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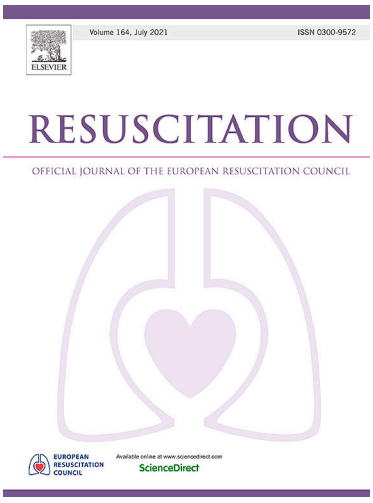

Review

Patient cohorts of interest in resuscitation science - Aligning Cardiac Arrest Registry Outputs with Stakeholder Needs

Ingvild Tjelmeland, Kristin Alm-Kruse, Lars-Jøran Andersson, Alf Inge Larsen, Thomas W. Lindner, Theresa Olasveengen, Jo Kramer-Johansen

PII: S0300-9572(25)00021-8
DOI: https://doi.org/10.1016/j.resuscitation.2025.110509
Reference: RESUS 110509

To appear in: *Resuscitation*

Received Date: 4 December 2024
Revised Date: 2 January 2025
Accepted Date: 10 January 2025

Please cite this article as: I. Tjelmeland, K. Alm-Kruse, L-J. Andersson, A.I. Larsen, T.W. Lindner, T. Olasveengen, J. Kramer-Johansen, Patient cohorts of interest in resuscitation science - Aligning Cardiac Arrest Registry Outputs with Stakeholder Needs, *Resuscitation* (2025), doi: https://doi.org/10.1016/j.resuscitation.2025.110509

Patient cohorts of interest in resuscitation science - Aligning Cardiac Arrest Registry Outputs with Stakeholder Needs

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Abstract word count: 250

Article Word count: 3206

Keywords: epidemiology, cardiology, cardiac arrest, registry, reporting

ABSTRACT

Introduction: Cardiac arrest registries can benchmark, enhance quality of care and provide data for research. Key stakeholders from Emergency Medical Communication Centre (EMCC), Emergency Medical Services (EMS), In-Hospital Care Providers (IHCP) and Recovery and Rehabilitation Providers (RRP) have different perspectives, and registry results and patient cohorts should be tailored to facilitate benchmarking, quality improvement projects and research in all sections of the chain of survival. In

this paper, we describe different cohorts of interest, exemplified by data from the Norwegian Cardiac Arrest Registry (NorCAR).

Method: Data from NorCAR for patients registered in 2022 is presented as descriptive statistics.

Results: The patient cohort with treatment initiated by EMCC comprised 3591 patients (67/100,000 inhabitants). EMS attended 4150 patients with confirmed cardiac arrest (77/100,000 inhabitants) and started cardiopulmonary resuscitation (CPR) in 3083 patients (57/100,000 inhabitants). The patient cohort eligible for treatment by IHCP consists of 1114 patients admitted to hospital alive or with ongoing CPR, along with 1230 in-hospital cardiac arrest cases. The cohort eligible for rehabilitation and follow-up consists of 1227 patients who were alive 24 hours after cardiac arrest, 705 out-of-hospital cardiac arrests and 522 in-hospital cardiac arrests.

Conclusion: It is essential to clearly define the cohort of interest when engaging with different stakeholders and to provide data that facilitates quality improvement projects in all areas of the chain of survival. We recommend defining several subgroups of cardiac arrest patients to accommodate benchmarking, quality improvement projects and research relevant for all stakeholders involved in resuscitation and care of cardiac arrest patients.

INTRODUCTION

The Global Resuscitation Alliance recommends establishing a cardiac arrest registry to improve survival after cardiac arrest. (1) The recent Lancet Commission (2) and current resuscitation guidelines (3) further endorses this. Cardiac arrest registries can monitor adherence to resuscitation guidelines and may identify time trends in incidence, treatment, and survival. Registries also provide data for benchmarking, quality improvement (QI), and research.

In research studies, careful consideration of patient selection is typically illustrated in a flowchart. When reporting cardiac arrest registry data to healthcare stakeholders, applying the same rigorous inclusion and exclusion criteria is essential to ensure relevance and actionable insights. A comprehensive understanding of potential reporting differences is crucial for meaningful insights into outcomes of out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA). However, only one internationally defined sub-group is recommended for comparing results across systems, namely survival in the Utstein comparator group consisting of patients with witnessed cardiac arrest and a shockable first rhythm. (4)

In this article, we underscore the indispensable role that cardiac arrest registries play in advancing the quality of care and providing critical data for benchmarking, QI and research projects, presenting a nuanced approach to tailoring registry outputs to meet the specific and distinct needs of key stakeholders in the Chain of Survival (5). We present results of interest to healthcare system stakeholders and illustrates how incidence and survival vary depending on the selected cohort. Data from the Norwegian Cardiac Arrest Registry (NorCAR) is used to demonstrate and recommend cohorts of patients.

METHOD

Stakeholders and cohorts of interest

The Chain of Survival refers to a chain of events that impact the outcome for individuals experiencing cardiac arrest. (5) Several versions of the Chain of Survival have been published, but the principle of timely interventions to improve outcomes continues to be a cornerstone. Although early recognition and early initiation of CPR and defibrillation improves survival, in-hospital care and rehabilitation also impact patient survival and quality of life after cardiac arrest.

The Chain of Survival is a useful framework to understand care and implement data driven quality improvement projects. The ability to address characteristics in each phase of care will aid in making the data relevant and recognisable to stakeholders. In our registry, we identified four groups of stakeholders within the healthcare system, where inclusion and exclusion criteria may differ: : Emergency Medical Communication Centres (EMCC), Emergency Medical Services (EMS), In-hospital Care Providers (IHCP) and Recovery and Rehabilitation Providers (RRP). (Figure 1)

EMCC is part of EMS in Norway, but this is not universal. In this article, EMS refers solely to ambulances (road and boat), air ambulances (rotor- and fixed-wing), and doctor-manned cars, excluding EMCC.

Emergency Medical Communication Centre

The cohort eligible for benchmarking, QI and research in EMCC comprises individuals who are unconscious and not breathing normally, where telephone-assisted cardiopulmonary resuscitation (T-CPR) is to be initiated. (6) It also includes individuals with OHCA not identified by EMCC during the initial call but subsequently identified on EMS arrival. Patients with cardiac arrest after the arrival of the ambulance are excluded from the EMCC cohort.

The proportions of patients with bystander CPR (B-CPR), with or without the application and use of an automatic external defibrillator (AED), may serve as indicators of public education and willingness to help, the accessibility of public AEDs and EMCC operational efficiency.

Emergency Medical Services

The cohorts eligible for benchmarking, QI and research in the EMS are confirmed OHCA, EMS-treated OHCA and the Utstein comparator group. The cohort of confirmed OHCA includes cases where EMS considers CPR to be futile, a do-not-resuscitate order already exists, or the patient has clear signs of death. Patients with spontaneous circulation upon EMS arrival after B-CPR but without evidence of cardiac arrest are omitted from this cohort. Patients with return of spontaneous circulation

(ROSC) after bystander defibrillation are considered to have a confirmed cardiac arrest, even though they do not have an EMS-treated cardiac arrest. (4)

In-hospital Care Providers

IHCP has two cohorts eligible for benchmarking, QI and research : patients arriving at hospital with ROSC or ongoing CPR, and patients with IHCA. OHCA patients transported to hospital for confirmation of death, but where no treatment is started or continued during transport, are excluded.

Addressing both OHCA and IHCA patients is vital for providing comprehensive and effective care, but the OHCA and IHCA patients differ and should be reported as two different cohorts. It is also important to acknowledge that the IHCA patients in specialised referral hospitals might differ from those of smaller local hospitals. Patients who experience cardiac arrest both outside and later inside the hospital should be included in both cohorts and may also warrant reporting as a separate cohort.

Recovery and Rehabilitation Providers

Two distinct cohorts of patients are eligible for benchmarking, QI and research by RRP: OHCA and IHCA patients surviving the event. In this paper, we have defined patients eligible for recovery and rehabilitation as patients who are alive 24 hours after cardiac arrests, including patients regardless of age or aetiology. RRP focuses not only on the immediate survival of these patients but also on long-term functional outcomes, quality of life, and reintegration into daily life and work.

Monitoring and supporting outcomes within these cohorts is critical for identifying effective rehabilitation practices, evaluating the impact of targeted interventions to enhance long-term survivorship and health-related quality of life, contributing to quality improvement and development of evidence-based practices within the broader field of cardiac arrest care.

Norway and the Norwegian Cardiac Arrest Registry

Norway is situated west on the Scandinavian peninsula and spans 2,271 km from the island of Svalbard (78°N) to Lindesnes (58°N) on the mainland, with a land area of 384,482 km². It is the 5th largest country in Europe, but only Iceland has a lower population density. There are 18 inhabitants per km², varying from 4.3 per km² in the north to 28.2 per km² in the southeast. (7) Most residents live along the coast, with 57 % concentrated in the southeastern region. The country's rugged terrain of mountains, fjords, over 230,000 islands, and extreme temperatures ranging from -40°C to +35°C pose unique challenges to the EMS healthcare system. (8)

Specialist healthcare is organised in four Regional Health Authorities, containing 19 local Health Trusts. (9) Norwegian residents are assigned an 11-digit personal

identifier at birth, which is used across public registries, including health systems. The identifier gives registries access to data about birth, name, address and date of death. Temporary or unknown residents receive provisional IDs when they are in contact with the healthcare system. Access to birth and death dates means that survival information is unknown only for temporary residents, or if a patient is entered into the registry without a known identity.

The Norwegian Cardiac Arrest Registry (NorCAR) was established in 2002 and was included in the Norwegian Cardiovascular Disease Registry in 2013, making cardiac arrest in Norway a reportable condition. (10) NorCAR collects information on both OHCA and IHCA. The registry includes information from EMCC, EMS, hospital records, and information from the patient on their health-related quality of life. (11-13) The Norwegian Cardiac Arrest Registry (NorCAR) has demonstrated a high level of case completeness (14) and validity of the data (15).

All EMCC-assessed patients who are unresponsive, without normal breathing, and who received bystander CPR or where T-CPR is initiated are included, even if EMS does not start CPR. In addition, all EMS-confirmed cardiac arrest cases are included. All patients with an IHCA who receive defibrillation or CPR for more than 30 seconds are also included in the registry. Patients who get CPR or defibrillation despite having a do-not-resuscitate order are included if they meet the relevant criteria. (10)

Statistical methods

According to the data distribution, descriptive measures are provided as mean with standard deviation (SD) or median with interquartile range (IQR). EMS-witnessed OHCA cases are subtracted from the denominator when calculating bystander CPR rates.

Variables included in this paper have no missing information as they are defined as core elements and a run sheet cannot be finalised without information on all core variables. Records marked as “Unknown” were retained in the denominator, and their impact on results are noted in table legends if excluding them impacts results.

Ethical considerations and data protection

Results in this study consist of aggregated results from NorCAR; no ethical approval was needed.

RESULTS

Emergency Medical Communication Centre

In Norway in 2022, the cohort of patients eligible for benchmarking, QI and research in EMCC contained 3591 patients, with bystander CPR rates of 83 %. The incidence was 67 per 100,000 inhabitants. (Table 1)

Emergency Medical Services

The EMS-confirmed cardiac arrest cohort contained 4150 patients (incidence 77 per 100,000 inhabitants), with a bystander rate of 65 %. The incidence of the EMS-treated cohort was 57 per 100,000 inhabitants and bystander CPR rate was 78 %. The Utstein comparator group cohort consisted of 475 patients. (Table 2)

In-hospital Care Providers

A total of 1114 patients were transported to hospital after OHCA. The incidence was 21 per 100,000 inhabitants, there was a B-CPR rate of 79 % and survival to 30 days was 8.3 per 100,000 inhabitants. A total of 447 patients survived to 30 days, out of whom 28 were patients successfully resuscitated by an AED before EMS arrival (Table 3).

The incidence in the IHCA cohort was 122 per 1,000 hospital beds, and survival to one year was 29 per 1,000 hospital beds. The incidence per 10,000 discharged patients was 17, and survival to 1 year was 4.1. (Table 4) Some patients have more than one IHCA resulting in 1340 registered events (incidence per 1,000 hospital beds of 133). One patient can only survive once; therefore, we report ROSC for all events, but alive at 30 days and one year related to the number of patients. 120 patients had an OHCA and, subsequently, an IHCA event.

Recovery and rehabilitation providers

The number of patients alive 24 hours after OHCA were 705, and survivors to 24 hours after IHCA was 522 patients (Table 4), giving a total of 1227 24-hours-survivors in the two cohorts.

Patients surviving 30 days after OHCA and IHCA constitute a cohort eligible for neurological assessment at discharge. NorCAR collects information about cerebral performance category (CPC) at discharge and patient-reported health-related quality of life 3 months post-arrest. Patients surviving to discharge after OHCA were reported to have CPC 1 or 2, considered to be a good neurological outcome, in 90 % of the cases where CPC was reported (missing data 7 %). Patients surviving to discharge after IHCA were reported to have CPC 1 or 2 in 85 % of the cases where CPC was reported (missing data 12 %).

A total of 350 OHCA survivors and 242 IHCA survivors received a health-related quality-of-life form, with response rates of 64 % and 63 %, respectively. Additional data on quality-of-life information from Norwegian survivors has been published previously. (13)

DISCUSSION

This paper demonstrates how some characteristics and outcomes vary depending on the stakeholders and inclusion and exclusion in the cohort relevant for benchmarking, QI and research projects. Cohort selection was tailored to address various perspectives in the treatment of OHCA and IHCA by stakeholders, including EMCC, EMS, IHCP and RRP. The total burden of disease of OHCA (77 per 100,000 inhabitants) and IHCA (23 per 100,000 inhabitants) is 100 per 100,000 inhabitants in Norway. Patients surviving to 24 hours, and who are the eligible for inclusion in the cohort for RRP, has an incidence of 23 per 100,000 inhabitants.

Emergency Medical Communication Centres

The Utstein recommendations for reporting start with all EMS-confirmed cardiac arrest cases. (12) This definition omits patients important for the EMCC, namely those who receive T-CPR or B-CPR without continued EMS treatment due to the patient being alive on the first assessment. Using the Utstein recommendation alone fails to identify EMCC's over-triage, precluding important improvement work in EMCC, public awareness, and training campaigns. On the other hand, if we include all EMCC-suspected OHCA, we also include patients receiving bystander CPR, later found to have spontaneous circulation on EMS arrival. The number of patients in this group may be higher in settings where bystander willingness and confidence in providing CPR is high, and where T-CPR is integrated into EMCC. If the patient has a pulse on the first assessment by EMS, it is not possible for the EMS to confirm the arrest. Most of these patients survive irrespective of the provided treatment, and calculating OHCA survival including this cohort, inflates both incidence and survival numbers. In our example, the reported rate of patients alive at 30 days and one year for the EMCC cohort was 16 and 14 per 100,000 inhabitants. This is substantially higher than the survival rate of patients who received CPR by EMS, where survival to 30 days and one year was 8.4 and 7.7, respectively.

EMCC under-triage of OHCA has been described in many systems (16) and represents patients in cardiac arrest when assessed by EMS but not recognised by EMCC. Under-triage in EMCC results in delayed start of CPR and reduced survival. As for EMCC over-triage described above, a problem arises if the EMS cohort includes patients who are declared dead on EMS arrival. A recent paper from Denmark found that patients with bystander CPR only, dying on the same day as the ambulance mission, comprised 5.7 %, equivalent to 10 per 100,000 per year in their system. (17)

In the latest Utstein update, it was recommended that a specific subgroup of patients - those successfully resuscitated by a shock from an AED without CPR by EMS – be included in the EMS-treated cohort. (4) However, whether these patients have been

consistently classified as confirmed cardiac arrest cases across different registries remains unclear. In our registry, 28 out of 416 (7 %) survivors are patients from this group. According to the inclusion criteria, these patients are included in the Danish, Swedish and German registries, but the exact number of patients is not reported.

Emergency Medical Services

Patient groups eligible for benchmarking, QI and research projects in the EMS include all EMS-assessed cardiac arrest patients. According to the Utstein definition, only confirmed cardiac arrests should be included. As discussed above, both inclusion of "EMCC over-triage" and heterogeneous interpretation of "dead-on-EMS-arrival" might partly explain the significant variation in the incidence of EMS-treated patients and the incidence of survival reported worldwide. (18, 19)

A study comparing data from registries in Germany and Norway emphasises the importance of comparing the overall incidence and survival based on the population served rather than relying on percentages of EMS-treated patients. (20) Unintentional differences in the cohort of patients, including inclusion and exclusion criteria, definitions and cultural differences, complicate comparisons across countries. A good system description is needed when comparing results, and additional core items have been added in the latest Utstein update. (4)

Guidelines for reporting results from cardiac arrest registries are based on consensus processes inspired by the original Utstein meetings. (11, 21) The Utstein comparator group is an example of a narrowly defined subgroup of patients with witnessed cardiac arrest and shockable initial rhythm. This group constitutes a minor proportion of the patients, 475 of 4150 (11 %) EMS-confirmed cardiac arrests. Treatment and results in this group may not reflect efforts to improve care for the entire cohort of cardiac arrest patients. However, it defines a group of patients that may be compared across systems and is useful in avoiding incorrect interpretations of differences.

In-hospital Care Providers

In some countries and regions, patients are not declared dead on scene but are transported to hospital. For these countries, the reported number of EMS treated and transported to hospital will differ from countries with possibility for termination of resuscitation outside hospital. In Norway, ambulance personnel can terminate resuscitation without the physical presence of a physician. Such regulatory characteristics contribute to high survival rates among patients admitted to hospitals as irrevocably dead patients are removed both in the nominator and the denominator. In the EuReCa two study, survival rate is 26 % for all patients admitted to hospital alive or with ongoing CPR. (19) In Norway in 2022, this was 56 %. Survival after hospital admission depends not only on prehospital practices but evidence suggests that centralisation to cardiac arrest centres might be beneficial. (22) An essential requirement for such conclusions is the selection process in deciding patient destination after ROSC. This decision may rely on rules based on clinical characteristics, but geographic and administrative organisational factors may equally affect selection.

Patient selection also affects the risk for IHCA at each hospital. In Norway, a complex system of primary, secondary, and tertiary hospital functions adds to the geographical factors in selecting the hospital for any admission. In some regions, the geography necessitates small hospitals with a broad range of capabilities. In contrast, specialisation and sub-specialisation contribute to patient selection into different hospitals in more densely populated regions. Comparisons between hospitals and studies must, therefore, be done cautiously.

There is a connection between OHCA and IHCA. Several OHCA patients have a new cardiac arrest after hospital admission, and some patients are admitted with ongoing CPR. We found 120 OHCA patients with ROSC on arrival at hospital that subsequent had an IHCA event. This constitutes 11 % of all OHCA patients admitted to hospital. For IHCP, the distinction between OHCA and IHCA may become blurred and less interesting when evaluating their performance. However, the patients are two very different cohorts, and the Norwegian registry reports OHCA as a separate cohort from IHCA.

Recovery and Rehabilitation Providers

Research studies and registries on OHCA have predominantly emphasised survival rates and functional outcomes. (22) However, there is a growing focus on understanding how patients personally perceive outcomes, incorporating elements related to health (23) and quality of life (13). Survival alone does not give us insight into a patient's need for rehabilitation and follow-up. In addition, it is valuable to identify patients who are not assessed or followed up, and do not respond to health-related quality-of-life questionnaires, as these patients may differ substantially from those who respond to such assessments.

Within a clinical setting, quality-of-life questionnaires evaluate the lasting impact of cardiac arrest and contribute valuable insights for guiding the selection of appropriate care pathways. Cardiac arrest survival and outcomes are relevant to assessing the public health impact, resource allocation and policy development, economic impact on society, community awareness and education, and monitoring of healthcare and medical interventions. (24)

Strengths and limitations

Registries, which encompass all patients, offer generalisability to the studied population. However, the challenge lies in ensuring complete data capture and avoiding selection bias. Numerous OHCA registries face limitations in accessing data from EMCCs or hospitals, posing challenges in reporting to all stakeholder groups. A feasible approach involves transparently outlining included patients and refraining from asserting the ability to report to stakeholders beyond the confines of our restricted dataset.

CONCLUSION

In cardiac arrest quality improvement and research, accurately defining and reporting distinct cohorts is crucial for the validity and applicability of results. The variability of outcomes across different cohorts highlights the importance of careful selection and standardisation in defining and reporting cardiac arrest cases, promoting impactful contributions to public health, resource allocation, and policy development. To support benchmarking, QI and research projects, , we recommend addressing all links in the chain of survival and defining four groups of stakeholders: EMCC, EMS, IHCP and RRP. Within each stakeholder area, there are also cohorts of patients that should be reported separately, encompassing not only patients with witnessed cardiac arrest and shockable rhythm but also additional cohorts tailored to the interests of various stakeholders. Understanding and reporting the correct cohorts directly impacts the validity of conclusions, generalisability, reproducibility and applicability of results.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Data availability: The data that support the findings of this study are available from the Norwegian Cardiac Arrest Registry through an application to the Norwegian Institute of Public health. Restrictions apply to the availability of these data, as only aggregated data can be shared unless there is an approval from an ethical committee and the steering committee of the registry.

Conflict of interest:

Ingvild Tjelmeland: None

Kristin Alm-Kruse: Limited project grants from the Division of Prehospital services and the Division of Emergencies and Critical Care, Oslo University Hospital, Norway. Travel grants from Forskerforbundet – The Norwegian Research Union and Sykepleierforbundet – The Norwegian Nursing Union.

Lars-Jøran Andersson: None

Alf Inge Larsen: None

Thomas W. Lindner: None

Theresa Olasveengen: None

Jo Kramer-Johansen: None

Credit author statement

Ingvild Tjelmeland; contributed in the conception, planning, design, acquisition of data, analysis and interpretation of data, first draft of article, revision of draft and approval of final manuscript.

Kristin Alm-Kruse: contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Lars-Jøran Andersson: contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Alf Inge Larsen; contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Thomas W. Lindner: contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Theresa Olasveengen; contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Jo Kramer-Johansen; contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Acknowledgements: We wish to acknowledge the steering committee of NorCAR that are not co-authors on this paper but who contributed to the conception of the paper: Eirik Skogvoll, Torill Andersen, Jarle Jortveit and Arne Ketil Hafstad.

Declaration of Interest Statement

Ingvild Tjelmeland: Daily manager of the Norwegian Cardiac Arrest Registry. Member of the study management team of the European Registry of Cardiac Arrest. Author on the ILCOR Scientific Statement; Cardiac arrest and cardiopulmonary resuscitation: 2024 update of the Utstein Out-of-Hospital Cardiac Arrest Registry Template.

Kristin Alm-Kruse: None

Lars-Jøran Andersson: Member of the steering committee for the Norwegian Cardiac Arrest Registry.

Alf Inge Larsen: Member of the steering committee for the Norwegian Cardiac Arrest Registry.

Thomas W. Lindner: Member of the steering committee for the Norwegian Cardiac Arrest Registry.

Theresa Olasveengen: Member of the steering committee for the Norwegian Cardiac Arrest Registry. Board Member, Laerdal Foundation. Member of the editorial board of Resuscitation and Resuscitation Pluss.

Jo Kramer-Johansen: Member of the steering committee for the Norwegian Cardiac Arrest Registry.

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TABLES AND FIGURES

Figure 1: The cohort of patients for stakeholders in Emergency Medical Communication Centres (EMCC), Emergency Medical Services (EMS), in-hospital care providers and recovery and rehabilitation providers.

1. Patients suspected of cardiac arrest by EMCC but alive on EMS arrival.

2. Patients shocked by a defibrillator before EMS arrival and who have a pulse on first assessment by EMS.

3. Patients with suspected cardiac arrest by EMCC who are confirmed dead on EMS arrival.

4. EMS-treated cardiac arrest patients.

5. EMS-treated cardiac arrest patients not recognised by EMCC.

6. EMS-witnessed cardiac arrest patients.

7. In-hospital cardiac arrests.

8. Survivors after out-of-hospital or in-hospital cardiac arrest.

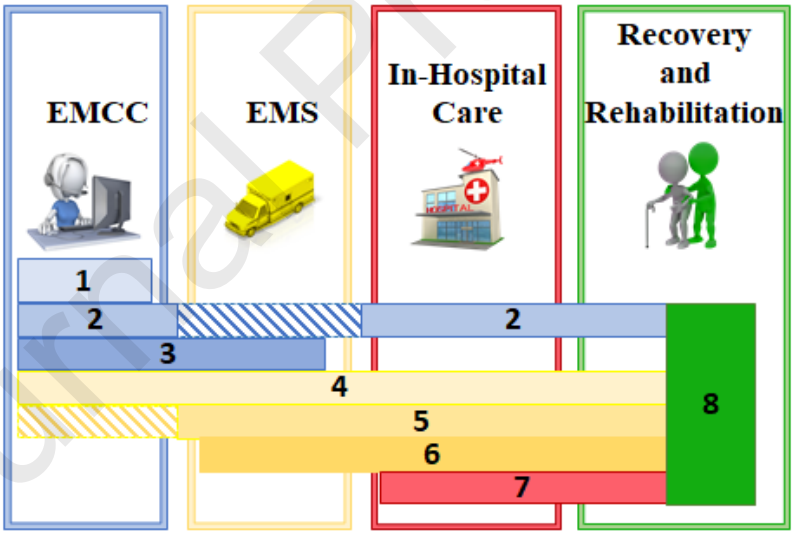

Table 1: Patients suspected of having a cardiac arrest by EMCC or confirmed cardiac arrest by emergency medical services in Norway in 2022.

	EMCC suspected cardiac arrests, n		**Incidence***
Total population in Norway in 2022	**5.4 million**		
Total number of patients	3591		67
Age, median (IQR) Missing: 12	68 (53,78)		
Gender male	2446	68 %	45
Place of cardiac arrest, home	2405	67 %	45
Presumed cardiac cause	2241	62 %	42
Not recognised by EMCC	41	1 %	1
EMS response interval # in minutes, median (IQR)**	9 (6.5,14)		
Bystander CPR	2978	83 %	55
Subgroups			0
EMS-treated patients	2681	75 %	50
Dead on EMS arrival and no EMS treatment	323	9 %	6
Alive on EMS arrival and *not* defibrillated by an AED	559	16 %	10
Shocked by AED and ROSC before EMS arrival	28	1 %	1
Outcome			

ROSC after EMS treatment	950	26 %	18
Alive at 30 days	838	23 %	16
Alive at 1 year**	773	22 %	14

Table 1: The population covered in 2022 was 5.4 million. Emergency Medical Communication Centre – EMCC, Cardiopulmonary Resuscitation - CPR, Emergency Medical Services – EMS, Return of Spontaneous Circulation – ROSC, Automated External Defibrillator – AED. * Incidence per 100,000 inhabitants in the catchment area of the EMS. **Unknown alive at 1 year =22 patients. # Response interval is the time interval from call received in EMCC to EMS arrival at defined address.

Table 2: Cardiac arrests confirmed by EMS, treated by EMS and the Utstein comparator group.

	EMS confirmed OHCA patients		**Incidence***	**EMS treated OHCA patients**		**Incidence***	**Utstein comparator group[$]**		**Incidence***
Total number of patients	**4150**		**77**	**3083**		**57**	**475**		**8.8**
Age, median	70 (57,79)			70 (57,79)			68 (58,76)		
Gender, male	2815	68 %	52	2151	70 %	40	395	83 %	7.3
Place of cardiac arrest, home	2888	70 %	53	2027	66 %	38	278	59 %	5.1
Presumed cardiac cause	2830	68 %	52	2121	69 %	39	453	95 %	8.4
EMS witnessed cardiac arrest	396	10 %	7.3	374	12 %	6.9			
EMS response interval[#], minutes, median (IQR)**	9.5 (7,15)			9.6 (7,15)			8.8 (7,13)		

Bystander CPR**	2430	65 %	45	2098	78 %	39	427	90 %	7.9
EMS-treated patients	3055	81 %	57	3055		57	447	94 %	8.3
Dead on EMS arrival and no EMS treatment	1067	26 %	20	-					
Shocked by AED and ROSC before EMS arrival	28	1 %	0.5	28	1 %	0.5	28	6 %	0.5
ROSC after EMS treatment	1164	28 %	22	1164	38 %	22	328	69 %	6.1
Alive at 30 days	452	11 %	8.4	452	15 %	8.4	198	42 %	3.7
Alive at 1 year	416***	10 %	7.7	416****	13 %	7.7	190	40 %	3.5

Table 2: The population covered in 2022 was 5.4 million. Emergency Medical Services – EMS, Out-of-hospital cardiac arrest – OHCA, Cardiopulmonary Resuscitation - CPR, Return of Spontaneous Circulation – ROSC, Automated External Defibrillator – AED, na – not applicable. * Incidence per 100,000 inhabitants in the catchment area of the EMS ** EMS witnessed cardiac arrests excluded. ***Unknown alive at 1 year EMS confirmed cases = 13. **** Unknown alive at 1 year EMS treated cases = 11. # Response interval is the time interval from call received in EMCC to EMS arrival at defined address. $ Utstein comparator group – patients with witnessed cardiac arrest and first rhythm is shockable.

Table 3: Out-of-hospital cardiac arrest patients treated by EMS and admitted to hospital, and out-of-hospital cardiac arrest patients alive 24 hours after cardiac arrest.

	OHCA patients admitted to hospital		Incidence*	OHCA patients alive at 24 hours		Incidence*
Total number of patients	**1114**		**21**	**705**		**13**
Age, median	66 (53,76)			63 (51,74)		
Gender, male	804	72 %	15	516	73 %	10
Place of cardiac arrest, home	624	56 %	12	387	55 %	7.2
Presumed cardiac cause	764	69 %	14	500	71 %	9.3
EMS witnessed cardiac arrest	212	19 %	3.9	136	19 %	2.5
EMS response interval[#] , minutes, median (IQR)**	9 (6,14)			9 (6,13)		
Bystander CPR**	715	79 %	13	476	84 %	8.8
EMS-treated patients	1086	97 %	20	677	96 %	13

Dead on EMS arrival and no EMS treatment	na			na		
Shocked by AED and ROSC before EMS arrival	28	3 %	0.5	28	4 %	0.5
ROSC after EMS treatment	962	86 %	18	658	93 %	12
Alive at 30 days	447	40 %	8.3	447	63 %	8.3
Alive at 1 year***	411	37 %	7.6	411	58 %	7.6

Table 3: The population covered in 2022 was 5.4 million. Emergency Medical Services – EMS, Out-of-hospital cardiac arrest – OHCA, Cardiopulmonary Resuscitation - CPR, Return of Spontaneous Circulation – ROSC, Automated External Defibrillator – AED, na – not applicable. * Incidence per 100,000 inhabitants in the catchment area of the EMS. ** EMS witnessed cardiac arrests excluded. ***Unknown alive at 1 year = 12 # Response interval is the time interval from call received in EMCC to EMS arrival at defined address.

Table 4: In-hospital cardiac arrest patients, and in-hospital cardiac arrest patients alive 24 hours after cardiac arrest.

	IHCA patients		**Incidence per 1,000 hospital beds**	**Incidence per 10,000 discharged patients**	**Incidence per 100,000 inhabitants**	**IHCA patients alive at 24 hours**		**Incidence per 1,000 hospital beds**	**Incidence per 10,000 discharged patients**	**Incidence per 100,000 inhabitants**
Total number of patients	**1230**		**122**	**17**	**23**	**522**		**52**	**7.2**	**9.7**
Age, median	73 (63,80)					68 (59,77)				
Gender, male	805	65 %	80	11		356	68 %	35	4.9	
Alive at 30 days	358	29 %	36	4.9	6.6	358	69 %	35	4.9	4.9
Alive at 1 year	295	24 %	29	4.1	5.5	295	57 %	29	4.1	4.1
Number of cardiac arrest events	**1341**		**133**	**19**	**25**	**599**		**60**	**8.3**	**8.3**

Place of cardiac arrest; hospital ward	525	39 %	52	7.3	10	174	29 %	17	2.4	2.4
Presumed cardiac cause	893	67 %	89	12	17	418	70 %	42	5.8	5.8
ROSC	711	53 %	71	10	13	na		na	na	na

Table 4: The total number of hospital beds was 10,049, and the number of discharged patients was 724,044. The population of Norway in 2022 was 5.4 million. In-hospital cardiac arrest – IHCA. Return of Spontaneo us Circulation – ROSC

Conflict of interest statement

Ingvild Tjelmeland: None

Kristin Alm-Kruse: Limited project grants from the Division of Prehospital services and the Division of Emergencies and Critical Care, Oslo University Hospital, Norway. Travel grants from Forskerforbundet – The Norwegian Research Union and Sykepleierforbundet – The Norwegian Nursing Union.

Lars-Jøran Andersson: None

Alf Inge Larsen: None

Thomas W. Lindner: None

Theresa Olasveengen: None

Jo Kramer-Johansen: None

Credit author statement - Defining apples and oranges to avoid fruit salad – patient cohorts of interest in resuscitation science

Ingvild Tjelmeland; contributed in the conception, planning, design, acquisition of data, analysis and interpretation of data, first draft of article, revision of draft and approval of final manuscript.

Kristin Alm-Kruse: contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Lars-Jøran Andersson: contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Alf Inge Larsen; contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Thomas W. Lindner: contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Theresa Olasveengen; contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Jo Kramer-Johansen; contributed in the conception, planning, design, first draft of article, revision of draft and approval of final manuscript.

Acknowledgements: We wish to acknowledge the steering committee of NorCAR that are not co-authors on this paper but who contributed to the conception of the paper: Eirik Skogvoll, Torill Andersen, Jarle Jortveit and Arne Ketil Hafstad.

Declaration of interest statement

Ingvild Tjelmeland: Daily manager of the Norwegian Cardiac Arrest Registry. Member of the study management team of the European Registry of Cardiac Arrest. Author on the ILCOR Scientific Statement; Cardiac arrest and cardiopulmonary resuscitation: 2024 update of the Utstein Out-of-Hospital Cardiac Arrest Registry Template.

Kristin Alm-Kruse: None

Lars-Jøran Andersson: Member of the steering committee for the Norwegian Cardiac Arrest Registry.

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