Part 6: Advanced Cardiovascular Life Support
Section 1: Introduction to ACLS 2000: Overview of Recommended Changes in ACLS From the Guidelines 2000 Conference

Evidence-Based International Resuscitation Guidelines
At the Second American Heart Association International Evidence Evaluation Conference and the international Guidelines 2000 Conference on CPR and ECC, the high level of participation of international experts changed profoundly the way all future resuscitation guidelines will be developed. Future resuscitation guidelines cannot achieve validity and consensus without international input. Enrichment comes when experts from different countries—with different systems, different personnel, and different resources—share their ideas, perspectives, and experiences. Our guidelines are no longer just descriptive—“This is how we do it here”—but now can also be prescriptive—“This is how we should be doing it in the future.”

The experts at the conferences reached a strong consensus to change a number of the CPR and ECC guidelines. Large portions of the earlier guidelines remain unaltered or have been refined on the basis of new data. Many topics, however, have been updated to reflect consensus opinions developed according to the principles of evidence-based medicine. While the evidence-based approach constrains the number of new guidelines endorsed, it clarifies perspectives on the evidence reviewed—and on the amount of research still needed.

New Topics, New Problems, New Guidelines
Because of rapid development of new therapies and strategies, the sections on acute myocardial infarction (MI) (now acute coronary syndromes) and stroke have undergone major change. We have expanded the section on special resuscitation situations for experienced providers. This includes new topics that are known to be important causes of cardiac arrest but that we have not addressed before, for example, cardiac arrest and altered vital signs caused by drug overdoses and toxins, life-threatening electrolyte abnormalities, near-fatal asthma, and anaphylaxis. These problems challenge ACLS providers all over the world.

This introductory ACLS section discusses these changes in recommendations, based on evidence review and consensus opinion. The reasons for the class recommendations and the evidence-based approach are reviewed briefly with comments from the Evidence Evaluation Conference and the Guidelines 2000 Conference. The full details of this intense process will be published in the Proceedings of the Guidelines 2000 Conference and in the journal Annals of Emergency Medicine.

The new recommendations include the following:

Pharmacology of Resuscitation
- **Amiodarone** (Class IIb) and procainamide (Class IIb) are recommended ahead of lidocaine and adenosine for the initial treatment of hemodynamically stable wide-complex tachycardia, especially in patients with compromised cardiac function.
- **Amiodarone** and sotalol (a drug that awaits Food and Drug Administration approval for US use) are new agents recommended as Class IIa agents for the treatment of stable monomorphic and polymorphic ventricular tachycardia (VT).
- References to bretylium have been dropped from the ventricular fibrillation (VF)/pulseless VT algorithm. In 1998 through 2000, severe problems with obtaining the raw materials to produce bretylium stopped the supply for a number of months. These guidelines must avoid generating a demand that cannot be met by an dependable source. The world’s natural sources of bretylium appear to be nearly exhausted. Bretylium remains acceptable to use, but it is no longer recommended. Bretylium has a high incidence of side effects, particularly hypotension, in the postresuscitation setting. Bretylium stays as a Class IIb recommendation because no new, supportive information is available and some studies question its efficacy.
- **Lidocaine** is an established agent that suffered during our new emphasis on evidence. Although lidocaine remains acceptable as an antiarrhythmic to use for the treatment of shock-refractory VF and pulseless VT, the evidence supporting its efficacy is poor and methodologically weak (levels 6, 7, and 8 only). The evidence supporting amiodarone is much stronger (one level 1 study) and justifies use of amiodarone before lidocaine in the opinion of many. The conference experts concluded that lidocaine could continue to be used for VF/VT but that given the antiquated evidence, it merits only an Indeterminate class of recommendation (Class Indeterminate).

Lidocaine has not been recommended for routine prophylaxis of ventricular arrhythmias in the setting of acute MI for >8 years. Conference experts reexamined this topic and concluded that the data do not justify changing the
classification of lidocaine to a Class III (evidence-of-harm) agent.

- **Amiodarone**, a respected and effective agent in the hospital, catheterization suite, and critical care unit, is included only in the notes for the VF/pulseless VT algorithm. The algorithm states “consider antiarrhythmics,” referring the reader to several notes. Methodological problems in studying out-of-hospital VF/VT arrest limit the conclusions that can be drawn about any antiarrhythmic. The evidence supporting antiarrhythmics in general is only fair, and this accounts for the fact that all antiarrhythmics are lumped into one Class IIb “consider” category. However, on the strength of design and execution in the ARREST study (Kudenchuk PJ, Cobb LA, Copass MK, Cummins RO, Doherty AM, et al. N Engl J Med. 1999;341:871–878), amiodarone does have better evidence-based support than any other antiarrhythmic. The expert panel members would have no problem with clinicians routinely using amiodarone as the first-choice antiarrhythmic for shock-refractory VF/VT. This practice decision, however, must be made with a clear awareness that the evidence—powerful in the design—was weak in the conclusions.

- **Magnesium** has shown effectiveness only in the treatment of known hypomagnesemic states and torsades de pointes, for which it still has a Class IIb recommendation.

- **Vasopressin** (arginine vasopressin) may be a more effective pressor agent than epinephrine for promoting the return of spontaneous circulation in cardiac arrest. The evidence from prospective clinical trials in humans is limited and consistently positive (Class IIb). Vasopressin (40 U IV, not repeated) may be substituted for epinephrine as an alternative Class IIb agent. The lower adverse effects profile may be the major indication for vasopressin.

- Research on high-dose epinephrine has yet not shown that routine use of initial and repeated or escalating doses of epinephrine can improve survival in cardiac arrest (Class Indeterminate). Nor has high-dose epinephrine (0.1 mg/kg) in adults been shown to improve survival or neurological outcomes. Some troublesome evidence indicates that cardiac arrest survivors who received high-dose epinephrine have more postresuscitation complications than survivors who received the standard dose. Because of the potential for harm, high-dose epinephrine (0.1 mg/kg) is not recommended (Class Indeterminate).

### Ventilation

- The experts on the Ventilation Panels recommend a reduction in the ventilation tidal volume for patients not in cardiovascular collapse to approximately one half of that recommended previously. Volume should approximate 6 to 7 mL/kg over 1.5 to 2 seconds (Class IIa). Higher volumes increase risk of gastric inflation without improving blood oxygenation. For clinical guidance, resuscitation professionals can use the “chest rise” sign as a rough indication of ventilation tidal volumes that are in the range of 6 to 7 mL/kg. Smaller tidal volumes, however, raise the risk of inducing both hypoxia and hypercarbia. Consequently, a widespread recommendation to provide supplemental oxygen, adjusted on the basis of oxygen saturation readings, appears laudable, although specific, high-level evidence to support this recommendation has not yet become available.

- **Tracheal intubation** in unconscious patients should be attempted only by healthcare providers experienced in performing this skill. Such persons should increase their experience in tracheal intubations steadily by performing intubations frequently or by retraining regularly. Only personnel with advanced life support training and documented skills should attempt tracheal intubation. Furthermore, ALS providers unable to obtain regular field experience (non—evidence-based guideline: 6 to 12 times per year) should use alternative, noninvasive techniques for airway management.

- In the absence of a bag-mask device or authorization to perform tracheal intubation, healthcare providers may use alternative airways (laryngeal mask airway, esophageal-tracheal Combitube, pharyngotracheal lumen airway) (Class IIb).

- In the opinion of many experts the single most important new recommendation from the Guidelines 2000 is long overdue: emergency responders must confirm tracheal tube position by using nonphysical examination techniques. These include esophageal detector devices, qualitative end-tidal CO₂ indicators, and capnographic and capnometric devices. In patients not in full cardiac arrest these devices are Class IIa. In cardiac arrest and conditions of low pulmonary flow, these devices are lowered to Class IIb because the devices may falsely indicate esophageal placement, leading to unnecessary removal of a properly placed tube.

- Growing evidence suggests that tracheal tube dislodgments after a successful tracheal tube insertion may be occurring at much higher rates than previously suspected. Emphasis should be placed on securing the tube carefully with a tie or tape. With little evidence to directly support any specific commercial device, tracheal tube holders are a Class IIb recommendation. During long transport efforts in the out-of-hospital setting, restless intubated patients can be fitted with a cervical collar and immobilized with sandbags (or some other validated technique) to prevent accidental tube dislodgment. With little evidence to directly support any specific commercial device, tracheal tube holders are a Class IIb recommendation. During long transport efforts in the out-of-hospital setting, intubated patients are at high risk for tracheal tube dislodgment. Monitors for oxygen saturation and end-tidal CO₂ levels can detect tube dislodgments. The best technique, however, to prevent, detect, and correct tube dislodgment is the constant vigilance of care providers.

### Defibrillation

- Healthcare providers with a duty to perform CPR need to be trained, equipped, and authorized to use an automated external defibrillator (AED) (Class IIa).

- Hospitals need to establish a comprehensive program for in-hospital early CPR and early defibrillation. Hospital
staff members trained in CPR need to be capable of providing early defibrillation.

- Hospitals need to establish programs to achieve early defibrillation throughout the facilities and in related patient care areas (Class I).

**Public Access Defibrillation Programs**

- Public access defibrillation (PAD) programs have the potential to reduce one of the major health problems—VF-induced cardiac arrest.
- AEDs are recommended for public sites with a high probability of at least one use every 5 years (1 arrest per 5 years). Select sites for AED deployment that are within a 5-minute radius of the majority of expected arrests but outside a 5-minute radius of the closest EMS units (Class IIb).

**Acute Coronary Syndromes**

- The prehospital 12-lead ECG improves prehospital diagnosis, reduces hospital-based time to treatment, identifies patients requiring reperfusion, contributes to mortality reduction, and facilitates triage to cardiac centers with interventional facilities. The prehospital ECG is useful and effective in prehospital urban/suburban EMS systems and should become standard equipment on all ACLS units that handle acute coronary syndrome patients (Class IIa).

- **Prehospital fibrinolytic therapy** is beneficial when the transport of patients with acute infarction from home to the hospital is prolonged and should be considered by busy EMS systems (Class IIa). At present, prehospital screening of chest pain allows ambulance personnel to notify hospital personnel that a person with a probable acute MI is en route for further evaluation and care.
  - If the total time of the following 2 intervals exceeds 60 minutes, consider prehospital fibrinolytics: (1) onset of chest pain to contact of ACLS personnel with the patient, and (2) arrival of ACLS personnel at the patient’s side to arrival at the hospital.
  - In Europe a prehospital fibrinolytic program is considered whenever the above intervals exceed 30 minutes. Moreover, if the Emergency Department has a door-to-fibrinolytic interval consistently >60 minutes, prehospital fibrinolytic treatment should offer superior outcomes.

- **Angioplasty** is an alternative to fibrinolytic therapy (Class I) in centers with high volume and experienced operators. Patients in cardiogenic shock who are <75 years of age need transportation to cardiac interventional centers for initiation of primary angioplasty and intra-aortic balloon placement. Benefit occurs, however, only when door-to-balloon times average ≤90 minutes (Class I). Patients who are not eligible for fibrinolytic therapy because of increased risk of intracranial bleeding need to be transported or transferred to these centers (Class IIa). Patients with large anterior infarctions, low blood pressure (systolic blood pressure ≤100 mm Hg), increased heart rate (≥100 beats per minute), or rales more than one third of the way up are also candidates (Class IIa). Prehospital EMS systems should develop triage policies where applicable.

  — Antiplatelet therapy with glycoprotein IIb/IIIa inhibitors for patients with non-Q-wave MI and high-risk unstable angina provides clinically significant benefit (Class IIa). Antithrombin therapy with low-molecular-weight heparins is now an alternative to unfractionated heparin in high-risk unstable angina/non-Q-wave MI patients. Data for this class of agents, however, is heterogeneous, in part because of variable anti-factor Xa inhibition (Class Indeterminate). The dose of unfractionated heparin, when used as adjunctive therapy with fibrin-specific lysites (alteplase, reteplase) is now reduced to a bolus of 60 U/kg (maximum 4000 U) and an infusion of 12 IU/kg per hour. This dose reduction will help to minimize the incidence of intracerebral hemorrhage.

  — Metabolic manipulation of the infarct with glucose-potassium-insulin is under continuing investigation. This therapy is acceptable and of some benefit for diabetic patients and patients undergoing reperfusion (Class IIb).

  — All patients with acute MI, including non-Q-wave MI, need aspirin and β-blockers in the absence of contraindications (Class I). Patients with a large anterior infarct, left ventricular dysfunction, and ejection fraction <40% need early angiotensin-converting enzyme inhibition in the absence of hypotension.

**Stroke**

- **Intravenous recombinant tissue plasminogen activator (rtPA)** improves neurological outcome when administered within 3 hours of stroke onset in patients who meet fibrinolytic criteria (Class I). Patients with stroke presenting within 3 hours require emergent triage. The urgency should equal that of an acute MI with ST-segment elevation.

  — The use of rtPA in patients with symptom onset between 3 and 6 hours of presentation at an Emergency Department is under investigation. While subgroups of such patients may benefit from fibrinolytic treatment, routine use is not currently recommended (Class Indeterminate).

  — **Prourokinase** has been found to improve neurological outcome in patients treated within 3 to 6 hours in one completed but unpublished study. Review of the published data and additional studies are needed before this fibrinolytic agent can be recommended (Class Indeterminate).

  — **EMS systems should implement a prehospital stroke protocol** to rapidly identify patients who may benefit from fibrinolytic therapy. This approach is similar to the protocol for chest pain patients (Class IIb). Transport patients who may be candidates for fibrinolytic therapy to hospitals identified as acute stroke treatment facilities with 24-hour availability of computerized tomography and interpretation (Class IIb).

**Postresuscitation Care**

- Following cardiac arrest, do not actively rewarm patients who are mildly hypothermic (Class IIb). Active initiation of hypothermia after cardiac arrest is under clinical inves-
tigation (Class Indeterminate). Treat febrile patients to achieve normothermia, a goal of early therapy (Class IIa).

- Following cardiac arrest, ventilatory values in patients who require mechanical ventilation should be maintained within the normal range (Class IIa). Hyperventilation may be harmful and should be avoided (Class III). An exception is the use of hyperventilation in patients who have signs of cerebral herniation after resuscitation.

### Toxicology

- Cocaine use is associated with serious ventricular arrhythmias and acute coronary syndromes. The use of β-blockers in patients with cocaine-associated acute coronary syndromes has caused coronary vasoconstriction and should be avoided (Class III). Nitrates should be first-line therapy (Class I) together with benzodiazepines (Class IIa). α-Adrenergic blocking agents may induce tachycardia and hypotension and should be reserved for patients who do not respond to nitrates and benzodiazepines (Class IIb).

- Hypotension or ventricular arrhythmias occur with tricyclic overdose. The induction of systemic alkalosis (pH of 7.50 to 7.55) is the treatment of choice (Class IIa). Antiarrhythmic agents such as lidocaine or procainamide have not been studied in this setting (Class Indeterminate).

- Acute respiratory failure (respiratory acidosis and hypoxemia) may occur with opiate overdose. Reverse these abnormalities by mechanical ventilation before the administration of naloxone. This will reduce the incidence of pulmonary edema and serious arrhythmias associated with abrupt catecholamine elevation (Class IIa).

### Overview of ACLS

ACLS includes the knowledge and skills necessary to provide the appropriate early treatment for cardiopulmonary arrest. Additional important areas include the proper management of situations likely to lead to cardiac arrest and stabilization of the patient in the early period following successful resuscitation. ACLS includes (1) basic life support; (2) use of advanced equipment and special techniques for establishing and maintaining effective ventilation and circulation; (3) ECG monitoring, 12-lead ECG interpretation, and arrhythmia recognition; (4) establishment and maintenance of intravenous access; (5) therapies for the treatment of patients with cardiac or respiratory arrest (including stabilization in the postarrest phase); (6) treatment of patients with suspected acute coronary syndromes, including acute MI; and (7) strategies for rapid assessment and treatment with tPA of eligible stroke patients. ACLS includes the knowledge, training, and judgment required to use these skills and the ability to perform them.

Communities should provide rapid and effective ACLS. Every community should strive continually to implement the Chain of Survival and provide as many high-quality ACLS components as possible, in particular very early defibrillation using AEDs (see “Part 4: The Automated External Defibrillator: Key Link in the Chain of Survival”) and noninvasive airway support.

BLS and ACLS should be integrated into a community as part of an EMS system. This system should have sufficient laypersons trained in BLS to ensure immediate ventilatory and circulatory assistance to any cardiac arrest victim within 5 minutes and immediate entry of that victim into the EMS system. We strongly encourage implementation of public access defibrillation in high-risk settings. In turn the emergency care system, under medical supervision, should provide rescue personnel adequately trained in BLS and ACLS to respond promptly when summoned. ACLS must be continued either until the patient has been admitted to a medical facility capable of continuing care or until life support efforts have been terminated by order of the responsible physician or by a properly executed advance directive.

The same level of training, commitment, and medical supervision should be applied to in-hospital ACLS. In particular, prompt BLS and rapid defibrillation should be available in all areas of a healthcare facility (Class IIa).

### BLS and Early Defibrillation

For people in cardiac arrest, **rapid defibrillation in <5 minutes** is a high-priority goal. Community and in-hospital ACLS must be supported by a well-established BLS program that can provide immediate emergency CPR. The Evidence Evaluation Conference and Guidelines 2000 Conference again affirmed and endorsed the principle of early defibrillation from 1991—the recommendation that healthcare providers with a duty to respond to cardiac arrest should be educated, equipped, and authorized to perform automated external defibrillation (Class IIa). The ideal response time is achieved when people collapse in front of a person who has an AED. Such cases occur in many locations, and in general the survival rate can be 70% to 80%.

For respiratory arrest, airway adjuncts and ventilation devices should be readily available. In cardiac arrest, the need for early defibrillation is clear and should have the highest priority. Today, with the availability of AEDs, defibrillation is considered part of BLS. Adjunctive equipment should not divert attention or effort from basic resuscitative measures. Rescue personnel should know the indications for and techniques of using adjunctive equipment. Such equipment should be tested periodically according to prescribed regulations and each periodic test documented.
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doi: 10.1161/01.CIR.102.suppl_1.I-86
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/102/suppl_1/I-86

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