Göteborg, 2020

The fight against time in prehospital cardiac arrest
– a true medical emergency

AKADEMISK AVHANDLING

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i Hjärtats Aula, Sahlgrenska Universitetssjukhuset, Vita stråket 12, Göteborg, fredagen den 11 september 2020 klockan 09:00

av

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Avhandlingen baseras på följande delarbeten:

I. Johan Holmén, Jacob Hollenberg, Andreas Claesson, Maria Jiménez Herrera, Youcef Azeli, Johan Herlitz, Christer Axelsson. **Survival in ventricular fibrillation with emphasis on the number of defibrillations in relation to other factors at resuscitation.** *Resuscitation 2017 Apr;113:33-38.*

II. Johan Holmén, Johan Herlitz, Christer Axelsson. **Immediate coronary intervention in prehospital cardiac arrest - Aiming to save lives.** *American Heart Journal 2018 Aug;202:144-147.*

III. Johan Holmén, Johan Herlitz, Maria Jimenez-Herrera, Thomas Karlsson, Christer Axelsson. **Passive leg raising in out-of-hospital cardiac arrest.** *Resuscitation 2019 Apr;137:94-101.*

IV. Johan Holmén, Johan Herlitz, Sven-Erik Ricksten, Anneli Strömsöe, Eva Hagberg, Christer Axelsson, Araz Rawshani. **Shortening ambulance response time increases survival in out-of-hospital cardiac arrest.** *Submitted manuscript 2020.*

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Abstract

Background: The chances of survival after an out-of-hospital cardiac arrest (OHCA) are one in ten. The majority of survivors have no or relatively mild neurological sequelae. Interventions are time critical and well-timed management is challenging. Randomised trials face ethical and legal barriers. The victim is unable to give informed consent and obtaining consent from a legal surrogate delays resuscitation actions. This highlights the need for observational efforts in clinical cardiac arrest research.

Methods: Study *I* describes the importance of the number of defibrillations in OHCA and their association with survival chances. It is based on data from the Swedish Registry of Cardiopulmonary Resuscitation (SRCR). Study *II* describes the implementation and feasibility of a direct pathway to immediate coronary angiography after OHCA and its outcome. Patients were screened in the field by ambulance crews and referred to the catheterisation laboratory after consultation with the interventionalist. Study *III* examines the effect of a basic manoeuvre (passive leg-raising, PLR) in cardiopulmonary resuscitation (CPR) in an observation comparing PLR with standard CPR. Study *IV* determines the association between ambulance response time and survival after an OHCA, based on data reported to the SRCR.

Results: *Study I:* Between 1990 and 2015, 19,519 patients with a shockable rhythm were reported to the SRCR and included in the study. The chances of survival decreased as the number of defibrillations required increased. Among patients found in a shockable rhythm, 7.5% required more than 10 shocks. Among the witnessed cases, we identified 12 factors associated with survival to 30 days, one of which was the number of shocks that were delivered. *Study II:* Prehospital screening identified 86 OHCA patients, but only 58% fulfilled the given criteria for pathway activation. Among these, the angiography procedure was started within an hour after collapse in half the cases and the majority had a culprit lesion. Thirty per cent of the patients survived to 30 days and 92% of the survivors presented with a shockable rhythm. All survivors had a good cerebral performance or sufficient function to manage activities of daily life independently. *Study III:* The PLR manoeuvre was performed in 44% of the n=3,554 OHCA patients included in the study. When matching 1:1 on a propensity score, we found no difference in 30-day survival between the two groups (OR 1.07; CI 0.80-1.44; p = 0.65). The matched comparison showed a 30-day survival rate of 8.6% in the PLR group versus 8.2% in the control group. *Study IV:* Survival chances after a witnessed OHCA decreased as ambulance response times increased. This was seen independently of the initial rhythm and whether or not CPR was performed before EMS arrival. The chances of survival to 30 days was 19.5% when the EMS crew arrived within 0-6 minutes in an OHCA situation, as compared with 9.4% if the crew arrived within 10-15 minutes.

Conclusion: *I)* The chances of survival after an OHCA decreased for each defibrillatory shock administered. *II)* The prehospital activation of a pathway to immediate coronary angiography in OHCA showed limited feasibility. The criteria for the prehospital initiation of a pathway of this kind have to be clear and simple in this time-critical situation. The initial rhythm could be an accurate criterion for prehospital screening to immediate coronary angiography after OHCA. *III)* We found no indications that the PLR manoeuvre during CPR was beneficial when performed by the EMS crew within five minutes of arriving on the scene. *IV)* The ambulance response time is important to survival chances in OHCA. Possible actions to reduce EMS response times need to be considered urgently, as this can be lifesaving for future OHCA patients.

Keywords: cardiac arrest, cardiopulmonary resuscitation, out-of-hospital.

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