

Title: Improving the Quality of Pediatric Emergency Care Using an Electronic Medical Record Registry

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**Purpose:** Every day, thousands of children seek care in emergency departments (EDs). Improving emergency care requires valid, reliable, and accessible information to evaluate quality across settings. This project allowed for systematic, widespread collection of electronic health record (EHR) data to improve care through reported performance and outcome measures.

**Scope:** All visits from seven pediatric EDs between 2012 and 2016. EDs were embedded in four health systems and included tertiary and community settings.

**Methods:** 1) Develop a pediatric emergency care registry from EHR data; 2) utilize the registry to create emergency care performance measures for important pediatric conditions and derive benchmarks for each measure; 3) distribute clinician- and site-level performance report cards and evaluate the effect of reports.

**Results:** A deidentified, centralized EHR registry was developed and includes 2.25 million visits and 911,239 distinct patients. There are 13.9 million laboratory results, 2.6 million medication orders, and 13.7 million narrative documents describing ED care. Registry data was used to derive benchmarks and calculate stakeholder prioritized pediatric emergency medicine quality of care performance measures. Approximately 475 site- and clinician-level quality performance measure report cards were distributed monthly for 29 months. Variations in quality metrics were assessed using the registry data.

**Key Words:** Pediatric, Emergency Medicine, Quality Improvement, Electronic Health Record, Registry

## **PURPOSE**

The objective of this study was to capture electronic health record (EHR) data to implement and report performance measures in order to provide a tool to track, report, and improve the quality of emergency care for children, within and across sites of care. To achieve this goal, this study had the following three specific aims:

1. Develop an emergency care visit registry for pediatric patients from merged electronic health record clinical data from different hospital emergency departments (EDs) with differing EHR data sources.
2. Use the registry to collect and determine benchmarks of care for stakeholder-prioritized emergency care performance measures for important pediatric medical and trauma conditions at the level of both the ED and individual clinician.
3. Use this registry to report performance to individual ED clinicians and sites.

## **SCOPE**

Background: Every day, approximately 80,000 children seek emergency care in U.S. emergency departments (EDs) and 20% of all children in the US will have at least one ED visit each year. Patients and caregivers expect emergency care clinicians to deliver high quality emergency care, yet many children do not receive appropriate care under the current system. The Institute of Medicine (IOM) report, "Emergency Care for Children: Growing Pains," notes that the delivery of care should be built on a strong foundation in which emergency care is based on scientific evidence, data are collected so clinicians can learn from past experience, and system performance is monitored to ensure quality.

Context: The complexity of contemporary health care systems makes measuring quality of care difficult. While EDs routinely collect substantial patient data with the potential to provide information on the quality of care provided, the capacity to capture, analyze and report these data back to front-line clinicians, who are capable of acting to improve health care delivery, has been previously limited. Leveraging advances in health information technology, particularly the electronic health record, to access patient-centric clinical data, researchers can measure and identify variation in performance and outcomes, enhancing the ability to design and implement interventions to improve outcomes and quality of care across multiple settings. EHR registries allow for robust data to be derived directly from the patient clinical record and can provide important information about processes of care delivery and patient health outcomes.

Setting: Emergency Departments of four health systems within the Pediatric Emergency Care Applied Research Network (PECARN) including Children's Hospital Colorado (main and satellite ED), The Children's Hospital of Philadelphia (main), Children's National Medical Center (main and satellite ED), and Cincinnati Children's Hospital Medical Center (main and satellite ED).

Participants: Data from all patients registered in the emergency department, will be collected from the each site.

Incidence: There are more than 27 million pediatric ED visits annually in the United States.

Prevalence: Twenty percent of all children in the United States will have at least one ED visit each year.

## **METHODS**

*Study Design:* Cohort study

*Data Sources/Collection:* EHR clinical data from two EHR vendors (Epic and Cerner) at four hospital systems were used to form a pediatric emergency care registry (the PECARN Registry). Discrete variables and free text data were de-identified and XML files were created and submitted to a central data coordinating center for inclusion in the registry. Automated data quality control occurred prior to submission through an application created for this project. Data quality reports were created for manual data quality review.

*Interventions:* Monthly performance report cards were provided to the sites and individual ED clinicians, specific to patients cared for at the site or at the provider level.

*Measures:* The PECARN Registry is comprised of a total of 176 distinct variables for each ED visit including demographics, encounter characteristics, timestamps, vital signs, clinical scores, clinical care orders, laboratory results, medications, coded diagnoses and procedures, and free-text narratives.

*Limitations:* Homogeneity of the participating hospitals may be considered a limitation of this proposal. The four institutions are all tertiary, academic, pediatric hospitals. However, there is documented variability in quality performance measures even within freestanding children's hospitals that, if reduced, can lead to significant improvement in the care of children. In addition, we utilized data from visits to both the base academic ED as well as a satellite ED in a community setting at three of the four sites to mitigate this limitation. Additional limitations are inherent in retrospective, clinical record based research and include potential inaccuracies or missing data in the medical record.

## **RESULTS**

*Principal Findings:*

The PECARN Registry includes ED visits from calendar years 2012-2016 and contains data from 2,250,444 pediatric ED visits, 911,239 distinct patients, more than 13.7 million narrative reports, and 13,920,477 laboratory tests. Monthly reports are provided to more than 475 clinicians on their individual performance on 20 quality metrics and to more than 50 site managers/physician leaders on overall site performance. These reports are provided approximately 45 days after the completion of each month and have been provided for 29 months. Natural language processing methods are used to identify acute long bone fractures from radiology reports for one of the performance measures.

We investigated whether patient race/ethnicity was associated with differences in antibiotic prescribing for viral acute respiratory tract infections (ARTI) without concurrent bacterial infection in the pediatric ED. Of 39,445 pediatric ED encounters that met inclusion criteria, 2.6% (95% CI 2.4%, 2.8%) received antibiotics, including 4.3% of non-Hispanic white, 1.9% of non-Hispanic black, 2.6% of Hispanic, and 2.9% of other non-Hispanic children. In multivariable analyses, non-Hispanic black (aOR 0.44; 0.36, 0.53), Hispanic (aOR 0.65; 0.53, 0.81), and other non-Hispanic (aOR 0.68; 0.52, 0.87) children remained less likely to receive unnecessary antibiotics for viral ARTI.

*Outcomes:* The PECARN Registry, representing four hospital systems and seven EDs, demonstrates that emergency care data from disparate health systems and EHR

vendors can be harmonized for use in a single registry with a common data model. From the PECARN Registry data, we have evaluated racial/ethnic differences in a quality performance measure related to unnecessary antibiotics and found that compared to non-Hispanic white children, non-Hispanic black and Hispanic children were less likely to receive unnecessary antibiotics for viral ARTI in the PED.

*Discussion:* The PECARN Registry contains EHR data that includes all vital signs, clinical scores, clinical documentation, laboratory and imaging results, and orders related to ED care. This represents a rich data source for benchmarking, quality improvement (including audit and feedback), and comparative effectiveness research. Strategic use of straightforward natural language processing methods offers quality improvement teams new opportunities to extract information from narrative documents. Using this EHR registry we found that compared to non-Hispanic white children, non-Hispanic black and Hispanic children were less likely to receive unnecessary antibiotics for viral ARTI in the ED.

*Conclusions:* Seven sites with two EHR vendors successfully extracted and submitted data for inclusion in a central ED registry. Data from the PECARN Registry is successfully used to derive the site- and individual-level quality performance measures and producing site- and individual provider report cards. Data from the PECARN Registry has been used for quality improvement audit and feedback as well as health services research.

*Significance:* The PECARN Registry includes diverse patients with heterogeneous diseases and the data provided is used for benchmarking, clinical quality improvement, and comparative effectiveness research, as well as audit and feedback.

*Implications:* The ability to accurately and comprehensively assess quality performance measure of outcomes of care in all pediatric emergency patients is imperative to the evaluation of the care provided. The data contained in the PECARN Registry allows for improved understanding of the quality of pediatric emergency care, determination of quality benchmarks, audit and feedback quality improvement, and health services research. This registry and other registries are instrumental to the future of comparative effectiveness research and improving the quality of care we provide our patients. The PECARN Registry has served as the basis for two successful grant applications to study the risk of pediatric sepsis in the ED and the racial/ethnic variation in pediatric pain control in the ED. Other future studies (e.g. variation in care of pain in sickle cell anemia, impact of variation of care in functional outcomes in long bone fractures, the role of implicit bias in pediatric emergency care provided) utilizing the foundation of the PECARN Registry are submitted or in development.

## LIST OF PUBLICATIONS AND PRODUCTS

### Manuscripts:

1. Grundmeier RW, Masino AJ, Casper TC, Dean JM, Bell J, Enriquez R, Deakyne S, Chamberlain JM, Alpern ER: Identification of long bone fractures in radiology reports using natural language processing to support healthcare quality improvement. *Appl Clin Inform.* 2016 Nov 9;7(4):1051-1068. PMID: 27826610
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### Abstracts and Manuscripts in Preparation:

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6. Johnson MD, Zorc J, Nelson D, Casper TC, Alessandrini EA, Bajaj L, Grundmeier RW, Chamberlain JM, Simmons T, Alpern E. Intravenous Magnesium for Status Asthmaticus in the Emergency Department: Variation in Treatment and Outcomes Using the PECARN Registry. *Pediatric Academic Societies 2017*