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# One-year survival after in-hospital cardiac arrest: a systematic review and meta-analysis

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## Abstract

### Introduction

In-hospital cardiac arrest is a major adverse event with an incidence of 1-6/1000 admissions. It has been poorly researched and data on survival is limited. The outcome of interest in IHCA research is predominantly survival to discharge, however recent guidelines warrant for more long-term outcomes. In this systematic review we sought to quantitatively summarize one-year survival after in-hospital cardiac arrest.

### Methods

For this systematic review and meta-analysis we performed a systematic search of all published data on one-year survival after IHCA up to March 9<sup>th</sup>, 2018. Results of the meta-analyses are presented as pooled proportions with corresponding 95% prediction intervals (95%PI). Between-study heterogeneity

was assessed using  $I^2$  statistic and the DerSimonian-Laird estimator for  $\tau^2$ . Subgroup analyses were performed for cardiac and non-cardiac patients.

## Results

We included 40 studies in our systematic review and meta-analysis. The pooled one-year survival after in-hospital cardiac arrest was 13.4% (95%PI: 5.6-28.8%,  $I^2=100\%$ ). Subgroup analysis of cardiac patients revealed a one-year survival of 39.3% (16.1%-68.6%) in patients with a non-cardiac admission characteristic one-year survival was 10.7% (4.4%-23.6%). These data cover the period 1985 – 2018 and show a modest change in survival over that period (10-year OR: 1.70, 95% CI: 1.04 – 2.76).

## Discussion

One-year survival after in-hospital cardiac arrest is poor. Survival is higher in patients admitted to cardiac wards. The time trend between 1985-2018 has shown a modest improvement in one-year survival rates. Research into IHCA population characteristics might elicit the issue of heterogeneity and stagnated survival over the past decades.

Keywords: in-hospital cardiac arrest; IHCA; cardiac arrest; survival; long-term outcome; systematic review; meta-analysis

## Introduction

Cardiac arrest, cardiopulmonary arrest, or circulatory arrest is the loss of mechanical heart function and effective blood circulation. If not treated by cardiopulmonary resuscitation (CPR) it inevitably means the end of life. However, if treated, circulation can be restored. Cardiac arrest is usually divided into two categories: out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA). The latter is poorly researched; data on incidence and survival of IHCA are limited. Current literature describes an incidence of 1-6 events per 1000 hospital admissions.[1–4]

The outcome of interest in IHCA research is predominantly survival to discharge. A recent meta-analysis shows a pooled survival rate at discharge of 15.0% (95%CI, 12.0-18.0%) with little change over time[5], while an analysis in the UK over the same period of time shows a significant increase in hospi-

tal survival after IHCA (9.0% in 2004 to 12.2% in 2014) [6]. Survival to discharge is an important outcome measure, however little is known about the long-term outcomes of patients discharged from the hospital. Recent guidelines warrant for more research into long-term outcomes and associated factors[7]. As patient-centred outcomes are increasingly important to biomedical and clinical research, long-term survival could be regarded as such and could serve as important information in clinical decision-making. This systematic review aims to quantitatively summarize one-year survival after in-hospital cardiac arrest.

## Methods

### Search strategy and study selection

This systematic review and meta-analysis was reported following the PRISMA and MOOSE guidelines for reporting of systematic reviews and meta-analyses of observational studies[8, 9]. The protocol was registered with PROSPERO (2017:CRD42017072037). We performed a systematic search of published data on one-year survival of IHCA using Embase, Medline Ovid, Cochrane Central, Web of Science, PubMed recent and Google scholar from their inception through March 9<sup>th</sup>, 2018. The search strategy is shown in supplemental table 1. We set no limitations on type of study or language. Mendeley (2017 Mendeley Ltd.) was used for the selection of relevant articles. Study selection was performed in a 2-staged process. Two reviewers (MS and BG) independently screened titles and abstracts (stage 1), and full-text papers for inclusion (stage 2). Disagreements were resolved with discussion and involvement of a third researcher (SH). Pre-defined inclusion criteria were: 1) In-hospital cardiac arrest, using conventional CPR (CCPR); 2) One year survival reported; 3) Adult patients; 4) Clinical study. Cardiac arrest definitions per article are provided in supplemental table 2. Conventional CPR is defined as chest compressions with or without use of compression devices, as opposed to extracorporeal CPR via cardiopulmonary bypass. Studies were excluded if they did not fit inclusion criteria, if they were only published as abstract or written in a language none of the reviewers was proficient in.

### Data extraction and quality assessment

Data extraction from selected studies was performed independently by two investigators (MS and BG) using a standardized form. To describe study design, we extracted the sample size of patients who underwent CCPR, the country of origin, the investigated period, the definition of the study population,

whether the study was retrospective or prospective, how the investigators attained their data, which comparisons were made, how they defined one year survival and which patients were excluded from the cohort. Patient populations were checked for overlap to prevent patients from appearing multiple times in our analysis. If this was the case the study with the smallest sample size was excluded. The characteristics of the study population included were: age, gender, prevalence of cardiac patients, percentage of witnessed arrests or monitored patients and prevalence of ventricle fibrillation or ventricle tachycardia as initial rhythm. A common denominator for comorbidity or severity of disease was sought. If age was defined in strata or ranges a weighed mean was calculated without SD. Finally, one-year survival of patients who underwent CCPR in hospital was extracted. Survival was defined as the survival of one single CPR attempt. Authors were contacted for the exact survival rate when the one-year survival was not directly available from the manuscript. We specifically looked at conventional CPR, and excluded extracorporeal CPR. When a study included both, only the conventional CPR group was extracted.

The quality of the studies was evaluated using the method of Hayden et al. for the evaluation of the quality of prognosis studies in systematic reviews[10]. Known prognostic factors such as initial rhythm and witnessed arrest were assessed. Two authors individually assessed all six items and discrepancies were resolved by a third researcher (SH).

### **Statistical analysis**

One-year survival data were pooled across studies using the inverse variance method. A random-effects model was used to estimate the pooled one-year survival probability after IHCA as considerable heterogeneity was expected. A random-effects meta-analysis model assumes the observed estimates can vary across studies because of real differences in each study as well as sampling variability (chance). Results of the meta-analyses are presented as pooled proportions with corresponding 95% confidence intervals (CI). Between-study heterogeneity was assessed using  $I^2$  statistic and the DerSimonian-Laird estimator for  $\tau^2$ . Furthermore in order to address heterogeneity between studies better, a 95% prediction interval was reported[11, 12].

A sensitivity analysis was performed to assess the presence or absence of heterogeneity. Subgroup analyses were performed for cardiac and other patients. Cardiac, or a cardiac admission characteristic, was defined as a study in which all patients came from cardio (-thoracic) units, or were predominantly admitted to the hospital for cardiac disease or cardiac surgery. The non-cardiac subgroup consisted of studies that included patients who were not specifically admitted for cardiologic or cardiac surgical reasons (i.e. general nursing wards, but also critical care units). Other subgroup analyses were done for study quality, geographical distribution (i.e. continents) and initial arrest rhythm. Furthermore, a random intercept meta-regression analysis (binomial-normal model) with corresponding bubble plot was carried out to assess the influence of study period on one-year survival. This model is appropriate for probability meta regression, since it avoids the bias that occur when a normal-normal model would be used for logit transformed proportion[13, 14]. Studies were allocated in time using the median of the period the study covered. After careful evaluation of all articles a post-hoc analysis of cognitive outcome was done with use of a random effects model to analyse available data on the fraction of one-year survivors with a cerebral performance category score (CPC) of 1 or 2. Secondly a post-hoc analysis was performed for survival to discharge.

All data was extracted into Microsoft Excel and then statistically analysed by importing the data in R (R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.). The packages used for the analysis were 'meta' and 'metafor', of which we used the 'metaprop', 'forrest' and 'rma.glmm' functions.

## Results

### Search results and characteristics of included studies

Our search strategy retrieved 7331 records, of which 4999 remained after duplicates were removed. The parallel exclusion of studies based on title and abstract resulted in 239 full text articles eligible for detailed assessment. Finally, we included 39 studies in our systematic review and meta-analysis[15–54]. Full details of study selection are summarized in figure 1.

Characteristics of the included studies and study populations are given in table 1 and 2. All studies were performed between 1985 and 2015, predominantly in North America and Western Europe. Data

was available on age in 35 (89.7%) studies, on gender in 33 (84.6%), on the proportion of cardiac patients in 14 (35.9%) studies and on shockable rhythm in 27 (69.2%) of the included studies. Of the included studies 18 (46.1%) described level of patient monitoring at the time of arrest (e.g. critical care units). Number of inclusions ranged from 25 to 471,962 patients and mean age of the study population ranged from 54 to 86 years.

### Quality assessment

The quality assessment of the included studies is given in supplemental table 3. The study population was adequately defined and described in 26 (66.6%) studies. The study attrition, referring to the manner in which patients were recruited for inclusion, was of good quality in 28 (71.8%) studies. Prognostic factors were adequately measured in 21 (53.8%) studies. The means of outcome measurement were not or inadequately described in 16 (41.0%) studies, and were sufficiently described and measured in 12 (30.8%) studies.

### Outcome

The meta-analysis of all studies showed a pooled one-year survival of 13.4% (95%PI: 5.6%-28.8%) summarized in figure 2. Statistical heterogeneity was high:  $I^2=100\%$ ,  $\tau^2=0.22$ ,  $p<0.01$ . Subgroup analysis of cardiac patients revealed a one-year survival of 39.3% (95%PI: 16.1%-68.6%;  $I^2=85.0\%$ ), while repeating this analysis in studies of the non-cardiac subgroup analysis resulted in a one year survival of 10.7% (95% PI: 4.4%-23.6%;  $I^2=100\%$ ) Survival plots for cardiac and non-cardiac patients are available in supplemental figures 1 and 2. As displayed in figure 3 survival to discharge was available in 35 studies. Pooled survival to discharge was 17.6% (95%PI: 13.1-22.7%,  $I^2=99\%$ ). All survival statistics are summarized in table 3.

Finally, when analysing the temporal trend of one year survival, a significant and modestly positive trend was observed (OR=1.70 per 10-year period, 95%CI: 1.04-2.76), as shown in figure 4. Seven studies reported CPC scores for one-year survivors. A pooled estimate shows 92.0% (95% CI: 85.0%-96%) of patients alive at one year after cardiac arrest have a CPC score of 1 or 2 (figure 5). Pooled estimates stratified by study quality, geographical distribution or initial arrest rhythm did not produce

any significant differences in effect estimates or heterogeneity. We were not able to identify a common denominator of comorbidity or severity of disease to perform analyses on.

## Discussion

In this systematic review one-year survival after in-hospital cardiac arrest is 13.4% (95%PI: 5.6%-28.8%). When viewed separately one-year survival in cardiac vs. non-cardiac patients is 39.3% and 10.7% respectively. As far as we have found these data represent the first documentation of a systematic overview on one-year survival after IHCA through most recent publications and covers the period 1985 – 2018.

One-year survival of 13.4% after IHCA is poor. When compared to survival to discharge this implies a large portion of patients discharged alive survive the following year[5,6]. The low survival rate is probably attributable to the presence of underlying disease. Comorbid disease has been demonstrated to worsen survival. This is most evident for severe COPD, cirrhotic liver disease, chronic kidney disease and heart failure and is supported by recent evidence that links comorbidity and age to 30-day survival[56]. Although we did not have sufficient data for a subgroup analysis, some of the studies we have included suggest a similar relationship between comorbidity and long-term survival[40][56].

We found significant heterogeneity in outcomes across the studies. These differences may be related to the variability in study populations, treatment strategies and/or international differences in life expectancy [57]. With regard to differences in study population, subgroup analyses showed a survival of 39.3% in patients who are admitted to hospital for cardiac disease or cardiac surgery. In these patients survival is higher than for patients admitted for other reasons and part of the heterogeneity can be explained by this subgroup analysis. The higher survival rates are related to the presence of monitored wards, a higher incidence of shockable rhythm (also demonstrated in this review) and presumably a higher incidence of reversible causes (e.g. tamponnade, coronary occlusion)[58]. This supports the hypothesis of earlier recognition and intervention, as well as higher baseline survival in cardiac patients compared to other patients after cardiac arrest. To further explain heterogeneity we have performed several subgroup analyses with the available information, but did not find any sufficient answer.



The heterogeneity of data can to greater extent be attributed to the epidemiological nature of the populations, rather than being selected or randomized groups. We believe that pooling of data was reasonable for outcome measures for different reasons. First (I) this approach is pragmatic and clinically relevant; (II) we took measures to reduce potential clinical heterogeneity by performing subgroup analyses on the basis of clinical criteria (i.e. cardiac vs. non-cardiac patients) (III) by contrast with comparative meta-analyses in which the presence of statistical heterogeneity might limit conclusions about effect size or exposure, pooling of data is an accepted method in single-group meta-analyses done for epidemiological purposes and (IV) pooling the data was necessary to appraise the available data on one-year survival in a comprehensive manner that could help inform the clinical context and related clinical decision making [59]. Although generalizability is limited due to a large diversity in study populations, pooling due of data provides a clinically relevant estimate for one-year survival after IHCA. In reporting survival rates we used the prediction interval, rather than the confidence interval. This provides an estimate of what survival rates can be expected in future studies. As to be expected with large heterogeneity in outcomes the prediction intervals we found were very broad and make prognostication difficult.

We compared one-year survival to survival to discharge from a recent meta-analysis (i.e. 15.0% 95% CI: 12.0% -18.0%) and to survival to discharge from this meta-analysis (i.e. 17.6%, 95%CI 13.1% - 22.7%)[5]. It suggests death after IHCA occurs mainly during hospital admission rather than after discharge. Furthermore, when pooled survival for in-hospital cardiac arrest patients is compared to one-year survival after out-of-hospital cardiac arrest survival it is nearly identical: 13.4% for IHCA vs. 12.0% for OHCA [60, 61]. These data give rise to new questions regarding the aetiology of IHCA in non-cardiac patients and factors that influence survival. It could be argued that factors concerning pre-existing health status have added value in predicting one-year survival after in-hospital cardiac arrest. A positive finding came from our analysis for cognitive performance showed CPC scores were 1 or 2 in 92.0% (95% CI: 85.0%-96.0%) of one-year survivors. This however pertains to performance and not necessarily to quality of life.

Certain limitations should be taken into account. Most studies have reported one-year survival from the moment of cardiac arrest, with a few reporting survival from the moment of discharge. We have considered this difference to be negligible to the interpretation of our outcome because survival is measured at least one year from the occurrence of cardiac arrest. Secondly we need to consider the heterogeneity of outcomes, as population-level data was not available for many of the included studies and therefore only stratification for cardiac and non-cardiac patients rather than for comorbidity or age was possible. No difference could be analysed between monitored or non-monitored wards or initial arrest rhythms, as sufficient data was not available. Although some subgroup analyses were attempted no clear explanation for this heterogeneity could be pinpointed. Lastly health care developments and changes in public health will have influenced incidence and outcome of IHCA. The meta-regression we have performed shows a trend in one-year survival that shows a slight improvement when viewed on a basis of 10-year intervals. One could state that survival improves over time, however this trend is only modestly positive and we hope this effect will become more evident in the future. Whether patient case mix has significantly altered, treatment strategies are insufficient or it is a combination of factors remains uncertain.

In the future heterogeneity in structure and processes of care should be explored. This variation in practice also adds to the heterogeneity in outcome. We do believe that careful assessment of quality of care should be performed, taking into account statistical uncertainty and case-mix. Being able to explain differences in outcome through quality of care could enable improving overall quality of care by identifying the most effective policy[62]. Secondly subgroup analyses can be performed if predefined subgroups are available. These subgroups need to be defined by known predictors and need to be comparable between studies[63]. We would recommend the implementation of nationwide registries and the use of standardized sets for reporting populations and outcomes, in this case the Utstein criteria and Core Outcome Set for Cardiac Arrest (COSCA)[64–66]. This will help improve comparability and enhance future implementation research[67].

This meta-analysis contains important information pertaining to all patients worldwide. In-hospital cardiac arrest is a global health issue, which concerns all patients and health care workers. Before mak-

ing decisions about cardiopulmonary resuscitation and treatment restrictions, physicians must communicate accurate expectations of outcome to patients and families. However, one important caveat when reviewing these survival data is that its applicability to individual patients is limited. Although data on long-term outcome can inform patients on medical decisions about CPR, these data represent survival spread over a large population rather than predicting the trajectory for any individual patient. Overall we can conclude that one-year survival is poor in patients admitted to hospital for non-cardiac disease. Specific patient-level prognostication may probably require more knowledge about age, comorbidity and intercurrent disease.

In conclusion, our systematic review showed a one-year survival of 13.4% in IHCA patients. The time trend between 1985-2018 has shown a modest improvement in one-year survival rates. Future research is needed, specifically into the subject of prognostic factors for long-term qualitative outcome. Furthermore description of IHCA populations might elicit the issue of stagnated survival over the past decades. Moreover, more studies are published randomizing extracorporeal CPR vs. conventional CPR, which in the future could be a more common method of resuscitation[68]. We feel multicentre prospective research in a known source population is needed to improve current knowledge on this subject.

### **Declaration of interest**

The authors state that there is no conflict of interest.

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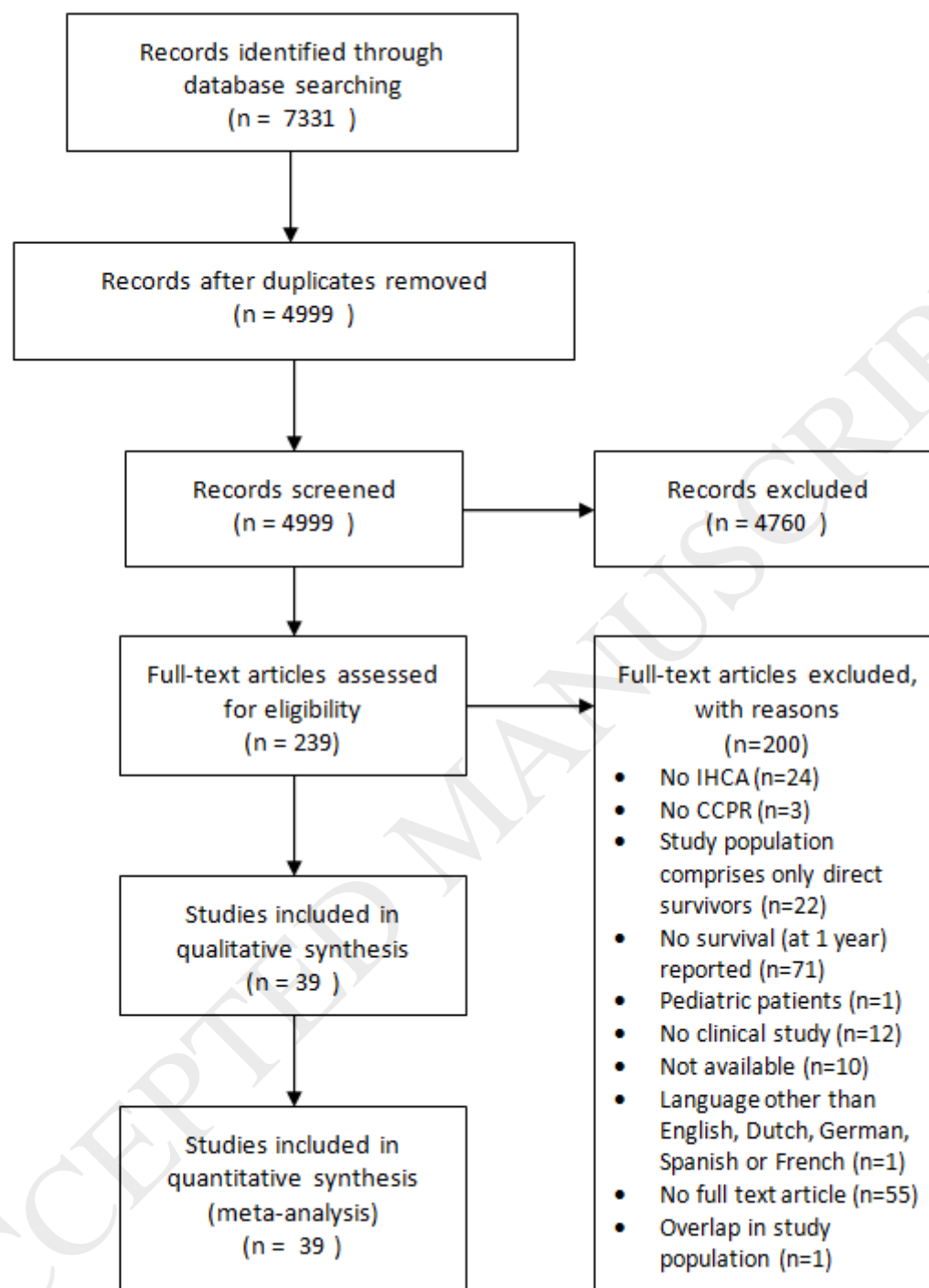


Figure 1. PRISMA Flow Diagram of search strategy and included studies.

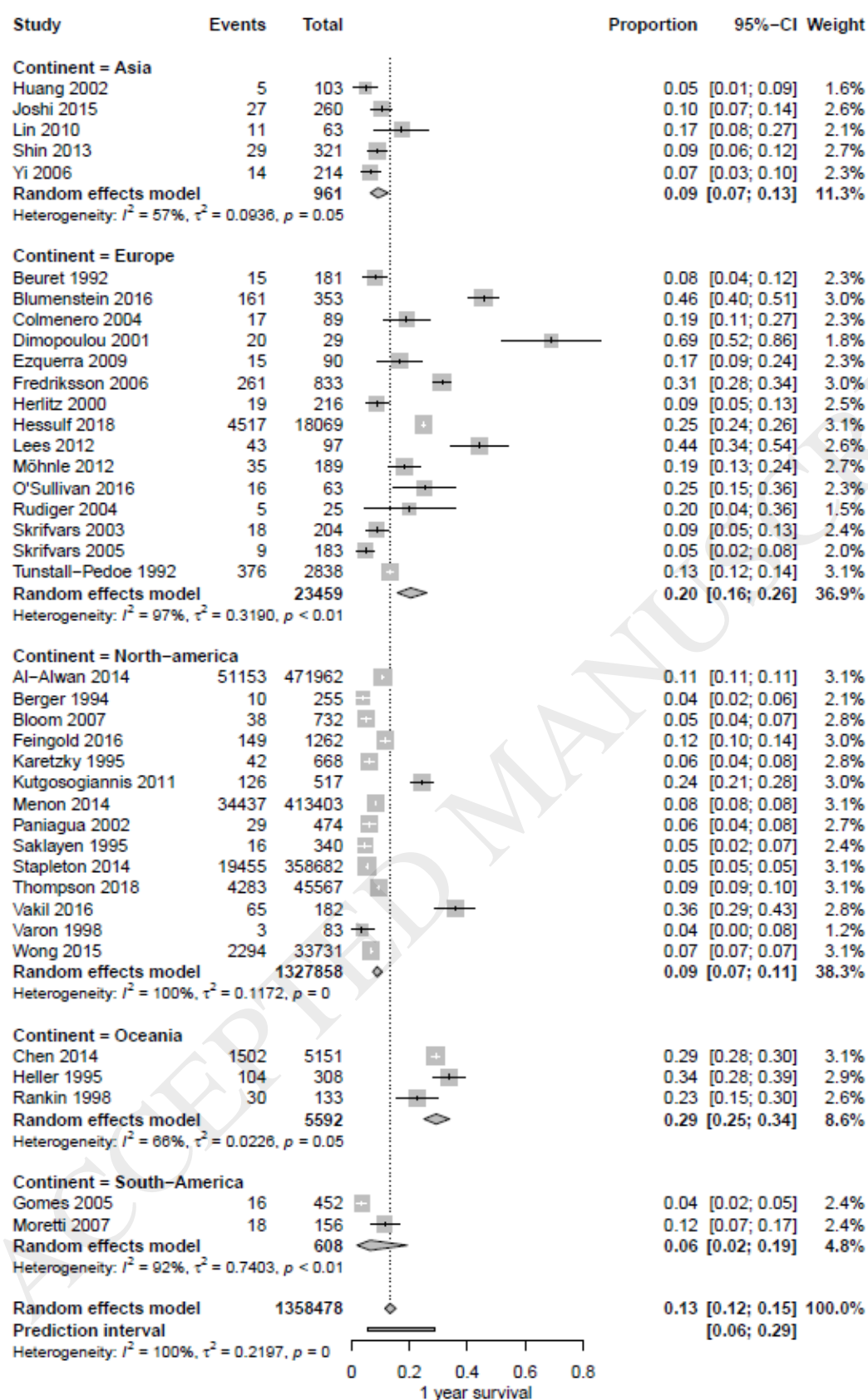


Figure 2. Pooled one-year survival rate after in-hospital cardiac arrest.

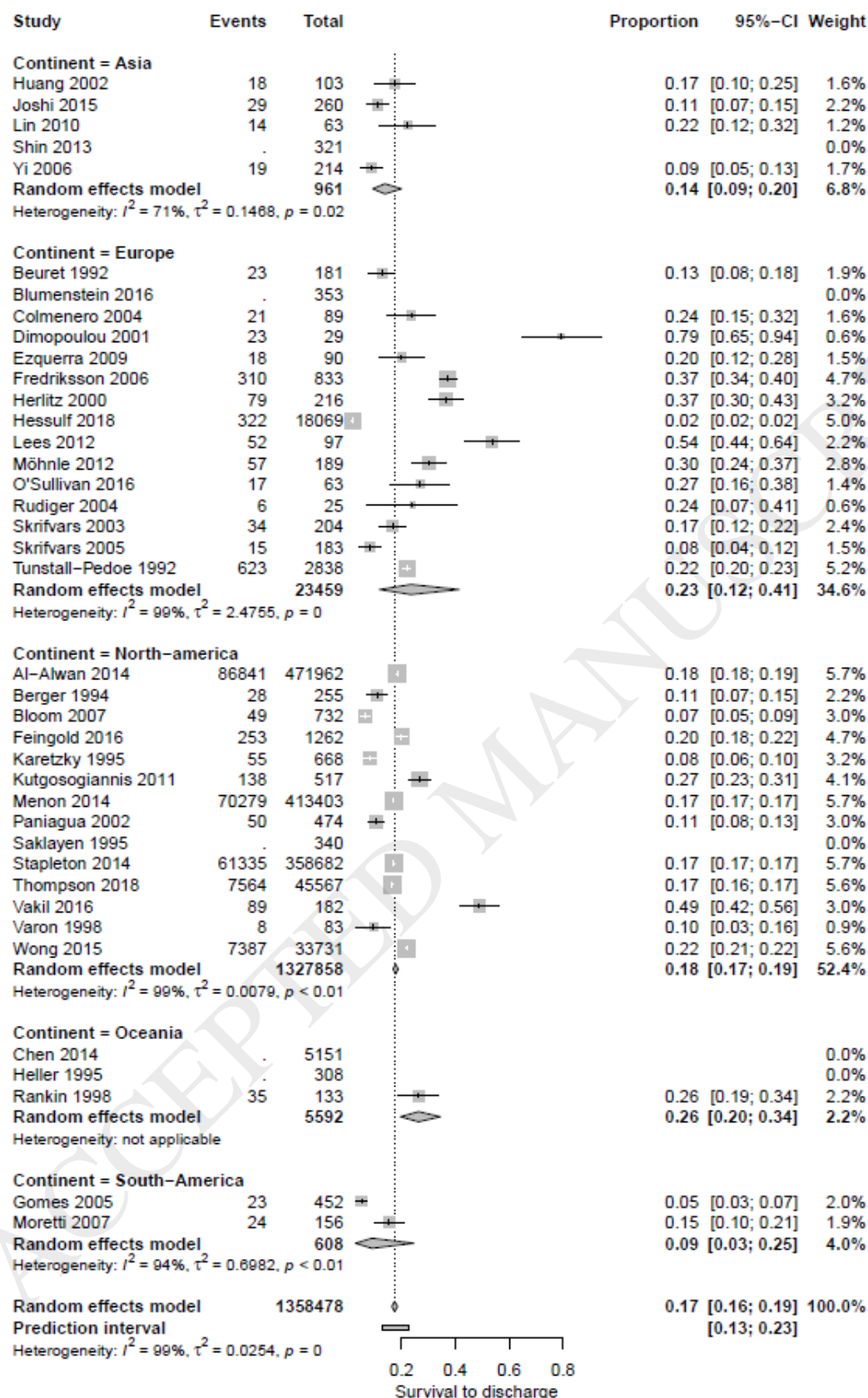


Figure 3. Pooled survival to discharge rate after in-hospital cardiac arrest for studies that reported this outcome measure.

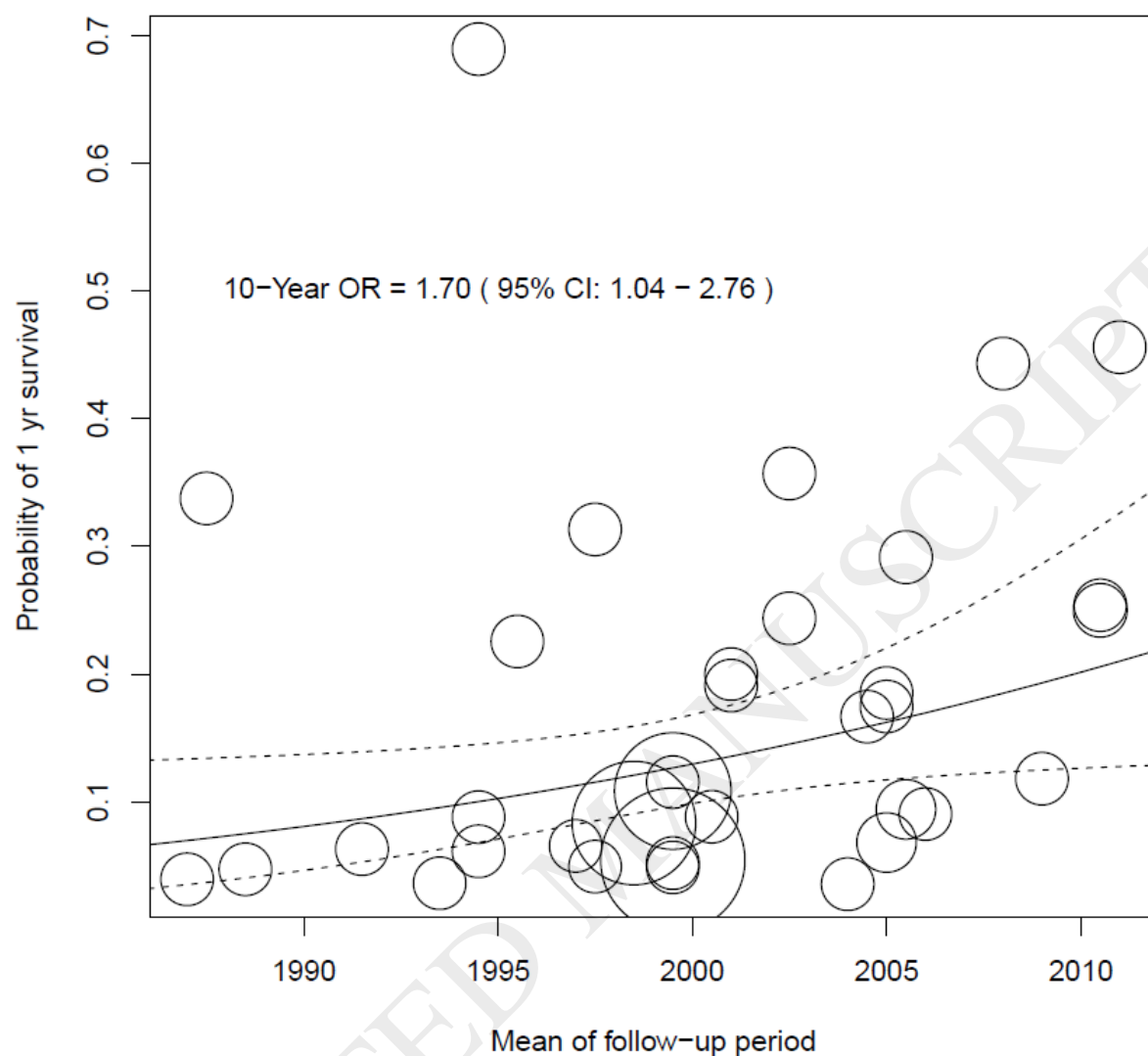


Figure 4. Bubble-plot for meta-regression analysis of the influence of study period on one-year survival (OR = 1.70, 95% CI: 1.04– 2.76 per ten year increase).

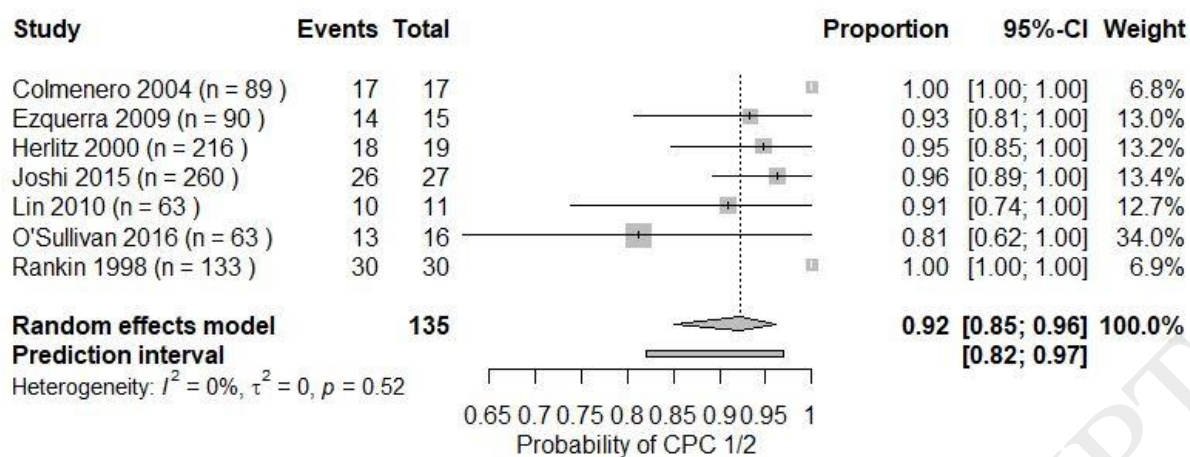


Figure 5. Pooled fraction of survivors at 1 year with a cerebral performance category of 1 or 2.

Table 1. General characteristics of included studies (n=39). Study design: PC = prospective cohort, RC= retrospective cohort

First author	Year of publication	N	Country	Investigated period	Study population	Design	Excluded	Outcome
Al-Alwan	2014	471 962	USA	1994-2005	IHCA patients without intubation and one or more days after intubation	RC	patients who were intubated or received CPR on the same day	1 year survival post-CA
Berger	1994	255	USA	1985-1989	IHCA, in non-critical hospital areas.	PC	-	1 year post-discharge
Beuret	1992	181	Switzerland	N/A (2 year period)	IHCA patients	RC	respiratory arrests not complicated by a malignant arrhythmia, syncopal episodes and seizures	1 year survival post-CA
Bloom	2007	732	USA	1995-2004	Veterans hospital CA patients	RC	-	1 year survival post-CA
Blumenstein	2016	272	Germany	2009-2013	IHCA patients in a specialized centre for cardiology	RC	-	1 year survival post-CA
Chen	2014	515 1	Australia	2002-2009	IHCA patients	RC	-	1-year survival post discharge
Colmenero	2004	89	Spain	2000-2002	IHCA patients	PC	Perioperative cardiac arrests	1 year survival post-CA
Dimopoulou	2001	29	Greece	1993-1996	Post-cardiac surgery IHCA patients	PC	IABP, maximal inotropic support, massive bleeding <2 hrs post-op	1 year survival from discharge
Ezquerria	2009	90	Spain	2003-2006	IHCA patients >18 years	RC	DNAR	1 year survival post-CA
Feingold	2016	126 2	USA	2008-2010	IHCA patients	PC	-	1 year survival from discharge
Fredriksson	2006	833	Sweden	1994-2001	IHCA patients	PC	-	1 year survival from discharge
Gomes	2005	452	Brazil	2004	IHCA patients >14 years	PC	-	1 year survival post-CA
Heller	1995	308	Australia	1984-1991	Myocardial infarction in in hospital patients aged 25-69	PC	-	1 year survival post-CA
Herlitz	2000	216	Sweden	1994-1995	IHCA patients	PC	-	1 year survival from discharge
Hessulf	2018	180 69	Sweden	2006-2015	IHCA (inside hospital walls) > 18 years	RC	-	1 year survival post-CA
Huang	2002	103	Taiwan	1999-2000	Patients, receiving CPR	PC	<17 years	1 year survival from discharge
Joshi	2015	260	India	N/A (1 year period)	IHCA patients	PC	-	1 year survival post-CA
Karetzky	1995	668	USA	1990-1992	IHCA patients	RC	Patients only receiving limited CPR (without compressions)	1 year survival post-CA
Kutgsogiannis	2011	517	Canada	2000-2005	Adult IHCA patients in critical care units	PC	Secondary arrests, patients that didn't need life support	1 year survival post-CA
Lees	2012	99	UK	2005-2011	Post-cardiac surgery IHCA patients	PC	-	1 year survival post-CA
Lin	2010	63	Taiwan	2004-2006	IHCA patients, cardiac origin, 18-75 years	PC	CPR <10 min, non-witnessed and no ROSC	1 year survival post-CA
Menon	2014	413 403	USA	1992-2005	IHCA patients ≥65 years, one vs multiple CPR events	RC	-	1 year survival
Möhnle	2012	189	Germany	2004-2006	IHCA patients	RC	-	1 year survival post-CA
Moretti	2007	156	Brazil	1998-2001	ICHA patients in a "service or unit"	PC	<20 years, found dead, futile CPR, DNAR order, <15 days ago surgery, drug overdose or trauma	1 year survival from CA
O'Sullivan	2016	63	Ireland	2011	IHCA patients who occupied a bed, >18 years old	RC	DNAR order	1 year survival post-CA
Paniagua	2002	474	USA	1993-1996	IHCA, >80 years old	RC	-	1 year post-discharge
Rankin	1998	133	New Zealand	1995-1996	IHCA	PC	-	1 year survival post-CA



<b>Rudiger</b>	2004	25	Switzerland	2000-2002	IHCA patients	PC	ICU patients	1 year survival post-CA
<b>Saklayen</b>	1995	340	USA	1988-1989	Veterans hospital CA patients	RC	-	1 year survival post-CA
<b>Shin</b>	2013	321	Korea	2003-2009	IHCA patients >20 years	RC	>80 years, previous serious neurological damage, current intracranial hemorrhage, terminal malignancy, traumatic origin of CA, septic origin of CA, MOF, DNAR order, CPR <10 min and unwitnessed arrest	1 year survival post-CA
<b>Skrifvars</b>	2003	204	Finland	2000-2001	IHCA	PC	-	1 year survival post-CA
<b>Skrifvars</b>	2005	183	Finland	1993-2002	IHCA on general wards	PC	-	1 year survival post-CA
<b>Stapleton</b>	2014	358 682	USA	1994-2005	IHCA patients, suffering from chronic illness	RC	-	1 year survival post-CA
<b>Thompson</b>	2018	455 67	USA	2000-2011	IHCA ≥65 years, in an inpatient ward or ICU.	PC	Patients without documented initial rhythm and unable to link to medicare claims data.	1 year survival post-CA
<b>Tunstall-Pedoe</b>	1992	283 8	UK	N/A (1 year period)	IHCA, or CPR continued on arrival	PC	false alarms, recurrences within 24 hours	1 year survival post-CA
<b>Vakil</b>	2016	182	USA	1991-2014	Post-cardiac surgery veteran IHCA patients	RC	<18 years	1 year survival post-CA
<b>Varon</b>	1998	83	USA	1993-1994	IHCA cancer patients	RC	Respiratory arrests, patients in shock	1 year survival from discharge
<b>Wong</b>	2015	337 31	USA	2000-2010	Medicare beneficiaries 18 years or older, initiating dialysis	RC	-	1 year survival from discharge
<b>Yi</b>	2006	214	South-korea	1992-2002	IHCA in the neurosurgical ICU	RC	-	1 year survival post-CA



Table 2. Patient characteristics of included studies (n=39). \* = Intubated vs non-intubated; \*\* = Mean (range); \*\*\* = Median with/without IQR; † = With vs without cardiac life support training groups (the survival is the overall survival).

First author	Mean age (±SD)	% male	% cardiac patients	% monitored/witnessed	% VF/VT	% CPC 1 or 2 at 1 year
Al-Alwan*	73.3 (±11.9) vs 75.0 (±11.4)	50.4 vs 50.4	N/A	N/A	N/A	N/A
Berger	67.4	N/A	N/A	N/A	25.0	N/A
Beuret	61.5 (17.0-89.0)**	69.0	N/A	34.0	39.0	N/A
Bloom	59.0	N/A	N/A	N/A	N/A	N/A
Blumenstein	75.3 (67.4 – 79.1)***	61.4	100	100	2.9	N/A
Chen	68.2 (±16.9)	61.2	N/A	N/A	N/A	N/A
Colmenero	68.0 (56-74.5)**	57.3	N/A	N/A	34.8	100
Dimopoulou	61.0 (±11.0)	87.5	100	N/A	44.0	N/A
Ezquerria	73.1 (±12.3)	68.9	N/A	N/A	22.2	93.0
Feingold	61.1 (±14.3)	50.8	N/A	N/A	N/A	N/A
Fredriksson	69.4	63.0	66.0	N/A	48.6	N/A
Gomes	54.1	54.9	N/A	76.8	39.0	N/A
Heller	60.4	63.0	N/A	N/A	N/A	N/A
Herlitz	68.0***	62.0	N/A	N/A	N/A	95.0
Hessulf	75***	71.0	29.0	50.0	32.0	N/A
Huang	66.8	71.0	17.0	N/A	14.0	N/A
Joshi	N/A	N/A	31.2	91.0	21.9	96.0
Karetzky	59.2	48.2	N/A	65.7	15.7	N/A
Kutgsogiannis	66.5 (±14.9)	62.3	60.6	100	33.7	N/A
Lees	N/A	N/A	100	100	26.8	N/A
Lin	60.6 (±12.7)	65.1	47.6	N/A	41.3	91.0
Menon	78.3 vs. 77.4	50.5 vs 50.7	N/A	N/A	N/A	N/A
Möhnle	65.2 (±16.1)	69.8	N/A	21.7	32.3	N/A
Moretti†	64.4 (±17.2) vs 63.6 (±15.8)	58.6 vs 55.2	N/A	90.3 vs 74.6	32.7 vs 22.1	N/A
O'Sullivan	74.3***	63.4	44.4	87.3	30.2	81.0
Paniagua	86.0 (±4.8)	42.0	N/A	N/A	N/A	N/A
Rankin	N/A	N/A	N/A	47.4	32.3	100
Rudiger	72.8	72.0	N/A	N/A	28.0	N/A
Saklayen	66.9	N/A	N/A	57.0	18.0	N/A
Shin	61.6 (±14.2)	62.6	49.5	100	22.7	N/A
Skrifvars	68.0 (±15.8)	59.3	N/A	72.1	28.0	N/A
Skrifvars	73 (64.0 – 78.0)**	60.0	N/A	75.4	33.3	N/A
Stapleton	78.9 (±7.2)	50.3	N/A	N/A	N/A	N/A
Thompson	77.2 (±7.4)	55.5	26.7	25.3	20.3	N/A
Tunstall-Pedoe	N/A	64.2	N/A	N/A	N/A	N/A
Vakil	68.0 (±8.0)	98.0	100	N/A	71.4	N/A
Varon	56.2	49.3	N/A	N/A	N/A	N/A
Wong	>65.0	53.9	16.7	N/A	N/A	N/A
Yi	54.0 (±9.4)	65.5	19.2	100	29.0	N/A

Table 3. Summary of outcomes from the performed meta-analyses. All survival rates are presented with a 95% prediction interval (95%PI). Non-cardiac was defined as studies not included in the cardiac subgroup analysis.

Survival rates (%; 95%PI)	Survival to discharge	I <sup>2</sup> , $\tau^2$ , p-value	One-year survival	I <sup>2</sup> , $\tau^2$ , p-value
<b>Overall</b>	17.6 (13.1 – 22.7)	99%, 0.03, <0.01	13.4 (5.6 - 28.8)	100%, 0.22, <0.01
<b>Cardiac</b>	49.7 (3.8 - 96.2)	88%, 0.44, <0.01	39.3 (16.1 - 68.6)	85.0%, 0.16, <0.01
<b>Non-cardiac</b>	15.9 (12.0 – 20.7)	99%, 0.02, <0.01	10.7 (4.4 – 23.6)	100%, 0.21, <0.01