Advanced Cardiac Life Support Algorithms: Changes and Current American Heart Association Recommendations

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Cardiopulmonary arrest is usually the result of a cardiac dysrhythmia. The majority of adults (80% to 90%) with sudden, nontraumatic cardiac arrest are found to be in ventricular tachycardia (VT) when an initial electrocardiographic rhythm strip is obtained. When ventricular fibrillation (VF) occurs outside the hospital, it most commonly results from chronic myocardial ischemia with electrical instability, rather than acute myocardial infarction.[1] Conversely, in-hospital cardiac arrest most often follows an acute myocardial infarction or is the result of severe multisystem disease; asystole, bradydysrhythmias, and pulseless electrical activity are the usual rhythms encountered in hospitalized patients.[2–6]

The American Heart Association (AHA), through its Emergency Cardiac Care Committee, routinely evaluates current knowledge in resuscitation techniques and education.[7,8] The year 2000 saw the publication of new and revised guidelines for advanced cardiac life support (ACLS) by the AHA.[8] The premise behind these guidelines is that survival of patients with cardiac arrest depends on prompt action and that, as in other time-critical endeavors, a preconstructed plan of action can speed appropriate interventions and thus increase the probability of success. The action plans commonly promulgated by the AHA are known as the *ACLS algorithms* (**Figures 1–10**) and provide general guidelines for management of victims of cardiac arrest and other acute cardiovascular problems.[7–9]

It has been noted previously that these algorithms can be regarded a "cookbook for a thinking cook." They represent a consensus about a reasonable approach to take with victims of acute cardiorespiratory emergencies.[8] The updated 2000 algorithms have been influenced by new data concerning what works in resuscitation.

MODIFICATIONS IN THE 2000 ACLS ALGORITHMS

As in previous versions, the emphasis of the current ACLS algorithms is on rapid application of basic life support and speedy defibrillation of patients who need it. Most adults who can be revived after cardiac arrest are in VF or pulseless VT. Electrical defibrillation provides the single most useful therapy for treatment of these patients.[10,11] Electrical defibrillation is the only effective method of terminating VF; the probability of survival diminishes as the interval between collapse and countershock lengthens. Precordial chest compressions should be regarded as a secondary priority and should begin immediately after attempts at electrical defibrillation have failed. For this reason, the AHA and the International Liaison Committee on Resuscitation endorse the concept that, in many settings, nonmedical persons should be allowed and even encouraged to use defibrillators.[8,12,13] Advances in automated external defibrillation devices have made it easier for nonmedical persons to provide this therapy and has led to placement of such defibrillators in many public venues (eg, airports, casinos, pools).

Following basic cardiac life support and defibrillation, the 2000 ACLS algorithms continue with a secondary survey, in which establishing an advanced airway and intravenous access is recommended. Although endotracheal intubation has long been advocated for resuscitation, the 2000 algorithms acknowledge that many rescuers have insufficient experience to perform laryngoscopy and orotracheal intubation reliably. Consequently, 2 new airway devices are recommended as potential

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alternatives: the laryngeal mask airway, a device with a rich history in anesthesia practice; and the Combitube, a dual-lumen device inserted blindly.[8]

Another key modification to the algorithms involves the choice of vasopressors. Augmentation of coronary perfusion pressure through use of epinephrine has been a mainstay of therapy for decades. The 2000 algorithms reflect an understanding that high doses of epinephrine not only may be deleterious to neurologic outcome but also have not resulted in improvement in survival to hospital discharge. Although administration of epinephrine at a dose of 1 mg every 3 to 5 minutes remains in the algorithm, despite lack of evidence that this agent is actually useful in patients with cardiac arrest,[13] vasopressin, an alternative vasoconstrictor, is also included in the algorithm to treat VF and pulseless VT (*see* Figure 3).

Vasopressin has been used for victims of cardiac arrest with encouraging results.[13,14] The drug is a potent vasoconstrictor that commonly is used in patients with esophageal varices as an adjunct for the control of bleeding.[13–15] In a randomized study of patients with cardiac arrest, Lindner and coworkers found that administration of vasopressin was associated with a higher rate of return of spontaneous circulation and a significantly higher hospital survival rate than was epinephrine.[14] The current algorithm for VF/VT recommends a single dose of vasopressin 40 U as an alternative to epinephrine.

The 2000 ACLS algorithm for the treatment of VF/VT also supports use of amiodarone, based on data from recent trials.[15,16] Some additional recommendations not present in the algorithms include the presence of family members during resuscitative efforts, formal death notification procedures, and postresuscitative debriefing of caregivers.

CONCLUSIONS

The ACLS algorithms provide useful guidance to health care providers caring for victims of cardiac arrest and other cardiopulmonary emergencies. The 2000 algorithms are constantly being revised and are subject to change. The reader is encouraged to consult other sources of resuscitation algorithms, such as the European Resuscitation Council guidelines and the revisions of the International Liaison Committee on Resuscitation. In the meantime, these algorithms represent the consensus of many experts in the field and are a useful tool for clinicians. **HP**

REFERENCES

1. Kremers MS, Black WH, Wells PJ. Sudden cardiac death: etiologies, pathogenesis, and management. Dis Mon 1989;35:381–445.
2. Bedell SE, Delbanco TL, Cook EF, Epstein FH. Survival after cardiopulmonary resuscitation in the hospital. N Engl J Med 1983;309:569–76.
3. Roberts D, Landolfo K, Light RB, Dobson K. Early predictors of mortality for hospitalized patients suffering cardiopulmonary arrest. Chest 1990;97:413–9.
4. Rozenbaum EA, Shenkman L. Predicting outcome of inhospital cardiopulmonary resuscitation. Crit Care Med 1988;16:583–6.
5. Berger R, Kelley M. Survival after in-hospital cardiopulmonary arrest of noncritically ill patients. A prospective study. Chest 1994;106:872–9.
6. Varon J, Fromm RE Jr. In-hospital resuscitation among the elderly: substantial survival to hospital discharge. Am J Emerg Med 1996;14:130–2.
7. Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. Part II. Adult basic life support. JAMA 1992;268:2184–98.
8. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 6: advanced cardiovascular life support: 7C: a guide to the International ACLS algorithms. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Circulation 2000;102:I142–57.
9. Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001.
10. Fromm RE Jr, Varon J. Automated external versus blind manual defibrillation by untrained lay rescuers. Resuscitation 1997;33:219–21.
11. Varon J, Sternbach GL, Marik PE, Fromm RE Jr. Automatic external defibrillators: lessons from the past, present and future. Resuscitation 1999;41:219–23.
12. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiac Care—an international consensus on science. Resuscitation 2000;46:291–302.
13. Varon J, Marik PE, Fromm RE. Cardiopulmonary resuscitation: a review for clinicians [published erratum appears in Resuscitation 1998;37:197]. Resuscitation 1998;36:133–45.
14. Wenzel V, Lindner KH. Vasopressin and epinephrine for cardiac arrest. Lancet 2001;358:2080–1.
15. Kudenchuk PJ, Cobb LA, Copass MK, et al. Amiodarone for resuscitation after out-of-hospital cardiac arrest due to ventricular fibrillation. N Engl J Med 1999;341:871–8.
16. Camm AJ, Karam R, Pratt CM. The azimilide post-infarct survival evaluation (ALIVE) trial. Am J Cardiol 1998;81:35D–9D.

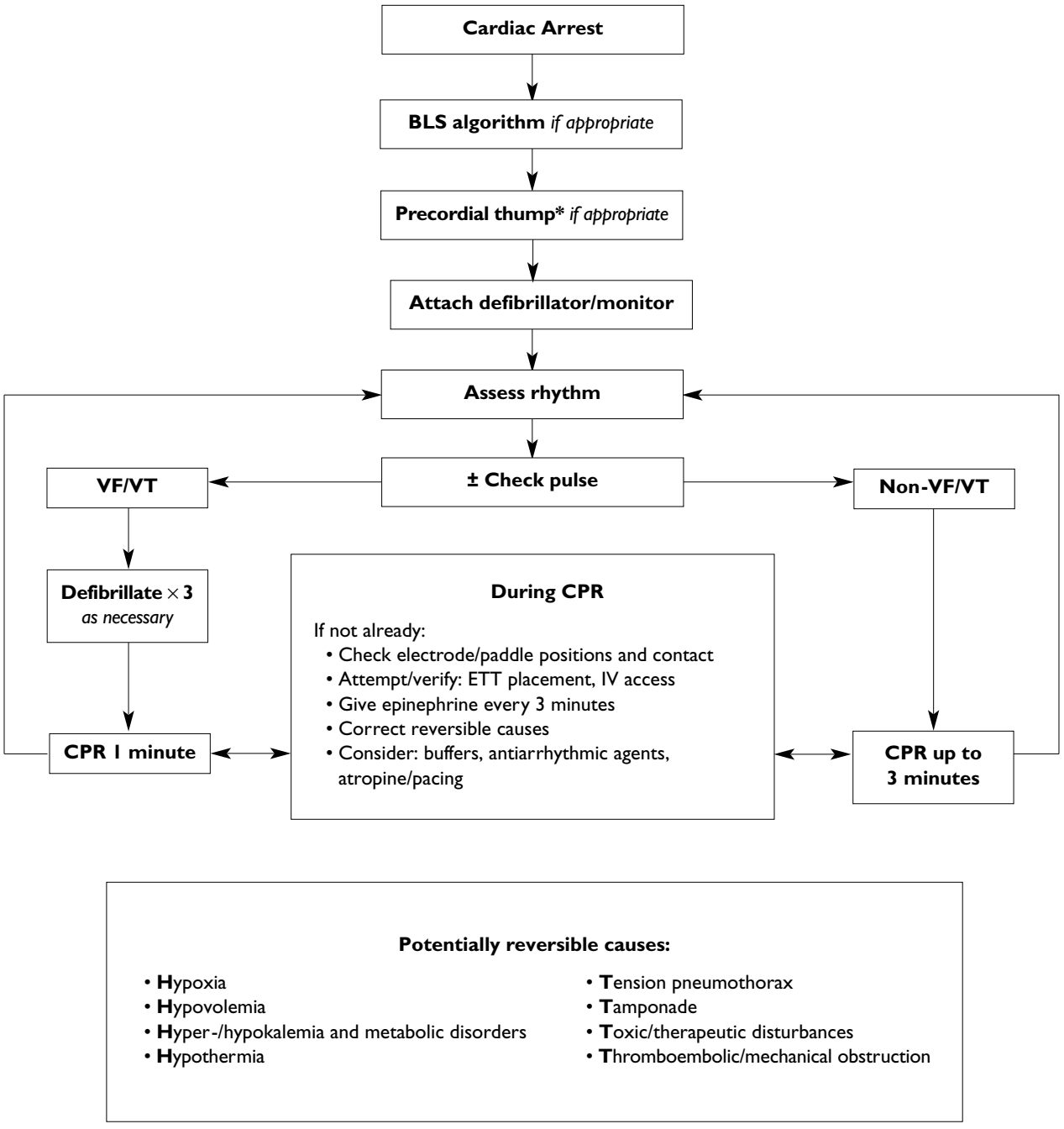

Figure 1. The universal advanced life support algorithm, according to the International Liaison Committee on Resuscitation. (Reprinted with permission of the American Heart Association. Copyright © 2002 American Heart Association. Available at http://216.185.112.5/presenter.jhtml?identifier=1506. Accessed 25 Sept 2002.) BLS = basic life support; CPR = cardiopulmonary resuscitation; ETT = endotracheal tube; IV = intravenous; VF = ventricular fibrillation; VT = ventricular tachycardia. *The American Heart Association considers the precordial thump an optional technique in a monitored arrest and a class IIb recommendation when the patient is pulseless and a defibrillator is not immediately available. For an unwitnessed arrest and in children, the thump is a class IIb recommendation.

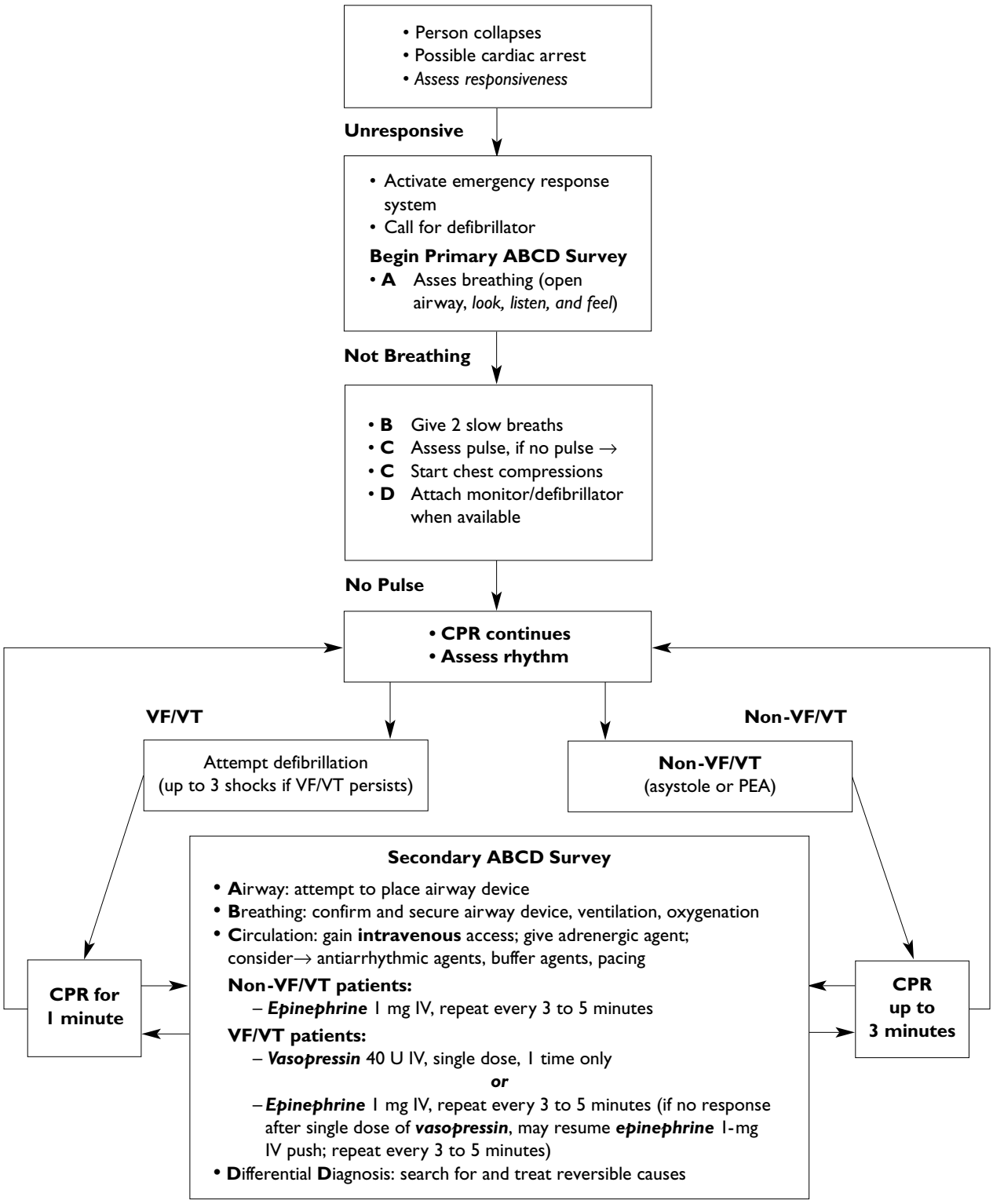

Figure 2. Comprehensive algorithm review, including the ABCDs. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:10. Copyright © 2001 American Heart Association.) CPR = cardiopulmonary resuscitation; IV = intravenous(ly); PEA = pulseless electrical activity; VF = ventricular fibrillation; VT = ventricular tachycardia.

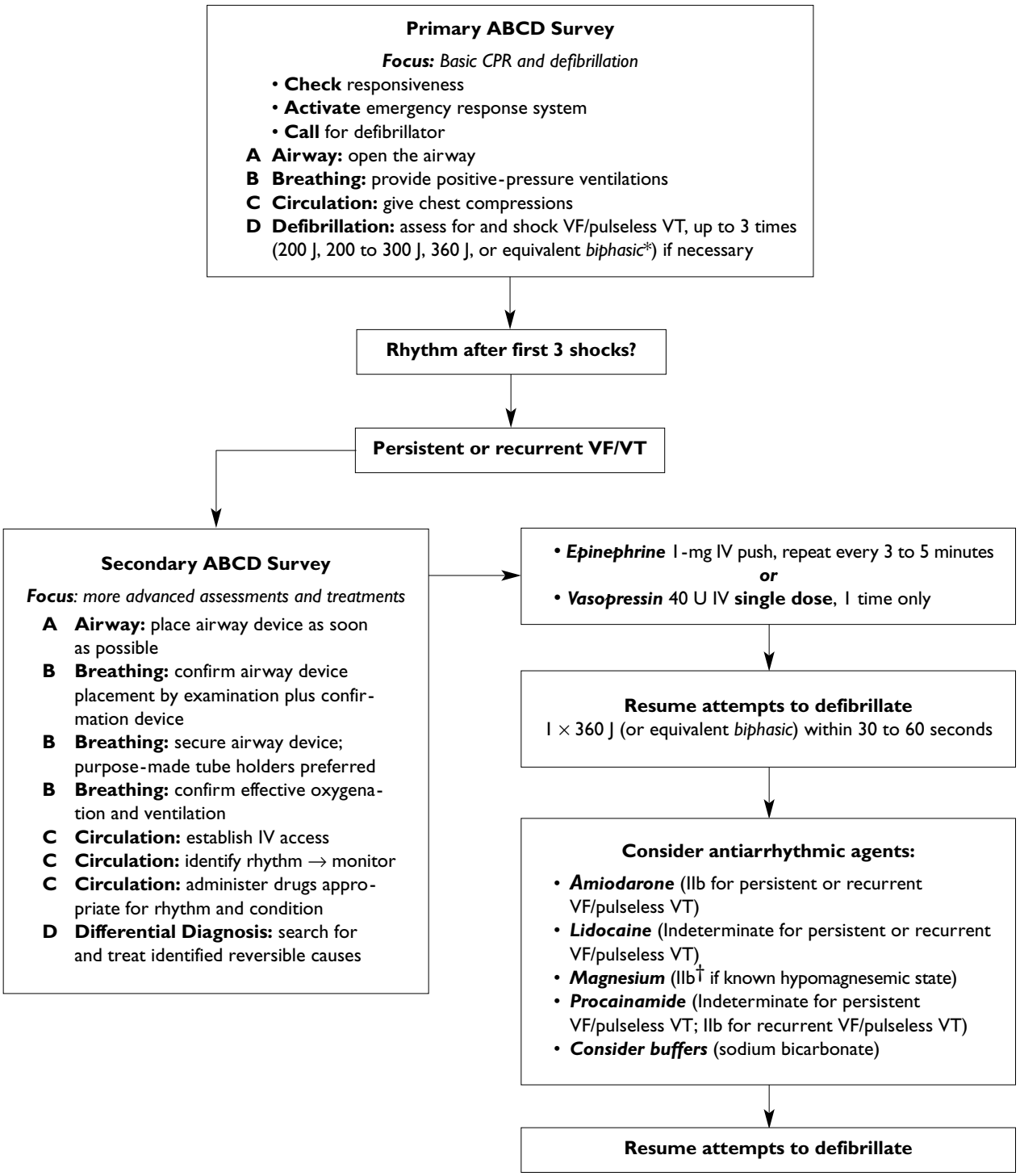

Figure 3. Algorithm for treating persons with ventricular fibrillation and pulseless ventricular tachycardia. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:77. Copyright © 2001 American Heart Association.) CPR = cardiopulmonary resuscitation; IV = intravenous(ly); VF = ventricular fibrillation; VT = ventricular tachycardia. *Biphasic waveform-based automatic external defibrillator. †Class IIb recommendation.

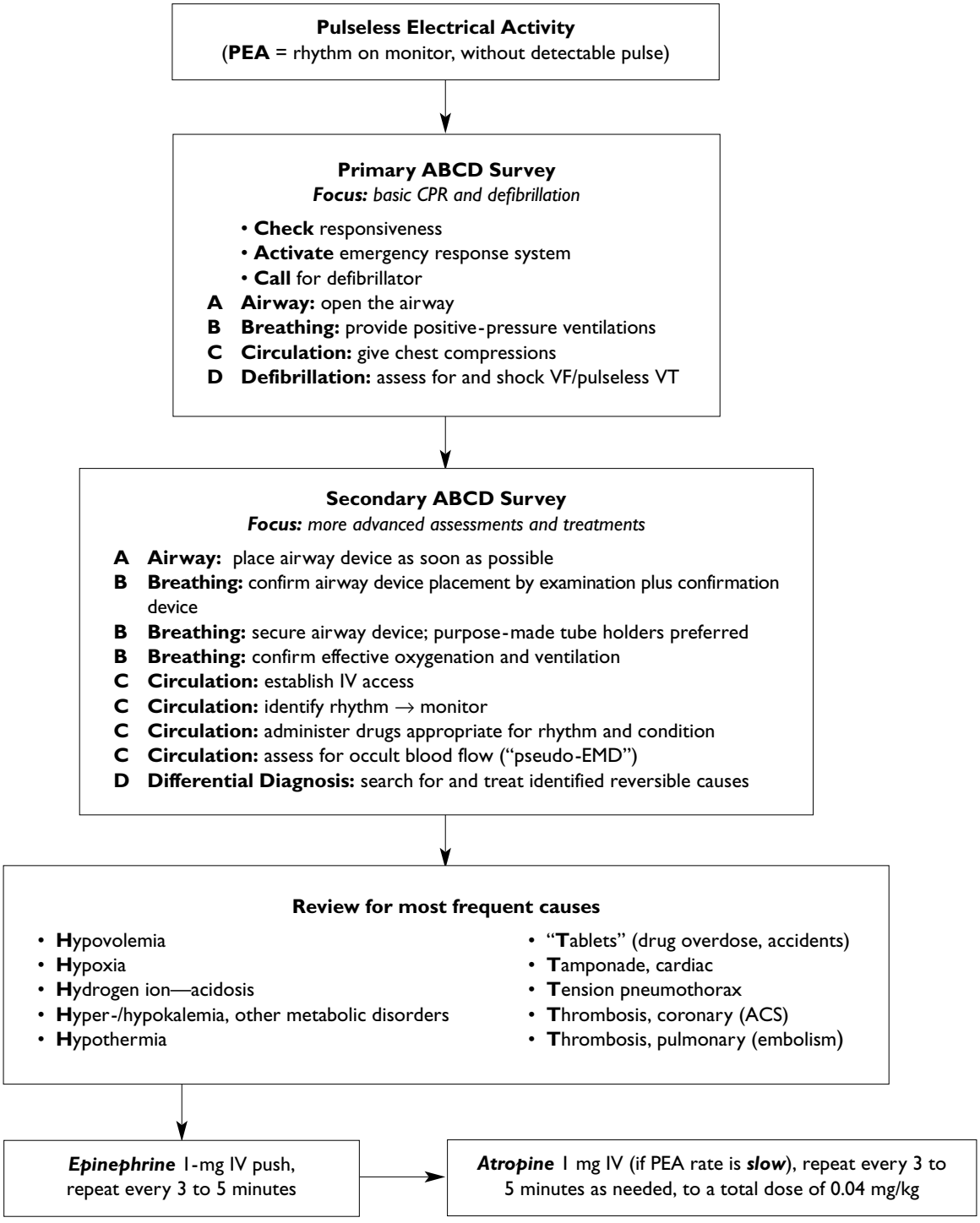

Figure 4. Algorithm for treating persons with pulseless electrical activity. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:100. Copyright © 2001 American Heart Association.) ACS = acute coronary syndrome; CPR = cardiopulmonary resuscitation; EMD = electromechanical dissociation; IV = intravenous(ly); PEA = pulseless electrical activity; VF = ventricular fibrillation; VT = ventricular tachycardia.

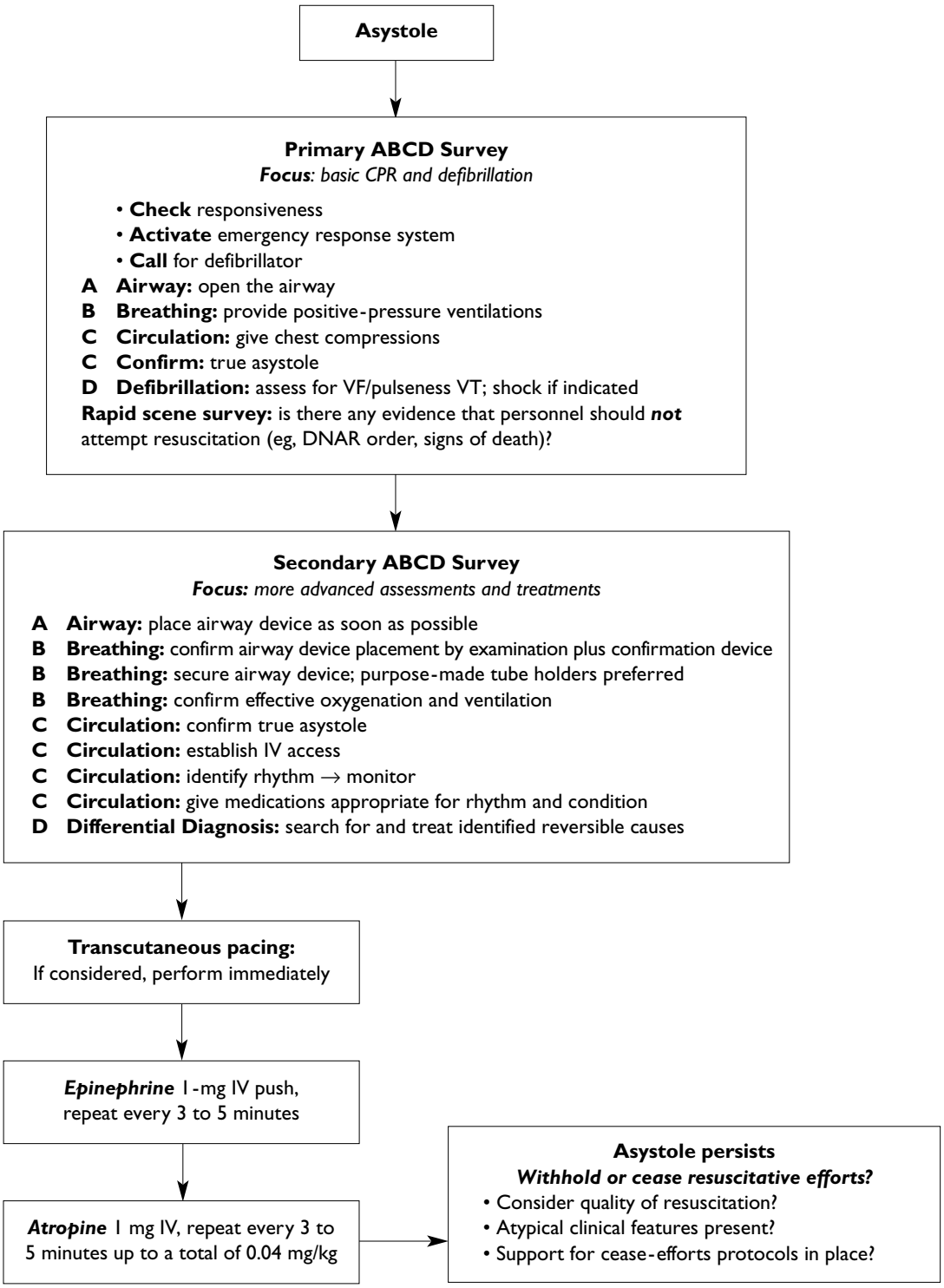

Figure 5. Algorithm for treating persons with asystole. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:112. Copyright © 2001 American Heart Association.) CPR = cardiopulmonary resuscitation; DNAR = do not attempt resuscitation; IV = intravenous(ly); VF = ventricular fibrillation; VT = ventricular tachycardia.

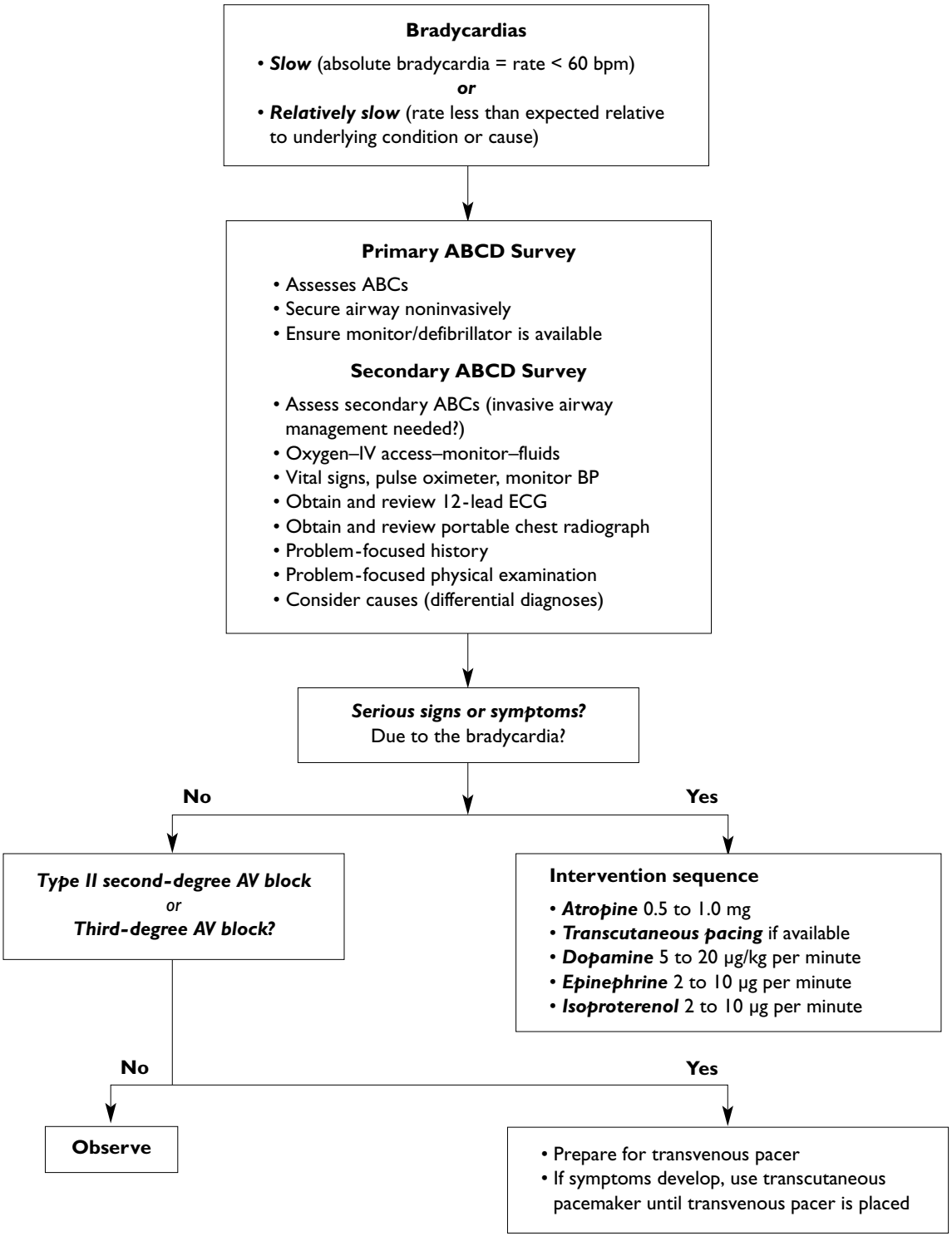

Figure 6. Algorithm for treating persons with bradycardia. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:147. Copyright © 2001 American Heart Association.) AV = atrioventricular; BP = blood pressure; ECG = electrocardiogram; IV = intravenous.

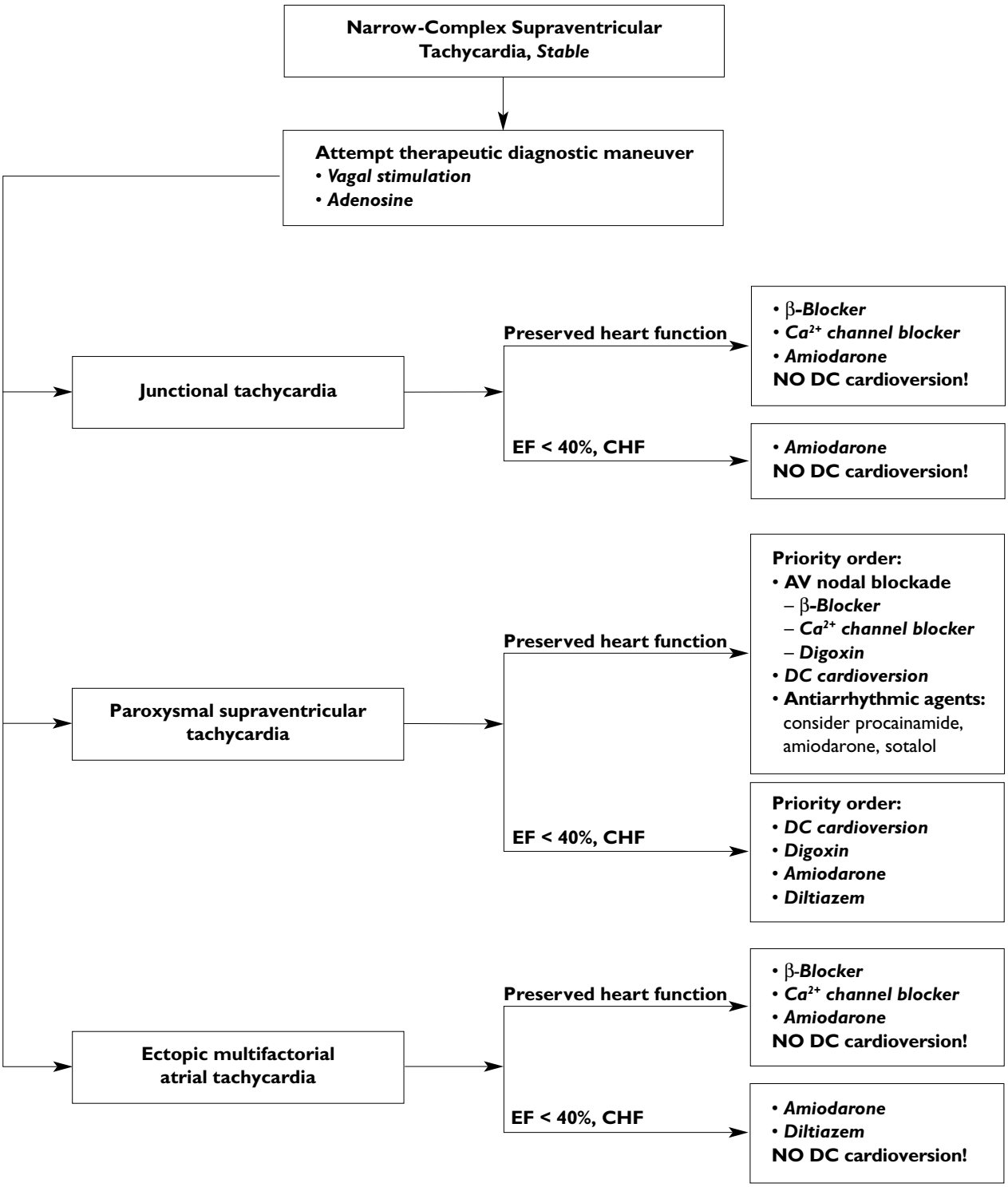

Figure 7. Algorithm for treating persons with a narrow complex tachycardia. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:insert. Copyright © 2001 American Heart Association.) Ca^{2+} = calcium; CHF = congestive heart failure; DC = direct current; EF = ejection fraction.

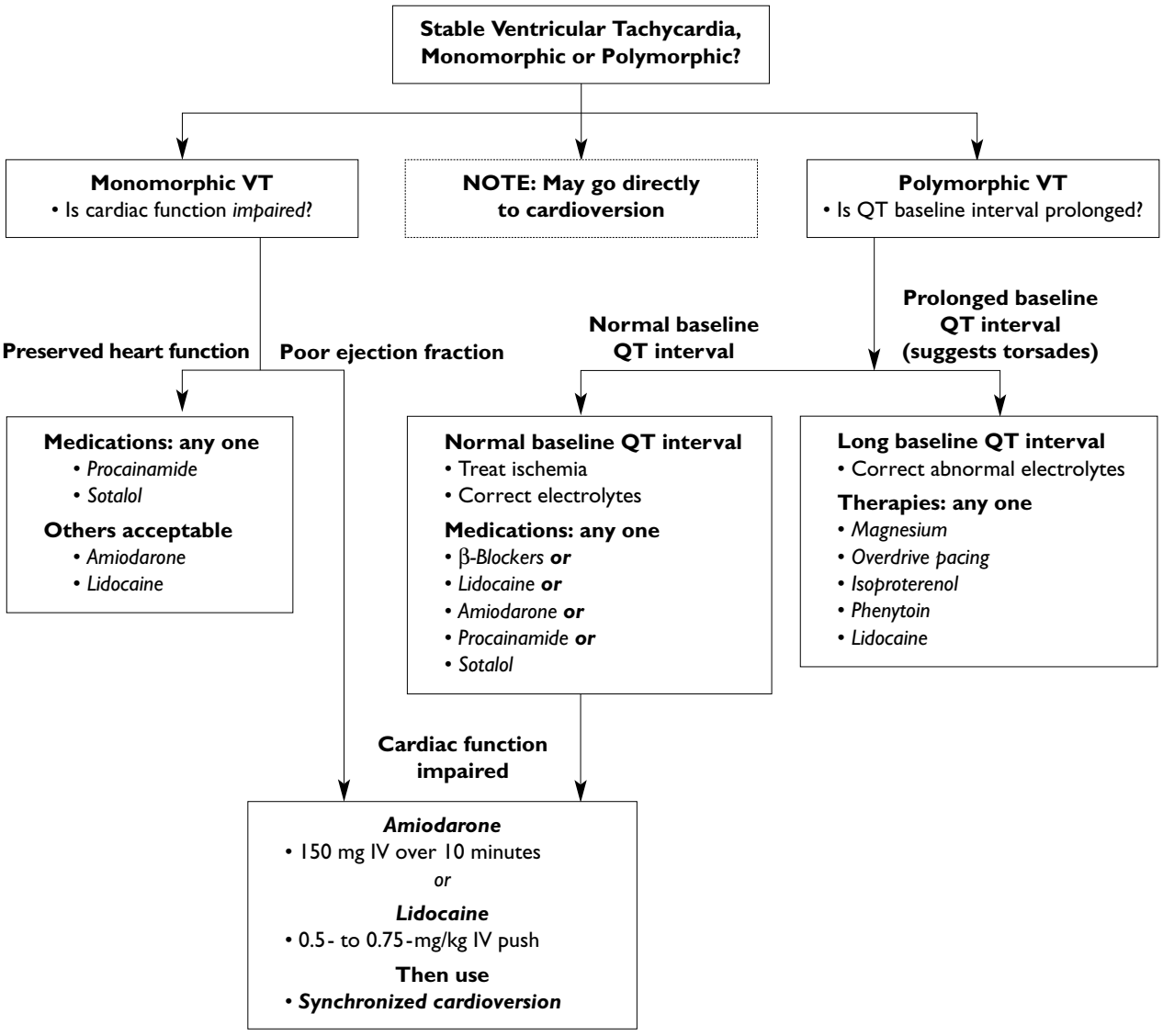

Figure 8. Algorithm for treating persons with stable ventricular tachycardia. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:insert. Copyright © 2001 American Heart Association.) IV = intravenous; VT = ventricular tachycardia.

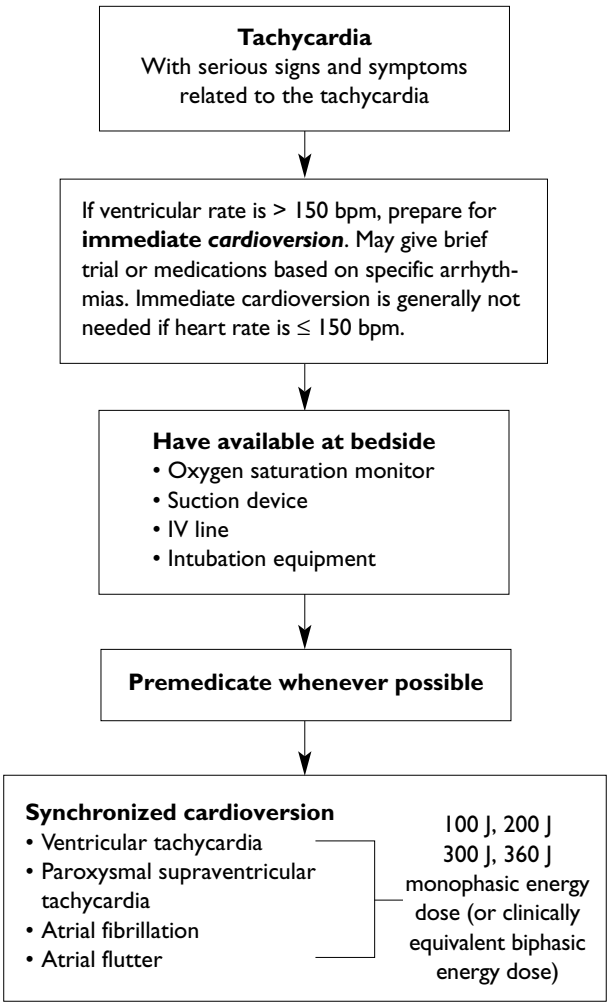

Figure 9. Algorithm for treating persons with unstable ventricular tachycardia. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:160. Copyright © 2001 American Heart Association.) IV = intravenous.

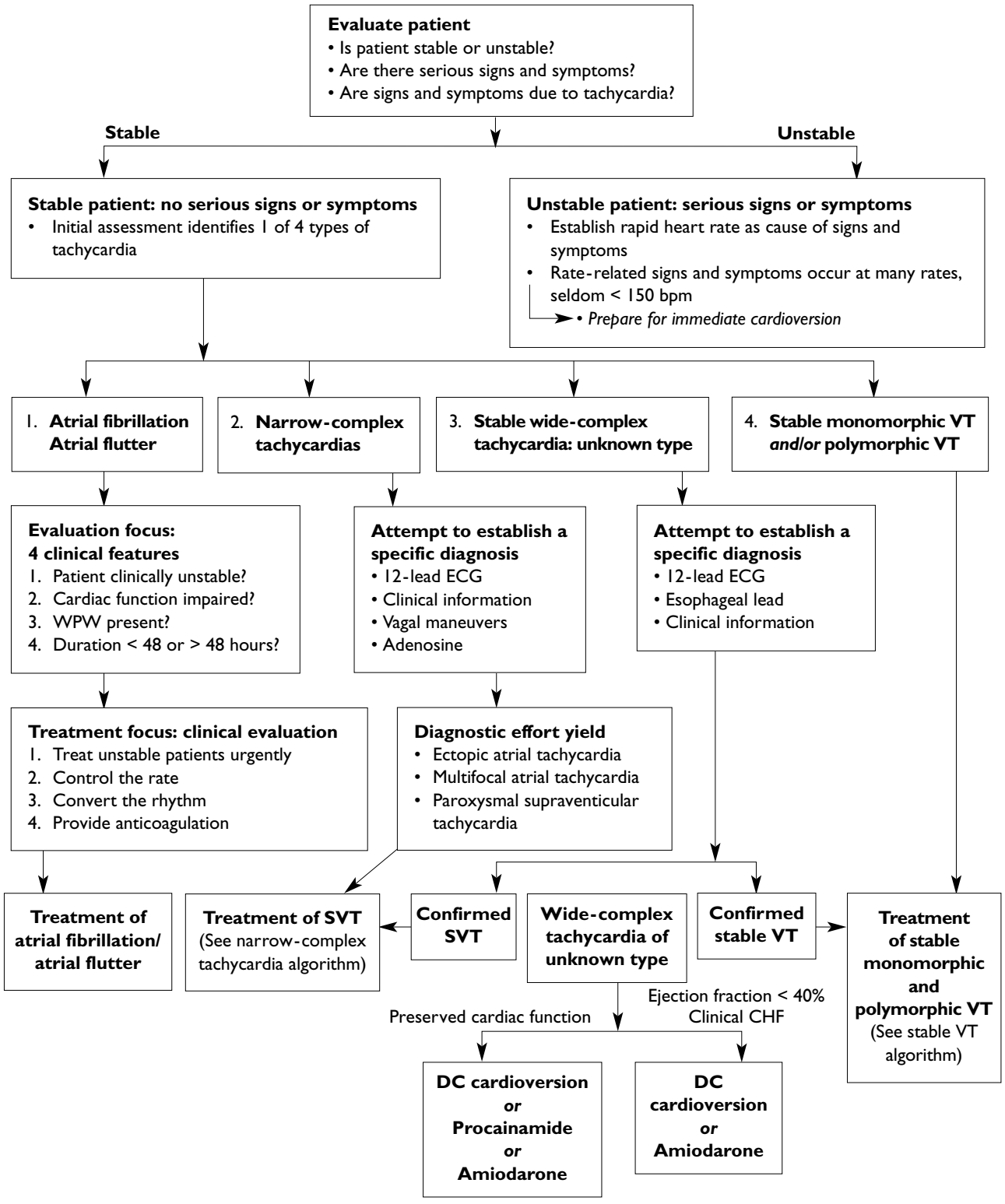

Figure 10. Overview of algorithms for treating persons with tachycardia. (Reprinted with permission from Cummins RO, editor. ACLS provider manual. Dallas: American Heart Association; 2001:173. Copyright © 2001 American Heart Association.) CHF = congestive heart failure; DC = direct current; ECG = electrocardiogram; IV = intravenous; SVT = supraventricular tachycardia; VT = ventricular tachycardia; WPW = Wolff-Parkinson-White syndrome.