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Addressing gaps in our understanding of the drowning patient: a protocol for the retrospective development of an Utstein style database and multicentre collaboration

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ABSTRACT

Introduction This retrospective observational study aims to create a comprehensive database of the circumstances of drowning (including care provided and outcomes of care) to report against the Utstein style for drowning (USFD) for patients presenting to the emergency department (ED). Four areas will be examined: a feasibility study of the USFD; a comparison of classification and prognostication systems; examination of indications and efficacy of different ventilation strategies; and differences in the circumstances, severity, treatment and outcomes of drowning by sex and gender.

Methods and analysis This protocol outlines retrospective data collection for all patients presenting to EDs of the Sunshine Coast Hospital and Health Service in Queensland, Australia with the presenting problem or discharge diagnosis of drowning or immersion between 2015 and 2022. Patients computerised health records (emergency medical service record, pathology, radiology results, medical and nursing notes for ED, inpatient units and intensive care units) will be used to extract data for entry into an USFD database. Descriptive (eg, median, IQR) and inferential statistical analyses (eg, analysis of variance) will be used to answer the separate research questions. Development of an International Drowning Registry using the USFD dataset and the Research Electronic Data Capture (REDCap) web application is discussed.

Ethics and dissemination This study has been approved by Metro North Human Research and Ethics Committee (Project No: 49754) and James Cook University Human Research Ethics Committee (H8014). It has been endorsed by national drowning prevention organisations Royal Life Saving Society Australia (RLSSA) and Surf Life Saving Australia (SLSA). Study findings will provide data to better inform clinical management of drowning patients and provide an evidence base on sex and gender differences in drowning. Results will be disseminated through peer review publications, conference presentations and media releases. Results will also be disseminated through RLSSA and SLSA membership of the Australian and New Zealand Resuscitation Council and the Australian Water Safety Council.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study is the first to use the Utstein style for drowning in such a comprehensive manner.
⇒ The methodology is simple and easily reproduced in other centres.
⇒ This is an initial, single-centre (Sunshine Coast Hospital and Health Service) study only.

INTRODUCTION

Drowning is a leading cause of non-intentional traumatic death around the world.[1] Approximately 300 000 preventable deaths occur due to drowning each year.[1] In Australia, on average 283 people die from unintentional drowning annually.[2] Although understanding of the causes of fatal drowning is improving, there remain many knowledge gaps regarding hospital and pre-hospital treatments for drowning. These include the indications for, and efficacy of, different ventilation strategies, and drowning classification and prognostication systems, as well as a lack of information regarding female drowning.

The USFD

A uniform dataset for the purposes of ensuring consistency in the reporting of drowning-related studies, the Utstein style for drowning (USFD), was published in 2003[3] and updated in 2015.[4] However, its uptake in drowning-related studies has been limited, with just over one published article a year reporting its use.[5] Possible explanations for this include the large number (76) of variables included in the USFD, outlined in table 1. There are 49 core variables and 27 supplementary variables (4).

The USFD was designed to include variables readily available in the healthcare

Table 1 Number of data points in Utstein style for drowning (2015)

Table no	Table name	Core variables	Supplementary Variables
1	Victim information	8	0
2	Scene information	6	3
3	Pre-EMS scene information (lifeguards and first responders with a duty to treat)	2	4
4	Time points	8	0
5	Hospital course (core data)	20	N/A
6	Hospital course (supplementary data)	N/A	11
7	Disposition	4	4
8	Quality of resuscitation	1	5
Total		49	27

EMS, emergency medical service.

systems of high-income countries.[4] However, to collect all the variables there is a requirement to extrapolate data from multiple sources, such as lifeguard services, emergency medical service (EMS), emergency department (ED), inpatient unit (IPU) and intensive care unit (ICU) patient documentation, as well as radiology and pathology reporting systems. Articles using the USFD have reported against different variables, with some variables such oxygen haemoglobin saturation, presence of cyanosis and time of victim rescue being rarely used.[5] Although the USFD has been revised to more accurately reflect the data that can be collected, to date no study has investigated whether the lack of use of variables is due to investigator choice or unavailability of the data. We intend to investigate and report on the availability of USFD variables in the healthcare system in Queensland, Australia.

Drowning classification and prognostication systems

A frequently used drowning classification system is based on the initial examination at the scene by medical first responders.[6] This system was derived from data on 1831 drowning cases over a 20-year period (1972–1991) in Brazil. In the 20 plus years since publication there has only been one external validation study of the drowning classification and prognostication systems published.[7] Other classification systems for drowning have been described but are not commonly used, such as the system proposed by Simcock[8] and later modified by van Berkel *et al*.[9] The Simcock/van Berkel system was based on the absence or presence of signs of inhalation of water and the adequacy or otherwise of the patients' ventilation[8] and then modified with the addition of blood gas analysis and chest X-ray results.[9] Modell *et al* described a classification system based on conscious state, Grade A awake, Grade B blunted and Grade C comatose.[10] All of the classification systems show rising mortality with increasing severity of the grading.[6–10]

The ED is unique among hospital units in that it sees patients with every condition and of every severity. The Rapid Emergency Medicine Score (REMS) utilises age and physiological variables such as blood pressure, heart rate and respiratory rate to predict in-hospital mortality.[11] REMS has been validated in medical[12] and patients with trauma,[13] but it has not previously been validated in drowning.

Along with the prognostication systems, there have been several attempts at validating criteria for safe early discharge following presentation to hospital after drowning, principally in children.[14–17] Shenoi *et al*, describes the Pediatric Submersion Score, which they report as performing well (area under the receiver operating characteristic=0.81) in predicting safe discharge 8 hours after ED presentation.[16] Cantu *et al* reports the ORs of various clinical criteria, with a normal oxygen saturation and a lack of field interventions independently predicting safe discharge.[15] The studies by Brennan and Causey report on clinical variables, such as a normal chest examination and normal oxygen saturation, associated with discharge versus admission of patients.[14 17] Unfortunately, none of these systems have been externally validated or undergone direct comparison.

Indications and efficacy of different ventilation systems

The best ventilatory strategies for the treatment of drowning patients is another example of a knowledge gap. Aspiration of water into the lung damages surfactant, disrupts the alveolar capillary membrane and leads to the development of alveolar oedema.[18] These effects result in the development of a local acute respiratory distress syndrome (ARDS)-like syndrome.[18] Current recommendations for drowning are to follow ARDS treatment guidelines,[19 20] based on observed similarities between the lung injury of drowning and ARDS.[18]

There are four substantial case series that describe the use of non-invasive ventilation (NIV) from drowning.[21–24] When compared with mechanical ventilation (MV), treatment with NIV resulted in a similar rate of improvement in oxygenation after the first 6 hours, but one difference was that clinicians tended to use MV in patients who were unconscious and NIV in more awake patients.[23] There is a single paper reporting the use of high flow nasal prongs as a treatment for 57 patients with moderate ARDS from drowning.[25] There was a reported failure rate (conversion to MV) of 12 (21%)/57 with this method. Two patients had poor outcomes (death/poor neurological recovery) and two patients required extracorporeal life support for respiratory failure refractory to MV.[25] Given the fundamental nature of the lung injury in drowning patients, the shortage of evidence regarding best practice for providing ventilatory support beyond supplemental oxygenation remains a priority.[26]

Sex and gender differences in drowning

Sex and gender differences in drowning burden and treatment represents another knowledge gap. Drowning is a significant global issue with males at particular risk.[1] Globally, a third of drowning deaths are female, which equates to approximately 100 000 female deaths a year.[1] However, in a recent literature review, of the 86 articles examining the epidemiology, risk factors, clinical treatment and outcomes for adult drowning patients in Australia, New Zealand, USA, UK and Canada, only 14 (16.2%) were found that reported results for females,[27] an exemplar of the sex and gender data gap in drowning.[28] Two studies have identified an increased survival rate among females compared with males in treatment outcomes after hospital admission for drowning,[29 30] with the survival: non-survival ratio 4:1 for females compared with 2:1 for males in Australia.[30] The reasons for the different survival rates are unclear, necessitating further investigation as proposed in this protocol.

METHODS

This is a retrospective, multisource, chart review of all drowning presentations to the Sunshine Coast Hospital and Health Service (SCHHS) EDs through to hospital discharge between 1 January 2015 and 31 December 2022.

Research Questions

This study aims to answer several research questions, the primary question being: What are the treatment modalities used, and effectiveness thereof, in the ED treatment of drowning patients?

Secondary aims are to:

1. Investigate the feasibility of an USFD database in a high-income setting.
2. Compare the described classification systems for drowning patients in an Australian population.
3. Compare and contrast the use and efficacy of MV with NIV and high-flow nasal prongs as treatment for the lung injury of drowning.
4. Examine sex and gender differences in the treatment provided and response to treatment in drowning patients.

Setting

This initial study will take place at the SCHHS. The Sunshine Coast has many popular surf beaches and inland waterways and is located approximately 100 km north of Brisbane in Queensland, Australia. The area has a population of 384 281[31] and receives over 8 million visitor nights booked annually.[32] The two hospitals within SCHHS contributing data to this project are Nambour General Hospital and Sunshine Coast University Hospital. In 2021 there were 150 000 patients treated in the two EDs.

Data Sources

All participants will be identified by attending the ED with a recorded presenting complaint or ED discharge diagnosis involving the risk of drowning or diagnosed drowning. This will include the words drowning, near drowning or immersion, lists of aquatic activity (swimming surfing/body surfing, etc), mention of a body of water (pool, beach, river, bath, etc), a visit reason coded for immersion or diagnostic codes related to drowning. This two-pronged approach will limit missed cases. While the term near-drowning is no longer an accepted terminology,[33] it remains commonly used in health system coding and will be included as a search term to identify drowning patients.

The EMS record, pathology and radiology results and medical and nursing notes for the ED, IPU and ICU will be examined and data entered into the electronic database. A deidentified copy of the database will be held at James Cook University and we will utilise Research Electronic Data Capture (REDCap)[34] technology to enable collaboration with other centres. The case report form developed is included in online supplemental appendix 1.

We propose using the REDCap secure web application to create the International Drowning Registry (IDR). The IDR will facilitate multicentre and multinational sharing of drowning data, using the USFD as a minimum dataset. Contributing members of the IDR will have equal access to the research data gathered. The IDR database will be administered through James Cook University in Townsville, Queensland, Australia.

Statistical Aanalysis

It is expected that this database will initially include data between 400 and 500 drowning presentations from this study. Descriptive data will be presented as mean and SD if normally distributed and medians, and IQRs if not normally distributed. Comparison of means in three or more groups will be conducted using analysis of variance (ANOVA). For example, we will use ANOVA to determine if there are differences in mode of ventilation by age, sex and gender, duration of submersion, EMS response time, type of water, initial arterial oxygen saturation (SaO_2), Glasgow Coma Scale (GCS), crepitations in the lungs and severity grade.[6 8–10]

Categorical outcomes will be analysed using regression. For example, does age, sex and gender, type of water, occurrence of out of hospital cardiac arrest and mode of ventilation influence the development of ARDS? Other examples would include (but not limited to) factors influencing mortality where duration of immersion, type of water, time to first cardiopulmonary resuscitation, EMS response time, witnessed drowning, serum lactate, initial GCS would be included as independent variables in the logistic regression analysis.

Continuous outcomes will be analysed using multiple regression. For example, we will use multiple regression to examine the impact of age, sex and gender, duration of submersion, EMS response time, mode of ventilation, initial vital signs, severity grade,[6 8–10] type of water (salt vs fresh) on hospital length of stay. The

ability of the various grading systems, REMS and paediatric submersion score to predict in hospital mortality will be calculated using ORs (with 95% CIs). Comparison of the different scoring systems will be achieved by comparing the area under the curves of the receiver operating characteristic.

Ethics and Dissemination

Ethics approval has been obtained from Metro North Human Research and Ethics Committee (Project 49754) and James Cook University Human Research Ethics Committee (H8014). Patient consent was not sought for this study given it is a retrospective study and will not interfere with clinical practice. Patient data collected as part of normal care will be analysed. Reidentifiable data will be kept on Queensland Health servers. The privacy requirements of the (Queensland, Australia) Public Health Act 2005 have been met and approval obtained.

Study findings will provide data to better inform initial hospital management of drowning patients, investigate sex and gender differences in drowning (with a focus on females), and improve the evidence base on drowning-related CSI. Results will be disseminated through peer review publications, presentation at academic conferences and through media releases to inform the general public. Results will also be disseminated through Royal Life Saving Society Australia (RLSSA) and Surf Life Saving Australia (SLSA) membership of the Australian Resuscitation Council and the Australian Water Safety Council. As this study is single centre, we will be actively seeking the participation of other sites, domestically and internationally, with the aim of informing practice on a broader scale.

Patient and public involvement

Patient involvement has not been sought due to the retrospective nature of this study. We have consulted with two national community-based drowning prevention organisations, RLSSA and SLSA. Both these organisations which partner with the Australian Government in reducing drowning deaths are members of the Australian Water Safety Council and developed and implement the Australian Water Safety Strategy. Both RLSSA and SLSA have endorsed this project and are committed to incorporating relevant results in national drowning prevention strategies.

DISCUSSION

Drowning is a global public health issue, including in Australia.[2 35] As research on the topic of drowning increases, particularly epidemiological research, there remain important clinical gaps in knowledge that this study will aim to address.

This is the first study to utilise the USFD[4] in creating a database of drowning presentations to the ED through to hospital discharge. We hope the publication of this protocol, case report form and data dictionary will encourage collaboration with other interested centres. We hope to establish and report the feasibility of using an USFD-based database in high-income countries in a project with research grant funding. Our findings will hopefully allow a revision of the processes and data required to establish a comprehensive picture of the circumstances and treatment of drowning patients. This we hope will improve outcomes and inform future research. Multicentre collaboration through the IDR will allow collaborating centres to use the data to improve the quality of care to drowning patients. While drowning has a significant impact on global morbidity and mortality[1] few centres will see sufficient drowning cases to develop into a centre of excellence. Development of a large multicentre database of drowning patients using the REDCap[34] web application will allow collaborating institutions to benchmark and compare outcomes, as well as providing multicentre data for research projects to better inform all those involved in the prevention of death by drowning.

Consistent classification of drowning patients and a clear relation to outcome is vital to the validity of published research. For 20 years this has been based on the work of Szpilman.[6] Unfortunately there has only been a single external validation of this important paper conducted[24] and the results were disparate. Our study will compare the performance of the classification system described by Szpilman as well as other drowning scores[16 36–38] and a physiological scoring system validated for use in the ED: the REMS.[13]

The study outlined in this protocol will also address sex and gender differences in drowning and will include a focus on the experience of female drowning patients from the circumstances of their drowning to their hospital discharge. Children and adult males are both recognised as being over-represented in drowning mortality figures and the scientific literature has reflected this.[39 40] However, females represent a very similar proportion of drownings to children and the paucity of evidence on female drowning, treatments and outcomes is an inequity that needs to be addressed.[27 28]

CONCLUSIONS

Drowning is a significant cause of preventable injury and death. The study outlined in this protocol will utilise the USFD to develop a database which will be used to answer several important research questions. The development of the Utstein style database will also help to facilitate multisite collaboration, a feature sorely lacking in most drowning research. The findings of this study will improve the evidence informing many aspects of the clinical care of the drowned patient.

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REFERENCES

1 Franklin RC, Peden AE, Hamilton EB, *et al*. The burden of unintentional drowning: global, regional and national estimates of mortality from the global burden of disease 2017 study. *Inj Prev* 2020:1–13.
2 Royal Life Saving Society - Australia. *Royal life saving national drowning report 2020*. Sydney, Australia: Royal Life Saving Society - Australia, 2020..
3 Idris AH, Berg RA, Bierens J, *et al*. Recommended guidelines for uniform reporting of data from drowning: the "Utstein style". *Resuscitation* 2003;59:45–57.
4 Idris AH, Bierens J, Perkins GD. 2015Revised Utstein-style recommended guidelines for uniform reporting of data from drowning-related resuscitation an ILCOR Advisory statement. *Resuscitation* 2017;10:147–58.
5 Venema AM, Absalom AR, Idris AH, *et al*. Review of 14 drowning publications based on the Utstein style for drowning. *Scand J Trauma Resusc Emerg Med* 2018;26:19.
6 Szpilman D. Near-Drowning and drowning classification: a proposal to stratify mortality based on the analysis of 1,831 cases. *Chest* 1997;112:660–5.
7 Markarian T, Loundou A, Heyer V, *et al*. Drowning classification: a reappraisal of clinical presentation and prognosis for severe cases. *Chest* 2020;158:596–602.
8 Simcock AD. Treatment of near drowning--a review of 130 cases. *Anaesthesia* 1986;41:643–8.
9 van Berkel M, Bierens JJ, Lie RL, *et al*. Pulmonary oedema, pneumonia and mortality in submersion victims; a retrospective study in 125 patients. *Intensive Care Med* 1996;22:101–7.
10 Modell JH, Graves SA, Kuck EJ. Near-Drowning: correlation of level of consciousness and survival. *Can Anaesth Soc J* 1980;27:211–5.
11 Olsson T, Lind L. Comparison of the rapid emergency medicine score and APACHE II in nonsurgical emergency department patients. *Acad Emerg Med* 2003;10:1040–8.
12 Olsson T, Terent A, Lind L. Rapid emergency medicine score can predict long-term mortality in nonsurgical emergency department patients. *Acad Emerg Med* 2004;11:1008–13.
13 Imhoff BF, Thompson NJ, Hastings MA, *et al*. Rapid emergency medicine score (REMS) in the trauma population: a retrospective study. *BMJ Open* 2014;4:e004738.
14 Brennan CE, Hong TKF, Wang VJ. Predictors of safe discharge for pediatric drowning patients in the emergency department. *Am J Emerg Med* 2018;36:1619–23.
15 Cantu RM, Pruitt CM, Samuy N, *et al*. Predictors of emergency department discharge following pediatric drowning. *Am J Emerg Med* 2018;36:446–9.
16 Shenoi RP, Allahabadi S, Rubalcava DM, *et al*. The pediatric Submersion score predicts children at low risk for injury following Submersions. *Acad Emerg Med* 2017;24:1491–500.
17 Causey AL, Tilelli JA, Swanson ME. Predicting discharge in uncomplicated near-drowning. *Am J Emerg Med* 2000;18:9–11.
18 Bierens JJLM, Lunetta P, Tipton M, *et al*. Physiology of drowning: a review. *Physiology* 2016;31:147–66.
19 Schmidt AC, Sempsrott JR, Hawkins SC, *et al*. Wilderness medical Society practice guidelines for the prevention and treatment of drowning. *Wilderness Environ Med* 2016;27:236–51.
20 Szpilman D, Bierens JJLM, Handley AJ, *et al*. Drowning. *N Engl J Med* 2012;366:2102–10.
21 Cerland L, Mégarbane B, Kallel H, *et al*. Incidence and consequences of Near-Drowning-Related Pneumonia-A descriptive series from Martinique, French West Indies. *Int J Environ Res Public Health* 2017;14. doi:10.3390/ijerph14111402. [Epub ahead of print: 17 Nov 2017].
22 Dick AE, Potgieter PD. Secondary drowning in the Cape Peninsula. *S Afr Med J* 1982;62:803–6.
23 Michelet P, Bouzana F, Charmensat O, *et al*. Acute respiratory failure after drowning: a retrospective multicenter survey. *Eur J Emerg Med* 2017;24:295–300.
24 Michelet P, Dusart M, Boiron L, *et al*. Drowning in fresh or salt water: respective influence on respiratory function in a matched cohort study. *Eur J Emerg Med* 2019;26:340–4.
25 Kim JH, Sun KH, Park YJ. The utility of non-invasive nasal positive pressure ventilation for acute respiratory distress syndrome in near drowning patients. *Journal of Trauma and Injury* 2019;32:136–42.
26 Groenveld J, Vincent J-L, Questions FRBierens J, ed. *Drowning*. 2nd. Hedielberg: Springer, 2014.
27 Roberts K, Thom O, Devine S, *et al*. A scoping review of female drowning: an underexplored issue in five high-income countries. *BMC Public Health* 2021;21:1072.
28 Richardson K, Peden AE. Another gender data gap: female drowning in Aotearoa, New Zealand. *Inj Prev* 2021;27:535–41.
29 El Sibai R, Bachir R, El Sayed M. Submersion injuries in the United States: patients characteristics and predictors of mortality and morbidity. *Injury* 2018;49:543–8.
30 Mahony A, Barnsley P, Peden AE. *A thirteen year national study of non-fatal drowning in Australia: data challenges, hidden impacts and social costs*. Sydney: Royal Life Saving Society - Australia, 2017.
31 Australian Bureau of Statistics. Sunshine coast: australian bureau of statistics. 2016. Available: https://itt.abs.gov.au/itt/

r.jsp?RegionSummary®ion=316&dataset=ABS_REGIONAL_ASGS2016&geoconcept=ASGS_2016&measure=MEASURE&datasetASGS=ABS_REGIONAL_ASGS2016&datasetLGA=ABS_REGIONAL_LGA2019®ionLGA=LGA_2019®ionASGS=ASGS_20 16
32 Tourism Research Australia. Tourism region profiles: tourism research australia. 2016. Available: https://www.tra.gov.au/tra/2016/Tourism_Region_Profiles/Region_profiles/index.html#
33 van Beeck EF, Branche CM, Szpilman D, *et al*. A new definition of drowning: towards documentation and prevention of a global public health problem. *Bull World Health Organ* 2005;83:853–6.
34 Harris PA, Taylor R, Thielke R, *et al*. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–81.
35 World Health Organization. *Global drowning report: preventing a leading killer*. Switzerland: Zurich, 2014.
36 Anderson KC, Roy TM, Danzl DF. Submersion incidents: a review of 39 cases and development of the submersion outcome score. *J Wilderness Med* 1991;2:27–36.
37 Gonzalez-Luis G, Pons M, Cambra FJ, *et al*. Use of the pediatric risk of mortality score as predictor of death and serious neurologic damage in children after submersion. *Pediatr Emerg Care* 2001;17:405–9.
38 Orlowski JP. Prognostic factors in pediatric cases of drowning and near-drowning. *JACEP* 1979;8:176–9.
39 Leavy JE, Crawford G, Leaversuch F, *et al*. A review of drowning prevention interventions for children and young people in high, low and middle income countries. *J Community Health* 2016;41:424–41.
40 Leavy JE, Crawford G, Portsmouth L, *et al*. Recreational drowning prevention interventions for adults, 1990-2012: a review. *J Community Health* 2015;40:725–35.