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REVIEW

The Danish in-hospital cardiac arrest registry (DANARREST)

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Aim of database: The aim of DANARREST is to collect data on processes of care and outcomes for patients with in-hospital cardiac arrest in Denmark, and thereby facilitate and monitor quality and quality improvement initiatives.

Study population: In-hospital cardiac arrest patients with a clinical indication for cardiopulmonary resuscitation in Denmark.

Main variables: DANARREST includes a number of descriptive variables as well as seven quality of care indicators; four related to processes of care and three related to clinical outcomes. The four process measures are related to whether the cardiac arrest was witnessed, whether the cardiac arrest was ECG-monitored, the timing of cardiopulmonary resuscitation, and the timing of the first rhythm analysis. The three outcomes measures include return of spontaneous circulation, 30-day survival, and 1-year survival.

Database status: DANARREST started in 2013, and the coverage has increased steadily since. As of 2017, 95% of relevant hospitals are reporting data with an estimated coverage rate of approximately 80%.

Conclusion: DANARREST is a relatively new national registry of in-hospital cardiac arrests in Denmark, with a high coverage rate. The registry provides an opportunity to monitor and improve quality of care for patients with in-hospital cardiac arrest.

Keywords: Heart arrest, cardiopulmonary resuscitation, Denmark, quality

Background

In-hospital cardiac arrest is a relatively common condition that is estimated to occur in almost 300,000 patients each year in the US and in approximately 2,400 patients each year in Sweden.[1,2] Despite improvements in outcomes over the last decade, survival remains low, with only approximately 25–30% of patients surviving to hospital discharge.[3] The incidence and outcomes from in-hospital cardiac arrest in Denmark have previously been unknown, and little is known about potential opportunities for quality improvement. In 2008, registration of in-hospital cardiac arrest started as a local initiative in Aarhus.[4] The Danish registry for in-hospital cardiac arrest (DANARREST) was established in 2013 as a clinical quality database.

Aim of the database

The aim of DANARREST is to monitor quality and quality improvement initiatives for patients with in-hospital cardiac arrest in Denmark by collecting data on processes and outcomes.

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Database population

All in-hospital cardiac arrests in Denmark with a clinical indication for cardiopulmonary resuscitation (CPR) (ie, without a prior "do-not-resuscitate" order) should be included in DANARREST. Cardiac arrest is defined as unconsciousness, abnormal breathing, and, for the trained responder, pulselessness. "In-hospital" is defined locally and constitutes all hospitals in Denmark with a cardiac arrest team. Patients with cardiac arrest outside the hospital are only included if they develop an in-hospital cardiac arrest after sustained (>20 minutes) return of spontaneous circulation. Similarly, a subsequent in-hospital cardiac arrest only counts as a new entry if there has been preceding sustained return of spontaneous circulation (>20 minutes). Patients of all ages are included, except for neonates with cardiac arrest in the delivery room. Lastly, limited information is collected on all patients where a cardiac arrest team was called but there was no true cardiac arrest or there was no indication for CPR. Patients who died without activation of the cardiac arrest team or CPR are not included.

As of December 31, 2017, there were 7,390 entries in the database, of which 6,528 were in-hospital cardiac arrests with a clinical indication for CPR. See Figure 1 for an overview of included cardiac arrest with a clinical indication for CPR from 2013 to 2017. As of January 1, 2017, 41 of 43 hospitals in Denmark with a cardiac arrest team reported data to the registry (Figure 1)

Data collection

The majority of data is collected immediately after the cardiac arrest by a designated member of the cardiac arrest team. Data is collected on a 1-page paper case report form consisting of 21 data fields (Table 1) with a number of questions and sub-questions. The data is subsequently entered electronically via a web-based application. Additional data is obtained from the Danish National Patient Register (comorbidities)[5] and the Danish Civil Registration System (survival).[6] Reporting of data to the registry is mandatory by law.

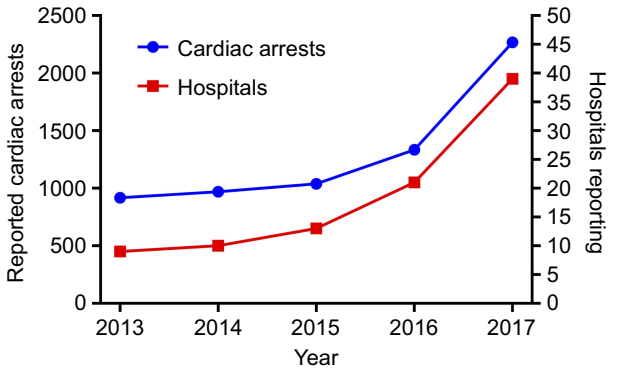

Figure 1 Number of reported cardiac arrests and reporting hospitals per year. The figure illustrates the number of reported cardiac arrests (blue circles, left *y*-axis) and the number of hospitals reporting at least one cardiac arrest per year (red squares, right *y*-axis). Only cardiac arrests with a clinical indication for cardiopulmonary resuscitation are included. In 2017, two hospitals were involved in the registry but had no in-hospital cardiac arrest.

Main variables

Quality indicators – process

There are four quality indicators related to processes of care (Table 2). The first is the proportion of patients with a witnessed cardiac arrest, and the second the proportion of patients with ECG-monitoring at the time of the cardiac arrest. These quality indicators were chosen based on international data indicating that both witnessed and monitored status is associated with improved outcomes after in-hospital cardiac arrest,[7–13] presumably due to faster treatment. The third quality indicator is the proportion of patients with the start of CPR ≤1 minute of recognition of cardiac arrest; and the fourth is the proportion of patients with time to the first rhythm analysis of ≤2 minutes. Early treatment of in-hospital cardiac arrest has been associated with improved outcomes.[14–17] It is, therefore, postulated that compliance with all these processes of care will be associated with improved outcomes.

Quality indicators – outcomes

The three outcomes indicators include the proportion of patients with return of spontaneous circulation, 30-day survival, and 1-year survival consistent with international practice.[18,19] Return of spontaneous circulation is defined as a palpable pulse (or other clear signs of circulation) sustained for at least 20 minutes without the need for chest compressions. Thirty-day and 1-year survival is obtained from the Danish Civil Registration System. In case a patient has multiple in-hospital cardiac arrests within a given year, only the first cardiac arrest is included for the outcome indicators.

Additional data

Data is collected on a number of different characteristics, including patient demographics (age, sex), cardiac arrest characteristics (eg, the initial rhythm, presumed cause), treatments (eg, drugs, airway managements), reasons for

Table 1 Data collected

Number	Variable	Options
1	Patient name and personal registration (CPR) number	Free text
2	Name of data collector+date	Free text+date
3	Location	• Emergency department • Outpatient clinic • Ward • Operation room • Post-anesthesia recovery room • Intensive care unit • Cardiac catherization laboratory • Neonatal ward • Other (free text)
4	Time cardiac arrest team called	Time+date
5.1	Cardiac arrest	• Yes • No
5.2	Clinical indication for CPR (ie, no prior "do-not-resuscitate" order)	• Yes • No
6.1	ECG-monitored	• Yes • No
6.2	Witnessed?	• Yes, professional • Yes, layperson • No
7	Cardiac arrest recognized by	• Professional • Layperson
8	CPR prior to arrival of the cardiac arrest team	• Chest compressions and ventilations • Compressions-only • Ventilations-only • None
9.1	Prior to arrival of the cardiac arrest team: First rhythm	• Non-shockable • Shockable • No rhythm analysis
9.2	Prior to arrival of the cardiac arrest team: First rhythm analysis done by	• AED • Manuel defibrillator • Other ECG-monitoring
9.3	Prior to arrival of the cardiac arrest team: First defibrillation with	• AED • Manuel defibrillator • No defibrillation • Other
10	First observed rhythm	• Ventricular fibrillation • Pulseless ventricular tachycardia • Pulseless electrical activity • Asystole • No manual analysis • Pulse-bearing rhythm
11	Patient status at the time of arrival of the cardiac arrest team: Cardiac arrest?	• Yes • No
12	Medication administered	• Adrenaline • Amiodaron • None • Other
13.1	Mechanical chest compressions	• Yes • No
13.2	Intubation prior to cardiac arrest	• Yes • No
13.3	Intubation during cardiac arrest	• Yes • No
13.4	Capnography	• Yes • No
14	Time of cardiac arrest recognition	Date+time
15	Time of chest compressions or ventilations	Time
16	Time of first rhythm analysis	Time
17	Time of first defibrillation	Time
18	Time of arrival of the cardiac arrest team	Time
19.1	Reason for termination of resuscitation attempt	• Return of spontaneous circulation • Artificial circulation[a] • Death
19.2	Time of termination of resuscitation attempt	Time
20	Cause of the cardiac arrest	• Non-cardiac • Presumed cardiac
21	Members of the cardiac arrest team	• Anesthesiologist • Nurse anesthetist • Cardiologist • Nurse • Service personnel • Other (free text)

Note: [a]eg, extracorporeal membrane oxygenation.
Abbreviations: AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; ECG, electrocardiogram.

termination of resuscitation, and the composition of the cardiac arrest team. See Table 1 for additional details. These variables were chosen by the steering committee (see below), based on relevance and feasibility, and with inspiration from other international registries and the Utstein guidelines.[18]

Table 2 Quality indicators in DANARREST[a]

Number	Indicator[b]	Type	Standard
1	Witnessed	Process	≥85%
2	ECG-monitored	Process	≥65%
3	Time from recognition of cardiac arrest to initiation of CPR ≤1 minutes	Process	≥90%
4	Time from recognition of cardiac arrest to first rhythm analysis ≤2 minutes	Process	≥90%
5	Return of spontaneous circulation	Outcome	≥55%
6	30-day survival	Outcome	≥30%
7	1-year survival	Outcome	≥20%

Notes: [a]As of January 1, 2017. [b]All indicators are reported as the proportion of patients who fulfilled the indicator.
Abbreviations: CPR, cardiopulmonary resuscitation; ECG, electrocardiogram.

Follow-up

All clinical data is collected immediately after the cardiac arrest. All follow-up data (ie, 30-day and 1-year survival) is obtained from the Danish Civil Registration System.

Completeness, missing data, and data validity

There is currently no known reliable source identifying all in-hospital cardiac arrests in Denmark, and any measure of the completeness of case entry is, therefore, an estimate. Based on such estimates from individual reporting hospitals (mainly based on the number of cardiac arrest calls), it is estimated that completeness in 2017 was 78%, although with great variation between hospitals and regions. This estimate should be interpreted very carefully, and efforts are ongoing to provide more precise estimates of completeness in the future.

Missing data is uncommon in the registry. In 2017, 96% of all registered in-hospital cardiac arrest with a clinical indication for CPR had no missing data at all.

Data validity is reliant on the accuracy of the data collected at the bedside by clinicians immediately after the cardiac arrest. Validity of data is optimized through ongoing instructions to data collectors, but has not been formally assessed. Efforts are ongoing to measure and optimize data validity, for example through automatic recording of time and built-in checks of data validity during data entry. As a consequence of the lack of a gold standard for synchronized time at present, time is reported in hours and minutes only.

Administrative issues and funding

Since 2016, DANARREST has been managed by the Danish Clinical Registries and is part of a group of clinical registries that are mandated by national law and funded by the Danish regions. The Danish Clinical Registries provides administrative, epidemiological, and biostatical support. The steering committee includes representatives from each of the five Danish regions and from the Danish Society of Cardiology, the Danish Society for Emergency Medicine, the Danish Society for Anesthesiology and Intensive Care, and the Danish Pediatric Society. In addition, the steering group consists of a representative for the region responsible for the database (Central Denmark Region), and a clinical epidemiologist.

Aggregated data at the hospital level with comments from the steering committee are published annually. In addition, data are provided monthly to relevant clinicians and hospital administrators. At the annual steering committee meeting, results are reviewed in order to add explanations and clinical interpretations. Here, it is also considered whether there is a need to change the quality indicators and/or standards (ie, the percentage cut-off).

Discussion

Over the last decades there has been an increased interest in tracking and reporting outcomes from in-hospital cardiac arrest through large registries. Such registries are currently available in multiple countries, including the US, UK, Germany, and Sweden.[20] Over the last 10 years, a local initiative to collect data on in-hospital cardiac arrest4 has developed into a nationwide quality-improvement registry in Denmark.

Data elements in DANARREST were originally chosen and are continuously updated based on a balance between relevance and feasibility, with the understanding that clinicians have limited time for comprehensive real-time data collection. In 1997 and 2004, international guidelines were published on the reporting of in-hospital cardiac arrest.[18,21] Reporting guidelines for out-of-hospital cardiac arrest were updated in 2015,[22] while updated guidelines specifically for in-hospital cardiac arrest are underway (personal communication, Jerry Nolan, March 2019). The DANARREST registry is largely consistent with the core variables suggested in the 2004 guidelines, and will continue to take into account updates of international reporting guidelines. The definition used for cardiac arrest is also largely consistent with international recommendation and

other registries.[23,24] International consistency in data collection and definitions will be valuable when comparing and contrasting data from different countries. It is important to note that many variables that are not part of DANARREST, for example comorbidities, post-cardiac arrest care, and long-term outcomes, can be obtained by linkage to other Danish registries.

Both pediatric and adult cardiac arrests are included in DANARREST. However, cardiac arrests in the delivery room are not included. It is well recognized that these situations are substantially different from other cardiac arrests in children, which is illustrated by different guidelines for neonatal resuscitation at the transition to life.[25] Capturing the nuances related to neonatal resuscitation in DANARREST was not considered to be feasible or meaningful.

DANARREST is a relatively new registry that has only recently achieved near-national coverage. There is, therefore, currently limited research utilizing DANARREST data. However, given the lack of randomized clinical trials within in-hospital cardiac arrest,26 much of the knowledge about cardiac arrest is obtained from large registries. For example, more than 80 research papers have been published from the US-based Get With The Guidelines – Resuscitation registry, and multiple articles have likewise been published from in-hospital registries in Sweden and the UK. The DANARREST dataset, which contains relatively granular clinical data, as well as complete follow-up on long-term survival, therefore has the opportunity to be a valuable resource for research in the future. This is particularly true given the opportunity to link the dataset with other Danish nationwide data sources, as has been illustrated with the Danish out-of-hospital cardiac arrest registry.[27,28] The combination of DANARREST and the Danish out-of-hospital cardiac arrest registry now covers all treated cardiac arrests in Denmark.

Conclusion

DANARREST is a relatively new national registry of in-hospital cardiac arrests in Denmark. The registry provides an opportunity to monitor and improve quality of care for patients with in-hospital cardiac arrest. Second, the registry will provide ongoing research opportunities. As of 2017, 95% of relevant hospitals were reporting data, with an estimated coverage rate of approximately 80%. Efforts are ongoing to improve data completeness and validity.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Holmberg M, Ross C, Chan P, et al. Incidence of adult in-hospital cardiac arrest in the united states (Abstract). American Heart Association Resuscitation Science Symposium. Chicago, IL, 2018.
2. *Svenska Hjärt-lungräddningsregistret*. Registercentrum Västra Götaland: Göteborg, 2017.
3. Benjamin EJ, Virani SS, Callaway CW, et al. Heart disease and stroke statistics-2018 update: a report from the American Heart Association. *Circulation*. 2018;137:e67–e492. doi:10.1161/CIR.0000000000000558
4. Vinther Krarup NH, Lofgren B, Hansen TK, Johnsen SP. [Registries of in-hospital cardiac arrest are a challenge in daily clinical practice]. *Ugeskr Laeger*. 2012;174:856–859.
5. Schmidt M, Schmidt SA, Sandegaard JL, Ehrenstein V, Pedersen L, Sorensen HT. The Danish national patient registry: a review of content, data quality, and research potential. *Clin Epidemiol*. 2015;7:449–490. doi:10.2147/CLEP.S91125
6. Pedersen CB. The Danish civil registration system. *Scand J Public Health*. 2011;39:22–25. doi:10.1177/1403494810387965
7. Saklayen M, Liss H, Markert R. In-hospital cardiopulmonary resuscitation. Survival in 1 hospital and literature review. *Medicine (Baltimore)*. 1995;74:163–175.
8. Weil MH, Fries M. In-hospital cardiac arrest. *Crit Care Med*. 2005;33:2825–2830.
9. Larkin GL, Copes WS, Nathanson BH, Kaye W. Pre-resuscitation factors associated with mortality in 49,130 cases of in-hospital cardiac arrest: a report from the national registry for cardiopulmonary resuscitation. *Resuscitation*. 2010;81:302–311. doi:10.1016/j.resuscitation.2009.11.021
10. Brady WJ, Gurka KK, Mehring B, Peberdy MA, O'Connor RE. American heart association's get with the guidelines I. In-hospital cardiac arrest: impact of monitoring and witnessed event on patient survival and neurologic status at hospital discharge. *Resuscitation*. 2011;82:845–852. doi:10.1016/j.resuscitation.2011.02.028
11. Cleverley K, Mousavi N, Stronger L, et al. The impact of telemetry on survival of in-hospital cardiac arrests in non-critical care patients. *Resuscitation*. 2013;84:878–882. doi:10.1016/j.resuscitation.2013.01.038
12. Perman SM, Stanton E, Soar J, et al. Location of in-hospital cardiac arrest in the United States-variability in event rate and outcomes. *J Am Heart Assoc*. 2016;5(10).
13. Chan PS, Spertus JA, Krumholz HM, et al. A validated prediction tool for initial survivors of in-hospital cardiac arrest. *Arch Intern Med*. 2012;172:947–953. doi:10.1001/archinternmed.2012.2050
14. Herlitz J, Bang A, Alsen B, Aune S. Characteristics and outcome among patients suffering from in hospital cardiac arrest in relation to the interval between collapse and start of CPR. *Resuscitation*. 2002;53:21–27.
15. Chan PS, Krumholz HM, Nichol G, Nallamothu BK. American heart association national registry of cardiopulmonary resuscitation I. Delayed time to defibrillation after in-hospital cardiac arrest. *N Engl J Med*. 2008;358:9–17. doi:10.1056/NEJMoa0706467
16. Andersen LW, Berg KM, Saindon BZ, et al. Time to epinephrine and survival after pediatric in-hospital cardiac arrest. *JAMA*. 2015;314:802–810. doi:10.1001/jama.2015.9678
17. Donnino MW, Salciccioli JD, Howell MD, et al. Time to administration of epinephrine and outcome after in-hospital cardiac arrest with non-shockable rhythms: retrospective analysis of large in-hospital data registry. *BMJ*. 2014;348:g3028. doi:10.1136/bmj.g3028

18. Jacobs I, Nadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the utstein templates for resuscitation registries. A statement for healthcare professionals from a task force of the international liaison committee on resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa). *Resuscitation*. 2004;63:233–249. doi:10.1016/j.resuscitation.2004.09.008
19. Haywood K, Whitehead L, Nadkarni VM, et al. COSCA (Core outcome set for cardiac arrest) in adults: an advisory statement from the international liaison committee on resus citation. *Resuscitation*. 2018;127:147–163. doi:10.1016/j.resuscitation.2018.03.022
20. Andersen LW, Holmberg MJ, Berg KM, et al. In-hospital cardiac arrest: a review. JAMA. 2019 Mar;321(12):1200–1210. doi:10.1001/jama.2019.1696. Review. PMID: 30912843
21. Cummins RO, Chamberlain D, Hazinski MF, et al. Recommended guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: the in-hospital 'Utstein style'. A statement for healthcare professionals from the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, the Australian Resuscitation Council, and the Resuscitation Councils of Southern Africa. *Resuscitation*. 1997;34:151–183.
22. Perkins GD, Jacobs IG, Nadkarni VM, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the utstein resuscitation registry templates for out-of-hospital cardiac arrest: a statement for healthcare professionals from a task force of the international liaison committee on resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association emergency cardiovascular care committee and the council on cardiopulmonary, critical care, perioperative and resuscitation. *Resuscitation*. 2015;96:328–340. doi:10.1016/j.resuscitation.2014.11.002
23. Morrison LJ, Neumar RW, Zimmerman JL, et al. Strategies for improving survival after in-hospital cardiac arrest in the United States: 2013 consensus recommendations: a consensus statement from the American Heart Association. *Circulation*. 2013;127:1538–1563. doi:10.1161/CIR.0b013e31828b2770
24. Nolan JP, Soar J, Smith GB, et al. Incidence and outcome of in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. *Resuscitation*. 2014;85:987–992. doi:10.1016/j.resuscitation.2014.04.002
25. Wyllie J, Bruinenberg J, Roehr CC, Rudiger M, Trevisanuto D, Urlesberger B. European resuscitation council guidelines for resuscitation 2015: section 7. Resuscitation and support of transition of babies at birth. *Resuscitation*. 2015;95:249–263. doi:10.1016/j.resuscitation.2015.07.029
26. Sinha SS, Sukul D, Lazarus JJ, et al. Identifying important gaps in randomized controlled trials of adult cardiac arrest treatments: a systematic review of the published literature. *Circ Cardiovasc Qual Outcomes*. 2016;9:749–756. doi:10.1161/CIRCOUTCOMES.116.002916
27. Kragholm K, Wissenberg M, Mortensen RN, et al. Bystander efforts and 1-year outcomes in out-of-hospital cardiac arrest. *N Engl J Med*. 2017;376:1737–1747. doi:10.1056/NEJMoa1601891
28. Wissenberg M, Lippert FK, Folke F, et al. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. *JAMA*. 2013;310:1377–1384. doi:10.1001/jama.2013.278483