

Part 1: Introduction

Toward International Consensus on Science

The International Liaison Committee on Resuscitation (ILCOR) was formed in 1993. Its mission is to identify and review international science and knowledge relevant to cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC) and to offer consensus on treatment recommendations.¹ Emergency cardiovascular care includes all responses necessary to treat sudden life-threatening events affecting the cardiovascular and respiratory systems but with a particular focus on sudden cardiac arrest.

In 1999 the American Heart Association (AHA) hosted the first ILCOR conference to evaluate resuscitation science and develop common resuscitation guidelines. The conference recommendations were published in the international *Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*.^{2,3} Since that time researchers from the ILCOR member councils have continued to evaluate resuscitation science in a process that culminated in the 2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations (2005 Consensus Conference). This publication summarizes the conclusions and recommendations of that evidence evaluation process.

The goal of every resuscitation organization and resuscitation expert is to prevent premature cardiovascular death. When cardiac arrest or life-threatening emergencies occur, prompt and skillful response can make the difference between life and death and between intact survival and debilitation. This document summarizes current evidence for the recognition and response to sudden life-threatening events, particularly sudden cardiac arrest in victims of all ages. The broad range and number of topics reviewed and the inevitable limitations of journal space require succinctness in science statements and, where recommendations were appropriate, brevity in treatment recommendations. This is not a comprehensive review of every aspect of resuscitation medicine; some topics were omitted if there was no evidence or no new information.

Evidence Evaluation Process

To begin the current evidence evaluation process, ILCOR representatives established 6 task forces: basic life support, advanced life support, acute coronary syndromes, pediatric life support, neonatal life support, and an interdisciplinary task force to consider overlapping topics such as educational issues. Each task force identified topics requiring evidence

evaluation and appointed international experts to review them. To ensure a consistent and thorough approach, a worksheet template was created with step-by-step directions to help the experts document their literature review (Table 1), evaluate studies, determine levels of evidence (Table 2), and develop treatment recommendations. When possible, 2 expert reviewers were recruited to undertake independent evaluations for each topic. In addition, 2 evidence evaluation experts reviewed all worksheets and assisted the worksheet reviewers to ensure that the worksheets met a consistently high standard. This process is described in detail in an editorial in this supplement.⁴ Two additional task forces were established by the AHA to review evidence about stroke and first aid. These topics were included in the 2005 Consensus Conference and are summarized in this document, but they were not part of the ILCOR process.

A total of 281 experts completed 403 worksheets on 276 topics. Two hundred and forty-nine worksheet authors (141 from the United States and 108 from 17 other countries) attended the 2005 Consensus Conference. In December 2004 the evidence review and summary portions of the evidence evaluation worksheets, with worksheet author conflict of interest statements, were posted on the Internet at <http://www.C2005.org>. Journal advertisements and e-mails invited public comment. Persons who submitted comments were required to indicate their potential conflicts of interest. Such comments were sent to the appropriate ILCOR task force chair and worksheet author for consideration.

To provide the widest possible dissemination of the science reviews performed for the 2005 Consensus Conference, the worksheets prepared for the conference are linked from the electronic version of this document. Worksheet numbers begin with W to distinguish them from other reference citations. Most worksheet numbers follow headings. Readers of the electronic version of this supplement can access a cited worksheet by clicking on the W# callout, which will take them to the correct "reference" in the Worksheets Cited list at the end of each section. That reference contains an active link to the worksheet. Readers of the print version can identify the complete title and author of a cited worksheet by referring to the numbered worksheet list in Appendix I at the end of this supplement. Readers can access the worksheets through the American Heart Association website <http://www.C2005.org>. Note that any incomplete worksheets have been deleted from the worksheet list and will not be cited in this document.

All 380 participants at the 2005 Consensus Conference received a copy of the worksheets on CD-ROM. Internet

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TABLE 1. Steps in Evidence Integration

Integrate all evidence following these steps:

1. Perform literature review and record search terms and databases searched.
2. Select studies relevant to hypothesis.
3. Determine level of evidence based on methodology (see Table 2).
4. Perform critical appraisal (*poor to excellent*).
5. Integrate evidence into a science summary and possible treatment recommendation.

Experts must develop consensus based on scientific evidence. Steps used include:

Evidence evaluation and worksheet preparation by experts, plus

2005 Consensus Conference presentations and discussions

ILCOR task force discussions

Approval by ILCOR member organizations

Final editorial review and approval by international editorial board

Blinded peer review

Publication

access was available to all conference participants during the conference to facilitate real-time verification of the literature. Expert reviewers presented topics in plenary, concurrent, and poster conference sessions. Presenters and participants then debated the evidence, conclusions, and draft summary statements. Each day the most controversial topics from the previous day, as identified by the task force chairs, were presented and debated in one or more additional sessions. The ILCOR task forces met daily during the conference to discuss and debate the experts' recommendations and develop interim consensus science statements. Each science statement summarized the experts' interpretation of all the relevant data on a specific topic. Draft treatment recommendations were added if a consensus was reached. Wording of science statements and treatment recommendations was refined after further review by ILCOR member organizations and the international editorial board. This format ensured that this final document represents a truly international consensus process.

At the time of submission this document represented a summary of the state-of-the-art science of many topics in

TABLE 2. Levels of Evidence

Evidence	Definition
Level 1	Randomized clinical trials or meta-analyses of multiple clinical trials with substantial treatment effects
Level 2	Randomized clinical trials with smaller or less significant treatment effects
Level 3	Prospective, controlled, nonrandomized cohort studies
Level 4	Historic, nonrandomized cohort or case-control studies
Level 5	Case series; patients compiled in serial fashion, control group lacking
Level 6	Animal studies or mechanical model studies
Level 7	Extrapolations from existing data collected for other purposes, theoretical analyses
Level 8	Rational conjecture (common sense); common practices accepted before evidence-based guidelines

resuscitation medicine. Several papers that were accepted for publication in a peer-reviewed journal before the 2005 Consensus Conference but had not yet been published were circulated, with the permission of the relevant journal editors, to the ILCOR task forces. These papers contributed to the consensus statements.

This manuscript was ultimately approved by all ILCOR member organizations and by an international editorial board (listed on the title page of this supplement). The AHA Science Advisory and Coordinating Committee and the editor of *Circulation* obtained peer reviews of this document before it was accepted for publication. The document is being published simultaneously in *Circulation* and *Resuscitation*, although the version in *Resuscitation* does not include the sections on stroke and first aid.

Management of Conflict of Interest

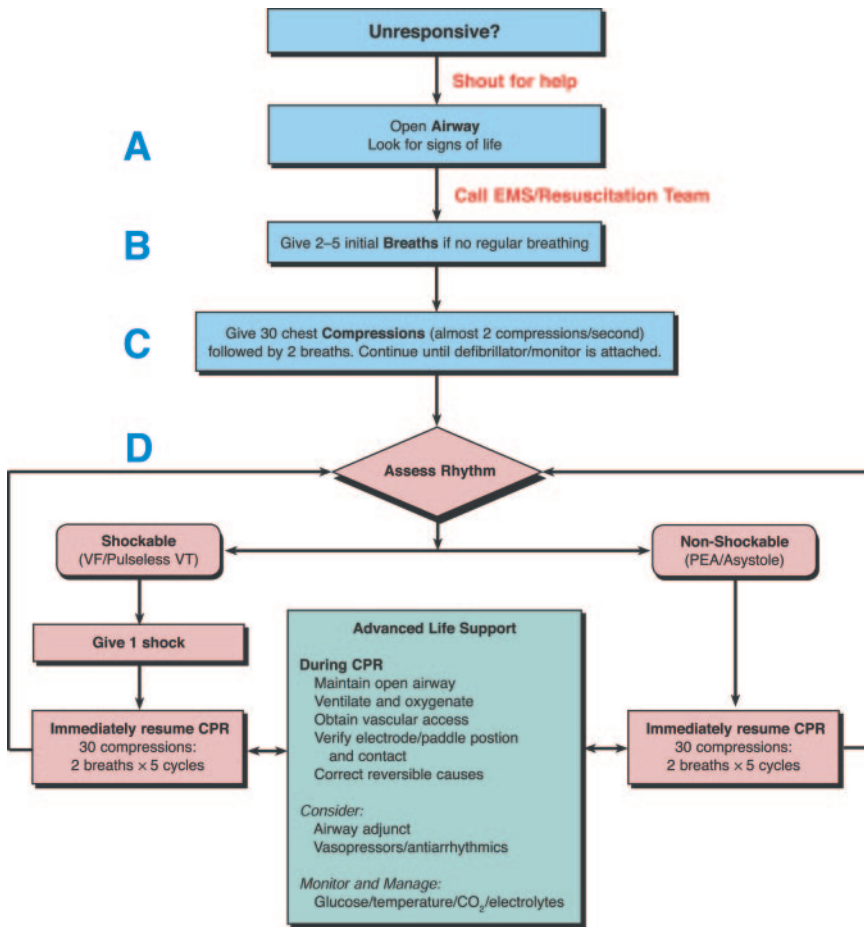
The world's leading experts in resuscitation science establish their expertise by undertaking and publishing research and related scholarly work (eg, presentation of research abstracts and participation in scientific conferences). This work potentially creates financial and intellectual conflicts of interest (COI) for the expert.^{5,6} Grants and other support for scientific research, speaker fees, and honoraria can also create financial conflicts of interest. Nonfinancial conflicts of interest include in-kind support, intellectual collaboration or intellectual investment in personal ideas, and long-term research agendas in which investigators have invested a substantial amount of time. A robust COI policy was developed to ensure full disclosure of potential conflicts and to protect the objectivity and credibility of the evidence evaluation and consensus development process. This policy is described in detail in an editorial in this supplement.⁷ Representatives of manufacturers and industry did not participate in this conference.

Potential conflicts of interest of the editorial board are listed in Appendix 3 at the end of this supplement. Potential conflicts of interest of the worksheet authors are noted in the worksheets and can be accessed through the links to the worksheets contained in this document. All 380 attendees were required to complete forms in order to document their potential conflicts of interest. Most attendees were also worksheet authors. The information from the conflict of interest forms completed by all conference attendees, including worksheet authors, can also be accessed at the website <http://circ.ahajournals.org/cgi/content/full/CIRCULATIONAHA.105.166471/DC1>. Readers of the print version can also access the statements at the AHA website: www.C2005.org.

Applying Science to Improve Survival

From Consensus on Science to Guidelines

This document presents international consensus statements on the science of resuscitation and, wherever possible, treatment recommendations. ILCOR member organizations will subsequently publish resuscitation guidelines that are consistent with the science in this consensus document, but they will also take into account geographic, economic, and system differences in practice and the availability of medical devices and drugs. All ILCOR member organizations strive to mini-



ILCOR Universal Cardiac Arrest Algorithm.

minimize international differences in resuscitation practice and to optimize the effectiveness of instructional methods, teaching aids, and training networks.

The recommendations of the 2005 Consensus Conference confirm the safety and effectiveness of some current approaches, acknowledge that other approaches may not be optimal, and introduce new treatments resulting from evidence-based evaluation. *New and revised treatment recommendations do not imply that clinical care that involves the use of previously published guidelines is unsafe.* ILCOR scientists and member organizations consider these new recommendations to be the most effective and easily learned interventions that can be supported by current knowledge, research, and experience. Implications for education and retention were also considered when developing the final treatment recommendations.

Ischemic heart disease is the leading cause of death in the world.⁸ Sudden cardiac arrest is responsible for >60% of the estimated 340 000 annual deaths from coronary heart disease in emergency departments or out-of-hospital in the United States.^{8,9} Most victims die out of hospital without receiving the interventions described in this publication. The actions linking the victim of sudden cardiac arrest with survival are called the adult Chain of Survival. The links in the Chain of Survival are early recognition of the emergency and activation of the emergency medical services (EMS) system, early CPR, early defibrillation, and early advanced life support,

including postresuscitation care. The links in the infant and child Chain of Survival are prevention of conditions leading to cardiopulmonary arrest, early CPR, early activation of the EMS system, and early advanced life support.

The most important determinant of survival from sudden cardiac arrest is the presence of a trained rescuer who is ready, willing, able, and equipped to act. Although some advanced life support techniques may improve survival,¹⁰ these improvements are usually less significant than the increased survival rates reported by lay rescuer CPR and automated external defibrillation programs in the community.¹¹⁻¹⁵ Thus, our greatest challenge remains the education of the lay rescuer. We must increase the effectiveness and efficiency of instruction, improve skills retention, and reduce barriers to action for both basic and advanced life support providers.^{16,17} The science of resuscitation education is addressed in this publication.

The Universal Algorithm

Several of the new treatment recommendations to emerge from this document are included in the updated ILCOR Universal Cardiac Arrest Algorithm (Figure). This algorithm is intended to apply to attempted resuscitation of infant, child, and adult victims of cardiac arrest (excluding newborns). Every effort has been made to keep this algorithm simple yet make it applicable to cardiac arrest victims of all ages and in most circumstances. Inevitably modification will be required

in some situations, and these exceptions are highlighted elsewhere in this document. Each resuscitation organization will base its guidelines on this ILCOR algorithm, although there will be subtle regional modifications.

Rescuers begin CPR if the victim is unconscious or unresponsive, not moving, and not breathing (ignoring occasional gasps). A single compression-ventilation ratio of 30:2 is used for the single rescuer of an infant, child, or adult victim (excluding newborns); this applies for the lay rescuer and for all adult CPR. This single ratio is designed to simplify teaching, promote skills retention, increase the number of compressions given, and decrease interruption to compressions.

Once a defibrillator is attached, if a “shockable” rhythm (ie, ventricular fibrillation or rapid ventricular tachycardia) is confirmed, a single shock is delivered. Irrespective of the resultant rhythm, chest compressions and ventilations (5 cycles of 30:2—approximately 2 minutes) are resumed immediately after the shock to minimize the “no flow” time (ie, time during which compressions are not delivered for actions such as rhythm analysis). Advanced life support interventions are outlined in a box at the center of the algorithm. Once an advanced airway (eg, tracheal tube, laryngeal mask airway [LMA] or esophageal-tracheal combitube) has been inserted during 2-rescuer CPR, one rescuer should provide 8 to 10 ventilations/min while the other delivers 100 compressions/min. The rescuer performing the chest compressions should not pause chest compressions for delivery of ventilations.

The theme of minimal interruption of chest compressions is emphasized throughout this document; recent evidence indicates that such interruptions occur frequently both in and out of hospital.^{18–20} Interruptions in chest compressions during CPR must be minimized.

Future Directions

The science of resuscitation is evolving rapidly. It would not be in the best interests of patients if we waited 5 or more years to inform healthcare professionals of therapeutic advances in this field. ILCOR members will continue to review new science and, when necessary, publish interim advisory statements to update treatment guidelines so that resuscitation practitioners may provide state-of-the-art treatment. Existing gaps in our knowledge will be closed only by continuing high-quality research into all facets of CPR.

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