

# Clinical, laboratory and X-ray findings of drowning and near-drowning in the Gulf of Aqaba

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## المظاهر السريرية والمخبرية والشعاعية لحالات الغرق وقرب الغرق في خليج العقبة عبدان الطلافية ورامي المجالي وغازي الدحيات

خلاصة: تعرض هذه المقالة المظاهر السريرية والمخبرية والشعاعية التي وجدت في أربع وثلاثين ضحية من ضحايا الغطس. لقد مات من هؤلاء خمسة أفراد وبقي على قيد الحياة تسعة وعشرون (تتراوح أعمارهم بين 12 وستين سنة). ووجد عوز الأكسجين بدرجة وخيمة في جميع المرضى (حيث كان متوسط ضغط الأكسجين 58 ملميمتر زئبق مع بعض الدعم بالأكسجين). أما تحليل غازات الدم الشرياني فقد أظهر وجود حمض استقلابي (أيضي) ملحوظ في تسعة عشر مريضاً وحمض تنفسي ملحوظ في خمسة عشر مريضاً. وكانت رضة الرئة هي أكثر المشاهدات في صور الأشعة السينية. وولوج أربعة عشر مريضاً بالتنفس الآلي على أساس الصورة السريرية وتحليل غازات الدم لديهم. ولقد كانت البيانات السريرية والمخبرية قريبة جداً من تلك التي سجلتها الدراسات الدولية.

**ABSTRACT** Clinical, laboratory and X-ray findings in 34 victims of submersion are presented. Five people died and 29 survived (age range 12–60 years). Severe hypoxia was found in all patients (mean  $P_{O_2}$  of 58 mmHg with some oxygen support). Arterial blood gas analysis showed significant metabolic acidosis in 19 patients and significant respiratory acidosis in 15 patients. Pulmonary oedema was the most common X-ray finding. Fourteen patients were put on mechanical ventilation on the basis of their clinical picture and blood gases analysis. Clinical and laboratory data are very similar to those reported in international studies.

### Observations cliniques, biologiques et radiographiques de la noyade ou de la quasi-noyade dans le golfe d'Aqaba

**RESUME** Les observations cliniques, biologiques et radiographiques chez 34 victimes de submersion sont présentées. Cinq personnes sont décédées et 29 ont survécu (âges extrêmes 12-60 ans). Une hypoxie sévère a été trouvée chez tous les patients (pression partielle en  $O_2$  moyenne de 58 mmHg avec un apport d'oxygène). L'analyse des gaz du sang artériel a montré une acidose métabolique importante chez 19 patients et une acidose respiratoire importante chez 15 patients. L'œdème pulmonaire était l'observation radiographique la plus courante. Quatorze patients ont été placés sous ventilation artificielle sur la base de leur tableau clinique et de leur gazométrie sanguine. Les données cliniques et biologiques sont très similaires à celles rapportées dans les études internationales.

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## Introduction

Drowning has been defined as "death by suffocation after submersion in water" and near-drowning as "survival, at least temporary, after suffocation by submersion in water" [1].

Near-drowning has been estimated to be from two- to twenty-fold more common than reported drowning [2,3]. More than 140 000 drowning deaths occur worldwide each year [4]. It is considered the third leading cause of death by unintentional injury for all age groups and the second leading cause of children's death in the United States of America [5]. The most important consequences of near-drowning are severe hypoxia and metabolic acidosis [6,7]. Life-threatening electrolyte disturbances caused by salt water aspiration are minimal [8].

In our study we evaluated 34 cases of drowning and near-drowning for clinical features, arterial blood gases and X-ray findings, and compared the data with international studies. Our field of study was the beach of Aqaba city, which is the only beach in Jordan and which is on the Gulf of Aqaba. The city has a population of 70 000 people which increases during the summer season. The beach is generally divided into two parts. The hotel area beach (which represents about a sixth of the total beach area) is clean, safe for swimming and is supervised by lifeguards. The other part of the beach (the non-hotel area) has parts which are not clean and are dangerous for swimming because of the lack of lifeguards, the presence of deadly marine animals (stone fish) or steep slopes in the beach. Our literature review could not find any similar studies from the Gulf of Aqaba or nearby area.

## Materials and methods

In a prospective study which was conducted in the Princess Haya Hussein Hospital (the only referral hospital in Aqaba for cases of drowning), we studied all cases of drowning and near-drowning during the period from April 1996 to April 1998. In total, 34 cases were studied with ages ranging from 8 years to 60 years and a mean age of 26 years. There were 29 survivors with ages ranging from 12 years to 60 years and a mean age of 28 years.

On arrival at the Emergency Department of the Princess Haya Hussein Hospital, every patient underwent resuscitation and was then evaluated thoroughly. A detailed history of what had been done for all victims was taken and all clinical findings were recorded. Arterial blood gases were taken for every live patient within the first three minutes of arrival, with an electrocardiogram after 15 minutes and a chest X-ray. The data were analysed and compared with similar reports on the subject. No data were available on how long the victims had been submerged before rescue. Three live patients had been resuscitated before arrival at the hospital (one of them by a doctor, the other two by qualified lifeguards). The rest of the live victims either had not received any resuscitation or had received improper attempts of resuscitation by inexperienced people.

## Results

On arrival, six patients had cardiopulmonary arrest and only one of them survived after cardiopulmonary resuscitation (CPR). The other 29 patients had various cardio-respiratory statuses as shown in Table 1. Only the patients who were fully alert with mild respiratory distress were admitted to

Table 1 Condition of the 34 patients on admission

Condition of patient	No. of deaths	No. of live patients	% of live patients
Fully conscious and alert with mild respiratory distress	0	9	26
Respiratory distress and cyanosis	0	16	47
Apnoea, but with cardiac activity	0	3	10
Cardiorespiratory arrest	5	6	17

Table 2  $P_{O_2}$ , pH and  $P_{CO_2}$  values of the 29 live patients on admission

$P_{O_2}$ (mmHg)	No.	%	pH	No.	%	$P_{CO_2}$ (mmHg)	No.	%
> 100	3	10	6.8–7.0	3	10	20–30	2	7
80–100	3	10	7.0–7.2	12	41	30–40	7	24
60–80	6	21	7.2–7.3	7	24	40–60	17	59
40–60	12	42	7.3–7.4	6	21	60–80	3	10
40 <	5	17	> 7.4	1	4			

the ward (nine patients). The rest were admitted to the intensive care unit (20 patients).

Radiographic appearances of those who survived were variable. Out of the 29 patients, pulmonary oedema was present in 18 patients, aspiration pneumonia in 6, pneumothorax in 1 patient and the rest had normal chest X-rays.

$P_{O_2}$  was measured when all patients had had 80%–100% of oxygen support for about 2 minutes after arrival. The mean  $P_{O_2}$  value was 58 mmHg (Table 2).

Most patients had acidosis (Table 2). Significant respiratory acidosis ( $P_{CO_2} > 50$  mmHg) occurred in 15 patients, while the mean  $P_{CO_2}$  value was 49 mmHg (Table 2). Significant metabolic acidosis occurred in 19 patients (Table 3). Fourteen patients were put on mechanical ventilation on the basis of their clinical picture (confusion,

Table 3 Base excess values on admission

Base excess value (meq/L)	No.	%
-30 to -20	5	17
-20 to -10	6	21
-10 to 1	17	59
1 to 5	1	3

apnoea, cyanosis) and/or a  $P_{O_2}$  less than 55 mmHg.

## Discussion

The present study confirms and extends the observation that arterial hypoxaemia and metabolic acidosis are the most significant pathophysiological abnormalities of near-

drowning victims [6,7]. Therefore, initial resuscitative efforts need to be directed at establishing a patent airway, oxygenation and ventilation. Initial management at the site of drowning is of great importance in saving more lives, as most of our victims did not have basic life support at the beach. All the patients who died were brought from places on the beach where there was no supervision by lifeguards and warning signs of danger were present but ignored by the victims.

In our study, chest roentgenograms were quite varied, ranging from a few patchy alveolar infiltrates to a picture of acute pulmonary oedema, which tended to be more frequent when compared with results in other papers [7]. Near-drowning cases were about six times as frequent as drowning

cases, which is in close agreement with other reports [2,3].

Although not all submersion victims require hospitalization (especially if the patient is asymptomatic, has a normal physical examination and normal arterial blood gases), all patients in our study were admitted because we could not guarantee medical follow-up if required.

We conclude that the speed of rescue and early effective CPR appear to be primary determinants of the outcome of near-drowning. Since the victims did not have adequate resuscitation at the place of submersion, as those present apparently had no knowledge of resuscitation, it would appear that public education about CPR is needed for initial management and the prevention of fatalities.

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