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Clinical paper

The German Resuscitation Registry – Epidemiological data for out-of-hospital and in-hospital cardiac arrest



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Abstract

Introduction: The German Resuscitation Registry was started in 2007 and collects data on out-of-hospital as well as in-hospital cardiac arrest and resuscitation. It has collected more than 400.000 datasets till today.

Methods: The German Resuscitation Registry (GRR) is a voluntary quality improvement tool and research tool for out-of-hospital and in-hospital resuscitation as well as in-hospital emergency treatment. It collects data for initial treatment, in-hospital care as well as long-term outcome in an online database. For risk stratification two scores have been developed, published, and implemented. The participants are getting annual and monthly or quarterly reports in addition to the standardized online, 24/7 available analyzing options. An annual public report is published as well. We are reporting on the OHCA annual report of 2022.

Results: In 2022 the incidence of CPR started or continued by EMS was 77.6/100.000 inhabitants/year. The mean age was 70.2 years and 66.7% were male bystanders who started CPR in 51.3%. The average response time for the first EMS vehicle to arrive on scene was 6:55 min.

In 57.9% of the cases, they had a presumed cardiac cause. The primary outcome, return-of-spontaneous circulation (ROSC) was achieved in 42.1%.

Discussion: With its more than 450.000 included datasets, the GRR is an established tool for quality improvement and research in Germany and internationally. The results for the incidence of OHCA and outcome from 2022 are compared to EuReCa TWO data ranging in the upper third of European countries. Furthermore, the GRR has contributed to increasing knowledge of OHCA by conducting and publishing research e.g. on epidemiology, airway management, and medication of OHCA.

Keywords: German resuscitation registry, Out-of-hospital cardiac arrest, Epidemiology, In-Hospital Cardiac Arrest, Resuscitation

Introduction

The German Resuscitation Registry (GRR) was officially launched in 2007 at the German Anesthesia Congress in Hamburg, Germany. It represents a continuation of an initiative of the German Society for Anesthesiology and Intensive Care Medicine (DGAI) to implement a nationwide interdisciplinary resuscitation registry in 2003 and is still operated by the DGAI today.¹ In 2007 the first participants were the emergency medical services (EMS) in the cities of Dortmund, Bonn, Wismar, Gelsenkirchen, and the county of Lueneburg. The GRR has grown continuously. Up to date 225 EMS, 123 Cardiac Arrest Center, and 228 hospitals are participating in the registry.

With its more than 450.000 data records the GRR has become an indispensable quality management instrument for the care of patients with in-hospital emergencies and with in- and after out-of-hospital cardiac arrest (OHCA) in Germany, Austria, and Switzerland. This contributes to process optimization and patient safety in CPR both in emergency medical services and in hospitals.

The GRR first started with the collection of prehospital OHCA care data (Erstversorgungsdatensatz EV).² This dataset (EV) was based, as were the following data set definitions, on the Utstein style.³ Through this comparison and evaluation of the data with worldwide datasets is possible and international scientific collaboration is enabled. The original prehospital OHCA dataset has been repeatedly adapted in recent years in line with the latest scientific

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findings and following intensive discussions with the participants of the GRR and in consideration of the current Utstein recommendations. In the last version, the prehospital dataset consists of 118 variables concentrating on prehospital care, logistic issues such as presumed etiology, primary rhythm, or use of intraosseous-access (IO-access).

Since 2007 the GRR has constantly changed and improved. For example, the prehospital OHCA dataset was supplemented by an in-hospital follow-up and a long-term follow-up dataset (Weiterversorgungsdatsatz WV and Langzeitverlauf LV), respectively. This made it possible to record the outcome of the OHCA patients in a structured way and thus make them analyzable.⁴

The datasets were continuously updated and adapted to current medical developments: Since the year 2021, the GRR has provided a special dataset for quality management in Cardiac Arrest Centers (WV CAC).⁵

In addition, evaluation has expanded by the developed optional modules, such as a dataset for out-of-hospital ventilation quality, and the recording of resuscitation measures guided by telephone, temperature management, or extracorporeal cardiopulmonary resuscitation (eCPR). The participating emergency medical services and clinics have online access to all standard and additional evaluation instruments for their quality management.

For a long time, in-hospital emergency care was not standardized in hospitals in Germany and the recording of such events was unsystematic. For the first time, the German Resuscitation Registry developed a documentation protocol for all emergency medical team interventions based on the data sets for in-hospital cardiac arrest (IHCA) and resuscitation.⁶ In addition to the time and reason for the operation, the dataset includes information on the emergency event, the measures taken, and the further procedure. This expansion of the German Resuscitation Registry enables hospitals to better evaluate the work of medical emergency teams to prevent IHCA and thus improve patient safety. In addition, this dataset has made it possible for the first time to gain important insights into in-hospital emergency care in Germany.⁷

In compliance with German data protection regulations, the German Resuscitation Registry can evaluate patient care from the onset of cardiac arrest to the discharge from hospital care.

Methods

The GRR collects data on OHCA, IHCA, and in-hospital emergency treatment, respectively as EMS local authorities can participate. Furthermore, hospitals can subscribe to participate with their respective emergency teams. Data is then collected by EMS units, usually by the EMS physician on scene, or emergency teams in the hospital.

How the data sets get into the German resuscitation registry

In addition to the manual input option of paper-based protocols into the GRR, users also have a variety of digital solutions: For example, most manufacturers of electronic patient documentation systems in EMS have certified interfaces for the electronic transmission of validated data records to the GRR. Also in the area of inpatient emergency care, the first digital solutions are already available. The GRR user interface is shown in Fig. 1 and a test database can be reached through the webpage <https://www.reanimationsregister.de>.

All cases of OHCA attended by an EMS can be enrolled in the registry when core variables are documented. The same applies to cases of IHCA or in-hospital emergency treatment. Usually, data is collected by the responding team, either manually or electronically captured and, in a second step, entered into the database.

After the manual input or import to the database, all cases are checked and approved by the locally responsible doctors or medical leaders. The data is then available for quality management and health services research.

To ensure a high data quality automated quality checks were implemented. It is automatically checked by the database that the required dataset definitions are met. Data that does not meet the data definition cannot be entered into the database. Automated cross-checks e.g. of process variables are implemented. Furthermore, incomplete datasets where core data elements are missing are not eligible for approval through the onsite responsible person and cannot be used for further analyses or automated reports.

Inclusion and exclusion criteria

All cases of OHCA and IHCA, irrespective of age and cause of cardiac arrest attended by an EMS or in-hospital emergency team are eligible for inclusion in the registry. Furthermore, data of all patients attended by an in-hospital emergency team, and not being in cardiac arrest are meeting inclusion criteria.

The online database is the heart of the German Resuscitation Registry

The online database is the core of the GRR. It offers users a multitude of online available evaluation options from the field of benchmarking. Various analyses can be used to generate information on percentages and incidences, frequency tables, and graphical representations. In addition, longitudinal processes over several years can be evaluated. In this way, a comparison of the performance of one's site with the performance of other sites can be made possible quickly and easily. A wide range of quality indicators from the areas of structural, process, and outcome quality are available for evaluation. The sites can also use an extensive rights and roles concept from the input to the evaluation of the data records.

RACA- and CRASS-score

Based on the existing data sets the German Resuscitation Registry was able to develop two own scoring systems, the RACA score and the CRASS, for quality management.

The RACA score (ROSC After Cardiac Arrest score) – enables the comparison between observed and predicted ROSC rates.⁸ It determines a ROSC probability based on all variables available when the emergency medical service arrives on the scene. This enables risk-adjusted assessments of EMS measures and the overall quality of the EMS.

With the CaRdiac Arrest Survival- Score (CRASS) a tool for calculating the probability of survival with good neurological function for patients hospitalized after cardiac arrest is established.⁹ This score is calculated from the variables known on admission to the hospital and thus enables an assessment of the therapy within the hospital until discharge. For the first time, this score also enables the inclusion of patients who were admitted to the hospital with ongoing resuscitation.

Both scores are an integral part of the GRR evaluation and reporting system and serve quality management both in the EMS as well as in the hospitals.

EV Reanimation präklinisch – Neues Protokoll erstellen

Stammdaten | Patienteninformation | Vermutete Ursache / Vorerkrankungen | Daten und Zeiten | Einsatzortbeschreibung | Ärztliche Qualifikation

Erstbefunde | Kernmaßnahmen und Ablauf | Weitere Maßnahmen Technik | Weitere Maßnahmen Medikamente | Defiauswertung

Ergebnis Reanimation / Primäres Reanimationsergebnis | Übergabe | Qualitätsmanagement | MTR | TelefonCPR | MGD | Gerätedaten | MBE | Beatmung CPR

Einsatzdatum *

Standortkennung *

Patientenidentifikation

Geburtsdatum * Alter geschätzt **Alter des Patienten (Jahre) ***

Geburtsdatum/Alter unbekannt

Das Geburtsdatum wird aus datenschutzrechtlichen Gründen beim Speichern auf den ersten Tag des Monats gerundet.

Altersgruppen Pädiatrie 1-7 Tage 8-28 Tage

Geschlecht * männlich weiblich

Protokollnummer

Rettungsmittel Bodengebunden (z.B. RTW, NEF, NAW) RTH/ITH

NEF Kennung

Fig. 1 – German Resuscitation Registry user interface.

Evaluation of the database

Each participating site receives comprehensive annual reports and statistics, in which all recorded items are evaluated and anonymously benchmarked with other sites. These annual reports are supplemented by a visually appealing short overview, from which the most important quality indicators can be quickly taken. In addition, the ambulance and emergency medical services receive monthly reports, and the clinical sites a quarterly reports as interim evaluations.

In addition, the German Resuscitation Registry publishes annual reports for the scientific community on the one hand and the public on the other, in which the most important key figures on the process and outcome quality of the registry are presented in a generally understandable way. As key figures we are presenting basic epidemiological data (e.g. incidence of OHCA and CPR started, age and gender distribution, first ECG), bystander CPR and dispatcher-assisted CPR rates, location of arrest, cause of OHCA, response time interval, and EMS interventions as well as outcome parameters (ROSC, ROSC on admission to hospital, 24 h survival and discharged alive).

To increase data quality a so-called reference group was defined and established within the database. The reference group includes only EMS systems that fulfill the following quality makers: incidence

CPR started > 30/100.000/inhabitants/year, ROSC < 80%, RACA score calculable in >60% of the cases, documented follow up for in-hospital treatment and outcome > 30%.

Ethical considerations

The GRR is collecting completely anonymized routine data from EMS and hospitals. The date of birth is collected as the first of the month of birth. No personalized data is collected. Ethical approval for the registry was granted by the ethics committee of the University of Kiel, medical faculty (ref. D432/13).

Results

Annually the German Resuscitation Registry evaluates the data of the participating sites in the form of an annual report. These annual reports are published with a focus on outpatient and inpatient resuscitation, intraclinical resuscitation care, and clinical care in the Cardiac Arrest Center. All are published open-access in the DGAI-journal Anesthesiology and Critical Care (ISSN 1439-0256 (online) ISSN 0170-5334 (Print)). They also provide the data basis for public annual reports, which are written in layperson understandable language and published on the website of the German Resuscitation Registry (<https://www.reanimationsregister.de>) website.

In 2022 the registry collected data from 18.830 OHCA patients, thereof 7.747 were included in our reference group. Following we will report on the reference group data. In 2022 the incidence of CPR started or continued by EMS was 77.6/100,000 inhabitants/year. The mean age was 70.2 years and 1.3% of the cases were younger than 18 years and 34.3% older than 80 years of age. In 66.7% the patients were male and the first ECG rhythm was shockable in 19.8%. Bystanders started CPR in 51.3% and thereof a dispatcher-assisted CPR was documented in 30.9% (Fig. 2). In 65.4% the arrest took place at home (Fig. 3) and the average response time for the first EMS vehicle to arrive at the scene was 6:55 min, respectively.

Fig. 4 shows by whom the event was witnessed.

In 57.9% of the cases, they had a presumed cardiac cause. The primary outcome, return-of-spontaneous circulation (ROSC) was achieved in 42.1%. Hospital admission with ROSC, 24-hour survival, and survival at hospital discharge were achieved at 32,8%, 21,1%, and 10,7% respectively (Fig. 5). The incidence of hospital discharge/30-day survival reached 8.3 patients / 10.000 inhabitants/year.

Furthermore, the German Reanimation Registry operates its own social media channels, to inform the interested public on the importance of e.g. lay resuscitation measures and to publish interesting facts and figures from the German Resuscitation Registry.

Discussion

With an incidence of started CPR of 77.6/100.000 inhabitants/year in 2022, CPR is started as frequently as in other European countries compared to the EuReCa TWO data. Within the last decade, bystander CPR has increased in Germany significantly and thus has reached a level that is comparable to other countries in Europe and North America,^{13,14} but still, it is below the average of 58% in Europe and still work is to do to shorten the resuscitation free interval. When comparing outcome parameters like ROSC, ROSC on admission, and hospital discharge compared to EuReCa ONE and TWO data for 2022 the results from the German registry are ranging in the upper range of countries.

Furthermore, the entire GRR database is available on request to all participants for scientific work. From the data sets of the –RR – in cooperation with a wide range of participants – a large number of nationally and internationally published papers on epidemiology, treatment, and outcome of cardiac arrest are available. The focal points of these recent publications were the impact of gender or airway management on resuscitation success,^{15,16} or on the use of IO vs IV access,¹⁷ or the use of mechanical chest compression devices [8–10], as well as on special circumstances e.g. poisoning.^{18,19}

With being not solely a platform for quality improvement, but also a platform for research it is possible to use real-life registry data for epidemiological studies. With the above-mentioned publications and projects registries and scientists working with registry data can contribute to the gain of knowledge and improvement of care in emergency medicine. Furthermore, it is of note that registry data reflects the real-life situation independently from clinical studies, and is, therefore, a valuable scientific tool.

The German Resuscitation Registry regularly participates in activities of the European Resuscitation Registry EuReCa and takes part in international collaborations outside Europe. Therefore, participants of the GRR are agreeing to share their data with the respective EuReCa studies. Doing so, the GRR has contributed to three large-scale epidemiological studies on OHCA treatment and survival within the last few years and contributed to enhancing the understanding of OHCA treatment and EMS organization throughout Europe. With the EuReCa TWO study, a large cohort on bystander CPR was evaluated.

Results of the studies from the German Resuscitation Registry were acknowledged by the ERC-Guidelines on Resuscitation and thus helped expand knowledge on CPR.

The German Resuscitation Registry continues to grow. From the original five founding sites, it has now grown to more than 450 participating emergency medical services, hospital-cardiac arrest teams, and Cardiac Arrest Centers.

The participating sites come from all over Germany, Austria and Switzerland.

In the future, the German Resuscitation Registry will increasingly serve to support the development of local and regional quality networks. As a cross-sectoral quality improvement tool, it is particularly suitable for this purpose, for this other players such as dispatch centers or app-alarmed first-responder systems should be included in the data collection and evaluation.

In the future, the German Resuscitation Registry will collect and calculate more sophisticated risk assessments of patients and processes. Therefore, data of all players involved in cardiac arrest treatment will be further merged. This will make even more detailed analyses possible, which in turn can reveal more optimization potential.

Limitations

A major limitation of every registry is a potential inclusion and reporting bias. To address this issue we have included certain quality proof mechanisms in our database. Furthermore, the GRR does not cover all German EMS and hospitals, since it is for them voluntarily to par-



Fig. 2 – Bystander CPR in Germany in 2022.

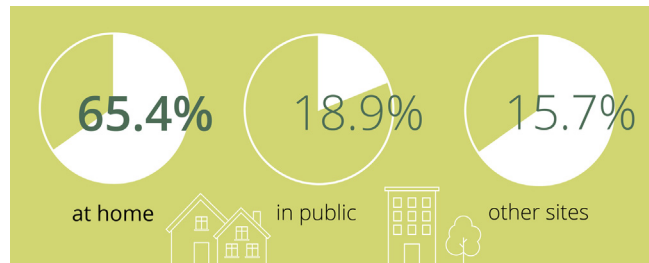


Fig. 3 – Place of OHCA in Germany in 2022.

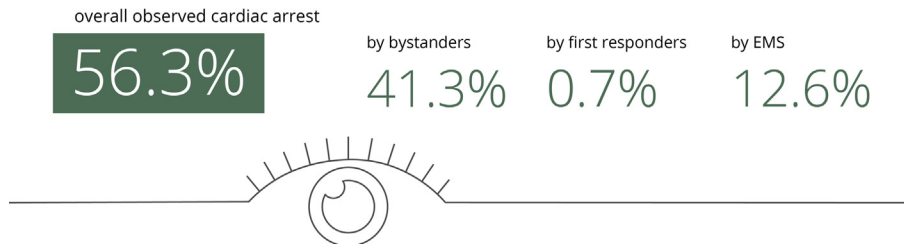


Fig. 4 – Rate of witnessed OHCA in 2022.

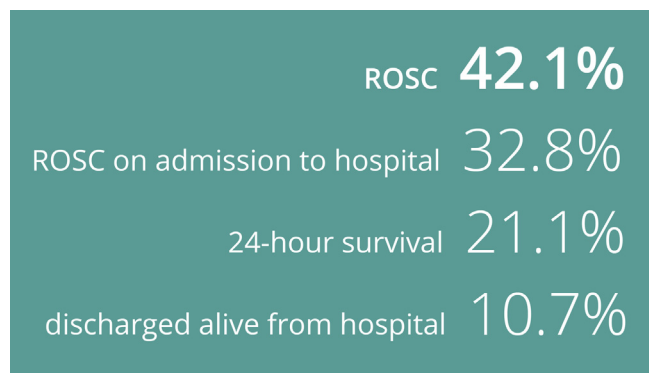


Fig. 5 – Observed outcome after resuscitation in Germany in 2022.

ticipate in the registry. But with the coverage of almost 30 Mio inhabitants, the GRR represents a representative sample of the German population. In addition, an automated direct import of all OHCA and IHCA cases of all participants would be desirable to ensure the completeness of data.

Conclusion

With a total of more than 450.000 datasets on IHCA and OHCA included in the registry the GRR is one of the biggest resuscitation databases in Europe and is comparable to other huge registries worldwide. On this background, the GRR is a well-evaluated platform to inform the medical community and the public on the epidemiology and outcome of IHCA and OHCA as well as to be a well-known and used research platform.

CRediT authorship contribution statement

Jan Wnent: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Jan-Thorsten Gräsner:** Writing – review & editing, Project administration, Funding acquisition. **Matthias Fischer:** Writing – review & editing. **Alexandra Ramshorn-Zimmer:** Writing – review & editing. **Andreas Bohn:** Writing – review & editing. **Berthold Bein:** Writing – review & editing. **Stephan Seewald:** Writing – original draft, Visualization, Methodology, Investigation.

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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REFERENCES

- Gräsner JT, Messelken M, Scholz J, Fischer M. Das Reanimationsregister der DGAI. *Anästh Intensivmed* 2006;47:630–1.
- Gräsner JT, Meybohm P, Fischer M, et al. A national resuscitation registry of out-of-hospital cardiac arrest in Germany—a pilot study. *Resuscitation* 2009;80:199–203.
- Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: the Utstein style. Prepared by a Task Force of Representatives from the European Resuscitation Council, American Heart Association, Heart and Stroke Foundation of Canada, Australian Resuscitation Council. *Resuscitation* 1991;22:1–26.
- Gräsner JT, Messelken M, Fischer M, Jantzen T, Bahr J, Böttiger BW, et al. Das DGAI-Reanimationsregister – Die Datensätze „Weiterversorgung“ und „Langzeitverlauf“. *Anesthesiol Intensivmed Notfallmed Schmerzther* 2008;43:706–9.
- Seewald S, Jakisch B, Gräsner JT, et al. Strukturierte Datenerfassung nach erfolgter Reanimation: Datensatz Cardiac Arrest Center. *Anästh Intensivmed* 2020;61:V1–3.
- Jantzen T et al. The in-hospital emergency protocol. *Anästh Intensivmed* 2011;52:723–6.
- Jansen G et al. Indications and measures of medical emergency teams: a retrospective evaluation of in-hospital emergency operations of the German Resuscitation Register. *Minerva Anestesiol* 2022. <https://doi.org/10.23736/S0375-9393.22.16665-4>.
- Gräsner JT, Meybohm P, Lefering R, et al. ROSC after cardiac arrest – the RACA score to predict outcome after out-of-hospital cardiac arrest. *Eur Heart J* 2011;32:1649–56.
- Seewald S, Wnent J, Lefering R, et al. CaRdiac Arrest Survival Score (CRASS) – A tool to predict good neurological outcome after out-of-hospital cardiac arrest. *Resuscitation* 2020;146:66–73.
- Gräsner JT, Lefering R, Koster RW, et al. EuReCa ONE-27 Nations, ONE Europe, ONE Registry: A prospective one month analysis of out-of-hospital cardiac arrest outcomes in 27 countries in Europe. *Resuscitation* 2016;105:188–95.
- Gräsner JT, Wnent J, Herlitz J, et al. Survival after out-of-hospital cardiac arrest in Europe - Results of the EuReCa TWO study. *Resuscitation* 2020;148:218–26.
- Böckler B, Preisner A, Bathe J, et al. Gender-related differences in adults concerning frequency, survival and treatment quality after out-of-hospital cardiac arrest (OHCA): An observational cohort study from the German resuscitation registry. *Resuscitation* 2023;194:110060.
- Knapp J, Huber M, Gräsner JT, Bernhard M, Fischer M. Outcome differences between PARAMEDIC2 and the German Resuscitation Registry: a secondary analysis of a randomized controlled trial compared with registry data. *Eur J Emerg Med* 2022;29(6):421–30.
- Monaco T, Fischer M, Michael M, Hubar I, Westenfeld R, Rauch S. Impact of the route of adrenaline administration in patients suffering from out-of-hospital cardiac arrest on 30-day survival with good neurological outcome (ETIVIO study). *Scand J Trauma Resusc Emerg Med* 2023;31:14.
- Hüser C, Baumgärtel M, Ristau P, et al. Higher chance of survival in patients with out-of-hospital cardiac arrest attributed to poisoning. *Resuscitation* 2022;175:96–104.
- Gässler H, Fischer M, Wnent J, Seewald S, Helm M. Outcome after pre-hospital cardiac arrest in accordance with the underlying cause. *Resuscitation* 2019;138:36–41.

FURTHER READING

- Behrens NH, Fischer M, Krieger T, et al. Effect of airway management strategies during resuscitation from out-of-hospital cardiac arrest on clinical outcome: A registry-based analysis. *Resuscitation* 2020;152:157–64.
- Seewald S, Obermaier M, Lefering R, et al. Application of mechanical cardiopulmonary resuscitation devices and their value in out-of-hospital cardiac arrest: A retrospective analysis of the German Resuscitation Registry. *PloS one* 2019;14:e0208113.
- Wnent J, Franz R, Seewald S, et al. Difficult intubation and outcome after out-of-hospital cardiac arrest: a registry-based analysis. *Scand J Trauma Resusc Emerg Med* 2015;23:43.