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Editorial

No association of CPR duration with long-term survival

Patient outcomes after out-of-hospital cardiac arrest (OHCA) are associated with a multitude of pre- and in-hospital variables. Of those, younger age, public location, presence of witnesses and bystander cardiopulmonary resuscitation (CPR), initial shockable rhythm, early defibrillation, short emergency medical service (EMS) response time, and short EMS-initiated CPR duration until the return of spontaneous circulation (ROSC) are crucial prehospital factors associated with 1-month neurological intact survival after OHCA.[1–4] EMS-initiated CPR duration and EMS-response time are independently and inversely associated with favourable outcomes at one month after OHCA or at hospital discharge.[5–9] Reynolds et al. found that conventional resuscitation was the most effective within the first 10 to 15 minutes of CPR, by which time 75% of patients with favourable neurological outcomes at hospital discharge had achieved rapid ROSC.[9] The probability of favourable neurological outcomes at hospital discharge fell to 2% beyond this point. Accordingly, in many EMS systems, except Asian countries, patients with OHCA are declared dead at the scene after a predetermined CPR duration is exceeded before hospital arrival.[2,3,10] However, the impact of EMS CPR duration on long-term (1 year and beyond) outcomes post-hospital discharge is unclear. It is reasonable to speculate that a longer EMS CPR duration may be associated with increased odds of long-term mortality, given that a longer CPR duration is associated with short-term unfavourable outcomes.

In this issue of *Resuscitation*, Chai et al. reported the association between EMS CPR duration and long-term outcomes (1-year and 3-year survival, and 1-year functional outcome) after hospital discharge in patients with OHCA.[11] Chai et al. found that the early risk of longer CPR-to-ROSC intervals did not translate into poor long-term outcomes in hospital discharge survivors.[11] They suggested that the duration of resuscitation prior to termination should not be influenced by the assumption of poor long-term outcomes. Using data from the British Colombia Cardiac Arrest Registry linked to the provincial database between 2009 and 2016,[12] they examined the relationship between CPR-to-ROSC intervals and survival using Kaplan–Meier analysis and all outcomes using the Cox proportional hazard model. Poor neurological status prior to OHCA, non-shockable rhythm, non-public arrest location, and unwitnessed arrest were associated with a longer EMS CPR duration. In patients who achieved ROSC (n = 4604), the median EMS CPR duration was 15.5 minutes (inter-quartile range 1–3, 9.0–22.9) and 27.0% (n = 1245) survived hospital discharge. When CPR-to-ROSC intervals were stratified by three categories (≤10, 10–20, >20 minutes), patients with ≤ 10 min interval had the highest survival rate (59.6%), and those with > 20 minutes had the lowest survival rate (7.8%) at hospital discharge. The CPR-to-ROSC intervals were significantly associated with hospital discharge survival and functional outcomes in univariate and multivariate analyses with nonlinear relationships. Among hospital survivors (n = 1245), the estimated Kaplan–Meier survival at 1-year and 3-years was 92% (95% confidence interval [CI], 90–93%) and 84% (95% CI, 82–86%), respectively. There was no significant difference among CPR-to-ROSC intervals in long-term survival rates using both the Kaplan–Meier and Cox regression models. Furthermore, there was no significant association between CPR-to-ROSC intervals and 1-year functional outcomes in the unadjusted and adjusted models. Longer EMS CPR duration was non-linearly associated with lower survival and functional outcomes at hospital discharge but not with post-discharge long-term outcomes. Moreover, they evaluated the association between pre-OHCA comorbidities and medications with longer professional CPR duration. They found that diabetes mellitus, chronic kidney disease, and prior myocardial infarction were associated with longer CPR-to-ROSC intervals. The presence of comorbidities prior to OHCA was associated with worse survival and functional outcomes persisting for one and three years. To the best of my knowledge, above-mentioned unexpected results are the first study that examined the relationship between EMS CPR duration and long-term outcomes post-hospital discharge. The restriction to one geographic location in Canada was one of the limitations of this study.

Based on previous studies, prehospital variables associated with long-term survival or neurological outcome were as follows: shockable rhythm, frequency of ventricular fibrillation, age, sex, arrest location, socioeconomic status, witnessed arrest, bystander CPR, asphyxia aetiology, Charlson comorbidity index, comorbidity (cancer, hypertension, diabetes, heart valve disease, peripheral artery disease), time from arrest to initiation of CPR, and low-flow time.[13–20] Of those variables, prehospital predictors with higher odds of favourable long-term outcomes were initial shockable rhythm, age, public location, and comorbidity prior to OHCA. A recently published systematic review and meta-analysis showed that the survival rates of 1-, 3-, 5-, 10-, and 15-years were 77.3%, 69.6%, 62.7%, 46.5%, and 20.8%, respectively.[13] In terms of initial rhythm, patients with shockable rhythms had three times the probability of 1-year survival and 1.5 times the probability of 3-year survival as compared to non-shockable patients.[13] Compared to these data, 1- and 3-years survival rates were both approximately 15% higher in Chai's study.[11] Prehospital variables associated with both 1- and 3-year survival in

Chai's study were younger age, initial shockable rhythm, and Charlson comorbidity index, which is consistent with previous studies.[13–16]

Regarding prehospital time variables for long-term outcomes, Kragholm et al. from Demark showed that the time interval from arrest to the start of EMS-initiated CPR was not associated with 1-year survival and brain damage or nursing home admission rates.[19] Rey et al. from Spain showed that the time interval from arrest to CPR initiation was a significant predictor of long-term survival.[16] However, they did not find any association between the time of arrest and ROSC. As in all epidemiological studies with different EMS systems, uncontrolled confounders could have influenced these contradictory results. As for Chai's study, the authors did not include the time from arrest to initiation of EMS CPR or the time from arrest to bystander-initiated CPR in their Cox proportional hazard model. These time variables may have influenced the results.

In the Utstein templates, 30-day survival or survival to discharge has been the core outcome. There are no requirements to capture long-term outcomes beyond 1 year.[21] Accordingly, the relationship between prehospital variables and long-term outcomes is poorly understood. As overtime survival after OHCA has increased worldwide, focus on long-term functional status after hospital discharge has been of increasing interest in addition to long-term survival.[20] The goal of resuscitation is not simply long-term survival but rather functional-intact survival with satisfactory quality of life, since anoxic brain injury is a major cause of morbidity and mortality after OHCA.[22] Baldi et al. compared the mortality of OHCA patients with the standardised and age-specific mortality rate over five years of follow-up showing that OHCA patients had increased mortality compared to the general population.[23] This indicates that OHCA may lead to long-term issues which could affect survival even years after the event. Accordingly, I would agree with the idea of Baldi, that long-term follow-up longer than 1-year should be included in the next Utstein-style revision.[23]

Although a long CPR duration may discourage all medical staff, including EMS crews, the results of Chai's study will shed some light on finding a rainbow.[11] A longer EMS CPR duration should not be considered when terminating resuscitation with a self-fulfilling prophecy bias. Early indications for novel strategies, such as extracorporeal CPR, would change the concept of long CPR duration or low-flow time intervals. We must further investigate the association between prehospital time factors and long-term favourable neurological outcomes after hospital discharge in patients with OHCA.

Conflict of Interest statement

None.

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