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Clinical paper

Validity of out-of-hospital and in-hospital cardiac arrest algorithms in the Danish National Patient Registry

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Abstract

Aims: Cardiac arrest is registered in the Danish National Patient Registry (DNPR) with the International Classification of Diseases 10[th] revision code I46. However, it does not distinguish between out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA). We validated an algorithm to identify cardiac arrest subtypes (out-of-hospital vs. in-hospital).

Methods: From Aarhus University Hospital, Denmark, we sampled patients with a primary or secondary cardiac arrest discharge diagnosis during 2019–2023. The algorithm categorized these patients as OHCA if they (1) only had a single department course during their hospitalization or (2) had multiple department courses during their hospitalization but were discharged with a cardiac arrest diagnosis from the first department course. The algorithm categorized the remaining patients as IHCA. We randomly sampled 200 patients with algorithm-based OHCA (n = 100) and IHCA (n = 100). Using medical record review as the reference, we calculated positive predictive values (PPVs) with 95% confidence intervals (CIs).

Results: Cardiac arrest was confirmed in 192 of 200 cases, yielding a PPV for cardiac arrest overall of 96% (95% CI: 92–98%). The PPV was 87% (95% CI: 79–92%) for OHCA and 61% (95% CI: 51–70%) for IHCA. The results were robust in age and sex strata.

Conclusions: The validity of a cardiac arrest diagnosis in the DNPR was overall high. The algorithm to distinguish cardiac arrest subtypes showed a high PPV for OHCA but a poor PPV for IHCA.

Keywords: Cardiac arrest, Registries, Epidemiology, Data quality, Validation

Introduction

Patient registries are widely used for research across the world. With data collection since 1977, the Danish National Patient Registry (DNPR) is a unique patient registry and, therefore, a valuable data source for cardiovascular epidemiology in Denmark.[1] In the DNPR, cardiac arrest is registered with the International Classification of Diseases 10[th] revision (ICD-10) code I46, which is also used in registries in other countries.[2–4] However, this code does not differentiate between out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA).[5] Differentiating between OHCA and IHCA is prognostically important as the proportion of patients surviving to discharge is lower among patients with OHCA (9%) than IHCA (19%).[6] The lack of ICD-10 differentiation of OHCA and IHCA in patient registries limits their use for studying cardiac arrest hospitalization and mortality rates when cardiac arrest-specific registries are not linked. We, therefore, validated the cardiac arrest diagnosis in the DNPR, as well as an algorithm to distinguish subtypes of cardiac arrest (out-of-hospital vs. in-hospital).

Methods

Setting

Denmark is divided into five regions, each with one university hospital and several regional hospitals.[7] Our study was conducted with data from Aarhus University Hospital which is the only university hos-

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pital in the Central Denmark Region.[7] Each hospital contact is registered with one primary and optional secondary diagnoses. These diagnoses are automatically recorded in the DNPR — since 1977 for inpatient non-psychiatric contacts and since 1995 for inpatient psychiatric, outpatient clinic, and emergency room contacts.[1] Diagnoses have been classified in the DNPR according to the ICD-8 through 1993 and the Danish version of the ICD-10 thereafter.[1] Compared with the international ICD-10, the Danish version of the ICD-10 allows more detailed registration for some diseases.[1] All Danish residents receive at birth or upon immigration a unique Civil Personal Register number that permits individual-level data linkage.[8] Importantly, the Danish tax-supported healthcare system provides free access to general practitioners and hospitals to all legal residents.[7]

Cardiac arrest algorithm

Fig. 1 depicts the algorithm used to identify OHCA and IHCA in the DNPR. First, all patients with a primary or secondary discharge diagnosis of cardiac arrest (I46) were identified. Patients were then categorized as OHCA if they (1) only had a single department course during their hospitalization (irrespective of the department) or (2) had multiple department courses during their hospitalization but were discharged with a cardiac arrest diagnosis from the first department course. The remaining patients were categorized as IHCA.

Study design and cohort

We conducted a validation study. We sampled patients from Aarhus University Hospital with a primary or secondary cardiac arrest diagnosis in the DNPR during 2019–2023. We did not restrict on age. The sampling was performed according to the algorithm, so the cohort consisted of 100 patients with algorithm-based OHCA and 100 patients with algorithm-based IHCA. The patients in each group were selected randomly. The sample size was based on feasibility and prior experience.[9,10] Patients with multiple separate hospital contacts for cardiac arrest could potentially be sampled more than once. In this case, each included cardiac arrest was considered independently.

Medical record review

We used medical record review as the reference for the validation. Two investigators (KDB and SRP), blinded to the algorithm result, each reviewed all medical records to determine if each patient had a cardiac arrest and, if so, whether it occurred out-of-hospital or in-hospital. Each cardiac arrest was validated by assessing whether it had clinically been considered a cardiac arrest as stated in the medical records, *i.e.*, if a treating physician described the patient's condition as cardiac arrest. If a cardiac arrest was not evident from the medical record, it was classified as a *disproved* cardiac arrest. We further noted if a cardiac arrest was *probable*, indicating that the cardiac arrest was likely but could not be confirmed due to insufficient information in the medical records. If we, when reviewing the medical records, found that a patient had multiple cardiac arrests during the same hospital contact, we only considered the first cardiac arrest for validating the cardiac arrest subtype. In cases of uncertainty regarding the subtype and/or the correctness of the cardiac arrest diagnosis, a third independent investigator (MS) reviewed the medical records. A final decision was then reached through consensus.

Statistical analyses

We computed the positive predictive value (PPV) for cardiac arrest overall as the proportion of all included patients with a cardiac arrest diagnosis confirmed by the medical records. The PPV for OHCA was computed as the number of medical record-confirmed OHCAs divided by the sum of all algorithm-based OHCAs. The OHCAs that could not be confirmed in the medical records covered patients with IHCA or disproved cardiac arrest. The PPV for IHCA was computed correspondingly. We computed the 95% confidence intervals (CIs)

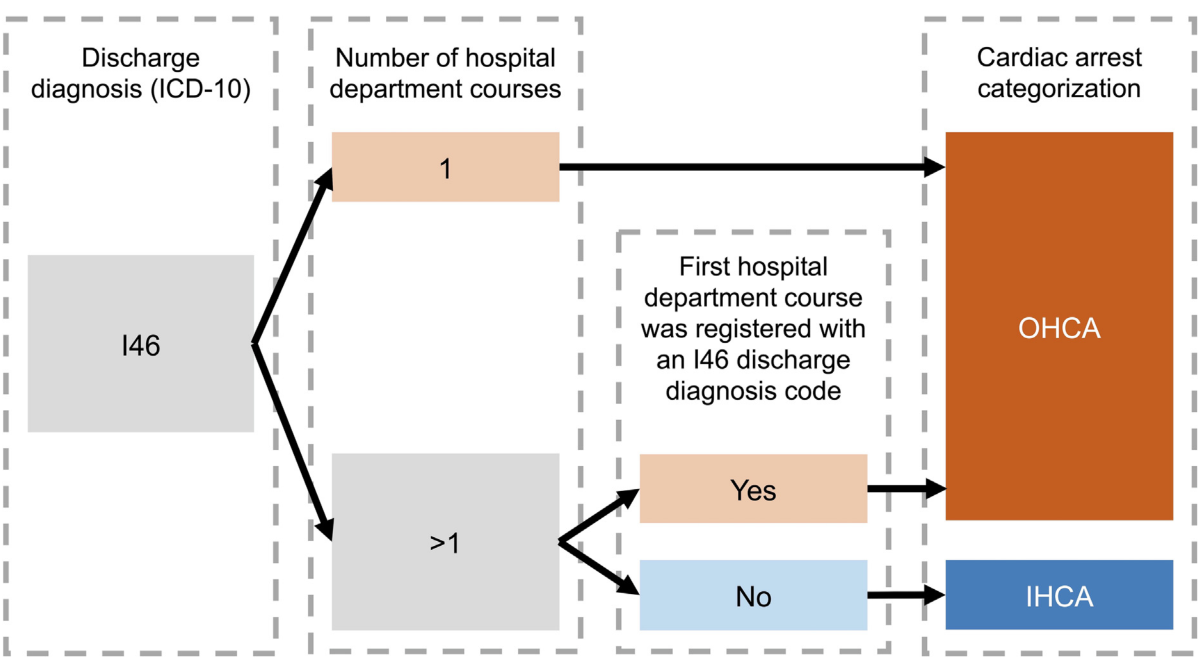

Fig. 1 – Flow diagram of the algorithm to identify out-of-hospital cardiac arrest and in-hospital cardiac arrest in the Danish National Patient Registry.
Abbreviations: ICD-10, International Classification of Diseases, 10th revision; IHCA, in-hospital cardiac arrest; OHCA, out-of-hospital cardiac arrest.

using the Wilson Score method.[11] We stratified the analyses by sex and age groups (<60, 60–69, or ≥70 years). As a sensitivity analysis, we computed worst-case PPVs by excluding probable cardiac arrests from the numerator.

Results

All 200 medical records were available for review. The study population consisted of 142 men and 58 women with a median age at admission of 66 years (interquartile range: 54–74). Six patients were under 18 years of age. For most patients, their medical records clearly stated if the cardiac arrest occurred out-of-hospital or in-hospital. Eight medical records were discussed with the third investigator to reach a consensus about the correctness and/or subtype of the cardiac arrest.

Table 1 presents the results of the validation of cardiac arrest overall and algorithm-based OHCA and IHCA. Cardiac arrest was confirmed in 192 of 200 cases, yielding a PPV of 96% (95% CI: 92–98%). The PPV was 87% (95% CI: 79–92%) for OHCA and 61% (95% CI: 51–70%) for IHCA. Incorrect algorithm-based cardiac arrest categorization was primarily due to incorrect subtype ($n = 10$ for OHCA; $n = 34$ for IHCA) and less due to disproved cardiac arrest ($n = 3$ for OHCA; $n = 5$ for IHCA).

The results remained consistent after stratification by sex and age (Table 2). Of note, we observed some potential variation in the PPV for IHCA according to age, with PPVs of 68% (95% CI: 53–80%) for patients ≥70 years of age, 50% (95% CI: 31–69%) for patients 60–69 years of age, and 59% (95% CI: 42–74%) for patients younger than 60 years of age.

Three cardiac arrests were categorized as *probable*. Here, the cardiac arrest occurred in another region/country, or it was not transparent from the medical record whether it was a cardiac arrest. Accordingly, the worst-case PPV was 95% (95% CI: 90–97%) for cardiac arrest overall, 86% (95% CI: 78–91%) for OHCA, and 61% (95% CI: 51–70%) for IHCA (eTable 1).

Discussion

In this first validation of an algorithm to identify OHCA and IHCA in the DNPR, we found that the algorithm had a high PPV for OHCA, whereas the PPV for IHCA was poor. We further demonstrated a high validity of cardiac arrest overall in the DNPR.

Previous literature

The cardiac arrest diagnosis has previously been validated in the DNPR. A study with patients diagnosed during 1993–2003 reported a PPV of 50% (95% CI: 34–66) for cardiac arrest.[12] However, one-third of the patients with cardiac arrest in that study were excluded from the analyses due to unavailable or insufficient medical records, leaving only 42 cardiac arrest patients for the analyses and raising concerns about possible selection bias.[12] Our PPV of 96% was markedly higher and more precisely estimated. Changes in coding practice over the past two decades and our restriction to a university hospital seem the most likely explanation for the observed difference. Supporting this hypothesis and our findings, a more recent study including 100 patients with an inpatient cardiac arrest diagnosis during 2010–2012 found a PPV of 94% (95% CI: 88–97%) for cardiac arrest.[9]

Outside of Denmark, other algorithms for identification of cardiac arrest subtypes have been used. In a Korean study, OHCA was defined as patients assigned a cardiac arrest or cardiopulmonary resuscitation code in an emergency room, which showed a PPV of 85%.[2] A Taiwan study developed and validated multiple case definition algorithms for OHCA based on ICD and billing codes.[4] Their best-performing algorithm during the ICD-10 era showed a PPV of 91%.[4] However, differences in registry structure and coding practices often restrict the applicability of such algorithms outside their original context.

Other cardiac arrest registries

In Denmark, health data are routinely collected through an extensive network of administrative, health, and clinical registries.[7] The DNPR is an administrative registry. As such, its main purpose is monitoring healthcare utilization relevant for healthcare planning rather than being a research tool.[1] In contrast, the main purpose of clinical registries is to collect detailed clinical data for clinical quality control.[7] Because of the detailed information in these databases, they contain large research potential.[13] The two main clinical registries for cardiac arrest in Denmark are the Danish Cardiac Arrest Registry[14] and the Danish in-hospital cardiac arrest registry (DANARREST)[15].

The Danish Cardiac Arrest Registry contains data on all persons who since 2001 have experienced an OHCA and received cardiopulmonary resuscitation or defibrillation by bystanders or emergency medical services personnel.[14] The registry has an assumed high completeness owing to nationwide coverage, but no reference exists to validate this assumption. It includes several variables with detailed information about parameters such as who witnessed the cardiac arrest, timing of cardiopulmonary resuscitation, and analysis of cardiac rhythm as well as multiple outcome measures.[14]

DANARREST contains information on IHCAs in Denmark with a clinical indication for cardiopulmonary resuscitation, except for neonates with cardiac arrest in the delivery room.[15] DANARREST contains a wide array of variables with detailed information, *e.g.*, about the location and time of the cardiac arrest, the resuscitation attempts,

Table 1 – Validation of the cardiac arrest diagnosis and algorithm-based out-of-hospital and in-hospital cardiac arrest in the Danish National Patient Registry.

Cardiac arrest algorithm	Reference (medical record review), n			Total, n	PPV, % (95% CI)[a]
	OHCA	IHCA	Disproved		
Overall	121	71	8	200	96 (92–98)
OHCA	87	10	3	100	87 (79–92)
IHCA	34	61	5	100	61 (51–70)

Notes: [a]Calculated using Wilson Score method.

Abbreviations: CI, confidence interval; IHCA, in-hospital cardiac arrest; n, number; OHCA, out-of-hospital cardiac arrest; PPV, positive predictive value.

Table 2 – Numbers of cardiac arrests and algorithm-based subtypes confirmed by medical records and corresponding positive predictive values in the Danish National Patient Registry stratified by sex and age.

Cardiac arrest algorithm	Confirmed by medical records, n	Total, n	PPV, % (95% CI)[a]
Men			
Overall	137	142	96 (92–98)
OHCA	70	80	88 (79–93)
IHCA	39	62	63 (50–74)
Women			
Overall	55	58	95 (86–98)
OHCA	17	20	85 (64–95)
IHCA	22	38	58 (42–72)
Age <60 years			
Overall	62	63	98 (92–100)
OHCA	27	31	87 (71–95)
IHCA	19	32	59 (42–74)
Age 60–69 years			
Overall	61	64	95 (87–98)
OHCA	35	40	88 (74–95)
IHCA	12	24	50 (31–69)
Age $\geq$70 years			
Overall	69	73	95 (87–98)
OHCA	25	29	86 (69–95)
IHCA	30	44	68 (53–80)

Notes: [a]Calculated using Wilson Score method.

Abbreviations: CI, confidence interval; IHCA, in-hospital cardiac arrest; n, number; OHCA, out-of-hospital cardiac arrest; PPV, positive predictive value.

and whether the cardiac arrest was witnessed.[15] The lack of a reference standard also makes the completeness of IHCA in DANARREST challenging to validate. However, using the number of IHCA calls plus the estimated number of IHCAs where a call was not set off as reference, the case entry completeness in DANARREST has been estimated at 94% in 2023,[16] indicating an increase from the 78% reported for 2017.[15]

Implications

As clinical registries with detailed patient data, the Danish Cardiac Arrest Registry and DANARREST may often be the first choice for cardiac arrest prognosis research. This validation does not suggest otherwise. However, when conducting non-cardiac arrest-specific research within the DNPR, information from the cardiac arrest-specific registries may not be available in many existing data sets due to separate data access. Thus, our algorithm may be used in such cases or when the cardiac arrest registries do not cover the desired study period. Additionally, our algorithm may increase the completeness of the clinical registries in studies where both data sources are available. Finally, the use of the ICD-10 code I46 to identify cardiac arrest in the DNPR and our algorithm to distinguish cardiac arrest subtypes enable studies of the long-term prognosis of OHCA and cardiac arrest overall.

Limitations

Some limitations must be considered. Sample size was based on feasibility and prior experience,[9,10] and not a formal power calculation. The statistical uncertainty is reflected by the width of the confidence intervals. Thus, although our results are most compatible with a PPV of 96% for cardiac arrest overall, our results are largely compatible with PPVs ranging from 92% to 98%,[17] which in any case supports high overall accuracy of the cardiac arrest coding. Due to the sampling method, it was not possible to estimate sensitivity and specificity.

The potential for selection bias was limited because of the complete availability of all medical records and the tax-supported healthcare system ensuring equal and free access to healthcare for all patients.[7]

As customary in validation studies, we used medical records as the reference, but their limitations must be considered. In clinical practice, uncertainties surrounding cardiac arrests are not uncommon. Regarding IHCAs, uncertainties may typically arise for patients without rhythm monitoring at the time of cardiac arrest. Especially in cases where the patient regained consciousness shortly after initiation of cardiopulmonary resuscitation, there may be uncertainty among clinicians about whether the event was a cardiac arrest. The medical records cannot compensate for such clinical uncertainty. Regarding OHCAs, medical records typically reflect the best available, but still potentially inaccurate or incomplete information provided by bystanders. Thus, we cannot rule out that the clinical evaluation, as reflected in the medical records, of cardiac arrests might be wrong in some cases. Finally, misclassification of cardiac arrest subtype in the medical records was not a concern because this parameter was easily assessable by both healthcare professionals and laymen.

The overall cardiac arrest PPV of 96% indicates that only around 4% of patients with the I46 diagnosis code did not have a cardiac arrest. When this code defines an exposure or outcome, such small misclassification will rarely impact effect estimates substantially.[18] Additionally, any misclassification will most likely be nondifferential, producing bias towards the null (underestimation), and thus cannot explain an observed association. Our restriction to a university hospital where the prevalence of cardiac arrest, and especially OHCA, may be higher compared with regional hospitals, may have increased the PPV compared with nationwide sampling. In accordance, a previous validation study showed that the PPV was higher at a university hospital (96%) compared with regional hospitals (88%).[9] The PPVs for algorithm-based OHCA and IHCA are partly dependent on the PPV for cardiac arrest overall. Thus, the higher the PPV for cardiac arrest, the better the performance of the algorithm. However, we note that the low PPV for IHCA was primarily caused by the algorithm misclassifying OHCAs (not disproved cardiac arrests) as IHCAs. This misclassification indicates a suboptimal completeness for OHCA despite the high PPV for OHCA. The acceptable levels of PPV and completeness generally depend on the specific objectives and design of a study. For instance, a high PPV is important in prognosis studies of patients with cardiac arrest,[9] while completeness is more critical when examining the incidence of cardiac arrest.

Regarding generalizability, the five regions in Denmark are very homogenous regarding both sociodemographic and health related characteristics.[19] Thus, we expect our findings to be generalizable to the other university hospitals in Denmark. Since very few children were included, the results were driven by adult patients. Our results relate to ICD-10; hence, it is unknown whether they also apply to other versions of the ICD (*e.g.* the 9th and 11th revisions). Our algorithm has already been implemented in a Danish study.[20] Whether it applies to other countries is to be confirmed. Of note, patient registries are often used for research in Europe, North America, Asia, and the Pacific. Correspondingly, the ICD-10 code for cardiac arrest overall (I46) has also been used for cardiac arrest research in other countries, such as Korea,[2] the United States,[3] and Taiwan,[4] emphasizing the potential applicability of our validation in other countries. Regardless, in light of the general need for better and more uniform methods to identify cardiac arrest subtypes in non-cardiac arrest registries, our algorithm offers a novel approach that may be a foundation for further development of cardiac arrest algorithms depending on the registry structure.

Conclusion

The validity of cardiac arrest in the Patient Registry in Denmark was overall high. While our algorithm could identify OHCA, cardiac arrest-specific clinical registries is needed for identifying IHCA.

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Contribution statement

KB and MS conceived the study idea. KDB, KB and MS designed the study. KDB and SRP performed the medical record review with assistance from MS in cases of doubt. KDB performed the analyses. All authors participated in the discussion and interpretation of the results. KDB organized the writing and wrote the initial drafts. All authors critically revised the manuscript for intellectual content and read and approved the final version of the manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. MS is the guarantor.

Data permission and ethics committee approval

In accordance with Danish law, no Ethics Committee approval was required. As part of quality control, the study was approved by the director of the participating hospital.

Transparency declaration

The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Data sharing

Not permitted.

Patient involvement statement

No patient involvement.

CRediT authorship contribution statement

Katrine D. Brodersen: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis. **Søren R. Petersen:** Writing – review & editing, Investigation. **Kasper Bonnesen:** Writing – review & editing, Visualization, Methodology, Conceptualization. **Christian J. Terkelsen:** Writing – review & editing. **Morten Schmidt:** Writing – review & editing, Visualization, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2024.100856.

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REFERENCES

1. Schmidt M, Schmidt SA, Sandegaard JL, Ehrenstein V, Pedersen L, Sørensen HT. The Danish National Patient Registry: a review of content, data quality, and research potential. Clin Epidemiol 2015;7:449–90.
2. Roh SY, Choi JI, Park SH, et al. The 10-year trend of out-of-hospital cardiac arrests: a Korean nationwide population-based study. Korean Circ J. 2021;51:866–74.
3. Arefin S, Alluri AA, Barua M, Patel TM, Kandhalu SK. Evaluation of mortality rate disparities for cardiac arrest between urban and rural cohorts in the United States using the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) database. Cureus 2024;16:e68803.
4. Tsai MJ, Tsai CH, Pan RC, Hsu CF, Sung SF. Validation of ICD-9-CM and ICD-10-CM diagnostic codes for identifying patients with out-of-hospital cardiac arrest in a national health insurance claims database. Clin Epidemiol 2022;14:721–30.
5. Birkun A. Updating the International Classification of Diseases: a potential way towards improving accountability and surveillance of cardiac arrest worldwide. Resuscitation 2020;146:1–2.
6. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart disease and stroke statistics-2023 update: a report from the American heart association. Circulation 2023;147:e93–e621.
7. Schmidt M, Schmidt SAJ, Adelborg K, et al. The Danish health care system and epidemiological research: from health care contacts to database records. Clin Epidemiol 2019;11:563–91.
8. Schmidt M, Pedersen L, Sørensen HT. The Danish Civil Registration System as a tool in epidemiology. Eur J Epidemiol 2014;29:541–9.
9. Sundbøll J, Adelborg K, Munch T, et al. Positive predictive value of cardiovascular diagnoses in the Danish National Patient Registry: a validation study. BMJ Open 2016;6:e012832.
10. Adelborg K, Sundbøll J, Munch T, et al. Positive predictive value of cardiac examination, procedure and surgery codes in the Danish National Patient Registry: a population-based validation study. BMJ Open 2016;6:e012817.
11. Wilson EB. Probable inference, the law of succession, and statistical inference. J Am Stat Assoc 1927;22:209–12.
12. Joensen AM, Jensen MK, Overvad K, et al. Predictive values of acute coronary syndrome discharge diagnoses differed in the Danish National Patient Registry. J Clin Epidemiol 2009;62:188–94.
13. Sørensen HT, Pedersen L, Jørgensen J, Ehrenstein V. Danish clinical quality databases - an important and untapped resource for clinical research. Clin Epidemiol 2016;8:425–7.
14. Jensen TW, Blomberg SN, Folke F, et al. The National Danish Cardiac Arrest Registry for out-of-hospital cardiac arrest - a registry in transformation. Clin Epidemiol 2022;14:949–57.
15. Andersen LW, Østergaard JN, Antonsen S, et al. The Danish in-hospital cardiac arrest registry (DANARREST). Clin Epidemiol 2019;11:397–402.
16. The Danish Clinical Quality Program – National Clinical Registries (in Danish, Regionernes Kliniske Kvalitetsudviklingsprogram, RKKP). DANARREST – In-hospital cardiac arrest, Annual report 2023, https://www.sundhed.dk/content/cms/83/70283_danarrest_aarsrapport2023_20240606_offentliggjort-version.pdf (June 6, 2024. Accessed December 1, 2024).
17. Schmidt M, Parner E. The conclusion generator. Ann Epidemiol 2024;97:33–7.
18. Gaster N, Hallas J, Pottegård A, Friis S, Schmidt M. The Validity of Danish prescription data to measure use of aspirin and other non-steroidal anti-inflammatory drugs and quantification of bias due to non-prescription drug use. Clin Epidemiol 2021;13:569–79.
19. Henriksen DP, Rasmussen L, Hansen MR, Hallas J, Pottegård A. Comparison of the five Danish regions regarding demographic characteristics, healthcare utilization, and medication use–a descriptive cross-sectional study. PLoS One 2015;10:e0140197.
20. Bonnesen K, Szépligeti SK, Szentkúti P, Horváth-Puhó E, Sørensen HT, Schmidt M. The impact of comorbidity burden on cardiac arrest mortality: a population-based cohort study. Resuscitation 2024;202:110352.