Preparedness for Pediatric Offices Emergencies: A Multicenter, Simulation-Based Study

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Abbreviations:
AAP: American Academy of Pediatrics
AMC: Academic Medical Center
EMS: Emergency Medical Services
EMSC: Emergency Medical Services for Children
AMC: Academic Medical Center

Table of content summary
This multicenter study revealed variability in pediatric offices emergency preparedness, measured as adherence to the AAP Policy Statement and the quality of simulated emergency care.

What's Known on This Subject?
The AAP has published a Policy Statement on preparedness for emergencies in the pediatric primary care office. Little is known about adherence to emergency preparedness in pediatric primary care offices and its correlation with the quality of care.

What This Study Adds
In a national cohort of pediatric primary care offices, there was suboptimal adherence to AAP Policy especially in smaller independent practices. Academic and community partnerships utilizing simulation can help as an effective strategy to improve pediatric offices preparedness.

Contributors' Statement Page

Drs. Abulebda, Auerbach and Yuknis conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript.

Mr. Whitfill executed the data analyses, drafted the initial manuscript, and reviewed and revised the manuscript.

Mrs. Montgomery and Mrs. Pearson, Mrs. Rousseau, Dr. Diaz, Dr. Brown, Dr. Wing, Dr. Tay, Dr. Lavoie, Mrs. Good, Dr. Malik, Dr. Makharashvili, Dr. Garrow, Dr. Zaveri, Mrs. Thomas and Dr. Burns have substantial contribution to study's conception and design, revising the manuscript critically, final approval of the submitted version and Agreement to be accountable for all aspects of the work.

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ABSTRACT

Objectives

Pediatric emergencies can occur in pediatric primary care offices. However, few studies have measured emergency preparedness or the processes of emergency care provided in the pediatric office setting. This study aimed to measure emergency preparedness and care in a national cohort of pediatric offices.

Methods

This was a multicenter study conducted over 15 months. Emergency preparedness scores were calculated as a percent adherence to two checklists based on the American Academy of Pediatrics guidelines (essential equipment/supplies and policies/protocols checklists). To measure the quality of emergency care, we recruited office teams for simulation sessions consisting of two cases: a child with respiratory distress and a child with a seizure. An unweighted percent of adherence to checklists for each case was calculated.

Results

Forty-eight teams from 42 offices across nine states participated. The mean emergency preparedness score was 74.7% (SD: 12.9). The mean essential equipment/supplies subscore was 82.2% (SD: 15.1), and the mean policies/protocols subscore was 57.1% (SD: 25.6). Multivariable analyses revealed that independent practices and smaller total staff size were associated with lower preparedness. The median asthma case performance score was 63.6% (IQR 43.2, 81.2), while the median seizure case score was 69.2% (IQR 46.2, 80.8). Offices that had a standardized process of contacting EMS had a higher rate of activating EMS during the simulations.

Conclusion

Pediatric office preparedness remains suboptimal in a multicenter cohort, especially in smaller independent practices. Academic and community partnerships utilizing simulation can help address gaps and implement important processes like contacting emergency medical services.

Introduction

Children with emergent medical needs can first present to pediatric primary care offices[1, 2], which are a common entry point into the emergency care continuum. Many offices often see emergencies: the incidence of a child requiring emergent stabilization in an individual office ranges from weekly to monthly[1, 3, 4], and seizures and respiratory distress are the most common office-based emergencies[1].

Pediatric office emergency preparedness is defined as the ability to provide high-quality care to children who have life-threatening illnesses or injuries before being transferred to an emergency department[5]. A patient presenting to an unprepared office may experience harm due to errors during acute stabilization or delays in the activation of the emergency medical system (EMS). An American Academy of Pediatrics (AAP) policy statement on preparation for emergencies in pediatric offices was first issued in 2007[2] and provided recommendations on personnel, equipment, medications, education, policies and protocols to optimize emergency preparedness.

Prior published research has reported that many pediatric offices are not adequately prepared for emergencies[6, 7]. Specific identified gaps included providers' resuscitation skills, availability of equipment and medications, and written plans for pediatric emergencies[6, 8]. The existing research measuring pediatric office emergency preparedness utilized self-reported surveys to assess adherence to the AAP guidelines or providers' comfort[6, 9].

A more robust assessment of pediatric office emergency care is needed. Simulation—especially in situ—is a useful tool to measure clinical care processes and identify safety threats to serve as targets for future interventions[10, 11]. In situ simulation contributes to realism and accuracy of measurement by bringing the simulator into the clinical environment to measure clinical processes of care using real-world teams, equipment, and supplies[12, 13] It also serves as a tool to identify deficiencies in clinical systems and provider teams' knowledge and skills[14].

Driven by the AAP policy statement and highlighting the pediatric office's vital role in emergency care, our network "Improving Pediatric Acute Care Through Simulation (ImPACTS)" launched a multiphase improvement initiative to measure and improve pediatric office emergency preparedness nationwide. A pilot study conducted between a regional academic medical center (AMC) collaborating with 12 pediatric offices in the DC metro area demonstrated wide variability in adherence to the AAP Policy Statement. In addition, it noted latent safety threats and gaps in clinical care processes measured during in situ simulations. The pilot study highlighted the need for a national assessment and improvement effort to optimize office emergency preparedness[15].

This article reports on the implementation of this initiative across a cohort of pediatric offices partnering with regional AMCs. The aim of this study was to describe pediatric office emergency preparedness, as measured by adherence to the AAP policy statement. Our secondary aim was to measure the quality of pediatric emergency care in participating offices, measured during in situ simulations. An exploratory aim was to describe the correlation between simulated quality of care and office preparedness measures.

Methods

We conducted a multicenter, observational study over 15-month period (December, 2018-March, 2020), which included the following components:

1) Measurement of adherence to the AAP policy statement for pediatric office emergency preparedness using an in-person survey.

2) Measurement of the quality of care for two simulated pediatric patients with emergencies.

Institutional Review Board approval was obtained from each collaborating site based on each participating AMC's requirements; the majority of reviews were deemed exempt.

Study Setting and Population

Investigators from nine pediatric AMCs each recruited a minimum of two pediatric primary care offices in their respective geographic regions. Offices were excluded if they provided subspecialty care or were physically connected to an emergency department or urgent care center. Urban/suburban setting was defined by whether estimated EMS response time of <15 min based on recorded EMS response times in previously categorized pediatric emergencies[1].

Study Protocol

All lead investigators and research coordinators from the participating AMCs participated in online train-the-trainer sessions to ensure standardization of the study protocol execution. These sessions were conducted via Zoom (Zoom Video Communications, Inc. San Jose, California) by the study principal investigators with each participating AMC. Each session lasted 90 minutes and involved reviewing the study protocol, each simulation scenario, performance and preparedness measurement checklists, and standardization of all data entry into a centralized database via Qualtrics (Qualtrics Inc., Provo, Utah). The AMC team members included pediatric emergency physicians, pediatric critical care physicians, registered nurses, respiratory therapists, medics, and nurse practitioners. The script of these sessions is provided in **Supplemental Appendix 1.**

The recruitment and selection of pediatric offices occurred through multiple methods including AMC physician liaisons, personal connections, and phone calls/emails distributed to selected sites. Each pediatric office identified a "champion" to serve as the site contact who worked with the AMC team to coordinate all study phases.

1) Measurement of adherence to AAP Policy Statement

Each AMC conducted an in-person site visit to each participating office and completed a pediatric emergency preparedness checklist-based tool. During this measurement, a trained member of the AMC study team completed a checklist for each office with the pediatric office champion. These two individuals directly identified all the items on the checklist (e.g., locating each piece of equipment, reviewing policies/protocols). If the champion and study team were unsure or unable to locate the scored item during the measurement, no credit was given for that item in the tool.

2) Measurement of the quality of simulated emergency care

The in situ simulation-based session was conducted to measure the quality of emergency care provided in these offices and to help identify target areas for improvement. Teams from each office were recruited for the simulations to mirror their typical team composition. These teams were composed of general pediatricians (1-2 physicians), advanced practice providers, registered nurses, medical assistants, and administrative staff. Participants were protected from clinical responsibilities during these simulations. Champions recruited providers at each site via an email sent one month prior to the simulation.

All sessions were conducted in the actual office space to promote realism. Teams were required to find the appropriate resources, equipment and medications within their office. However, these items were replaced by equipment and medications provided by the simulation team to prevent the participating office from incurring costs or using of their limited supplies.

Details of the simulation cases are summarized in our previously published work[15]. Briefly, each simulation session consisted of two scenarios: a 7-year-old child presenting with asthma and a 5-year-old presenting with seizure. A standardized and scripted orientation was utilized to introduce the project and the AMC team and described the format and expectations for the day. At each office, one or two teams participated. In offices with small numbers of staff, the same team of providers participated in both simulations. In larger offices, the staff were separated into two teams with one caring for the patient and the other team observing. Both teams participated in the debriefings for each case. No incentives were given for participation in the simulated sessions. Other details of the simulation setup, the cases, and checklists are presented in **Supplemental Appendix 2A and 2B**.

Within 48 hours of completing the preparedness checklist and simulation-based measurements, each AMC team entered the collected data into a centralized data collection form in Qualtrics (Qualtrics Inc., Provo, Utah). These data were compiled into a database to collate data of all participating offices.

Measures

Office emergency preparedness scores

We recorded measures of office preparedness for pediatric emergencies at each participating office using a checklist derived from the AAP Policy Statement. This checklist included equipment, supplies, medications, policies and protocols. Items in this checklist are considered in the AAP guideline as either essential for all offices or strongly suggested for offices with EMS response times of > 10 minutes.

1- Essential equipment and supplies checklist (20-item)

2- Policies and protocols checklist (9-item)

3- Strongly suggested equipment and medications checklist (32-item)

Items on all three checklists were not weighted, and a dichotomous response of yes or no was given based on the availability of each item. Each checklist score was normalized to a 100-point scale. A total emergency preparedness score was calculated based on the essential equipment/supplies checklist and the policies/protocols checklist. All sites' demographics were also collected, including EMS response time, distance to the nearest emergency department, number of staff in the office (staff size), affiliation with an AMC, annual patient volume, and other demographics. Annual patient volume was divided into four quartiles.

Simulation performance

These scenarios and checklists were created by content experts in pediatric emergency medicine and critical care using evidence-based guidelines and best practices. Content validity was obtained using a consensus-based approach among experts. Developed scenarios and checklists were piloted and iteratively adapted in simulations at independent sites that did not participate in this study.

Statistical Analyses

All data were manually entered into Qualtrics (Qualtrics, LLC, Provo, UT) and transferred into SPSS (v. 27.0; IBM Corp., Armonk, NY), with which all statistical analyses were performed. For categorical variables, frequencies and percentages were calculated. For continuous variables, medians and IQRs were calculated. Bivariate analyses were used to explore associations between practice characteristics and pediatric preparedness scores, which included independent t-tests or one-way analysis of variance (ANOVA) tests for normal continuous data. Bivariate analyses were also used to describe the association between the pediatric preparedness checklist (e.g., regular emergency drills/practice and EMS activation) and the simulation checklist using Chi-square tests. We used additional bivariate analyses to explore associations between practice characteristics and simulation scores using Mann-Whitney U tests.

Finally, we used a generalized linear mixed model to model emergency preparedness scores as the dependent variables with a robust variance estimator to account for within-practice correlation in order to examine which variables explain higher emergency preparedness. Potential covariates in the model (e.g., patient volume, staff size, AMC affiliation, type of practice) were introduced if bivariate analyses were significant at $p<0.10$. This model accounts for the nesting of teams within each site. Unstandardized beta coefficients were reported.

Results

Office Characteristics

Forty-two offices from nine states participated in the study. Sixteen (38%) offices were recruited from the state of Indiana; ten (24%) offices were recruited from the state of Maryland (**Table 1**). The median annual patient volume was 6,000 patients, the median staff size was 17, and the median EMS response time was 5 minutes. The quartiles for the annual patient volume were: quartile 1: ≤3919 patients; quartile 2: 3920-6000 patients;

quartile 3: 6001-8819 patients; quartile 4: ≥8820 patients. Fifteen (36%) of the offices were independent practices (i.e. not part of a larger group).

Providers/Teams characteristics

A total of 48 teams participated in the simulation across 42 offices. There was a median of six members per team, and the median ratio of physicians to team members was 0.2 (IQR: 0.14 to 0.33) (**Table 1).**

Emergency Preparedness Scores

The offices' mean emergency preparedness score across the 42 offices was 74.7% (standard deviation [SD]: 12.9). The mean essential equipment/supplies score was 82.2% (SD: 15.1). All participating offices had an oxygen source, pediatric oxygen masks, and pediatric bag valve mask, nebulizers and albuterol, pulse oximeter and blood pressure cuffs. The least available items were infant bag valve mask, cardiac arrest boards and oral airways in 18%, 43% and 47% of offices, respectively. The mean policies/protocols score was 57% (SD: 25.6). Only 33% of offices had policies for regular self-assessment, and only 43% conducted regular emergency drills (**Table 2**). The mean preparedness score for the additional equipment was 38% (SD: 28.3) (**Supplemental Table S1).**

Bivariate analyses revealed that several variables were associated with pediatric preparedness scores (**Figure 1**). Independent practices had lower pediatric preparedness score compared to those that were part of a larger group (β=-11.89, 95% confidence interval [CI]: -19.33, -4.45). Higher annual patient volume and larger total staff size were associated with higher scores (β=0.001; 95%CI: 0.00, 0.001, p=0.017 and β=0.51; 95% CI: 0.19, 0.83, p=0.002, respectively). AMC affiliation and the presence of learners were not associated with higher scores. Looking at a multivariable regression model, higher annual patient volume was no longer significantly associated with higher preparedness. Independent practices were associated with lower preparedness scores while larger total staff size was associated with higher scores in the multivariable model (β= -10.52; 95%CI: -17.74, -3.29, p=0.005 and β=0.41; 95% CI: 0.09, 0.73, p=0.014, respectively). The results of these analyses are in **Table 3.**

Simulation-Based Performance

The median performance score of the asthma case was 63.6% (IQR 43.2,81.2), while the median score of the seizure case was 69.2% (IQR 46.2, 80.8). Details of performance with the subcomponents of each case-based checklist are reported in **Table 4.** We stratified the simulation performance by practice characteristics in **Supplemental Table S2**.

Relationships between preparedness scores, offices characteristics and simulation scores

We looked at simulation scores stratified by two of the checklist items, regular emergency drills/practice (essential checklist #6) and a standardized process of contacting EMS (essential checklist #7). The asthma simulation score was lower at sites that had policies for regular drills: 82% (IQR: 64, 91) for those without a policy for regular drills versus 50% for those with (IQR: 36, 64) (p=0.002). The difference was non-significant for the seizure scores: 69% (IQR: 62, 85) versus 54% (17, 77) (p=0.302). Additionally, offices that had a standardized process of contacting EMS had a higher rate of activating EMS for the simulation cases (72% vs. 47%, p=0.014).

Discussion

This study revealed variability in both pediatric emergency preparedness (adherence to the AAP policy statement) and the quality of emergency care measured by in situ simulations in a national sample of pediatric primary care offices. This is the first multicenter study to directly measure pediatric office emergency preparedness and quality of emergency care. These measurements provide the first step in improvement efforts aiming to ensure optimal care for children presenting to offices with emergencies. These data can be used to guide the development of interventions to improve emergency preparedness and care delivery in pediatric offices.

We found that non-independent offices, with larger staff size, and with higher annual patient volume had higher preparedness scores. However, on multivariable analysis, only larger staff size and non-independent practices were significantly associated with higher preparedness scores. This higher preparedness could be secondary to additional staff to focus on this topic and additional resources available as a part of a larger system of practices. Larger staff size may correlate with higher patient volume and subsequently more exposure to pediatric patients, which could contribute to the higher preparedness score.

Despite the AAP policy statement being reaffirmed multiple times since its initial publication, pediatric office emergency preparedness remains highly variable. This study adds to the evidence reported in previous studies that noted poor pediatric office preparedness through self-reported surveys that are prone to bias. Notably, the in-person direct observation survey methods conducted in this study are less prone to biases[7, 16, 17].

The mean preparedness score of essential equipment and supplies was 82%, reflecting a higher score compared to what has been reported in our previous pilot report of 64%[15]. Although some equipment items are rarely utilized in everyday office-based clinical care, it is concerning that 82% of offices did not have an infant bag valve mask and would therefore need to wait for EMS arrival to administer life-saving ventilation to an infant. This highlights the need to have this equipment available and maintain the skills necessary to care for patients in respiratory distress, the most common emergency encountered in the office setting. A cardiac arrest board is another example of a potentially life-saving piece of equipment that was not available in the majority of offices, likely due to the extremely rare occurrence of cardiac arrests in the office setting. Lack of a board may lead to poor CPR quality prior to the arrival of EMS. The mean preparedness score for the additional equipment, noted as essential only if EMS response time > 10 min, was much lower (38%). This may again be attributed to its rare use in the office setting. Future work should explore the benefit of these items to potentially guide changes to the existing guidelines designation of essential equipment.

The mean preparedness score of policies and protocols was low at 57% with common deficiencies in conducting a regular self-measurement, regular emergency drills/practice and having written protocols for emergency response. Despite the AAP recommendation of performing regular mock codes in the office, our findings were aligned with previously published surveys that reported 20%-40% presence of regular mock codes in offices. This highlights major opportunities for future improvement through providing templates for standardized policies [6, 8, 16].

Surprisingly, we did not find a correlation between office preparedness scores with simulation performance scores. This could be attributed to a small sample size or the fact that the presence of certain equipment and supplies does not necessarily translate to high quality care. We noted that offices with policies for regular drills had lower asthma performance scores. This could be secondary to the poor quality of the simulation drills conducted by pediatric offices or the lack of rigorous validity of the simulation checklists used. We also noted that offices with a standardized process of contacting EMS had a higher rate of activating EMS during the simulations. This is an important finding since easy accessibility and contact of EMS will ensure timely transfer and definitive resuscitative care.

All participating sites received a customized preparedness report of office-based emergency preparedness and the quality of simulated care (**Supplemental Appendix 3).** Additionally, all offices received clinical and educational resources and continued to collaborate with the academic medical centers to support improvement efforts. This collaborative model mirrors the components of our published ED readiness improvement collaborative situ simulations[10, 11, 15, 18, 19]. Our future work will focus on developing, implementing and evaluating improvement interventions involving academic medical centers collaborating with regional offices.

Our study has a few limitations. Our recruitment method may have led to selection bias with the recruited office sites being more engaged in emergency preparedness, which may limit the generalizability of findings. We did not recruit any rural offices with very low patient volume nor offices that provided care to both children and adults. However, to mitigate this limitation, we recruited a spectrum of sites to represent the range of offices in the nation. Second, the emergency preparedness checklists we used have limited validity evidence, and the items are not weighted. However, these checklists are derived from an AAP policy statement and represent the best checklists available in the literature. Similarly, the simulated case checklists we used have limited validity evidence regarding internal structure and consequences. Lastly, we did not obtain interrater reliability of the checklist scoring since only one study personnel performed the on-site measurement. However, all lead investigators and research coordinators underwent a train-the-trainer session to ensure consistency and standardization.

Conclusions

This study revealed variability in the emergency preparedness and the quality of simulated emergency care provided in pediatric primary care offices. Essential life-saving equipment, such as an infant bag valve mask, was missing in most offices, highlighting the need for efforts to assess and improve pediatric office emergency preparedness. Many offices did not have emergency policies and procedures. Academic and community partnerships are a promising strategy to address these gaps in preparedness, as they were already found to be effective in the ED setting. This study informs future efforts and initiatives to work collaboratively to update the current policy statement for pediatric offices preparedness for emergencies and serves as a baseline for developing interventions to improve emergency preparedness and emergency care in the pediatric office.

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