American Journal of Emergency Medicine 36 (2018) 446–449

Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Original Contribution

Predictors of emergency department discharge following pediatric drowning☆,☆☆

Rebecca M. Cantu, MD, MPH [a,*], Christopher M. Pruitt, MD [b], Nichole Samuy, MD [b], Chang L. Wu, MD, MSCR [b]

[a] Department of Pediatrics, University of Arkansas for Medical Sciences, Little Rock, AR, United States
[b] Department of Pediatrics, University of Alabama at Birmingham, Birmingham, AL, United States

ARTICLE INFO

Article history:
Received 18 April 2017
Received in revised form 23 August 2017
Accepted 24 August 2017

Keywords:
Pediatrics
Drowning
Immersion
Discharge

1. Introduction

The World Health Organization defines drowning as "the process of experiencing respiratory impairment from submersion in liquid," with possible outcomes of death, morbidity, or no morbidity [1]. Drowning is among the top ten causes of death in children in all regions of the world, and among the top five causes in the United States [2]. The highest rates of drowning both globally and in the US are in children age 1–4 years [2-6]. Almost 6000 drowning victims are treated annually in US emergency departments (ED), more than half of whom are children age 4 and younger [5]. In 2003, pediatric drowning accounted for estimated hospital costs of $9.5 million [4].

Despite significant healthcare resource utilization, evidence suggests that mortality rates for drowning have been decreasing in the US [4,5,7]. Studies evaluating drowning have shown that bystander cardiopulmonary resuscitation (CPR) has become more common, with higher rates of survival to hospital admission. More than three-quarters of children presenting to an ED with nonfatal fatal drowning in 2013 were discharged home from the ED [8]. Though the majority of nonfatal drowning incidents are not associated with significant health-related sequelae, a considerable subset of this population, specifically those who require and survive CPR, has significant morbidity [9].

No standard emergency management of pediatrics drowning victims exists, despite the significant morbidity and mortality due to drowning worldwide. This may be due in part to the wide variation of clinical presentation of these patients [10]. Asymptomatic patients may require little to no laboratory or radiological evaluation while tests in symptomatic patients may include various labs and imaging [11]. Though no longer a recommended term [1], "secondary drowning," or acute respiratory distress syndrome developing after drowning, has been reported hours after initial submersion event [12-14]. However, Causey and colleagues [15] showed no delayed deterioration in patients with normal oxygen saturations on room air at 6 h post-submersion. Therefore, reports of this phenomenon likely represent an extremely rare outcome.

As with many other clinical entities, the lack of a consensus approach to pediatric drowning may be associated with variability in medical resource utilization. Expanded knowledge of clinical factors associated with potential morbidity, or lack thereof, from drowning could inform medical decision-making for these children. To this end, our study aims to identify predictors of discharge in children presenting to the ED after accidental drowning.

2. Methods

In this retrospective cohort study, we included patients ages 0–18 years who presented to the ED of a large, urban, free-standing tertiary care children's hospital in the southeastern United States from January 1, 2010 through December 31, 2014 for drowning or submersion injury. Subjects were identified using International Classification of Diseases, Ninth Revision (ICD-9) codes 994.1 or E910.0-910.9. Visits were excluded if codes indicated intentional submersion (E914, E964,

☆ Funding Sources/Disclosures: There was no funding support for this study. The authors have no financial relationships relevant to this article to disclose.
☆☆ Prior Presentations: Poster presentations at University of Alabama at Birmingham Pediatric Science Day; March 19, 2016; Birmingham, LA and Pediatric Hospital Medicine conference, July 29, 2016, Chicago, IL.
* Corresponding author at: #1 Children's Way, Slot 512-8, Little Rock, AR 72202, United States.
E-mail address: rmcantu@uams.edu (R.M. Cantu).

http://dx.doi.org/10.1016/j.ajem.2017.08.057
0735-6757/

E984). At our institution, there is no clinical guideline or protocol in place for drowning patients in the ED. The primary endpoint was disposition from the ED, which we defined dichotomously as discharged to home from the ED versus the following outcomes: admitted for observation, admitted to any inpatient setting, or deceased prior to admission. Secondary outcomes of all-cause readmission to the facility (to the ED or inpatient admission) in the 7 days and 30 days following presentation to the ED were also examined.

Primary predictor variables included standard demographics (age, gender, race), insurance type, and rurality. Race was classified as non-Hispanic white, non-Hispanic black, and other. Insurance type was categorized as government, commercial, or other. Rurality was designated by linking patient ZIP code data to their Rural-Urban Commuting Area (RUCA) categorization [17]. RUCA is a classification system based on the US Census Bureau that distinguishes urban and non-urban areas by using population density and commuting travel patterns. We dichotomized the four category classifications (urban, large rural, small rural, isolated) a priori as urban and non-urban [18].

Charts were further manually reviewed for specific details of the submersion event, including location (pool, bathtub, natural body of water), whether the event was witnessed, and reported field intervention. We considered a submersion event witnessed if a person directly observed the child going underwater; reports of "just turning away for a minute" then finding the child submerged were considered unwitnessed. Field intervention was defined as report of intervention by a bystander or first responder at the scene of the submersion, including chest compressions, back/chest blows, or rescue breaths. Witnessed event and field intervention were categorized as "yes" if explicitly mentioned in the historical data versus no/unknown. Triage vital signs obtained in the ED were also reviewed, with hypoxia defined as peripheral capillary oxygen saturation (SpO_2) ≤95%. We also reviewed blood gas tests and radiological studies [chest radiograph and head computerized tomography (CT)] ordered. Though literature is scarce on chest radiography findings associated with drowning [19], we considered a chest radiograph abnormal if the final radiology report mentioned findings of atelectasis, edema, infiltrates, or opacities. We elected to consider a lack of radiographic imaging as "normal," assuming that patients for whom no such testing was pursued were likely judged to be clinically well based on examination and other factors.

Univariate descriptive statistics were performed for all demographic variables and dichotomous drowning characteristics as described above. Bivariate comparisons among each predictor variable against the primary outcome were obtained via χ [2] analyses. Multivariable logistic regression modeling with fixed effects was conducted for the primary outcome variable of ED disposition. The logistic model was created with a forward selection approach. Fixed effects were selected with the alpha criterion set at 0.15. The threshold for statistical significance was set at $p < 0.05$. All tests were two-tailed, and missing data were excluded. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). The study was approved by the University of Alabama at Birmingham Institutional Review Board for Human Use.

3. Results

Ninety-one ED visits during the study period were screened (Table 1). One case was excluded due to miscoding. Thirty-seven percent of patients were discharged home from the ED. One patient died in the ED, and the remaining 63% of patients were admitted from the ED, with 26% admitted to an intensive care unit. More than three-quarters of the submersion events occurred in swimming pools (Table 2). In two cases, the submersion event occurred during a swimming lesson. Twenty-five percent of all patients had abnormal chest imaging; two patients had incidental findings of foreign body in the gastrointestinal tract seen on chest imaging. In our study population, drowning was most common in summer, followed by spring months. Most cases were unwitnessed and had field intervention following the drowning event.

Four patients (4%) had abnormalities on head CT. Two were <1 year of age and found submerged unattended in a bathtub; two were 1–5 years of age and unattended in a pool and a lake. The abnormal imaging findings included evidence of ischemia, hypoxic/anoxic injury, cerebral edema, and herniation (one patient).

Bivariate analysis (Table 3) revealed that patients were significantly more likely to be discharged home from the ED if they presented with lack of hypoxia, did not receive supplemental oxygen in the ED, did not undergo blood gas testing, had a normal chest radiograph, or if historical details included witnessed submersion event or no field intervention performed after submersion (all $p < 0.01$). In the multivariable model (Table 4), children presenting with oxygen saturation > 95% or with no reported field intervention were more likely to be discharged home from the ED.

Records were also assessed for 7- and 30-day all-cause readmissions for all subjects regardless of initial disposition. Three patients (3%) were readmitted within 7 days of the initial presentation, none seemingly related to the drowning event; two were seen in the ED and discharged home (diagnoses of acute pharyngitis and hematuria), and one patient

Table 1
Characteristics of patients evaluated in emergency department following drowning ($N = 90$).

	N (%)
Age (years)	
<1	24 (27)
>1–5	43 (48)
>5–12	18 (20)
≥13	5 (6)
Gender	
Male	53 (59)
Female	37 (41)
Race	
Non-Hispanic white	65 (72)
Non-Hispanic black	21 (23)
Other	4 (4)
Insurance	
Government	32 (36)
Commercial	48 (53)
Other	10 (11)
Rurality	
Urban	80 (89)
Non-urban	10 (11)
Disposition from ED	
Discharged home	33 (37)
Admitted to hospital or died in ED	57 (63)
Intensive care unit-level admission	23 (26)

ED = emergency department.

Table 2
Characteristics of submersion events.

	N (%)
Season	
Spring (March–May)	20 (22)
Summer (June–August)	55 (61)
Fall (September–November)	13 (14)
Winter (December–February)	2 (2)
Witnessed[a]	
Yes	30 (33)
No	60 (67)
Field intervention[b]	
Yes	53 (59)
No/unknown	37 (41)

[a] Event was directly witnessed (e.g. someone saw child go underwater).
[b] Any field intervention (e.g. rescue breaths, chest compressions, back/chest blows) reported at the time of event.