The chance of survival and the functional outcome after in-hospital cardiopulmonary resuscitation in older people: a systematic review

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Abstract

Background: physicians are frequently confronted with the question whether cardiopulmonary resuscitation (CPR) is a medically appropriate treatment for older people. For physicians, patients and relatives, it is important to know the chance of survival and the functional outcome after CPR in order to make an informed decision.

Methods: a systematic search was performed in MEDLINE, Embase and Cochrane up to November 2012. Studies that were included described the chance of survival, the social status and functional outcome after in-hospital CPR in older people aged 70 years and above.

Results: we identified 11,377 publications of which 29 were included in this review; 38.6% of the patients who were 70 years and older had a return of spontaneous circulation. More than half of the patients who initially survived resuscitation died in the hospital before hospital discharge. The pooled survival to discharge after in-hospital CPR was 18.7% for patients between 70 and 79 years old, 15.4% for patients between 80 and 89 years old and 11.6% for patients of 90 years and older. Data on social and functional outcome after surviving CPR were scarce and contradictory.

Conclusions: the chance of survival to hospital discharge for in-hospital CPR in older people is low to moderate (11.6–18.7%) and decreases with age. However, evidence about functional or social outcomes after surviving CPR is scarce. Prospective studies are needed to address this issue and to identify pre-arrest factors that can predict survival in the older people in order to define subgroups that could benefit from CPR.

Keywords: cardiopulmonary resuscitation, geriatrics, in-hospital, prognostic factors, systematic review, older people

Background

Since the introduction of external cardiac massage in 1960 [1], cardiopulmonary resuscitation (CPR) has become the standard treatment for patients with a cardiac arrest worldwide. However, CPR should be applied only if considered effective and not harmful. With increasing age of in-hospital patients, physicians are frequently confronted with the question if resuscitation is a medically appropriate and ethically acceptable treatment for an older patient.

Ideally, the resuscitation policy should be discussed with every patient on admission and after clinically relevant changes in health status [4, 5]. The main factor in this decision concerns the reasonable chance of survival and the functional outcome.

Research has shown that physicians are not accurate in predicting the outcome of CPR, as their prediction of the likelihood of immediate survival after reading detailed information of actual patient cases were no better than random guessing [6]. Moreover, patients initially tend to have an overly positive view of the outcome of CPR, causing them to misjudge their options [7, 8]. After provision of expected...
survival rates, half of the patients who initially said they wanted to be resuscitated changed their minds [7]. It is therefore important that physicians, patients and their relatives have objective information regarding outcomes of CPR, in order to make an informed decision in the emotional and complicated discussion about resuscitation.

Advanced age is frequently mentioned as a negative predictor for outcome after CPR, but consensus is still lacking for out-of-hospital [9] and in-hospital CPR [10, 11, 12]. Therefore, we performed a systematic review to provide an overview of the chance of surviving in-hospital CPR and the social and functional status after successful resuscitation in the older people.

Methods

Search strategy

A systematic search was conducted to identify studies evaluating survival rates of in-hospital CPR in older people. We performed the following search in MEDLINE, Embase and Cochrane on 5 November 2012: (Resuscitation[Mesh] OR reanimat*[tiab] OR CPR*[tiab] OR resuscitat*[tiab] OR life support*[tiab]) AND (‘Hospitals’[Mesh] OR ‘Hospital Units’[Mesh] OR hospital*[tiab] OR clinic*[tiab] OR clinics [tiab] OR centre*[tiab] OR centres*[tiab] OR centre*[tiab] OR centres*[tiab]) AND (Aged[MeSH] OR elder*[tiab] OR senior*[tiab] OR geriatric*[tiab] OR older*[tiab] OR oldest*[tiab]). No limitations in publication date were applied to the search; only studies written in English or Dutch were considered.

Study selection

First, one author (M.v.G.) screened the titles of the retrieved records to identify potentially eligible studies. Two authors (M.v.G. and D.F.) screened selected studies based on abstracts and full text assessment. Disagreements were discussed with a third reviewer (M.H.). Finally, references of included publications were cross-referenced to retrieve any additional relevant citations. In case of insufficient data in the original study, the authors were contacted for additional information.

We included studies that investigated in-hospital CPR in older people aged 70 years and older as well as studies that conducted a subgroup-analysis of patients aged 70 years and older. The studies had to report one of the following outcomes: return of spontaneous circulation (ROSC), survival to hospital discharge or the social status or functional outcome after surviving CPR. We excluded publications that investigated out-of-hospital resuscitation or in-hospital resuscitation that only occurred in coronary care unit (CCU), intensive care unit (ICU) or operating room (OR). Furthermore, non-original publications and articles for which no full text was available were excluded.

Data extraction

The following data were independently extracted by two authors (M.v.G. and D.F): patient demographics (age and sex), type of hospital, specific included wards, year and country of publication. A differentiation was made between prospective and retrospective study designs; in the prospective studies, the data collection was performed individually shortly after CPR was performed, in the retrospective studies the data were collected for all patients on a later point of time. The following outcomes were extracted: ROSC, survival to discharge, long-term follow-up (>6 months), social status and functional outcome.

Quality assessment

The methodological quality of the included studies was assessed by using a framework developed by Hayden et al. [13] See Supplementary data available in Age and Ageing online, Appendix S2. This checklist exposes six potential sources of bias. Each item could score ‘low risk of bias’, ‘moderate risk of bias’ or ‘high risk of bias’. The quality assessment was independently performed by two authors (M.v.G. and D.F). Differences were discussed until a consensus was reached. When necessary, disagreements were resolved through discussion with a third author (M.H.).

Data synthesis and analysis

As a result of heterogeneity in study designs and inclusion criteria of the different studies, a formal meta-analysis was not possible. Most articles used the cut-off-points 70–79, 80–89 and >90 years, therefore we used these age groups for the calculations of a pooled survival rates. The pooled survival rates were presented in a Forest plot, developed by Neyeloff et al. [14] The survival rates of other age groups were only described. A distinction was made between studies that included all hospital wards, studies that excluded acute settings such as the emergency room, operating suites and ICU and studies that only included the geriatric ward. Differences in survival rate between different wards were determined by one-way analysis of variance.

Results

Study characteristics

A total of 11,377 articles were identified by the search strategy as potentially relevant of which 3,305 were duplicates. After exclusion of another 8,044 articles, a total of 28 studies were included. Cross-referencing yielded one additional publication that did not specifically refer to older patients in the abstract [15]. Details on the search and reasons for exclusion can be found in Figure 1.

The characteristics of the 29 included studies are summarised in Table 1. The studies were published between 1968 and 2012 and involved a total of 417,190 patients aged 70 years and older of which two studies exclusively focused on older people patients [16, 17]. Seventeen studies were conducted retrospectively [2, 3, 11, 12, 16, 17, 18–21, 22–28]. Most studies were conducted in industrialised countries.
Thirteen studies took place in a general hospital [3, 17, 18, 20, 22, 27, 28, 29, 30, 31, 32, 33, 34] and eight studies in a tertiary hospital [2, 15, 23, 26, 29, 35, 36, 37]. Fourteen studies provided a description of the definition of cardiac arrest [2, 12, 15, 18, 20, 22, 24, 26, 30, 31, 32, 33, 34, 36]. Two studies mentioned the number of patients with a do-not-resuscitate (DNR) policy [15, 26].

Quality of the included studies
An overview of the general study quality can be found in Supplementary data available in Age and Ageing online, Appendix S3; full details are supplied in Supplementary data available in Age and Ageing online, Appendix S4. Reviewer agreement was >95% for all aspects. The majority of the studies scored a low risk of bias for study participation and study attrition. Eleven studies (38%) [2, 3, 17, 18, 20, 22, 24, 26, 27, 29, 35] scored a moderate or high risk of bias for the study participation because either the in- and exclusion criteria were unclear or the description of baseline criteria was incomplete. A moderate or high risk of bias was assessed for the domain of study attrition when the loss-to-follow-up was high or not reported at all.

The vast majority of the studies (86%) scored a moderate risk of bias for prognostic factors, [2, 11, 12, 15, 17, 18–21, 22, 24–28, 29, 30, 31, 32, 33, 35, 36, 37, 38, 39] as they did not include factors other than age or they did not clearly describe the investigated prognostic factors. The outcome measurement also predominantly incurred a moderate risk of bias because most studies did not report on duration until hospital discharge [2, 11, 12, 15, 16, 18–21, 22, 23, 26, 29, 32, 35, 36]. The risk of bias due to confounding was high in 15 studies (52%), because they did not report any possible confounders such as shockable rhythm, witnessed arrest or the duration of resuscitation [3, 17, 18–20, 23–26, 29, 34, 36, 37, 38, 39]. Of the studies that did measure study confounding, most of them did not include all important confounders leading to a moderate risk of bias. Finally, 22 studies (76%) [3, 11, 12, 15, 16, 17, 18–20, 23, 26, 27, 29, 30, 31, 32, 33, 34, 36, 37, 38, 39] had a moderate or high risk of bias, due to insufficient presentation of the data or inadequate statistical design.

Short-term outcome
Ten studies [12, 16, 18, 23, 24, 28, 31, 32, 35, 39] investigated the ROSC for patients aged 70 years and older. The rate of ROSC varied between 20.8 and 57.9%, with a pooled rate of 38.6%.

Survival to hospital discharge per age group is presented in Figure 2. Eleven studies investigated survival to hospital discharge for patients between 70 and 79 years old and found a pooled survival of 18.7% (range 8.2–35.7%) [1, 3, 11, 22, 26, 30, 33–35, 38, 39, 40]. Six studies [3, 11, 22, 26, 32, 39] included all wards and found a pooled survival rate of 17.3%. In the four studies [30, 33, 35, 38] that included all wards except emergency settings the average survival rate was 18.7%. Finally, one study [34] included only geriatric wards and found a survival rate of 14.8%. In the 10 studies investigating survival to hospital discharge for patients between 80 and 89 years old, a pooled survival rate of 15.4% (range 4.0–31.0%) was found [3, 11, 17, 22, 26, 33–35, 38, 39]. Nine studies described this outcome for patients aged 90 years and older and found a pooled survival to hospital discharge of 11.6% (range 0–50.0%) [3, 11, 17, 22, 26, 33–35, 38]. No significant difference in survival rates was seen between the types of included wards for any age group.
Table 1. Characteristics of the included studies

<table>
<thead>
<tr>
<th>Author and year of publication</th>
<th>Retrospective/prospective</th>
<th>Country</th>
<th>Year</th>
<th>Type of hospital</th>
<th>Wards</th>
<th>Included patients</th>
<th>Sex, % (%) men</th>
<th>Age, mean/median and range</th>
<th>Older people, % (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Araujo (1997) [18]</td>
<td>Retrospective</td>
<td>Portugal</td>
<td>1995</td>
<td>General hospital</td>
<td>All</td>
<td>83</td>
<td>54 (65.1%)</td>
<td>Mean 69.9, range 21–93 year</td>
<td>&gt;70 years: 38 (45.8%)</td>
</tr>
<tr>
<td>Bolandparvaz (2009) [29]</td>
<td>Prospective</td>
<td>Iran</td>
<td>2007–2008</td>
<td>Referral centre</td>
<td>All</td>
<td>600</td>
<td>349 (58.1%)</td>
<td>1 to &gt;80 years, mean unknown</td>
<td>&gt;80 years: 34 (5.7%)</td>
</tr>
<tr>
<td>Brindley (2002) [30]</td>
<td>Prospective</td>
<td>Canada</td>
<td>1998–1999</td>
<td>Three teaching hospitals</td>
<td>All</td>
<td>247</td>
<td>154 (62.3%)</td>
<td>Unknown</td>
<td>71–80 years: 72 (29.1%), &gt;80 years: 42 (17.5%)</td>
</tr>
<tr>
<td>Chakravarthy (2012) [19]</td>
<td>Retrospective</td>
<td>India</td>
<td>2007–2009</td>
<td>Multi-specialty hospital</td>
<td>All</td>
<td>78</td>
<td>47 (60.3%)</td>
<td>Unknown</td>
<td>&gt;80 years: 14 (17.9%)</td>
</tr>
<tr>
<td>Bolandparvaz (2009) [29]</td>
<td>Prospective</td>
<td>Iran</td>
<td>2007–2008</td>
<td>Referral centre</td>
<td>All</td>
<td>600</td>
<td>349 (58.1%)</td>
<td>1 to &gt;80 years, mean unknown</td>
<td>&gt;80 years: 34 (5.7%)</td>
</tr>
<tr>
<td>Cooper (1997) [31]</td>
<td>Prospective</td>
<td>United Kingdom</td>
<td>1993–1996</td>
<td>General hospital</td>
<td>All</td>
<td>808</td>
<td>507 (62.7%)</td>
<td>Median 72, range 1–93 years</td>
<td>&gt;70 years: 474 (58.7%)</td>
</tr>
<tr>
<td>Cooper (2005) [32]</td>
<td>Prospective</td>
<td>United Kingdom</td>
<td>1993–2003</td>
<td>General hospital</td>
<td>All</td>
<td>2,121</td>
<td>1,252 (59.0%)</td>
<td>Mean 70, range 1–93 years</td>
<td>&gt;70 years: 1,456 (68.6%)</td>
</tr>
<tr>
<td>de Vor (1999) [2]</td>
<td>Retrospective</td>
<td>The Netherlands</td>
<td>1988–1994</td>
<td>Academical centre</td>
<td>All</td>
<td>553</td>
<td>317 (57.3%)</td>
<td>Median 68, range 18–98 years</td>
<td>&gt;70 years: 266 (48.1%)</td>
</tr>
<tr>
<td>DeBard (1981) [20]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1971–1976</td>
<td>Urban community and teaching hospital</td>
<td>All</td>
<td>1,073</td>
<td>Unknown</td>
<td>Mean 62 years</td>
<td>&gt;70 years: 299 (27.9%)</td>
</tr>
<tr>
<td>Di Bari (2000) [12]</td>
<td>Retrospective</td>
<td>Italy</td>
<td>1988–1998</td>
<td>Unknown</td>
<td>All</td>
<td>245</td>
<td>146 (59.6%)</td>
<td>Mean 70 ± 11 years</td>
<td>&gt;70 years: 137 (55.9%)</td>
</tr>
<tr>
<td>Ehlenbach (2009) [11]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1992–2005</td>
<td>Different hospitals; 33.3% of analysed</td>
<td>All</td>
<td>433,985</td>
<td>219,377 (50.5%)</td>
<td>Unknown</td>
<td>&gt;70 years: 370,686 (85.4%)</td>
</tr>
<tr>
<td>Fredriksson (2005) [37]</td>
<td>Prospective</td>
<td>Sweden</td>
<td>1994–2001</td>
<td>Tertiary hospital</td>
<td>All</td>
<td>833 (910 arrests)</td>
<td>525 (63.0%)</td>
<td>Unknown</td>
<td>&gt;70 years: 369 (40.6%)</td>
</tr>
<tr>
<td>George (1989) [33]</td>
<td>Prospective</td>
<td>USA</td>
<td>1985</td>
<td>Teaching hospital</td>
<td>All</td>
<td>140</td>
<td>91 (65.0%)</td>
<td>18–92 years</td>
<td>&gt;70 years: 65 (46.4%)</td>
</tr>
<tr>
<td>Gulati (1983) [34]</td>
<td>Prospective</td>
<td>UK</td>
<td>1982</td>
<td>General hospital</td>
<td>All</td>
<td>52</td>
<td>32 (61.5%)</td>
<td>Mean 75.6 years; range 64–91</td>
<td>&gt;70 years: 41 (78.8%)</td>
</tr>
<tr>
<td>Juchems (1993) [3]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1981–1989</td>
<td>Teaching hospital</td>
<td>All</td>
<td>574</td>
<td>Unknown</td>
<td>Unknown</td>
<td>&gt;70 years: 327 (57.0%)</td>
</tr>
<tr>
<td>Jung (1968) [19]</td>
<td>Prospective</td>
<td>USA</td>
<td>1964–1966</td>
<td>University hospital</td>
<td>All</td>
<td>100</td>
<td>68 (68.0%)</td>
<td>Mean 60.1 years</td>
<td>&gt;70 years: 19 (19.0%)</td>
</tr>
<tr>
<td>Kvale (1987) [17]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1980–2004</td>
<td>National registry of cardiopulmonary resuscitation; 366 hospitals</td>
<td>All</td>
<td>86</td>
<td>49,130 (57.5%)</td>
<td>Mean 66.7, interquartile range 57–79 years</td>
<td>&gt;70 years: 80,100 (22.2%)</td>
</tr>
<tr>
<td>Larkin (2019) [21]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1971–1976</td>
<td>Community hospital</td>
<td>All</td>
<td>259</td>
<td>108 (41.7%)</td>
<td>Range 70–103 years</td>
<td>&gt;70 years: 259 (100%)</td>
</tr>
<tr>
<td>Lazzam (1991) [15]</td>
<td>Prospective</td>
<td>Canada</td>
<td>Unknown</td>
<td>Tertiary care teaching hospital</td>
<td>All</td>
<td>125</td>
<td>83 (66.4%)</td>
<td>Unknown</td>
<td>&gt;70 years: 49 (39.2%)</td>
</tr>
<tr>
<td>Murphy (1989) [16]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1977–1986</td>
<td>Three general hospitals, one rehabilitation hospital, one Jewish memorial hospital</td>
<td>All</td>
<td>259</td>
<td>108 (41.7%)</td>
<td>Range 70–103 years</td>
<td>&gt;70 years: 259 (100%)</td>
</tr>
<tr>
<td>Paniagua (2002) [27]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1993–1996</td>
<td>General hospital</td>
<td>All</td>
<td>956</td>
<td>468 (49.0%)</td>
<td>Mean 76 ± 15 years; &gt;80 years: mean 86 ± 4.8 years, range 80–103</td>
<td>&gt;70 years: 474 (49.0%)</td>
</tr>
<tr>
<td>Parish (2000) [22]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1987–1996</td>
<td>Community teaching hospital</td>
<td>All</td>
<td>3327</td>
<td>1,724 (51.8%)</td>
<td>Mean 62.7, range 1–100 years</td>
<td>&gt;70 years: 1,358 (40.8%)</td>
</tr>
<tr>
<td>Perdok (2005) [24]</td>
<td>Retrospective</td>
<td>The Netherlands</td>
<td>1994–1999</td>
<td>Unknown</td>
<td>All</td>
<td>282</td>
<td>173 (61.3%)</td>
<td>Mean 69 ± 12 years, range unknown</td>
<td>&gt;70 years: 156 (55.3%)</td>
</tr>
<tr>
<td>Rogove (1995) [25]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1979–1989</td>
<td>36 hospitals</td>
<td>All</td>
<td>245</td>
<td>Unknown</td>
<td>Mean 69 ± 12 years, range unknown</td>
<td>&gt;70 years: 34 (9.0%)</td>
</tr>
<tr>
<td>Schultz (1996) [26]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1988–1991</td>
<td>Tertiary hospital</td>
<td>All</td>
<td>266</td>
<td>122 (45.9%)</td>
<td>Mean 69 ± 12 years, range unknown</td>
<td>&gt;70 years: 128 (48.1%)</td>
</tr>
<tr>
<td>Smith (2007) [35]</td>
<td>Prospective</td>
<td>New Zealand</td>
<td>2001–2004</td>
<td>Tertiary hospital</td>
<td>All</td>
<td>243</td>
<td>Unknown</td>
<td>Mean 68.6 ± 3 years, range 22–91</td>
<td>&gt;70 years: 78 (51.7%)</td>
</tr>
<tr>
<td>Tresh (1994) [28]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1989–1990</td>
<td>Acute care teaching hospital</td>
<td>All</td>
<td>151</td>
<td>108 (71.5%)</td>
<td>Mean 68.6 ± 3 years, range 22–91</td>
<td>&gt;70 years: 78 (51.7%)</td>
</tr>
<tr>
<td>Valent (1995) [36]</td>
<td>Prospective</td>
<td>Austria</td>
<td>1989–1991</td>
<td>Tertiary centre</td>
<td>All</td>
<td>253</td>
<td>145 (57.3%)</td>
<td>Mean 69 ± SD 13.3, range 27–97</td>
<td>&gt;70 years: 97 (38.3%)</td>
</tr>
<tr>
<td>Varon (1996) [23]</td>
<td>Retrospective</td>
<td>USA</td>
<td>1991–1992</td>
<td>Tertiary hospital</td>
<td>All</td>
<td>213</td>
<td>134 (62.9%)</td>
<td>Mean 70 ± 4 years, range 67–86</td>
<td>&gt;70 years: 89 (41.8%)</td>
</tr>
</tbody>
</table>

OR, operating room; ED, emergency department; CCU, coronary care unit; ICU, intensive care unit.
Six studies described both the ROSC and the survival to discharge in patients of 70 years and older (Figure 3) [12, 16, 23, 24, 28, 39]. In these six studies, a pooled rate of 41.1% of the patients had ROSC after CPR while only 17.5% of the resuscitated patients survived to hospital discharge. Thus, more than half of the patients who initially survived resuscitation died in the hospital before discharge.

Eight studies could not be used for the Forest plots, because they used other cut-off-points for age, see for the results Supplementary data available in Age and Ageing online, Appendix S5 [2, 15, 19–21, 29, 36, 37]. The diversity in ROSC (14.7–52.0%) and the survival of discharge rate is in line with the analysed studies.

Survival rates did not appear to be affected by type of hospital (17.1% in general hospitals and 13.7% in tertiary hospitals, $P = 0.687$ [2, 23, 26, 33, 35, 39]), location of hospital (USA 17.4 compared with 21.5% in Europe, $P = 0.287$ [2, 12, 24, 32, 34]) or time of publication (studies published before 1990 17.7 compared with 17.8% for studies published after 1990, $P = 0.641$ [3, 12, 16, 23, 33, 34, 39]).

**Long-term outcome**

Only five studies addressed the survival rate of patients after 6 months or more after in-hospital CPR [17, 24, 25, 27, 28]. A study that included 156 patients of 70 years and older who were resuscitated found a survival rate of 15.4% after 1 year [24]. In another study that included 78 patients, the survival rate was 20.9% after 1 year, 18.5% after 2 years and 17.3% after 3 years in this age group [28]. In 86 patients of 75 years and older, the survival rate was 7.0% after 1 year [17]. In a study on patients older than 80 years who survived CPR, the survival rate was 6.1% at 6 months after CPR [25].

In another study of patients aged 80 years and older, 50 out of 474 (10.5%) patients who were resuscitated survived to hospital discharge. The survival rates were 8.4% after 1 week, 7.0% after 1 month and 5.7% after 6 months [27].

**Functional and social status**

The social status was investigated in one study. Of the 50 patients who survived to hospital discharge, 9 were placed in a nursing home and 12 were admitted to a rehabilitation or psychiatric facility. Ten were transferred to a chronic care hospital with ventilator capabilities, 7 of the 10 patients died within a week [27].

Three studies investigated functional status after in-hospital CPR [25, 28, 34]. One study showed that all successfully resuscitated patients (7 out of 41) of 70 years and older enjoyed a level of independence similar to their level before the resuscitation, measured 1 month after the resuscitation [34]. Another study with 42 successfully resuscitated patients (54% of total) of 70 years and older also found that there were no significant differences in the functional level of the survivors at the time of hospital discharge compared with their pre-arrest status [28]. In a study with 24 patients older than 80 years, only 20% of the survivors were capable of independent functioning outside of institutionalised care [25].

**(Pre)-arrest patient-related factors associated with outcome**

Only two studies investigated the influence of pre-arrest and arrest factors on the survival rates during in-hospital CPR.
specifically for older people [16, 25]. One study analysed 205 patients of 70 years and older with a witnessed arrest. They found that 20.8% (11 out of 53) of the patients with ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT) survived to hospital discharge. This was much higher than the survival rate of patients with other rhythms (such as electromechanical dissociation, asystole or a junctional rhythm) who had a survival rate of 2.6% (4 out of 152). A duration of chest massage of 5 min or less was significantly associated with higher survival to discharge compared with a duration of >5 min (22.5 versus 2.6% respectively). Finally, only a haematocrit level of <0.35 and the presence of more than two acute diseases before the arrest were significantly associated with a lower change of survival (10.6 versus 0.0%, P < 0.01 for both characteristics). An independent function level and normal mental status before the arrest tended to have a higher chance of survival, but the results were not significant [16].

The other study investigated the mortality of resuscitated patients aged 81 years and older and found that of the 26 patients with VT/VE, 92.3% died compared with 95.2% of the 21 patients with rhythms other than VT/VE. This difference was not significant. The other investigated factors (gender, history of diabetes mellitus, congestive heart failure or COPD, pre-arrest functional cardiopulmonary status, cause of the arrest, arrest time and CPR time) were also not significantly associated with survival [25].

Discussion

In this systematic review, an overview of the outcome of in-hospital resuscitation in older people is presented. In patients aged 70 years and older, 38.6% had ROSC, but more than half of the patients who initially survived resuscitation died in the hospital before hospital discharge. The survival rates to hospital discharge decline with increasing age. In patients aged 70–79 years, the pooled survival was 18.7%, for patients aged 80–89 years the pooled survival was 15.4%, while for patients aged 90 years and older the pooled survival was 11.6%. We found only four studies that reported the quality of life of older people survivors of CPR, the results were diverse. In two studies all patients had a similar level of independence as before the resuscitation. In contrast, in two other studies only 20 and 40% of the survivors were capable of independent functioning outside of institutional care.

Our results are in line with a recent meta-analysis, which found older age to be a significant predictor of failure to survive to discharge after CPR, with odds ratio 1.5, 2.7 and 2.5 for age over 70, 80 or 90 years, respectively [41]. A previous review concluded that most patients have a relative good functional outcome after CPR, but found that age over 70 years was significantly associated with decreased functional outcomes [42].

This review has several limitations most of which are related to the design and quality of the original studies. The
included studies were heterogeneous in year of publication, inclusion criteria, number of included patients, age groups and outcome measurements. Owing to this heterogeneity, performing a meta-analysis was not possible. Furthermore, the quality of the studies was moderate to poor and no publication had a low risk of bias for all quality items. Finally, after cross-referencing, we included one extra article which was not selected in the search because it did not specifically refer to older patients in the abstract. It is possible that other eligible studies were missed, because they did not specifically refer to older patients in their abstract. However, by performing an elaborate search and thorough cross-referencing, we have reduced this risk to a minimum. Despite these limitations, this review provides a comprehensive overview of all currently available data on the outcome of in-hospital CPR in older patients. This makes this article helpful to physicians and patients in their advanced directive decision-making.

In discussing the decision about CPR, it is important to give objective information. Research has shown that older patients readily understand prognostic information after an educational intervention [7]. When information about the prognosis was given by explicitly with mentioning the chance of survival in percentages, it influenced patients’ decisions about DNR orders [7, 43]. Our results can be used to give older people the information they need in order to make a well-informed decision. However, it is important to realise that the results of the included studies are only based on a selected group of patients >70 years, namely those patients with a do-resuscitate policy. These patients are likely to be healthier when compared with patients with a DNR policy; extrapolating the study results to the entire patient population could therefore result in an overestimation of survival.

In order for patients to make well-informed decisions about CPR, further research is urgently needed. First of all, we stratified patients according to age but other pre-arrest factors could be used to assess the risk of a negative outcome of CPR for the individual patient. Previous studies in patients of all ages have identified a range of pre-arrest factors associated with mortality after CPR, including black race [21, 41, 42], higher body mass index [46] metastatic or haematological malignancy [21, 41, 42], impaired renal function [41, 42, 46], hepatic insufficiency [21], hypotension on admission [41], sepsis [21, 42, 47], acute stroke [21, 42], admission for pneumonia [41], trauma [21, 41] or medical non-cardiac diagnoses [41] and dependency for activities of daily living [41, 42, 47]. However, it cannot be assumed that these also apply to older people, especially given their lower overall chance of survival. Second, previous studies have shown that for older people an expected good quality of life is associated with a greater willingness to receive life-sustaining treatments [8, 48]. The long-term quality of life and functional status of survivors may be as important as survival itself. However, the information on the quality of life after surviving CPR is still scarce. Therefore, future research should focus on both pre-arrest factors and patient-centred outcome measures after survival. We believe that this will require a prospective study design, as many potentially relevant pre-arrest factors or outcome measures cannot be retrieved retrospectively from the patient’s chart by a researcher who was not involved at the time of CPR.

In conclusion, survival rates of in-hospital CPR in older people seem to be moderate to low and decline with increasing age. However, it is not clear if age alone is a limiting factor, because most studies did not adjust for pre-arrest factors. Furthermore, important information about the quality of life after surviving CPR is lacking. Even though the survival rates appear to be low in older people in general, the mentioned limitations indicate that there could be certain elderly patients for who CPR is a worthwhile intervention. Future research should focus on pre-arrest factors that could predict mortality specifically in older people, in order to define subgroups of patients most likely to benefit from CPR. Such studies should not only address ROSC and hospital discharge survival rates, but more importantly quality of life, care dependence, cognitive functioning and the long-term survival rates.

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**Key points**

- This review described the chance of survival, the social status and functional outcome after in-hospital CPR in older people.
- More than half of the patients who initially survived resuscitation died in the hospital before hospital discharge.
- The chance of survival to hospital discharge for in-hospital CPR in older people is low to moderate and decreases with age.
- Data on social and functional outcome after surviving CPR were scarce and contradictory.
- This objective information could be used to make an informed decision in the heavy-laden decision about resuscitation.

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**Supplementary data**

Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

**Authors’ contribution**

Study concept and design was done by M.H., in collaboration with all other authors. M.v.G. performed the literature search. M.v.G. and D.F. independently performed the data extraction, quality assessment and data syntheses. After that analyses were done. M.H. critically revised draft manuscript. All authors read and approved the final manuscript. M.H. and D.F. contributed equally as lead authors.

**Conflicts of interest**

None declared.
References

The very long list of references supporting this review has meant that only the most important are listed here and are represented by bold type throughout the text. The full list of references is available on Supplementary data available in Age and Ageing online, Appendix S1.


Chance of survival and the functional outcome