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Submersion injuries in the United States: Patients characteristics and predictors of mortality and morbidity

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ABSTRACT

Introduction: Drowning leads to 372,000 deaths annually worldwide and to severe morbidity secondary to asphyxiation or aspiration. Previous studies described submersion injuries mainly in the pediatric population. This study describes characteristics of patients presenting with submersion injuries to United States emergency departments (EDs) and identifies predictors of poor outcomes (death or long term neurologic deficits) after drowning.
Methods: This retrospective cross-sectional study included ED visits for submersion injuries from the United States 2013 Nationwide Emergency Department Sample (NEDS) dataset using discharge data (CCS diagnosis codes). Descriptive analysis was done for the collected variables and was followed by a multivariate regression analysis to identify predictors of poor outcomes (mortality and morbidity).
Results: A total of 12,529 weighted patients presented to EDs for submersion injury in 2013 yielding a rate of 9.29 per 100,000 ED visits. Patients were more frequently males (65.8%, 95%CI: 64.0–67.6) and in the 19–65 years age group (41.8%, 95%CI: 40.0–43.6). Poor outcomes were present in 11.7% (95%CI: 10.5–13.0) of patients. Significant positive predictors of poor outcomes were: male gender (OR = 1.761, 95%CI: 1.247–2.487); presence of chronic conditions involving infectious and parasitic disease (OR = 2.824, 95%CI: 1.155–6.908), the circulatory system (OR = 12.818, 95%CI: 8.953–18.351), the respiratory system (OR = 1.498, 95%CI: 1.079–2.079) or the digestive system (OR = 2.006, 95%CI: 1.106–3.636); associated motor vehicle traffic injury (OR = 5.221, 95%CI: 1.563–17.441) and self-payers.
Conclusion: Submersion remains a high impact emergency condition in the United States. Significant predictors of poor outcomes were identified. Prevention efforts targeting susceptible population are needed to reduce the impact of submersion injuries on different communities in the United States.

Introduction

Accidental injuries result in a great number of deaths worldwide. According to the World Health Organization (WHO), drowning is the 3rd leading cause of worldwide unintentional injury death with an estimated 372,000 annual drowning deaths [1]. Children ages 1–14 are particularly susceptible to drowning – especially in the United States (US) where drowning constitutes the leading cause of death in this age group [2]. Drowning and submersion injuries can also lead to severe morbidity secondary to asphyxiation and aspiration. Furthermore, the economic burden of drowning in the US and in low and middle-income countries remains substantial [1].

In 2002, the World Congress on Drowning issued recommendations regarding the definition, prevention, and treatment of drowning. Its final report, entitled *Handbook on Drowning*, recommended further exploration of drowning risk factors, with particular attention to age, culture, ethnicity, and socio-economic status [3]. Drowning is defined as "a process resulting in primary respiratory impairment from submersion/immersion in a liquid medium" [4]. Drowning encompasses two main categories: "fatal drowning" for any death related to drowning and "nonfatal

Abbreviations: US, United States; ED, Emergency Department; CCS, Clinical Classifications Software; NEDS, Nationwide Emergency Department Sample; WHO, World Health Organization; IRB, Institutional Review Board; ICD-9 CM, International Classification of Diseases, 9th Revision, Clinical Modification; CPT, Current Procedural Terminology; HMO, Health Maintenance Organization; OR, Odds Ratio; SES, Socioeconomic Status.

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drowning" for victims who survive after the event [3].

To date, studies examining drowning are relatively few and mostly limited to the pediatric population. Risk factors for drowning include epilepsy, underlying cardiac dysrhythmias, hyperventilation, hypoglycemia, hypothermia, alcohol and illicit drug use [2]. Moreover, differing ethnic groups, boat refugees, and participants in water recreational activities are at risk of drowning [5].

The management of submersion injuries also remains challenging to health care providers. Emergency physicians are less frequently faced with this type of injury due to decreasing trends in drowning events [6]. Understanding the epidemiology of submersion injuries, characteristics of submersion victims and impact of drowning are important. This study uses a large US database of ED visits to describe characteristics of patients with submersion injuries and to identify predictors of death and morbidity after submersion events.

Patients and methods

Study design

This retrospective cross-sectional study used the 2013 public release dataset of the US Nationwide Emergency Department Sample (NEDS) database. An Institutional Review Board (IRB) exemption was obtained at the American University of Beirut for the use of this de-identified dataset.

Study setting

NEDS is a product of Healthcare Cost and Utilization Project (HCUP) that is sponsored by the Agency for Healthcare Research and Quality (AHRQ) [7].[1] It is the largest all-payer ED database in the US and data is publicly released approximately 3 years after data collection. It combines data from national and state sources. NEDS sampling frame consists of hospital-owned emergency departments across the United States and follows the definition of a limited data set under the HIPAA Privacy Rule. Weighting of the data was done according to HCUP specifications and as per NEDS provisions for national estimates using the following stratification variables: US census region, trauma center designation, urban-rural location of the hospital, ownership, and teaching status [8].

NEDS collects hospital discharge information on treatments and resource utilization from 947 hospitals located in 30 States and the District of Columbia. NEDS is a stratified sample that represents around 20% of US hospital-based EDs. The data elements collected in NEDS include: demographic patient information; category, intent, and severity of injury; admission and discharge status; hospital characteristics; payment source and healthcare expenses. All re-coding measures that were done for this study are included in Supplementary Appendix A.

Study population

The 2013 NEDS dataset contains information on weighted 134,869,015 ED visits. The study included all ED visits with an

[1] More information can be accessed via: www.hcup-us.ahrq.gov/nedsoverview.jsp

Table 1
Characteristics and Demographics of Patients with Submersion Injuries.

	Frequency (N = 12529)	*Percent (95% CI)*
Age (years)		
Newborn–3	3351	26.8 (25.3–28.3)
4–18	3158	25.3 (23.7–26.9)
19–65	5228	41.8 (40.0–43.6)
>65	769	6.1 (5.2–7.2)
Gender		
Male	8236	65.8 (64.0–67.6)
Female	4283	34.2 (32.4–36.0)
Season of Admission		
Winter	743	8 (6.7–9.4)
Spring	1858	19.9 (18.1–21.9)
Summer	5532	59.3 (57.1–61.4)
Autumn	1197	12.8 (11.4–14.4)
Missing (% of total)	3198	25.5
Median Household Income[a]		
$1–$37,999	2914	24.2 (22.7–25.7)
$38,000–$47,999	3199	26.5 (25.0–28.1)
$48,000–$63,999	3258	27.0 (25.4–28.7)
$64,000 or more	2687	22.3 (20.8–23.9)
Admission Day is a Weekend		
Admission on Monday-Friday	7521	60.0 (58.3–61.8)
Admission on Saturday- Sunday	5008	40.0 (38.2–41.7)
Primary Expected Payer		
Medicare/Medicaid	4439	35.6 (33.8–37.3)
Private including HMO	5319	42.6 (40.8–44.5)
Self-pay	1977	15.8 (14.5–17.2)
No charge	75	0.6 (0.4–0.9)
Other	675	5.4 (4.6–6.3)
Patient Location: NCHS Urban-rural Code		
Large central metropolitan	3219	26.3 (24.8–27.8)
Large fringe metropolitan	2923	23.9 (22.5–25.3)
Medium metropolitan	2824	23.0 (21.8–24.4)
Small metropolitan	1303	10.6 (9.7–11.6)
Micropolitan	1311	10.7 (9.6–11.9)
Not metropolitan or micropolitan	672	5.5 (4.9–6.2)

[a] National quartile for patient ZIP code derived from ZIP Code-demographic data obtained from Claritas.

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