

The Danish Drowning Cohort: Evaluation of Data Availability for Fatal and Non-Fatal Drowning Incidents

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Aim: The Danish Drowning Cohort has collected nationwide prehospital data on fatal and non-fatal drowning incidents in Denmark. The database contains 47 variables: 22 variables from the existing Utstein Drowning Template and 25 additional variables based on the availability in the Danish prehospital medical records. This study aimed to estimate the availability of data (ie, data completeness) for the predefined prehospital registry variables in the Danish Drowning Cohort and the availability of Utstein variables in the subpopulations of drowning patients with and without out-of-hospital cardiac arrest (OHCA).

Methods: This study included all fatal and non-fatal drownings in the Danish Drowning Cohort from January 1, 2016, to December 31, 2023. Data availability rates were reported for all variables in the Danish Drowning Cohort and the Utstein variables in the subpopulations of patients with and without OHCA, presented as medians with interquartile ranges (IQR).

Results: A total of 1,664 drowning patients were analysed (697, 42% with OHCA). The median data availability rate in the Danish Drowning Cohort was 100% (IQR: 88–100%); 100% (IQR: 81–100%) for non-OHCA and 100% (IQR: 87–100%) for OHCA patients. Among the subset of 22 available Utstein variables, the overall data availability was 95% (IQR: 75–100%). For the 17 Utstein variables applicable to both non-OHCA and OHCA, the availability rate was 92% (IQR 76–100%) in non-OHCA cases and 88% (IQR 78–100%) in OHCA cases, with no difference between groups. Overall, 21 of 79 (26%) Utstein variables were unavailable in the Danish setting.

Conclusion: The Danish Drowning Cohort contained nationwide data on fatal and non-fatal drowning patients with high degrees of availability. Data availability was high for most variables defined in the Utstein Drowning Template, both for drowning patients with and without OHCA. However, 21 of 79 Utstein variables were unavailable despite the Danish high-resource healthcare setting.

Plain Language Summary: Drowning is a serious public health problem, and high-quality data are essential to improve prevention and medical care. In Denmark, the Danish Drowning Cohort collects nationwide data on fatal and non-fatal drowning patients treated by the Emergency Medical Services or Search And Rescue helicopters. The database contains 47 variables: 22 variables from the existing Utstein Drowning Template and 25 additional variables based on the availability in the Danish prehospital medical records. This cohort was established to ensure centralised collection of structured and comprehensive drowning data with minimal bias as an alternative to resource-intensive studies with on-site data collection. This study aimed to estimate the availability of data for the Danish Drowning Cohort and the availability of Utstein variables in the subpopulations of drowning patients with and without out-of-hospital cardiac arrest (OHCA).



This study included all 1,664 drowning patients registered in the Danish Drowning Cohort between 2016 and 2023, 42% with out-of-hospital cardiac arrest, and examined the availability of data for each predefined data item. The Danish Drowning Cohort contained nationwide data on fatal and non-fatal drowning patients with high degrees of availability. Data availability was high for most variables defined in the Utstein Drowning Template, both for drowning patients with and without OHCA. However, 21 of 79 Utstein variables were unavailable despite the Danish high-resource healthcare setting.

Keywords: drowning, helicopter emergency medical services, HEMS, emergency medical services, EMS, prehospital care, out-of-hospital cardiac arrest, OHCA, data accuracy

Introduction

Enhancing data collection systems to ensure accurate, complete data is essential for supporting evidence-based prevention strategies and improving medical care, ultimately reducing drowning incidence and improving mortality and morbidity.¹ The Utstein Drowning Template for uniform data reporting on drowning involving out-of-hospital cardiac arrest (OHCA) was published in 2003 and revised in 2015, and is widely regarded as the gold standard for uniform reporting of data on drowning resuscitation.^{2,3} In contrast to the Utstein OHCA Template, the Utstein Drowning Template incorporates a set of variables, many of which are not specific to OHCA, that may be feasible to collect for non-OHCA patients.⁴ However, the utility of such guidelines depends on the availability of data. Recent studies, including those from high-income countries, have often failed to report all relevant variables due to inconsistent data availability.^{1,5–8}

In Denmark, the Danish Drowning Cohort has collected nationwide data on fatal and non-fatal drowning patients in Denmark treated by the Emergency Medical Services (EMS), Helicopter EMS (HEMS), and Search And Rescue (SAR) helicopters since 2016.^{9–12} The Danish Drowning Cohort was established to ensure centralised collection of structured and comprehensive drowning data with minimal bias.¹¹ Using such datasets may improve the quality and efficiency of drowning studies if data are valid and timely. While similar completeness of data fields, concordance, and timeliness between on-site and centrally collected outcome data from registries have been reported,¹³ barriers such as inconsistent data capture and variable availability can reduce data quality.¹⁴ These limitations can hinder efforts to use registry data for evaluating preventive measures and treatment effects, ultimately to reduce the number of drowning incidents and improve patient outcomes, because key variables may be missing, delayed, or only partially recorded.¹⁴ Therefore, evaluating data availability in the Danish Drowning Cohort is paramount.

The primary objective was to estimate the availability of data (ie, data completeness) for the predefined prehospital registry variables collected in the Danish Drowning Cohort using the Utstein template. Secondary objectives were to estimate the availability of Utstein variables in the subpopulations of drowning patients with and without OHCA. We hypothesised that availability would be high for selected variables, while many Utstein variables would be unavailable. We further hypothesised that most Utstein variables with available data would be feasible to collect for drowning patients without OHCA.

Materials and Methods

Study Design

This observational study evaluated the data availability in the Danish Drowning Cohort.¹¹ It was reported according to the “Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)” guidelines ([Online Supplement S1](#)).¹⁵ The Danish Drowning Cohort has collected nationwide data on fatal and non-fatal drowning patients in Denmark from January 1, 2016, to December 31, 2023.^{10–12}

Setting

Denmark is a high-income country in Northern Europe with a geographical area of approximately 43,000 square kilometres and a population of 6 million. All Danish citizens are registered in the Danish Civil Registration System with a unique civil registration number, enabling deterministic individual-level record linkage across all Danish registries for outcome research.^{16,17} The Danish National Health Service provides free, tax-supported healthcare to all Danish

citizens, including a 24-hour prehospital EMS response comprising ambulances, physician-staffed vehicles, and helicopters from both HEMS and SAR.¹⁸ HEMS teams are staffed with specialists in anaesthesiology and respond a wide range of critical incidents, including drowning cases on land, such as in swimming pools or small lakes.¹⁰ The Royal Danish Air Force's SAR helicopters, generally staffed by physicians, serve as the primary resource for sea rescue operations.¹²

All Danish EMS units have utilised the Danish Prehospital Medical Record system since 2015.¹⁹ EMS personnel are responsible for registering data, which is stored electronically. The SAR database remains a separate system, in which SAR staff are responsible for documenting data on paper-based forms.¹² Both systems comprise predefined sets of multiple-choice variables and free-text fields for individual patient notes, eg, a short medical report.^{12,18}

Patients

Fatal and non-fatal drowning patients registered in the Danish Drowning Cohort were included in this study. As previously described, drowning patients were identified through the Danish Prehospital Medical Record system and the SAR database using a two-step approach with high sensitivity and specificity.¹¹ First, the Danish Drowning Formula identified potential drowning patients by searching the medical records for trigger words.⁹ Second, the identified patients were manually validated using the WHO definition of drowning, supported by the clarification statement for non-fatal drowning.^{20,21} Patients declared dead prehospitally, or patients with obvious clinical signs of irreversible death, were included.¹¹

Variables

The Danish Drowning Cohort reported prehospital variables under the Utstein Drowning Template.^{2,3} The name, extraction method, definition, and coding of each variable in the Danish Drowning Cohort were described separately.¹¹ The Utstein Drowning Template contained 79 variables (49 core and 30 supplementary).^{2,3} In-hospital data are currently unavailable in the Danish Drowning Cohort, as data were sourced only from the Danish Prehospital Medical Record system and the SAR database.^{11,12} In summary, the Danish Drowning Cohort contained data on 22 variables from the Utstein Drowning Template, with the possibility of adding 35 potential variables from in-hospital medical records,²² and one variable from the Danish Civil Registration System,¹⁷ leaving 21 Utstein variables unavailable ([Online Supplement S2](#)).^{2,3} Twenty-five additional non-Utstein variables were implemented in the Danish Drowning Cohort, based on the availability in the Danish Prehospital Medical Record system, the SAR database, and the Danish Civil Registration System.^{11,12,17} These variables included "Activity" (ie, type of activity at the time of the drowning incident), "Severity of respiratory impairment" (according to the clarification statement for non-fatal drowning²⁰), "Drowning severity" (according to the classification system of drowning²³), "EMS response time" (ie, time from scramble to arrival on-scene), "EMS first respiratory rate", and information on various EMS treatment interventions (eg, "Nasopharyngeal airway", "Oropharyngeal airway", "Intravenous access", "Intraosseous access", "Intravascular crystalloid", and "Spinal stabilisation"), and outcome variables (ie, "Survival at hospital admission" and "30-day survival") 30-day survival was extracted from the Danish Civil Registration System via individual-level linkage using patients' civil registration numbers.¹⁷

Data Cleaning Methods

Certain clinical variables, such as "Ventilation method", "Intravenous access", and "Spinal stabilisation", were documented in the medical records as "Yes"; the absence of such documentation was considered indicative of non-use, consistent with other studies.⁶ Accordingly, data on these clinical variables were assumed to be present even if not explicitly documented in the medical records. However, for most variables (eg, "Identifier," "Age," and "Sex"), missing entries were classified as missing, as these data were expected to be routinely recorded.

Data Sources

Data were imported directly from the predefined variables in the Danish Prehospital Medical Record system.¹¹ Data from the Danish SAR Database were documented in paper-based patient data forms, which were subsequently manually

entered into the electronic Danish Drowning Cohort.¹² To reduce missing data, the investigators manually supplemented predefined variables using information from the EMS incident description. Variables extracted from free-text fields in the medical records were manually validated by three trained investigators, following inter-rater reliability assessment. A Krippendorff's alpha >0.80 indicated acceptable agreement. All data items extracted from the free-text fields were collected and managed using Research Electronic Data Capture (REDCap), hosted by Region Zealand. REDCap is a secure, web-based software platform designed to support data capture for research studies.²⁴

Statistical Methods

Results were presented as descriptive statistics. Overall data availability rates were reported as medians with 95% confidence intervals (CIs) calculated using the exact binomial method. Data availability rates were reported for each variable as the proportion of drowning patients for which data were available. Data availability rates were compared between OHCA and non-OHCA patients using Fisher's exact or Wilcoxon rank sum test. Overall data availability rates per year and per age groups, stratified by OHCA status, were reported as medians with first and third quartiles. Missing data were not imputed. All analyses were performed using R Statistical software and processed in R Studio (version 4.5.2–2025-10-31).²⁵

Results

Participants

A total of 4,748,007 medical records of patients assessed by EMS or SAR helicopters were screened using the Danish Drowning Formula, and 73,435 were included for manual validation (Figure 1). Following manual validation, 71,771 records were excluded, covering 67,412 non-aquatic incidents and 4,359 aquatic incidents. An aquatic incident was defined as a patient requiring a EMS response following immersion or submersion in liquid without experiencing respiratory impairment. As a result, 1,664 drowning patients were included: 697 (42%) with OHCA, 648 (39%) without OHCA, and 319 (19%) with signs of irreversible death without a resuscitative attempt.

Data Availability in the Danish Drowning Cohort

The Danish Drowning Cohort contained data on 47 variables (22 from the Utstein Drowning Template, and 25 additional non-Utstein variables, based on the availability of data in Danish prehospital medical records. The overall median data availability rate in the Danish Drowning Cohort was 100% (IQR: 88–100%). In total, 44/47 variables had substantial (60–79%) or high ($\geq 80\%$) data availability (Table 1 and Table 2). Only three variables had $<60\%$ data availability, including “Precipitating event”, “Initial cardiac rhythm”, and “Vital signs” (Table 1 and Figure 2). The median data availability rate was 100% (IQR: 81–100%) for drowning patients without OHCA and 100% (IQR: 87–100%) for those with OHCA. Data availability rates remained consistent throughout the study period. There were no significant differences in median availability rates between patients without OHCA, with OHCA, and with signs of irreversible death (Figure 3A). Data availability was generally high across all age groups (Figure 3B). Drowning patients of unknown age had the lowest overall median availability rate of 68%. Missing patient identifiers were observed in 29% of patients (95% CI: 27–31%), with a significantly higher proportion among patients with OHCA compared to those without OHCA (31% vs 24%). On the contrary, “Witnessed drowning” and “Pulmonary status” demonstrated significantly higher data availability rates among patients with OHCA compared to those without OHCA. Only 19% (95% CI: 17–23%) of patients without OHCA had complete vital signs, including heart rate, blood pressure, temperature, and peripheral capillary oxygen saturation.

Data Availability for the Utstein Variables in the Danish Drowning Cohort

The Danish Drowning Cohort included data on 22 variables from the Utstein Drowning Template, with the possibility of adding 35 variables from in-hospital medical records and one variable from the Danish Civil Registration System,¹⁷ leaving 21 Utstein variables unavailable (Online Supplement S2). The median data availability rate for the 22 Utstein variables available across all patients in the Danish Drowning Cohort was 95% (IQR: 75–100%). Overall, 19/22 Utstein

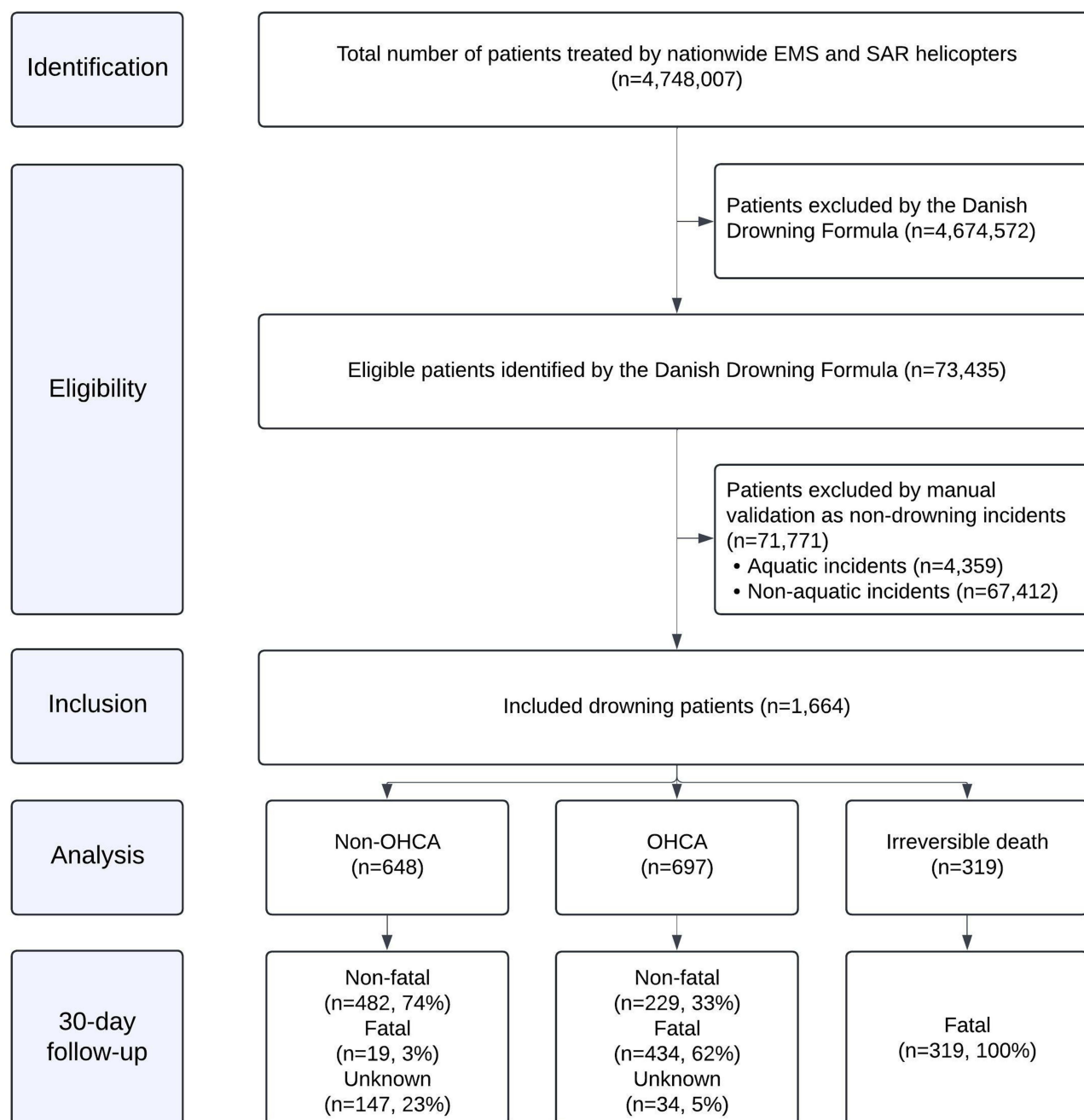


Figure 1 Inclusion flowchart for the Danish Drowning Cohort from 2016 to 2023. Inclusion flowchart illustrating the establishment of the Danish Drowning Cohort for the period from 2016 to 2023.

Abbreviations: EMS, Emergency Medical Services; SAR, Search And Rescue; OHCA, Out-of-Hospital Cardiac Arrest.

variables had substantial (60–79%) or high ($\geq 80\%$) data availability (Table 1). Among drowning patients with OHCA, only three of 22 Utstein variables demonstrated $< 60\%$ data availability: “Precipitating event”, “Initial cardiac rhythm”, and “Vital signs” (Table 1 and Figure 4A).

A total of 17 of 22 prehospital variables from the Utstein Drowning Template also applied to drowning patients without OHCA, excluding “Bystander CPR”, “Initial cardiac rhythm”, “Time ROSC achieved”, “CPR ongoing at hospital arrival”, and “If CPR was not ongoing on arrival, why?” (Table 1). The data availability rates for the 17 Utstein variables appropriate for patients with and without OHCA were 88% (IQR 78–100%) and 92% (IQR 76–100%),

Table 1 Data Availability Rates of Utstein Variables in the Danish Drowning Cohort Stratified by OHCA Status

Variable	Non-OHCA (n=648)	OHCA (n=697)	Total (n=1,664)
Patient information			
Identifier*	76 [72–79]	69 [66–73]	71 [69–73]
Sex*	93 [91–95]	88 [85–90]	88 [87–90]
Age	79 [76–82]	76 [73–79]	76 [74–78]
Incident date and time of day	100 [99–100]	100 [99–100]	100 [99–100]
Precipitating event*	55 [51–59]	37 [33–41]	41 [39–43]
Face submerged	85 [82–88]	87 [84–89]	88 [87–90]
Scene information			
Water temperature	100 [99–100]	100 [99–100]	100 [99–100]
Witnessed drowning*	57 [53–60]	78 [74–81]	72 [70–74]
Bystander CPR	NA	100 [99–100]	100 [99–100]
Vital status	100 [99–100]	100 [99–100]	100 [99–100]
Initial cardiac rhythm	NA	58 [54–61]	28 [26–30]
Vital signs ^{a,*}	19 [17–23]	5 [3–6]	10 [8–11]
EMS first heart rate	37 [33–41]	45 [41–48]	34 [31–36]
EMS first blood pressure	72 [69–76]	37 [34–41]	44 [42–46]
EMS first temperature	39 [36–43]	12 [9–14]	20 [19–23]
EMS first SpO ₂	79 [76–82]	47 [43–50]	51 [48–53]
Pulmonary status ^{a,*}	92 [90–94]	100 [99–100]	97 [96–98]
Type of water ^a	100 [99–100]	100 [99–100]	100 [99–100]
Body of water ^a	100 [99–100]	100 [99–100]	100 [99–100]
Pre-EMS scene information (Lifeguards and First responders)			
Rescuer = caregiver ^a	74 [70–77]	78 [75–81]	74 [72–76]
Time points and time intervals from first responder or EMS data			
Time of first treatment	92 [90–94]	93 [91–95]	93 [92–94]
Time ROSC achieved	NA	100 [100–100]	100 [100–100]
Submersion duration	85 [82–88]	87 [84–89]	88 [87–90]
Hospital Course, Core data			
CPR ongoing at hospital arrival	NA	100 [100–100]	100 [100–100]
Hospital Course, Supplementary data			
If CPR was not ongoing on arrival, why?	NA	100 [100–100]	100 [100–100]
Quality of Resuscitation Factors			
Ventilation method	100 [99–100]	100 [100–100]	100 [100–100]

Notes: Table showing the median data availability rates for the 22 Utstein variables with 95% confidence intervals stratified by OHCA status and for the total population (including patients with signs of irreversible death). ^aSupplementary variable in the Utstein Drowning Template. *Statistically significant.

Abbreviations: CPR, CardioPulmonary Resuscitation, EMS, Emergency Medical Services, NA, Not Applicable, OHCA, Out-of-Hospital Cardiac Arrest, ROSC, Return Of Spontaneous Circulation, SpO₂, Peripheral oxygen saturation.

Table 2 Data Availability Rates of Non-Utstein Variables in the Danish Drowning Cohort Stratified by OHCA Status

Variable	Non-OHCA (n=648)	OHCA (n=697)	Total (n=1,664)
Patient information			
EMS incident description	99 [98–100]	100 [99–100]	100 [99–100]
Activity*	87 [84–89]	65 [61–69]	67 [65–69]
Suspected alcohol or drug intoxication	100 [99–100]	100 [100–100]	100 [100–100]
Scene information			
OHCA	100 [100–100]	100 [100–100]	100 [100–100]
Bystander defibrillation	NA	100 [100–100]	100 [100–100]
Attended by physician	100 [99–100]	100 [100–100]	100 [100–100]
EMS CPR	NA	100 [100–100]	100 [100–100]
Mechanical chest compression	NA	100 [100–100]	100 [100–100]
EMS defibrillation	NA	100 [100–100]	100 [100–100]
EMS first respiratory rate*	75 [71–78]	62 [58–66]	60 [58–63]
Nasopharyngeal airway	100 [100–100]	100 [100–100]	100 [100–100]
Oropharyngeal airway	100 [100–100]	100 [100–100]	100 [100–100]
Suctioning	100 [100–100]	100 [100–100]	100 [100–100]
Chest drain	100 [99–100]	100 [100–100]	100 [100–100]
Intravenous access	100 [100–100]	100 [100–100]	100 [100–100]
Intraosseous access	100 [100–100]	100 [100–100]	100 [100–100]
Intravenous fluid	100 [100–100]	100 [100–100]	100 [100–100]
Intravenous vasopressors	100 [100–100]	100 [100–100]	100 [100–100]
Spinal stabilisation	100 [99–100]	100 [100–100]	100 [100–100]
Type of response to hospital	71 [68–75]	68 [64–72]	66 [64–68]
Severity of respiratory impairment*	92 [90–94]	100 [100–100]	97 [96–98]
Drowning severity*	92 [89–94]	100 [100–100]	97 [96–98]
Time points and time intervals from first responder or EMS data			
Response time*	75 [72–78]	82 [79–84]	80 [78–82]
Hospital Course			
Survival at hospital admission	100 [99–100]	100 [100–100]	100 [100–100]
Disposition			
30-day survival*	77 [74–81]	95 [93–97]	89 [88–91]

Notes: Table showing the median data availability rates for the 25 non-Utstein variables with 95% confidence intervals stratified by OHCA status and for the total population (including patients with signs of irreversible death). *Statistically significant.

Abbreviations: CPR, CardioPulmonary Resuscitation; EMS, Emergency Medical Services; NA, Not Applicable; OHCA, Out-of-Hospital Cardiac Arrest.

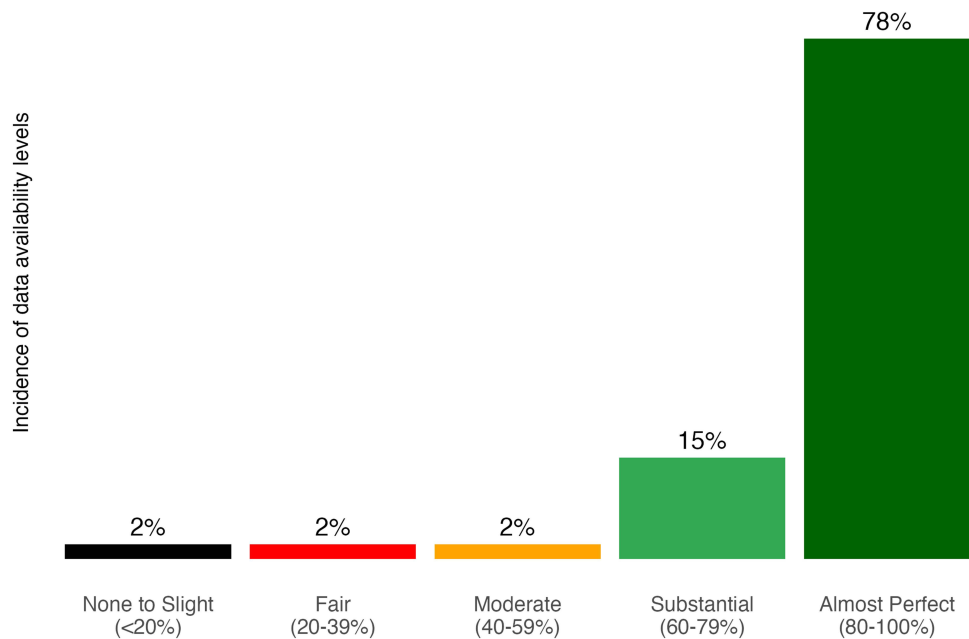


Figure 2 Distribution of the median data availability rates of all variables in the Danish Drowning Cohort across five data availability levels from 2016 to 2023. Results are shown for all variables in the Danish Drowning Cohort, including Utstein variables (22 in total) and non-Utstein variables (25 in total). The figure excludes 36 Utstein variables that require linkage to other data sources and 21 Utstein variables that are unavailable in the Danish setting.

respectively. Among drowning patients without OHCA, only three of 17 Utstein variables had <60% data availability: “Precipitating event”, “Witnessed drowning”, and “Vital signs” (Table 1 and Figure 4B).

Discussion

Summary of Results

The Danish Drowning Cohort demonstrated high availability of nationwide prehospital data on fatal and non-fatal drowning patients treated by the Danish EMS, HEMS, and SAR helicopters since 2016.¹¹ Accessible Utstein drowning variables demonstrated high and comparable data availability for drowning patients with and without OHCA. The Utstein Drowning Template could be applied, with a few exemptions, to ensure standardised reporting of all drowning incidents, including those without OHCA. However, some variables were characterised by low availability, and 21 of the 79 Utstein variables were unavailable, despite the Danish high-resource healthcare setting. These findings supported the growing evidence base and highlighted the need for a revised Utstein Drowning Template that focuses on a smaller set of relevant and available data points.^{6,8} The Utstein Drowning Template is currently undergoing revision to address this need.²⁶

Interpretation and Generalisation

This study was the first to evaluate the data availability of the Danish Drowning Cohort. The Danish Drowning Cohort demonstrated high availability of data variables, similar to the Danish Cardiac Arrest Registry,²⁷ the Danish HEMS Database,²⁸ and the Danish Prehospital Medical Record system,²⁹ all of which relied on prehospital data and had been used previously for drowning research.^{9–11,22} The main strengths of these and similar registries include the availability of longitudinal data, which enhances the efficiency of drowning studies, nationwide coverage that minimizes selection bias, and independent recording using unique patient identifiers, ensuring data reliability.³⁰ Key limitations of registry-based studies include incomplete information, limited data on confounders, limited documentation of data quality, and delays in reporting.^{14,30} Consequently, epidemiological studies that rely on nationwide, valid, and timely data are important in drowning epidemiology, while data limitations must be acknowledged.

There was no overall significant difference in the data availability observed between the drowning patients with and without OHCA or with signs of irreversible death, suggesting that missingness was not dependent on OHCA status. This

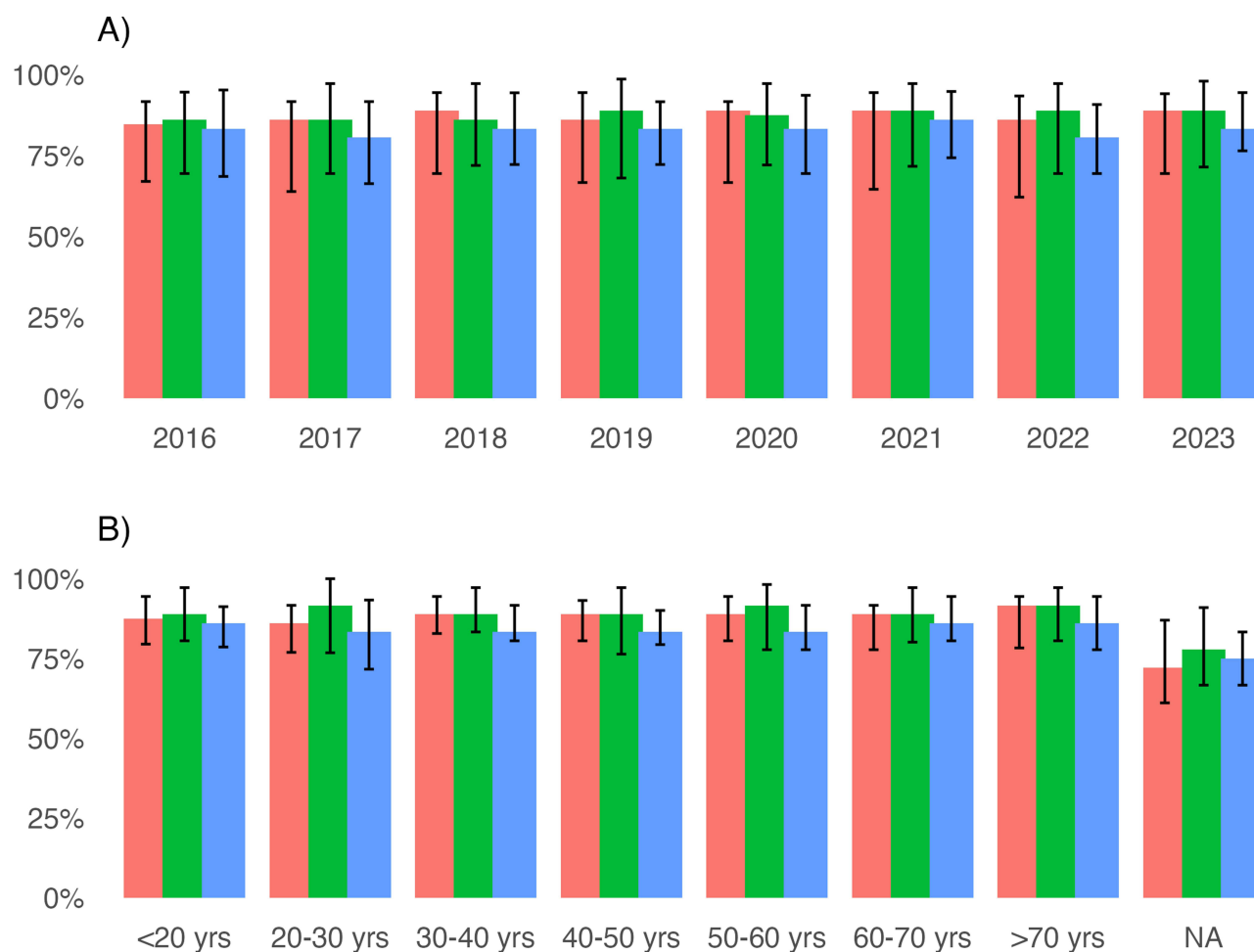


Figure 3 Median data availability rates for all data variables in the Danish Drowning Cohort per year (**A**) and by age groups (**B**) stratified by OHCA status. Results are shown for all variables in the Danish Drowning Cohort stratified by prehospital status (red = non-OHCA; green = OHCA; blue = irreversible death) per year (**A**) and age groups (**B**) from 2016 to 2023, including Utstein variables (22 in total) and non-Utstein variables (25 in total). The figure excludes 36 Utstein variables that require linkage to other data sources and 21 Utstein variables that are unavailable in the Danish setting. Whiskers represent the IQR around the median.

Abbreviation: OHCA, Out-of-Hospital Cardiac Arrest.

reduced the likelihood of selection bias and argued against a Missing-Not-at-Random mechanism linked specifically to OHCA. Only six variables exhibited significantly lower data availability rates in patients with OHCA compared to those without OHCA, which may reflect the inherent challenges of the prehospital setting, where rapid response, limited time, and acute patient management can take priority over detailed documentation.^{19,31} On the contrary, the variables “Witnessed drowning” and “Pulmonary status” demonstrated significantly higher data availability rates in patients with OHCA compared to patients without OHCA, probably due to their prognostic value in drowning-related OHCA.^{9,32} Other reasons for missing data may be related to documentation practices, as the primary objectives of the Danish Prehospital Medical Record system and the SAR database were to document parameters relevant to patient treatment, rather than to collect data for research purposes.¹⁹ Furthermore, data in the Danish SAR Database were documented in paper-based patient data forms, which were subsequently manually entered into the electronic Danish Drowning Cohort.¹² This data entry practice was prone to registration errors. Since drowning patients treated by the SAR helicopters accounted for 7% of the Danish Drowning Cohort, this may explain some of the missing data. Data availability for some variables could be higher if data were collected from multiple sources using a triangulation approach, as in previous studies.^{6,33,34} However, differences in coding practices and data definitions would necessitate extensive data cleaning when accessing and merging multiple datasets, thereby increasing the complexity of the data extraction process. Improving data quality within the existing systems may provide a better solution. Several

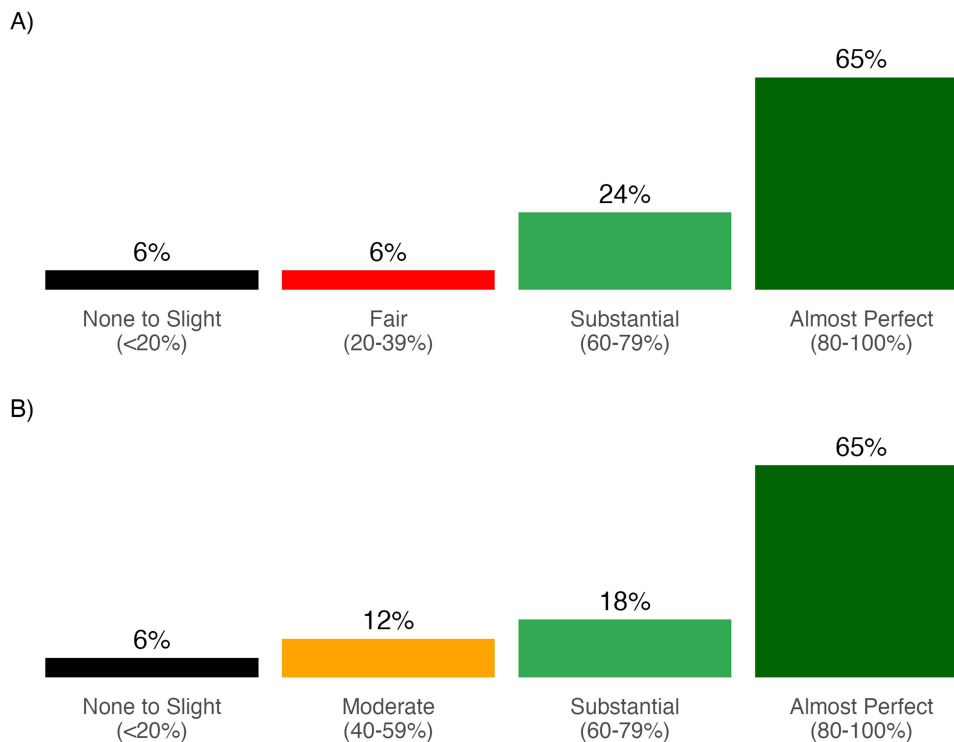


Figure 4 Distribution of the median data availability rate of Utstein variables in the Danish Drowning Cohort across five data availability levels from 2016 to 2023. Results are shown for Utstein variables (22 in total) in the Danish Drowning Cohort for patients with drowning-related OHCA (**A**) and without OHCA (**B**) from 2016 to 2023. The figure excludes 36 Utstein variables that require linkage to other data sources and 21 Utstein variables that are unavailable in the Danish setting.

interventions have been suggested, including visual warnings, mandatory fields to ensure data capture of key variables, multiple-choice menus with branching logic to prevent conflicting registrations, and electronically entered data combined with ongoing educational efforts, training, and audits.²⁸

Bias and Study Limitations

This study assessed data quality only in terms of data availability. Other important dimensions of data quality were not evaluated, including the accuracy of timestamps, timeliness of data registration, internal consistency between variables, and potential misclassification or documentation bias. As in previous studies, certain clinical variables were documented in the medical records as “Yes”. As mentioned in the data collection section, if a variable had missing data, it was treated as not applicable to the current situation. However, different scenarios may influence the reason for missing variables. As such, the reported data availability for these variables can be skewed towards an overestimation. Only prehospital variables in the Utstein Drowning Template were evaluated, yet in-hospital and post-hospital data are important for evaluating factors across the drowning timeline.^{7,35} Finally, missing patient identifiers were observed in 29%, limiting their ability to be linked with other national public registries. This is in contrast to other Danish prehospital studies, which reported missing values of 5–9%.^{19,28} Future interventions should focus on increasing the availability of patient identifiers in prehospital medical records for drowning patients as discussed previously.

Perspectives and Future Research

This study demonstrated the feasibility of using the Utstein Drowning Template to standardise reporting of all drowning patients irrespective of OHCA status. However, the Utstein Drowning Template includes 79 variables (49 core and 30 supplementary),^{2,3} and studies have reported varying data availability, even within health systems in high-income countries.^{5–8} The Danish Drowning Cohort included data on 22 variables from the Utstein Drowning Template, with the possibility of adding 35 variables from in-hospital medical records²² and one from the Danish Civil Registration

System,¹⁷ leaving 21 Utstein variables unavailable in the Danish prehospital medical records. Overall, these findings suggest that either data collection practices in Denmark must be adapted to ensure more complete capture of the currently missing variables, or the Utstein framework should be revised to reflect a smaller set of relevant and available data that enables meaningful comparison across countries. A previous study extracted data from several data sources, such as electronic medical records, radiology reporting systems, and prehospital medical records, to achieve a median data availability of 89% (IQR: 40–100%), with data availability rates >59% for 63% of all the variables.⁶ It was reported that this approach increased the median time to record the core variables to 30 minutes in patients with drowning-related OHCA.⁶ Published studies also identified other parameters of interest that were not included in the current Utstein Drowning Template.^{5,8,36} The proposed revision of the Utstein Drowning Template will focus on a smaller set of relevant and available data points, making it more effective and feasible to complete.²⁶

Conclusion

The Danish Drowning Cohort contained nationwide data on fatal and non-fatal drowning patients treated by the Danish EMS, HEMS, and SAR helicopters since 2016, with high availability and a potential for future research. The Utstein drowning variables demonstrated high data availability for drowning patients with and without OHCA. However, few variables demonstrated low availability, and 21 of the 79 Utstein variables were unavailable in the Danish high-resource healthcare setting.

Data Sharing Statement

The data from the Danish Drowning Cohort used and analysed in the current study are available after obtaining the necessary approvals and pending a formal research collaboration with corresponding author.

Ethics Approval and Informed Consent

According to Danish legislation, retrospective studies that do not include human biological material are exempt from ethical approval (journal number EMN-2022-03474). Region Zealand approved the handover of medical records without patient consent in accordance with relevant data protection and privacy regulations (R-22019028 (RS)). Data management and processing were approved (REG-041-2022).

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Collaborators

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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