

PEDIATRIC NEAR DROWNING: THE EXPERIENCE OF KING KHALID UNIVERSITY HOSPITAL

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Background: The purpose of the study was to evaluate the outcome of warm pediatric near drowning, and assess possible predictors of the outcome.

Subjects and Methods: The study was performed at King Khalid University Hospital, Riyadh, Saudi Arabia. Twenty-eight cases of pediatric near drowning (one to 13 years of age) over a 10-year period ending June 1998, were reviewed retrospectively. Multiple variables during the prehospital and the hospital stages were evaluated to assess their effect on the outcome.

Results: None of the patients' families had official training in cardiopulmonary resuscitation. Only one of the 21 private swimming pools had features compatible with swimming pool safety regulations. Eleven patients (39.3%) died in the pediatric intensive care, and 17 (60.7%) were discharged alive. Submersion time of >5 minutes and the emergency room documentation of absence of vital signs, Glasgow Coma Scale of ≤ 4 , arterial pH of ≤ 7.0 and blood sugar of ≥ 10 mmol/L all predicted bad outcome, with a statistical significance ($P < 0.05$).

Conclusion: This audit highlighted major concerns about our prehospital medical care, general population basic life support education and our society's adherence to swimming pool safety regulations. It demonstrated that hypothermia on arrival to the emergency department in warm near-drowning victims is likely to be associated with bad outcome. The audit results also agree with the opinion of not aggressively intervening or prolonging aggressive intervention in warm near-drowning cases presenting with bad prognostic outcome.

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Key Words: Drowning, cardiopulmonary resuscitation.

Drowning is a preventable catastrophic accident. It is the fourth leading cause of death for children younger than 19 years of age, and the single leading cause of injury death for children under 5 years of age in the US.^{1,2} A rate of drowning of between 0.7 and 2.9 per 100,000 children younger than 19 years has been reported.^{1,3} Roughly 80% of the children with near-drowning histories are admitted for at least one day, and 40%-50% of the cases die, with as many as 20% of the survivors suffering severe permanent disability.⁴⁻⁶

Residential swimming pools continue to be the most common place for immersion injuries, particularly in preschool children.^{2,6-12} The total annual economic losses due to swimming pool drowning and near drowning of young children in the United States are estimated to be between \$450 and \$650 million.¹³ Adherence to safety precautions for residential swimming pools, such as four-

sided fencing, is estimated to have prevented 50%-90% of swimming pool immersion injuries.^{4,14-18} Near-drowning cases in Saudi Arabia do not get the deserved publicity from the media or from pediatricians. To the best of our knowledge, this is the first audit tackling the issue of near-drowning of children in Saudi Arabia.

Subjects and Methods

A retrospective case review study was conducted to evaluate near-drowning cases managed at King Khalid University Hospital (KKUH) Pediatric Intensive Care Unit (PICU) in Riyadh, Saudi Arabia, over a 10-year period ending June 1998. Cases involving children up to the age of 13 years who were managed primarily at our PICU were included in the study. The medical records of all the cases were retrieved and the data regarding age, sex, nationality, season of near drowning, type of drowning, duration of water submersion, duration of transport to the hospital, initial vital signs, initial Glasgow Coma Scale (GCS), initial temperature, initial blood gas, pH and the initial blood sugar levels, were extrapolated and their effects on the patient's outcome analyzed. Patients who survived were evaluated by pediatric neurologists. Severe neurological damage means the patient remained in a vegetative state.

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TABLE 1. Demographic data.

Variable	No. of cases	Full Recovery	BD or SND	P-value
Age				
≤6 years	22	11	11	0.160
>6 years	6	1	5	
Gender				
Male	17	6	11	0.269
Female	11	6	5	
Nationality				
Saudi	21	10	11	0.334
Non-Saudi	7	2	5	

BD or SND=brain death or severe neurological damage.

TABLE 2. Relation of the prehospital variables to near-drowning outcome.

Variable	No. of cases	Full Recovery	BD or SND	P-value
Season				
Summer	17	8	9	0.44
Winter	11	4	7	
Location				
Swimming Pool	21	10	11	0.334
Others	7	2	5	
Submersion time (minutes)				
<5	12	12	0	0.003
>5	16	0	16	
CPR				
Yes	9	5	4	0.212
No	19	6	13	

BD or SND=brain death or severe neurological disease; CPR=cardiopulmonary resuscitation.

TABLE 3. Relation of the variables in the emergency department to near-drowning outcome.

Variable	No. of cases	Full Recovery	BD or SND	P-value
Vital signs				
Absent	17	1	16	0.006
Present	11	11	0	
GCS				
≤4	17	1	16	0.006
>4	11	11	0	
pH				
≤7.0	17	1	16	0.006
>7	11	11	0	
Temperature (°Celsius)				
≤35	21	5	16.0	0.002
>35	7	7	0	
Blood sugar (mmol/L)				
<10	13	10	0	0.001
≥10	15	2	12	

TABLE 4. Initial temperature of patients and relation to near-drowning outcome.

Temperature (degree Celsius)	No. of cases	Full Recovery	BD or SND	P-value
30-33	8.0	0	8.0	0.004
>33-35	13.0	5.0	8.0	
>35	7.0	7.0	0	

Fisher's exact and chi-squared tests were used for statistical analysis, and *P*-value equal to or less than 0.05 was considered significant. The authors could not obtain

information on drowning and near-drowning cases in other hospitals, or on those cases where the patient died prior to arrival at the hospital, because of the lack of a national drowning and near-drowning registry.

Results

Of the 28 near-drowning subjects who met the admission criteria, 17 (61%) were male, 22 (79%) were under 6 years of age, and 21 (75%) were Saudi citizens. Of the total cases, 12 (43%) recovered fully, 11 (39%) were diagnosed to have brain death and 5 (18%) were discharged from the PICU with severe neurological injury (totally dependent on others). Of the survivors with severe neurological damage, 2 (40%) died in the hospital, 3 (60%) were discharged home with severe neurological injury, with the patients having to be dependent on others. Three groups of variables were evaluated to assess their relation to the outcome of the cases. The first group included patients' demographic data, such as the age, gender and nationality. None of them correlated significantly with bad or good outcome (Table 1). The second group included prehospital variables, such as the site of drowning, season of drowning, submersion time, duration of transportation to health facility, and attempts at performing cardiopulmonary resuscitation (Table 2). Of the pre-hospital variables, only submersion time of >5 minutes correlated with bad outcome (brain death or severe neurological damage), with statistical significance of *P*=0.03. The third group included variables assessed at the emergency department, such as initial vital signs, GCS, arterial blood gas pH, temperature and blood sugar (Table 3). Of the variables assessed on arrival, cardiopulmonary arrest, GCS of ≤4, pH ≤7.0, and blood sugar ≥10 mmol/dL, were found to correlate with bad outcome with statistical significance.

It is worth mentioning that none of our patients' families had any official training in cardiopulmonary resuscitation (CPR), and only 1 of the 9 CPRs done prior to arriving at the hospital was performed by a trained person. Safety precautions were available in only one of the 21 private swimming pools. The four children who drowned in dams had bad outcome, as did 1 of the 3 who drowned in a bathtub and 11 of the 21 who drowned in a swimming pool.

Discussion

CPR of pulseless near-drowning victims continues to be an ongoing dilemma for emergency and critical care physicians. Although no one would want to cease resuscitative efforts in a patient who has an opportunity for neurologic recovery, the potential for resuscitating pulseless cases to the level of a persistent vegetative state is very real. Prediction of outcome in near-drowning victims is important in guiding triage decisions, counseling families, reducing unnecessary interventions and guiding withdrawal of support.¹⁹ Despite efforts to develop scoring and

classification systems and individual prognostic factors to predict the near-drowning bad outcomes, the unfortunate reality is that there is no consensus on them in the literature.²⁰⁻²⁶ Published factors shown to correlate with bad near-drowning outcome include: submersion duration >10 minutes, normal or high water or patient temperature, delayed rescue at the scene, need for CPR in the emergency department, depth of coma (GCS <4), delayed neurological response to therapy, initial arterial pH <7.0, and initial blood sugar level >12 mmol/L.^{21,24,27-35}

Our results showed a trend (not statistically significant) for bad near-drowning outcome with children >6 years of age. The likely cause is that they drowned unwitnessed in swimming pools or in dams where rescue was not prompt. Duration of transport to the hospital of <10 minutes and performance of CPR at the scene or during transport correlated with better outcome (not statistically significant). This might be related to the fact that care during the transport is not optimal, where it is provided by non-medically or paramedically trained personnel, and to the poor general population knowledge of basic life support (of the prehospital-attempted CPR events, only one was done by a certified person). This might explain the lack of statistical significance of the duration of transport to the hospital and performance of CPR at the drowning scene or during transport on the near-drowning outcome.

The small sample size in this study could be contributing to the lack of significant statistics in the previous predictors of outcome. The submersion of more than 5 minutes in our study, compared to more than 10 minutes in the literature, was found to correlate significantly with bad outcome (brain death or severe neurological insult), and may be related to the inadequacy of prehospital care.

Our results concur with others^{21,24,27-35} regarding the predictive values of the initial clinical examinations and laboratory results done in the emergency department (Table 2). Initial findings of pulseless, breathless child, GCS of ≤4.0, blood gas pH of ≤7.0 and blood sugar of ≥10 mmol/L predicted significantly bad outcome. The only case that survived among the 17 cases that arrived pulseless and breathless was reported to have a heartbeat, and CPR had been performed during transport. He became pulseless and breathless just prior to arrival at the emergency room. He responded quickly to resuscitative measures and attained a GCS of 7 within the first 24 hours.

Although better prognosis with low-core body temperature was reported in cold water near drowning,^{27,29,36,37} we found a consistent trend of association between low patient core temperature and bad outcome (Table 4), which probably indicates that the more hypothermic the child, the longer it has been since death occurred in warm near-drowning cases. Although some authors have recommended rationalizing early invasive intervention for warm water near-drowning cases who arrive pulseless and breathless,³⁶⁻³⁸ others demand full early

support and evaluation later on.¹⁹ The findings of our study go with the notion of not providing prolonged aggressive support to children who drown in warm water and arrive pulseless and breathless. In situations where aggressive medical support was started, prolonging it should be justified. The findings demonstrated that hypothermia in warm near-drowning victims is associated with bad outcome. The finding of this study also shows clearly that we have significant defects in our prehospital medical care, general population CPR education, and in following swimming pool safety regulations. The correction of those defects will likely decrease near-drowning events and improve their outcome once they happen.

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