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The role of bystanders during rescue and resuscitation of drowning victims☆

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ABSTRACT

Background: Bystanders make a critical difference in the survival of drowning victims. Little information on their role before arrival of the Emergency Medical Services (EMS) is available in the scientific literature. In a descriptive study, this role is investigated.
Methods and results: We studied 289 rescue reports (1999–2004) available from the Dutch *Maatschappij tot Redding van Drenkelingen* (Society to Rescue People from Drowning), an organisation that, since 1767, acknowledges awards to bystanders who have contributed to the survival of a drowning victim. There were 138 variables retrieved from these reports. The Utstein Style for Drowning (USFD) was used as a guideline. Of the 26 USFD parameters on victim and scene information, 21 were available for analysis. Eight non-USFD parameters, defined by the authors of this research, were available in >60% of the cases. There were 343 victims, rescued by 503 rescuers. 109 victims were resuscitated by bystanders. Of the 18 victims who first received resuscitation from bystanders and then consequently from pre-hospital professionals, 14 survived. Rescues often occurred in dangerous circumstances: multiple victims (n = 90/343), cold or ice-cold water (n = 295/341), deep water (n = 316/334), swimming to the victims (n = 262/376), young age of rescuers (the youngest rescuer was 5 years of age).
Conclusions: Bystander rescue and resuscitation of drowning victims seems to contribute to a positive outcome. Bystanders are prepared to take responsibility to rescue a drowning victim in spite of significant dangers. The USFD is helpful in understanding the role of bystanders in drowning situations, but may need modification to become more instrumental.

1. Introduction

Some recent studies have concluded that drowning victims have a good chance of survival when bystander resuscitation has already been started before the arrival of the emergency medical services (EMS). Outcome is poor if rescue or resuscitation is delayed.[1–7] Unfortunately, little data on what exactly happens during the rescue and resuscitation of drowning victims by bystanders is available. This information is important to provide input in training courses, aimed at the rescue and resuscitation of drowning victims.

Unique sources of data on how bystanders respond to drowning incidents are the rescue reports of the Dutch *Maatschappij tot Redding van Drenkelingen* (Society to Rescue People from Drowning). Since 1767, this organisation has given awards to bystanders who have performed the rescue, and also in many cases the resuscitation, of a drowning victim.[8,9] Each year, several bystanders are rewarded, depending on the actions of the bystanders. These actions vary from heroic and lifesaving actions (in which case a gold, silver, or bronze medal is awarded) to simple assistance (in which case a written certificate is awarded). The archives of the *Maatschappij tot Redding van Drenkelingen* cover more than 240 years and more than 7000 reports.

In 2002, by means of a painstaking multidisciplinary process, international consensus has been reached about the uniform dataset that should be used to register and study drownings: The Utstein Style for Drowning (USFD).[10] The USFD includes sets of parameters related to victim information, scene information, emergency department evaluation and treatment, hospital course, and disposition. Since then, the USFD has been applied in two articles related to out-of-hospital resuscitation and in-hospital cardiopulmonary bypass.[1,5]

In this study, USFD parameters related to victim and scene information (Tables 1 and 2), as well as other potentially relevant parameters to study the involvement of bystanders, have been retrieved from 289 consecutive rescue reports of the *Maatschappij tot Redding van Drenkelingen* on accidental drowning cases in the period 1999–2004. At the same time, the feasibility of the USFD parameters was tested.

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Table 1
USFD parameters on victim information: availability and results (n = 343 drowning victims).

	USFD parameters	Number of data available/data not available (% available)	Results (% based on number available)
Core	Victim identifier	343/0 (100%)	Unique code for every victim
	Victim gender	326/17 (95%)	Male = 213/326 (65%) Female = 113/326 (35%)
	Victim age	296/47 (86%)	See Fig. 2
	Incident date	292/51 (85%)	June–August (summer) = 101/292 (35%) September–November (fall) = 60/292 (21%) December–February (winter) = 59/292 (20%) March–May (spring) = 72/292 (25%)
	Time of day of incident	236/107 (69%)	12 AM–8 PM = 158/236 (67%) 9 PM–11 AM = 78/236 (33%)
	Precipitating event	166/177 (48%)	Motor vehicle accident = 132/166 (80%) Boating accident = 25/166 (15%) Alcohol intoxication = 15/166 (9%) Drug use = 2/166 (1%)
Supplemental	Race or ethnic category[a]	90/253 (26%)	Netherlands = 72/90 (80%) Other European = 6/90 (7%) Non-European = 12/90 (13%)
	Residence	333/10 (97%)	No useful information
	Pre-existing illness	10/333 (3%)	Epilepsy = 5/10 (50%) Cardiac problems = 4/10 (40%) Diabetes = 1/10 (10%)

[a] USFD parameter by proxy.

Table 2
USFD parameters on scene information: availability and results (n = 343 drowning victims).

	USFD parameters	Number of data available/data not available (% available)	Results (% based on number available)
Core	Event witnessed	262/81 (76%)	Yes = 135/262 (52%) No = 127/262 (49%)
	Body of water	290/53 (85%)	Public open water = 233/290 (80%)[a] Public swimming pool = 46/290 (16%) Salt water beach = 4/290 (1%) Private property = 7/290 (2%)
	Loss of consciousness	287/56 (84%)	Yes = 114/287 (40%) No = 173/287 (60%)
	Pre-EMS resuscitation	273/70 (80%)	Yes = 109/273 (40%) No = 160/273 (59%) EMS-only = 4/273 (2%)
	EMS called[b]	306/37 (89%)	Yes = 254/306 (83%) No = 52/306 (17%)
	Initial vital signs assessed by EMS	1/342 (0.3%)	Not available
	Time of first EMS resuscitation attempt	0/343 (0%)	Not available
	Neurological status[b]	250/93 (73%)	Unconscious = 41/250 (16%) Conscious = 209/250 (84%)
Supplemental	Type of water/liquid	343/343 (100%)	Fresh water = 326/343 (95%) Salt water = 17/343 (5%)
	Water temperature[b]	341/2 (99%)	Warm = 46/341 (14%) Cold = 285/341 (84%) Ice-cold = 10/341 (3%)
	Time of submersion	49/294 (14%)	0–5 min = 46/49 (94%) 6–10 min = 3/49 (6%)
	Time of removal of victim from water	84/259 (25%)	0–5 min = 66/84 (79%) 6–10 min = 8/84 (10%) 11–15 min = 2/84 (2%) 16 min or more = 8/84 (10%)
	EMS vehicle dispatched	300/43 (88%)	EMS = 219/300 (73%)[c] Other rescue teams = 31/300 (10%)[d] No assistance available = 50/300 (17%)
	Time of first EMS assessment	0/343 (0%)	Not available
	Cyanosis (yes/no)	0/343 (0%)	Not available
	Method of CPR	70/43 (62%)[e]	According to guidelines = 59/70 (84%) Not according to guidelines = 7/70 (10%) EMS-only = 4/70 (6%)
	Pupillary reaction, temperature, blood pressure, oxygen saturation	4/339 (1%)	Not available

[a] Public open water: canals, ditches, lakes.
[b] USFD parameter by proxy.
[c] EMS: mobile medical team or ambulance.
[d] Other rescue teams: police, fire-fighters, lifeboat crew or beach-lifeguards, but no EMS.
[e] Percentage of the 113 victims who received resuscitation.

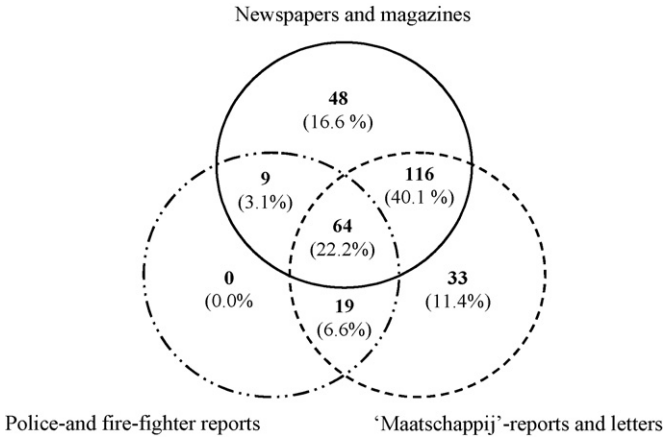

Fig. 1. Data sources of the 'Maatschappij' reward scheme ($n = 289$).

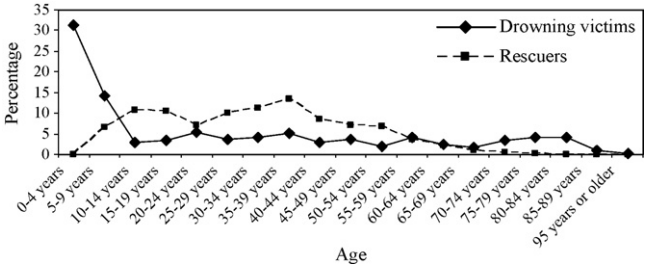

Fig. 2. Drowning victims ($n = 296$) and rescuers ($n = 350$) 1999–2004; per age group. Mean age victims: 23 years (minimum 1 month; maximum 96 years); mean age rescuers: 22 years (minimum 5 years; maximum 76 years).

2. Methods

The information in the rescue reports of the *Maatschappij tot Redding van Drenkelingen* is based on the three data sources that are used for the decision to reward a rescuer: registration forms of the *Maatschappij tot Redding van Drenkelingen*, formal police or fire-fighter reports, and newspapers and magazines. The registration forms of the *Maatschappij tot Redding van Drenkelingen* consist of 13 questions with the objective to determine the category of reward in accordance with formal criteria. The other data sources have no fixed information structure and are used by the *Maatschappij tot Redding van Drenkelingen* as complementary information (Fig. 1). For the *Maatschappij tot Redding van Drenkelingen*, a successful rescue means that the victim has been taken out of the water successfully and that, when needed, resuscitation was initiated. Outcome parameters such as restoration of spontaneous circulation or discharge form hospital are often not mentioned in the rescue reports. The actual survival of a drowning victim is not a criterion for considering a reward, but rather the willingness to take action (Fig. 2).

All rescue reports related to submersion or immersion are included, regardless of whether an award has been handed out or not. Only the 26 USFD parameters on victim information and scene information are recorded, based on the USFD definitions.[10] During the collection of data, it appeared that five USFD parameters were not available. A parameter by proxy has been defined for four USFD parameters. 'Race or ethnic category' was not described but information on 'country of birth' was available as a parameter by proxy. We have used '112 called' as a parameter by proxy for 'EMS called'. In the Netherlands the national emergency telephone number 112 is called. The 112 dispatch centre then decides upon whether to send police, fire-fighters, EMS, combinations thereof, or others. Because 'water temperature' was described in only three victims, 'categories of water temperature' has been defined as a parameter by proxy: warm (when drowning occurred in a swimming pool), cold (when drowning occurred outdoors) and ice-cold (when drowning occurred after the victim fell through ice or fell into water with ice in or on it). No information, based on a neurological scoring system as required by the USFD, was available. As a parameter by proxy, the neurological status is defined as conscious or not conscious[10] (Tables 1 and 2). Resuscitation has not been

Table 3
Non-USFD parameters that were available in more than 60% of the reports: availability and results.

	Non-USFD parameters	Number of data available/data not available (% available)	Results (% based on number available)
Victim information ($n = 343$)	Submersion or immersion[a]	221/122 (64%)	Submersion = 205/221 (93%) Immersion only = 16/221 (7%)
	Estimated water depth[b]	334/9 (97%)	More than 1 m deep = 316/334 (95%) 1 m or less = 18/334 (5%)
Rescuer information ($n = 503$)	Rescuer identifier[c]	503/0 (100%)	Unique code for every rescuer
	Gender of rescuer[d]	463/40 (92%)	Male = 356/463 (77%) Female = 107/463 (23%)
	Age of rescuer[e]	350/153 (70%)	Fig. 2
	Country of residency of rescuer[f]	455/48 (91%)	Netherlands 453/455 (99.6%) Other European countries = 2/455 (0.4%)
	Number of rescuers[g]	503/0 (100%)	Single rescuer = 162/503 (32%) More than one rescuer = 341/503 (68%)
	Rescue technique[h]	376/127 (75%)	Grabbing body or clothes = 82/376 (22%) Walk in water = 12/376 (3%) Swimming = 262/376 (70%) Other techniques = 20/376 (5%)

[a] Submersion/immersion: a drowning victim is submerged when the face is below the water surface at any time during the incident. A drowning victim is immersed when the victim's body is in the water but the face is not below the water surface at any time during the incident.
[b] Estimated water depth: an estimation of the depth of the liquid in which the victim drowned.
[c] Rescuer identifier: a specific code to identify each rescuer.
[d] Gender of rescuer: male or female.
[e] Age of rescuer: the age category of a rescuer.
[f] Country of residence of rescuer: the country in which a rescuer has a formal residency on the day of the rescue.
[g] Number of rescuers: the number of rescuers involved in a rescue.
[h] Rescue technique: the technique used to rescue a drowning victim from the water.

defined in the original USFD article.[10] We recorded a resuscitation when resuscitation was mentioned verbatim in the rescue reports, or when the description of bystander activities clearly revealed the intention to revive a drowning victim.

Another 112 non-USFD parameters considered to be potentially relevant for the study objectives have been selected and defined, based on literature, expert knowledge and discussion between the authors.[11–13]

When data were not mentioned verbatim in the data sources, but could be estimated by logical reasoning, estimated data were included. For example: a victim who had received assistance to get out of the water and who then walked home was not considered to have received resuscitation.

In a study protocol also used for this manuscript it was *a priori* and arbitrarily decided that all USFD parameters, or USFD parameters by proxy, on victim information and scene information would be analysed. Of the non-USFD parameters, only those that were available in more than 60% of the reports would be analysed. As a consequence, eight of the 112 non-USFD parameters have been included in the analysis (Table 3).

All available variables were retrieved from the original three data sources used for the reports and included in SPSS version 13.0. The study is descriptive and no statistical analysis has been used.

3. Results

Between 1999 and 2004, during 289 rescue events (minimum per year 29, maximum 63, mean 48), 343 drowning victims were rescued by 503 bystanders: 253 victims (73.8%) were alone (single victim rescues), another 90 victims (26.2%) were together with one or more others (multiple victim rescues).

The availability and data of the USFD parameters, and USFD parameters by proxy, on victim and scene information are summarised in Tables 1 and 2. Table 3 shows the non-USFD parameters, including their definitions. Some additional data are described below.

Precipitating event. Of the 132 motor vehicle accidents, 18 were with a vehicle for the disabled (electric wheelchair, scoot mobile). Alcohol intoxication was described in 15 victims, of which three were involved in a motor vehicle accident and four in a boating accident. Recreational drug use was described in two victims, of which one was involved in a motor vehicle accident.

Residence. The residences of the victims were widely scattered over the country. Information on residence provided no useful information and no pattern or relationship with water surface or population density could be identified.[14]

Loss of consciousness. When removed from the water, 114 victims were unconscious and 173 were conscious.

Neurological status. After bystander rescue and resuscitation attempts, 41 victims were unconscious and 209 victims were conscious upon arrival of the EMS.

Method of CPR. Once the drowning victims were ashore, resuscitation was started in 113 victims. Four victims received immediate EMS resuscitation after being brought ashore. When removed from the water, 109 victims received bystander resuscitation. Of these, 59 victims received bystander resuscitation according to

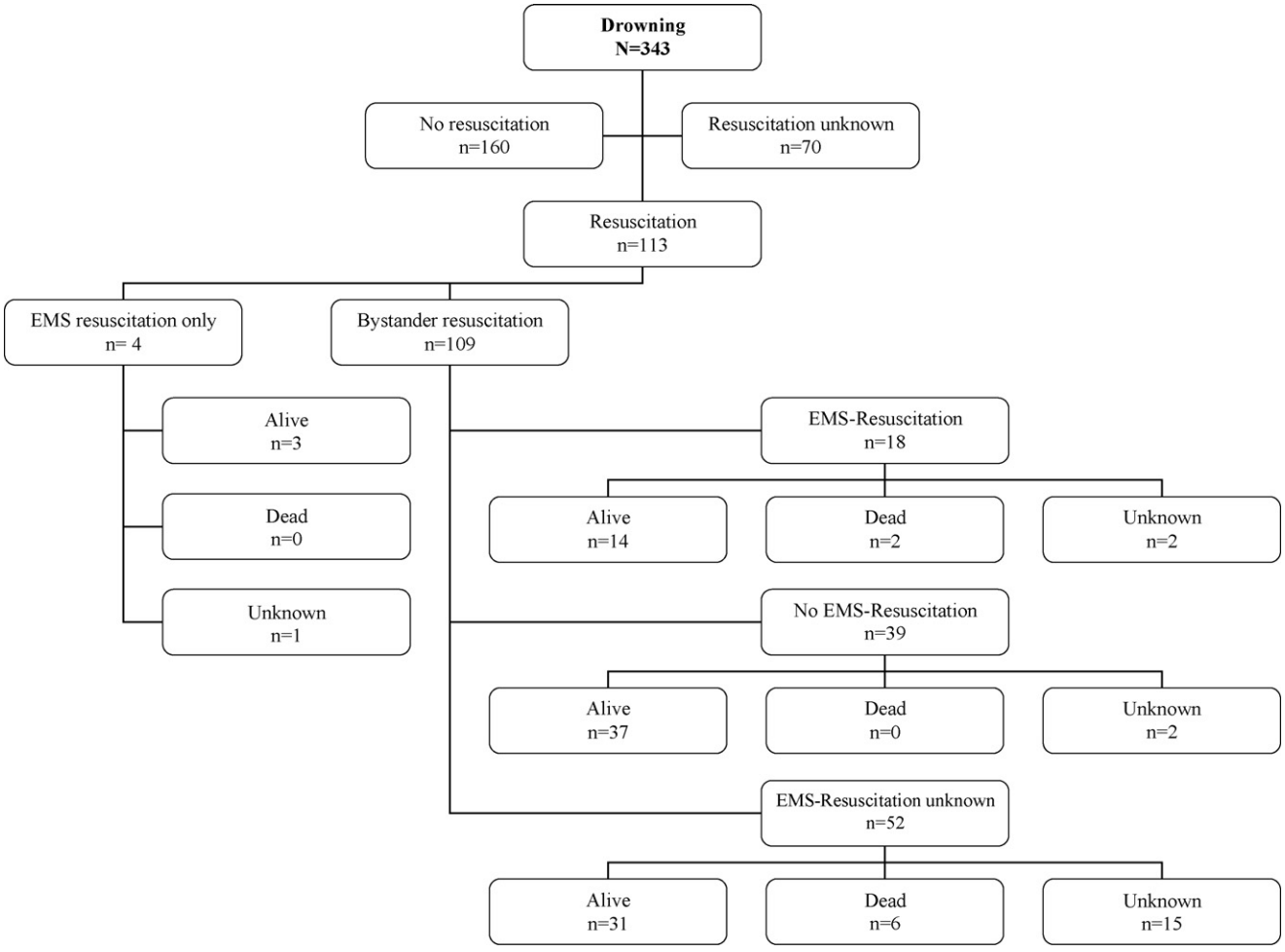

Fig. 3. Outcome of bystander resuscitation and EMS resuscitation in drowning victims. In four victims resuscitation was immediately started by EMS after the victim was brought ashore.

the current guidelines.[15–17] Seven victims received unconventional resuscitation: tapped on the back ($n = 2$, one was rubbed on the abdomen as well); water pressed out of the lungs ($n = 2$); Heimlich manoeuvre ($n = 1$); thorax and abdominal compressions ($n = 1$); and lateral position to drain water from the mouth ($n = 1$). No information on the resuscitation technique was available in 43 victims (Fig. 3).

4. Discussion

The behaviour of bystanders is seen as one of the most important factors in the survival of drowning.[1–7,10,17–19] As far as we know, this is the first study based on a large population, that points out how bystanders deal with the rescue and resuscitation of drowning victims before the arrival of the EMS.

Analysis of our data provided descriptive data on scenes and participants in drowning situations. Some of the data also show that bystanders, when confronted with a life threatening or potentially life threatening drowning situation, have often acted just in time, adequately and successfully regarding rescue and resuscitation. The drowning was witnessed in 135 victims, which allowed a fast response. In 50 victims the EMS system was not involved and bystanders were the sole providers of first aid. While 114 victims were unconscious when removed from the water, 41 victims were unconscious upon arrival of the EMS. Of the 39 victims resuscitated without additional EMS resuscitation, 37 survived. Of 18 victims who received bystander resuscitation and EMS resuscitation, 14 survived. This success rate is high compared to primary cardiac arrest in the Netherlands.[20]

A fast rescue, to take the person away from the life threatening situation, and fast resuscitation, to restore oxygen supply and circulation, are essential in order to survive a drowning incident. The small time-window of success for these actions puts bystanders in a key position.[1–7,10,17–19] It should, however, be realised that it is often unclear whether the drowning victim who has received bystander resuscitation has indeed been in circulatory arrest.[4,6,21] The mechanism of dying in drowning is based on progressive hypoxia, sometimes in combination with acute hypothermia. This is different from a cardiac arrest due to cardiac origins. Asystole, pulseless electrical activity, idioventricular bradycardia and low cardiac output are common, while ventricular fibrillation is rare.[1,2,5,22–24] When the heart stops beating, oxygen content in the blood and lungs is low. The diagnosis of a 'real' circulatory arrest in a drowning victim can be extremely difficult. Mouth-to-mouth ventilation has a prominent role during resuscitation in drowning to treat hypoxia and can be extremely difficult due to aspiration and pulmonary oedema.[25,26] Our study did not include objective data on the correct indication of bystander resuscitation, or whether resuscitation had been adequate and effective.[15–17]

This study shows that when bystanders perform a rescue, this is often in unsafe circumstances: 90 victims were in the water with at least one additional victim; 295 victims were in cold or ice-cold water; 244 victims were in natural bodies of water with poor or no underwater visibility; 316 victims were in water more than 1 m deep; 262 rescuers had to rescue a victim by swimming and 162 rescuers had to perform the rescue on their own. Traffic accidents were involved in 132 rescues. Such rescue efforts can be expected to involve significant dangers because, for example, the victims may have had to be rescued from cars that were upside down, in the process of submerging under water, or victims were trapped under or in their vehicles. Because many roads in the Netherlands are next to water, the incidence of drowning due to traffic incidents is high compared to international data.[13,27,28]

The rescue of drowning victims is notoriously dangerous with a serious potential for injury or death.[29–31] Our findings show that many bystanders in the Netherlands are prepared to put their own lives at risk. This is in contrast to publications which describe that the majority of bystanders have a fear of providing mouth-to-mouth ventilation to strangers.[32,33] The reason for this paradox in altruistic response involving drowning needs further study, especially in other countries and environments. Maybe the fact that the Netherlands has a strong water related culture and that about 93% of children in the Netherlands learn to swim plays a role.[34] The water culture may also explain why the rescuers were of all ages and included very young and very aged rescuers. Furthermore, most of the drownings occurred in waters with little to no currents, which may be very different from situations in other countries.

A limitation of the study is that the database of the *Maatschappij tot Redding van Drenkelingen* consists of rescue reports and was not set up for research purposes. All reports relate to immersion and submersion. Respiratory impairment, as included in the definition of drowning, did not occur in each event.[10,35] The database includes non-structural, non-consistent and biased data and not all data on all USFD parameters were available.[36,37] Also, not all rescue reports included the final outcome. For this reason, we were unable to calculate the outcome of all successful rescues. The study also does not include all rescues in the Netherlands, but only the portion of rescues of which the *Maatschappij tot Redding van Drenkelingen* has been notified. The variety of the rescues ranges from simple assistance to a life threatening situation for both victim and rescuer. Due to the purpose of the dataset, the rescue cases in this study will have a tendency to be skewed to the more severe cases. Our data about risk-groups[13,27,38,39] and months,[13] however, correspond with previous reports on the epidemiology of drowning.

This is the first study in a large cohort of drowning victims that has tried to use the 26 USFD parameters for victim information and scene information. Our study confirms the concerns expressed in the original article on the USFD, that supplemental data are more difficult to collect than core data.[10] Some core data proved to be difficult to collect as well (Tables 1 and 2). We could not study five USFD parameters (initial vital signs assessed by EMS, time of first EMS resuscitation attempt, time of first EMS assessment, cyanosis, and data on pupillary reaction, temperature, blood pressure and oxygen saturation) and had to define four parameters by proxy (race or ethnic category, EMS called, neurological status, water temperature). Some of these data may have been available when EMS and hospital data had been included. The USFD parameter residence did not provide relevant information and we did not find any relationship between residence, population density and water exposure.[27] This parameter may not work in the Netherlands, which is a small country where water is ubiquitous. This parameter may, however, be useful in regions where water culture and water exposure is not so normal. Country of birth as parameter by proxy for the USFD parameter race or ethnic category should be considered. The data are available and allow the evaluation of water adaptation of subsequent generations of immigrant groups.[38]

The experiences with the use of the USFD in this study enhance research methodology in drowning. Based on this study, changing some of the current parameters on victim and scene should be considered. In addition, including rescue parameters in the USFD should also be considered. Considering the dangerous circumstances, we suggest including rescue related injuries. At this stage, we are reluctant to advise changes in the current set of parameters and would rather wait for a new consensus process to improve the USFD.

Finally, the rescue reports of the *Maatschappij tot Redding van Drenkelingen* to reward bystanders appears to be an incomplete, but still unique, source for studying the role of bystanders during the rescue and resuscitation of drowning victims. We were able to

study eight non-USFD parameters related to the rescue and resuscitation of drowning victims. A more structured data collection in the rescue reports may allow more conclusive research.

5. Conclusions

This is the first study in a large cohort of drowning victims that uses USFD parameters to study the behaviour of bystanders in the rescue and resuscitation of drowning victims, before the arrival of the EMS. Our data suggest that bystander rescue and resuscitation play a critical role in the survival of drowning. The interventions of bystanders occur in dangerous situations. Adaptation and expansion of the current USFD parameters should be considered.

Conflict of interest statement

Joost Bierens is an honorary advisory consultant of the *Maatschappij tot Redding van Drenkelingen* (Society to Rescue People from Drowning). The *Maatschappij tot Redding van Drenkelingen* (Society to Rescue People from Drowning) provided partial funding (travel expenses, software) for Allart Venema. This had no influence on the contents of the manuscript in any way. This research was not otherwise funded.

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