

Research Article

Factors that contribute to failure to rescue events in pediatric emergency department patients

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Abstract

Background: Failure to rescue is defined as the inability to identify early signs or symptoms of deterioration leading to the development of an event that was not expected or desired. We explored 3 types of failure to rescue events in patients who presented to the pediatric emergency department (ED): Patients admitted to a general care unit and transferred to a pediatric intensive care unit (PICU) within 4 hours of arrival to the general care unit; patients who required a critical procedure within the first hour of arrival to the PICU; and patients who require initiation of cardiopulmonary resuscitation (CPR) 30 minutes after arrival in the ED.

Methods: This was a retrospective study conducted at a children's hospital. Eligible patients were identified using our electronic medical record.

Results: Between March 1, 2013 and February 28 2015, 50 patients met the inclusion criteria. 28 (56%) patients received a critical procedure within 1 hour of arrival to the PICU, 21 (42%) patients were transferred to the PICU within 4 hours of being admitted to the general care unit, and 1(2%) patient received CPR after being in the ED for greater than 30 minutes. The average age was 7.06 years old. Significant past medical histories were present in 36 (72%) patients. Abnormal vital signs were seen in the 4 hours prior to the failure to rescue events in all 3 groups.

Conclusion: Failure to rescue events are not an uncommon occurrence in the Pediatric Emergency Department, especially in patients with significant past medical histories.

Abbreviations

ED: Emergency Department; PICU: Pediatric Intensive Care Unit; CPR: Cardiopulmonary Resuscitation; VP: Ventriculoperitoneal; HR: Heart Rate; BP: blood pressure; RR: Respiratory rate; GCS: Glasgow Coma Scale; Neuro: Neurology; GI: Gastrointestinal; Resp: Respiratory

Introduction

It is imperative that healthcare professionals identify and mitigate risk of harm. The evaluation and revision of care practices are necessary to ensure this goal [1]. Failure to rescue events have been identified by the National Quality Forum as a sensitive indicator of the quality of care. Failure to rescue is defined as the inability to identify early signs or symptoms of deterioration leading to the development of unanticipated deterioration that was not present on admission [2].

Failure to rescue is thought to occur due to a number of factors including lack of vigilance, surveillance, or action [3,4]. Vigilance is defined as identification of clinically significant signals and a readiness to act appropriately. Surveillance involves detecting signs and symptoms of a complication in a timely manner and then acting by mobilizing necessary resources [4].

We explored three types of failure to rescue events in patients who present to pediatric emergency departments. The first type involves those patients who are admitted to a general medical-surgical care unit and are transferred to a higher level of care, usually a pediatric intensive care unit (PICU) within 4 hours of arrival to the general care unit. Second, patients requiring a critical procedure, including intubation, central line placement, or cardiopulmonary resuscitation (CPR) within the first hour of arrival to a higher level of care. Finally, the third type of failure to rescue event includes those patients who

require initiation of CPR after arrival in the emergency department. For the purposes of this study, patients who receive CPR after being in the emergency department for at least 30 minutes would be included. Patients who experience a failure to rescue event frequently have had an unrecognized period of deterioration in clinical status during the hours leading up to the event. We aimed to describe the general epidemiology of patients with failure to rescue events. Our overall research goal was to improve recognition and response to clinical deterioration and decrease adverse events and risk of failure to rescue.

Materials and methods

Study design and setting

This study is a retrospective study conducted in an urban, tertiary care children's hospital. The Institutional Review Board at University of Louisville approved the study.

Eligible patients were identified using our electronic medical record, EPIC (Version 2015). We identified a failure to rescue event using times recorded in EPIC for a) arrival in the ED, on general ward, or in the PICU, b) transfer to PICU, c) performance of critical procedures after arrival in PICU, and d) initiation of CPR in ED.

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Key words: pediatric emergency department, cardiopulmonary resuscitation, pediatric intensive care unit

Received: April 12, 2017; **Accepted:** May 11, 2017; **Published:** May 15, 2017

Patients were excluded from the study if they were over the age of 18 years or had incomplete data including the times of procedures, transfer to the PICU, or initiation of CPR in the emergency department.

Recorded data included age, date and time of service, past medical history, medical devices present prior to presentation (*i.e.*, ventriculoperitoneal (VP) shunt, gastrostomy tube (g-tube), mediport, pacemaker, etc) admitting diagnosis, and discharge diagnosis. The date and time of patient's vital signs (heart rate (HR), blood pressure (BP), oxygen saturation by pulse oximetry, respiratory rate (RR)), Glasgow Coma Scale (GCS) scores in the 4 hours preceding the failure to rescue as well as the types of critical procedures performed within 1 hour of arriving to the PICU were also recorded.

We used descriptive statistics to help identify patients who may be at higher risk of a FTR event. We evaluated the proportion of patients with complex past medical histories (*i.e.*, cardiac, neurological, renal, etc.). We also described the proportion of patients with devices as well as demographic characteristics including age, vital signs, and diagnosis. We also described the proportion of these events that occurred during the time of day and which quarter of the year.

We also evaluated the proportion of patients that fall into the following categories (Cardiac pathology, nephrology pathology, neurology pathology, pulmonary pathology, GI pathology, infectious pathology, trauma patients, and if they were previously healthy)

When evaluating the heart rate, respiration rate, and blood pressure, we used the vitals listed in the American Heart Association for our normal ranges. We determined if the vital sign was abnormal and how severely the vitals deviated from normal.

Results

Between March 1, 2013 and February 28 2015, 50 patients met the inclusion criteria (Table 1). Abnormal vital signs were seen in the 4 hours prior to the failure to rescue events in all 3 groups and are further described in Tables 5 and 6. The time of day and part of the year that the failure to rescue events occurred are described in Table 2.

Patients who received a critical procedure within 1 hour of arrival to the PICU

Twenty-eight patients (56%) received a critical procedure within one hour of arrival to the PICU. The average age of these patients was 11.12 years (range 0.35 years to 14.07 years). The most common procedure was an arterial catheter (23) followed by a central venous catheter (18). However, only one patient was intubated or received an intraosseous catheter within 1 hour of arrival to the PICU.

The majority of these patients (59.7%) had significant past medical histories, the most common being a neurological disorder (35.7%). However, of note, eleven (39.3%) of these patients had no past medical history. Eight of the patients with no past medical history were admitted to the PICU due to a trauma and one of the patients presented in septic shock. Of the other 2 patients that who did not have any significant past medical history, one was subsequently diagnosed

with coarctation of the aorta and the other presented in respiratory failure from a hydrocarbon ingestion and aspiration.

Nineteen (67.9%) of these patients had previous medical hardware. A g-tube was the most common medical hardware (7, 25.0%), closely followed by a VP shunt (6, 21.4%). Three (10.7%) of the patients had a tracheostomy tube. Finally, one patient each had either a cardiac pacemaker, dialysis catheter, or a vagus nerve stimulator (VNS).

Fourteen (50%) of the patients had an abnormal GCS prior to being admitted to the PICU. Thirteen (46.4%) of the patients had a GCS of 3 during the ED course.

The most common diagnostic category for patients who received a critical procedure within 1 hour of arrival to the PICU was trauma (8, 28.5%). Renal issues and septic shock were the next two most common diagnosis categories each with 4 patients (14.2%).

Patients who were transferred to the PICU within 4 hours of being admitted to the floor

Twenty-one (42%) patients were transferred to the PICU within 4 hours of being admitted to the floor. The average age of these patients was 5.9 years (range 0.05 – 17.4 years). Seventeen (81%) of these patients had past medical histories, the most common being a cardiac history (6, 28.5%) followed by neurological and respiratory disorders (4, 19% each). Three patients (14.2%) had no past medical history.

Eight (38%) patients had previously installed medical hardware. Similar to the previous group, the most common medical hardware was a g-tube (6, 28.6%). There was one (4.8%) of each of the following hardware: mediport, VNS, pacemaker, NJ tube, and tracheostomy tube.

Three patients had an abnormal GCS (<15) while in the ED. One patient who was later diagnosed with septic shock had had a GCS of 12 that rose to 15 just prior to admission. One patient who presented with seizures had a GCS of 11 prior to admission. Finally, one patient, who presented after a drug ingestion, had a GCS of 3 while in the ED. Her GCS rose to 9 during her ED course and a GCS immediately prior to admission to the general medical surgical unit was not recorded.

The most common diagnostic category for patients who were transferred to the PICU within 4 hours of arrival to the floor was respiratory (11, 52.4%) followed by neurological (4, 19%). Of the patients with respiratory diagnoses, 5 were due to bronchiolitis, 2 were due to status asthmaticus, 1 had a diagnosis of pneumonia, 1 was tracheitis, 1 was due to aspiration, and 1 was an upper respiratory infection. Of the neurological patients, 3 were diagnosed with seizures, and one had a cerebrovascular accident.

Patient who received CPR after being in the ED for greater than 30 minutes.

There was only one (2%) patient who received CPR after being in the ED for greater than 30 minutes. This patient was 9 years old and had a very complex past medical history resulting from being a pedestrian victim hit by a motor vehicle 6 years earlier. She had a traumatic brain injury resulting in hydrocephalus and subsequently a VP shunt and severe developmental delay. She had a history of seizures and asthma. She also had a tracheostomy tube. She presented in septic shock and received CPR 34 minutes after arrival to the ED. The patient's GCS was a 3 throughout her ED course. The patient died 35 minutes after CPR was initiated. Medical care was withdrawn, per the parent's request.

Table 1. Total Number of Failure to Rescue Events

	Total Number of Events	Average Age
CPR after 30 minutes in the PED	1	9
Critical Procedure within 1 hour of arrival to the PICU	28	11.12
Transferred to the PICU within 4 hours of arrival to the floor	21	5.9
Total	50	7.06

Table 2. Time of FTR Event

	Jan - March	April - June	July - Sept	Oct - Dec	Day (8a-4p)	Evening (4p-12a)	Night (12a-8a)
CPR after 30 minutes in ED	0	1	0	0	1	0	0
Critical procedure within 1 hour of arrival to PICU	7	6	10	5	10	13	5
Transferred to PICU within 4 hours of admitting to the floor	7	2	8	4	3	8	10

Table 3. Past Medical History

	Cardiac	Neuro	GI	Respiratory	None	Renal
CPR after 30 minutes in ED	0	1	1	1	0	0
Critical procedure within 1 hour of arrival to PICU	4 (14.2%)	10 (35.7%)	0	5 (17.9%)	11 (39.3%)	3 (10.7%)
Transferred to PICU within 4 hours of admitting to the floor	6 (28.5%)	4 (19%)	3 (14.3%)	4 (19%)	3(14.3%)	0 (0%)

Table 4. Diagnosis Category

	Trauma	Ingestion	Cardiac	Neuro	Resp	Renal	Sepsis	GI
CPR after 30 minutes in ED	0	0	0	0	0	0	1	0
Critical procedure within 1 hour of arrival to PICU	8 (28.5%)	1 (3.57%)	3 (10.7%)	1 (3.5%)	4 (12.2%)	4 (14.2%)	4 (14.2%)	3 (10.7%)
Transferred to PICU within 4 hours of admitting to the floor	0	2 (9.5%)	2 (9.5%)	4 (19%)	11 (52.4%)	0	1 (4.8%)	1 (4.8%)

Table 5. Vital signs in patients show received a critical procedure within 1 hour of arrival to the PICU

	Number of Patients Who Had Abnormal Vital signs within these parameters
HR>10% above normal	13 (46.4%)
HR > 20% above normal	11 (39.3%)
HR> 30% above normal	12 (42.9%)
HR >10% below normal	1 (3.6%)
HR > 20% below normal	0 (0.0%)
HR > 30% below normal	1 (3.6%)
Compressions	4 (14.3%)
Systolic Blood Pressure > 10% lower than normal	12 (42.9%)
Systolic Blood Pressure > 20% lower than normal	13 (46.4%)
Respiration rate >10% above normal	9 (32.1%)
Respiration rate >20% above normal	4 (14.3%)
Respiration rate > 30% above normal	4 (14.3%)
Respiration rate lower than normal	10 (35.7%)
Pulse oxygenation 85-89%	5 (17.9%)
Pulse oxygenation 80-84%	5 (17.9%)
Pulse oxygenation <79%	6 (21.4%)

Table 6. Patients transferred to the PICU within 4 hours of being admitted to a general medical –surgical floor

	Number of Patients Who Had Abnormal Vital signs within these parameters
HR>10% above normal	3 (14.3%)
HR > 20% above normal	1 (4.8%)
HR> 30% above normal	4 (19.0%)
HR >10% below normal	1 (4.8%)
HR > 20% below normal	0 (0.0%)
HR > 30% below normal	1 (4.8%)
Compressions	0 (0.0%)
Systolic Blood Pressure > 10% lower than normal	2 (9.5%)
Systolic Blood Pressure > 20% lower than normal	0 (0.0%)
Respiration rate >10% above normal	5 (23.8%)
Respiration rate >20% above normal	4 (19.0%)
Respiration rate > 30% above normal	5 (23.8%)
Respiration rate lower than normal	3 (14.3%)
Pulse oxygenation 85-89%	3 (14.3%)
Pulse oxygenation 80-84%	0 (0.0%)
Pulse oxygenation <79%	0 (0.0%)

Discussion

Significant past medical histories were often present in patients who underwent a failure to rescue event (36, 72%). The exception to this was with trauma patients who were admitted to the PICU and received a critical procedure within 1 hour of arrival. Patients who suffered a substantial traumatic event were more likely not have any chronic medical issues. Among the patients who had medical hardware prior to presentation, g-tubes were the most common. A recent study found that g-tubes were performed at a fairly high rate, 18.5/100,000 US children in 2009 [5]. This supports the notion that the reason why g-tubes are the most common medical hardware noted during a failure to rescue event is because they occur in a higher number of pediatric patients compared to other types of medical hardware.

The most likely time of year for a failure to rescue event to occur is July through October. This corresponds with the first quarter of the medical year. This is the time of the year where new, inexperienced physicians begin practicing at the hospital. This finding is consistent with previous studies. Phillips et al described the “July Effect” where there was an increase in fatal medical errors in teaching medical institutions in the month of July when new medical staff started [6]. Failure to rescue events also occur during the evening (4pm – 12am) and night (12am – 8am) hours when there is likely to be less supervising staff available.

The critical procedures performed in the PICU within 1 hour of arrival are consistent with the national shift of procedures being less likely to be performed in the pediatric emergency department. A recent article by Mittiga et al found that over the course of 12 months, 63% of

pediatric emergency faculty at a tertiary care pediatric institution did not perform any critical procedures. Mittiga et al found that the most common procedure to be performed was orotracheal intubations [7]. For patients who received a critical procedure within 1 hour of arrival to the PICU, the most common procedures included arterial catheters followed by a central venous catheters, procedures much less likely to be performed in a pediatric emergency department. However, only one patient was intubated or received an intraosseous catheter within 1 hour of arrival to the PICU, procedures that pediatric emergency physicians are more likely to perform.

Limitations

The current study has several limitations. The patients were included in the study based on the times recorded in our electronic medical record, EPIC. If the times were incorrect patients may have been improperly included or excluded. Also, vital signs were not recorded at regular intervals and it is possible that more abnormalities in vital signs were missed.

Conclusion

Failure to rescue events are commonly associated with significant past medical histories and abnormalities in vital signs leading up to the event. Further studies are warranted to establish a guideline for high risk patients to help predict failure to rescue events for children who present to the pediatric emergency department.

Acknowledgements

Dr. Herr conceptualized and designed the study, helped analyze the data, reviewed the initial manuscript, and approved the final manuscript as submitted.

Dr. Montgomery conceptualized and designed the study, helped

analyze the data, reviewed the initial manuscript, and approved the final manuscript as submitted.

Dr. Wadia carried out the initial analyses, wrote the initial draft of the study and revised the manuscript, and approved the final manuscript as submitted.

Funding Source: No external funding for this manuscript

Conflict of Interest: The authors have no conflict of interest to disclose

Financial Disclosure: The authors have no financial relationships relevant to this article to disclose.

Clinical Trial Registration: None

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