Vasopressin and Beyond - Resuscitation and New ACLS Protocols

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OBJECTIVES

At the conclusion of this Problem Based Learning Discussion, the discussant/learner will be able to:

1) become familiar with the changes in Advanced Cardiac Life Support protocols that were enacted in 2000.
2) understand the rationale for and use of vasopressin in cardiac arrest and other situations.
3) discuss the use of amiodarone in cardiac arrest and the indications for that use.
4) know the limitations of medications such as lidocaine, bretylium and procainamide and understand why they no longer are prominent in the ACLS protocols.

STEM CASE - KEY QUESTIONS

Case History:

A 60-year-old man is brought emergently from the hemodialysis unit to the OR for bilateral below knee amputation (BKA). He was recently admitted to the hospital for acute myocardial infarction, and on admission his physical examination revealed bilateral cold ischemic lower extremities. However, the patient and his family refused surgery. His other history is significant for HTN, end stage renal disease on hemodialysis, coronary artery disease, seizure disorder and pneumonia. His medications included digoxin, coumadin, metoprolol, amlodipine, and clonazepam. His most recent lab test showed a CPK of 15,000; Hct. 49%, EKG showed atrial fibrillation with LVH; CXR showed cardiomegaly and pulmonary infiltrates; echocardiogram shows severe LVH, ischemic inferior wall, large left atrium, moderate mitral stenosis and aortic stenosis. The patient was undergoing hemodialysis when he became increasingly lethargic and a code was called; during that time he was intubated, the patient's wife agreed to surgery, and he was brought emergently to the operating room for the above procedure.

In the operating room, no additional IV access or monitoring could be established due to previous attempts at hemodialysis vascular access, so pressors were infused via the patient's dialysis catheter. The first ABG in the OR showed pH 7.28 with a base excess of –7 and potassium of 4.7. The patient was surprisingly stable during the bilateral BKA and towards the end of the case a repeat ABG shows pH 7.29, B.E. –8.7, and K potassium of 6.9. Shortly after that, the patient develops pulseless ventricular tachycardia and CPR is immediately started.

Questions:

1) What is the ACLS protocol for pulseless ventricular tachycardia / ventricular fibrillation?
2) What is the role and mechanism of action of vasopressin in cardiac arrest? In septic shock?
3) What is the role (and dose) of amiodarone in ventricular tachycardia, ventricular fibrillation, and atrial fibrillation? What special precautions must be taken when using amiodarone IV? How many bolus doses of amiodarone can be given?
4) Do lidocaine, bretylium or procainamide have any role in the above dysrythmias any more? Why or why not?

PROBLEM BASED LEARNING DISCUSSION

The treatment of patients with cardiac arrest represents, perhaps, the most widespread example of protocolized patient care in modern medicine. Almost every practitioner, at one point or another, is exposed to the guidelines of the American Heart Association, in the form of the Advanced Cardiac Life Support algorithms. What is unusual, however, is that many people take the algorithms as representing the results of incontrovertible scientific evidence, and they are far from that. The American Heart Association, to their credit, recognized this with the update of the protocols in 2000.

With the update, they looked at recent studies showing value in the use of vasopressin and amiodarone, and at a paucity of convincing evidence pertaining to outcomes of treatment with such stalwarts of the ACLS guidelines as epinephrine, lidocaine, bretylium and procainamide, and made recommendations classified level of recommendation as follows:

Class I interventions are always acceptable, proven safe, and definitely useful.

Class IIa interventions are acceptable, safe, and useful. • Considered standard of care: reasonably prudent physicians can choose • Considered *intervention of choice* by majority of experts

Class IIb interventions are acceptable, safe, and useful. • Considered within "standard of care": reasonably prudent physicians can choose • Considered *optional* or *alternative interventions* by majority of experts

Indeterminate can still be recommended for use, but reviewers must acknowledge that research quantity/quality fall short of supporting a final class decision. Not for use to resolve debates among experts, especially when evidence is available but experts disagree on interpretation. *Indeterminate* is intended to be used for promising interventions.

Class III Interventions are designated as Class III when evidence of benefit is completely lacking or studies suggest or confirm harm.

When they looked at the data, and the new algorithms were formulated, it was clear that the available experimental evidence favored a large role early on in cardiac arrest for vasopressin and amiodarone, a slightly lessened role for epinephrine, and a drastically reduced role for lidocaine, bretylium and procainamide. Practitioners who have not updated their ACLS certification since 1999 or have not kept up with the literature in the subject may not be aware of the current recommendations.

Here are the new recommendations:

Evidence Based Recommendations on the Pharmacological Resuscitation of Patients		
#	Recommendation	Class of Rec.
1	Amiodarone and procainamide are recommended ahead of lidocaine and adenosine for initial treatment of hemodynamically stable wide complex tachycardia, especially in patients with compromised cardiac function.	IIb
2	Amiodarone and sotalol are new agents recommended as agents for the treatment of stable monomorphic and polymorphic ventricular tachycardia (VT).	IIa
3	References to bretylium have been dropped from the ventricular fibrillation (VF)/pulseless VT algorithm. This is mainly due to severe supply problems. It remains acceptable to use, but it is no longer recommended. Bretylium has a high incidence of side effects, particularly hypotension, in the postresuscitation setting, and there is no new, supportive information available and some studies question its efficacy.	IIb
4	The evidence supporting lidocaine efficacy is poor and methodologically weak (animal studies, extrapolations and common sense) and although lidocaine remains acceptable as an antiarrhythmic to use for the treatment of shock-refractory VF and pulseless VT, the evidence supporting amiodarone is much stronger (one level 1 study) and justifies use of amiodarone before lidocaine. Lidocaine could continue to be used for VF/VT but that given the antiquated evidence, it merits only an indeterminate class of recommendation. Lidocaine has not been recommended for routine prophylaxis of ventricular arrhythmias in the setting of acute myocardial infarction for a while, but the data do not justify changing the classification of lidocaine to a Class III (evidence-of-harm) agent.	Ind.
5	Amiodarone 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, et al. below), 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.	IIb
6	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.	IIb
7	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 but 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.	IIb
8	Research on high-dose epinephrine has not yet shown that routine use of initial and repeated or escalating doses of epinephrine can improve survival in cardiac arrest (Class Ind.). 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 Ind.).	Ind.

From: Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. An International Consensus on Science. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Circulation 102(suppl I):I-86-I-89; 2000

Also, the Guidelines looked at ventilation of patients with the same critical eye and made some recommendations that are also of interest to anesthesiologists and intensivists:

Evidence Based Guidlines on the Ventilations of Patients in Emergency Cardiac Care		
#	Recommendation	Class of Rec.
1	The guidelines 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. 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.	IIa
2	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.	Ind.
3	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)	IIb
4	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 cardiac arrest and conditions of low pulmonary flow, these devices are lowered because the devices may falsely indicate esophageal placement, leading to unnecessary removal of a properly placed tube.	Non-Cardiac Arrest – IIa; Cardiac Arrest - IIb
5	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, 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.	IIb

From: Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. An International Consensus on Science. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Circulation 102(suppl I):I-86-I-89; , 2000.

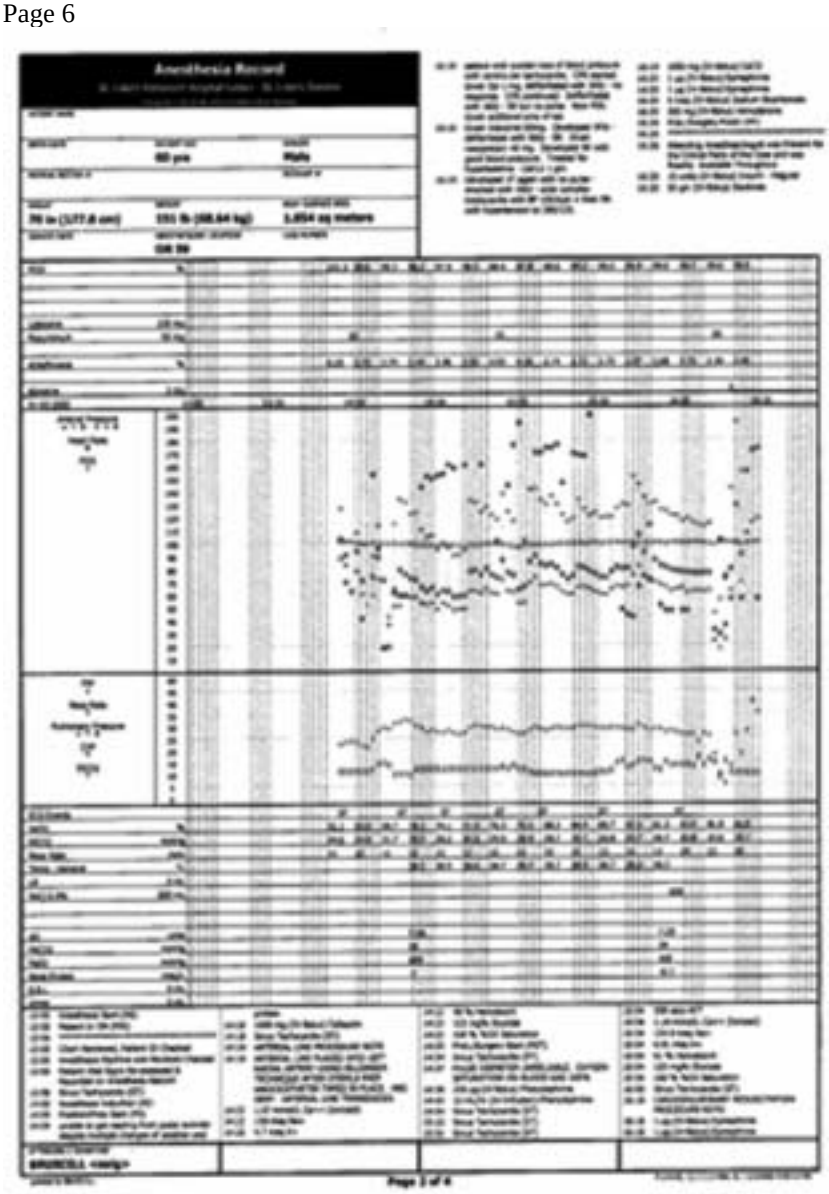
In addition, other studies on vasopressin deficiency in septic shock, a condition not unseen in the operating room, and on using low doses of vasopressin, not as a pressor but as a replacement and adjunct to reduce doses of other pressors, give anesthesiologists yet another tool to use in the OR for treating the critically ill patient.

While many of these ACLS guidelines may not reflect an individual anesthesiologist’s practice, it is important to realize what the most widespread example of protocolized patient care says, because deviation from them, while totally acceptable, needs to be done with thought in mind if one is to please regulators, Quality Improvement bodies and the legal system.

By reading and becoming familiar with the articles below, all from major and widely available journals (some available free online to all), and by discussing the case above, the discussant should be able to easily meet the objectives of the session.

REFERENCES

1) Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. An International Consensus on Science. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Circulation 102(suppl I):I-86-I-89; I-112-I-128; I-129-I-135, 2000.
2) Stiell IG, Hebert PC, Wells GA, et al. Vasopressin versus epinephrine for in-hospital cardiac arrest: a randomized controlled trial. Lancet 2001 Jul 14;358 (9276):105-9.
3) Kern KB, Halperin HR, Field J. New guidelines for cardiopulmonary resuscitation and emergency cardiac care: changes in the management of cardiac arrest. JAMA 2001 Mar 14;285(10):1267-9.
4) Malay MB, Ashton RC Jr, Landry DW, et al. Low-dose vasopressin in the treatment of vasodilatory septic shock. J Trauma 1999 Oct;47(4):699-703; discussion 703-5.
5) Dorian P, Cass D, Schwartz B, et al. Amiodarone as compared with lidocaine for shock-resistant ventricular fibrillation. N Engl J Med 2002 Mar 21;346(12):884-90.
6) 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 Sep 16;341(12):871-8.
7) MacLeod BA, Heller MB, Gerard J, et al. Verification of endotracheal tube placement with colorimetric end-tidal CO2 detection. Ann Emerg Med. 1991 Mar;20(3):267-70.
8) Bozeman WP, Hexter D, Liang HK, et al. Esophageal detector device versus detection of end-tidal carbon dioxide level in emergency intubation. Ann Emerg Med. 1996 May;27(5):595-9.



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