

**STATE OF THE ART**

**2005 emergency cardiovascular care guidelines**

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**Introduction**

The *2005 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care* (referred to here as the “2005 ECC guidelines”) recommend major changes to basic resuscitation practices and significant changes to advanced care.<sup>1</sup> This article highlights some of those changes and gives a brief overview of the guidelines creation process.

***Creating the 2005 ECC guidelines***

The comprehensive guidelines creation process followed in 2005 has evolved significantly beyond the process used to create previous guidelines.

In 1992, the Heart and Stroke Foundation of Canada (HSFC) participated in the American Heart Association’s (AHA) guideline process and then adapted the AHA guidelines for Canada.

In 2000, the HSFC partnered with the AHA and other members of the International Liaison Committee on Resuscitation (ILCOR)\* to develop the first international ECC guidelines. Consensus on some issues was difficult or impossible to reach because of differences in resources and medical practice in different parts of the world. Even after the guidelines were agreed upon, each of the international participants then altered the guidelines for their home countries.

In 2005, rather than try to reach an international consen-

sus on guidelines, ILCOR agreed to develop an international consensus on science and also on treatment recommendations where possible, but to leave the establishment of guidelines to each of its members. The HSFC decided that, rather than “Canadianize” the AHA guidelines as it had done before 2000, HSFC would work with the AHA to develop a single set of guidelines that would be acceptable in both Canada and the United States.

This 2005 guideline revision is the result of a process that began 5 years ago, immediately following the completion of the 2000 guidelines. The process has involved thousands of volunteer hours by hundreds of resuscitation experts and researchers from around the world, who reviewed 276 topics and completed more than 400 worksheets. In January 2005, 380 experts from around the world met in Dallas under the auspices of ILCOR to examine the evidence on resuscitation and to develop a consensus on science and on treatment recommendations. This international consensus forms the basis for the new guidelines. The guidelines themselves are a result of a collaboration between the AHA and the HSFC.

Previous guidelines have been criticized for reflecting the influence of pharmaceutical companies and other special interests. For the 2005 guidelines, ILCOR and the AHA went to great lengths to ensure full disclosure of potential conflicts and to manage conflict of interest when it existed. Details of the conflict of interest policy have been published along with the consensus document.<sup>2</sup>

***Why create new ECC guidelines***

The purpose of guidelines is to encourage rational treatment decisions with a view to reducing preventable mor-

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bility and mortality. These resuscitation guidelines provide advice for best practice based on the best available evidence, and on expert consensus when sufficient evidence is not available.

The guidelines are intended to assist practitioners who perform resuscitation sporadically, or even regularly, to take a rational approach to the procedure. The guidelines serve as a substitute for individual research, as it is unrealistic for most care providers to evaluate all of the existing evidence around every resuscitation situation they encounter. These guidelines are not intended to lock physicians into a particular care regimen, as “rules” or “standards” would. Since there is always lag time between the publication of evidence and the incorporation of that evidence into guidelines, the expert who is familiar with all of the latest evidence and who is able to critically review that evidence may well choose to deviate from guidelines that have not yet taken new research into account.

Because of the need for guidelines to make recommendations even when the evidence is weak (i.e., caregivers cannot opt not to care for patients because there is no definitive evidence of therapeutic benefit) some of the recommendations may be controversial. While caregivers do not want to rush into changes that may at best be unhelpful, or at worst cause harm, they cannot be paralyzed into inaction by a lack of definitive evidence in a condition where mortality is 95% or higher and definitive evidence is extremely difficult to develop.

### **Major ECC guidelines changes**

Table 1 illustrates the major changes in the 2005 ECC guidelines. Few of the changes are based on clear-cut evidence from large randomized controlled trials. While a great deal of research has been done on resuscitation in the past 5 years, little is certain beyond the knowledge that early cardiopulmonary resuscitation (CPR) and early defibrillation are important determinants of survival.

The story behind ILCOR’s development of an updated algorithm for CPR provides an excellent demonstration of how the committee dealt with gaps in the science of resuscitation.

There are no human studies showing that the new CPR algorithm produces better outcomes than the previous CPR algorithm. However, there is a great deal of circumstantial evidence to suggest that it should.

**Compression:ventilation ratio:** In order to be successful, CPR must develop and maintain adequate myocardial perfusion pressure.<sup>3-5</sup> The ILCOR committee concluded that the 2000 algorithm is not optimal at achieving this aim.

Two recent studies show that interruptions in chest compressions are frequent and, for a substantial proportion of arrest time, no compressions are provided.<sup>6,7</sup>

Coronary perfusion pressure is lost each time CPR is paused, and it then takes 3 to 5 compressions to develop adequate perfusion pressure when CPR is resumed.<sup>8-10</sup> While it may seem that pausing for a couple of seconds to ventilate doesn’t greatly affect “no perfusion” time, studies show that it takes a team of 2 rescuers ~8 seconds, or a single rescuer ~15 seconds, to perform a set of ventilations.<sup>11,12</sup> At a ratio of 15:2, and a rate of 100 compressions per minute, a single rescuer therefore provides only about 45 compressions per minute — of which only 33 are effective — along with 5 ventilations per minute, while 2 rescuers deliver 44 effective compressions per minute (60 actual compressions) along with 6 ventilations.

One human study and multiple animal studies clearly show that higher compression rates (>80) without interruption are more effective in non-asphyxial arrest than compressions with many or prolonged interruptions.<sup>9,13-21</sup> In an analysis of ventricular fibrillation (VF) waveform, the interruption of CPR was associated with a lower probability of conversion of VF to another rhythm.<sup>22</sup> In both manikin and animal studies, coronary and cerebral perfusion pressure increases as chest compression rates increase.<sup>5,23,24</sup>

Compression:ventilation ratios of 100:2 and 50:2 have received limited study with mixed results.<sup>25,26</sup> Rescuer fatigue at high continuous compression rates may be a limiting factor.<sup>27</sup> In the single animal study where it was tried, a ratio of 30:2 was associated with a significantly shorter time to return of spontaneous circulation, and greater systemic and cerebral oxygenation as compared with continuous chest compressions.<sup>28</sup> Finally, a theoretical analysis of various compression:ventilation ratios suggests 30:2 would provide the best blood flow and oxygen delivery.<sup>29</sup>

Therefore, with a variety of circumstantial and low-level evidence, and with a view toward simplifying teaching, promoting skills retention, increasing the number of compressions and decreasing the interruptions to compressions, the consensus of ILCOR experts was that a change to a ratio of 30:2 was warranted.

**Single versus stacked shocks:** Another change to the guidelines that will have a positive effect on decreasing “no perfusion” time is the elimination of “stacked shocks,” which have been a part of the guidelines for many years. The practice was introduced because of evidence that trans-thoracic impedance decreased with each successive shock and that lower energy shocks were not effective in patients with high impedance.<sup>30,31</sup>

The new guidelines replace stacked shocks with a single (preferably biphasic) shock. With a first-shock efficacy of around 90% for biphasic defibrillation, stacked shocks provide little incremental value and unduly delay compressions.<sup>32–40</sup> This change will have a major impact on “no perfusion” time for all defibrillator uses, but especially when an automatic external defibrillator (AED) is

used because programmed re-analysis and shock may take up to 55% of resuscitation time.<sup>36</sup> Yu and colleagues demonstrated experimentally that there is a dramatic increase in the predicted return of spontaneous circulation when defibrillation is not preceded by a long pause in compressions.<sup>41</sup>

Recommended shock energy for biphasic defibrillation

**Table 1. Major differences between the 2005 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care and the 2000 guidelines**

Item	Major guideline differences	
	New 2005 guideline	Old 2000 guideline
Compression:Ventilation ratio – Adult, with unprotected airway (compression rate 100/min)	30:2	15:2
Compression:Ventilation ratio – Pediatric, with unprotected airway (compression rate 100/min)	30:2 (lay rescuers and single health care provider) or 15:2 (two health care providers)	15:2 (lay rescuers and single health care provider) or 5:1 (two health care providers)
Ventilation rate (with protected airway)	Max 8–10 per minute	10–12 per minute
Duration of CPR between shocks	2 minutes	1 minute
Shocks per defibrillation attempt	Single shock, preferably biphasic	3 escalating energy “stacked” shocks
CPR quality	<ul style="list-style-type: none"> <li>• limit interruptions</li> <li>• ensure adequate depth of compression</li> <li>• allow full chest recoil</li> <li>• don't hyperventilate</li> </ul>	Not emphasized
Pulse check post-shock	No Resume CPR immediately post-shock	Yes
Rhythm check post-shock	No Resume CPR immediately post-shock	Yes
Advanced airways	LMA, Combitube™ and tracheal tube are equally acceptable	LMA and Combitube™ recommended over bag-mask when tracheal tube not available
Vasopressors	Give after one unsuccessful shock followed by 2 minutes of CPR if still no perfusing rhythm	Give after series of 3 unsuccessful shocks
Anti-arrhythmics	“Consider” after 2nd unsuccessful shock followed by 2 minutes of CPR if still in VF	“Consider” after unsuccessful stacked-shock series and second unsuccessful shock
Atropine for asystole	“Consider” for brady-asystolic arrest	“Recommended”
Fibrinolysis during cardiac arrest	Consider if suspected pulmonary embolism or when acute thrombotic etiology suspected in initially failed resuscitation	N/A
Treatment of stable tachycardia out-of-hospital	Limit prehospital treatment of stable narrow complex tachycardia to vagal manoeuvres or adenosine. Defer treatment of stable wide-complex tachycardia until patient is in hospital.	Complex algorithm
Post cardiac arrest care	Cool unconscious adult patients with spontaneous circulation to 32–34°C for 12–24 hr (“recommended” post-VF out-of-hospital arrest, “consider” post non-VF out-of-hospital arrest or any in-hospital arrest)	N/A

CPR = cardiopulmonary resuscitation; LMA = laryngeal mask airway; Combitube (Tyco/Kendall, Mansfield, Mass.) = a double lumen tube, one lumen resembling a tracheal tube, the other an esophageal obturator type tube with a distal blocked end and perforations at the pharyngeal level; VF = ventricular fibrillation

is 200 J if the device-specific energy setting is not known. Because devices use different biphasic waveforms, device-specific shock energy will vary. High first shock efficacy has been demonstrated for energy levels ranging from 120 J to 200 J depending on the specific device used. Subsequent shocks can safely and effectively be given at 150–360 J.

If a monophasic defibrillator is used, the new recommendation is to deliver a single shock of 360 J. Under the previous guidelines, the first shock was performed at 200 J because of a single study that showed a higher rate of post-shock atrioventricular heart block using 320 J.<sup>42</sup> The post-shock heart block that was demonstrated at this higher setting was transitory, and the experts now concur that a single energy level setting of 360 J for all monophasic shocks is reasonable.

**Post-shock rhythm analysis and pulse checks:** The 2005 guidelines recommend that CPR resume immediately following defibrillation, thus eliminating the intervening steps of the post-shock rhythm analysis and pulse check that had been previously recommended. Not only do these post-shock interventions result in a substantial “no perfusion” time, but studies indicate that pulse checks are unreliable, and analyses of electrical activity and of perfusion pressures suggest that delaying compressions post-shock is detrimental to VF conversion and to survival.<sup>22,39,41,43–45</sup> Furthermore, there is evidence that chest compressions do not adversely affect a patient with an organized rhythm and a minimally perfusing rhythm.<sup>46</sup> Taken together, the evidence supports the conclusion that there is more benefit than risk in the immediate resumption of CPR following defibrillation.

**Drug administration:** Recommendations regarding vasopressors and anti-arrhythmic drugs were both subjects of controversy following the 2000 guidelines. Since that time, little new evidence has emerged. There is still no placebo-controlled trial of vasopressors in cardiac arrest, and new studies comparing vasopressin to epinephrine have not cast any light on the issue. A meta-analysis of 5 randomized controlled trials comparing vasopressin to epinephrine shows no difference between the 2 drugs for any outcome.<sup>47</sup> Nor are there any placebo-controlled trials of anti-arrhythmics to guide therapy. A study that compared amiodarone to lidocaine, while favouring amiodarone to lidocaine for survival to hospital admission, was not powered to examine survival to hospital discharge. Given the lack of new evidence, the 2005 guidelines have not changed with respect to vasopressors (which are recom-

mended) and anti-arrhythmics (which should be considered). However, the timing and frequency of administration does change substantially.

The 2000 guidelines recommended the following sequence: shock, rhythm analysis, pulse check, vasopressor. The new guidelines recommend the immediate resumption of CPR after the first shock, with the first post-shock rhythm analysis taking place following 2 minutes of CPR. Vasopressor is administered after this analysis (i.e., 2 minutes later in the course of the arrest than the old guidelines recommended) — but only if administration will not delay a second shock. If giving the vasopressor will delay the shock, it should be administered immediately after the second shock. Because there is no evidence that vasopressors improve survival, the new guidelines give priority to uninterrupted CPR at the expense of earlier administration of vasopressor. Similarly, because there is no evidence that anti-arrhythmics improve survival, the experts felt that consideration of anti-arrhythmic administration should occur only after a second shock fails to convert the rhythm from ventricular fibrillation (i.e., 3 minutes later in the course of the arrest than the 2000 guidelines recommended).

## Conclusion

The 2005 ECC guidelines are a work in progress. The last 30 years have seen the development of a much more evidence-based approach to medical science, an expansion of our knowledge of resuscitation and related issues, and far broader involvement of the international scientific community in sharing expertise, ideas and creativity. There remain glaring gaps in our knowledge of resuscitation science. It is hoped that this iteration of the guidelines, along with the accompanying controversies, will, as previous iterations have, highlight new avenues for exploration, raise questions for which we do not yet have answers and inspire research that will lead to improved future guidelines and ever better outcomes for our patients.

**Competing interests:** Michael Shuster chairs the Heart and Stroke Foundation of Canada’s Policy Advisory Committee on Resuscitation. He has been involved with Emergency Cardiovascular Care guidelines review since 1992, actively participating in the literature evaluation and consensus meetings that led to the *2005 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*.

**Key words:** guidelines, emergency cardiovascular care; resuscitation

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