

Drowning in Children in Iran: Outcomes and Prognostic Factors

Z Mosayebi*, A H Movahedian**, G A Mousavi***

*Department of Pediatrics, Tehran University of Medical Sciences, Tehran, Iran, **Department of Pediatrics, Kashan University of Medical Sciences, Kashan, Iran, ***Department of Health, Kashan University of Medical Sciences, Kashan, Iran

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 problem¹⁻³. 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 liquid³.

Drowning targets all age groups worldwide, but certain groups are at increased risk including toddlers and adolescents⁴. 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^{1-3, 5-7}.

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 old². Mazandaran province (in north of Iran) had a mean drowning rate 7.6 per 100000 population during a 5 year study period⁸.

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 well⁹. 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 outcome¹⁰.

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.

This article was accepted: 13 June 2011

Corresponding Author: Amir Hosein Movahedian, Kashan University of Medical Sciences, Pediatrics, Beheshti hospital, Pezeshk Blvd, Ghotb-E-Ravandi Blvd kashan, Kashan, Isfahan 87159-85131 Iran (Islamic Republic Of) 00989121271759 Email: movahedian.ah@gmail.com

Table I: Relation of the variables with the drowning outcome

Variables	No of cases	Recovery	Mortality	P value	OR	CI
Age						
<5	42	34	8	0.571	N/A	N/A
≥5	5	5	0			
Gender						
Male	33	26	7	0.405	3.5	0.38 to 31.5
Female	14	13	1			
Nationality						
Iranian	40	33	7	1	1.27	0.13 to 12.3
Noniranian	7	6	1			
Submersion Time						
≤5	17	17	0	0.104	N/A	N/A
>5	18	14	4			
Vital Signs						
Absent	7	0	7	< 0.0001	N/A	N/A
Present	40	39	1			
GCS						
<5	9	1	8	< 0.0001	N/A	N/A
≥5	38	38	0			
Temperature						
<36	13	7	6	0.003	13.7	2.27 to 82.7
≥36	34	32	2			
CPR						
Yes	18	10	8	< 0.0001	N/A	N/A
No	29	29	0			
pH						
<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^{11,12}.

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 fatality¹³⁻¹⁵, this was not statistically significant.

The mortality rate for drowning victims seems much higher in males than females in all age groups^{16,17}. 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 obvious².

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 findings¹⁸.

Many authors have considered submersion time as a valid predictor of outcome^{19,21} full recovery or mild neurologic disability was shown to occur in 91% of children with submersion time of less than 5 minutes²¹ 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^{22,23}. 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 outcome²⁴. 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 damage²⁵⁻²⁷. 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^{18,24,28}.

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%¹⁹.

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 normally²⁹. 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 outcome²⁰. 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 outcome³⁰.

Acidosis as an adverse outcome in drowning has been quoted by many authors^{18,26,31}. 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 reliable¹⁹.

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.

ACKNOWLEDGEMENT

We are grateful to Dr. Amir Hossein Fallahi for his assistance with the preparation of this manuscript.

REFERENCES

- Hyder AA, Borse NN, Blum L, Khan R, El Arifeen S, Baqui AH. Childhood drowning in low – and middle – income countries: Urgent need for intervention trials. *J Paediatr Child Health* 2008; 44: 221-7.
- Kiagalayeh AD, Mohammadi R, Ekman DS, Chabok SY, Janson B. Unintentional drowning in northern Iran: A population-based study. *Accid Anal Prev* 2008; 40: 1977-81.
- Van Beeck EF, Branche CM, Szpilman D, Modell JH, Bierens JJ. A new definition of drowning: towards documentation and prevention of a global public health problem. *Bull World Health Organ* 2005; 83: 853-6.
- Brenner RA, Trumble AC, Smith GS, Kessler EP, Overpeck MD. Where Children Drown, United States, 1995. *Pediatrics* 2001; 108: 85-9.
- Yang L, Nong QQ, Li CL, Feng QM, Lo SK. Risk factors for childhood drowning in rural regions of a developing country: a case-control study. *Inj Prev* 2007; 13: 178-82.
- Blum LS, Khan R, Hyder AA, Shahanaj S, El Arifeen S, Banqui A. Childhood drowning in Matlab, Bangladesh: An in-depth exploration of community perceptions and practices. *Soc Sci Med* 2009; 68: 1720-7.
- Fang Y, Dai L, Jaung MS, Chen X, Yu S, Xiang H. Child drowning deaths in Xiamen city and suburbs, People's Republic of China, 2001-5. *Inj Prev* 2007; 13: 339-43.
- Sabery Anary SH, Sheikhezadi A, Ghadyani MH. Epidemiology of Drowning in Mazandaran Province, North of Iran. *Am J Forensic Med Pathol* 2010; 31: 236-42.

9. Susiva C , Boonrong T. Near- Drowning in Pediatric Respiratory Intensive Care Unit , Siriraj Hospital. *J Med Assoc Thai* 2005; 88(supp 8): S44-7.
10. Burford AE, Ryan LM, Stone BJ, Hirshon JM, Klein BL. Drowning and Near-Drowning in Children and Adolescents: a succinct review for emergency physicians and nurses.. *Pediatr Emerg Care* 2005; 21: 610-6.
11. Szpilman D. Near-drowning and drowning classification: a proposal to stratify mortality based on the analysis of 1831 cases. *Chest* 1997; 112: 660-5.
12. Quan L, Kinder D. Pediatric submersions: prehospital predictors of outcome. *Pediatrics* 1992; 90: 909-13.
13. Claesson A, Svensson L, Silfverstolpe J, Herlitz J. Characteristics and outcome among patients suffering out of hospital cardiac arrest due to drowning. *Resuscitation* 2008; 76: 381-7.
14. Cohen RH, Matter KC, Sinclair SA, Smith GA, Xiang H. Unintentional pediatric submersion injury related hospitalizations in the United States , 2003 . *Inj Prev* 2008; 14: 131-5.
15. Quan l, Cummings P. Characteristics of drowning by different age groups. *Inj Prev* 2003; 9: 163-8.
16. Lindholm P, Steensberg j. Epidemiology of unintentional drowning and near- drowning in Denmark in 1995. *Inj Prev* 2000; 6: 29-31.
17. Giustini A, Ade P, Taggi F. Accidents in recreational waters. *Ann Ist Super Sanita* 2003; 39: 69-76.
18. Al-Mofadda SM, Nassar A, Al-Turki A, Al-Sallounm AA. Pediatric Near Drowning: The experience of King Khalid University Hospital. *Ann Saudi Med* 2001; 21: 300-3.
19. Eich C, Brauer A, Timmermann A , *et al.* Outcome of 12 drowned children with attempted resuscitation on cardiopulmonary bypass: An analysis of variables based on the "Utstein Style for Drowning ". *Resuscitation* 2007; 75: 42-52.
20. Hon KL, Leung TF, Cahan SY, Cheung KL, Ng PC. Indoor versus outdoor childhood submersion injury in a densely populated city. *Acta Paediatr* 2008; 97: 1261-4.
21. Suominen P, Caillie C, Korpela R, Rautanen S, Ranta S, Olkkola KT. Impact of age, submersion time and water temperature on outcome in near-drowning. *Resuscitation* 2002; 52: 247-54.
22. Modell JH, Idris AH, Pineda JA. Survival after prolonged submersion in freshwater in Florida. *Chest* 2004; 125: 1948-51.
23. Grenfell R. Drowning management and prevention. *Aust Fam Physician* 2003; 32: 990-3.
24. Quan L, Wentz KR, Gore EJ, Copass MK. Outcome and predictors of outcome inn pediatric submersion victims receiving prehospital care in King Country, Washington. *Pediatrics* 1990; 86: 586-93.
25. Salomez F, Vincent JL. Drowning: a review or epidemiology, pathophysiology, treatment and prevention. *Resuscitation* 2004; 63: 261-8.
26. Williamson JP, Llling R, Gertler P, Braude S. Near-drowning treated with therapeutic hypothermia. *Med J Aust.* 2004; 181: 500-1.
27. Burford AE, Ryan LM, Stone BJ, Hirshon JM, Klein BL. Drowning and Near-Drowning in Children and Adolescents. *Pediatr Emerg Care* 2005; 21: 610-6.
28. Crowe S, Mannion D, Healy M, O Hare B, Lyons B. Paediatric near-drowning: mortality and outcome in a temperate climate. *Ir Med J* 2003; 96: 274-6.
29. Habib DM, Tecklenburg FW, Webb SA, Anas NG, Perkin RM. Prediction of childhood drowning and near-drowning morbidity and mortality. *Pediatr Emerg Care* 1996; 12: 255-8.
30. Lavelle JM, Shaw KN. Near drowning: is emergency department cardiopulmonary resuscitation or intensive care unit cerebral resuscitation indicated? *Crit Care Med* 1993; 21: 368-73.
31. Orłowski JP. Prognostic factors in pediatric cases of drowning and near-drowning . *JACEP* 1979; 8: 176-9.