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Drownings in Fresh and Salt Water: a 15-Year Study

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Abstract

Objective: To evaluate the cases of drowning attended in our Health Department, assessing their clinical and pathophysiological behavior, as well as to study the influence of corticosteroids in the course of the disease.

Methods: We retrospectively analyzed drowning cases admitted to the Hospital of San Juan during 15 years. Clinical and analytical variables were compared between drowning in fresh water (group A) and salt water (group B) and correlations were obtained between age, sex, need for resuscitation and level of consciousness. Blood analysis, arterial blood gases, radiology, mean hospital stay, clinical evolution, treatment and prognosis were compared according to the site of drowning.

Results: 109 patients were included: 71% in group A and 28% in group B. There were statistical differences in age (A: 57 ± 22 vs B: 35 ± 33, p<0.001), hemoglobin (A: 15 ± 2 vs B: 13 ± 2, p<0.002), hematocrit (A: 45 ± 8 vs B: 40 ± 5, p<0.001), pH (A: 7.2 ± 0.2 vs B: 7.3 ± 0.1, p<0.001), HCO3 (A: 16 ± 6 vs B:21 ± 5, p<0.001), PaO2/FiO2 (A: 316 ± 148 vs B: 223 ± 98, p<0.034), cardiopulmonary resuscitation (A: 23% vs B: 45%, p<0.039). 43 patients were directly admitted to the Intensive Care Unit (ICU) receiving 47% of them corticosteroids with a reduction in mean ICU stay.

Conclusions: Morbimortality of patients with drowning is low, being more frequent in salt water. Corticoids could reduce ICU stay.

Keywords: Drowning, Near-drowning, Saltwater, Freshwater, Corticoids, Pneumonia, Antibiotic, Acute respiratory failure

Introduction

From 1966 to 2002, more than 33 different definitions of drowning have been described [1]. In 2002, the term drowning was agreed upon: the process of respiratory failure following an episode of submersion or immersion in liquid [2]. Submersion occurs when the head is completely covered by water, whereas immersion refers to a part of the body being submerged.

Terms such as "near-drowning" [3], "dry" or "wet" drowning, "submersion syndrome" and "secondary drowning" [4,5] have been used for decades. Due to the imprecision and confusion of these concepts, drowning is currently described as fatal and non-fatal and the outcomes classified as death, morbidity or no morbidity [2].

Drowning accounts for 0.7% of deaths worldwide constituting 236.000 deaths/year. Those secondary to catastrophic floods, tsunamis or navigation accidents and those intentional (suicides and homicides) are not classified as such, according to the International Classification of Diseases codes, which underestimates their magnitude [6,7]. In Spain, 422 people died from drowning in 2023, 46 of them in the Valencian Community, being one of the autonomous region with the highest number of deaths, and in the latest data of the National Report on Drowning [8].

The risk factors are: male sex, age under 14 years, alcohol abuse (30-50%), low-income countries, low educational level, rural residence, coastal regions with easy access to aquatic activities, risky behaviours, lack of supervision (main cause in children) and concomitant diseases, such as epilepsy, acute myocardial infarction, autism, cerebrovascular accident (CVA), trauma and long QT syndrome [6]. Most of them are accidental, although in adults, suicide is frequent (coexisting with previous psychiatric disease). They especially happen during the months of May, August and weekends. In adults, most drownings occur in salt water (SW) while in children they predominate in fresh water (FW): bathtubs, swimming pools and natural aquatic spaces (lakes, reservoirs, ditches, ponds or rivers) [2].

Drowning starts when the airway is under water. The first response is to hold the breath, but the sudden reduction in alveolar oxygen concentration, together with the inspiratory drive, facilitates aspiration of fluid, producing coughing and reflex laryngospasm. If the individual is not rescued, aspiration continues, which further worsens hypoxemia and hypercapnia, leading to unconsciousness, apnea and cerebral ischemic damage. The sequence of cardiac rhythm deterioration is usually tachycardia, followed by bradycardia, pulseless electrical activity, and finally asystole [6].

Regardless of the medium, the osmotic gradient alters the integrity of the alveolar membrane, increasing its permeability and causing massive non-cardiogenic pulmonary edema that decreases gas exchange and pulmonary distensibility. Furthermore, there is surfactant dysfunction with alveolar collapse, increase of pulmonary regions with very low or no ventilation-perfusion, intrapulmonary shunt and the appearance of atelectasis and bronchospasm. All this causes acute respiratory distress syndrome (ARDS) and severe hypoxemia that can lead cardiorespiratory arrest [9].

Treatment is based on ensuring airway patency, improving oxygenation, hemodynamic support, thermal isolation, glycemic

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control and water and electrolyte replacement. The main objective is to correct hypoxemia and metabolic acidosis.

Although there is controversy, the use of bicarbonate is not recommended [6]. If there is a poor response to conventional ventilation, extracorporeal membrane oxygenation (ECMO) has been effective [10], although its availability is limited. Similarly, in acute lung injury associated with refractory hypovolemic shock, Angiotensin II is useful to achieve hemodynamic stabilization [11]. Given the scarce evidence on the value of glucocorticoids and antibiotics, their systematic use is not recommended [6,12,13].

Complications include tachyarrhythmias, pneumonia and vomiting (30-85%) which, in turn, can lead to aspiration pneumonia. Cases of Systemic Inflammatory Response Syndrome, rhabdomyolysis and renal failure, sepsis and Disseminated Intravascular Coagulation (DIC) during the first 72 hours have also been documented [6,14].

Finally, it should be noted that optimal prevention would prevent up to 85% of drownings [6].

Material And Methods

Type of study

Single-centre cohort study based on the history of patients attended and admitted with a diagnosis of non-fatal drowning in the Pneumology Department and/or Intensive Care Unit (ICU) of the San Juan de Alicante University Hospital.

Study period

January 2009-December 2023.

Instrumentation

A database was protocolised including epidemiological, anthropological, clinical, analytical, gasometric, radiological and therapeutic variables, mean hospital stay and evolution (discharge or exitus laetalis) of each patient.

Variables included

Socio-demographic characteristics (age, sex, place, date), comorbidity, usual treatment, precipitating event, duration of immersion, clinical features in emergency department (ED), blood tests and blood gases from admission to the ED until hospital discharge. Mean stay, complications and sequelae were evaluated.

Inclusion criteria

Major diagnosis: drowning, near-drowning, accidental submersion and non-fatal submersion. Diagnosis of ARDS during hospital admission was made according to new global definition [15].

Exclusion criteria

Out-of-hospital deaths and those for whom complete information could not be obtained.

Population groups

- Group A: drownings in SW.

- Group B: drownings in FW.

Statistical analysis

A descriptive analysis of the numerical and qualitative variables was performed. After testing for normality using the Kolgomorov-Smirnof test, the Student's t-test (unpaired data) was used to compare groups A and B, ARDS/non-ARDS, influence of steroid use, antibiotics and other treatments, using non-parametric tests for unequal variances. For qualitative tests, the $\chi2$ test or Fisher's exact test was employed. A $p<0.05$ was considered significant. We use SPSS version 18.0 (Chicago, IL, USA).

Ethical aspects

The rules of the Declaration of Helsinki and the updated in Edinburgh in 2000 were applied. In accordance with the exception foreseen in Circular 15/2002, it was considered to be exempt from the requirement of informed consent, since access to the clinical history comes from the medical team, coding the data information on an anonymised basis. The protocol was approved by the IRB (Committee Code: 22/024) of the University Hospital San Juan de Alicante.

Results

We studied 109 patients, 77 men (71%) and 32 women (29%), mean age 51 ± 27 years, duration of immersion 2 ± 3 minutes, CPR 15 ± 12 minutes, time from event to hospital 49 ± 28 minutes, ICU mean stay 4 ± 5 days and hospital mean stay 5 ± 4 days. 31 drownings occurred in FW and 79 in SW and the season with the highest number of drownings was summer (78%). **Figure 1** shows the clinical characteristics collected by the ED and the emergency ambulance service (EAS).

Table 1 shows the main analytical and blood gas data. Analytically there was progressive improvement of leukocytosis, neutrophilia and renal failure during the hospitalisation. Rhabdomyolysis was associated, greater at 48 hours, with improvement on discharge. In blood gas analysis there was a predominance of metabolic acidosis and alteration of PaFi, more severe at 24 hours.

The main precipitating events were accidental falls (main event), sea swell, no triggering cause, syncope and epilepsy.

57 patients were under treatment being the most administered antihypertensive drugs (46% of patients) and hypnotics/antidepressants (25%).

Table 1: Analytical and arterial blood gas evolution during hospitalization. pCO2: partial pressure of carbon dioxide; pO2: partial pressure of oxygen; HCO3: bicarbonate; FiO2: inspiratory fraction of oxygen.

Variables	Blood analysis			
	In ED	At 24h	At 48h	At discharge
Leukocytes (x109/L)	12 ± 5	14 ± 6	11 ± 6	11 ± 5
Neutrophils (%)	57 ± 18	81 ± 11	80 ± 10	73 ± 14
Hemoglobin (g/dL)	14 ± 2	13 ± 2	12 ± 2	13 ± 2
Hematocrit (%)	44 ±8	39 ±6	36 ± 4	38 ± 5
Platelets (x109/L)	243 ± 93	209 ± 100	163 ± 57	216 ± 89
Glucose (mg/dL)	175 ± 72	155 ± 60	162 ± 60	130 ± 55
Urea (mg/dL)	39 ± 14	45 ± 33	50 ± 27	42 ± 27
Creatinine (mg/dL)	2 ± 1	1 ± 1	2 ± 1	1 ± 1
Sodium (mmol/L)	141 ± 15	141 ± 5	140 ± 3	140 ± 5
Potassium (mmol/L)	4 ± 2	4 ± 1	4 ± 1	4 ± 1
Variables	**Arterial blood gases**			
pH	7,2 ± 0,2	7,4 ± 0,9	7,4 ± 0,7	7,4 ± 0,4
pCO2 (mmHg)	41 ± 11	39 ± 8	38 ± 6	39 ± 5
pO2 (mmHg)	87 ± 56	115 ± 67	116 ± 53	88 ± 44
HCO3 (mmol/L)	17 ± 6	22 ± 5	24 ± 7	25 ± 3
SaO2 (%)	87 ± 13	92 ± 7	95 ± 5	94 ± 6
PaFi (mmHg)	291± 142	254 ± 155	281 ± 108	328 ± 85

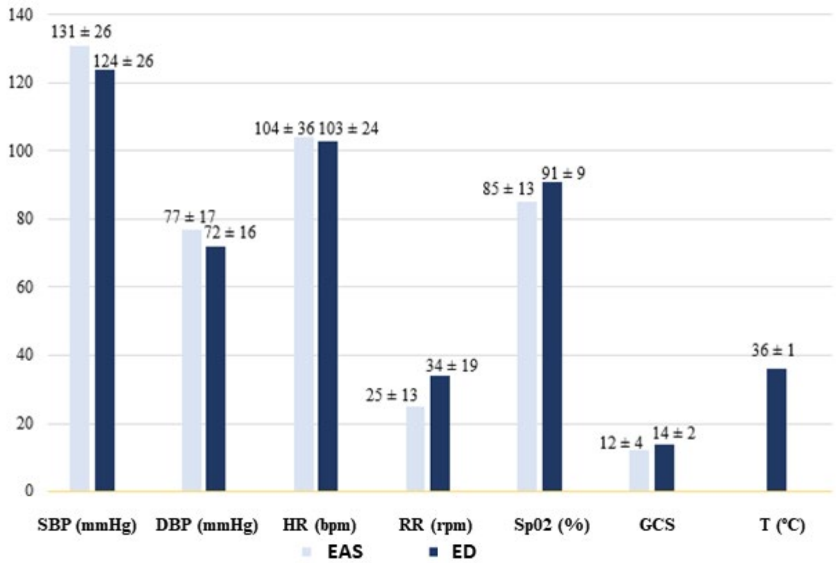

Figure 1: Clinical indicators of the patients included in the study (n=109). EAS: emergency ambulance service, ED: emergency department, SBP: Systolic blood pressure, DBP: diastolic blood pressure, HR: heart rate, RR: respiratory rate, Sp02: oxygen saturation mesured with pulse oximetry, GCS: Glasgow coma score, T: Temperature.

In the EAS, loss of consciousness was reported in 65 subjects (60%). In 22 of these (34%), the pupils were no reactive and CPR was performed in 35 (54%). In ED, 36 (33%) patients presented loss of consciousness, with pupils no reactive in 5 of these (14%) and requiring CPR in only 3 patients (8%).

Sixty-six individuals (61%) were admitted to Pneumology (62%), Internal Medicine (31%) and Paediatrics (7%) while the remaining 43 were admitted directly to the ICU (39%), of whom 44% required mechanical ventilation (MV), 60% antibiotherapy, and 47% received corticosteroids.

Radiological alterations appeared in 79 patients being the most frequent bilateral diffuse alveolar infiltrates (44% of patients) and perihilar alveolar opacities (29%).

The main complications were bacterial pneumonia in 15% of patients, bronchoaspiration in 28%, arrhythmias in 26% and febrile syndrome in 14% being the main micro-organisms isolated: *Escherichia coli, Staphylococcus aureus, Streptococcus pneumoniae, Pseudomonas aeruginosa, Candida albicans, Staphylococcus epidermidis and Haemophilus spp.*

Of the 66 patients admitted, 51 required oxygen therapy and antibiotherapy being Amoxicillin-Clavulanic acid the most administered antibiotic. In addition, corticotherapy was initiated in 39 patients. Regarding sequelae, 4 patients developed permanent neurological damage, 5 developed acute renal failure due to rhabdomyolysis and 1 developed polyneuropathy.

Comparison of clinical, analytical and blood gas parameters between groups A and B showed that individuals with drowning in SW were older (p=0.001) and had higher DBP (p=0.037) and lower SpO2 in the ED (p=0.004). The respiratory rate (RR) measured by the emergency team is higher in SW cases and shows a trend towards significance (p=0.052).

On arrival at the ED, significant differences were observed in haemoglobin (p=0.002), haematocrit (p=0.001), pH (p=0.001), HCO3 (p=0.001) and PaFi (p=0.034). Haemoconcentration and metabolic acidosis take place in SW drowning. Furthermore, sodium (p=0.075), urea (p=0.06) and creatine kinase (p=0.065) tend to statistical significance, with more rhabdomyolysis in FW **(Table 2).**

When comparing FW and AS, no significant differences were found in gender, triggering event, comorbidity, loss of consciousness, in CPR in ED, in radiographic alterations, in complications, except in ARDS (p=0.035), or in sequelae. In the ICU there was no statistical significance in the number of admissions, MV, use of antibiotics or corticoids. There were significant differences in CPR in EAS (p=0.039) and ARDS (p=0.035), being higher in FW (**Table 3**).

Bronchoaspiration is the most frequent complication in both FW and SW along with cardiac arrhythmias. Convulsions occurred equally in both groups. ARDS is more frequent in drowning in FW while heart failure, pleural effusion and bronchospasm are more linked to SW.

Patients admitted to the ICU who received corticoids showed a higher heart rate in the ED (p=0.02) and a trend towards a reduction in stay in the ICU (p=0.056). ICU patients given corticosteroids tended to have higher leukocytes (p=0.063) and higher blood glucose levels (p=0.018). Furthermore, more corticods were prescribed in subjects with rhabdomyolysis **(Table 4).**

Corticosteroids were used more frequently in ARDS (p=0.023) and convulsions (p=0.017) in the ICU, with a trend towards statistical significance in pneumonia (p=0.057). Similarly, on the hospital ward, corticotherapy was used to a greater extent in cases of atelectasis (p=0.004). There were no significant differences between corticosteroid administration and sequelae, either in the ICU or hospital ward.

Those admitted to the hospital ward with corticoids were older (p=0.002) and tended to have a higher heat rate in the ED (p=0.055). No significant differences were observed in hospital stay despite corticotherapy. In terms of blood tests and blood gases, patients on the hospital ward who received corticotherapy associated leukocytosis (p=0.010) with neutrophilia (p=0.008) **(Table 5).**

Regarding PaFi, the greatest alteration occurs in the first 24 hours of admission and in both groups, there is a progressive improvement

Table 2: Analytical and gasometric values in fresh water and salt water drowning on arrival at emergency department.

Variables		**Salt water**	**Fresh water**	**P-value**
Blood test	Leukocytes (x109/L)	12 ± 5	12 ± 6	0,577
	Neutrophils (%)	56 ± 17	62 ± 21	0,126
	Hemoglobin (g/dL)	15 ± 2	13 ± 2	0,002
	Hematocrit (%)	45 ± 8	40 ± 5	0,001
	Platelets (x109/L)	237 ± 93	258 ± 93	0,306
	Glucose (mg/dL)	179 ± 73	161 ± 68	0,271
	Urea (mg/dL)	41 ± 14	35 ± 13	0,06
	Creatinine (mg/dL)	1 ± 1	1 ± 1	0,210
	Sodium (mmol/L)	143 ± 17	137 ± 5	0,075
	Potassium (mmol/L)	4 ± 1	4 ± 1	0,665
	Creatine kinase (U/L)	172 ± 116	266 ± 148	0,065
	pH	7,2 ± 0,2	7,3 ± 0,1	0,001
Arterial blood gases	pCO2 (mmHg)	41 ± 12	43 ± 10	0,468
	pO2 (mmHg)	88 ± 50	85 ± 72	0,768
	HCO3 (mmol/L)	16 ± 6	21 ± 5	0,001
	SpO2 (%)	88 ± 9	83 ± 19	0,114
	FiO2 (%)	0,3 ± 0,2	0,5 ± 0,4	0,955
	PaFi (mmHg)	316 ± 148	223 ± 98	0,034

Table 3: Comparison between gender, comorbidities, consciousness and CPR in EAS and ED and alterations in imaging tests, complications, sequelae and ICU management between salt water and fresh water drowning. ICU: Intensive Care Unit; CPR: cardiopulmonary resuscitation; ARDS: acute respiratory distress syndrome ; EAS: Emergency ambulance service; ED: Emergency department.

Variables		**Salt water**	**Fresh water**	**P-value**
Sex	Man	22 (71%)	55 (71%)	0,962
	Woman	9 (29%)	23 (29%)	
Previous comorbid disease		20 (65%)	63 (81%)	0,664
Loss of consciousness	EAS	17 (55%)	48 (62%)	0,520
	ED	18 (58%)	55 (71%)	0,213
CPR	EAS	14 (45%)	18 (23%)	0,039
	ED		3 (4%)	0,520
Radiological alterations		24 (77%)	55 (71%)	0,245
ARDS		3 (10%)	1 (1%)	0,035
Sequelae		4 (13%)	6 (8%)	0,276
ICU	Number of admissions	10 (32%)	33 (42%)	0,333
	Mechanical ventilation	6 (19%)	13 (17%)	0,411
	Antibiotics	7 (23%)	19 (24%)	0,269
	Corticoids	5 (16%)	15 (19%)	0,323

until normalisation at 48 hours on the ward and at 72 hours in the ICU.

Discussion

Drowning is a serious public health problem in terms of both economic cost and mortality, constituting the third leading cause of death due to unintentional trauma [16]. Despite the alarming number of drownings, the number of publications is scarce, retrospective in nature and mainly centred on the paediatric population and those admitted directly to the ICU. Furthermore, there are only two series comparing clinical, analytical and blood gas parameters between FW and SW, which, together with the lack of standardisation of drowning until 2002, entails an added difficulty. Published Spanish studies included Blasco Alonso et al. [17] with 62 paediatric patients and Ballesteros et al. [18] with 43 adults. To the best of our knowledge, our series is the largest in the Spanish literature consulted.

We highlight the mean age of 51 years, with a higher proportion of men (71%), similar to other publications [19,20]. In addition, most of them occurred in SW (72%), as we are in a maritime area, with a predominance of subjects with an older mean age (57 years), compared to those in FW (28%), with a younger population (35 years), coinciding with other series [21].

In our study, 76% of the subjects had comorbidity, higher than in other series. Cerland et al describe 54% [22] with hypertension being the main one (14%) as in our series (28%), followed by epilepsy (13%) and DM2 (11%) similar to our work (14%). Markarian et al. [20] reported 59%, with cardiovascular (26%) and psychiatric (16%) diseases being the most frequent, compared to 24% and 13%, respectively, in our series.

Accidental fall was the most frequent precipitating event (31%), followed by no identifiable cause (15%) and coma (12%). In Cerland et al. [22] the main factor was unknown (29%) followed by accidental fall (25%), CHD (22%), alcoholism (8%), convulsions (7%) and attempted suicide (2%). In our study, the majority took place during the summer season, in agreement with Spanish series [17,18].

Mean stay in ICU was 4 days, similar to that of Ballesteros et al. [18], without differences between SW and FW. In Reizine et al. [21] and Robert et al. [23] it was 3 days, with more days of hospitalisation in FW [19,21].

Analytically, renal failure was secondary to renal hypoperfusion and acute tubular necrosis due to rhabdomyolysis, not only related to hypoxia, but also due to strenuous muscular exercise in the struggle for survival [14]. Multifactorial metabolic acidosis related to tissue hypoxia and increased lactic acid during submersion was also described [24].

Sodium, haemoglobin and haematocrit levels are slightly higher in SW. Experiments in dogs by Orlowski et al. [25], determined that haemodynamic and water-electrolyte balance changes depend on tonicity and volume of fluid aspirated.

In FW, hypervolaemia, haemodilution and hyponatraemia take place due to the movement of fluid from the alveolus to the blood, with haemolysis, hyperkalaemia and ventricular fibrillation. Although in our series the decrease in haemoglobin may indicate mild haemolysis, it does not lead to increased potassium concentration3. In SW, because its osmolality, it results in massive pulmonary edema, hypernatraemia,

Table 4: Clinical, analytical and gasometric features of patients who received corticosteroids in the ICU. SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate; RR: Respiratory rate; Sp02: oxygen saturation; GCS: Glasgow coma score.

Variables		**No corticoids**	**Corticoids**	**P-value**
Age (years)		52 ± 25	55 ± 26	0,679
Time of CPR (minutes)		15 ± 13	15 ± 14	0,984
Time from event to hospital (minutes)		51 ± 23	45 ± 49	0,821
ICU mean stay (days)		5 ± 7	2 ± 2	0,056
Mean hospital stay (days)		6 ± 5	6 ± 4	0,948
ED	SBP (mmHg)	123 ± 25	131 ± 32	0,313
	DBP (mmHg)	70 ± 16	76 ± 15	0,224
	HR (bpm)	99 ± 23	116 ± 17	0,02
	RR (rpm)	36 ± 18	35 ± 21	0,916
	SpO2 (%)	89 ± 9	85 ± 15	0,453
	GCS	14 ± 3	14 ± 3	0,776
	Temperature (ºC)	36 ± 1	36 ± 1	0,831
Blood test	Leukocytes (x109/L)	9 ± 4	16 ± 8	0,063
	Neutrophils (%)	77 ± 10	87 ± 6	0,115
	Hemoglobin (g/dL)	12 ± 2	12 ± 1	0,985
	Hematocrit (%)	37 ± 5	36 ± 2	0,617
Arterial blood gases	Glucose (mg/dL)	142 ± 50	227 ± 43	0,018
	Creatinine (mg/dL)	1 ± 1	1 ± 1	0,210
	Creatine kinase (U/L)	172 ± 116	266 ± 148	0,065
	pH	7,4 ± 0,03	7,4 ± 0,1	0,536
	pCO2 (mmHg)	40 ± 6	35 ± 2	0,191
	pO2 (mmHg)	107 ± 60	117 ± 80	0,814
	HCO3 (mmol/L)	26 ± 4	24 ± 2	0,459
	SpO2 (%)	93 ± 8	94 ± 8	0,993
	FiO2 (%)	0,4 ± 0,1	0,6 ± 0,4	0,135
	PaFi (mmHg)	325 ± 103	302 ± 143	0,854

Table 5: Clinical, analytical and gasometric features of patients who received corticosteroids in the hospitality ward.

Variables		**No corticoids**	**Corticoids**	**P-value**
Age (years)		45 ± 28	61 ± 23	0,002
Time of CPR (minutes)		17 ± 14	11 ± 6	0,551
Time from event to hospital (minutes)		50 ± 25	48 ± 46	0,925
Mean hospital stay (days)		5 ± 5	5 ± 4	0,926
EAD	SBP (mmHg)	128 ± 29	135 ± 22	0,562
	DBP (mmHg)	74 ± 17	81 ± 17	0,410
	HR (bpm)	98 ± 32	115 ± 41	0,296
	RR (rpm)	16 ± 14	21 ± 14	0,557
	SpO2 (%)	85 ± 14	85 ± 9	0,971
ED	SBP (mmHg)	124 ± 26	124 ± 25	0,927
	DBP (mmHg)	71 ± 17	73 ± 14	0,616
	HR (bpm)	95 ± 20	106 ± 25	0,055
	RR (rpm)	35 ± 15	34 ± 24	0,871
	SpO2 (%)	92 ± 8	89 ± 9	0,261
Blood test	Leukocytes (x109/L)	9 ± 4	13 ± 6	0,010
	Neutrophils (%)	69 ± 14	79 ± 13	0,008
	Hemoglobin (g/dL)	13 ± 2	13 ± 2	0,897
	Platelets (x109/L)	223 ± 97	208 ± 80	0,533
	Urea (mg/dL)	40 ± 28	46 ± 28	0,369
	Creatinine (mg/dL)	1 ± 1	1 ± 1	0,927
Arterial blood gases	pH	7,4 ± 0,04	7,4 ± 0,03	0,919
	pCO2 (mmHg)	39 ± 5	39 ± 5	0,913
	pO2 (mmHg)	88 ± 40	87 ± 51	0,923
	HCO3 (mmol/L)	25 ± 4	25 ± 3	0,967
	SaO2 (%)	93 ± 7	94 ± 3	0,776

hypovolaemia and increased haemoglobin and haematocrit and thus blood viscosity [2,25].

We found that drowning in FW was associated with more ARDS. However, greater severity of initial hypoxaemia does not imply longer stay in the ICU or higher mortality, as in other studies [19, 21]. In our study, only 4% developed ARDS, lower than in other series. In Reizine et al. [21], 38% developed ARDS, in of Cerland et al [22] 16% and in Robert et al. [23] 25%, which could be explained by the fact that they include only those admitted to the ICU.

Bacterial pneumonia happened in 15% of our series, in agreement with other studies [22,26] and was more frequent in SW [21]. There were no cases of septic shock or DIC.

Treatment is based on fluid therapy, oxygen therapy with MV, mostly due to hypoxaemic respiratory failure (44%) [18,22], antibiotherapy and corticotherapy. When comparing the use of corticosteroids in the ICU, they tended to be administered in patients with rhabdomyolysis and greater alteration of PaFi, reducing mean stay in the ICU, without modifying total mean stay. Corticosteroids are controversial, as there are no prospective randomised studies,which prevents solid conclusions. For the moment, there is no evidence demonstrating the benefit of their systematic use, as they do not improve survival and increase the risk of infection. They would be indicated for bronchospasm after failure of bronchodilator treatment [6,12,26,27]. Similarly, prophylactic antibiotics are not recommended, except under MV, as they do not improve the clinical course and favour colonisation by multidrug-resistant microorganisms. They should only be used when there is clinical, analytical and radiological suspicion of pneumonia, guided by the environment in which drowning occurs and according to the samples obtained [6,13].

Regarding morbidity and mortality, sequelae appeared in 10 subjects and only 2 death (2%), lower than in other studies. Ballesteros et al. [28] report a mortality rate of 35%, Cerland et al. [22] 31% and Robert et al. [23] 26%. This discrepancy could be justified because they only analyse ICU admissions. In our series, the number of deaths was higher in SW in agreement with other studies [19]. Furthermore, the duration of submersion is the main prognostic factor, directly related to hypoxic-ischaemic encephalopathy, on which survival and subsequent quality of life depend. Severe neurological damage is seen after 6 minutes [29] and after 10 minutes it is considered critical for survival [18]. In our study, the mean duration reported was 2 minutes. Similarly, the quality, speed and duration (>25 minutes) of CPR, a score <5 on the GCS, and no reactive pupils on admission to the ICU are indicators of cerebral hypoxia and, therefore, poor prognosis [18]. Water temperature is controversial, as cold water decreases cerebral metabolism exerting a neurological protective role, so induced hypothermia (32-34°C) can be used as a treatment [2,18].

In Spain, surveillance systems in public swimming pools began in 1960. Lifeguards have been compulsory in aquatic facilities since 1990. With regard to lifeguarding plans in maritime areas, in 1988 it was established that the competence for lifeguarding and safety of human lives depended on the State Administration, with the Autonomous Communities and, specifically, the municipalities, being responsible for their fulfilment. In Spain, the compulsory qualification of Sports Technician in Lifesaving and Lifeguarding was introduced in 2011[30]. All this has contributed to a decrease in the number of drownings, findings that are consistent with our work.

Our study has some potential limitations. The retrospective methodology, which makes it difficult to draw firm conclusions on the influence of corticosteroids and antibiotic therapy on drowning, as well as the impossibility of knowing with certainty which patients died prior to their arrival at the hospital. However, it is exceptional that they are not transferred to a health centre.

Among the strengths, it is a real-life study, representative of a long period of time (15 years), and includes a large number of patients, which allows conclusions to be drawn. Also, the therapeutic management has undergone few modifications over time, so that the methodology has followed a uniform systematic approach.

In conclusion, the number of drownings has decreased due to the establishment of rescue and lifesaving protocols. Drownings were more frequent in SW and predominantly affect middle-aged males with higher comorbidity. In FW there was a greater tendency to rhabdomyolysis and ARDS without correlation with longer ICU stay or higher mortality. The use of corticosteroids tended to reduce the length of stay in the ICU, without modifying the total hospital stay. The combined organisation of the surveillance, emergency, emergency, ICU and pneumology services allowed good clinical outcomes to be obtained, despite the severity of the disease.

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