Celebrating 50 years of cardiopulmonary resuscitation

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It is now fifty years since Kouwenhoven, Jude and Knickerbocker published their seminal paper describing the use of closed chest cardiac massage for the resuscitation of patients in cardiac arrest[1]. The widespread adoption of these techniques by both laypersons and healthcare professionals has seen many tens of thousands of lives saved over the years. The science supporting the practice of resuscitation has grown substantially since these early descriptions. It has also become increasingly recognised that advances in science alone are insufficient to improve patient outcomes unless they can be integrated into clinical practice[2]. The International Liaison Committee for Resuscitation (ILCOR) (http://www.ilcor.org) was formed in 1992 with the aim of providing a forum for liaison between resuscitation organisations worldwide. ILCOR has been leading on an appraisal of existing evidence over the last four years. This process will culminate with the simultaneous publication of the International Consensus on Science and Treatment recommendations in the journals Resuscitation and Circulation on 18th October 2010. In parallel with these publications, Resuscitation Councils from around the world will publish new and updated resuscitation guidelines.

This themed edition of Current Opinion in Critical Care is dedicated to providing an update on key areas of resuscitation research over the last 2 years. The papers are arranged to flow through the "Chain of Survival" concept which identifies the four central pillars to improving outcomes from cardiac arrest (cardiac arrest prevention; CPR, defibrillation and post resuscitation care)[3-4].

Cardiac arrests, particularly in the hospital setting are rarely an un-heralded event. In 30-80% of in-hospital arrests evidence of physiological deterioration is recorded in the medical and nursing charts in the hours prior to the arrest. Establishing system-wide approaches to minimising these risks have focused on combinations of risk prediction, surveillance and emergency response systems. Risk prediction systems seek to identify, early during an admission, those patients most at risk of adverse outcomes such as cardiac arrest, critical care admission and death. Surveillance systems aim to identify the deteriorating patient, prior to cardiac arrest whilst response systems provide the mechanisms for ensuring the right clinicians are called in a timely manner to provide appropriate treatment for the patient. Whilst these advances have undoubtedly improved the process of care for the critically ill patient, their impact on patient outcomes has been more difficult to determine [5-6].

Jansen and Cuthbertson report on an extensive review of the literature focusing on one type of physiological surveillance systems – the so called track and trigger systems. These systems combine the periodic observation of physiological signs (the "tracking") with predetermined calling or response criteria (the "trigger") for requesting the attendance of more experienced or skilled staff. Perhaps contrary to the widely held perception, they found that the formal statistical evaluation of these systems were often limited. They found that most systems have low sensitivity, low positive predictive values and high specificity meaning that they often fail to identify patients who need additional care. This may explain some of the reason why it has been difficult to clearly delineate positive effects on patient outcomes from introducing these systems[7]. The authors appropriately make a plea for the validation work to be undertaken urgently. Fortunately, an international, multi professional consensus conference has recently taken place to tackle these very issues. The proceedings from this conference provide a pathway for undertaking these validation steps which will help ensure these systems are optimally configured[8].

Our understanding of the importance of the quality of CPR has expanded significantly over the last 5 years. Chest compression depth[9-10], rate[11], failure to release pressure between compressions(leaning)[12], interruptions in CPR[13], pauses prior to defibrillation[14] and ventilation rate[15] all impact the effectiveness of resuscitation. Despite this, CPR is still frequently performed sub-optimally by both laypersons[16] and healthcare providers[17-19]. Building on the theme that science alone without translation into practice cannot improve outcomes, a number of strategies have emerged to support implementing best practice. Researchers from the University of Pennsylvania note that technologies have been developed that are able to prompt CPR providers to undertake specific actions and provide real time feedback on the quality of chest compressions and ventilations. There is good evidence that the use of these devices can improve CPR skill acquisition and retention during training and some evidence they improve CPR performance in real life[20]. Complimentary to the use of these devices, simulation training is noted to improve resuscitation performance in actual cardiac arrests[21-22] and the importance of frequent targeted training sessions is explored[23]. Focused debriefing, which allows resuscitation team members to revisit and learn from actual cardiac arrests also shows promise for improving the quality of CPR and survival[24].

Mechanical chest compression devices offer an alternative to manual chest compression. The devices have several potential advantages over manual chest compression. Mechanical compression devices compress the chest to specified depths/rates, compressions are uniform and efficacy does not decline due to fatigue. Despite good evidence from animal models suggesting superiority over manual chest compressions, the evidence supporting their use in patients is either lacking or equivocal[25]. There is an urgent need for definitive studies to examine the clinical and cost effectiveness of these technologies.

Defibrillation is life saving for patients in ventricular fibrillation (VF) / pulseless ventricular tachycardia (VT). The time from the onset of VF / VT to shock delivery is critical; with survival falling by approximately 5% for every minute defibrillation is delayed [26-27]. The introduction of Public Access Defibrillation (PAD) programmes in the early 90's facilitated significant reductions in the times taken to deliver the first shock. There is now convincing evidence for both the clinical [28-29] and cost effectiveness [30] of these programs. Having established effectiveness, the next step is to consider where technology can best be deployed. Dianne Atkins from the University of Iowa undertakes an in depth appraisal of PAD programs, exploring in detail how, where and when they can be best utilised. She identifies that placing devices in public places with the highest frequency of cardiac arrests, ensuring appropriate supportive infrastructure is provided and integrating with local EMS systems are the key elements for success.

The Universal Advanced Life Support algorithm prompts resuscitation teams to identify and treat potentially reversible causes of cardiac arrest during CPR[31]. Of the potentially reversible causes of cardiac arrest it is possible with simple bedside examination / tests to identify hypoxia, electrolyte disturbances and hypothermia. The remaining reversible causes (hypovoleamia, tamponade, pulmonary embolism, myocardial infarction and tension pneumothorax, toxin) are dependent upon subjective clinical assessment with or without supportive diagnostic imaging (pneumothorax) and laboratory tests (toxins, haemoglobin). The increasing availability of portable ultrasound /

echocardiograph equipment has opened up the possibility of using these diagnostic techniques during CPR. Price *et al* review the role that echocardiography can play during advanced life support both in terms of diagnosis of underlying heart rhythm[32], identification of potentially reversible causes[33-34] and targeted treatment[35]. The authors raise the importance of further studies in this area and in ensuring that competency based training programmes are developed in parallel with changes in guidelines in order to ensure that the full potential of this technology can be realised.

The return of spontaneous circulation heralds the commencement of the final link of the chain of survival – post resuscitation care. Since therapeutic hypothermia was shown in 2002 to improve neurological outcome after cardiac arrest[36], renewed focus and attention has been applied to the post resuscitation phase of care. The International Liaison Committee for Resuscitation published a full evidence appraisal of the epidemiology, pathophysiology, treatment, and prognostication after return of spontaneous circulation in 2008[37]. Nolan and Soar provide a succinct yet state of the art review of how to manage patients during this phase of their care. They highlight the potential benefits of institutions developing post resuscitation bundles of care[38] comprising control of glucose, therapeutic hypothermia and percutaneous coronary intervention and cite the latest evidence of the potential efficacy of this approach[39].

Beyond the concept of post resuscitation care bundles – the question becomes where can care most effectively be delivered? Given the marked regional variation in outcomes from cardiac arrest[40] and well-defined relationship between patient volume and outcomes in several other diseases the question arises as to whether outcomes would be improved if care was centralised into regional cardiac arrest centres[41]. Nichol and Soar explore the evidence for and against cardiac arrest centres and come to the conclusion that the successful implementation and maintenance of cardiac resuscitation centres would have a significant and important impact on outcomes.

So fifty years after the first description of chest compressions we should celebrate the success of how the science of resuscitation has grown and the success of how CPR has spread to all corners of the globe. At the same time we need to recognise the limitations to our current practice and strive to see the next fifty years evolve to conquer these limitations and eliminate morbidity and mortality from cardiac arrest.

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