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Review

Incidence, characteristics, and outcome of out-of-hospital cardiac arrest in Italy: A systematic review and meta-analysis

Tommaso Scquizzato [a], Lorenzo Gamberini [b,], Sonia D'Arrigo [c], Alessandro Galazzi [d], Giovanni Babini [e], Rosario Losiggio [a], Guglielmo Imbriaco [f,g], Francesca Fumagalli [h], Alberto Cucino [i], Giovanni Landoni [a], Andrea Scapigliati [c], Giuseppe Ristagno [e,j], Federico Semeraro [b], Collaborators [1]*

Abstract

Introduction: Data on out-of-hospital cardiac arrest (OHCA) is limited in Italy, and there has never been a comprehensive systematic appraisal of the available evidence. Therefore, this review aims to explore the incidence, characteristics, and outcome of OHCA in Italy.

Methods: We systematically searched PubMed, Embase, Google Scholar, ResearchGate, and conference proceedings up to September 23, 2022. Studies investigating OHCA in Italy and reporting at least one outcome related to cardiac arrest were considered eligible. The primary outcome was survival at the longest follow-up available. Risk of bias was assessed using the Joanna Briggs Institute critical appraisal tool. A random-effects model proportion meta-analysis was performed to calculate the pooled outcomes with 95% confidence interval (CI).

Results: We included 42 studies (43,042 patients) from 13 of the 20 Italian regions published between 1995 and 2022. Only five studies were deemed to be at low risk of bias. The overall average incidences of OHCA attended by emergency medical services and with resuscitation attempted were 86 (range: 10–190) and 55 (range: 6–108) per 100,000 populations per year, respectively. Survival at the longest follow-up available was 9.0% (95% CI, 6.7–12%; 30 studies and 15,195 patients) in the overall population, 25% (95% CI, 21–30%; 16 studies and 2,863 patients) among patients with shockable rhythms, 28% (95% CI, 20–37%; 8 studies and 1,292 patients) among the Utstein comparator group. Favourable neurological outcome was 5.0% (95% CI, 3.6–6.6%; 16 studies and 9,675 patients). Return of spontaneous circulation was achieved in 19% (95% CI, 16–23%; 40 studies and 30,875 patients) of cases. Bystanders initiated cardiopulmonary resuscitation in 26% (95% CI, 21–32%; 33 studies and 23,491 patients) of cases but only in 3.2% (95% CI, 1.9–4.9%; 9 studies and 8,508 patients) with an automated external defibrillator. The mean response time was 10.2 (95% CI, 8.9–11.4; 25 studies and 23,997 patients) minutes.

Conclusions: Survival after OHCA in Italy occurred in one of every ten patients. Bystanders initiated cardiopulmonary resuscitation in only one-third of cases, rarely with a defibrillator. Different areas of the country collected data, but an essential part of the population was not included. There was high heterogeneity and large variation in outcomes results and reporting, limiting the confidence in the estimates of incidence and outcome. Creating and maintaining a nationwide registry is a priority.

Introduction

Out-of-hospital cardiac arrest (OHCA) is a major health problem worldwide, affecting 275,000 individuals annually in Europe and 420,000 in the United States.[1–3] The estimated annual incidence of emergency medical services (EMS)-treated OHCA has been reported as 41 individuals per 100,000 person-years in Europe, 47 in North America, 46 in Asia, and 51 in Australia.[4] The incidence in Europe was recently reported during EuReCa ONE in 2014 and EuReCa TWO in 2017 and was 84 and 56 per 100,000 population per year, respectively.[2,5] The outcome is generally poor, but a

* Corresponding author at: Department of Anaesthesia, Intensive Care and Emergency Medical Services Maggiore Hospital, Bologna, Italy.
E-mail address: lorenzo.gamberini@ausl.bologna.it (L. Gamberini).

[1] Collaborators are listed in Appendix A at the end of the article.

https://doi.org/10.1016/j.resplu.2022.100329
Received 5 October 2022; Received in revised form 27 October 2022; Accepted 28 October 2022

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substantial variation is reported across regions, suggesting opportunities for improvement.[2,5–6]

The first report from the International Liaison Committee on Resuscitation (ILCOR) from nine national and seven regional cardiac arrest registries across the world showed a wide variation among nations and regions in survival rate (ranging from 3.1 to 20.4 %) and favorable neurological outcome (ranging from 2.8 to 18.2 %) at hospital discharge or 30 days after EMS-treated OHCA.[7] Cardiac arrest registries are recommended by current European Resuscitation Council (ERC) guidelines,[1] since they are at the root of population and health services interventions of growing complexity such as prevention and screening programs,[8] public access to defibrillators (PAD) logistics,[9] first responder programs and EMS performance optimization.[10]

Due to a lack of a nationwide registry of cardiac arrest patients in Italy, there are scarce data on incidence, characteristics, and outcome of OHCA. Moreover, a few studies on OHCA patients are available and existing ones identified a prevalence of approximately 100 OHCAs per year per 100,000 inhabitants.[11–12] Therefore, we aimed to systematically review the incidence, characteristics, and outcome of adult OHCA occurring in Italy.

Methods

This systematic review and meta-analysis was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines,[13] and the protocol was registered in the International Prospective Register of Systematic Reviews PROSPERO (protocol registration number: CRD42021287046). This work was promoted by the Scientific Committee of the Italian Resuscitation Council (IRC).

Search strategy and study selection

We systematically searched PubMed via MEDLINE, Embase, Google Scholar, and ResearchGate (**Supplementary Appendix B**) for prospective and retrospective studies from inception up to September 23, 2022. The review question was developed using the PICO (Population, Intervention or Exposure, Comparison, Outcome) framework. The primary aim was to investigate patients in Italy (P) affected by OHCA (E) and their survival (O). There was no control group. All clinical studies reporting at least one outcome related to cardiac arrest were considered for inclusion. In addition to articles published as full-text in indexed journals, conference proceedings and theses (grey literature) were also included to provide a more comprehensive review.

To reduce the possibility of missed studies, backward snowballing was applied to retrieve additional records, the reference lists of included and excluded manuscripts were examined, and subject experts were contacted. Systematic reviews, editorials, and narrative reviews were excluded. No publication period or language restrictions were imposed. Studies including only in-hospital cardiac arrest patients and those conducted on pediatric populations only were excluded. In the case of overlapping populations (identified by study timeframes and locations), we included studies with the largest sample size or with more outcome data in case of similar samples sizes.

The final selection of included articles was made independently by two review team members on full-text manuscripts. Disagreements were resolved by the supervision of an expert investigator.

Data collection and quality assessment

Two authors independently extracted data using a standardized form with disagreements resolved by discussion involving a third reviewer. Extracted data included first author, publication year, study period, city or region, study population, population covered, characteristics and outcomes of cardiac arrest patients, and quality of included studies was assessed using the Joanna Briggs Institute critical appraisal tool.[14]

Outcomes

The primary outcome was the survival rate at the longest follow-up available. Secondary outcomes were cardiac arrest occurring in a public location, attempted resuscitation by EMS, witnessed cardiac arrest, proportion of shockable rhythm, rate of bystander cardiopulmonary resuscitation (CPR), rate of bystander automated external defibrillator (AED) use, time from call to EMS arrival, return of spontaneous circulation (ROSC), survival rate at hospital discharge or 30 days, with favourable neurological outcome (defined as Cerebral Performance Categories [CPC] of 1–2), among patients with shockable rhythms and Utstein group (OHCA witnessed by a bystander and having an initial shockable rhythm). Outcomes were calculated using the number of EMS-attended OHCAs as denominator. Overall incidence of EMS-attended OHCA, defined as all OHCAs attended by the EMS regardless of whether or not resuscitation was started, of OHCA with EMS-attempted resuscitation, and of shockable OHCA were also calculated across studies and reported as cases per 100,000 populations per year.

Statistical analysis

All analyses were performed with R version 4.1.2. A meta-analysis of proportion was performed to calculate the pooled outcomes with 95 % confidence intervals (CI). Due to the high heterogeneity, we applied the DerSimonian & Laird random-effects models. For the meta-analysis of continuous outcomes, those reported as medians and interquartile range were converted into mean and standard deviation.[15] Heterogeneity was assessed using the I^2 statistic. Publication bias was evaluated by visual examination of funnel plots and the Egger Test. Meta-regression analyses evaluating the relationship between survival and prespecified variables (e.g., age, sex, public location, bystander witnessed status, bystander CPR, bystander AED use, shockable rhythm, and EMS response time) were conducted if available for 10 studies or more.

Results

Study characteristics

Our search strategy yielded a total of 291 records. After duplicate removal and records screening, a total of 42 studies were considered eligible, of which 26 original articles published in peer-reviewed journals,[2,5,11–12,16–37] 10 abstracts presented at national or international congresses,[38–47] and six theses[48–53] (Fig. 1). A list of excluded studies with reasons for exclusion is reported in **Supplemental** Table 1.

Included studies were conducted between 1992 and 2021 and published between 1995 and 2022, but the majority (60 %) were published after 2015. Most studies (n = 33) were conducted in northern Italy, three in central Italy, and three in southern Italy, and the remaining three studies, including Italian data from EuReCa ONE and EuReCa TWO, involved different regions across the country.[2,5,49] Available studies covered 52 % of the current Italian

Table 1 – Characteristics of the 42 included studies ordered by publication year.

Study	Publication year	Journal	City/region	Study period	Sample size (n)
Casaccia et al	1995	G Ital Cardiol	Torino	March 1992–May 1994	207
D'Este et al	1998	G Ital Cardiol	Mestre	February 1996–September 1997	72
Bussani et al	2000	Abstract	Perugia	January 1, 2000–September 10, 2000	127
Capucci et al	2002	Circulation	Piacenza	June 6, 1999–April 30, 2001	354
Paoli et al	2004	Thesis	Province of Padova	November 1, 2002–January 31, 2003	69
Cappato et al	2006	Eur Heart J	Brescia	July 2000–June 2002	702
Citerio et al	2006	Eur J Emerg Med	Pavia, Como, Monza	November 5, 2002–February 2, 2003	174
Fabbri et al	2006	Resuscitation	Forlì	July 1, 1994–December 31, 2004	479
Furgani et al	2006	Thesis	Genova (period 1) Crotone, Genova, La Spezia, Mantova, Modena, Molise, Perugia, Savona, Siena, Udine (period 2)	January 1, 2004–December 31, 2005 (period 1) January 1, 2005–March 31, 2005 (period 2)	1702 (period 1) 839 (period 2)
Terranova et al	2006	Indian Pacing Electrophysiol J	Cernusco sul Naviglio, Milano	January 2003–December 2004	446
Kette et al	2007	Resuscitation	Pordenone province	February 1, 2003–February 29, 2004	522
Morici et al	2010	Eur J Emerg Med	Milan	January 2007–October 2008	1426
Taglieri et al	2011	Acute Card Care	Bologna	January 1, 2004–December 31, 2007	2572
Serra et al	2012	Italian J Emerg Med	Ferrara	2010	682
Castelli et al	2014	Thesis	Mantova	January 1, 2012–August 31, 2014	1381
Butturini et al	2014	Thesis	Padova	August 16, 2010–January 31, 2014	756
Brugioni et al	2014	Abstract	Modena province	January 1, 2012–December 31, 2012	1142
Capucci et al	2015	Am Heart J	Piacenza	June 1, 2001–August 1, 2014	3366
D'Alpaos et al	2015	Thesis	Treviso	January 2013–August 2015	896
Kotsonis et al	2015	Abstract	Trento	2010–2015	270
Ristagno et al	2015	Circulation	Lombardy	2008–2009	860
Leone et al	2015	GIMUPS	Provincia di Brindisi	August 1, 2002–September 30, 2004	555
Stella et al	2015	Thesis	Padova	February 1, 2014–March 31, 2015	179
EuReCa ONE (Italy)	2016	Resuscitation	Pordenone, Trieste, Pavia, Lodi, Crema, Mantova, Cremona Milano, Legnano, Bologna, Romagna, Lecce	October 1–October 31, 2014	773
Sorlini et al	2016	Abstract	Milano and Monza-Brianza	January 2016–April 2016	1620
Caggegi et al	2018	Abstract	Trieste	April 4, 2016–April 3, 2018	206
Scquizzato et al	2018	Abstract	Alta Padovana, Padova	2017	288
Canalini et al	2019	Italian J Emerg Med	Modena	2017	1221
Caputo et al	2019	Resuscitation	Pavia	January 1, 2015–December 31, 2017	1391
Danielis et al	2019	Eur J Cardiovasc Nurs	Udine	January 1, 2010–December 31, 2014	1105

(*continued on next page*)

Table 1 (continued)

Study	Publication year	Journal	City/region	Study period	Sample size (n)
Sanson et al	2019	Intern Emerg Med	Trieste	January 1, 2013–June 30, 2015	340
Santomauro et al	2019	Annals of Heart	Sorrento Peninsula	January 2012–September 2017	138
Villa et al	2019	Acta Biomed	Lombardia	2013–2014	1219
EuReCa TWO (Italy)	2020	Resuscitation	Udine, Trento, Bolzano, Trieste, Pavia, Lodi, Crema, Mantova, Cremona, Milano, Legnano, Bologna, Modena, Romagna, Lecce	October 1–December 31, 2017	2184
Paoli et al	2020	Resuscitation	Province of Padova	March 1, 2019–April 30, 2019	206
Tammaro et al	2020	Int Emerg Nurs	Lecce	2013–2017	4202
Coppa et al	2021	Abstract	Empoli	2018	422
Coppo et al	2021	Abstract	Verona	September 1, 2021–October 31, 2021	59
Pegani et al	2021	Abstract	Friuli Venezia Giulia	June 1, 2020–June 1, 2021	656
Salvadori et al	2021	Abstract	Firenze-Prato	January 1, 2017–December 31, 2017	205
Baldi et al	2021	Front Cardiovasc Med	Provinces of Lodi, Cremona, Pavia, and Mantova	January 1, 2015–December 31, 2019	4924
Semeraro et al	2022	G Ital Cardiol	Bologna	January 1, 2009–December 31, 2019	2105

population. However, no data was available for seven out of 20 regions (Fig. 2).

The main study characteristics are detailed in Table 1. Outcome reporting is described in Fig. 3. Quality assessment is shown in **Supplemental** Fig. 1. Only five studies (12 %) were deemed to be at low risk of bias. The most significant issues concerned the sample size, the representativeness of the population included, and the definitions used for data collection.

Incidence of OHCA in Italy

The overall average incidence of EMS-attended OHCA (all cases attended by the EMS regardless of whether or not resuscitation was started) was 86 (range: 10–190) per 100,000 populations per year, that of OHCA with EMS-attempted resuscitation was 55 (range: 6–108) per 100,000 populations per year, and that of shockable OHCA was 13 per 100,000 population per year (range: 2–35).

ROSC and survival

The incidence of ROSC and the rate of survival at the longest follow-up available were reported in 40 studies (n = 30,875 OHCAs) and 30 studies (n = 19,931 OHCAs), respectively **(**Table 2**)**. Follow-up ranged from survival at hospital admission to 10 years; however more than half of studies (55 %) reported only survival at hospital discharge or 30 days.

Overall, ROSC was achieved in 19 % (95 % CI, 16–23 %; I^2 = 99 %) of OHCA patients, reaching a significant increase up to 49 % (95 % CI, 43–55 %; I^2 = 91 %) among those with a shockable rhythm (17 studies, 2,733 patients).

Pooled survival at the longest follow-up available was 9.0 % (95 % CI, 6.7–12 %; I^2 = 96 %). Univariate meta-regression analyses (Table 3) suggested a higher rate of survival for lower mean age (P = 0.009), male sex (P = 0.020), shockable rhythm (P = 0.002), and public location (P = 0.008). Meta-regressions for bystander witnessed (p = 0.613), bystander CPR (p = 0.404), EMS response time (p = 0.358), resuscitation attempted (p = 0.808), and publication year (p = 0.209) did not have an effect on survival while analyses were not performed due to limited number of studies available (<10) for different areas of the country (north, centre, south) and bystander AED use. Visual inspection of funnel plot (no asymmetry) and Egger's test (P = 0.83) suggest absence of publication bias or small study effect (**Supplemental** Fig. 3). Rate of survival at the longest follow-up available was 25 % (95 % CI, 21–30 %; I^2 = 73 %) among patients with shockable rhythms (n = 2,863 from 16 studies) and 28 % (95 % CI, 20–37 %; I^2 = 53 %) among patients included in the Utstein comparator group (eight studies, 1,292 patients).

Rate of survival censored at hospital discharge or 30 days, available for 30 studies (19,931 patients) was 9.5 % (95 % CI, 7.4 %–12 %; I^2 = 96 %). Survival rate with favorable neurological outcome, available in 16 studies and 9,675 patients, was 5.0 % (95 % CI, 3.6–6.6 %; I^2 = 87 %).

Characteristics of patients and cardiac arrests

Among patients enrolled in included studies, pooled mean age, available in 29 studies, was 73 years (95 % CI, 71–75; I^2 = 99 %) while males were 61 % (95 % CI, 59–63 %; I^2 = 88 %). OHCAs occurred in a public place in 19 % of cases (95 % CI, 16–22 %; I^2 = 97 %, 23 studies), and were witnessed by bystanders in 68 % of cases (95 % CI, 60–75 %; I^2 = 99 %; 26 studies). Bystanders initiated CPR in 26 % (95 % CI, 21–32 %; I^2 = 99 %; 33 studies) of OHCAs and used an AED only in 3.2 % (95 % CI, 1.9–4.9 %; I^2 = 86 %; nine studies).

Resuscitation was attempted by EMS (24 studies) in 55 % (95 % CI, 48 %-63 %; I^2 = 99 %) of OHCAs. Pooled mean EMS response

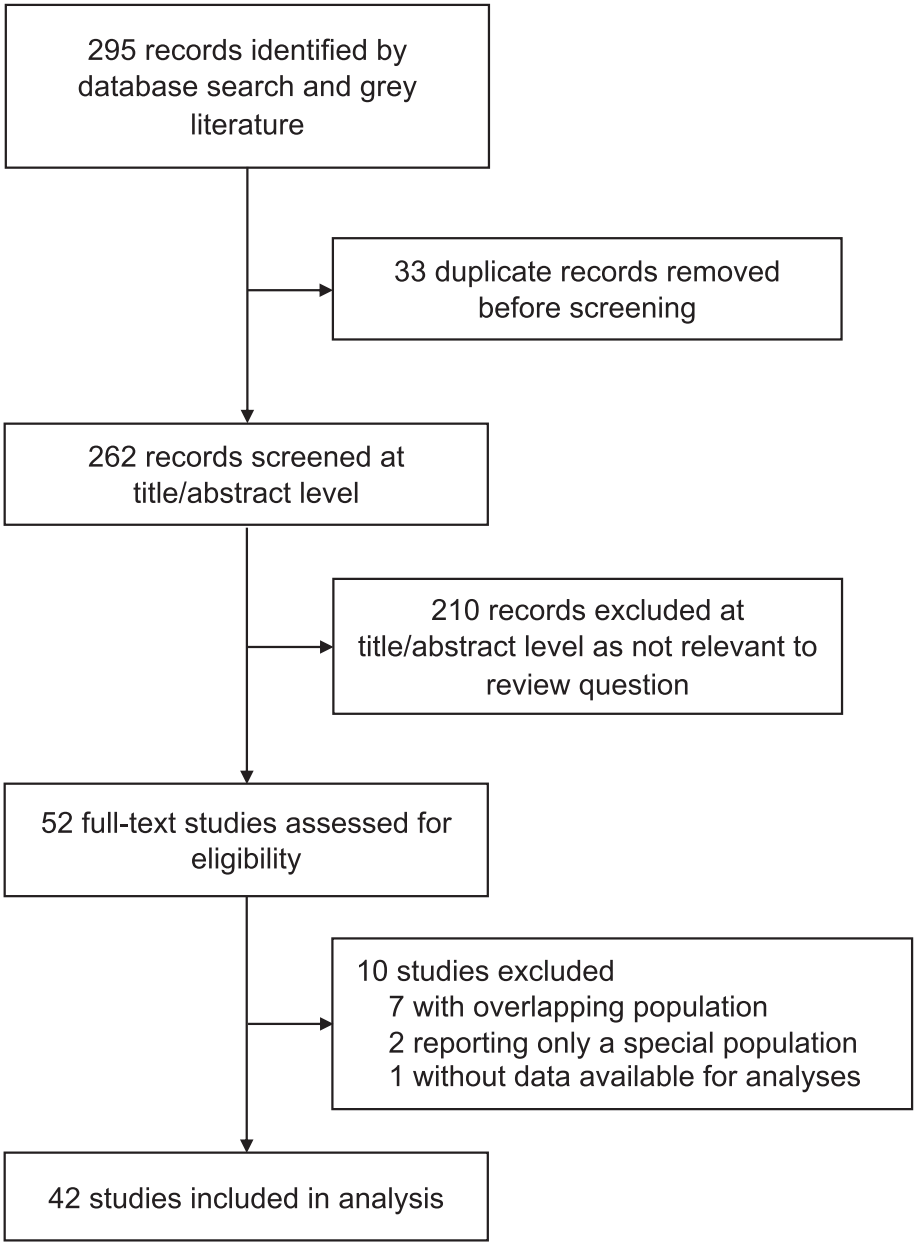


Fig. 1 – Flowchart of study selection.

time (25 studies) was 10.2 minutes (95 % CI, 9.0–11.4; I^2 = 99 %). In 22 % (95 % CI, 19 %-26 %; I^2 = 98 %) of cases the first monitored cardiac rhythm was a shockable one (38 studies).

Discussion

This is the first comprehensive systematic appraisal of the incidence, characteristics, and outcomes of OHCA occurring in Italy. EMS-attended OHCA occurs in Italy with an estimated incidence of 86 per 100,000 population per year, confirming the approximated incidence of one OHCA per year per 1,000 inhabitants. Survival occurred in one out of ten patients and only in one out of 20 had a favourable neurological outcome, even if survival increase to 25 % in patients with shockable rhythms. Bystanders initiated CPR in only one third of cases and an AED was rarely used.

In the EuReCa ONE[5] and EuReCa TWO[2] studies, the overall incidence of OHCA in which CPR was attempted by EMS was 84 and 56 per 100,000 population per year, respectively. Outside Europe, the overall incidence of EMS-attempted resuscitation was 48 per 100,000 population in the AusROC epistry in 2015[6] and 57 per 100,000 from the CARES registry in the United States, in 2013.[54] The findings of this systematic review found a very similar incidence rate in Italy: 55 per 100,000 populations per year of EMS-attempted resuscitation.

In this systematic review, the pooled survival rate was 9.0–9.5 % and ROSC 19 %, increasing respectively to 25 % and 49 % among patients with a shockable rhythm. These findings are comparable to those reported in EuReCa TWO study,[2] in which Italy also participated, where all-rhythm survival and shockable rhythm survival were respectively 8 % and 24 % and all-rhythm ROSC and ROSC in the shockable rhythm group were respectively 25 % and 58 %. Further-



Fig. 2 – Availability of data on out-of-hospital cardiac arrest in the Italian regions and provinces.

more, our results are similar to another systematic review including 141 studies from Europe, North America, Asia, and Oceania and reporting a 8.8 % pooled incidence of overall survival and 29.7 % of ROSC.[55] When analyzing shockable rhythms and Utstein comparator group (cardiac arrest witnessed by a bystander, and having initial shockable rhythm) separately, survival rates were respectively 25 % and 28 %, slightly lower than 31 % and 28 % reported in the EuReCa TWO study.[2] Of note, in our systematic review, there was a tenfold variation in Utstein survival across studies, varying from 11 % to 48 %. Survival with favourable neurological outcome, reported only in less than 40 % of studies, occurred in 5 % of patients, in line with international registry data reporting a highly variable rate from 2.8 % to 18 %.[7] Such variations might reflect different countries' approaches to post-cardiac arrest care and practice of withdrawal of life-sustaining treatments.[56] A study including successfully resuscitated cardiac arrests in Italy in which life-sustaining treatments were never suspended indicated that only 32 % of survivors had a favourable neurological outcome.[57] Unfortunately, an increase

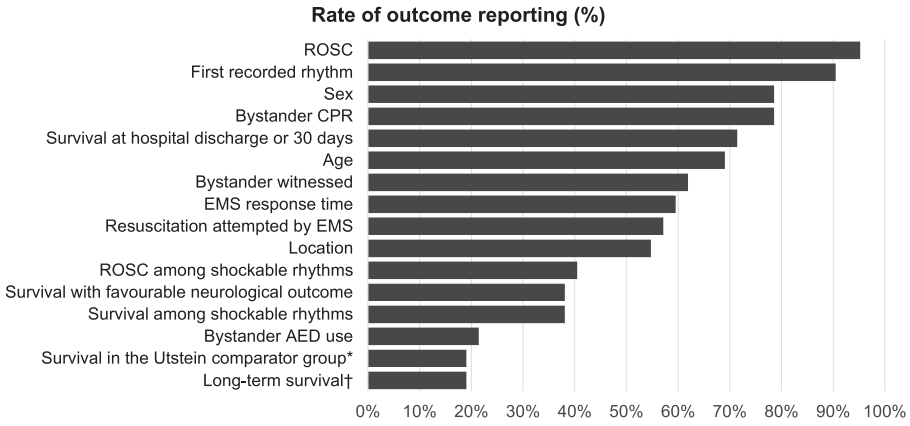


Fig. 3 – Rate of reporting of outcomes among studies. Abbreviations: ROSC, return of spontaneous circulation; CPR, cardiopulmonary resuscitation; EMS, emergency medical services; AED, automated external defibrillator. *The Utstein comparator group include cardiac arrests witnessed by a bystander and having initial shockable rhythm.†Includes follow-ups of six months or more.

Table 2 – Pooled estimates of characteristics and outcomes of out-of-hospital cardiac arrests.

	Number of studies (patients)	Pooled estimate (95 % CI)	I^2
Age (years), mean	29 (28,898)	73 (71–75)	99 %
Sex (male), %	33 (31,434)	61 % (59 %–63 %)	88 %
Public location, %	23 (20,497)	19 % (16 %–22 %)	97 %
Bystander witnessed, %	26 (22,226)	68 % (60 %–75 %)	99 %
Bystander CPR, %	33 (23,491)	26 % (21 %–32 %)	99 %
Bystander AED use, %	9 (8,508)	3.2 % (1.9 %–4.9 %)	86 %
Shockable rhythm, %	38 (30,296)	22 % (19 %–26 %)	98 %
EMS response time (minutes), mean	25 (23,997)	10.2 (9.0–11.4)	99 %
Resuscitation attempted, %	24 (26,840)	55 % (48 %–63 %)	99 %
Return of spontaneous circulation, %	40 (30,875)	19 % (16 %–23 %)	99 %
Shockable rhythm, %	17 (2,733)	49 % (43 %–55 %)	91 %
Survival at hospital discharge or 30 days, %	30 (19,931)	9.5 % (7.4 %–12 %)	95 %
Survival at the longest follow-up available*, %	30 (15,195)	9.0 % (6.7 %–12 %)	96 %
Shockable rhythm, %	16 (2,863)	25 % (21 %–30 %)	73 %
Utstein comparator group†, %	8 (1,292)	28 % (20 %–37 %)	53 %
Survival with favourable neurological outcome, %	16 (9,675)	5.0 % (3.6 %–6.6 %)	87 %

Abbreviations: CI = confidence interval, CPR = cardiopulmonary resuscitation, AED = automated external defibrillator, EMS = emergency medical services.

* Follow-ups ranged from hospital admission to 10 years but was 30 days/discharge in 53 % of studies.

† Out-of-hospital cardiac arrests witnessed by a bystander and having an initial shockable rhythm.

Table 3 – Univariate meta-regression analyses to evaluate the interaction with survival at the longest follow-up available.

	Number of studies	Estimate (95 % CI)	P-value
Mean age (years)	26	-0.0126 (-0.0218–-0.0034)	**0.009**
Sex (male)	24	0.0098 (0.0017–0.0179)	**0.020**
Public location	18	0.0083 (0.0025–0.0140)	**0.008**
Bystander witnessed	18	0.0008 (-0.0025–0.0041)	0.613
Bystander CPR	23	0.0013 (-0.0019–0.0045)	0.404
Bystander AED use†	6	-	-
Shockable rhythm	28	0.0024 (0.0010–0.0038)	**0.002**
EMS response time (minutes)	22	-0.0084 (-0.0269–0.0102)	0.358
Resuscitation attempted	15	-0.0004 (-0.0042–0.0033)	0.808

Abbreviations: CI = confidence interval, CPR = cardiopulmonary resuscitation, AED = automated external defibrillator, EMS = emergency medical services.
Bold denotes statistical significance ($P < 0.05$).

† Not performed due to limited number of studies available (<10).

in incidence of OHCA coupled with worse outcomes was observed in many countries during COVID-19 pandemic,[58] including some areas of Italy.[59]

Wide differences in rates of EMS-attempted resuscitation are responsible for wide variations in clinical outcomes after OHCA. Our systematic review highlighted that in only half of the OHCAs attended by EMS advanced life support was started, varying between 31 % and 85 %. Other factors such as witnessed collapse, bystander-initiated CPR and initial shockable rhythm, and the use of a defibrillator could play a crucial role in determining the outcome. In our study, 22 % of the OHCAs had an initial shockable rhythm, very close to 20 % observed in EuReCa TWO study.[2] In this review, CPR was initiated by bystanders in 26 % of cases and an AED was used by bystanders before EMS arrival in only 3.2 % of the cases. This result is markedly lower when compared to the average European rates of bystander CPR from the EuReCa ONE study (47 %, ranging from 6 % to 78 %)[5] and the EuReCa TWO study (58 %, ranging from 13 % to 82 %).[2] Numerous strategies can be implemented at a system level to improve bystander CPR and AED use.[10,60] Among these, the use of citizen as first responders, coordinated by the EMS dispatch centre, is the most promising[61–64] but to date, unfortunately, only one region in Italy has implemented it.[65–66] On August 4th, 2021, an Italian law concerning AEDs implementation has been finally approved.[67] This new law represents for Italy a fundamental step forward to improve survival after OHCA, allowing it to be aligned with the latest European recommendations in the upcoming years.[10]

Differences in reporting and data collection are another key reason that could explain the variations in outcomes and the very high heterogeneity across studies. As already observed in EuReCa ONE,[5] EuReCa TWO,[2] nationwide studies,[68] and existing systematic reviews,[4,55,69] there was also a large variability between different regions/cities in terms of incidence rate, patient characteristics and outcomes within studies from the same country included in this systematic review. While globally and across European countries, variations could be explained by differences in culture and attitude toward CPR, in this nationwide systematic analysis the observed variations can be attributed only to differences in bystander CPR and rate of defibrillation, EMS system effectiveness, hospital treatment, and data reporting. These variations need a deeper investigation in order to understand the reasons for the found differences.

Finally, this systematic review showed data collected on OHCA patients from different parts of our country, covering more than 30 million inhabitants. However, an important part of the country is not included, data are not uniformly collected, some factors such as bystander AED use, neurological outcome, and outcomes among shockable rhythms and the Utstein comparator group were also infrequently reported, and often do not follow the Utstein recommendations.[70] Moreover, while we attemped to use the same denominator (EMS-attended OHCA), included populations were often poorly detailed and denominators may not have been completely standardized. Most of our data come from observational and retrospective studies, abstracts presented in conference proceedings, or theses of low methodological quality and togheter with an high heterogeneity and large variation in outcomes, the confidence in the estimates of incidence and outcome and the quality of evidence is limited. However, given that only few publications describing OHCA in Italy are available in indexed journals, the inclusion of grey literature avoided a strong reporting bias. The lack of an Italian nationwide registry leads to an important gap in actual knowledge regarding the incidence, characteristics, treatment, and outcomes of OHCA patients. A central goal over the next few years should be building a network of clinicians and researchers across the country to build and maintain a nationwide OHCA registry and participate in EuReCa projects.[71]

Conclusions

OHCA in Italy occurred with an estimated incidence of 86 per 100,000 population. Survival occurred in one every ten patients and only one every 20 has a favourable neurological outcome. Unfortunately, bystanders initiated CPR in only one third of cases and an AED was rarely used. Although numerous areas of the country collected data about OHCA patients, the greater portion of the country was not included, and data were not uniformly collected preventing meaningful comparisons. Building and maintaining a nationwide OHCA registry is a priority for the healthcare systems and EMS systems to improve the quality of data and to measure and compare the performance nationwide.

Authors' contribution

Design of the study: Scquizzato T, Gamberini L, D'Arrigo S, Galazzi A, Babini G, Losiggio R, Imbriaco G, Fumagalli F, Cucino A, Landoni G, Scapigliati A, Ristagno G, Semeraro F.

Data collection: Scquizzato T, Losiggio R, Gamberini L, D'Arrigo S, Cucino A, Semeraro F.

Statistical analysis: Scquizzato T, Gamberini L, Ristagno G.

Manuscript draft and critical review: Scquizzato T, Gamberini L, D'Arrigo S, Galazzi A, Babini G, Losiggio R, Imbriaco G, Fumagalli F, Cucino A, Landoni G, Scapigliati A, Ristagno G, Semeraro F.

Administrative support: Cucino A, Scapigliati A, Ristagno G, Semeraro F.

Conflict of interests

TS, LG, SDA, AG, GB, GI, FF, AC are members of the Scientific Committee of the Italian Resuscitation Council (IRC). TS is the Social Media Editor of Resuscitation and Resuscitation Plus journals. AS is the Vice President of IRC and GR is the Past President. FS is the Chair-Elect of European Resuscitation Council (ERC). All other authors have no conflict of interests to declare.

Acknowledgments

The study was supported by the COST Action PARQ (grant agreement No CA19137) supported by COST (European Cooperation in Science and Technology) and Italian Resuscitation Council.

Appendix A

Collaborators: Francesco Bertoncello, Alberto Canalini, Stefano Colelli, Giuseppe Conti, Maurizio Giacometti, Giovanni Giuliani, Alessandro Graziano, Andrea Mina, Silvia Orazio, Andrea Paoli, Alberto Peratoner, Carlo Pegani, Andrea Roncarati, Cesare Sabetta, Simone Savastano, Federica Stella, Rosanna Varutti, Francesca Verginella, Michele Zuliani

Appendix B. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2022.100329.

Author details

[a]*Department of Anesthesia and Intensive Care, IRCCS San Raffaele Scientific Institute, Milan, Italy* [b]*Department of Anaesthesia, Intensive Care and Emergency Medical Services, Ospedale Maggiore, Bologna, Italy* [c]*Institute of Anaesthesia and Intensive Care, Catholic University of the Sacred Heart, Fondazione Policlinico Universitario A. Gemelli, IRCCS, Rome, Italy* [d]*Department of Healthcare Professions, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy* [e]*Department of Anesthesiology, Intensive Care and Emergency, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy* [f]*Centrale Operativa 118 Emilia Est, Maggiore Hospital Carlo Alberto Pizzardi, Largo Bartolo Nigrisoli 2, 40133, Bologna, Italy* [g]*Critical Care Nursing Master Course, University of Bologna, Via Giuseppe Massarenti, 9, 40138, Bologna, Italy* [h]*Istituto di Ricerche Farmacologiche Mario Negri IRCCS, Italy* [i]*Department of Anaesthesia and Intensive Care Medicine, Azienda Provinciale per i Servizi Sanitari, Provincia Autonoma di Trento, Italy* [j]*Department of Pathophysiology and Transplantation, University of Milan, Milan, Italy*

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