

Outcomes of patients admitted for drowning

Dear Editor,

According to the latest Utstein-style consensus, drowning is defined as the primary respiratory impairment resulting from submersion or immersion in a liquid medium.¹ Patients may experience hypothermia, acute respiratory distress syndrome and shock.¹ The pathophysiology is poorly understood, but could relate to physiological responses to temperature, water swallowing and electrolyte disturbances.² Globally, more than 500,000 deaths from drowning are reported every year.³ Poor prognostic factors include low Glasgow Coma Scale (GCS) score and cardiorespiratory arrest. Treatment is largely supportive. Most preventative measures are centred on aquatic safety education and swimming lessons. Based on the National Sport Participation Survey 2018–2022, swimming has consistently ranked among the 5 most popular sports in Singapore.⁴ This study aimed to describe the outcomes of patients admitted for drowning.

All patients admitted to a tertiary hospital for drowning between January 2011 and December 2021 were identified from a prospectively maintained institutional database and included in this study. Relevant clinical data pertaining to the pre-hospital, emergency department (ED), inpatient and discharge care were anonymised and extracted. The primary outcome measured was in-hospital mortality and the secondary outcome measured was hospital length of stay (LOS). Statistical analysis was performed using R version 4.0.5 (R Core Team 2020, Vienna, Austria). Univariate and multivariate logistic regression analyses were performed to evaluate potentially prognostic risk factors. The odds ratio (OR) and corresponding 95% confidence intervals were calculated and $P < 0.05$ was deemed statistically significant.

A total of 56 patients were included. All patients had signs of life in the ED. The majority were male (73.2%), under 40 years of age (57.1%) and had GCS scores more than 12 (64.3%). Most drowning incidents occurred at the open sea (41.1%) and private pools (37.5%); 14 patients (25%) consumed alcohol and the majority of these patients were male (78.6%). None of the patients consumed psychoactive drugs. Occupational accidents and suicide attempts were uncommon, with only 2 (3.6%) and 4

(7.1%) occurrences, respectively. There was equal sex distribution for suicide attempts.

Cardiac arrest and pneumonitis were the most common complications, and these were observed in 27 patients (48.2%) and 18 patients (32.1%), respectively. Mild hypothermia (temperature 32–35°C) was observed in 5 patients (8.9%). Invasive ventilation was required in 32 patients (57.1%) for a median duration of 1 day (interquartile range [IQR] 0–2). Operations were performed in 2 patients (3.6%) for cervical spine injury and facial fractures. The median duration of high dependency and intensive care were 0 and 1 day, respectively.

There were 9 deaths (16.1%) and 4 (7.1%) took place in the ED. Low GCS score (OR 0.014, 95% CI 0.001–0.276, $P = 0.005$), cardiac arrest (OR 0.047, 95% CI 0.003–0.872, $P = 0.040$), hypothermia (OR 0.078, 95% CI 0.010–0.633, $P = 0.017$), hypoxic-ischaemic encephalopathy (OR 0.078, 95% CI 0.010–0.633, $P = 0.017$) and traumatic brain injury (OR 0.017, 95% CI 0.0008–0.356, $P = 0.009$) were predictive of mortality in the univariate analysis, but none were statistically significant in the multivariate analysis. Low GCS score approached significance with OR 0.064 (95% CI 0.004–1.05, $P = 0.054$).

The median LOS was 3.00 days (IQR 1–6.75). The need for mechanical ventilation (OR 25.62, 95% CI 3.80–172.80, $P = 0.001$), duration of ventilation (OR 7.95, 95% CI 1.63–38.68, $P = 0.010$) and duration in intensive care (OR 6.51, 95% CI 1.48–28.65, $P = 0.013$) were predictive of longer LOS in the univariate analysis. The need for mechanical ventilation (OR 22.91, 95% CI 2.29–229.48, $P = 0.008$) alone was statistically significant in the multivariate analysis. The area under the curves of the multivariate logistic regression models for in-hospital mortality and LOS were 0.85 (95% CI 0.7–1) and 0.9 (95% CI 0.704–1), respectively. Fig. 1 shows the distribution of observed LOS for survivors and non-survivors. The distribution of LOS was skewed to the right for survivors, with a median of 4 days and mean of 5.57 days (standard deviation [SD] 5.61). For non-survivors, the median LOS was 1 day and mean was 1.11 days (SD 1.27).

Inpatient mortality was 16.1%. Among the possible predictive factors for mortality, hypothermia can be easily addressed by covering patients with warmed blankets and infusing warmed fluids. Hypoxic-ischaemic encephalopathy may be preventable with early recognition of cardiopulmonary compromise and prompt resuscitation in accordance to Advanced Cardiac Life Support and Advanced Trauma Life Support. With regards to LOS, the need for mechanical ventilation and duration in intensive care are contingent on the severity of injuries and these factors are non-modifiable. Patients who undergo major surgery or require mechanical ventilation

Fig 1. Distribution of hospital length of stay for survivors and non-survivors.



may require a multidisciplinary approach for discharge planning.

In terms of preventive measures, a targeted approach to public health education and instituting stricter safety policies at beaches and private pools may be helpful. Public health education and drowning prevention campaigns targeting male youth may be effective, including water safety lessons during full-time national service. Refresher lessons can also be conducted for operationally ready national servicemen. Since 78.6% of patients who consumed alcohol prior to the drowning incidents were male, targeted public education efforts on responsible drinking may help.

Most patients (78.6%) experienced drowning at beaches and private pools. In contrast to public pools, not all beaches and private pools employ lifeguards and there is no legal requirement to do so.^{5,6} It is likely costly and difficult to find trained lifeguards for every swimming pool. Perhaps cameras can be installed to allow remote surveillance and alarms can be activated when help is needed. Even in the absence of lifeguards, trained civilians can help too. Beaches and private

pools also do not have restrictions on alcohol consumption and this should be re-evaluated. The Singapore Life Saving Society (SLSS) is the primary organisation leading national efforts in promoting water safety in Singapore.⁷ SLSS regularly conducts lifesaving courses and examinations to not only develop a pool of trained lifeguards, but also impart skills to the common civilian. There is also SwimSafer, which is a national programme designed to teach essential swimming skills, water safety awareness and build water confidence from a young age. Public campaigns should also increase awareness and adoption of such programmes.

One limitation of this study is the absence of data on out-of-hospital mortality. The results presented in this study are derived from the survivors and are prone to selection bias. There is also a lack of data on drowning among children as this study was conducted in an adult ED. Nonetheless, establishing a baseline inpatient mortality rate remains a strength of this paper. Like all aspects of trauma management and prevention, work in the pre-hospital setting is required.

Disclosure

The authors declare no conflict of interest.

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