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Addressing gaps in our understanding of the drowning patient: A study protocol for the development of an Utstein Style Database Collaboration

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Title: Addressing gaps in our understanding of the drowning patient: A study protocol for the development of an Utstein Style Database Collaboration

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Abstract

Introduction: This retrospective observational study aims to create a comprehensive database reporting 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; differences in the circumstances, treatment, and outcomes of drowning by sex.

Methods and Analysis

This protocol outlines retrospective data collection for all drowning patients presenting to EDs of the Sunshine Coast Hospital and Health Service in Queensland (SCHHS), Australia 2015-2022. Patients computerized health records (Emergency Medical Services, ED, inpatient units, and intensive care unit) will be used to extract data for entry into an USFD database. Descriptive (e.g. median, interquartile range) and inferential statistical analyses (e.g. ANOVA) will be used to answer the separate research questions. Development of an International Drowning Registry using the USFD dataset and the 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 Royal Life Saving Society Australia (RLSSA) and Surf Life Saving Australia (SLSA). Study findings will better inform clinical management of drowning patients and provide an evidence base on sex differences in drowning. Results will be disseminated

through peer review publications and through RLSSA and SLSA membership of the Australian and New Zealand Resuscitation Council and the Australian Water Safety Council.

Keywords: emergency medicine, drowning, adult intensive and critical care, paediatric intensive and critical care, trauma management, public health.

Article summary

Strengths and limitations of this study

- This study will explore the full extent of the medical treatment of drowning and includes cases not currently captured in Australian hospital admission or mortality estimates.
- This study will provide a comprehensive description of the treatments and investigations used in pre-hospital care (by lifeguards and Emergency Medical Services) and in-hospital (in the emergency department and inpatient units) linked to patient outcomes.
- This study will be the first to use the Utstein Style for Drowning in such a comprehensive manner.
- This is an initial, single center (SCHHS) study only. However, development of the REDCap database provides the opportunity to collaborate with interested centers elsewhere.

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 evidence on female drowning.

The Utstein Style for Drowning

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).

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 services

The USFD was designed to include variables readily available in the health care 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 (LS), 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 as 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 health care 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 (6). In the twenty 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 (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 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) utilizes 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 trauma patients (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 odds ratios 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 to mechanical ventilation (MV), treatment with NIV resulted in a similar rate of improvement in oxygenation after the first six 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 12/57 (21%) 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, United States of America, United Kingdom and Canada, only 14 (16.2%) were found that reported some limited 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 to males in treatment outcomes after hospital admission for drowning (29, 30), with the survival: non-survival ratio 4:1 for females compared to 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, multi-source, chart review of all drowning presentations to the SCHHS EDs through to hospital discharge between January 1st, 2015 and December 31st, 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 Emergency Department treatment of drowning patients?

Secondary aims are to:

- Investigate the feasibility of an USFD database in a high-income setting.
- Compare the described classification systems for drowning patients in an Australian population.

- Compare and contrast the use and efficacy of mechanical ventilation with non-invasive ventilation and high flow nasal prongs as treatment for the lung injury of drowning.
- 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 and CSI. This two-pronged approach will limit missed cases. While the term near-drowning is no longer 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 de-identified copy of the database will be held at James Cook University and we will utilize REDCAP (34) technology to enable collaboration with other centers. The case report form developed is included as Appendix 1 and the data dictionary based on the revised Utstein Style for Drowning (4) is included as Appendix 2.

We propose using the Research Electronic Data Capture (REDCap) secure web application to create the International Drowning Registry (IDR). The IDR will facilitate multi-center 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 Analysis

It is expected that this database will initially include data on between 400-500 drowning presentations from this study. Descriptive data will be presented as mean and standard deviation if normally distributed and medians, and interquartile ranges if not normally distributed. Comparison of means in three or more groups will be conducted using 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 SaO2, 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 (OHCA) and mode of ventilation influence the development of acute respiratory distress syndrome? Other

examples would include (but not limited to) factors influencing mortality where duration of immersion, type of water, time to first cardiopulmonary resuscitation (CPR), EMS response time, witnessed drowning, serum lactate, initial Glasgow Coma Scale (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 pediatric submersion score to predict in hospital mortality will be calculated using odds ratios (with 95% confidence intervals). Comparison of the different scoring systems will be achieved by comparing the area under the curves of the receiver operating characteristic.

Consent, Ethics and Privacy

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 analyzed. Re-identifiable 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.

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 organizations, Royal Life Saving Society – Australia (RLSSA) and Surf Life Saving Australia (SLSA). Both these organizations 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.

Dissemination of Findings

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 RLSSA and SLSA membership of the Australian Resuscitation Council and the Australian Water Safety Council. As this study is single center, we will be actively seeking the participation of other sites, domestically and internationally, with the aim of informing practice on a broader scale.

Discussion

Drowning is a global public health issue, including in Australia (35, 36). 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 utilize 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. Multicenter collaboration through the IDR will allow collaborating centers 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 centers will see sufficient drowning cases to develop into a center of excellence. Development of a large multicenter database of drowning patients using the REDCap (34) web application will allow collaborating institutions to benchmark and compare outcomes, as well as providing multicenter 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 twenty 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, 37-39) 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 recognized as being over-represented in drowning mortality figures and the scientific literature has reflected this (40, 41). 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 utilize 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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Author contributions: Study concept and design (OT, KR, SD, PL, RF, AP), design of data dictionary and case report form (KR, OT) acquisition of the data (OT, KR), analysis and interpretation of the data (OT, KR, RF), drafting of the manuscript (OT, KR), critical revision of the manuscript (SD, PL, RF, AP), acquisition of funding (OT, KR, SD, PL, AP, RF)

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Competing interests' statement: The authors declare no competing interests.

Data availability statement: Access to data is restricted by ethical agreements and the Public Health Act, 2005, Queensland, Australia. Researchers with queries or interested in collaborating can contact Ogilvie.Thom@my.jcu.edu.au.

Ethics approval: Ethics approval has been obtained from Metro North Human Research and Ethics Committee (Project 49754) and James Cook University (H8014)

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Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

ED DROWNING -SCREENING FORM

Form 1. Inclusion criteria

1.1 ED presentation date and time	Click or tap here to enter text. Time: Click or tap here to enter text.
1.2 Presenting complaint (contains the terms)	☐ Drowning ☐ Near drowning ☐ Immersion ☐ Other (specify)
1.3 ED visit reason is coded for:	☐ ED visit reason is coded for immersion ☐ ED diagnosis codes of drowning, submersion and immersion (SNOMED for ieMR data) ☐ ED diagnosis code for EDIS (ICD-10)
1.4 ED diagnosis code	Click or tap here to enter text.
1.5 Keyword search:	Location: Choose an item. Event: Choose an item. Activity: Choose an item. **OR** keyword: Click or tap here to enter text.
1.6 Cervical spine injury-keyword search	Location: Choose an item. Event: Choose an item. Activity: Choose an item. **OR** keyword: Click or tap here to enter text.

ED DROWNING – Case Report Form

Form 2. Patient Information

Core data

Data collection date: Click or tap here to enter text.	Data collected by: Click or tap here to enter text.	DATA
Hospital: Choose an item.		
2.1 Patient ID	Click or tap here to enter text.	CORE
2.2 Sex	Sex: MALE ☐ FEMALE ☐ NOT IDENTIFIED ☐	CORE
2.3 Age	DOB: Click or tap here to enter text. Age: Click or tap here to enter text.	CORE
2.4.1 Incident date + time	Date: Click or tap here to enter text. Time: Click or tap here to enter text.	CORE
2.4.2 Incident postcode + location	Postcode: Click or tap here to enter text. Location: Click or tap here to enter text.	ADD
2.4.3 Residential postcode	Postcode: Click or tap here to enter text.	ADD
2.4.4 Activity at time of event	Choose an item. Other: Click or tap here to enter text.	ADD
2.4.5 Mechanism	Choose an item. Other: Click or tap here to enter text.	ADD
2.5 Precipitating event (more than one add free text)	Choose an item. Other: Click or tap here to enter text.	CORE
2.6 Face submerged	Choose an item.	CORE
2.7 Pre-existing illness	Choose an item. Specify: Click or tap here to enter text.	CORE
2.8 Born in Australia?	Choose an item.	ADD
2.9 Eligible for Medicare?	Choose an item.	ADD
2.10 Overseas visitor/migrant?	Choose an item.	ADD

ED Drowning – Screening and Case Report Form

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

Form 3. Scene information

Core data

3.1 Water temperature	Choose an item. Water temp: Click or tap here to enter text.	CORE
3.2 Drowning witnessed?	Choose an item.	CORE
3.3 Bystander CPR	Choose an item.	CORE
3.4 CPR method	Choose an item.	SUPP
3.5 Bystander ventilation	Choose an item.	CORE
3.6 Trained first responder-provide CPR or ventilation only?	CPR: Choose an item. Ventilation only: Choose an item. ☐ N/R	CORE
3.7 Vital signs at first trained responder/EMS assessment	Response: AVPU Choose an item. **OR** GCS: Choose an item. Normal breathing: Choose an item. Pulse: Choose an item.	CORE
3.8 AED use	AED used: Choose an item. AED discharged?: Choose an item. No. AED discharges (if known): Click or tap here to enter text.	ADD
3.9 Initial cardiac rhythm (monitored/ECG)	Rhythm: Choose an item. Other: Click or tap here to enter text.	CORE

Supplementary data

3.10 Initial vital signs (on scene non-EMS)	Heart rate (bpm): Click or tap here to enter text. Respiratory rate (brpm):Click or tap here to enter text. Systolic BP (mmHg): Click or tap here to enter text. Diastolic BP (mmHg): Click or tap here to enter text. Temperature (degrees Celsius): Click or tap here to enter text. Oxygen saturation (SpO_2): Click or tap here to enter text. Supplemental oxygen: Choose an item. ☐ MISS ☐ ERROR ☐ N/R	SUPP
3.11 Initial chest exam	Choose an item.	SUPP
3.12 Type of fluid	Choose an item. Other: Click or tap here to enter text.	SUPP

3.13 Body of water	Choose an item. Other: Click or tap here to enter text.	SUPP

Form 4. Pre-EMS Scene information

Core data

4.1 Level of training	Choose an item. Other: Click or tap here to enter text.	CORE
4.2 Interventions used	Choose an item. Other: Click or tap here to enter text.	CORE

Supplementary data

4.3 Cervical spine immobilisation	Choose an item.	ADD
4.4 Rescuer CPR/patient care and rescue	Rescuer CPR? Choose an item. Was person performing CPR/patient care the same person who performed the water rescue? Choose an item.	SUPP
4.5 Number of lifeguards or first responders attending the patient	Click or tap here to enter text.	SUPP
4.6 Water conditions	Choose an item. Specify: Click or tap here to enter text.	SUPP
4.7 Method of rescue from water	Who removed the victim? Choose an item. How was the victim removed? Choose an item. Other specify:Click or tap here to enter text.	SUPP
4.8 Time CPR ceased	Click or tap here to enter text.	ADD
4.9 CPR outcome	Choose an item.	ADD

Form 5. Time points from First responder/EMS data

Core data

5.1 Time face/airway seen underwater	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.2 Time call was placed with EMS	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	ADD

5.3 Time victim removed from water	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.4 Time of first trained responder/EMS treatment	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.5 Time CPR first begun	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.6 Time ROSC was achieved	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.7 Time first conscious/awake	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.8 Submersion duration (face underwater) *Time from underwater/EMS call time to first EMS Tx or CPR	*Minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.9 Cervical spinal precautions (initiated by EMS)	Initiated by EMS: Choose an item. Method: Choose an item.	ADD

Form 6. EMS

Additional data

6.1 Paramedic level	Choose an item. Specify:Click or tap here to enter text.	ADD
6.2 CPR (by EMS)	Choose an item.	ADD
6.3 Airway support	Choose an item.	ADD
6.4 Ventilation support	Choose an item.	ADD
6.5 Circulatory support	Choose an item.	ADD
6.6 Cervical spine immobilisation	Choose an item.	ADD
6.7 Cyanosis	Choose an item.	ADD
6.8 SOB/IWOB?	Choose an item.	ADD
6.9 Initial patient response	Choose an item.	ADD

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Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

6.10 Initial heart rate (bpm)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.11 Initial respiratory rate (brpm)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.12 Initial systolic BP (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.13 Initial diastolic BP (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.14 Initial MAP (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.15 Initial $Sp0_2$ (%)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.16 Initial $Fi0_2$ (%)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.17 Initial Temperature (degrees Celsius)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.18 EMS chest exam	Choose an item. Specify (if two): Click or tap here to enter text.	ADD
6.19 Patient response at time of ED H/O	Choose an item.	ADD
6.20 HR at ED H/O (bpm)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.21 RR at ED H/O (brpm)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.22 Systolic BP at ED H/O (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.23 Diastolic BP at ED H/O (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.24 $Sp0_2$ at ED H/O (%)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.25 $Fi0_2$ at ED H/O (%)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.26 Temp at ED H/O (degrees Celsius)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.27 BSL (mmol/L)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.28 Medications administered by EMS	Steroids: Choose an item. Sedation/agitation: Choose an item. Diuretics: Choose an item.	ADD

	Cardiac medications: Choose an item. RSI: Choose an item. Other (specify type): Click or tap here to enter text.	
6.29 IVT Fluid administered by EMS	Bolus: Choose an item. Bolus volume (total): Click or tap here to enter text.	ADD

Form 7. Emergency Department

Additional data

7.1 ED Arrival date	Click or tap here to enter text.	CORE
7.2 ED Arrival time (hrs:mins)	Click or tap here to enter text.	CORE
7.3 Triage category	Choose an item.	ADD
7.4 Single or multiple patients	Choose an item.	ADD
7.5 ED disposition	Choose an item. Other (specify):Click or tap here to enter text.	ADD
7.6 Date of ED D/C	Click or tap here to enter text. **OR** ☐ N/R	ADD
7.7 Time of ED D/C	Click or tap here to enter text. **OR** ☐ N/R	ADD
7.8 D/C destination from ED	Choose an item. Other (specify): Click or tap here to enter text.	ADD
7.9 CPR on ED arrival?	Choose an item.	CORE
7.10 Time CPR ceased in ED (mins)	Click or tap here to enter text.	SUPP
7.11 Outcome of CPR	Choose an item.	SUPP
7.12 Number of defibrillations	Click or tap here to enter text. **OR** ☐ N/R	SUPP
7.13 First ED temp (degrees Celsius)	Click or tap here to enter text.	CORE
7.14 First ED HR (bpm)	Click or tap here to enter text.	CORE
7.15 First ED Systolic BP (mmHg)	Click or tap here to enter text.	CORE
7.16 First ED Diastolic BP (mmHg)	Click or tap here to enter text.	CORE
7.17 First ED MAP (mmHg)	Click or tap here to enter text.	CORE

ED Drowning – Screening and Case Report Form

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

7.18 First ED Spontaneous RR (brpm)	Click or tap here to enter text.	CORE
7.19 First ED $Sp0_2$ (%)	Click or tap here to enter text.	CORE
7.20 Initial $Fi0_2$ (%)	Click or tap here to enter text.	ADD
7.21 First ED cardiac rhythm	Choose an item. Specify: Click or tap here to enter text.	CORE
7.22 First ED AVPU assessment	Choose an item.	CORE
7.23 First ED GCS	Choose an item.	CORE
7.24 Initial patient response	Choose an item.	ADD
7.25 ED chest exam	Choose an item.	ADD
7.26 ED CXR/ CT chest	Choose an item. Specify: Click or tap here to enter text.	CORE
7.27 First ED blood gas	Choose an item.	CORE
7.28 pH	Click or tap here to enter text.	CORE
7.29 $P0_2$ (mmHg)	Click or tap here to enter text.	CORE
7.30 $PC0_2$ (mmHg)	Click or tap here to enter text.	CORE
7.31 $HC0_3^-$ (mEq/l)	Click or tap here to enter text.	ADD
7.32 Base excess (mmol/L)	Click or tap here to enter text.	CORE
7.33 Lactate (mmol/L)	Click or tap here to enter text.	SUPP
7.34 Na^+ (mmol/L)	Click or tap here to enter text.	ADD
7.35 K^+ (mmol/L)	Click or tap here to enter text.	SUPP
7.36 BAL (mEq/L)	Click or tap here to enter text.	SUPP
7.37 Prior substance abuse	Choose an item.	SUPP
7.38 Initial ECG	Choose an item. Specify: Click or tap here to enter text.	CORE
7.39 Medication administered in ED	Antibiotics: Choose an item. Steroids: Choose an item. Sedation/agitation: Choose an item. Diuretics: Choose an item.	ADD

	RSI: Choose an item. Cardiac medications: Choose an item. Other (specify): Click or tap here to enter text.	
7.40 IVT Fluids administered in ED	Choose an item. Total volume (bolus) in ED: Click or tap here to enter text.	ADD
7.41 Ventilation in ED	Choose an item.	CORE
7.42 Airway support in ED	Choose an item.	CORE
7.43 ICU review in ED?	Choose an item.	ADD
7.44 Allied health consultation in ED?	Choose an item. Type of review or examination: Click or tap here to enter text.	ADD

Form 8. Hospital course

Core data

8.1 Hospital ward admission	Date: Click or tap here to enter text. Time: Click or tap here to enter text.	CORE
8.2 Time CPR ceased in ICU	Date: Click or tap here to enter text. Time: Click or tap here to enter text. N/R: ☐	CORE
8.3 Duration of CPR	Minutes: Click or tap here to enter text.	CORE
8.4 First vital signs after admission to ward	Heart rate (bpm): Click or tap here to enter text. RR (brpm): Click or tap here to enter text. Systolic BP (mmHg): Click or tap here to enter text. Diastolic BP (mmHg): Click or tap here to enter text. MAP: Click or tap here to enter text. Temperature (degrees Celsius): Click or tap here to enter text. Oxygen saturation (SpO_2): Click or tap here to enter text. FiO_2: Click or tap here to enter text. Supplemental oxygen: Choose an item. ☐ MISS ☐ ERROR ☐ N/R	CORE

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Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

8.5 First cardiac rhythm	Rhythm: Choose an item. Other: Click or tap here to enter text.	CORE
8.6 Initial neurological status	AVPU: Choose an item. **OR** GCS: Choose an item. **OR** ☐ N/R	CORE
8.7 BSL (mmol/L)	Click or tap here to enter text.	ADD
8.8 Arterial blood gas analysis	pH: Click or tap here to enter text. PaO_2: Click or tap here to enter text. $PaCO_2$: Click or tap here to enter text. Base deficit: Click or tap here to enter text. HCO_3^-: Click or tap here to enter text. ☐ N/R	CORE
8.9 Venous blood gas analysis	pH: Click or tap here to enter text. PvO_2: Click or tap here to enter text. $PvCO_2$: Click or tap here to enter text. Base deficit: Click or tap here to enter text. HCO_3^-: Click or tap here to enter text. ☐ N/R	ADD
8.10 Serum lactate (mmol/L)	Initial: Click or tap here to enter text. Highest: Click or tap here to enter text. Date first measured < 2 mmol/L: Click or tap to enter a date. ☐ N/R	ADD
8.11 Pulmonary oedema	Bilateral lung opacities present on CXR < 24hrs: Choose an item.	CORE
8.12 ARDS	Choose an item.	CORE
8.13 Ventilation requirements	Choose an item.	CORE
8.14 Airway support	Choose an item.	CORE
8.15 Induced hypothermia	Choose an item.	CORE

8.16 Targeted temperature management	Choose an item.	CORE
8.17 Core temperature (degrees Celsius)	Highest: Click or tap here to enter text. Lowest: Click or tap here to enter text. ☐ N/R	CORE
8.18 Serum sodium	Initial: Click or tap here to enter text. **OR** ☐ N/R Highest: Click or tap here to enter text. Lowest: Click or tap here to enter text.	ADD
8.19 Serum potassium (mEq/L)	Initial: Click or tap here to enter text. **OR** ☐ N/R Highest: Click or tap here to enter text. Lowest: Click or tap here to enter text.	ADD
8.20 Serum glucose	Initial: Click or tap here to enter text. **OR** ☐ N/R Highest: Click or tap here to enter text. Lowest: Click or tap here to enter text. Was normoglycaemic maintained: Choose an item.	CORE
8.21 Hypotension	Did the patient have 2 documented episodes of BP<90mmHg for adults and age adjusted for children? Choose an item. **OR** ☐ N/R	CORE
8.22 Medications administered as inpatient	Antibiotics: Choose an item. Steroids: Choose an item. Sedation/agitation: Choose an item. Diuretics: Choose an item. Cardiac medications: Choose an item. RSI: Choose an item. Other (specify type): Click or tap here to enter text.	ADD
8.23 Circulatory support	Vasopressor infusion commenced? Choose an item. Inotrope infusion commenced? Choose an item. **OR** ☐ N/R	CORE
8.24 IVT Fluids administered as inpatient	Choose an item.	ADD

ED Drowning – Screening and Case Report Form

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

	Total volume (bolus) as inpatient: Click or tap here to enter text.	
8.25 ECMO/CPB	Was patient treated with ECMO or CPB? Choose an item. **OR** ☐ N/R	CORE
8.26.1 Neurological function	Best GCS during hospitalisation: Choose an item. **OR** ☐ N/R	CORE
8.26.2 Cervical Spine Imaging	X-ray: Choose an item. CT scan: Choose an item. MRI scan: Choose an item.	ADD
8.26.3 Cervical Spine Injury (CSI)	Did radiological imaging report CSI: Choose an item. CSI reported: Click or tap here to enter text.	ADD
8.27 In-hospital resuscitation	In hospital cardiac arrest requiring CPR? Choose an item.	CORE
8.28 Complicating illness of drowning	Check all that apply: Acute respiratory distress syndrome: ☐ Pneumothorax: ☐ Pneumonia: ☐ Disseminated intravascular coagulation: ☐ Pancreatitis: ☐ Acute kidney injury: ☐ Shock: ☐ Multiple system organ failure: ☐ Sepsis: ☐ Electrolyte disturbance: ☐ Glucose disturbance: ☐ Nil recorded: ☐ Other: ☐ Specify: Click or tap here to enter text. Unknown: ☐ MISS: ☐ ERROR: ☐ N/R: ☐	CORE

Supplementary data

8.29 Oxygenation (PaO_2)	Highest PaO_2 < 96hrs of ROSC: Click or tap here to enter text. **OR** ☐ N/R Lowest PaO_2 < 96hrs of ROSC: Click or tap here to enter text.	SUPP

8.30 Neurological function tests	Does patient have neuromonitoring/neuroimaging or biomarker measurement? Choose an item. CT - Choose an item. MRI - Choose an item. EEG -Choose an item. Evoked potential - Choose an item. ICP monitoring - Choose an item. Microdialysis - Choose an item. Tissue oxygen monitoring/serum biomarkers - Choose an item.	SUPP
8.31 Other investigations/interventions (conducted as inpatient)	Investigation: Click or tap here to enter text. Interventions: Click or tap here to enter text.	ADD
8.32 Inpatient Allied health consultation	Choose an item. Type of review or examination: Click or tap here to enter text. Multiple reviews (list examination type): Click or tap here to enter text. Click or tap here to enter text. Click or tap here to enter text.	ADD

Form 9. Disposition

Core data

9.1 Date of hospital discharge	Click or tap here to enter text.	CORE
9.2 Time of hospital discharge	Click or tap here to enter text.	ADD
9.3 Survival to hospital discharge	Choose an item.	CORE
9.4 Status at hospital discharge	Choose an item.	ADD
9.5 Hospital discharge destination	Choose an item.	ADD
9.6 Cause of death, if did not survive	Choose an item. Other: Click or tap here to enter text.	CORE

9.7 Neurological outcomes at discharge (if survived)	CPC score: Click or tap here to enter text. **OR** ☐ N/R **OR** Modified Rankin Score: Click or tap here to enter text. **OR** Age appropriate validated scoring system (specify) Click or tap here to enter text.	CORE

Supplementary data

A. If patient died in hospital		
9.8 How did patient die?	Choose an item.	SUPP
9.9 Was an autopsy performed?	Choose an item.	SUPP
9.10 Channelopathy evaluation?	Choose an item.	SUPP
B. If patient survived to hospital discharge:		
9.11 Neurological and QoL outcomes 6 months after hospital discharge?	CPC score: Click or tap here to enter text. **OR** Modified Rankin Score: Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	SUPP

Form 10. Quality of resuscitation factors

Core data

10.1 Method of administering ventilation	Equipment used: Choose an item.	CORE

Supplementary data

10.2 Ventilation rate	Breaths per minute: Click or tap here to enter text. **OR** Unknown: ☐ **OR** N/R: ☐	SUPP
10.3 Chest compression rate	Rate/min: Click or tap here to enter text. **OR** Unknown: ☐ **OR** N/R: ☐	SUPP
10.4 Chest compression fraction	Proportion of time doing chest compressions/minute: Percent: ☐ Click or tap here to enter text. **OR** Proportion: ☐ Click or tap here to enter text.	SUPP

	OR Unknown: ☐ **OR** N/R: ☐	
10.5 Chest compression depth (cm/mm)	Measured: cm: ☐ Click or tap here to enter text. **OR** mm: ☐ Click or tap here to enter text. **OR** Unknown: ☐ **OR** N/R: ☐	SUPP
10.6 Preshock pause interval	Time between last compression and shock Seconds: ☐ Click or tap here to enter text. **OR** Unknown: ☐ **OR** N/R: ☐	SUPP

Form 11. Oxygenation and ventilation strategies

Additional data

11.1 Mode of oxygenation	Choose an item. NP/Hudson/NBM O_2 Litres/min: Click or tap here to enter text.	ADD
11.2 Date and time oxygenation commenced	Click or tap here to enter text. Time: Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	ADD
11.3 Type of ventilation	Choose an item.	ADD
11.4 Ventilation mode	Choose an item.	ADD
11.5 Adverse events	Choose an item.	ADD
11.6 High Flow Nasal Prong (HFNP) duration	Date commenced: Click or tap here to enter text. Time: Click or tap here to enter text. Date ceased: Click or tap here to enter text. Time: Click or tap here to enter text. Reason for weaning/ceased HFNP: Click or tap here to enter text. Pt weight (kg): Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	ADD
11.7 NIV duration	Date of commencement: Click or tap to enter a date. Time of commencement: Click or tap here to enter text.	ADD

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

	Date NIV ceased: Click or tap to enter a date. Time NIV ceased: Click or tap here to enter text. Outcome of NIV: Choose an item. Other: Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	
11.8 MV duration	Date of commencement: Click or tap to enter a date. Time of commencement: Click or tap here to enter text. Date MV ceased: Click or tap to enter a date. Time MV ceased: Click or tap here to enter text. Outcome of MV: Choose an item. Other: Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	ADD

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Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

11.9 Ventilation support/observations (Additional form)

Date: Click or tap here to enter text. Pt weight (kg): Click or tap here to enter text.

PATIENT LOCATION:												
Supplemental O2/HFNP observations												
Time												
Temp (HF)												
Flow rate (L/min)												
Fi02 (%)												
Pt temp												
HR (bpm)												
RR												
SBP (mmHg)												
DBP (mmHg)												
MAP (mmHg)												
SpO_2 (%)												
EW (Q-ADDS score)												
NIV observations												
Time												
Mode (CPAP/BiPAP)												
IPAP (cm H_20)												
EPAP (cm H_20)												
PS (cm H_20)												
Leak (L/min)												
Vt (mL)												
MV (L/min)												
PIP (cm H_20)												
Fi02 (%)												
Temperature												
HR (bpm)												
RR												
SBP (mmHg)												
DBP (mmHg)												
MAP (mmHg)												
SpO2 (%)												
AVPU												

ED Drowning – Screening and Case Report Form

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

EW (Q-ADDS score)												
MV settings												
Mode (PSIMV/SIMV/CMV/PCV)												
Vt (mL)												
RR												
Pmax (cm H_20)												
MV (L/min)												
Ppeak (cm H_20)												
Pplateau (cm H_20)												
PEEP (cm H_20)												
PS (cm H_20)												
I:E ratio												
Fi02 (%)												
ETT size												
ETT cm at teeth/lips												
ETT cuff pressure (cmH_20)												
MV observations												
Time												
Mode												
Vt (mL)												
MV (L/min)												
Ppeak (cm H_20)												
Pplateau (cm H_20)												
PEEP (cm H_20)												
PS (cm H_20)												
I:E ratio												
Fi02 (%)												
$ETCO_2$ (mmHg)												
Temperature												
HR (bpm)												
RR												
SBP (mmHg)												
DBP (mmHg)												
MAP (mmHg)												
$Sp0_2$ (%)												
Air entry (L-R)												
EW (Q-ADDS score)												

BMJ Open

Addressing gaps in our understanding of the drowning patient: A protocol for the retrospective development of an Utstein Style Database and multi-centre collaboration.

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Title: Addressing gaps in our understanding of the drowning patient: A protocol for the retrospective development of an Utstein Style Database and multi-centre 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; 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 (SCHHS), Australia with the presenting problem or discharge diagnosis of drowning or immersion between 2015-2022. Patients computerized 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 (e.g. median, interquartile range) and inferential statistical analyses (e.g. ANOVA) will be used to answer the separate research questions. Development of an International Drowning Registry using the USFD dataset and the 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.

Keywords: emergency medicine, drowning, adult intensive and critical care, paediatric intensive and critical care, trauma management, public health.

Article summary

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 centers.
- This is an initial, single center (SCHHS) 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 Utstein Style for Drowning

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).

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 services

The USFD was designed to include variables readily available in the health care 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 (LS), 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 health care 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 twenty 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 (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 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) utilizes 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 trauma patients (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 odds ratios 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 to mechanical ventilation (MV), treatment with NIV resulted in a similar rate of improvement in oxygenation after the first six 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 12/57 (21%) 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, United States of America, United Kingdom 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 to males in treatment outcomes after hospital admission for drowning (29, 30), with the survival: non-survival ratio 4:1 for females compared to 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, multi-source, chart review of all drowning presentations to the SCHHS EDs through to hospital discharge between January 1st, 2015 and December 31st, 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 Emergency Department treatment of drowning patients?

Secondary aims are to:

- Investigate the feasibility of an USFD database in a high-income setting.
- Compare the described classification systems for drowning patients in an Australian population.
- Compare and contrast the use and efficacy of mechanical ventilation with non-invasive ventilation and high flow nasal prongs as treatment for the lung injury of drowning.

- 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 and CSI. This two-pronged approach will limit missed cases. While the term near-drowning is no longer 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 de-identified copy of the database will be held at James Cook University and we will utilize

REDCAP (34) technology to enable collaboration with other centers. The case report form developed is included as Appendix 1.

We propose using the Research Electronic Data Capture (REDCap) secure web application to create the International Drowning Registry (IDR). The IDR will facilitate multi-center 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 Analysis

It is expected that this database will initially include data on between 400-500 drowning presentations from this study. Descriptive data will be presented as mean and standard deviation if normally distributed and medians, and inter quartile ranges if not normally distributed. Comparison of means in three or more groups will be conducted using 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 SaO2, 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 (OHCA) and mode of ventilation influence the development of acute respiratory distress syndrome? Other examples would include (but not limited to) factors influencing mortality where duration of immersion, type of water, time to first cardiopulmonary resuscitation (CPR), EMS response time, witnessed drowning, serum lactate, initial Glasgow Coma Scale (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 pediatric submersion score to predict in hospital mortality will be calculated using odds ratios (with 95% confidence intervals). 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 analyzed. Re-identifiable 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 RLSSA and SLSA membership of the Australian Resuscitation Council and the Australian Water Safety Council. As this study is single center, 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 organizations, Royal Life Saving Society – Australia (RLSSA) and Surf Life Saving Australia (SLSA). Both these organizations 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 (35, 36). 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 utilize 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 centers. 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. Multicenter collaboration through the IDR will allow

collaborating centers 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 centers will see sufficient drowning cases to develop into a center of excellence. Development of a large multicenter database of drowning patients using the REDCap (34) web application will allow collaborating institutions to benchmark and compare outcomes, as well as providing multicenter 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 twenty 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, 37-39) 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 recognized as being over-represented in drowning mortality figures and the scientific literature has reflected this (40, 41). 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 utilize 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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Data availability statement: Access to data is restricted by ethical agreements and the Public Health Act, 2005, Queensland, Australia. Researchers with queries or interested in collaborating can contact Ogilvie.Thom@health.qld.gov.au.

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Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

ED DROWNING -SCREENING FORM

Form 1. Inclusion criteria

1.1 ED presentation date and time	Click or tap here to enter text. Time: Click or tap here to enter text.
1.2 Presenting complaint (contains the terms)	☐ Drowning ☐ Near drowning ☐ Immersion ☐ Other (specify)
1.3 ED visit reason is coded for:	☐ ED visit reason is coded for immersion ☐ ED diagnosis codes of drowning, submersion and immersion (SNOMED for ieMR data) ☐ ED diagnosis code for EDIS (ICD-10)
1.4 ED diagnosis code	Click or tap here to enter text.
1.5 Keyword search:	Location: Choose an item. Event: Choose an item. Activity: Choose an item. **OR** keyword: Click or tap here to enter text.
1.6 Cervical spine injury-keyword search	Location: Choose an item. Event: Choose an item. Activity: Choose an item. **OR** keyword: Click or tap here to enter text.

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

ED DROWNING – Case Report Form

Form 2. Patient Information

Core data

Data collection date: Click or tap here to enter text.	Data collected by: Click or tap here to enter text.	DATA
Hospital: Choose an item.		
2.1 Patient ID	Click or tap here to enter text.	CORE
2.2 Sex	Sex: MALE ☐ FEMALE ☐ NOT IDENTIFIED ☐	CORE
2.3 Age	DOB: Click or tap here to enter text. Age: Click or tap here to enter text.	CORE
2.4.1 Incident date + time	Date: Click or tap here to enter text. Time: Click or tap here to enter text.	CORE
2.4.2 Incident postcode + location	Postcode: Click or tap here to enter text. Location: Click or tap here to enter text.	ADD
2.4.3 Residential postcode	Postcode: Click or tap here to enter text.	ADD
2.4.4 Activity at time of event	Choose an item. Other: Click or tap here to enter text.	ADD
2.4.5 Mechanism	Choose an item. Other: Click or tap here to enter text.	ADD
2.5 Precipitating event (more than one add free text)	Choose an item. Other: Click or tap here to enter text.	CORE
2.6 Face submerged	Choose an item.	CORE
2.7 Pre-existing illness	Choose an item. Specify: Click or tap here to enter text.	CORE
2.8 Born in Australia?	Choose an item.	ADD
2.9 Eligible for Medicare?	Choose an item.	ADD
2.10 Overseas visitor/migrant?	Choose an item.	ADD

ED Drowning – Screening and Case Report Form

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

Form 3. Scene information

Core data

3.1 Water temperature	Choose an item. Water temp: Click or tap here to enter text.	CORE
3.2 Drowning witnessed?	Choose an item.	CORE
3.3 Bystander CPR	Choose an item.	CORE
3.4 CPR method	Choose an item.	SUPP
3.5 Bystander ventilation	Choose an item.	CORE
3.6 Trained first responder-provide CPR or ventilation only?	CPR: Choose an item. Ventilation only: Choose an item. ☐ N/R	CORE
3.7 Vital signs at first trained responder/EMS assessment	Response: AVPU Choose an item. **OR** GCS: Choose an item. Normal breathing: Choose an item. Pulse: Choose an item.	CORE
3.8 AED use	AED used: Choose an item. AED discharged?: Choose an item. No. AED discharges (if known): Click or tap here to enter text.	ADD
3.9 Initial cardiac rhythm (monitored/ECG)	Rhythm: Choose an item. Other: Click or tap here to enter text.	CORE

Supplementary data

3.10 Initial vital signs (on scene non-EMS)	Heart rate (bpm): Click or tap here to enter text. Respiratory rate (brpm):Click or tap here to enter text. Systolic BP (mmHg): Click or tap here to enter text. Diastolic BP (mmHg): Click or tap here to enter text. Temperature (degrees Celsius): Click or tap here to enter text. Oxygen saturation (SpO_2): Click or tap here to enter text. Supplemental oxygen: Choose an item. ☐ MISS ☐ ERROR ☐ N/R	SUPP
3.11 Initial chest exam	Choose an item.	SUPP
3.12 Type of fluid	Choose an item. Other: Click or tap here to enter text.	SUPP

3.13 Body of water	Choose an item. Other: Click or tap here to enter text.	SUPP

Form 4. Pre-EMS Scene information

Core data

4.1 Level of training	Choose an item. Other: Click or tap here to enter text.	CORE
4.2 Interventions used	Choose an item. Other: Click or tap here to enter text.	CORE

Supplementary data

4.3 Cervical spine immobilisation	Choose an item.	ADD
4.4 Rescuer CPR/patient care and rescue	Rescuer CPR? Choose an item. Was person performing CPR/patient care the same person who performed the water rescue? Choose an item.	SUPP
4.5 Number of lifeguards or first responders attending the patient	Click or tap here to enter text.	SUPP
4.6 Water conditions	Choose an item. Specify: Click or tap here to enter text.	SUPP
4.7 Method of rescue from water	Who removed the victim? Choose an item. How was the victim removed? Choose an item. Other specify:Click or tap here to enter text.	SUPP
4.8 Time CPR ceased	Click or tap here to enter text.	ADD
4.9 CPR outcome	Choose an item.	ADD

Form 5. Time points from First responder/EMS data

Core data

5.1 Time face/airway seen underwater	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.2 Time call was placed with EMS	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	ADD

5.3 Time victim removed from water	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.4 Time of first trained responder/EMS treatment	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.5 Time CPR first begun	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.6 Time ROSC was achieved	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.7 Time first conscious/awake	Hours: minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.8 Submersion duration (face underwater) *Time from underwater/EMS call time to first EMS Tx or CPR	*Minutes: Click or tap here to enter text. **OR** Unknown: ☐	CORE
5.9 Cervical spinal precautions (initiated by EMS)	Initiated by EMS: Choose an item. Method: Choose an item.	ADD

Form 6. EMS

Additional data

6.1 Paramedic level	Choose an item. Specify:Click or tap here to enter text.	ADD
6.2 CPR (by EMS)	Choose an item.	ADD
6.3 Airway support	Choose an item.	ADD
6.4 Ventilation support	Choose an item.	ADD
6.5 Circulatory support	Choose an item.	ADD
6.6 Cervical spine immobilisation	Choose an item.	ADD
6.7 Cyanosis	Choose an item.	ADD
6.8 SOB/IWOB?	Choose an item.	ADD
6.9 Initial patient response	Choose an item.	ADD

6.10 Initial heart rate (bpm)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.11 Initial respiratory rate (brpm)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.12 Initial systolic BP (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.13 Initial diastolic BP (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.14 Initial MAP (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.15 Initial $Sp0_2$ (%)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.16 Initial $Fi0_2$ (%)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.17 Initial Temperature (degrees Celsius)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.18 EMS chest exam	Choose an item. Specify (if two): Click or tap here to enter text.	ADD
6.19 Patient response at time of ED H/O	Choose an item.	ADD
6.20 HR at ED H/O (bpm)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.21 RR at ED H/O (brpm)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.22 Systolic BP at ED H/O (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.23 Diastolic BP at ED H/O (mmHg)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.24 $Sp0_2$ at ED H/O (%)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.25 $Fi0_2$ at ED H/O (%)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.26 Temp at ED H/O (degrees Celsius)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.27 BSL (mmol/L)	Click or tap here to enter text. **OR** ☐ N/R	ADD
6.28 Medications administered by EMS	Steroids: Choose an item. Sedation/agitation: Choose an item. Diuretics: Choose an item.	ADD

	Cardiac medications: Choose an item. RSI: Choose an item. Other (specify type): Click or tap here to enter text.	
6.29 IVT Fluid administered by EMS	Bolus: Choose an item. Bolus volume (total): Click or tap here to enter text.	ADD

Form 7. Emergency Department

Additional data

7.1 ED Arrival date	Click or tap here to enter text.	CORE
7.2 ED Arrival time (hrs:mins)	Click or tap here to enter text.	CORE
7.3 Triage category	Choose an item.	ADD
7.4 Single or multiple patients	Choose an item.	ADD
7.5 ED disposition	Choose an item. Other (specify):Click or tap here to enter text.	ADD
7.6 Date of ED D/C	Click or tap here to enter text. **OR** ☐ N/R	ADD
7.7 Time of ED D/C	Click or tap here to enter text. **OR** ☐ N/R	ADD
7.8 D/C destination from ED	Choose an item. Other (specify): Click or tap here to enter text.	ADD
7.9 CPR on ED arrival?	Choose an item.	CORE
7.10 Time CPR ceased in ED (mins)	Click or tap here to enter text.	SUPP
7.11 Outcome of CPR	Choose an item.	SUPP
7.12 Number of defibrillations	Click or tap here to enter text. **OR** ☐ N/R	SUPP
7.13 First ED temp (degrees Celsius)	Click or tap here to enter text.	CORE
7.14 First ED HR (bpm)	Click or tap here to enter text.	CORE
7.15 First ED Systolic BP (mmHg)	Click or tap here to enter text.	CORE
7.16 First ED Diastolic BP (mmHg)	Click or tap here to enter text.	CORE
7.17 First ED MAP (mmHg)	Click or tap here to enter text.	CORE

7.18 First ED Spontaneous RR (brpm)	Click or tap here to enter text.	CORE
7.19 First ED $Sp0_2$ (%)	Click or tap here to enter text.	CORE
7.20 Initial $Fi0_2$ (%)	Click or tap here to enter text.	ADD
7.21 First ED cardiac rhythm	Choose an item. Specify: Click or tap here to enter text.	CORE
7.22 First ED AVPU assessment	Choose an item.	CORE
7.23 First ED GCS	Choose an item.	CORE
7.24 Initial patient response	Choose an item.	ADD
7.25 ED chest exam	Choose an item.	ADD
7.26 ED CXR/ CT chest	Choose an item. Specify: Click or tap here to enter text.	CORE
7.27 First ED blood gas	Choose an item.	CORE
7.28 pH	Click or tap here to enter text.	CORE
7.29 $P0_2$ (mmHg)	Click or tap here to enter text.	CORE
7.30 $PC0_2$ (mmHg)	Click or tap here to enter text.	CORE
7.31 $HC0_3^-$ (mEq/l)	Click or tap here to enter text.	ADD
7.32 Base excess (mmol/L)	Click or tap here to enter text.	CORE
7.33 Lactate (mmol/L)	Click or tap here to enter text.	SUPP
7.34 Na^+ (mmol/L)	Click or tap here to enter text.	ADD
7.35 K^+ (mmol/L)	Click or tap here to enter text.	SUPP
7.36 BAL (mEq/L)	Click or tap here to enter text.	SUPP
7.37 Prior substance abuse	Choose an item.	SUPP
7.38 Initial ECG	Choose an item. Specify: Click or tap here to enter text.	CORE
7.39 Medication administered in ED	Antibiotics: Choose an item. Steroids: Choose an item. Sedation/agitation: Choose an item. Diuretics: Choose an item.	ADD

	RSI: Choose an item. Cardiac medications: Choose an item. Other (specify): Click or tap here to enter text.	
7.40 IVT Fluids administered in ED	Choose an item. Total volume (bolus) in ED: Click or tap here to enter text.	ADD
7.41 Ventilation in ED	Choose an item.	CORE
7.42 Airway support in ED	Choose an item.	CORE
7.43 ICU review in ED?	Choose an item.	ADD
7.44 Allied health consultation in ED?	Choose an item. Type of review or examination: Click or tap here to enter text.	ADD

Form 8. Hospital course

Core data

8.1 Hospital ward admission	Date: Click or tap here to enter text. Time: Click or tap here to enter text.	CORE
8.2 Time CPR ceased in ICU	Date: Click or tap here to enter text. Time: Click or tap here to enter text. N/R: ☐	CORE
8.3 Duration of CPR	Minutes: Click or tap here to enter text.	CORE
8.4 First vital signs after admission to ward	Heart rate (bpm): Click or tap here to enter text. RR (brpm): Click or tap here to enter text. Systolic BP (mmHg): Click or tap here to enter text. Diastolic BP (mmHg): Click or tap here to enter text. MAP: Click or tap here to enter text. Temperature (degrees Celsius): Click or tap here to enter text. Oxygen saturation (SpO_2): Click or tap here to enter text. FiO_2: Click or tap here to enter text. Supplemental oxygen: Choose an item. ☐ MISS ☐ ERROR ☐ N/R	CORE

8.5 First cardiac rhythm	Rhythm: Choose an item. Other: Click or tap here to enter text.	CORE
8.6 Initial neurological status	AVPU: Choose an item. **OR** GCS: Choose an item. **OR** ☐ N/R	CORE
8.7 BSL (mmol/L)	Click or tap here to enter text.	ADD
8.8 Arterial blood gas analysis	pH: Click or tap here to enter text. PaO_2: Click or tap here to enter text. $PaCO_2$: Click or tap here to enter text. Base deficit: Click or tap here to enter text. HCO_3^-: Click or tap here to enter text. ☐ N/R	CORE
8.9 Venous blood gas analysis	pH: Click or tap here to enter text. PvO_2: Click or tap here to enter text. $PvCO_2$: Click or tap here to enter text. Base deficit: Click or tap here to enter text. HCO_3^-: Click or tap here to enter text. ☐ N/R	ADD
8.10 Serum lactate (mmol/L)	Initial: Click or tap here to enter text. Highest: Click or tap here to enter text. Date first measured < 2 mmol/L: Click or tap to enter a date. ☐ N/R	ADD
8.11 Pulmonary oedema	Bilateral lung opacities present on CXR < 24hrs: Choose an item.	CORE
8.12 ARDS	Choose an item.	CORE
8.13 Ventilation requirements	Choose an item.	CORE
8.14 Airway support	Choose an item.	CORE
8.15 Induced hypothermia	Choose an item.	CORE

8.16 Targeted temperature management	Choose an item.	CORE
8.17 Core temperature (degrees Celsius)	Highest: Click or tap here to enter text. Lowest: Click or tap here to enter text. ☐ N/R	CORE
8.18 Serum sodium	Initial: Click or tap here to enter text. **OR** ☐ N/R Highest: Click or tap here to enter text. Lowest: Click or tap here to enter text.	ADD
8.19 Serum potassium (mEq/L)	Initial: Click or tap here to enter text. **OR** ☐ N/R Highest: Click or tap here to enter text. Lowest: Click or tap here to enter text.	ADD
8.20 Serum glucose	Initial: Click or tap here to enter text. **OR** ☐ N/R Highest: Click or tap here to enter text. Lowest: Click or tap here to enter text. Was normoglycaemic maintained: Choose an item.	CORE
8.21 Hypotension	Did the patient have 2 documented episodes of BP<90mmHg for adults and age adjusted for children? Choose an item. **OR** ☐ N/R	CORE
8.22 Medications administered as inpatient	Antibiotics: Choose an item. Steroids: Choose an item. Sedation/agitation: Choose an item. Diuretics: Choose an item. Cardiac medications: Choose an item. RSI: Choose an item. Other (specify type): Click or tap here to enter text.	ADD
8.23 Circulatory support	Vasopressor infusion commenced? Choose an item. Inotrope infusion commenced? Choose an item. **OR** ☐ N/R	CORE
8.24 IVT Fluids administered as inpatient	Choose an item.	ADD

	Total volume (bolus) as inpatient: Click or tap here to enter text.	
8.25 ECMO/CPB	Was patient treated with ECMO or CPB? Choose an item. **OR** ☐ N/R	CORE
8.26.1 Neurological function	Best GCS during hospitalisation: Choose an item. **OR** ☐ N/R	CORE
8.26.2 Cervical Spine Imaging	X-ray: Choose an item. CT scan: Choose an item. MRI scan: Choose an item.	ADD
8.26.3 Cervical Spine Injury (CSI)	Did radiological imaging report CSI: Choose an item. CSI reported: Click or tap here to enter text.	ADD
8.27 In-hospital resuscitation	In hospital cardiac arrest requiring CPR? Choose an item.	CORE
8.28 Complicating illness of drowning	Check all that apply: Acute respiratory distress syndrome: ☐ Pneumothorax: ☐ Pneumonia: ☐ Disseminated intravascular coagulation: ☐ Pancreatitis: ☐ Acute kidney injury: ☐ Shock: ☐ Multiple system organ failure: ☐ Sepsis: ☐ Electrolyte disturbance: ☐ Glucose disturbance: ☐ Nil recorded: ☐ Other: ☐ Specify: Click or tap here to enter text. Unknown: ☐ MISS: ☐ ERROR: ☐ N/R: ☐	CORE

Supplementary data

8.29 Oxygenation (PaO_2)	Highest PaO_2 < 96hrs of ROSC: Click or tap here to enter text. **OR** ☐ N/R Lowest PaO_2 < 96hrs of ROSC: Click or tap here to enter text.	SUPP

8.30 Neurological function tests	Does patient have neuromonitoring/neuroimaging or biomarker measurement? Choose an item. CT - Choose an item. MRI - Choose an item. EEG -Choose an item. Evoked potential - Choose an item. ICP monitoring - Choose an item. Microdialysis - Choose an item. Tissue oxygen monitoring/serum biomarkers - Choose an item.	SUPP
8.31 Other investigations/interventions (conducted as inpatient)	Investigation: Click or tap here to enter text. Interventions: Click or tap here to enter text.	ADD
8.32 Inpatient Allied health consultation	Choose an item. Type of review or examination: Click or tap here to enter text. Multiple reviews (list examination type): Click or tap here to enter text. Click or tap here to enter text. Click or tap here to enter text.	ADD

Form 9. Disposition

Core data

9.1 Date of hospital discharge	Click or tap here to enter text.	CORE
9.2 Time of hospital discharge	Click or tap here to enter text.	ADD
9.3 Survival to hospital discharge	Choose an item.	CORE
9.4 Status at hospital discharge	Choose an item.	ADD
9.5 Hospital discharge destination	Choose an item.	ADD
9.6 Cause of death, if did not survive	Choose an item. Other: Click or tap here to enter text.	CORE

9.7 Neurological outcomes at discharge (if survived)	CPC score: Click or tap here to enter text. **OR** ☐ N/R **OR** Modified Rankin Score: Click or tap here to enter text. **OR** Age appropriate validated scoring system (specify) Click or tap here to enter text.	CORE

Supplementary data

A. If patient died in hospital		
9.8 How did patient die?	Choose an item.	SUPP
9.9 Was an autopsy performed?	Choose an item.	SUPP
9.10 Channelopathy evaluation?	Choose an item.	SUPP
B. If patient survived to hospital discharge:		
9.11 Neurological and QoL outcomes 6 months after hospital discharge?	CPC score: Click or tap here to enter text. **OR** Modified Rankin Score: Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	SUPP

Form 10. Quality of resuscitation factors

Core data

10.1 Method of administering ventilation	Equipment used: Choose an item.	CORE

Supplementary data

10.2 Ventilation rate	Breaths per minute: Click or tap here to enter text. **OR** Unknown: ☐ **OR** N/R: ☐	SUPP
10.3 Chest compression rate	Rate/min: Click or tap here to enter text. **OR** Unknown: ☐ **OR** N/R: ☐	SUPP
10.4 Chest compression fraction	Proportion of time doing chest compressions/minute: Percent: ☐ Click or tap here to enter text. **OR** Proportion: ☐ Click or tap here to enter text.	SUPP

	OR Unknown: ☐ **OR** N/R: ☐	
10.5 Chest compression depth (cm/mm)	Measured: cm: ☐ Click or tap here to enter text. **OR** mm: ☐ Click or tap here to enter text. **OR** Unknown: ☐ **OR** N/R: ☐	SUPP
10.6 Preshock pause interval	Time between last compression and shock Seconds: ☐ Click or tap here to enter text. **OR** Unknown: ☐ **OR** N/R: ☐	SUPP

Form 11. Oxygenation and ventilation strategies

Additional data

11.1 Mode of oxygenation	Choose an item. NP/Hudson/NBM O_2 Litres/min: Click or tap here to enter text.	ADD
11.2 Date and time oxygenation commenced	Click or tap here to enter text. Time: Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	ADD
11.3 Type of ventilation	Choose an item.	ADD
11.4 Ventilation mode	Choose an item.	ADD
11.5 Adverse events	Choose an item.	ADD
11.6 High Flow Nasal Prong (HFNP) duration	Date commenced: Click or tap here to enter text. Time: Click or tap here to enter text. Date ceased: Click or tap here to enter text. Time: Click or tap here to enter text. Reason for weaning/ceased HFNP: Click or tap here to enter text. Pt weight (kg): Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	ADD
11.7 NIV duration	Date of commencement: Click or tap to enter a date. Time of commencement: Click or tap here to enter text.	ADD

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

	Date NIV ceased: Click or tap to enter a date. Time NIV ceased: Click or tap here to enter text. Outcome of NIV: Choose an item. Other: Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	
11.8 MV duration	Date of commencement: Click or tap to enter a date. Time of commencement: Click or tap here to enter text. Date MV ceased: Click or tap to enter a date. Time MV ceased: Click or tap here to enter text. Outcome of MV: Choose an item. Other: Click or tap here to enter text. MISS: ☐ ERROR: ☐ N/R: ☐	ADD

ED Drowning – Screening and Case Report Form

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

11.9 Ventilation support/observations (Additional form)

Date: Click or tap here to enter text. Pt weight (kg): Click or tap here to enter text.

PATIENT LOCATION:												
Supplemental O2/HFNP observations												
Time												
Temp (HF)												
Flow rate (L/min)												
Fi02 (%)												
Pt temp												
HR (bpm)												
RR												
SBP (mmHg)												
DBP (mmHg)												
MAP (mmHg)												
SpO_2 (%)												
EW (Q-ADDS score)												
NIV observations												
Time												
Mode (CPAP/BiPAP)												
IPAP (cm H_20)												
EPAP (cm H_20)												
PS (cm H_20)												
Leak (L/min)												
Vt (mL)												
MV (L/min)												
PIP (cm H_20)												
Fi02 (%)												
Temperature												
HR (bpm)												
RR												
SBP (mmHg)												
DBP (mmHg)												
MAP (mmHg)												
SpO2 (%)												
AVPU												

ED Drowning – Screening and Case Report Form

Site name: Click or tap here to enter text.
Patient UR: Click or tap here to enter text.
Study ID: Click or tap here to enter text.

EW (Q-ADDS score)												
MV settings												
Mode (PSIMV/SIMV/CMV/PCV)												
Vt (mL)												
RR												
Pmax (cm H_20)												
MV (L/min)												
Ppeak (cm H_20)												
Pplateau (cm H_20)												
PEEP (cm H_20)												
PS (cm H_20)												
I:E ratio												
Fi02 (%)												
ETT size												
ETT cm at teeth/lips												
ETT cuff pressure (cmH_20)												
MV observations												
Time												
Mode												
Vt (mL)												
MV (L/min)												
Ppeak (cm H_20)												
Pplateau (cm H_20)												
PEEP (cm H_20)												
PS (cm H_20)												
I:E ratio												
Fi02 (%)												
$ETCO_2$ (mmHg)												
Temperature												
HR (bpm)												
RR												
SBP (mmHg)												
DBP (mmHg)												
MAP (mmHg)												
$Sp0_2$ (%)												
Air entry (L-R)												
EW (Q-ADDS score)												