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Rationale for Changes in BCLS and ACLS

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Continuing research in resuscitation and acute cardiac care has prompted periodic conferences sponsored by the American Heart Association to develop consensus recommendations to the medical community. The latest such meeting was held in July of 1985. Previous meetings were held in 1973 and 1979. These meetings have each produced a major paper in the *Journal of the American Medical Association (JAMA)*(1, 2, 3) detailing methods advocated for basic and advanced cardiac life support (BCLS, ACLS) as well as related logistical and legal issues of their implementation. This latest publication, entitled "Standards and Guidelines For Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC), " was published in the June 6, 1986 issue of *JAMA (3)*.

The considerable attention given to these proceedings stems from the esteem held by the medical community for the personnel and organizations which participate. Persons involved in these proceedings include prominent clinical research scientists, educators and organizational representatives. Organizational participation at the 1985 meeting included, the American Academy of Pediatrics, American College of Emergency Physicians, American Medical Association, National Research Council -- National Academy of Sciences, Society For Critical Care Medicine and the United States Department of Transportation-National Highway Traffic Safety Administration.

The opening paragraph of the paper clearly defines the aim of their efforts. "This publication is the product of the 1985 National Conference on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC) and represents an updating of the standards and guidelines that were published in 1974 and updated once since, in 1980. It is intended for use as a guide for the proper training in and performance of CPR and ECC. Like the 1974 and 1980 standards and guidelines, these represent a consensus of experts from a variety of disciplines. Cardiopulmonary resuscitation and ECC are dynamic disciplines, however, that continue to develop through ongoing experience and research. Thus, there is no intent to limit the adoption of new standards as they emerge; deviations from these standards and guidelines may occur when a trained physician proficient in CPR and ECC recognizes that such is in the best interest of the patient."

The purpose of this paper is to highlight some of the more significant changes in these BCLS and ACLS guidelines concerning direct patient care. Bibliographic citations have been intentionally limited to those in the 1986 JAMA paper (3), to assure that the research rationale behind these changes is based on those considered by the conference participants and not the authors of this article.

BASIC ADULT CARDIAC LIFE SUPPORT

Opening The Airway

The head tilt/chin lift technique is now the recommended lay rescuer method for opening the airway in cases without suspicion of neck injury. Suspected neck injury cases should still be managed with the jaw thrust. The head tilt/neck lift has been superceded by the head tilt/chin lift on the basis of research which found the latter to be more effective in alleviating obstruction by the tongue (4). However, it is recommended that professional rescuers learn both the neck lift and chin lift techniques.

Ventilation

Inflation of the stomach with air during the course of rescue breathing has the potential to cause regurgitation and aspiration with lethal consequences. The air pressure at the pharynx required to inflate the lungs is less than that which will distend the esophagus and thereby allow gastric inflation (5-7). Consequently, the new ventilation procedures are aimed towards reduction of high pharyngeal pressures by using slower and more sustained breaths lasting 1 to 1.5 seconds. This should reduce the likelihood of air entering the stomach. Initial ventilations will no longer be "staircased" for the same reason. Instead, the first ventilation will be followed by a pause before delivery of a second ventilation. This same sequence will be used for one rescuer CPR ventilations between each set of 15 chest compressions. In two rescuer basic CPR, a pause is made between sets of every 5 chest compressions to allow for the slower single ventilation. In the interest of simplifying training, 2 rescuer CPR will no longer be taught to the lay public.

In the event that another professional rescuer may be assisting with basic ventilation (without an endotracheal tube or esophageal airway), the assistant may apply firm downward pressure with their fingers on the cricoid cartilage. This procedure, sometimes called the Selick Maneuver, holds the esophagus closed between the cricoid cartilage anteriorly and the spinal column posteriorly (8, 9). It is intended to prevent air from entering the stomach and gastric contents from being regurgitated.

Obstructed Airway

The basic categorization of airway obstruction has been changed from complete and partial to those with good or poor air exchange. A good air exchange allows forceful coughing, while a poor exchange has a weak, ineffective or absent cough. A patient with good exchange should be allowed to cough on their own. A natural cough produces higher lung pressures to expel foreign bodies than does an artificial cough (back blow or thrust) (4).

Those with poor air exchange should be treated as if it were a complete airway obstruction. In such situations, a sequence of six to ten successive Heimlich maneuvers (abdominal thrusts) should be used. Patients with advanced pregnancy or marked obesity should receive chest thrusts in lieu of the Heimlich maneuver.

Controversy between the use of back blows and the Heimlich maneuver continues. A research study has reported that when back blows and the Heimlich maneuver are evaluated separately, the Heimlich maneuver had better efficacy than the back blows (10). On that basis and in the interest of simplification in training, the Heimlich maneuver alone is advocated for adults.

Near Drowning

The use of the Heimlich maneuver has been considered in treatment of the near drowning victim who requires rescue breathing. The Heimlich maneuver may be effective in expelling water from the lungs (11-13). However, due to the low incidence of actual lower airway aspiration of water (14, 15) and rapid absorption of aspirated freshwater (14), the Heimlich maneuver should only be applied if there is strong suspicion of foreign matter obstructing the airway or if the patient fails to respond appropriately to ventilatory support.

Chest Compression

A better understanding of the mechanisms generating blood flow during CPR have led to a recommendation for compression rates of 80 to 100 per minute (16-18). In addition to improving the cardiac output, the faster rate may better compensate for the interruptions in chest compressions during pauses for ventilation of non-intubated patients during two rescuer CPR.

Discussion was presented on the use of new techniques to improve blood flow during CPR, such as simultaneous compression-ventilation CPR (19), interposed abdominal compression CPR (20), MAST-assisted CPR (21) and CPR with abdominal binding (22). None of these techniques were specifically recommended on the basis that specialized devices are required and that their efficacy in long term outcome has yet to be established. Further research into these methods has been encouraged.

Statements are now being made about the application of CPR in the prehospital setting. It is recommended that moving a patient to a position of convenience be deferred until it can be done without interruption of CPR or until a pulse is restored. Interruptions in CPR for movement down stairs should not exceed 30 seconds. CPR should not be interrupted during movement of a patient to the ambulance by litter.

BASIC PEDIATRIC AND NEONATAL CARDIAC LIFE SUPPORT

The techniques for CPR are essentially the same in adult and pediatric patients with use of the head tilt/chin lift and a rate of 100 compressions per minute.

Airway obstruction in the child over one year of age is treated the same as for the adult, with the Heimlich maneuver. The concern for intra-abdominal injury in children less than one year of age has led to a decision to retain the incumbent sequence of back blows and chest thrusts with the head of the child held lower than the chest to gain gravity assistance in alleviating the obstruction.

For ventilations and chest compressions in the depressed neonate, an assisted ventiatory rate of 40 breaths per minute should be employed. After 15-30 seconds of adequate ventilation, a decision may be made on subsequent treatment. If the heart rate is over 100 with spontaneous breathing, support may be discontinued. With a heart rate less than 60, both ventilation and chest compression are applied. A heart rate of 60-100 and rising indicates continuation of ventilation without chest compressions. A heart rate of 60-100 and falling should prompt reevaluation of ventilation efficacy and application of chest compressions should the heart rate fall below 80.

The infant heart has been found to be comparatively lower in the chest than in the adult. Thus, the fingers are positioned lower on the sternum during performance of CPR. Using three fingers, the finger closest to the head should be positioned one finger width below a line between the nipples (23).

ADULT ADVANCED CARDIAC LIFE SUPPORT

Ventilation

Oxygen powered mechanical breathing devices using manually-triggered ventilation have had a propensity to produce gastric distention in patients due to the higher pharyngeal pressures associated with their gas flow rates exceeding 100 liters per minute. With the recognition of this potential complication, these devices are now recommended to provide flow rates of only 40 liters per minute with the venting of gases to the atmosphere if the airway pressure exceeds 60 centimeters of water. These specifications are appropriate only for adult use and therefore, these devices should not be used with children.

The esophageal obturator airway devices have previously been recognized as an acceptable airway adjunct. However, their potential for complications (24, 25) and possibly inferior efficacy in ventilation (26-28) prompted a clear statement favoring endotracheal intubation as the preferred method of advanced airway control. Specifically, endotracheal intubation should be a part of the armamentarium of all ACLS providers, including paramedical personnel (29-31). Thus, it seems that esophageal obturator airways are no longer acceptable first-line substitutes for endotracheal intubation in prehospital ACLS.

Concerns about developing gastric distention during ventilation are not applicable to the patient with a cuffed endotracheal tube. Therefore, a pause need not be made during two rescuer CPR to facilitate ventilation. Further, synchronization of ventilation between chest compressions has been found to be unnecessary when a cuffed endotracheal tube is in use. Research has demonstrated that ventilation remains adequate despite ventilation performed out of synchronization with chest compression (32).

Medical Anti-Shock Trousers (MAST)

The use of MAST in ACLS was discussed, with the suggestion that it not be applied in the routine care of the cardiac arrest victim, due to a lack of data demonstrating an improvement in survival. However, MAST was mentioned as a method to provide a reversible volume load in cases of congestive heart failure with pulmonary congestion. It must be remembered that MAST may provide an increased preload and aggravate pulmonary congestion and is therefore potentially dangerous in this setting. In pulmonary congestion cases where hypovolemia is suspected to be part of the clinical problem, MAST may be beneficial. If the clinical picture deteriorates with inflation, MAST can be deflated. It is emphasized that MAST should only be used in these circumstances by personnel familiar with this physiology and potential complications.

Drug Routes and Delivery

The reliability and speed of drug delivery to target sites when given under conditions of poor perfusion during CPR has been questioned (33-35). In patients without an I.V. prior to the start of CPR, the antecubital is asserted to be the vein of first preference. The distal veins of the hand, wrist and leg were specifically mentioned as the least favorable sites during CPR due to their poor perfusion.

Suggested measures to improve transport of drugs from the extremity veins into the central circulation include using a large volume of flush solution following I.V. drug administration. This would essentially flush the drugs out of the tubing as well as the peripheral vein up to the point where it empties into the larger central veins. Lifting up the extremity to promote gravity drainage into the central blood circuit and use of a longer I.V. catheter were also mentioned. Due to the inherent delays of drug transport from peripheral veins to target sites in the central circulation, a one to two minute period should be allowed following peripheral venous drug administration before assessment of its effects during CPR.

Situations occur where an endotracheal tube is placed the endotracheal route is mentioned as a suitable alternative for administration of epinephrine, lidocaine, and atropine (36). This may be of particular significance in the field, where intubation often preceeds establishment of an I.V. in cases of unwitnessed arrest. The intracardiac route for drug administration is mentioned as an alternative, appropriate only to cases where neither I.V. or endotracheal routes are available.

Central venous access is acknowledged as a drug route with faster central drug delivery and more consistent availability in situations with poor peripheral perfusion. Thus, if circulation is not rapidly restored after initial drug therapy through a peripheral I.V., a central I.V. should be placed. It is important to choose a central I.V. technique that minimizes any interruptions in chest compression or ventilation. With an intubated patient, the internal jugular may be cannulated with less interruption in chest compression than that required for the subclavian. External jugular cannulation can access the central circulation using the J-wire technique and do so without interruption in CPR when an endotracheal tube is utilized.

Drug Therapy

I.V. Fluids – It is acknowledged that electromechanical dissocation is common in cases of arrest secondary to severe traumatic blood loss. Aggressive fluid expansion is indicated. In cases with acute myocardial infarction and hypotension, cautious volume expansion may also be useful but should be done with appropriate monitoring of filling pressures and cardiac output. Volume expansion is not recommended in the cardiac arrest victim without specific suspicion of prior volume depletion, because it may result in an actual reduction of blood flow to the brain and heart (37).

Lidocaine – Lidocaine has been designated as the first-line anti-arrhythmic drug for management of ventricular ectopy. Previous recommendations had given a first-line option between lidocaine and bretylium in management of ventricular fibrillation (VF). This clear preference toward lidocaine is based on research showing lidocaine at least as effective as bretylium in VF (38, 39).

The dosage for lidocaine has been reconsidered. Lidocaine should now be given to the non-arrested patient with significant ventricular ectopy (40) with both an initial bolus of 1 milligram per kilogram and a constant infusion running at 2 milligrams per minute (40). Additional boluses of 0.5 milligrams per kilogram may be given at 2 to 3 minute intervals, as needed to a maximum bolus dose of 3 milligrams per kilogram, to achieve suppression of ventricular ectopy. With each repeat administration of a 0.5 milligram per kilogram bolus, the lidocaine drip rate should be increased by an additional 1 milligram per minute up to a maximum of 4 milligrams per minute (41) (Figure 3). In patients with advanced age (greater than 70 years) or liver disease, lidocaine dosage should be attenuated to half of the normal dosage (40).

When lidocaine is given during VF or pulseless ventricular tachycardia (VT), there is likely to be a decreased clearance of the drug by the liver, similar to that

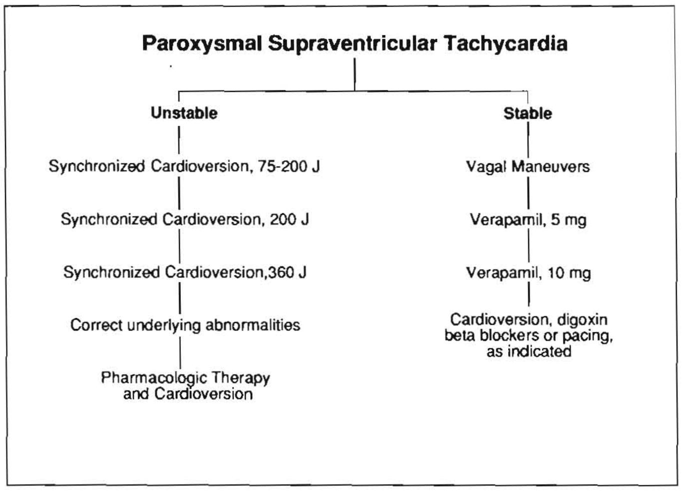

Figure 1 - Paroxysmal Supraventricular Tachycardia

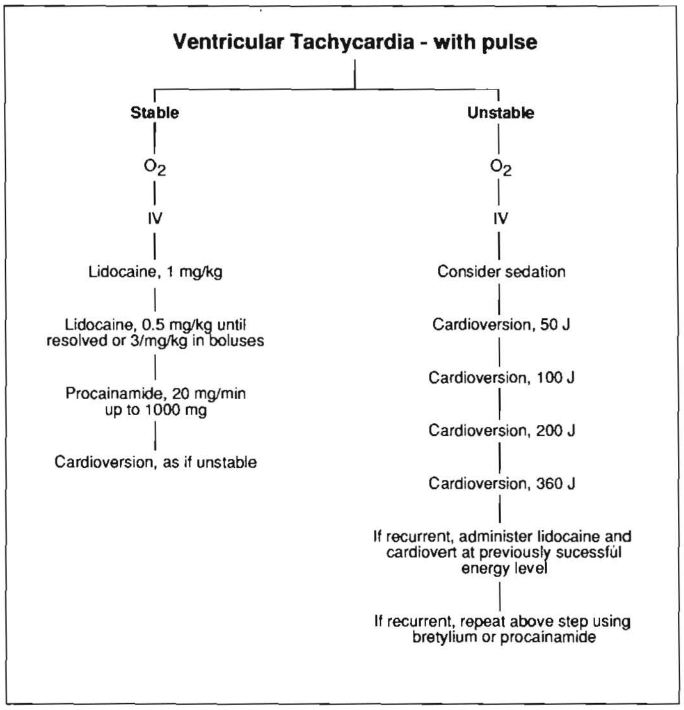

Figure 2 - Ventricular Tachycardia with Pulse

seen with shock and liver disease (42). An initial dose of 1 milligram per kilogram is suggested. A lidocaine infusion is not necessary until the pulse is restored. If VF or pulseless VT remains after lidocaine and countershock, a single 5 milligram per kilogram bolus of bretylium and another countershock may be used. If refractory, administer additional boluses of 0.5 milligram per kilogram boluses of lidocaine with countershocks at 8 to 10 minute intervals to a maximum bolus dosage of 3 milligrams per kilogram (Figure 4).

During early myocardial infarction, ventricular ectopy may not be present, yet a high risk of ventricular

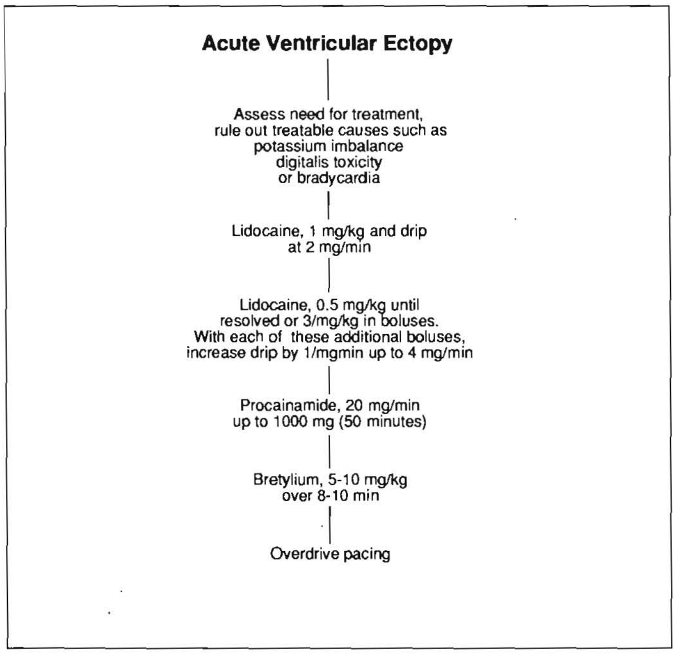

Figure 3 - Acute Ventricular Ectopy

fibrillation exists. Thus, lidocaine continues to be recommended with suspected myocardial infarction, on a prophylactic basis, in the absence of ventricular ectopy (43-45).

Procainamide – Procainamide has been included in the management sequence for stable ventricular tachycardia (Figure 2) and acute ventricular ectopy (Figure 3), after repeated boluses of lidocaine have been unsuccesful. The procainamide is given acutely as a drip, running at 20 milligrams per minute. It should be discontinued if the QRS widens by 50% of baseline or after a total of 1000mg of procainamide has been infused (46).

Atropine – Previous algorithms for treatment of asystole limited its dosage to 1 milligram, despite its maximum dosage of 2 milligrams in non-arrested cases (Figure 5). Atropine, 1 milligram, may now be repeated once during sustained asystole, five minutes after the first 1 milligram bolus (47-49) (Figure 4).

Isoproterenol – Isoproterenol has been deleted from the management sequence for asystole and electromechanical dissociation. Specific references to research behind this decision were not given in the latest JAMA paper (3). It is still included in the management of A-V blocks and bradycardia when a pulse is present. This should be used only until a pacemaker becomes available (Figure 5).

Verapamil –Verapamil is the cornerstone of a new algorithm for treatment of sustained paroxysmal supraventricular tachycardia (PSVT) (Figure 1). In the stable patient, it is given after vagal attempts have failed to break the tachycardia. An initial dose of 5 milligrams, intravenously, may be followed, if needed, in 15 to 20 minutes by a repeat dose of 10 milligrams (50). The unstable patient would receive verapamil only if an initial sequence of synchronized countershocks fail. Hypotension following verapamil may be reversed with a 0.5 to 1.0

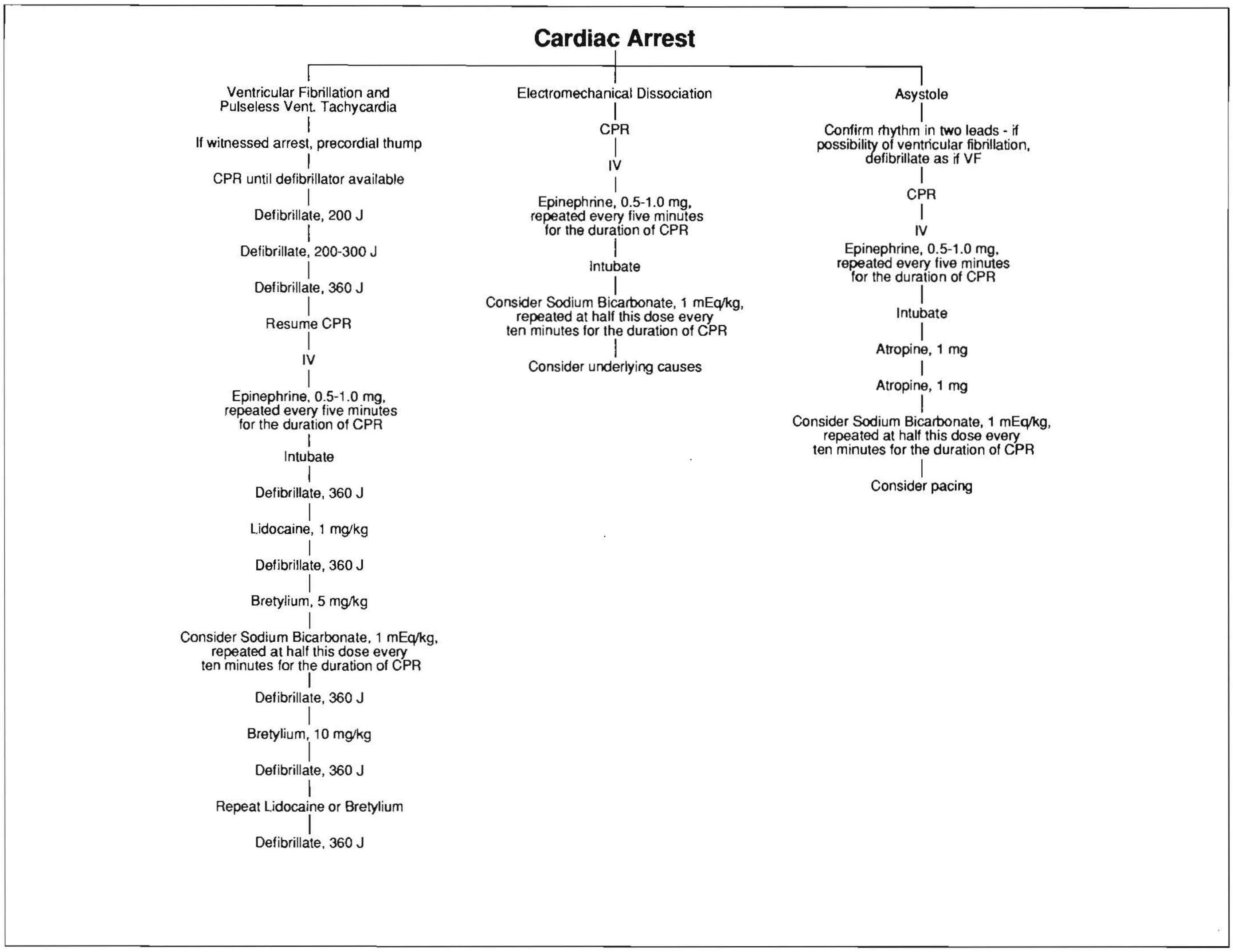

Figure 4 - Cardiac Arrest Algorithms

milligram bolus of calcium chloride.

Dopamine and Dobutamine – These drugs are indicated in the treatment of myocardial infarction with hypotension. However, dobutamine has been portrayed as having preference in first-line treatment, having primarily inotropic effects which will increase the cardiac output. Dopamine, in contrast, has inotropic effects, but also has a more pronounced vasoconstrictive effect which may impair mesenteric and renal blood flow at its higher dosages (51).

Amrinone – This drug is now included in the official ACLS armamentarium, with effects similar to those of dobutamine, yet with a non-adrenergic mechanism (52). Use of this drug is not specifically addressed in any of the clinical management sequences.

Calcium – Calcium has been removed from the routinely recommended management of asystole and electromechanical dissociation. Research studies have failed to show an improvement in survival from asystole or electromechanical dissociation when calcium was utilized (53-55). Calcium has been implicated to cause adverse

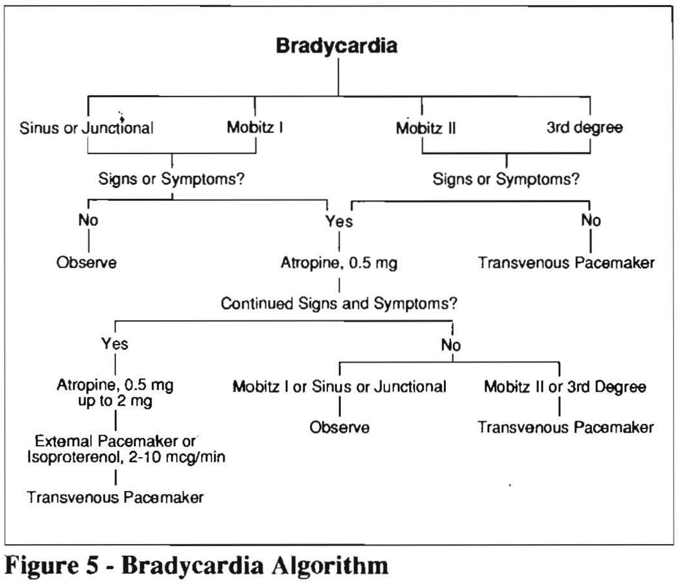

Figure 5 - Bradycardia Algorithm

effects on the brain during and following resuscitation (56, 57). It may be appropriate for use in less common situations with electrolyte imbalances or calcium channel blocker toxicity.

Nitroglycerin – The time honored use of sublingual nitroglycerin remains a part of ACLS. New is its use in I.V. form. It is the preferred agent, over nitroprusside, in treatment of hypertension without congestive failure and in those patients with ischemic heart disease. Nitroglycerin is less likely than nitroprusside to exacerbate ischemia (58). It may be administered intravenously as a constant infusion of 10-500 mcg/min, with a usual effective range of 50-200 mcg/min. Hemodynamic monitoring is required for the safe use of this agent.

Sodium Nitroprusside – This is a new agent for ACLS, indicated in the treatment of heart failure and hypertension. It is similar to I.V. nitroglycerin as a potent vasodilator. It is preferred over I.V. nitroglycerin in cases of hypertension with congestive heart failure (58-60). It is administered at a rate of 10-20 milligrams/min, under careful hemodynamic monitoring.

Sodium Bicarbonate – The role of this drug in resuscitation has been deemphasized. A considerable body of research has shown that sodium bicarbonate may fail to correct acidosis at the cellular level - it may even exacerbate it (61-71). Sodium bicarbonate may produce other adverse complications such as severe hyperosmolality and hypernatremia (72). Endotrachial intubation and effective ventilation seem to provide the best management for acidosis.

Unless there is a strong suspicion of a preexisting metabolic acidosis, more so than that normally expected with an unwitnessed arrest, sodium bicarbonate should not be routinely administered. It should be considered to be a tertiary intervention, behind BLS and the antiarrythmic measures of drugs and countershocks (Figure 4).

COUNTERSHOCKS AND PACING

Defibrillation

In recognition of changes in electrical impedance with repeated shocks (73-88), an initial sequence of three consecutive unsynchronized countershocks should be used in ventricular fibrillation and pulseless ventricular tachycardia. The initial energy level for the adult should be 200 joules (89-99), with the second and third countershock energy levels at 200-300 and 360 joules, respectively (Figure 4).

Pacing

Despite the development of external non-invasive pacing systems, pacing has not demonstrated clinical efficacy during resuscitation (100). However, these same devices do show promise for patients with a pulse in hemodynamically significant bradycadia or blocks that are refractory to atropine (101) (Figure 5).

ADULT TREATMENT ALGORITHMS

Figures 1-5 present treatment algorithms based on those which appear in the 1986 JAMA paper (3).

PEDIATRIC AND NEONATAL ADVANCED CARDIAC LIFE SUPPORT

The advanced life support sequences for treatment of the arrested child are generally the same as those now recommended for the adult. However, atropine is no longer recommended in the acute phase of neonatal resuscitation.

I.V. Access

The difficulty in obtaining intravenous access during resuscitation of children is recognized. Due to more reliable drug delivery to the heart and brain during CPR, central venous access is preferred (102).

The technique of intraosseous (bone marrow) infusion has been acknowledged as an acceptable emergency drug administration route. Intraosseous injections of catecholamines (103) and sodium bicarbonate (104) have demonstrated rapid absorption. In the neonate, the umbilical vein is the preferred route of vascular access.

CONCLUSION

As research continues to provide a better understanding of the pathophysiology of acute cardiovascular diseases, new approaches to clinical management will be developed. The American Heart Association has taken a leadership role in providing much needed interpretations of scientific debate bringing about consensus recommendations for general clinical care. These efforts constitute a major component of emergency and critical care medicine.

REFEREE COMMENTARY

Edward J. Straub, M.D. (Cardiology, Memorial Hospital, Tampa) - I think that a comment should be made regarding ventilation being the corner stone of improving acid-base balance in the cardiac arrest patient. Previous enthusiasm for correcting acidosis with sodium bicarbonate has now subsided in favor of correcting the ventilatory component. When discussing drugs and catecholamines, no mention was made of the use of epinephrine. The new guidelines of advanced life support underscore the importance of the alpha and beta attributes as being salutary and that as a result, epinephrine is the chief catecholamine recommended.

Joe Nelson, D.O. (Emergency Department, Carrollwood Community Hospital, Tampa) - Although regurgitation of stomach contents is a serious problem in BCLS, I question the safety of digital pressure on the cricoid cartilage (Sellick manuver) as a routine BCLS procedure. This manuver was primarily brought about as a tool for "crash" intubation under direct laryngoscopy, although it has been used in pediatric bag-valve-mask resuscitator techniques. Medical professionals not trained in anesthesia and not using this procedure on daily basis may actually do the patient as disservice by 1) closing the airway with too much cricoid pressure, 2) inadvertently impairing a good head-tilt/chin-lift, also closing the airway and 3) misplacement of the fingers on the neck, resulting in impaired carotid blood flow for dangeroud periods of time. More investigation is needed before this manuver is routinely used as a BCLS procedure. Esophageal obturator aiways have never been universally accepted as a first line substitute for endotracheal intubation, although they continue to be a good temporary back-up device, when endotracheal intubation has been unsucessful. The new ACLS guidelines merely reflect an increased emphisis on endotracheal intubation as the only acceptable primary advanced airway adjunct for use during cardiac arrest, specific neck injury or obstructed airway problems not withstanding. Medical anti-shock garment (MASG) use was incorrectly stated in the article. It is inappropriate to utilize the MASG in congestive heart failure. The device is, as you state, beneficial in cases of cardiac arrest with suspected hypovolemia, as a reversible "fluid challenge." Temporary cardiac pacing, either internal or external, should be instituted as early as possible and is preferred over isoproterenol in cases of symtomatic bradycardia refractory to atropine. Isoproterenol can exacerbate myocardial ischemia and cardiac arrythmia.

Mr. Gunderson's response - I agree with Dr. Straub that ventilation should now be considered to be the primary means of acid-base control during resuscitation. This point bears additional emphisis. However, I am concerned about the lack of quantification of ventilation during most resuscitation efforts. While it is easy enough to say that one should provide adequate alveolar ventilation, what does this mean to the paramedic in the field without blood gases or the means to measure delivered tidal volume? The alpha effects of epinephrine are widely regarded in the research literature as being responsible for its beneficial effects during resuscitation. There is controversy about the benefits of its beta attributes. Both these points are made in this latest J.A.M.A. paper. The ACLS textbook based on the 1980 standards made some discussion of the value of pure alpha agonist administration with mixed reviews. Dr. Joeseph Redding has conducted much of the original research along these lines. The new guidelines give additional emphsis to the q5m dosage regimen for epinephrine during CPR. The application of cricoid pressure as a means of both preventing gastric distention during ventilation and for the prevention of regurgitation is presented in the paper for use by "health care professionals in two-rescuer CPR situations; its application is simple but requires an assistant." It would seem the burden is on the medical directors and training staffs to provide an appropriate introduction of this technique that avoids the pitfalls mentioned by Dr. Nelson. I don't percieve this to be that different than many of the other procedures we routinely use in regards to a risk-benefit ratio. I might restrict its use in the field to those who serve in primary EMS roles and withhold training of first responders, etc. until we have some experience with it. The EOA is used by many systems as a primary advanced airway adjunct to the exclusion of endotracheal intubation. While previous standards highlighted the preference of endotracheal intubation, they did not make specific mention that endotracheal intubation should be used in the field in preference to the EOA. I have a problem with having paramedic students learn to manage an airway during their ACLS resuscitation training by first inserting an EOA and later performing endotracheal intubation. The endotracheal tube should be used as a first line advanced airway adjunct after initial ventilation and perhaps a simple oralpharyngeal aiway. That's the message. I don't think we're in disagreement. The use of MAST in cases of heart failure might play a potential role only in those cases where hypovolemia is considered to be a factor contributing to the reduced cardiac output. Typically, these pateints have too much preload. If hypovolemia is suspect on the basis of perhaps of an indicator such as pulmonary artery wedge pressure, MAST might offer a means to give a reverisble fluid challenge. If the hemodynamics deteriorate, it can be withdrawn. That isn't so easy to do with a crystalloid fluid challenge. I wholeheartedly agree with Dr. Nelson's comments about pacing and isoproterenol - they bear further emphisis. I would like to thank Dr. Straub and Dr. Nelson for their remarks.

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