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To ventilate or not to ventilate during cardiopulmonary resuscitation: that is the question

Raghu R Seethala, Benjamin S Abella

As we approach the 50th anniversary of modern cardiopulmonary resuscitation (CPR), there has been a renewed interest in the practical details of CPR, including training methods, the quality of CPR delivery and the very composition of CPR itself—that is, the ratio of chest compressions and ventilations given in a period of time. This latter topic has been the focus of intensive study and debate for the past decade. For example, increasing data have suggested that hyperventilation during CPR is both common and probably deleterious to patient survival. In addition, it has been recognised that most cardiac arrest victims do not receive bystander CPR, in part due to reluctance by the public to engage in mouth-to-mouth (MTM) respirations. Ramaraj and Ewy presented the case for removing ventilations altogether from the composition of CPR provided by the lay public (so-called ‘continuous chest compression (CCC)/CPR’) or, in current American Heart Association parlance, ‘hands-only CPR’.

The history of CPR has been a complex and serendipitous one. During the 1950s in Baltimore, Maryland, USA, Peter Safar demonstrated the importance of MTM ventilation as a key component of resuscitation in dramatic fashion. Safar performed experiments in which he pharmacologically paralysed medical students and showed that MTM ventilations served as an effective form of respiration. Within the same few years, Kouwenhoven and colleagues unintentionally discovered the significance of chest compressions. At the time, Kouwenhoven was studying defibrillation in a canine model of ventricular fibrillation (VF). He noticed that when he pressed down on the chest of the dogs with the paddles to defibrillate, the arterial blood pressure would increase. Along with his colleagues, they soon realised that they could apply their hands to the chest in repetitive fashion and induce similar blood pressure elevations. In 1960, Safar and Kouwenhoven each presented their findings at a Maryland Medical Society meeting. Thus, through two independent discoveries modern CPR was born.

In the early 1990s, several investigators began to question the necessity of initially providing ventilations during primary cardiac arrest (ie, with arrhythmia as a culprit, not asphyxia or haemorrhage). In 1993, a study from the University of Arizona showed that swine in VF receiving standard CPR (chest compressions and ventilations) had an equal survival rate to those receiving chest compressions alone. Since that time, several laboratory and clinical studies have been published showing the value of CCC-CPR. In 2008, the American Heart Association published a science advisory that encouraged layperson delivery of CCC-CPR for witnessed cardiac arrests, in situations in which bystanders were not trained in MTM or were unwilling to perform rescue breaths. Bystanders who were previously trained in CPR and confident in their abilities had the option of providing standard CPR or CCC-CPR.

The article by Ramaraj and Ewy provides a comprehensive summary of the logic and evidence behind CCC-CPR. They suggest that ventilations be abandoned altogether during layperson delivery of CPR for witnessed cardiac arrest. They argue that: (1) bystanders are more likely to perform CCC-CPR than standard CPR; (2) early ventilations are unnecessary because the blood is adequately oxygenated; (3) MTM ventilations interrupt chest compressions and therefore negatively affect perfusion; and (4) CCC-CPR is easier to learn and teach.

EVIDENCE IN SUPPORT OF CHEST COMPRESSION-ONLY CPR

Bystander CPR is an essential component of the ‘chain of survival’, as the prompt delivery of CPR during cardiac arrest provides a two to threefold survival benefit. Despite widespread CPR training over decades, the rates of bystander CPR remain low: less than 25% of cardiac arrest victims receive bystander CPR in the USA. One of the barriers to performing CPR as described by Ramaraj and Ewy is the reluctance to perform MTM ventilations. Survey investigations have suggested that lay public CPR providers are afraid of the risk of transmissible diseases and/or have a general aversion towards MTM. It is suggested that by eliminating MTM ventilations, bystanders will be more willing to perform CPR.

Several clinical studies have suggested that CCC-CPR is as effective or even better than standard CPR. An early investigation looking at CCC-CPR was by Hallstrom et al in 2000. In that randomised trial of CCC versus standard CPR, there was no significant difference in outcomes between patient cohorts receiving either form of resuscitation care. In a larger non-randomised study published in 2007, a Japanese group demonstrated that CCC-CPR was equivalent to standard CPR and in certain sub-groups (shockable rhythms, early basic life support care) CCC-CPR resulted in better neurological outcomes at 30 days post-arrest.

In addition to the animal and human studies, the notion of ventilations being unnecessary early during resuscitation is grounded in arrest physiology. In contrast to primary asphyxial arrest, the arterial blood is initially well oxygenated in cardiac arrest precipitated by arrhythmia and probably remains so for up to 3–5 minutes. Furthermore, ventilations may be less necessary early in arrest as patients frequently gasp for several minutes, providing a certain degree of continued oxygenation. Also, administering MTM ventilations increases intrathoracic pressure, which thereby decreases venous return to the heart and cardiac output.

UNRESOLVED QUESTIONS WITH CHEST COMPRESSION-ONLY CPR

The evidence elaborated by Ramaraj and Ewy supports CCC-CPR for primary cardiac arrest of short duration. But how long is a ‘short duration’? Studies have provided conflicting data regarding the duration of cardiac arrest and the benefit of CCC-CPR compared with standard CPR. Ewy et al showed that in a swine model of VF, ventilations were not necessary for the first 12 minutes of untreated VF even if compressions were started as late as

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6 minutes into the arrest episode. In contrast, Idris et al.\textsuperscript{12} showed that in a different model of 6 minutes of untreated VF, swine that did not receive ventilations had a much lower rate of return of spontaneous circulation. Another study showed that swine treated with ventilations after an 8-minute period of untreated VF had a better 24 h neurological outcome than the CCC-CPR group.\textsuperscript{15} It is reasonable to conclude that as the duration of untreated cardiac arrest lengths, ventilations become increasingly important.

The notion that MTM ventilation discourages many individuals from performing CPR because of the fear of communicable diseases also receives conflicting support in the literature and, while seeming to have face validity, remains largely unproved. One survey study of actual cardiac arrest bystanders noted that a small minority of respondents objected to MTM ventilations.\textsuperscript{14} The most common reasons given for not doing CPR in this investigation were that bystanders panicked and described fear of doing harm, irrespective of the notion of MTM ventilation delivery.

Although the majority of cardiac arrests in the developed world are from primary cardiac arrhythmia, objections to CCC-CPR have been raised due to the contribution of asphyxia and other respiratory causes of arrest. CCC-CPR might not be the optimal therapy for primary asphyxial arrests that occur in drowning or drug overdoses, for example. In laboratory studies of asphyxial arrest, the inclusion of ventilations in CPR delivery improved survival compared with CCC-CPR.\textsuperscript{15}

Given the evidence presented above, CCC-CPR seems to be supported for bystanders during witnessed primary cardiac arrests. Additional prospective studies need to be performed specifically looking at unwitnessed arrests and arrests of non-cardiac origin. Although we support the notion that bystanders should perform CCC-CPR, the question of what approach is appropriate for emergency medical services (EMS) remains unanswered. There is growing evidence demonstrating that it would also be prudent for EMS to minimise ventilations. Bobrow et al.\textsuperscript{16} showed that after EMS implementation of a new protocol termed ‘minimally interrupted cardiac resuscitation’, survival to hospital discharge improved considerably. The protocol of Bobrow et al.\textsuperscript{16} minimised interruptions in chest compressions by delaying endotracheal intubation and positive pressure ventilations and initially providing passive oxygen insufflation via an oral pharyngeal airway and non-rebreather face mask. Some 50 years after its pivotal development, the emphasis in cardiac arrest care is moving towards a reorganisation of the original ABCs (airway, breathing, circulation) to the CABS (circulation, airway, and then breathing), offering a possibility to improve initial survival from this lethal disease.

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