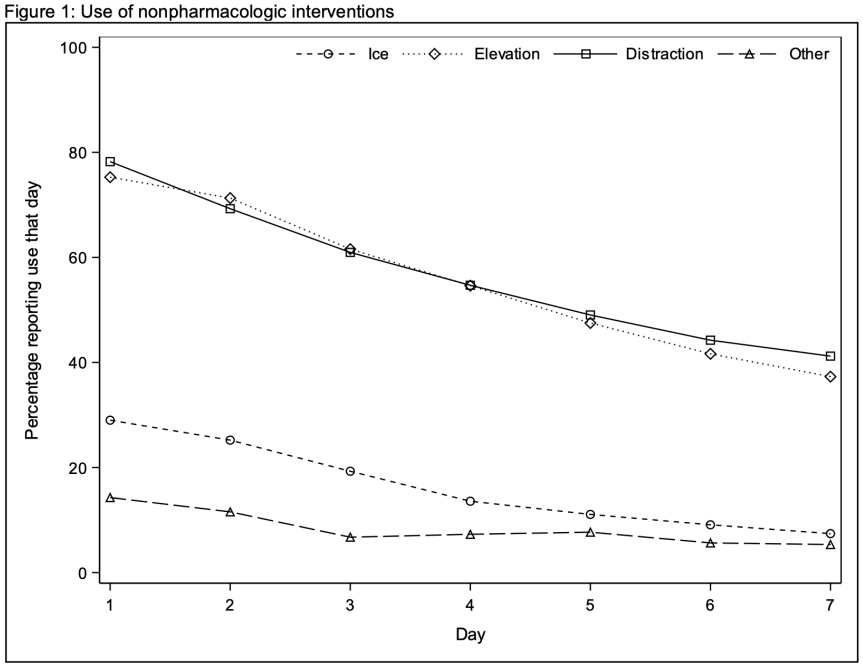


Figure created using imputed data. Some common responses for other nonpharmacologic use are sleep/rest, socializing, and spending time outside.

Figure 2: Pain treatment use

Figure 2: Pain treatment use

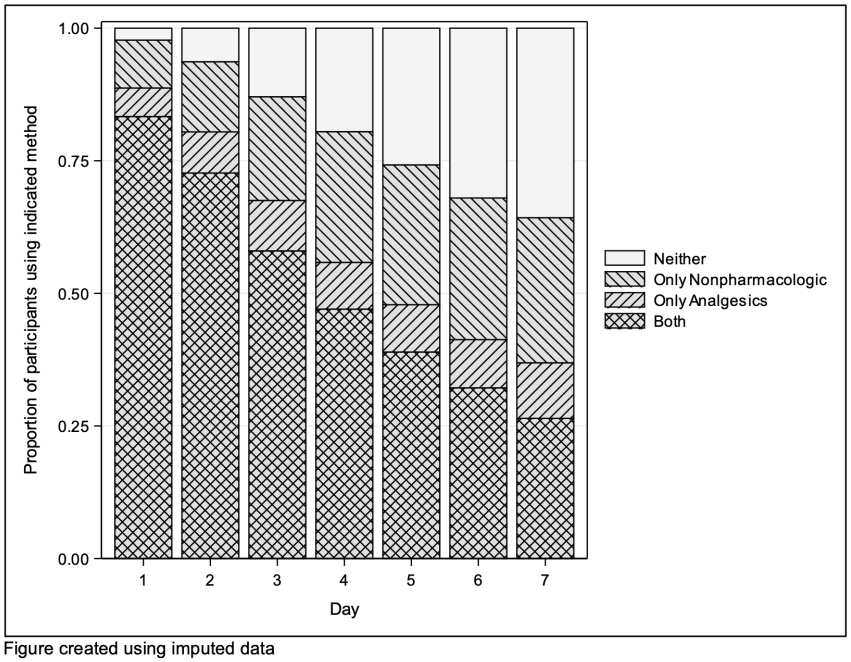


Figure created using imputed data

The Super Learner Ensemble: A Powerful Artificial Intelligence-based Predictive Modeling Method for Identifying Patients at Risk of Poor Outcomes

10/20/2023

Oral Presentation

Oluwakemi Badaki-Makun, MD, PhD[1]; Jeremiah Hinson, MD, PhD[1]; Xihan Zhao, BSc[1]; Deborah Persaud, MD[1]; Bryan Lau, PhD[2], (1) Johns Hopkins University, Baltimore, MD, (2) Johns Hopkins School of Public Health, Baltimore, MD

Background: The Super Learner (SL) ensemble approach is a novel technique in which multiple machine learning and regression algorithms can be combined into an ensemble algorithm to produce a predictive model. It produces a final model at least as good as, if not better than, any of the single algorithms that comprise the ensemble and removes the need to test multiple algorithms individually or to choose a single one a priori. Our objective was to test this approach to identify optimal prediction models for complications of SARS-CoV-2 (as an example disease process) in patients presenting to the Emergency Department (ED) using data available at the time of presentation only.

Methods: We performed a multi-center observational study at three hospitals. Electronic health record data for children aged 0-21 years presenting to the ED were included if the patient was tested for SARS-CoV-2 between 3/15/2020 and 12/31/2022. Predictors included variables available at the time of presentation to the ED: demographics, medical history, chief complaints, vital signs. The main outcomes were admission and need for critical care interventions (invasive respiratory support, pressors, intensive care admission, death). Nine algorithms were chosen for inclusion in the ensemble based on literature review. Ten-fold cross validation was performed and a cross-validated mean square error calculated for each included algorithm. The

SL ensemble function was calculated using an optimal weighted combination of the included algorithms.

Results: Models were trained and internally validated on 25,305 ED encounters and the final SL ensemble externally validated on 11,520 and 5,665 encounters at the two other sites. Across all sites, 51.4% of patients were male, 45.5% were Black, 23.0% were White, and 18.9% were Hispanic. Median age was 4.0 years (interquartile range [IQR] 1.0–11.0). Fever was the most common chief complaint (26.2%) and gastrointestinal (26.2%) and pulmonary conditions (24.2%) were the most common co-morbid conditions. Admissions occurred in 5,181 encounters (12.2%), and critical care interventions in 1,758 encounters (4.1%). For the critical care outcome, the SL ensemble had AUCs of 0.88 (95% Confidence Interval [CI] 0.86-0.89) at internal validation and 0.86 (95%CI 0.82-0.90) and 0.78 (95%CI 0.73-0.83) respectively at external validation. For the admission outcome, the SL ensemble produced AUCs of 0.84 (95%CI 0.83-0.86) at internal validation and 0.81(95%CI 0.78-0.83) and 0.82 (95%CI 0.76-0.88) respectively at external validation.

Conclusion: The Super Learner Ensemble, using data only available at the time of initial presentation to the ED, accurately identified patients with SARS-CoV-2 infection requiring admission or critical care. Since data required for the models are available in other non-ED settings, e.g. urgent care centers and primary care clinics, the models may also provide useful predictions in those settings. Future studies could evaluate the performance of the Super Learner in non-ED settings and for other disease processes.

Table 1. Training Cross-Validated Area Under The Receiver Operating Characteristic Curves (AUC) and Mean Square Errors (MSE) for the Nine Algorithms Included In the Super Learner Ensemble.

Included Algorithms	**Critical Care**		**Admission**	
	AUC (95%CI)	**MSE**	**AUC (95%CI)**	**MSE**
Logistic Regression	0.88(0.87-0.90)	0.039	0.85(0.84-0.86)	0.102
Lasso	0.88(0.87-0.90)	0.039	0.85(0.84-0.86)	0.102
K-Nearest Neighbors Classifier	0.71(0.69-0.73)	0.046	0.74(0.74-0.75)	0.121
Decision Tree Classifier	0.83(0.81-0.85)	0.044	0.80(0.80-0.81)	0.109
Bagged Decision Tree	0.88(0.87-0.89)	0.041	0.84(0.83-0.84)	0.105
Boosted Decision Tree	0.82(0.81-0.83)	0.107	0.76(0.75-0.77)	0.201
Random Forest Classifier	0.88(0.87-0.89)	0.041	0.86(0.85-0.86)	0.103
Stochastic Gradient Descent	0.79(0.74-0.83)	0.047	0.82(0.79-0.84)	0.110
Gradient Boosting Classifier	0.88(0.87-0.89)	0.040	0.85(0.84-0.86)	0.101
Super Learner Ensemble	**0.98(0.97-0.98)**	**0.041**	**0.92(0.92-0.92)**	**0.101**

Table 1. Area under the receiver operating characteristic curves (AUC) for the nine algorithms included in the Super Learner ensemble. Data in the training dataset (data from the largest hospital) were randomly divided into ten mutually exclusive blocks of approximately equal size. The Super Learner analysis entailed fitting each of the algorithms to the first nine blocks of data and then validating each algorithm in the tenth block. This process was repeated ten times using a different block as a validation block each time, resulting in a ten-fold cross-validation. The cross-validated mean square error (MSE) is displayed for each algorithm. The final Super Learner ensemble was derived from the optimal weighted combination of the nine algorithms and this Super Learner ensemble internally validated on a separate dataset from the large hospital and externally validated on data from the two other hospitals (see Figure 1).

Figure 1. Receiver Operating Characteristic Plots for the Two Primary Outcomes: Critical Care Need and Admission

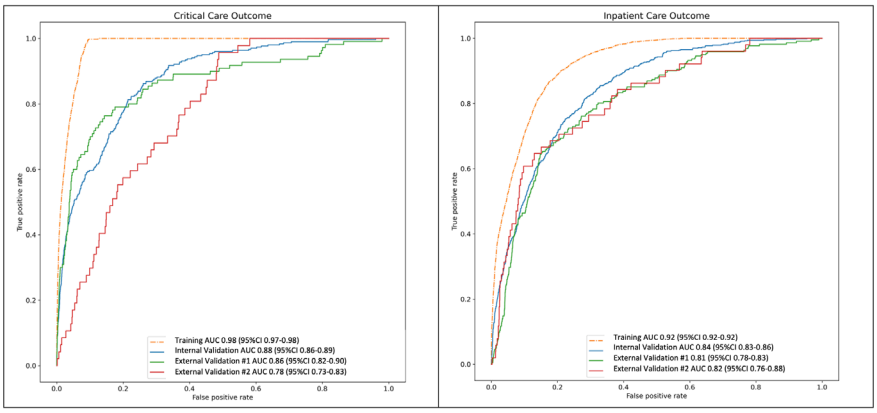


Figure 1. Receiver operating characteristic plots for models evaluating the two primary outcomes, critical care need (invasive respiratory support, pressors, intensive care admission or death) and general inpatient admission. The final Super Learner ensemble was derived from the optimal weighted combination of the nine included algorithms (see Table 1). All algorithms were trained on data available at initial presentation (demographics, past medical history, chief complaint, and triage vital signs) from the largest of the three hospitals. The final Super Learner ensemble was internally validated on a separate dataset from the large hospital and externally validated on data from the two other hospitals. AUC = Area under the receiver operating characteristic curve.

Prevalence of and Factors Associated with the Application of Spinal Motion Restriction by Emergency Medical Services (EMS) for Children at Risk for Cervical Spine Injury

10/20/2023

Oral Presentation

Caleb E. Ward, MB BChir, MPH, FAAP[1]; Lorin R. Browne, DO[2]; Alexander Rogers, MD[3]; Monica L. Harding, MS[4]; Lawrence J. Cook, PhD[5]; Robert Sapien, MD, MMM[6]; Robert W. Hickey, MD, FAAP, FAHA[7]; Kathleen M. Adelgais, MD MPH FAAP FAEMS[8]; Leah Tzimenatos, MD[9]; Fahd A. Ahmad, MD, MSCI[10]; Sylvia Owusu-Ansah, MD, MPH, FAAP[11]; Julie C. Leonard, MD, MPH[12], (1) Children's National Hospital, The George Washington University School of Medicine and Health Sciences, Washington, DC, (2) Medical College of Wisconsin, Milwaukee, WI, (3) University of Michigan, Ann Arbor, MI, (4) University of Utah, Jacksonville, FL, (5) Department of Pediatrics, University of Utah, Salt Lake City, UT, (6) University of NM Health Sciences Center, Albuquerque, NM, (7) CHP, wexford, PA, (8) University of Colorado School of Medicine, Aurora, CO, (9) University of California, Davis, School of Medicine, Sacramento, CA, (10) Washington University in St. Louis, Saint Louis, MO, (11) University of Pittsburgh School of Medicine, Pittsburgh, PA, (12) Nationwide Children's Hospital, Columbus, OH

Background: Cervical spine injuries (CSI) in children are uncommon but potentially devastating. Spinal motion restriction (SMR) remains the standard of care for children with potential CSI. There are, however, risks to indiscriminate application of SMR by Emergency Medical Services (EMS). We recently derived the Pediatric Emergency Care Applied Research

Network (PECARN) CSI clinical decision rule for children experiencing blunt trauma. To effectively implement this decision rule, an accurate understanding of current EMS SMR practices is needed. Little is known about the prevalence of, and factors associated with, SMR application by EMS. Our primary objective was to determine the proportion of children sustaining blunt trauma who are placed in SMR by EMS. Our secondary objective was to identify factors associated with SMR placement by EMS.

Methods: We conducted a secondary analysis of data collected during a prospective study of children 0-17 years with blunt trauma transported by EMS to one of 18 PECARN emergency departments. EMS clinicians completed surveys regarding CSI risk factors and the application of SMR. We summarized SMR prevalence, techniques used, reasons for application, and EMS clinician suspicion for CSI by age group. We conducted univariable and multivariable logistic regression to determine factors associated with SMR placement.

Results: Of the 13,453 children transported by EMS, we enrolled a convenience sample of 7,721 (57.4%) where EMS surveys were completed. The CSI rate for enrolled children in this secondary analysis was 1.6%, compared to 1.2% for children transported by EMS but where EMS surveys were not completed. Prehospital SMR was applied to 41.5% of children. The proportion of children with SMR application increased as EMS provider suspicion for CSI increased, ranging from 25.9% (CSI suspicion < 1%) to 87.7% (CSI suspicion > 50%). Children < 2 years were less likely to have SMR placed (22.0%) compared to older age groups (35.5–50.4%) (Table 1). In multivariable analysis, factors associated with SMR placement included patient demographics (non-Hispanic white race/ethnicity, age > 2 years), mechanisms of injury (high-risk motor vehicle crash (MVC), unrestrained passenger in MVC, high-risk fall, axial load mechanism), clinical history (loss of consciousness, self-reported neck pain, paresthesia, numbness, or extremity weakness) and physical exam findings (altered mental status, neck tenderness, inability to move neck, focal neurological deficits, and substantial head or torso injuries) (Table 2).

Conclusion: In this study, 41.5% of children transported by EMS after blunt trauma had SMR placed, while only 1.6% had CSIs. Multiple factors were associated with SMR placement including patient demographics, mechanism of injury, history, and exam findings. Most factors associated with placement of SMR were not in the new PECARN CSI clinical decision rule. Future implementation of a risk-centered EMS decision aid for placement of SMR in children after blunt trauma must address this discrepancy.

Table 1. Spinal motion restriction prevalence, reasons for application, and clinical suspicion for CSI by age group for injured children transported by EMS

Table 1. Spinal motion restriction prevalence, reasons for application, and clinical suspicion for CSI by age group for injured children transported by EMS

		Age (years)				
	Overall (N = 7721)	0 - <2 (N = 927)	2 - <8 (N = 2304)	8 - <16 (N = 3711)	≥16 (N = 779)	P-value[5]
Spinal Motion Restriction Prevalence[1]						
Spinal motion restriction used during EMS transport	3206 (41.5%)	204 (22.0%)	819 (35.5%)	1790 (48.2%)	393 (50.4%)	<.001
Full Immobilization[3]	1137 (35.5%)	30 (14.7%)	266 (32.5%)	703 (39.3%)	138 (35.1%)	<.001
Cervical collar only	1689 (52.7%)	54 (26.5%)	429 (52.4%)	977 (54.6%)	229 (58.3%)	<.001
Rigid long board or Vacuum mattress only	162 (5.1%)	35 (17.2%)	50 (6.1%)	65 (3.6%)	12 (3.1%)	<.001
Towel only	55 (1.7%)	32 (15.7%)	19 (2.3%)	3 (0.2%)	1 (0.3%)	<.001[6]
Other	163 (5.1%)	53 (26.0%)	55 (6.7%)	42 (2.3%)	13 (3.3%)	<.001
No immobilization	4515 (58.5%)	723 (78.0%)	1485 (64.5%)	1921 (51.8%)	386 (49.6%)	<.001
Reasons for applying SMR[1,2]						
Severe mechanism of injury	1900 (59.3%)	127 (62.3%)	528 (64.5%)	1027 (57.4%)	218 (55.5%)	0.002
Young age	1236 (38.6%)	118 (57.8%)	424 (51.8%)	606 (33.9%)	88 (22.4%)	<.001
Complaint of neck pain	892 (27.8%)	1 (0.5%)	163 (19.9%)	557 (31.1%)	171 (43.5%)	<.001
Agency protocol	746 (23.3%)	49 (24.0%)	189 (23.1%)	415 (23.2%)	93 (23.7%)	0.989
Decreased mental status	442 (13.8%)	50 (24.5%)	121 (14.8%)	215 (12.0%)	56 (14.2%)	<.001
Abnormal torso examination[4]	190 (5.9%)	4 (2.0%)	35 (4.3%)	121 (6.8%)	30 (7.6%)	0.003
Other reason for spinal motion restriction	157 (4.9%)	16 (7.8%)	50 (6.1%)	80 (4.5%)	11 (2.8%)	0.013
Complaint of limited neck mobility	150 (4.7%)	0 (0.0%)	12 (1.5%)	112 (6.3%)	26 (6.6%)	<.001
Distracting Injury	151 (4.7%)	1 (0.5%)	47 (5.7%)	93 (5.2%)	10 (2.5%)	0.016
Placed by previous provider	136 (4.2%)	6 (2.9%)	32 (3.9%)	83 (4.6%)	15 (3.8%)	0.164
Abnormal head examination	125 (3.9%)	11 (5.4%)	47 (5.7%)	63 (3.5%)	4 (1.0%)	0.026
Focal neurologic deficit on examination	92 (2.9%)	5 (2.5%)	19 (2.3%)	52 (2.9%)	16 (4.1%)	0.382
Complaint of focal neurologic deficit	66 (2.1%)	0 (0.0%)	5 (0.6%)	41 (2.3%)	20 (5.1%)	<.001
Abnormal neck examination	63 (2.0%)	2 (1.0%)	13 (1.6%)	37 (2.1%)	11 (2.8%)	0.369
Clinical Suspicion for CSI						
Clinical suspicion for the presence of CSI						0.003
< 1%	5176 (67.0%)	645 (69.6%)	1594 (69.2%)	2459 (66.3%)	478 (61.4%)	
1-5%	1430 (18.5%)	169 (18.2%)	386 (16.8%)	706 (19.0%)	169 (21.7%)	
6-10%	555 (7.2%)	61 (6.6%)	167 (7.2%)	273 (7.4%)	54 (6.9%)	
11-50%	406 (5.3%)	36 (3.9%)	120 (5.2%)	196 (5.3%)	54 (6.9%)	
> 50%	154 (2.0%)	16 (1.7%)	37 (1.6%)	77 (2.1%)	24 (3.1%)	

[1] Percentages for specific types of SMR and reasons for SMR are out of those that had any SMR only.
[2] Reasons for applying SMR with total prevalence < 2% were excluded from table: predisposing condition, advised by medical direction, and unknown.
[3] Full Immobilization is defined as the application of cervical collar and rigid long board/Vacuum mattress.
[4] Abnormal torso examination indicates that the EMS provider chose either: Abnormal chest, back, abdominal or pelvic examination.
[5] Pearson chi-square test of independence unless otherwise specified.
[6] Fisher's exact test of independence.

Table 2. Factors associated with placement of spinal motion restriction (SMR) by EMS

Table 2. Factors associated with placement of spinal motion restriction (SMR) by EMS[1]

		Univariable analysis		Multivariable analysis	
	Overall[2] (N = 3206)	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age			<.001		<.001
0 - <2 years	204 (6.4%)	Reference		Reference	
2 - <8 years	819 (25.5%)	1.95 (1.64, 2.34)		1.95 (1.59, 2.40)	
8 - <16 years	1790 (55.8%)	3.30 (2.80, 3.92)		3.05 (2.50, 3.73)	
≥16 years	393 (12.3%)	3.61 (2.93, 4.46)		2.30 (1.79, 2.96)	
Race/Ethnicity			<.001		<.001
Non-Hispanic White	1338 (41.7%)	Reference		Reference	
Non-Hispanic Black	969 (30.2%)	0.49 (0.44, 0.55)		0.59 (0.52, 0.67)	
Hispanic or Latino	491 (15.3%)	0.58 (0.51, 0.67)		0.64 (0.54, 0.75)	
Asian	51 (1.6%)	0.58 (0.40, 0.82)		0.71 (0.46, 1.08)	
Other	357 (11.1%)	0.86 (0.73, 1.02)		0.89 (0.73, 1.08)	
High-risk MVC (intrusion, ejection, death or telemetry)			<.001		<.001
No	2620 (81.7%)	Reference		Reference	
Yes	586 (18.3%)	2.20 (1.93, 2.52)		2.31 (1.96, 2.72)	
Unrestrained passenger in MVC			<.001		<.001
No	2890 (90.1%)	Reference		Reference	
Yes	316 (9.9%)	1.97 (1.66, 2.35)		1.67 (1.35, 2.07)	
Fall from height greater than 10 feet			<.001		<.001
No	2980 (93.0%)	Reference		Reference	
Yes	226 (7.0%)	3.19 (2.52, 4.05)		4.27 (3.26, 5.62)	
Axial load			<.001		<.001
No	2861 (89.2%)	Reference		Reference	
Yes	345 (10.8%)	2.33 (1.96, 2.78)		1.56 (1.25, 1.93)	
History of loss of consciousness (LOC)			<.001		<.001
No	2486 (77.5%)	Reference		Reference	
Yes	720 (22.5%)	4.57 (3.95, 5.31)		2.63 (2.20, 3.14)	
Self-reported neck pain[3]			<.001		<.001
No	2088 (65.1%)	Reference		Reference	
Yes	1118 (34.9%)	8.10 (7.04, 9.34)		4.57 (3.82, 5.46)	
Self-reported paresthesia (abnormal tactile sensation)			<.001		0.039
No	3038 (94.8%)	Reference		Reference	
Yes	168 (5.2%)	5.37 (3.90, 7.55)		1.58 (1.02, 2.46)	

Table 2. Factors associated with placement of spinal motion restriction (SMR) by EMS[1]

		Univariable analysis		Multivariable analysis	
	Overall[2] (N = 3206)	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Self-reported numbness			<.001		0.001
No	2925 (91.2%)	Reference		Reference	
Yes	281 (8.8%)	3.43 (2.77, 4.27)		1.66 (1.22, 2.25)	
Self-reported extremity weakness			<.001		0.047
No	2823 (88.1%)	Reference		Reference	
Yes	383 (11.9%)	1.45 (1.25, 1.68)		0.81 (0.66, 1.00)	
Abnormal airway, breathing, or circulation findings[3]			<.001		0.283
No	2915 (90.9%)	Reference		Reference	
Yes	291 (9.1%)	2.52 (2.08, 3.07)		1.14 (0.90, 1.46)	
Altered mental status[3]			<.001		<.001
No	2440 (76.1%)	Reference		Reference	
Yes	766 (23.9%)	4.66 (4.04, 5.39)		3.20 (2.68, 3.84)	
Signs of substantial head injury[3]			<.001		<.001
No	2748 (85.7%)	Reference		Reference	
Yes	458 (14.3%)	4.29 (3.58, 5.16)		2.74 (2.20, 3.42)	
Neck pain upon examination			<.001		<.001
No	2513 (78.4%)	Reference		Reference	
Yes	693 (21.6%)	9.77 (8.05, 11.94)		2.74 (2.14, 3.52)	
Inability to move the neck upon examination			<.001		0.028
No	2954 (92.1%)	Reference		Reference	
Yes	252 (7.9%)	7.47 (5.56, 10.23)		1.48 (1.04, 2.14)	
Substantial torso injury[3]			<.001		<.001
No	3032 (94.6%)	Reference		Reference	
Yes	174 (5.4%)	4.26 (3.19, 5.78)		2.64 (1.89, 3.72)	
Focal neurologic deficits[3]			<.001		<.001
No	2962 (92.4%)	Reference		Reference	
Yes	244 (7.6%)	5.31 (4.07, 7.01)		1.86 (1.32, 2.65)	

[1] After limiting to variables with univariable significance (p-value ≥ 0.05), the Lasso method, with a base regularization parameter of 0.80, was used to select variables for multivariable logistic regression. Variables from univariable analysis not included in multivariable analysis were: sex, scapula fracture, substantial abdominal injury, bruising of abdomen, seat belt sign, substantial pelvic injury, pelvic bone tenderness, thoracic or lumbar spine tenderness, AVPU, GCS, substantial thoracic injury, rib fracture (including flail chest), diving mechanism of injury, sports related mechanism of injury, self reported inability to move neck.

[2] Overall percentages are out of those with spinal motion restriction applied.

[3] Variables in the PECARN C-SPINE rule. Complete list of variables in the rule: GCS 3 – 8 or Unresponsive to pain; Abnormal airway, breathing or circulation findings; Focal neurological deficits; Altered mental status (GCS > 8); Self-reported neck pain or tenderness on examination; Substantial head or torso injury.