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Ten strategies to increase survival of cardiac arrest patients

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International out-of-hospital cardiac arrest (OHCA) survival rates vary considerably and reflect differences in the quality of the local chain of survival. In this paper, we describe the ten priorities for strengthening this chain, thereby improving survival from OHCA (Fig. 1).

1. High bystander CPR rate in the community

Good quality cardiopulmonary resuscitation (CPR) maintains vital circulation and improves the chances of having an initial shockable rhythm and ultimately of long-term survival [1]. Health authorities should address key CPR education goals and training programs within their system/community including dispatcher-guided telephone CPR programs.

2. Early AED programs in the community

Early defibrillation improves survival [1], and every effort should be made to reduce the time to first shock. This can be done by introducing automated external defibrillators (AEDs) to individuals outside EMS systems. AEDs are easy to use and can be used by police, fire fighters and lay people.

3. Good quality advanced life support by responders

Advanced life support (ALS) is the combination of CPR, defibrillation, airway and drug management, and the use of more advanced adjuncts. Although there are no data showing that any of these interventions improve outcome, we argue strongly that EMS services should continue to focus on training and delivery of high quality ALS, as described in current guidelines [1]. Drugs, combinations of drugs, or adjuncts such as mechanical chest compression devices might improve with further research and development.

4. Monitoring during ALS

Better quality ALS can be achieved by monitoring the quality of CPR. End-tidal carbon dioxide ($ETCO_2$), reflecting cardiac output, is currently the best real-time physiological monitoring device to guide CPR [1]. It requires an advanced airway and can be used for continuous quality evaluation of chest compressions. It can also distinguish between return of spontaneous circulation (ROSC) and pulseless electric activity (PEA) after shock delivery. Near-infrared spectroscopy (NIRS) and

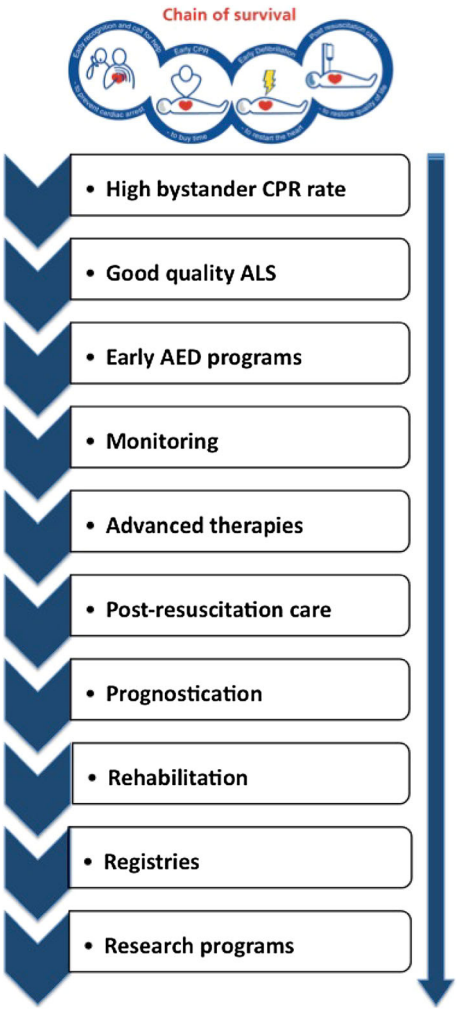

Fig. 1 Ten strategies to increase survival of cardiac arrest patients. Abbreviations: see text

ventricular fibrillation (VF) waveform analysis (incorporated in the defibrillator) are other promising tools helping to optimise circulation and shock delivery, thereby individualising ALS management. Since diagnosis of the cause of arrest might be important in refractory cases, ultrasound techniques should be further developed and explored, enabling individualised therapy for specific diagnoses requiring specific treatment [1].

5. Developing advanced therapies in refractory cardiac arrest

In refractory cardiac arrest patients, resuscitation efforts can in selected cases be extended by using mechanical chest compression devices [2]. Even if not considered standard of care for all patients, they enable transport to hospital with adequate organ perfusion before implementation of extracorporeal life support (ECLS). There is growing evidence that ECLS can save lives when standard resuscitation fails [3]. However, there are still many obstacles to the rapid implementation of the technology (even pre-hospital) and questions regarding selection of patients and efficacy of the intervention.

6. Improving post-resuscitation care

Post-resuscitation care can improve short- and long-term outcome after cardiac arrest by treating the cause of the arrest and protecting the brain from worsening injury [4]. Recent guidelines recommend that resuscitated patients of presumed coronary cause should undergo immediate coronary angiography with subsequent revascularization if indicated [5]. Hypoxic–ischaemic brain injury is the main cause of death following OHCA [6]. Today, the only way to maximise neurological recovery is to lower the body temperature during the first 24 h, even if the optimal target is still debated (between 33 and 36 °C). The combination of both early coronary reperfusion and therapeutic hypothermia is associated with a better long-term outcome.

7. Prognostication

Predicting reliably which comatose post-cardiac arrest patients will eventually make a good neurological recovery is challenging. Many patients who eventually make a good recovery will take several days to awaken from coma, and decisions to withdraw life-sustaining therapy (WLST) are often taken far too early. Clinical examination alone is insufficiently reliable for WLST decisions. The European Resuscitation Council (ERC) and European Society of Intensive Care Medicine (ESICM) have recently published guidelines for prognostication in comatose survivors of cardiac arrest [7]. In general, the prediction of outcome should be delayed until 72 h or more after ROSC and should incorporate multiple predictors (neuro-electrophysiology, neuro-imaging and/or biomarkers). If the results of prognostic tests produce conflicting results or prognostication is uncertain, further clinical observation and re-evaluation is recommended. Adoption of these guidelines has the potential to considerably impact outcome.

8. Rehabilitation

Although the majority of cardiac arrest survivors achieve a good neurological outcome as assessed by global measures such as cerebral performance category (CPC), and some studies have shown that the majority of these

individuals have good cognitive function and quality of life [8, 9], others have shown that they have considerable memory impairments [10]. The active rehabilitation of survivors of traumatic brain injury is widely recognised as being vital to their optimal long-term recovery, and yet survivors of cardiac arrest are typically discharged from hospital with no consideration for their rehabilitation needs. In the Netherlands, an early psychosocial intervention service has been introduced for survivors of cardiac arrest [11], and such an approach should be more widely adopted.

9. Registries

High-quality cardiac arrest registries include data from many patients and enable comparisons between different healthcare systems. Such comparisons are made more reliable when risk-adjustment modelling is applied to the data [12]. They also facilitate observational studies that, although subject to bias, serve the important function of being hypothesis generating and, as such, can guide and facilitate prospective trials. There are several examples from good registries worldwide [13, 14], and as these registries become more sophisticated they will become valuable for assessing the impact of guideline changes and other cardiac arrest interventions.

10. Research programs

As many guidelines are based on low quality evidence, we need more high-quality research to improve the understanding of interventions. However, cardiac arrest research is challenging, not least because of the extreme urgency of interventions and because, by definition, the patient is unconscious and unable to provide consent. Overall survival from cardiac arrest, although increasing, remains comparatively low, and studies powered to show significant reductions in mortality typically need to recruit several thousands of patients. Prospective controlled studies in resuscitation require collaboration across multiple sites, organisations and careful ethical considerations [15]. International research consortia will underpin the future of cardiac arrest research.

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