DOI: 10.4274/forbes.galenos.2024.97752
Forbes J Med 2024;5(2):135-43

Original Article / Orijinal Araştırma

A Life-threatening Environmental Emergency: Childhood Drowning

Hayatı Tehdit Eden Bir Çevresel Acil: Çocukluk Çağı Boğulmaları

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Cite as: Gökalp G, Nalbant T, Bıcılıoğlu Y, Bardak Ş, Demir G, Çiçek A, Berksoy E. A Life-threatening Environmental Emergency: Childhood Drowning. Forbes J Med. 2024;5(2):135-43

ABSTRACT

Objective: Childhood drowning is a common environmental emergency worldwide. In this study, we examined drowning and non-fatal drowning (NFD) cases and tried to determine which parameters could predict prognosis during follow-up.

Methods: This study was conducted in a tertiary pediatric emergency room. The study population comprised cases of drowning/NFD between 2008 and 2021. Age, gender, and drowning mechanisms. Laboratory examinations, and the outcomes of these cases were analyzed. The data were obtained from the hospital automation system. The Szpilman score (SC) of each patient was calculated.

Results: A total of 150 cases were included in the study. The ages of the cases were 5.2±3.8. The mean Glasgow Coma Scale (GCS) score was found to be 12.2±3.8. Cardiopulmonary resuscitation (CPR) was performed in 75 cases (50%), and 30 cases (20%) patients were intubated. Cases were divided into two groups: those in the intensive care unit and those followed in the emergency department. The mean SC of the follow-up group was 1.4±0.6, and the mean SC of the intensive care group was 4.6±1.4 (p<0.01, T=19.3). A strong negative correlation was found between the SC and GCS (p<0.01, r=-929) and a strong positive correlation was found between the respiratory support system ranking-from simple to complex-and the SC (p<0.01, r=827).

Conclusion: High SC, CPR, low GCS, young age, and low blood pH were associated with an increased rate of intensive care unit admission.

Keywords: Environmental emergency, childhood drowning, Szpilman score

ÖZ

Amaç: Çocukluk çağında boğulma, dünya çapında yaygın bir çevresel acil durumdur. Bu çalışmada boğulma ve ölümcül olmayan boğulma (ÖOB) olgularını inceleyerek takip sırasında hangi parametrelerin prognozu tahmin edebileceğini belirlenmeye çalışılmıştır.

Yöntem: Bu çalışma üçüncü basamak bir pediatrik acil serviste gerçekleştirilmiştir. Araştırmanın evrenini 2008-2021 yılları arasında boğulma/ÖOB olguları oluşturmuştur. Yaş, cinsiyet, boğulma mekanizmaları, laboratuvar tetkikleri ve sonuçları analiz edilmiştir. Veriler hastane otomasyon sisteminden elde edilmiştir. Her olgu için Szpilman skoru (SC) hesaplanmıştır.

Bulgular: Çalışmaya toplam 150 olgu dahil edildi. Olguların yaşları 5,2±3,8 idi. Ortalama Glasgow Koma Skalası (GCS) skoru 12,2±3,8 olarak bulundu. Olguların 75'ine (%50) kardiyopulmoner resüsitasyon (CPR) uygulandı ve 30 olgu (%20) entübe edildi. Olgular yoğun bakımda yatanlar ve acil serviste takip edilenler olmak üzere iki gruba ayrıldı. Takip grubunun ortalama SC'si 1,4±0,6, yoğun bakım grubunun ortalama SC'si 4,6±1,4 idi (p<0,01, T=19,3). SC ve GCS arasında güçlü bir negatif korelasyon bulundu (p<0,01, r=-929) ve solunum destek sistemleri sıralaması (basitten karmaşığa) ile SC arasında güçlü bir pozitif korelasyon bulundu (p<0,01, r=827).

Received/Geliş: 16.05.2024
Accepted/Kabul: 12.07.2024

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Sonuç: Yüksek SC, CPR, düşük GCS, genç yaş ve düşük kan pH'sının yoğun bakıma yatış oranını artırdığı görüldü.
Anahtar Kelimeler: Çevresel acil, çocukluk çağı boğulmaları, Szpilman skoru

INTRODUCTION

Every year, approximately 500,000 people worldwide and 4.000 people in the United States (US) die from drowning.[1,2] Mortality due to drowning was found to be 0.003% for individuals between the ages of 1 and 4 in a study in the US, and 0.1% in children under the age of 2 in a study in Thailand.[3,4] More than 90% of all drowning deaths occur in low-and middle-income countries.[5-9] Although it is difficult to obtain statistics on non-fatal drowning (NFDs), it is a fact that NFDs are several hundred times greater than reported drowning deaths.[10,11] Many terminologies related to drowning have been defined in the literature in recent years, but this approach has also led to serious confusion. In the nomenclature that is accepted today, the condition of death due to respiratory causes as a result of exposure to a liquid environment is simplified as "drowning." If this does not result in death, it is termed NFD.[12] Global age-standardized drowning death rates have decreased from 9.3% in 1990 to 0.004% per year in 2017, but they remain a major preventable cause of pediatric morbidity and mortality.[13-15]

Because of the complexity of the situation, many researchers have developed classification systems to predict prognosis in drowning cases. These studies used large case series data and generally covered the adult age group.[16-19] For example, Menezes and Costa[20] (1972) divided all cases into four grades according to severity and prognostic predictions. The Semple-Hess and Campwala classification systems categorize pediatric drowning patients according to respiratory distress, hypothermia, and the Glascow Coma Scale (GCS) score.[21] In our study, we preferred to use the Szpilman[22] (1997) classification, in which 2.304 cases were examined, including pediatric cases, because this classification system provided a more sensitive grading system compared with Menezes and Costa's[20] classification. According to this classification, Grade 1 has only cough, Grade 2 has occasional crepitant rales on lung auscultation, Grade 3 has crepitant rales in all parts of the lung and a pink foam near the mouth/nose, Grade 4 has Grade 3 auscultation findings in addition to hypotension, Grade 5 has respiratory arrest/apnea, and Grade 6 is classified as "cardiopulmonary arrest."[22]

The aim of the current study was to investigate the characteristics of this life-threatening environmental emergency on the west coast of Turkey. The secondary aim is to determine whether the clinical and laboratory findings at presentation can provide insights regarding prognosis.

METHODS

This was a cross-sectional, observational, and retrospective study. The study was performed at the University of Health Sciences Türkiye, İzmir Tepecik Training and Research Hospital pediatric emergency clinic, which is the largest trauma reference center in the region of İzmir, a seaside port city located in the west of the Republic of Turkey, a peninsula surrounded by sea. The period examined was 01.01.2008-31.12.2021. Information about the cases was obtained from the hospital's automation system. After obtaining permission from İzmir Kâtip Çelebi University, Non-Interventinal Clinical Studies Ethics Committee (decision no: 0492, date: 18.11.2021) and other necessary approvals, the study began.

All patients admitted to the pediatric emergency department with a complaint of drowning were included in the study. Patients whose data could not be obtained or those referred to a different center during the treatment process were excluded from the study. The dependent variable of the study was fatal or NFD cases, and the independent variables were fatal or NFD case mechanisms, physical and chemical properties of the exposed water, clinical and laboratory findings, and clinical progression of the cases, in addition to demographic information such as age and gender. The cases were assigned to the appropriate Szpilman classification grade according to the available information. Cases were divided into two groups: those in the intensive care unit and those followed in the emergency department. The parameters of these two groups were compared. The cases were also divided into two groups according to whether the water to which they were exposed was salty. The analyses were repeated in these groups as well.

Statistical Analysis

The data obtained were analyzed using the Statistical Package for the Social Sciences 22 package program, and the frequency information of the numerical data was presented as a percentage and mean standard deviation. Chi-square analysis was used for categorical data, Fisher's exact test was used in cases where the chi-square assumption could not be provided, and the T-test was used for numerical data in the comparisons of the two groups. In cases in which normality could not be achieved, non-parametric tests were used. Pearson's correlation coefficient was applied to determine the relationship between the numerical data. Logistic regression modeling was performed. The receiver operating characteristic (ROC) curve was drawn to determine the cut-off value.

RESULTS

A total of 150 patients were included in the study. Ninety (60%) patients were males. The mean age of patients was 5.2±3.8 (1-13). The mean age of the female patients was significantly lower than that of the male patients (mean age of female cases 3.7±1.9, male cases 6.3±4.9 years; p<0.01, T=-4.1). Ninety cases (60%) were in seawater (75 males, 15 females), 30 (20%) were in swimming pools (all girls), and 30 (20%) occurred by falling into a mop bucket (15 girls and 15 boys). The mean GCS was found to be 12.2±3.8 (3-15). Cardiopulmonary resuscitation (CPR) was performed in 45 cases (30%) patients in the field and in 30 cases (20%) patients in the emergency department. Treatment with vasoactive agents was provided in 30 cases (20%) cases, and antibiotics were provided in 75 cases (50%). Sixty cases (40%) were monitored in normal room air, 45 cases (30%) were followed up with a simple oxygen mask, 15 cases (10%) were followed up with high-flow nasal cannula oxygen therapy, and 30 cases (20%) were intubated. Forty-five cases (30%) were followed in the emergency department for 6 hours, 45 cases (30%) were followed for 24 hours in the emergency department, and 60 cases (40%) were followed in the pediatric intensive care unit. None of the cases resulted in death. Chest X-ray of 75 patients (50%) was abnormal. In the physical examination of 75 patients (50%), an abnormal respiratory pattern was detected. In 45 patients (30%), hypothermia was present at admission (Table 1).

Cases of drowning by falling into a swimming pool or bucket were considered drowning in fresh water. When the rates of drowning in fresh and saltwater were compared according to age, the mean age of cases in saltwater was 6.5±4.3 years, whereas the mean age of cases in freshwater was 2±2.3 years (p<0.01, T=-5.6). The mean GCS of cases in freshwater (10.2±4.5) was significantly lower than that in saltwater (13.5±2.5) (p<0.001, T=5.5). There were significant differences in white blood cell counts, hemoglobin levels, blood creatin kinase levels, blood sodium levels, blood potassium levels, blood C-reactive protein levels, partial corbondioxide levels, blood lactate levels, and blood glucose levels between the groups (Table 2). Szpilman scores (SC) were 3.1±1.9 on average in freshwater samples and 2.4±1.8 in saltwater samples (p=0.02, T=2.2) (Table 2).

If we divide the cases into two groups-patients followed for 24 hours and patients hospitalized in the pediatric intensive care unit-the mean age of the follow-up group (6.3±4 years) was significantly higher than that of the intensive care group (3.5±2.5 years) (p=0.001, T=4.7). The mean GCS score of the follow-up group (14.6±0.7 years) was significantly higher than that of the intensive care group (8.5±3.6) (p<0.001, T=15.4). There were significant values in terms of white blood cell counts, blood creatin kinase levels, blood sodium, potassium, calcium, chlorur, C-reactive protein levels, blood pH, partial corbondioxide levels, and blood glucose, urea, creatinin, alanine amino transferase, and aspartat amino transferase levels between the groups. The mean SC of the follow-up group (1.4±0.6) was significantly lower than that of the intensive care group (4.6±1.4) (p<0.01, T=19.3) (Table 3).

ROC curve analysis was performed to determine the cut-off value for the SC. Accordingly, the cut-off point was 3.5, the area under the curve was 0.99, sensitivity was 82%, and specificity was 92%. In subsequent analyses, the cutoff point was 3 because it was an integer. When the correlation between the SC and GCS was examined, a strong negative correlation was found between them (p<0.01, r=-29). When respiratory support systems were ranked from simple to complex, a strong positive correlation was found when this order was compared with the SC (p<0.01, r=827) (Table 4). When CPR performance was compared with the SC, CPR was not performed in any of the cases with a SC 3, and the cases with a SC >3 resulted in 66.7% of all CPR cases (p<0.01, x^2=87). It was observed that all patients in whom vasoactive agents were initiated had a SC >3 (Table 5).

When the relationship between chest X-ray findings and antibiotic use was evaluated, 80% of the patients with abnormal chest X-ray findings started on antibiotic therapy (p<0.01, x^2=54). Antibiotic treatment was started in 75% of the pediatric intensive care unit patients. This value was significantly higher than that of the follow-up group (p<0.01, x^2=25). It was observed that 66.6% of the patients with hypothermia upon admission were admitted to the pediatric intensive care unit (p<0.01, x^2=19). It was observed that 66.6% of the patients with hypothermia upon admission drowned in salt water (p=0.27, x^2=1.1). It was determined that 66.6% of the hypothermic patients received CPR (p=0.01, x^2=41) (Table 6).

In the logistic regression modeling we carried out to determine which variable increased the risk of admission to the intensive care unit, being male resulted in a 3.18-fold increase [95% confidence irterval (CI)=0.941-0.161, p=0.01], freshwater resulted in a 7.9-fold increase (95% CI=4.327-33.010, p=0.01), low pH resulted in a 3.17-fold increase (95% CI=1.005-24.198, p=0.02), a high SC resulted in a 2.3-fold increase (95% CI=4.762-10.192, p<0.01), a low GCS score resulted in a 2.3-fold increase (95% CI=2.751-10.152, p<0.01), and exposure to CPR resulted in a 7.5-fold increase (95% CI=3.761-101.112, p<0.01).

DISCUSSION

The primary aim of this study was to examine the clinical and laboratory parameters of drowning/NFD cases in

Turkey. The aim of this study was also to determine which prognostic factors had a significant effect on outcomes. As a result, we found that being young, drowning in fresh water, receiving CPR, having a low GCS score, and having a low pH were associated with worse prognosis. The secondary aim was to determine how prognosis could be predicted. We conclude that the Szpilman classification is useful in terms of the necessity for respiratory support systems and admission to intensive care units.

By examining the cases of drowning/NFD in terms of average age, the mean age in this study was 5.2 years. This average age has been observed in many studies in the literature. For example, Loux et al.[23] examined 153 drowning/NFD cases in the US and found that the mean age was 4 years. Another study conducted by Moffett et al.[24] in the US, in which they examined 114 cases, the mean age was 4.2 years. Another study conducted by Salas Ballestín et al.,[27] the mean age was 5.3 years, and a mean age of 3.5 years was found according to Habib et al.'s[26] study.

Table 1. The properties of whole-group

		N	%
Gender	Female	60	40
	Male	90	60
Age (mean)	5.2±3.8 (1-13) (whole group)	3.7±1.9 (girls) 6.3±4.9 (boys)	p<0.01 T=-4.1
Drowning mechanism	Sea	90 (75 boys + 15 girls)	60
	Swimming pool	30 (all girls)	20
	Mop bucket	30 (15 boys + 15 girls)	20
CPR in the field	Yes	45	30
	No	105	70
CPR in the ER	Yes	30	20
	No	120	80
Vasopressor agent	Yes	30	20
	No	120	80
Antibiotic	Yes	75	50
	No	75	50
Abnormal breathing	Yes	75	50
	No	75	50
Hypotermia	Yes	45	30
	No	105	60
Breathing support	Normal room O2	60	40.0
	O2 with masc	45	30.0
	High-flow nasal cannula	15	10.0
	IV	30	20.0
GCS (mean)	12.2±3.8 (3-15)		
Spilzman score	1	60	40
	2	28	18.7
	3	24	16
	4	4	2.7
	5	4	2.7
	6	30	20
Observation conditions	6 h in the ER	45	30.0
	6-24 h in the ER	45	30.0
	PICU	60	40.0

GCS: Glasgow Coma Scale, CPR: Cardiopulmonary resuscitation, ER: Emergency room, PICU: Pediatric intensive care unit

By examining the drowning/NFD cases in terms of sex, we found that the number of male cases was higher in both the literature and this study. The rate of male patients in this study was 60%; the rates were 70%, 65%, 60%, 72.5%, and 69%, respectively, in other studies examining childhood drowning/NFD cases.[23-27]

When examining drowning/NFD cases, it is also important to note in which waters these events take place. Undoubtedly, the geographical location of the study site, its distance from the sea, and the temperatures in the summer months will impact this rate. For example, Şık et al.[27] examined 89 drowning/NFD cases on the West Coast of Turkey, of which 58.5% were drowned in salt water. In this study, similarly, the NFD in salt water was found to be 60%. In a study conducted in Florida, US, 93.5% of drowning/NFD cases occurred in fresh water.[23] In a study conducted far from the coast of Texas, 93.4% of cases occurred in fresh water. In a study conducted in Spain, 90% of cases occurred in fresh water.[23-25]

In this study, we evaluated the cases according to their follow-up periods. We evaluated them by dividing them into three groups: those who were discharged from the emergency room (ER) after less than 24 hours, those who were followed up in the ward/ER for more than 24 hours, and those who needed intensive care for any reason. Undoubtedly, the most severe patient group was those admitted to the intensive care unit. In this study, although the rate of hospitalization in the intensive care unit was 40% of all cases, similar values were found in the literature. For example, the percentage of patients hospitalized in the intensive care unit was 31.7%, 44.2%, and 50%, respectively.[23,25,28] Similarly, although the number of cases followed in the ER for 24 hours in this study constituted 30% of all cases, this rate was 60% and 48% in studies in the literature.[27,29]

Table 2. Differences according to salty and fresh water

	Whole group	Fresh water	Salty water	T	p
Age (year) mean	5.2±3.8	2±2.3	6.5±4.3	5.6	**0.01**
Gender	N=120	45 girls+15 boys	15 girls+75 boys	x^2=51	**<0.01**
GCS (mean)	12.2±3.8	10.2±4.5	13.5±2.5	5.5	**0.001**
WBC/μL	11900±3.8	3600±5068	10800±2255	4.6	**0.001**
Hb g/dL	11.2±1	10.7±1.1	11.6±0.6	6.1	**0.001**
Platelet/μL	245900±73960	249000±83821	243833±67002	0.4	**0.6**
CK U/L	530±485	1032±351	196±172	19.3	**0.001**
Na mmol/L	137.2±8.4	133±5.1	139±9.2	5	**0.001**
K mmol/L	3.8±0.3	3.9±0.5	3.8±0.2	5	**0.001**
Ca mg/dL	9.2±0.3	9.27±0.3	9.2±0.3	1.2	**0.2**
Cl mmol/L	105.4±7.1	102.0±5.2	107.6±7.4	1.2	**0.2**
CRP mg/L	8.3±11.5	5.3±5.6	10.7±14.2	2.7	**0.001**
pH	7.26±.09	7.23±0.1	7.28±0.1	3.1	**0.01**
Pa CO_2, mmHg	44.5±6.1	43.7±8.2	45±4.3	1.2	**0.001**
HCO_3 mmol/L	20.8±4.4	21.0±3.7	20.6±4.9	0.4	**0.6**
Lactate mmol/L	2.7±1.6	3.3±1	2.4±1.8	3.1	**0.001**
Glucose mg/dL	129.8±49.3	159.2±57.9	110.1±29.6	6.1	**<0.01**
Ure mg/dL	25.3±9.3	26.5±7.8	24.5±10.2	1.2	**0.2**
Creatinin mg/dL	0.5±0.1	0.4±0.1	0.5±0.1	2.5	**0.1**
AST U/L	44.8±16.3	59.0±12.7	35.3±10.5	12	**0.05**
ALT U/L	19.9±7.9	24.0±6.6	6.6±7.6	5.6	**0.8**
Szpilman score	2.7±1.9	3.1±1.9	2.4±1.8	2.2	**0.02**
Outcome					
Observation group PICU group	N=150	N=30 N=30	N=60 N=30	x^2=4.1	**0.04**

GCS: Glasgow Coma Scale, WBC: White blood cell, Hb: Hemoglobin, CK: Creatine kinase, Na: Sodium, K: Potassium, Cl: Clorur, CRP: C-reactive protein, $PaCO_2$: Partial carbon dioxide pressure, HCO_3: Bicarbonate, AST: Aspartate amino transferase, ALT: Alanine amino transferase, PICU: Pediatric intensive care unit, x^2: Chi-square

Table 3. Differences between the PICU and observation groups				
	Observation group	**PICU group**	**T**	**p**
Age (year) mean	6.3±4	3.5±2.5	4.7	**0.001**
GCS mean	14.6±0.7	8.5±3.6	15.4	**<0.001**
WBC /µL	10025±2156	13181±4200	5.3	**<0.001**
Hb g/dL	11.2±0.5	11.2±11.2	0.1	0.8
Platelet /µL	203333±59252	309750±40061	12.1	0.1
CK U/L	459.3±479.2	637.5±478.8	2.2	**0.02**
Na mmol/L	134±3.5	140±11	T=4.4	**<0.001**
K mmol/L	3.7±0.2	3.9±0.5	2.6	**<0.001**
Ca mg/dl	9.3±0.3	9.05±0.3	5.2	**<0.01**
Cl mmol/L	103±3.3	108±9.8	4.5	**<0.001**
CRP mg/L	3.9±2.2	13.9±15	5.4	**<0.001**
pH	7.30±0.6	7.20±0.1	7.8	**<0.001**
Pa CO_2, mmHg	43.2±9.2	45.3±3.3	2.4	**<0.001**
HCO_3 mmol/L	23.3±3.5	17.0±2.7	11	0.3
Laktat mmol/L	2.5±1.6	2.9±1.6	1.2	0.2
Glucose mg/dL	121±26	143±69	2.7	**<0.001**
Ure mg/dL	23.3±7.9	28.2±10	3.2	**<0.001**
Creatinine mg/dL	0.4±0.1	0.5±0.01	5.4	**<0.001**
AST U/L	42±12	48±20	2.3	**<0.001**
ALT U/L	17.5±9.4	21±4.1	3.08	**<0.001**
Szpilman score	1.4±0.6	4.6±1.4	19.3	**<0.01**

GCS: Glasgow Coma Scale, WBC: White blood cell, Hb: Hemoglobin, CK: Creatine kinase, Na: Sodium, K: Potassium, Cl: Clorur, CRP: C-reactive protein, $PaCO_2$: Partial carbon dioxide pressure, HCO_3: Bicarbonate, AST: Aspartate amino transferase, ALT: Alanine amino transferase, PICU: Pediatric intensive care unit

Table 4. Correlation between the Szpilman score and GCS and respiratory support system ranking		
	Szpilman score	
	R	**p**
GCS	-0.929	0.01
Respiratory support system ranking from simple to complex	0.827	0.01

GCS: Glasgow Coma Scale

Table 5. Qui-square analyses between Szpilman and categoric parameters					
		Szpilman score <3 N=120 %(coloumn)	**Szpilman score >3 N=30**	**χ^2**	**p**
CPR	No	105 (87.5)	0 (0)	87	**<0.01**
	Yes	15 (12.5)	30 (100)		
Vasoactive agent 1		120 (100)	0 (0)	150	**<0.01**
	Yes	0 (0)	30 (100)		
Observation group		90 (75)	0 (0)	56	**<0.01**
PICU group		30 (25)	30 (100)		
Fresh water		45 (37.5)	15 (50)	1.5	0.2
Salty water		75 (62.5)	15 (50)		
Antibiotic	Yes	45 (37.5)	30	37.5	**<0.01**
	No	75 (62.5)	0		

CPR: Cardiopulmonary resuscitation, PICU: Pediatric intensive care unit, x^2: Chi-square

Table 6. Chi-square analyses between hypothermia and categoric parameters					
		Hyopothermic N=45 %(coloumn)	**Normothermic N=105**	χ^2	**p**
Fresh water		15 (33.3)	45 (42.8)	1.1	0.2
Salty water		30 (66.6)	60 (57.1)		
Observation group		15 (33.3)	75 (71.4)	19	<0.01
PICU group		30 (66.6)	30 (28.5)		
CPR	No	15 (33.3)	90 (85.7)	41	<0.01
	Yes	30 (66.6)	15 (14.3)		
CPR: Cardiopulmonary resuscitation, PICU: Pediatric intensive care unit, x^2: Chi-square					

CPR in cases of drowning is commonly reported in the literature. For example, in Şık et al.'s[27] study, CPR was applied to 15.7% of the cases, and 13.4% of them were intubated. Similarly, in this study, 20% of our patients received CRP in the ER, and these patients were followed up as they were intubated. Cohen et al.[28] examined 70 drowning cases and determined that CPR was performed in 23% of surviving cases.

None of the cases included in this study resulted in death. However, mortality has been reported for both freshwater and saltwater drowning events in the literature. For example, Szpilman's[22] (1997) study examined 1.831 drowning/NFD cases over 20 years, found that 12% occurred in seawater and 16% occurred in freshwater. The high mortality rate can be explained by the outdated medical data used in this study. However, Şık et al.'s[27] (2020) mortality rate was 4.4%. When the cases resulting in death in this study were examined, most deaths occurred in individuals with chronic diseases and neurological deficits. Another reason for the absence of exitus cases in our study may be that cases involving exitus in the area were not brought to the ER. In addition, given that this study did not include data pertaining to cases undergoing the intensive care process due to its design, individuals who died after being admitted to the intensive care unit from the ER were not mentioned in the study.

Moffett et al.[24] examined 114 NFD cases and investigated the antibiotic initiation status. Antibiotics were started empirically in 50% of the cases, but they were also given to all intubated individuals who had undergone CPR. Similarly, in this study, antibiotics were given in 50% of the cases, and 75% of those admitted to the intensive care unit were given antibiotic treatment.

In NFD cases, the temperature of the water to which the individual is exposed and the duration of exposure are important. The literature indicates that the prognosis of individuals admitted as hypothermic is worse than normothermics.[29] In this study, patients who were found to have hypothermia at the time of first admission had higher CPR administration and intensive care unit admission rates than those who were normothermic. However, one limitation of our study is that information on how long the individual remained in the water and the temperature at which they did so was not noted.

When we look at the literature, we see scoring schemes used to predict prognosis in drowning/NFD cases. For example, Blasco Alonso et al.[29] used the Conn Modell and Orlowski classifications in their study, which examined 62 drowning cases in Spain. The Conn Model classification was not sufficient for our study because it was based only on the neurological status of the cases.[26] Orlowski's classification was developed in 1979 to determine prognostic factors for childhood drowning; it was mainly based on age, immersion duration, CPR duration, consciousness, and pH. This classification is more comprehensive than the Conn Model, but it does not include pulmonary findings.[30] For this reason, we decided to use the Szpilman scoring system, as described above. According to Şık et.[27] al's studies, 37% of the cases were classified as Grade 1, 10% as Grade 2, 31% as Grade 3, 6% as Grade 4, 12% as Grade 5, and 2% as Grade 6. In other words, 78% of the cases were in the first three grades in their studies. In our study, 40% of the cases were in Grade 1, 18.7% were in Grade 2, 16% were in Grade 3, 2.7% were in Grade 4, 2.7% were in Grade 5, and 20% were in Grade 6. Similarly, in our study, 74.7% of the cases were in the first three grades. Salas Ballestín et al.'s[25] study of the prognostic factors of 131 drowning/NFD cases in Spain indicated that "low GCS, change in pupil size, choking without witnesses, low pH, need for CPR" were poor prognostic factors. In this study, we found a significant correlation between the Szpilman classification score, the need for respiratory support, and the need for inotrope; however, we did not encounter such data in the literature.

According to a study comparing the laboratory data of hospitalized and nonhospitalized drowning cases, blood glucose, alanine transaminase, and lactate levels were found to be significantly higher, and blood pH was found to be significantly lower in hospitalized patients.[27] Similarly, in our study, blood glucose, alanine transaminase, and lactate levels were higher, and blood pH was lower in intensive care patients. In the same study, similar to this current study, the SC was found to be higher and the GCS score was lower in the hospitalized group. In addition, a strong negative correlation was found between the SC and GCS, which is similar to the results of our study.[27]

Many studies have shown that there is no difference in laboratory and clinical parameters between the victims of drowning in freshwater and saltwater, except for those who died in the field.[31-34] However, an interesting study in the literature provided the autopsy results of 118 drowning cases; autopsies were performed on 74 cases that drowned in freshwater and 44 cases that drowned in saltwater within an average of 750 minutes. The mean age of those who drowned in freshwater was lower than that of those who drowned in saltwater, and those who drowned in saltwater had higher mean serum sodium and chlorine levels and lower mean serum potassium levels than the other group (same as in our study).[17]

Study Limitations

In this study, although there were differences between fresh and saltwater waters regarding white blood cell count, hemoglobin level, potassium level, pH, and glucose level, these were not clinically significant, as the average of all values were within normal limits. The missing data in this study, especially the inaccessibility of data on the patients who underwent CPR in the field, the characteristics of the water to which the patients were exposed, and the neurological outcomes of the patients after discharge, created serious limitations. We believe that a larger study on this topic will contribute to the literature. However, we believe that this study can serve as a guide, as there are not many studies in this field pertaining to childhood.

CONCLUSION

In conclusion, as a result of an examination of drowning cases in Turkey, we found that the prognosis was poor for those who drowned in freshwater, had low GCS, had low blood pH upon admission, had high blood lactate levels, and received CPR. In addition, we conclude that the Szpilman classification, which was created at admission, may be a prognostic guide.

Ethics

Ethics Committee Approval: The study was approved by the İzmir Kâtip Çelebi University, Non-interventinal Clinical Studies Ethics Committee (decision no: 0492, date: 18.11.2021).

Informed Consent: Retrospective study.

Authorship Contributions

Concept: G.G., Design: G.G., Data Collection or Processing: G.G., T.N., Y.B., G.D., Analysis or Interpretation: G.G., T.N., Ş.B., A.Ç., Literature Search: G.G., Y.B., Ş.B., E.B., Writing: G.G.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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