Submersion and acute respiratory failure

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ABSTRACT

Objectives: To know the relationship between hypothermia, etiology, respiratory failure and prognosis of submersion in environmental emergency medicine. **Methods:** From December 1, 2002 to September 30, 2007, there were 52 hospitalized near− drowning cases in a medical center at northern Taiwan. Retrospective study of 52 submersion patients who were hospitalized during the duration was analyzed. **Results:** The hypothermic groups are more commonly seen in acute respiratory failure after submersion, 36% $vs.$ 21%, $P<0.05$. The hypothermic submersion patients who are older in age than normothermic submersion patients (44 $vs.$ 27 years old, $P<0.05$). The suicidal submersion patients are older, hypothermic and longer length of stay than accidental submersion patients. **Conclusions:** Submersion patients who are hypothermic on arrival of emergency department (ED) are risky to respiratory failure and older, more hypothermic, longer hospital stay in suicidal submersion patients.

1. Introduction

Drowning is defined as death less than 24 hours by suffocation in a liquid. In contrast, near−drowning is defined as survival longer than 24 h after a drowning accident. According to the statistic information of Department of Health, Executive Yuan of Taiwan, drowning is the third cause of death by accident, next to traffic accidents and falls. About 100 children drown every year in Taiwan with the highest rate out of 21 nations surveyed by the World Health Organization (WHO), and statistics report 1.8 deaths in every 100 000 children aged 0 to 14 in Taiwan, a rate over three times above that of the equally maritime Australia and even further exceeding that of Italy, Great Britain, Japan, Singapore and others. So Drowning and submersion are important issues in emergent resuscitation in Taiwan, especially summer time. Herein we analyzed the prognostic factors and outcome in submersion.

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2. Methods and materials

From December 1, 2002 to September 30, 2007, there were 52 near drowning cases hospitalized in a medical center at northern Taiwan. Retrospective chart review of these near drowning patients who were hospitalized during this duration was performed. We recorded the body temperatures, blood pressures, electrocardiography (ECG) at emergency department (ED), and therapeutic equipment of oxygen supplements, etiologies of near drowning, hospital stays, and dispositions to find out the prognostic factors of submersion. We defined the hypothermia as the body temperature is less than 35 degrees Celsius, and divided cases into two groups according to the etiology of submersion.

We use (SPSS 11.5.0, Chicago, IL, USA) for statistical analysis with student t test and set P value less than 0.05 as significant difference.

3. Results

We retrospectively review chart of the 52 submersion cases. Of them, 35 males and 17 females, aged from 0.75 to 82 years old with a mean ± SD (31.5 ± 21.5) yeas old. The basic data is shown in the Table 1. The hypothermic submersion patients are elderly than the normo–thermic ones 44 *vs.* 27 year–old, *P*<0.05. The hypothermic groups are more commonly seen in acute respiratory failure after submersion, 36% vs. 21%, *P*<0.05. There are no significant difference in systolic blood pressure (SBP) and heart rate between the hypothermic and normo–thermic (*P*=0.06; 0.45) [Table 2]. The suicidal submersion patients are 23 years older than accidental submersion group, and hypothermic (lower 2 degrees), longer length of stay (2.7 d) than accicental submersion group [Table 3]. The comparisons of age, body temperature, and length of stay are shown in Figure 1, 2 and 3.
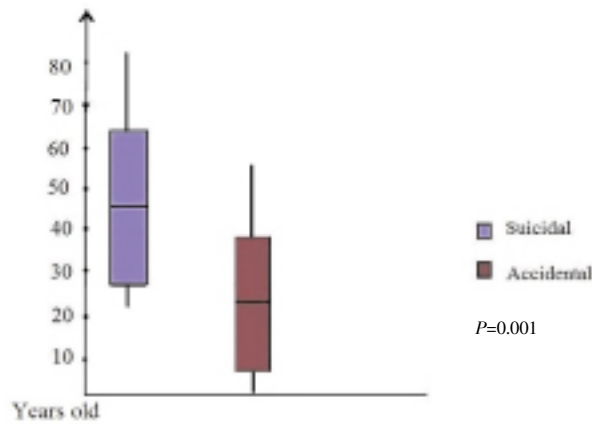

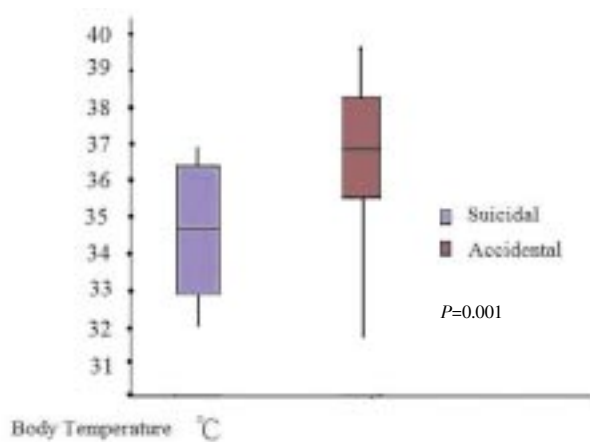**Figure 1.** The mean age of suicidal submersion are older than accidental submersion ones.

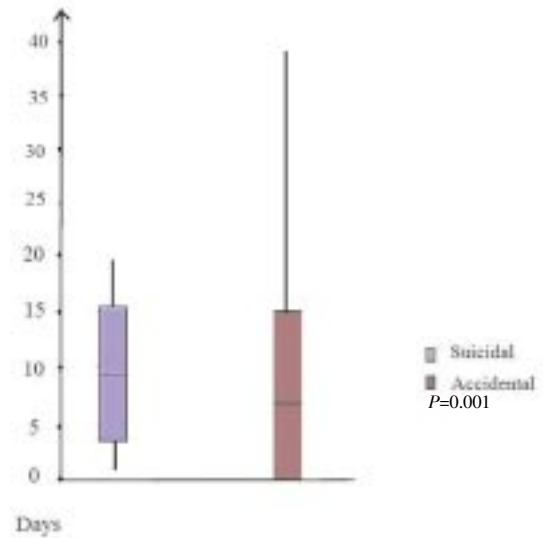**Figure 2.** Suicidal submersion patients are 2 degrees lower in body temperature than accidental submersion ones.

Figure 3. Suicidal submersion patients have longer length of stay than accidental submersion ones.

Table 1

Basic data of 52 cases of near–drowning. Heat rate (per min).

Parameter		(n, %)
Gender	Male	(35, 67.3%)
	Female	(17, 32.7%)
Heart rate	Tachycardia	(36, 69.2%)
	Normal sinus rhythm	(16, 30.8%)
Oxygen supply	Mechanical ventilator	(13, 25%)
	T–piece	(3, 5.8%)
	Oxygen mask	(19, 36.5%)
	Nasal cannula	(10, 19.2%)
	No	(7, 13.5%)
Disposition	Respiratory ward	(33, 63.5%)
	Intensive care unit	(19, 36.5%)
Outcome	Survival to discharge	(52, 100%)

Table 2

Multi–variate comparisons of parameters in body temperature (in Celsius). Age (years old); Heart rate (per–minute); Systolic BP = Systolic blood pressure (mmHg); ARF = acute respiratory failure; MV = mechanic ventilator.

	All	Normothermic (>=35)	Hypothermic (<35)	*P* value
Age	31±22	27±21	44±21	0.01*
Heart rate	111±23	110±23	115±23	0.45
Systolic BP	128±24	124±22	138±25	0.06
ARF with MV	(13, 25%)	(8, 21%)	(5, 36%)	0.02*

Table 3

Multi–variate comparisons of parameters in etiology. Age (years old); Body temperature (in Celsius); ARF = acute respiratory failure; MV = mechanic ventilator. ICU = intensive care unit.

	Suicidal	Accidental	*P* value
Age	45 ± 19	22 ± 17	<0.01*
Body temperature	35 ± 1.7	37 ± 1	<0.01*
ARF with MV	30% (6/20)	21.88% (7/32)	0.51
ICU admission	35% (7/20)	37.50% (12/32)	0.86
Hospital stays (days)	9.5 ± 5.9	6.8 ± 8.1	<0.01*

4. Discussion

The mean age of near–drowning patients is 31 years old, this maybe result from that submersion patients are often happened in some water sports and water activities. In gender, near–drowning is more commonly seen in male[1]. In our study, the hypothermic presentation is more commonly seen in the fourth decades in age. This is related to the thermo–regulation is poor in older people than the young.

For the majority of submersion patients, the primary insult is pulmonary, resulting in severe arterial hypoxemia and secondary damage to other organs, such as neurologic injury, acute renal impairment and pneumonia. Respiratory manifestations of near–drowning in adult immersion victims are often severe[2–6]. However, drowning victims may survive neurologically intact even after prolonged submersion time, in particular in cold water[3]. The major reason is that hypothermia provides cerebral protection from hypoxia, permitting total recovery with appropriate resuscitation and intensive care[7,8]. In the past, there is no article ever describing hypothermia is high relation to pulmonary insufficiency. In our study, the submersion patients needing tracheal intubation are hypothermic significantly.

Pre–hospital resuscitation should be initiated as quickly as possible after careful removal the victim from the water. All patients should be supplied 100% oxygen, and rapidly be sent to the ED of hospital[9]. A systematic and aggressive approach needs to be followed with particular emphasis on cardiopulmonary support to optimize neurological outcome. Treatment of pulmonary complications depends on the lung injury that occurred during aspiration and the bacteria involved in aspiration. Understanding the pathophysiology of drowning may help us to understand lung injuries and ischemic brain injuries[10]. For submersion victims, there is no need to hospitalize when there are no signs or symptoms of aspiration upon arrival in the ED[11]. Generally speaking, ED observation for four to six hours could effectively screen for those patients requiring inpatient therapy[12]. Submersion time was the only independent predictor of survival[1]. In the year of 1997, Szpilman D ever estimated mortality of near–drowning patients as classifying six subgroups by symptoms of cough, rales in pulmonary auscultation, pulmonary edema, arterial hypertension, respiratory arrest, and cardiopulmonary arrest[13]. In near–drowning with cardiopulmonary arrest patients had a very high mortality rate as 93% and it was higher than our study 83.3%[13]. Gregorakos et al ever studied 43 submersion cases in the year of 2009 and found the mean hospital stay is 5.2 days; in our study, overall all mean hospital stay is 7.4 d[2]. We also found the suicidal group of submersion patients had longer hospital stay than the accidental group.

The key to successful management is the prevention of near–drowning. For prevention of accidental near–drowning, many water submersion accidents are avoidable; close supervision of infants and toddlers, installation of a fence around home swimming pools, and abstinence from alcohol during participation in water sports are some practical precautions[14]. The suicidal near–drowning patients are 23 years older in mean age than the accidental ones. They also had more hypothermic status (2 degrees Celsius lower than the accidental group), and need longer hospital stays (2.7 d than the accidental ones) to treat and observe.

Hypothermic submersion increased the rate of respiratory failure and older than normothermic submersion patients. Suicidal submersion patients are 23 years older in age than accidental submersion group, two degrees in body temperature lower than accidental submersion group, and need longer hospital stays (2.7 d than the accidental ones) to treat and observe. We should pay more attention to patients who are submersion with hypothermia and prevention of suicidal submersion.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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