Classifications of Drowning

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Research tools to study the epidemiology, prevention, rescue, and treatment of drowning include definitions, coding, and registration systems. Classification systems are most of all helpful for clinical use. This chapter provides an overview.

105.1 Definitions

A uniform definition of drowning has been established allowing the inclusion of a well-defined group of patients [1]. The definition includes mechanism (respiratory impairment by submersion or immersion) and outcome (fatal and not fatal). Since the introduction in 2002, the definition has been accepted by many organizations and is increasingly used in reports and scientific publications (Chap. 9). Further development of the definition is needed. Most of all, there is a need for additional definitions of the morbidity after drowning.

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105.2 Coding

The International Classification of Diseases system (ICD-10) includes several drowning-related codes. At the three and four character levels, these codes allow to differentiate the location and etiology of drowning (Table 105.1 and 105.2). However many countries fail to report detailed drowning mortality data, either for their own national statistics or for submission to the WHO [2]. As a consequence, the profile of drowning location and etiology is vague, and WHO figures of

Table 105.1 International Classification of Diseases system (ICD-10): main codes

Unintentional drowning-related codes	
W65	Drowning and submersion while in bathtub
W66	Drowning and submersion following fall into bathtub
W67	Drowning and submersion while in swimming pool
W68	Drowning and submersion following fall into swimming pool
W69	Drowning and submersion while in natural water
W70	Drowning and submersion following fall into natural water
W73	Other specified drowning and submersion
W74	Unspecified drowning and submersion
V90	Accident to watercraft causing drowning and submersion
V90.0	To merchant ship causing drowning and submersion
V90.1	To passenger ship causing drowning and submersion
V90.2	To fishing boat causing drowning and submersion
V90.3	To other powered watercraft causing drowning and submersion
V90.4	To sailboat causing drowning and submersion
V90.5	To canoe or kayak causing drowning and submersion
V90.6	To inflatable craft (no powered) causing drowning and submersion
V90.7	To water skis causing drowning and submersion
V90.8	To other unpowered watercraft causing drowning and submersion
V90.9	To unspecified watercraft causing drowning and submersion
V92	Water transport-related drowning and submersion without accident to watercraft
V92.0	Merchant ship
V92.1	Passenger ship
V92.2	Fishing boat
V92.3	Other powered watercraft
V92.4	Sailboat
V92.5	Canoe or kayak
V92.6	Inflatable craft (nonpowered)
V92.7	Water skis
V92.8	Other unpowered watercraft
V92.9	Unspecified watercraft
T75.1	Nonmortal submersion (Drowning)
Intentional drowning-related codes	
X71	Suicide
X92	Homicide
Intentional unknown	
Y21	Intention unknown
Y36.4	Drowning during war

Table 105.2 International Classification of Diseases system (ICD-10): subdivisions

The recommended fourth subdivisions – place of occurrence of events W65-Y21	
.0	Residence
.1	Residential institution
.2	Schools and other public institutions
.3	Sports area
.4	Street and roads
.5	Business and service area
.6	Industrial and building areas
.7	Farm
.8	Other specified places
.9	Other places not specified
Recommended codes but optional – activity code W65-Y21 (after fourth division)	
.0	While engaged in sports activity
.1	While engaged in leisure activity
.2	While working for income
.3	While engaged in other types of work
.4	While resting, sleeping, eating, or engaging in other vital activities
.8	While engaged in other specified activities
.9	During unspecified activity

unintentional drowning in developed countries are probably underestimated by 35 % [3]. This lack of information contributes largely to a deficient knowledge on drowning epidemiology. For clinical use, these codings are helpful for a uniform registration of location and etiology (Chap. 10).

105.3 Registration Systems

Based on the need for a more uniform reporting of data to study drowning incidents, the Utstein Style for Drowning (USFD) guidelines have been established in 2002. These guidelines allow consistency in nomenclature and reporting data. The recommendations improve the clarity of scientific communication and the comparability of scientific investigations [4]. A few studies have shown that most variables are relevant and useful for clinical drowning research [5, 6] (Chap. 115).

105.4 Classification Systems

Classification systems can be used for clinical decision making, such as referral, triage, treatment, and prognosis. Classification systems are also useful for data collection, analysis, and reporting of clinical studies.

One of the earlier (1950–1970) classifications was by type of water: seawater or freshwater. Treatment in these early days was frequently aimed at electrolyte evaluation. While electrolyte changes occur when massive quantities of either seawater or freshwater are aspirated, those surviving the drowning episode rarely aspirate such amounts of water and, therefore, do not develop serum electrolyte changes requiring specific therapy [7, 8].

In later studies, it was demonstrated that the primary pathophysiology created by aspiration of either seawater or freshwater is hypoxia secondary to an increase in intrapulmonary shunt [9, 10, 11]. In the subsequently developed classification systems for drowning, the magnitude of the hypoxia, as related to the severity of the pulmonary lesion, has been emphasized [7, 8].

105.5 Clinical Classification Systems Available and Their Utility

105.5.1 Respiratory and Cardiovascular Classification System

In 1979, Simcock reported a classification that resulted from a 5-year study of drowning incidents in Cornwall, UK [7]. Victims were classified into four groups once they arrived at the hospital: Group 1, those with no apparent aspiration; Group 2, those with evidence of aspiration of water but adequate ventilation; Group 3, those with inadequate ventilation; and Group 4, those with no ventilation or cardiac output. Intact survival was excellent in those who did not suffer cardiac arrest. Even those in the cardiac arrest group who were given rapid, aggressive intensive therapy produced encouraging results. Water temperature was important in determining outcome. In 2002, Simcock reported the same findings after an extended study period that included 407 drowning incidents between 1974 and 2000 [12]. All survivors in Groups 1, 2, and 3 were cerebrally normal. Those suffering cardiopulmonary arrest, Group 4, had a 25 % survival rate, but 3 of the 14 survivors were neurologically impaired.

Szpilman developed a classification with six grades of severity with treatment recommendations for each grade (Table 105.3). The classification was developed in Rio de Janeiro (Brazil) in 1972, updated in 1997 [8] and revalidated in 2001 by a 10-year study with 46,080 rescues of which 930 (2 %) needed medical attention [13]. The classification provides a useful framework for the pre-hospital situation and allows lifeguards and medical staff to speak the same language regarding the severity of drowning cases. The classification encompasses recommendation for treatment and estimates the likelihood of death. One of the most difficult medical decisions for lifeguards, ambulance personnel, and doctors is how to treat a drowning victim. Cardiopulmonary or isolated respiratory arrest comprises approximately 0.5 % of all rescues done by lifeguards. The classification is supportive when questions arise in the other 99.5 % of cases rescued at the beach. Such questions include: should the rescuer observe for some time, administer oxygen, call an ambulance, and transport the person to a hospital? Also hospital physicians may be in doubt as to what is the most appropriate treatment. In addition the classification has proven to allow research concerning treatment and prognosis.

Table 105.3 Severity drowning classification with treatment*† [8, 13]

Grade (mortality %)	Signs and symptoms (lifeguard terminology)	Pre-hospital treatment
Rescue	Alive with normal pulmonary auscultation (no coughing, foam, difficulty breathing, or cardiac arrest)	Evaluate and release from the accident site without further medical care
1 (0 %)	Cough, without foam in mouth or nose	Rest, warm, and calm the victim; advanced medical attention or oxygen is not required
2 (0.6–1.2 %)	Rales in some pulmonary fields (small amount of foam in mouth or nose)	Five liters per minute of oxygen by nasal cannula; warm and calm the victim; recovery position if unconscious; hospitalization required for 6–48 h; chest x-ray and arterial blood gas
3 (3.6–5.2 %)	Acute pulmonary edema without hypotension or shock (large amount of foam in mouth or nose with palpable radial pulse)	Oxygen 15 l per minute by face mask or endotracheal tube at accident site; recovery position if unconscious; ICU required for 48–96 h. Mechanical ventilation with PEEP or CPAP, F_iO_2 1.0 until arterial blood gases available. Sedation as necessary during 48 h. Restore pH to normal. Chest x-ray, arterial blood gas, electrolytes, urea, creatinine, glucose, urinalysis. If any abnormal level of consciousness, axial cranial tomography
4 (19.4–22 %)	Acute pulmonary edema with hypotension or shock (large amount of foam in mouth or nose, without palpable radial pulse, but carotid pulse present)	Careful monitoring of breathing. Treatment for grade 3. Start crystalloid intravenously via peripheral vein (independent of type of water) until restoration of normal blood pressure. Inotropic or vasopressor drugs rarely needed
5 (31–44 %)	Isolated respiratory arrest	Mouth-to-mouth ventilation immediately at 12–20 breaths per minute with 15 l of O_2 until restoration of normal breathing, then treat as grade 4
6 (88–93 %)	Cardiopulmonary arrest	Start BLS. Insert endotracheal tube as early as possible. Defibrillate if necessary. Obtain venous access to give epinephrine each 3 min. Monitor ECG. After CPR follow grade 3 and 4 support
Dead body	Submersion time over 1 h or obvious physical evidence of death (rigor mortis, putrefaction, or dependent lividity)	Do not start resuscitation

*Based on data from 41,279 rescues.
†Mortality is considered from the accident site until discharge from the hospital. The in-hospital mortality is 15.5 %.

105.5.2 Neurological Classification Systems

Because neurological dysfunction is a major complication after drowning, other classifications have been introduced based on the assessment of the central nervous system. Modell and Conn in 1980 published a classification based on the degree of neurological deficit on arrival to a tertiary referral center [14]. The drowning victims were classified into three categories: category A (awake), category B (blunted), and category C (comatose). Modell used these categories in a retrospective review of 121 cases of drowning [15]. Those in category A survived with normal brain function; in category B, 89 % of adults and 92 % of children survived normally; in category C, 73 % of adults survived with normal brain function, and 44 % of children recovered neurologically intact. Treatment of all these patients was aimed at the cardiopulmonary system. The A-B-C classification was revalidated in two other studies [16, 17].

Conclusion

Classifications are helpful as an instrument for the appropriate therapy and for the standardized reporting of drowning incidents [18]. At the same time, classification systems will guide clinicians and researchers away from archaic, cumbersome, and confusing terms as wet, dry, blue white, active, passive, silent, and near drowning [1].

The current set of definition, codes, registration, and classification systems are most useful for drowning-related clinical research. Classification systems can also facilitate the development of standardized treatment protocols and the comparison of outcomes with different levels of severity of injury. Classifications systems can also be included in studies that evaluate the efficacy of prevention strategies [19].

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