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EDITORIAL

Controversial Topics from the 2005 International Consensus Conference on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations

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Cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC) constitute a relatively young field of medicine concerned literally with issues of life and death. The scientific evidence is scant and opinions are strong. It is difficult to perform clinical intervention studies with sufficient power, and this has been compounded by the severe restrictions on research created by consent legislation in North America[1] and Europe.[2] There is very little high-level evidence for resuscitation therapies, and many traditional treatment recommendations such as the use of adrenaline/epinephrine, are based on animal studies and reluctance to change an existing treatment recommendation until it is proven ineffective or less effective than a novel therapy.

A rigorous evidence evaluation worksheet process,[3] full disclosure and management of potential conflicts of interest,[4] and focus on science rather than treatment guidelines enabled the 380 international participants at the 2005 Consensus Conference ultimately to achieve consensus constructively and transparently. Participants agreed to focus on the few factors known to have the greatest impact on outcome, specifically recommendations most likely to improve survival rates without adding to the complexity of rescuer training. It was feared that complexity of training could have a negative impact by reducing attention to the most important factors.

There was unanimity about the need for increased emphasis on the quality of CPR, particularly the quality and number of chest compressions provided and the need to minimise interruptions in chest compressions. Participants also considered the need for altering the sequence of actions (i.e. compression first or shock delivery first) based on the interval from collapse of the victim to the arrival of rescuers (i.e. on the phase of resuscitation).

Selection and debate of controversial topics during the 2005 Consensus Conference

Plenary sessions were scheduled daily for presentation and additional debate on the most controversial issues from the previous day. Controversial topics were identified by panel moderators, conference participants, and the International Liaison Committee on Resuscitation (ILCOR) task force cochairs. During the final day of the conference the entire group of experts focused on the most controversial issue of the conference: selection and sequence of the critical actions needed

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to treat sudden cardiac arrest (SCA). This session crystallised discussion of controversial topics that had been debated daily and enabled the group to reach consensus on these topics. The topics included the relative merits of a compression-first sequence versus a shock-first sequence for treatment of ventricular fibrillation (VF) SCA, the compression—ventilation ratio, and the concept of a one-shock strategy (followed by immediate CPR) versus the three-shock strategy for treatment of VF/pulseless ventricular tachycardia (VT), and other topics (see below).

Summary of debate and decision about the most controversial topics

Compression first versus shock first for VF SCA

Recent data challenge the standard practice of providing defibrillation first to every victim with VF, particularly when 4—5 min or longer has elapsed from collapse to rescuer intervention. Only three human studies plus a somewhat larger body of animal data were available for experts to consider.

If the emergency medical services (EMS) response interval (interval between call to EMS and EMS arrival) for out-of-hospital VF arrest is more than 4—5 min, a period of CPR before attempted defibrillation may improve outcome.[5,6] If all of the human evidence had been positive, there would have been no debate. But one randomised study (LOE 2)[7] failed to show any effect of CPR before defibrillation at any collapse-to-response or collapse-to-defibrillation interval. An added factor is the realisation that rescuers may not know the interval since collapse of the victim.

Some conference participants proposed a treatment recommendation for rescuers to ''perform CPR for 3 min (or some specified interval or number of CPR cycles) before the first shock if more than 4—5 min had elapsed since arrest.'' Animal evidence[8—10] and one large case series (LOE 5)[11] suggests that ventilation is unnecessary for the first few minutes after primary VF cardiac arrest. But ventilation is important in asphyxial arrest (e.g. most arrests in children and many noncardiac arrests, such as drowning and drug overdose). Some conference participants suggested that recommendations provide the option of omitting ventilation for the first few minutes unless the victim is a child or the possibility of asphyxial cardiac arrest exists (e.g. drowning). To simplify lay rescuer education, the consensus among conference participants was to strive for a universal sequence of resuscitation by lay rescuers that would be identical for all victims.

Because the improvement in survival rates associated with provision of CPR before defibrillation was observed only in the subset of victims for whom EMS response intervals were 4—5 min or longer, the consensus was that there were insufficient data to justify recommending CPR before defibrillation for all victims of VF SCA. The experts wanted the treatment recommendations to allow rescuers the option of providing CPR first, particularly for out-of-hospital cardiac arrest in settings where the EMS response interval is >4—5 min. Therefore, the final decision was that 1.5—3 min of CPR before attempting defibrillation may be considered for treatment of out-of-hospital VF or pulseless VT when the EMS response interval is typically greater than 4—5 min.

There were insufficient data to determine (1) whether this recommendation should be applied to in-hospital cardiac arrest; (2) the ideal duration of CPR before attempted defibrillation; or (3) the duration of VF at which rescuers should switch from defibrillation first to CPR first.

Compression—ventilation ratio

The compression—ventilation ratio was one of the most controversial topics of the conference. The experts began the conference acknowledging that rates of survival to hospital discharge from witnessed out-of-hospital VF SCA are low, averaging $\leq$6% internationally (LOE 5),[12—14] and that survival rates have not increased substantially in recent years.[6] The North American Public Access Defibrillation trial showed that lay rescuer AED programs produced higher survival than lay rescuer CPR programs without AEDs, and that organised lay rescuer AED and CPR programs improved survival for witnessed VF SCA over the international average of 6%.[15] High (49—74%) survival rates for out-of-hospital witnessed VF SCA have been reported in some lay rescuer programs using CPR plus automated external defibrillation (AED) in casinos (LOE 5),[16] airports (LOE 5),[17] and commercial passenger planes (LOE 5),[18,19] and in some first responder AED programs (LOE 2,[20] LOE 3,[21,22] LOE 4,[23] and LOE 5[24]). Typically the higher rates were associated with provision of both early CPR and early (within 3—5 min of collapse) defibrillation.

No human data have identified an optimal compression—ventilation ratio for CPR in victims of any age. Compelling animal data indicate that frequent and prolonged interruption of chest compressions is deleterious. Recent clinical data showed frequent hands-off periods without chest compressions even for advanced CPR providers in both out-of-hospital[25] and in-hospital[26] settings, and laypeople require hands-off intervals of 14—16 s (during which chest compressions are interrupted) to give two rescue breaths.[27,28]

In animal models better results were achieved with a compression—ventilation ratio higher than 15:2.[29] In animals with sudden VF cardiac arrest and open airways, good results were achieved with continuous compressions without any ventilatory support.[30] One study of dispatcher-assisted CPR with apparent cardiac arrest and short (4 min) EMS call-to-ambulance response intervals had good results with chest compressions only.[31] However, it is difficult to determine the relevance of these studies to victims of out-of-hospital arrest with no patent airway, victims of asphyxial arrest, and victims in areas where EMS response intervals are longer than 4 min.

There was substantial evidence that the current practice of CPR provides too much ventilation to victims of cardiac arrest. Participants agreed that fewer ventilations are needed during CPR than previously recommended. One observational study showed that experienced paramedics provided ventilations at excessive rates to intubated patients during treatment for out-of-hospital cardiac arrest and that these excessive rates of ventilation persisted despite intensive retraining (LOE 5).[32] An in-hospital study also showed delivery of ventilation at excessive rates during CPR to patients with and without an advanced airway in place.[26] Although no human outcome studies were identified, one animal study showed that hyperventilation is associated with excessive intrathoracic pressure, decreased coronary and cerebral perfusion pressures, and decreased rates of survival (LOE 6).[32]

The obvious challenge was how to translate the need to increase chest compressions into recommendations that would be simple and appropriate for both asphyxial and VF cardiac arrest. There was agreement that continuous chest compressions could be appropriate in the first minutes of VF arrest, but ventilations would be more important for asphyxial arrest and all forms of prolonged arrest. There was also agreement that it would be too complicated to teach lay rescuers different sequences of CPR for different circumstances. For simplicity, a universal compression—ventilation ratio of 30:2 for lone rescuers of victims from infancy (excluding neonates) through adulthood was agreed on by consensus based on integration of the best human, animal, manikin, and theoretical models available. For two-rescuer CPR in children, a compression—ventilation ratio of 15:2 was recommended.

Oxygenation and ventilation are crucial for the newborn infant and few newborn infants require chest compressions. No new data were discussed to support a higher compression—ventilation ratio in newborns. For this reason, the 3:1 compression—ventilation ratio was retained for newborns.

One-shock versus three-shock sequence for attempted defibrillation

The *ECC Guidelines* 2000[33] recommended the use of a stacked sequence of up to three shocks without interposed chest compressions if VF/VT persists after the first or second shock. The 2005 Consensus Conference participants challenged this strategy, partly because the three shocks require prolonged interruption of compressions that is likely to be needless in the face of relatively high first-shock efficacy (defined as termination of VF for at least five seconds following the shock) of modern biphasic defibrillators.[34]

Researchers found no studies of three-shock defibrillation compared with one-shock defibrillation strategies in humans or animals. But there was consensus that interruptions in effective CPR should be minimised. Several relevant studies reported on the magnitude of success of initial or subsequent shocks, and these studies were compared to determine success rates for shocks. The experts reached consensus that the best overall strategy would be to recommend delivery of one shock with immediate resumption of CPR, beginning with chest compressions, with no check of rhythm or pulse until after a period of CPR.

Resumption of chest compressions immediately after each shock is novel and not based on outcome data. This recommendation follows concern about the excessive interruptions in chest compressions during resuscitation and the dramatic fall in predicted return of spontaneous circulation (ROSC) with even short periods of no compressions before defibrillation attempts.[35]

Shock dose

The recommendation to use a one-shock strategy creates a new challenge: to define the optimal energy for the initial shock. The consensus is that for the initial shock it is reasonable to use selected energies of 150—200 J for a biphasic truncated exponential waveform or 120 J for a rectilinear biphasic waveform.

In a study of out-of-hospital cardiac arrest, first-shock efficacy was no higher using a 360-J shock than a 200-J shock, and repeated shocks at the higher dose were associated with more atrioventricular block but no evidence of long-term harm.[36] The consensus recommendation was that when using a monophasic waveform defibrillator, it is reasonable to use 360 J for the initial and subsequent shocks.

Role of vasopressors in treatment of cardiac arrest

One of the most contentious topics debated during the conference was the role of vasopressin in advanced life support. It was conceded that despite the widespread use of epinephrine and several studies involving vasopressin, no placebo-controlled study shows that routine administration of any vasopressor at any stage during human cardiac arrest increases rates of survival to hospital discharge. Despite animal data indicating the advantages of vasopressin over epinephrine, a meta-analysis of five randomised trials showed no statistically significant differences between vasopressin and epinephrine for ROSC, death within 24 h, or death before hospital discharge.[37] Individual resuscitation councils will need to determine the role of vasopressin in their resuscitation guidelines.

Post-resuscitation care

Optimal treatment in the post-resuscitation period has not been well researched and is not standardised across healthcare communities.[38] In two studies therapeutic hypothermia improved neurological outcome among initially comatose survivors from out-of-hospital VF cardiac arrest, but the role of this therapy after in-hospital cardiac arrest or arrest from other rhythms remains inconclusive.[39,40] It is hoped that additional studies will add precision to our use of hypothermia in the future.

Summary

We acknowledge the limited data that we have to support many resuscitation interventions; further research is needed in virtually all facets of CPR and ECC. Ethics committees must empower investigators to challenge the unproven dogma that we have tolerated for far too long.

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