

# Drowning in Children in Iran: Outcomes and Prognostic Factors

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## SUMMARY

The aim of this study was to determine possible associations between some prognostic factors and drowning outcome. There were 47 drowning victims during the study period, of whom 39(83%) survived and 8(17%) died. All deaths occurred in children aged under 5 including 7 (87.5%) male and 1(12.5%) female victims. Seven (87.5%) were Iranian and only one (12.5%) was from Afghanistan. Absence of vital signs at hospital arrival, need for resuscitation, GCS<5 and acidosis all were associated with adverse outcome with a statistical significance ( $P<0.05$ ), but hypothermia was the only independent predictor of poor outcome (OR 13.7; 95% CI 2.27 to 82.7,  $P = 0.003$ ). Since prognostic factors do not predict outcome with 100% accuracy, performing cardiopulmonary resuscitation at the scene and continuing it in the hospital can provide higher chances of recovery for the children.

## KEY WORDS:

Children, Drowning, Outcome, Prognosis

## INTRODUCTION

Drowning is a major global public health problem<sup>1-3</sup>. Based on the new definition of drowning agreed by the First World Congress on Drowning and the World Health Organisation (WHO) drowning is the process of experiencing respiratory impairment from submersion or immersion in a liquid<sup>3</sup>.

Drowning targets all age groups worldwide, but certain groups are at increased risk including toddlers and adolescents<sup>4</sup>. Drowning outcomes are classified as death, survival with morbidity, and survival without morbidity.

More than half of all deaths caused by drowning occur in children less than 15 years of age. A majority of drowning deaths occur in low and middle income countries. In China, drowning is the leading cause of death from injury in children younger than 14. In Bangladesh 20% of all deaths in 1-4 years old children is due to drowning and in Vietnam seven of nine drowning victims are children under 15 years old<sup>1-3, 5-7</sup>.

There is geographic differences in drowning pattern in Iran. Drowning is the second leading cause of injury related deaths in northern Iran. According to Ministry of Health and Medical Education in Iran, in 2001 the mortality rate due to drowning ranged from 4.1 per 100000 population in a coastal

area in northern Iran to a low of 0.9 per 100000 population in central Iran where there is no access to the sea. More than 50% of the victims were less than 15 years old<sup>2</sup>. Mazandaran province (in north of Iran) had a mean drowning rate 7.6 per 100000 population during a 5 year study period<sup>8</sup>.

The outcome for drowning is bimodal. The majority have a good outcome but some survivors may remain in a vegetative state or have permanent neurologic deficit, which is a great social and economic burden on family and the society as well<sup>9</sup>. Predicting outcome in drowning is difficult. Several factors may influence outcome. Duration of submersion, the need for resuscitation, the effectiveness of resuscitative efforts, and the speed of regaining consciousness by the victims may predict the prognosis. Drowned children with stable vital signs, no impairment of consciousness state, no or minimal requirement of resuscitation efforts at the scene usually have good outcome<sup>10</sup>.

The aim of this study was to determine possible associations between some prognostic factors and the outcome of drowned children admitted to Shahid Beheshti Hospital of Kashan in Iran over a 12- year period.

## MATERIALS AND METHODS

We retrospectively reviewed the medical records of drowned victims admitted during a 12- year period(1993- 2005) to Kashan Beheshti Hospital, a 400- bed teaching university hospital with tertiary care facilities. The data regarding age, gender, nationality, duration of submersion, initial vital signs on admission, Glasgow Coma Scale (GCS), body temperature on arrival at the hospital, performance of cardiopulmonary resuscitation (CPR) and pH were extracted from the patient's files and their impact on victim's outcome were evaluated. Fisher's exact test were used for statistical analyses and a P value of less than 0.05 was considered for the level of significance.

## RESULTS

There were 47 victims of drowning admitted during the study period, of whom 33(70.2%) were male. The age range was 10 months to 15 years with a mean of 36 months and a median of 24 months. Forty two(89.3%) were children under the age of 5, 40 (85%) were Iranian and 7(15%) were Afghans. The majority of submersion events occurred in the warm months of the year and in residential ponds and swimming pools.

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Table I: Relation of the variables with the drowning outcome

Variables	No of cases	Recovery	Mortality	P value	OR	CI
<b>Age</b>						
<5	42	34	8	0.571	N/A	N/A
≥5	5	5	0			
<b>Gender</b>						
Male	33	26	7	0.405	3.5	0.38 to 31.5
Female	14	13	1			
<b>Nationality</b>						
Iranian	40	33	7	1	1.27	0.13 to 12.3
Noniranian	7	6	1			
<b>Submersion Time</b>						
≤5	17	17	0	0.104	N/A	N/A
>5	18	14	4			
<b>Vital Signs</b>						
Absent	7	0	7	< 0.0001	N/A	N/A
Present	40	39	1			
<b>GCS</b>						
<5	9	1	8	< 0.0001	N/A	N/A
≥5	38	38	0			
<b>Temperature</b>						
<36	13	7	6	0.003	13.7	2.27 to 82.7
≥36	34	32	2			
<b>CPR</b>						
Yes	18	10	8	< 0.0001	N/A	N/A
No	29	29	0			
<b>pH</b>						
<7.2	7	0	7	< 0.0001	N/A	N/A
≥7.2	19	19	0			

Fisher exact tests was used for statistical analysis.

Of all the 47 drowned victims 39 (83%) recovered and 8(17%) died. All deaths 8 occurred in children aged under 5 years old, including 7(21.2%) male and 1(7.1%) female cases. Seven cases (7.2%) were Iranian whereas one of victims (14.3%) was from Afghanistan.

Submersion time in 17 cases (36.2%) was equal to or less than 5 minutes in which case all survived but in 14 of the cases (38.3%) the submersion time was more than 5 minutes of which case 4 subjects (22.2%) died. Twelve episodes of drowning were not witnessed and it could not be estimated how long the child had been drowned. Among this later group 4 patients (33.3%) died as well.

The demographic characteristics of the patients such as age, gender, nationality and duration of submersion had no significant association with poor clinical outcome (Table I).

Cardiopulmonary resuscitation (CPR) was attempted in 18 cases, two were resuscitated at the scene, 4 during transport to hospital and 12 in hospital. Among the resuscitated patients 10(55.5%) survived and 8(44.5%) died. In 29 victims who did not need resuscitation all survived (p<0.0001).

Core temperature on arrival at the hospital in 34 subjects was equal to or above 36°C with 5.1% mortality rate whereas in 13 patients with temperature under 36°C, mortality rate was 46.2%.

Victims with poor outcome were 13.7 times more likely to have hypothermia than the patients with favourable outcome (95% CI 2.27 to 82.7, p=0.003). So hypothermia was strongly associated with adverse clinical outcome.

Forty cases had detectable vital signs at hospital arrival with 97.5% survival rate but all the 7 children without initial vital signs had the worst outcome (p<0.0001).

All the cases with GCS equal to or more than 5 survived but out of the 9 patients with GCS<5, eight (88.9%) died (p<0.0001).

Acidosis was associated with an unfavorable outcome. All of the seven patients with pH <7.2 died whereas all the 19 children with pH equal to or more than 7.2 had a favourable outcome. Twenty one cases had no pH record, of whom 20 (95.2%) survived and 1 (4.8%) expired.

Table I demonstrates the association between the studied variables and clinical outcomes in the research population.

## DISCUSSION

Predicting outcome in drowning is difficult. Many researchers have investigated prognostic factors but none of the factors, either individually or in combination, have been shown to have absolute predictive significance and accuracy<sup>11,12</sup>.

Although children under 5 years had the highest mortality rate (19.1%) in our study which was consistent with other studies showing this age group to be at the greatest risk for fatality<sup>13-15</sup>, this was not statistically significant.

The mortality rate for drowning victims seems much higher in males than females in all age groups<sup>16,17</sup>. In the present study, there was a trend (not statistically significant) for greater mortality in males than females (21.2% versus 7.2%).

The Ministry of Health and Medical Education of Iran found no gender difference in drowning-related fatalities when victims were under 10 years old however as age increased, gender differences became obvious<sup>2</sup>.

Furthermore, the nationality of drowned victims was not found to associate with outcome. Therefore, none of the demographic characteristics associated significantly with poor outcome and this is compatible with Al-Mofadda et al's findings<sup>18</sup>.

Many authors have considered submersion time as a valid predictor of outcome<sup>19,21</sup> full recovery or mild neurologic disability was shown to occur in 91% of children with submersion time of less than 5 minutes<sup>21</sup> and we did not find a strong association between submersion time and poor outcome. The small sample size and some episodes of unwitnessed events might have influenced the results. Moreover, it is difficult to determine the submersion time accurately in many cases of drowning.

Early and effective resuscitation is important for improving clinical outcome after drowning<sup>22,23</sup>. At the scene of accident resuscitation is usually attempted by bystanders who are often lay persons with little knowledge and training about CPR. The arrival of paramedical personnel to the accident scene is often delayed. All these can influence the success of resuscitation. Quan *et al* reported that CPR by bystanders was not associated with improved outcome<sup>24</sup>. In our study, all the victims who did not need resuscitation had the best outcome and 55.5% survival rate was observed in victims who received CPR.

Hypothermia usually accompanies children drowning due to their large surface area to body mass ratio and reduced subcutaneous fat content. Favourable outcomes have been reported for hypothermia which is thought to be mediated by a reduction in brain metabolic requirements limiting hypoxic cellular damage<sup>25-27</sup>. In our study, mortality rate was higher in hypothermic victims than nonhypothermics (46.2% versus 5.1%). This finding could be due to the longer duration of submersion and/or prolonged hospital transportation time. The same has been also reported by others<sup>18,24,28</sup>.

Absence of vital signs, GCS<5 and acidosis were associated with adverse outcome in our patients.

Drowned children admitted to hospital with stable vital signs and no coma have a survival rate of almost 100%<sup>19</sup>.

Habib *et al* evaluated the hemodynamic and neurologic status of 93 victims of warm water submersion and found that none of the 21 asystolic patients survived whereas all the cases with a detectable pulse and blood pressure on arrival to the emergency department recovered and from 18 comatose patients all died or were vegetative but the noncomatose ones recovered normally<sup>29</sup>. They considered patient's hemodynamic status in emergency department and neurologic status as predictors of outcome.

A study by Hon and his colleagues revealed all patients with GCS of 3 who were admitted in PICU were either dead or disabled and that patients with GCS>10 at emergency room had favourable outcome<sup>20</sup>. Lavelle *et al* in their 6-year retrospective study of all patients drowned and admitted to ICU reported unreactive pupils and a GCS< or = 5 on arrival to ICU as predictors of poor neurologic outcome<sup>30</sup>.

Acidosis as an adverse outcome in drowning has been quoted by many authors<sup>18,26,31</sup>. In Eich *et al's* study which was conducted on 12 drowned children attempting resuscitation with cardiopulmonary bypass, low pH was associated with higher survival rate in children, but due to their small sample size this finding can not be considering very reliable<sup>19</sup>.

Variables studied in our research were partially predictive of outcome but there were some limitations due to the relatively small number of patients in the 12 years of the study period and some missing data regarding submersion time and pH recordings in medical files. Therefore it is not all the time possible to recognize which particular victim will benefit from therapeutic interventions and completely survive. On the other hand, it seems that any delay in initiating appropriate interventions can lead to conditions that result only in death or vegetative status.

## CONCLUSION

The clinical outcome of drowning is dependent on multiple factors. Predicting the outcome is very difficult. As initial clinical presentations or laboratory data could not accurately predict the neurologic prognosis, prompt and rapid interventions including aggressive and skillful resuscitation is required to provide the child the best chance for normal recovery.

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