

CME ARTICLE

Ventricular Arrhythmias and the Use of Antiarrhythmic Drugs After Cardiovascular Surgery

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This activity is designed for physicians caring for the cardiovascular patient in the perioperative period.

GOAL

To provide an overview of the problem of ventricular arrhythmias after cardiovascular surgery and to review treatment options.

OBJECTIVES

1. Review the different types of ventricular arrhythmias.
2. Present the various approaches to treating ventricular tachycardia and ventricular fibrillation, including the various antiarrhythmic drugs and their advantages and disadvantages based on the study results available.
3. Discuss the use of amiodarone with life-threatening ventricular tachycardia and ventricular fibrillation, including its efficacy, side effects, and dosing requirements.

Many remarkable advances in the area of cardiovascular surgery have not only improved patient quality of life and reduced hospital stay, but they have saved countless lives as well. Unfortunately, the risk remains of operating on a patient to correct a serious underlying cardiovascular disorder and ending up with a malignant arrhythmia that is difficult to control and that can lead to death. Although perioperative arrhythmias tend to be common, they are mainly supraventricular and are not life-threatening; ventricular arrhythmias, however, can be devastating. These can occur after coronary artery bypass graft surgery or valve replacement, and they represent a serious life-threatening consequence of otherwise uncomplicated cardiac surgery. In addition, they lead to increased cost and length of hospital stay. Fortunately, serious ventricular arrhythmias are rare. Less than 2% of all patients who have cardiac surgery develop some form of serious ventricular arrhythmia.¹⁻⁵ This article addresses the problem of life-threatening ventricular arrhythmias, employing evidence collected on use of antiarrhythmic drugs and other therapies to help provide a cost-effective, low-risk approach to treatment.

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Types of Ventricular Arrhythmias

Several types of ventricular arrhythmias may require treatment in the postoperative period. Because therapeutic options vary and treatment can be quite difficult to optimize, it is important to distinguish one type of arrhythmia from another. The main ventricular arrhythmias that require assessment include monomorphic ventricular tachycardia, polymorphic ventricular tachycardia, torsade de pointes, ventricular fibrillation, premature ventricular contractions (PVCs), and nonsustained ventricular tachycardia.

Monomorphic ventricular tachycardia suggests there is an underlying cause that may require acute or chronic therapy. Patients who have this type of arrhythmia, even in the early stages after surgery, may ultimately require chronic antiarrhythmic therapy, including an implantable cardioverter defibrillator.

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This is especially true if there is evidence of left ventricular dysfunction.

Polymorphic ventricular tachycardia, conversely, could be due to myocardial ischemia or the effects of surgery itself, including concomitant catecholamine elevation or hemodynamic instability. As such, it could be a transient problem. Torsade de pointes, a polymorphic ventricular tachycardia associated with a long QT interval, is an irregular type of ventricular tachycardia occurring in paroxysms, most likely due to electrolyte problems such as hypokalemia and hypomagnesemia. This is the most common proarrhythmia due to procainamide infusion.⁶

Ventricular fibrillation can be the primary process or the culmination of any of the types of ventricular tachycardia mentioned. If the episodes of ventricular tachycardia or fibrillation are sustained or nonsustained and associated with hemodynamic problems, urgent treatment is required to save the patient's life.

PVCs are frequently more common in the perioperative period but are of little therapeutic consequence. Nonsustained ventricular tachycardia, when asymptomatic, warrants little concern in terms of need for acute treatment; it may, however, have a prognostic meaning that is as-yet undefined:

Approach to Ventricular Tachycardia/Ventricular Fibrillation

Ventricular tachycardia and fibrillation are uncommon and can be very difficult to control. The initial steps after surgery are the same as those indicated in the advanced cardiac life support (ACLS) protocol used in other clinical situations. (See final section of this paper for a fuller discussion of these guidelines.) This protocol, however, does not include specific data for the unique issues surrounding the perioperative period. Most of the data available have been accumulated from practical experience; there are few carefully controlled, randomized trials. The trials that are available are discussed later in this article. Therefore, standard approaches in this time interval have not been defined.

The initial approach to the patient with ventricular tachycardia or hemodynamically unstable ventricular fibrillation is to first perform a direct current (DC) shock and then attempt to stabilize the rhythm and hemodynamics. Occasionally, the shock is ineffective, and repositioning the paddles with maximum energy is required. In emergency situations, often every option is made available to the patient—the “kitchen sink” approach—and these therapies sometimes harm rather than help the patient. One suggestion is to minimize the often excessive use of inotropic support

because it can trigger ventricular arrhythmias.⁷ These medications may often do more harm than good by creating a proarrhythmia milieu. In an attempt to stabilize the patient, a vicious cycle can ensue: hemodynamics worsen; excessive inotropic support, such as dopamine and dobutamine, is given; arrhythmias and hemodynamics then worsen.

Several other approaches exist for patients who have refractory ventricular tachycardia and ventricular fibrillation. Intra-aortic balloon pumps, for example, can help stabilize a patient without exacerbating the risk for proarrhythmia and can also stabilize hemodynamics while simultaneously providing increased myocardial blood flow and unloading the heart. Minimizing inotropic support may prevent arrhythmias without altering patient outcome. Little solid data support the use of the “background” inotropes (eg, norepinephrine, dopamine, and dobutamine that are often prescribed in the postoperative period.

Antiarrhythmic Drugs

Antiarrhythmic drugs are often a necessary adjunct to help stabilize a patient who has ventricular tachycardia or fibrillation that is refractory or that is resistant to DC shock. Antiarrhythmic drugs are a two-edged sword: improper use can hurt more than help, but proper utilization can aid in stabilizing the patient after reversible causes have been discovered and treated.

Lidocaine has been available for more than 30 years and is sometimes quite useful. It rarely impairs hemodynamics, and it is fast acting and easy to use. However, lidocaine is frequently ineffective and can lead to neurologic toxicity and seizures.⁸⁻¹⁴ It continues to infuse for 24 to 48 hours, especially in the perioperative period, when acute-phase reactants (such as a potent binder to lidocaine, α -1 acid glycoprotein) are high; thus, high levels of bound and total lidocaine can occur, which, over several days of infusion, may cause toxicity. Careful monitoring of lidocaine levels are therefore necessary over the course of infusion to prevent toxicity.⁸⁻¹⁴

Randomized clinical trials of lidocaine in the postoperative period are lacking. Some large interesting studies¹⁰⁻¹³ have compared lidocaine with placebo in the postmyocardial infarction period, and it appears that lidocaine may—surprisingly—increase mortality. The mechanism of this effect is unknown.

Procainamide, a class IA drug, another antiarrhythmic drug, has an active metabolite (N-acetylprocainamide) that has Class III antiarrhythmic properties. Although procainamide is considered useful, caution is indicated because elevation in both pro-

cainamide and especially N-acetylprocainamide levels can lead to torsade de pointes.^{15,16} This is especially true when renal insufficiency is present, which can cause N-acetylprocainamide levels to become elevated excessively.¹⁷⁻¹⁹ Although procainamide works fairly well for monomorphic ventricular tachycardia, there are virtually no randomized data demonstrating that procainamide is better than placebo or any other drug to prevent death or arrhythmia recurrence in the perioperative period. Benefits have been shown in clinical situations in individual patients, but no data indicate where and when procainamide is most helpful. Disadvantages include the potential negative inotropic effect, the risk of hypotension, and the possible issue of proarrhythmia that can occur.¹⁴⁻¹⁹ It is unclear where procainamide use belongs in the antiarrhythmic drug regimen in patients with refractory ventricular tachycardia.

Bretylium can effectively suppress both polymorphic and monomorphic ventricular tachycardia, although its effectiveness has not been well tested. Because of its reversible cause, polymorphic ventricular tachycardia may not require drug therapy, and bretylium may exacerbate the problem by exacerbating torsade de pointes.²⁰⁻²⁵ Bretylium can lengthen the QT interval, and it frequently causes hemodynamic instability.²² Bretylium apparently has limited relative efficacy in treating acute arrhythmias in the postoperative period. It appears that bretylium use is declining as newer therapies become available.

Amiodarone is one of the newer therapies proven useful for treatment of perioperative ventricular tachycardia and ventricular fibrillation.²⁶⁻⁴⁷ This drug is now being used with increased frequency in the postoperative period both for atrial and ventricular arrhythmias. Both intravenous (IV) and oral formulations of the drug are available. However, there are important physiologic differences of these two formulations on the QRS complex, QT interval, atrioventricular (AV) conduction, and His-Purkinje system conduction and all refractory periods. In fact, based on available data³⁹ the main measurable physiological effect of IV amiodarone appears to be a slowing of AV nodal conduction. Yet, despite this fact, amiodarone appears highly effective in treating ventricular tachycardia and ventricular fibrillation.

It is unclear why differences exist between the IV and the oral form of amiodarone.^{37,38,40-44} Oral amiodarone, however, is absorbed and distributed over a long period of time. It has an active metabolite, desethyl amiodarone, which appears to have Class III antiarrhythmic drug properties. It is unclear how the parent compound and its active metabolite interact to provide antiarrhythmic drug efficacy.

The IV form of amiodarone is associated with potential concerns. The drug is oil soluble and must be mixed with an ioniphore, Tween 80. This ioniphore by itself has negative inotropic and vasodilatory effects that can contribute to both low cardiac output and hypotension. This effect can be obviated by slowing the infusion of the drug and by giving concomitant IV fluid. Fortunately, it appears that the adverse hemodynamic effect with amiodarone is actually less than with other antiarrhythmic drugs.^{29,30,32,33,45-47}

Data on Antiarrhythmic Drugs

Initial Studies. What data show that these antiarrhythmic drugs work at all? There are no controlled data on lidocaine's effectiveness in the perioperative period, nor are there data on procainamide. Scant data exist on bretylium. In contrast, controlled data exists for amiodarone.^{29,30}

Background information concerning the use of IV amiodarone dates back to at least 1984. Mostow et al³¹ tested amiodarone on patients who had refractory ventricular tachycardia or ventricular fibrillation. Most patients had failed treatment with two or three antiarrhythmic drugs. They were then given IV amiodarone; the rate of episodes decreased ($P < 0.01$) from approximately 20 per day to 5 per day. This study was limited, however, by the small number of participants and the lack of a placebo control.

Initial controlled trials targeted PVC suppression.³¹ While such use of IV amiodarone is not warranted in the perioperative period, it did show the antiarrhythmic effect of the drug. Compared with placebo, amiodarone worked better in suppressed ventricular arrhythmias in the post-bypass period.

Hohnloser demonstrated that repetitive ventricular arrhythmias diminished markedly with IV amiodarone hours after coronary bypass graft surgery compared with placebo.²⁸ This finding was consistent despite time from surgery. Although these data are compelling, treatment of repetitive ventricular arrhythmias, such as nonsustained ventricular tachycardia, is not required in most perioperative patients.

Several, additional, small uncontrolled trials^{35-41,48-50} using different protocols for various arrhythmias showed positive responses to IV amiodarone. IV amiodarone appeared to be beneficial, with the response rate in the trials varying between 54% and 80%.

Larger Trials. Large placebo-controlled, multicenter trials offer additional data. In one report, patients were randomized to three different dosing regimens of IV amiodarone over a 24-hour period. Another important multicenter, randomized trial compared bretylium with two doses of IV amiodarone. The patients included

in these trials had ventricular tachycardia and ventricular fibrillation refractory to other antiarrhythmic drugs (including lidocaine and procainamide). Almost all patients were given lidocaine before being administered the test drug. The synergistic or antagonistic effects of these drugs, therefore, were not assessed. At some centers, including my own, individuals included in the trial were generally perioperative patients. The surgeons requested urgent use of the antiarrhythmic drugs before going through the required lidocaine and procainamide infusions since the test drug appeared to work better in their clinical experience than lidocaine and procainamide. Further clinical experience has shown IV amiodarone to be effective for ventricular tachycardia and ventricular fibrillation.^{26-41,48-50}

In one trial by Kowey et al,³⁰ bretylium was compared with IV amiodarone; the study included 82 centers and 302 patients. Bretylium at 2500 mg for 24 hours was compared with low doses (125 mg for 24 hours) and high doses (1000 mg for 24 hours) of IV amiodarone. In this trial, bretylium appeared to be as effective as the high dose of amiodarone. However, it is noteworthy that 50% of the patients in the bretylium arm were "crossed over" due to lack of efficacy or severe hemodynamic consequences. In this way, IV amiodarone was actually much more effective compared with bretylium. The percentage of patients responding to the high dose of amiodarone and bretylium in the first 12 hours was 60%. The load

given in the high-dose amiodarone arm was 150 mg over 10 minutes, followed by a 1 mg/m infusion over 6 hours, followed by a maintenance infusion of 0.52 mg for the remainder of the 42 hours. Bretylium was given as 350 mg over 10 minutes, followed by 1.5 mg/m over 6 hours, and then 1.5 mg for the remaining 24 hours (Figure).

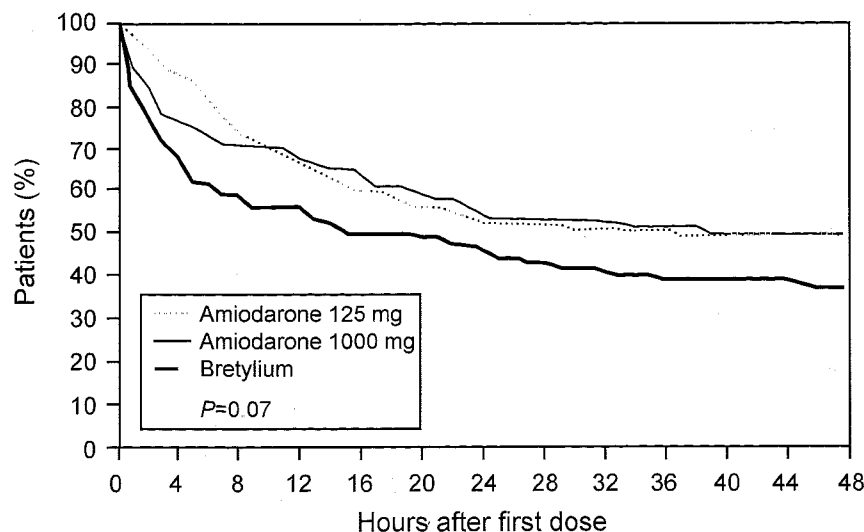
Another multicenter, dose-ranging study was conducted by Scheinman et al²⁹; it involved 342 patients and 42 centers. Patients with refractory arrhythmia were randomized to one of three doses of amiodarone: 125 mg per 24 hours, 500 mg per 24 hours, or 1000 mg per 24 hours. This report demonstrated that the mean number of ventricular tachycardia/ventricular fibrillation events was as follows: 0.48 in the 1000-mg group, 0.96 in the 500-mg group, and 1.68 in the 125-mg group ($P = 0.067$). It appeared that the higher dose of amiodarone was the most appropriate for these patients with refractory malignant ventricular arrhythmias.

It is important to remember that the above-mentioned patients are not necessarily the patients for whom we would use amiodarone today. These were patients who were basically out of options because to be included in these trials they needed to be refractory to all other therapies. These were patients that often were given the drug in the "heat of the moment" when cardiopulmonary resuscitation was being performed, multiple shocks were being given, and the patient was in the midst of a cardiac arrest. These

patients, surprisingly, often reverted to normal rhythm spontaneously after the infusion was given. IV amiodarone facilitated the electrical conversion of ventricular fibrillation when electric shock alone was not effective enough. The results were so impressive that some patients who had had no hope of survival actually survived and were discharged without any major sequela. Results such as these made the use of amiodarone quite compelling.

Bretylium was shown effective in a comparative clinical trial with amiodarone.³⁰ Compared with amiodarone, however, efficacy was limited, since 50% of patients receiving bretyli-

Figure. Amiodarone-Betylium Comparison—Patients Remaining on Therapy



Adapted from reference 30. *Circulation* 1995;92:3255-3263.

um had hemodynamic or proarrhythmic problems leading to drug discontinuation or crossover to amiodarone. IV amiodarone was clearly the better drug to prevent recurrent ventricular arrhythmias. In addition, supplemental IV amiodarone infusions were not needed for high dose amiodarone loading as compared with low dose loading.³⁰

To date, more than 2000 patients have been evaluated using IV amiodarone. Although these results have demonstrated the clear benefit of amiodarone, there are some factors to consider: the patients in these studies were very sick, with a mean age of 63 years, and had a primary diagnosis of unstable ventricular tachycardia or fibrillation. A total of 80% had coronary artery disease, and 32% had cardiac surgery within 3 days of the use of the drug, 19% had mechanical ventilator support, 17% were functional Class IV, 19% were functional Class III, and 23% had balloon pump support. It is likely the beneficial effects of IV amiodarone may differ in a healthier population.

From present data, IV amiodarone has a low discontinuation rate (5% due to side effects). The type of side effects that occur from IV amiodarone (notably pulmonary toxicity) are surprisingly low compared with the oral formulation of the drug. Hypotension has occurred in 16% of patients and is treated by decreasing the infusion rate and giving IV fluid. Bradycardia occurs in 4.9% of patients (0.5% of which is due to AV block), does not appear to be dose related, and is generally not a clinically important issue. Abnormal liver function tests are a potential difficulty in 3.4% of patients. Cardiac arrest and ventricular tachycardia are potentially serious issues because distinguishing between a proarrhythmic effect and a lack of an antiarrhythmic effect requiring further infusions can sometimes be difficult. Marked prolongation in QT interval associated with polymorphic ventricular tachycardia is reason for prompt discontinuation of the drug. Since the half life of IV amiodarone is much shorter than that of the oral form, the above side effects can usually be managed by prompt discontinuation of the drug.^{33-37, 39}

Drug interactions can also occur. Warfarin anticoagulation is exacerbated; international normalized ratio (INR) values increase with amiodarone and stay higher longer. β -blockers and calcium channel blockers also block the AV node and slow the sinus node. This, in conjunction with IV amiodarone, can slow the rate tremendously. Antiarrhythmic drug effects, both antiarrhythmic and proarrhythmic, can be exacerbated when used concomitantly with amiodarone. Digoxin levels increase as well, and the risk for bradycardia

due to digoxin and digoxin toxicity are real concerns for these patients.

Results of the Amiodarone in the Out-of-hospital Resuscitation of Refractory Sustained Ventricular Tachyarrhythmia (ARREST) trial³¹ support the use of IV amiodarone in a slightly different group. Patients with out of hospital, nontraumatic, cardiac arrest with ongoing pulseless ventricular tachycardia or ventricular fibrillation after three defibrillations were eligible for randomization to either 300 mg IV bolus of amiodarone or placebo. The primary end point was admission alive to the hospital, while the duration of follow-up was to hospital discharge. More patients given amiodarone were admitted alive to the hospital than those in the placebo group (44% vs 35 %, $P = 0.03$); although the study was not sufficiently powered to evaluate survival to hospital discharge, this was slightly better (albeit inconclusive) in patients treated with amiodarone. Nevertheless, IV amiodarone appears to be effective for ventricular fibrillation that is refractory to DC shocks and standard ACLS protocol. Adverse effects were as expected and were manageable.

Amiodarone Dosing

Dosing is as follows: the first dose is an infusion that is rapid, 150 mg, over the first 10 minutes. A peripheral IV line can be used, but if continued infusion is given, it is better to use a central line; if further boluses are necessary, it is best to use a central line to prevent phlebitis. After the first 10 minutes, 360 mg is given over the next 6 hours (ie, 1 mg/m), and a maintenance dose of 440 mg over the next 8 hours (0.5 mg/m). Additional boluses can be given, and the main risk is hypotension. In my experience, up to nine boluses of 150 mg have been used in 1 day without any serious hemodynamic or arrhythmic problems. Of note is that IV amiodarone penetrates the tissues quickly, the level is detected shortly after infusion, and the active metabolite appears to be absent. Because the distribution into the fat, liver, and brain, as well as the myocardium, is quick, and with the large volume of distribution (approximately 70 L/kg), there is a short serum half-life of between 12 and 48 hours. This is distinctly different from the long-term load of oral amiodarone.

Transitioning amiodarone to oral therapy is another issue that must be considered and the following recommendations are offered. If the IV infusion of amiodarone is less than 1 week, the initial daily dose of oral amiodarone should be between 800 and 1600 mg, with gradual tapering over the next 4 weeks. If the infusion has been given for 1 to 3 weeks, the initial daily dose of oral amiodarone should be between

600 and 800 mg, with gradual tapering. If the dose of IV amiodarone has been longer than 3 weeks, the recommended dose is 400 mg/d.

Proarrhythmia

Proarrhythmia due to procainamide can be fairly easy to identify, as it is associated with torsade de points and lengthening of the QT interval. N-acetylprocainamide levels greater than greater than 20 mg/dL are often associated with proarrhythmia. Proarrhythmia can also occur with bretylium and amiodarone. Determining proarrhythmia related to amiodarone is slightly more difficult since classic torsade de pointes is not always seen. Amiodarone can also cause recurrence of monomorphic ventricular tachycardia, and determining the frequency and severity of monomorphic and polymorphic ventricular tachycardia after infusion is an important clinical issue. If the problem becomes more frequent, assessment for other potential causes for rhythm exacerbation is warranted. However, the possibility that IV amiodarone might be exacerbating the problem should always be considered. This assessment can be complex, often requiring an electrophysiologist to provide insight into the potential mechanisms regarding drug/arrhythmia interactions. Because the half life of IV amiodarone is less than the oral formulation, proarrhythmic problems related to the drug can be stopped much more quickly.

ACLS Guidelines and a New Treatment Algorithm

Currently, IV amiodarone has been recommended for use with arrhythmias in the postmyocardial infarction period. It has not been approved specifically for patients who are in the perioperative period, although it appears to be safe and effective for this indication. Why the American Heart Association in their ACLS guidelines has not identified IV amiodarone as a vital therapy is unknown. This is even more curious since data on other antiarrhythmic drugs is lacking. Reconsideration of the algorithmic approach must be undertaken to ensure proper patient treatment. It is likely that there will be changes in the ACLS guidelines over time.

An appropriate treatment algorithm for life-threatening ventricular tachycardia or fibrillation in the perioperative period could be summarized as follows.

It is important to first determine the patient's stability. If the patient is stable and has sustained monomorphic ventricular tachycardia, ACLS guidelines, as stated, are appropriate and include use of lidocaine as a first-line drug. Antitachycardia pacing might also be helpful if the patient has epicardial wires.

Procainamide is also commonly used for these patients; in our institution, we are shifting away from procainamide as mentioned and moving to IV amiodarone.

For patients who have a life-threatening ventricular tachycardia and/or fibrillation with a normal QT interval (if measurable when the patient is in a rhythm other than ventricular tachycardia or fibrillation), cardioversion or defibrillation should be given to return the patient to sinus rhythm. If there is recurrence of the arrhythmia, a lidocaine bolus plus an infusion of lidocaine is recommended. Following this, many physicians are proceeding to IV amiodarone.

We also employ ACLS guidelines, including epinephrine as indicated. Intra-aortic balloon pumping may also be helpful. Pacing when the rhythm returns to normal and pacing at a more rapid rate to prevent ectopy from triggering ventricular tachycardia and ventricular fibrillation may be helpful. The use of IV magnesium has not been well tested in the perioperative period but appears to be useful and safe. Therefore we give generally 2g to 4g of IV magnesium soon after ventricular tachycardia or ventricular fibrillation has been confirmed.

There are little data to support the use of either bretylium or procainamide. Of note, if defibrillation is ineffective, it might be worth moving directly to IV amiodarone since it might actually lower the defibrillation threshold. IV lidocaine and other antiarrhythmic drugs do not appear to have this potential benefit.

There are several questions and caveats that must also be considered in patients who have life-threatening ventricular arrhythmias in the postoperative situation. First, it is important to avoid iatrogenic issues such as the overuse of inotropic support and the effects of diuretics on changes in potassium and magnesium levels. It is important, therefore, to discontinue use of unnecessary drugs, maintain electrolyte levels, eliminate the possibility of ischemia, and control hemodynamics as best as possible without the use of drugs that have proarrhythmic potential. Most important, however, is to treat the *patient*, not the rhythm. If a patient is doing well and a rhythm problem exists, remember that the rhythm problem is only a reflection of the patient's clinical status and should not be treated aggressively just to satisfy the physician. In other words, treatment of PVCs or nonsustained ventricular tachycardia that are asymptomatic should not be given as it might exacerbate an arrhythmic problem.

Several clinical questions arise concerning difficult treatment issues. How long do you need to give amiodarone if a patient has ventricular tachycardia and ventricular fibrillation? What is the next step after

amiodarone is given and the patient is stabilized? Should the patient be given oral amiodarone or should a patient have an implantable defibrillator? Is cardiac catheterization or revascularization necessary? How long can infusions be continued? How often can boluses be given? When is the drug proarrhythmic? How is it best to switch to oral amiodarone therapy? How the switch in therapy is made all depends on the arrhythmia, the time after surgery, the type of surgery, and the impairment of left ventricular function. If this occurs late after cardiac surgery—that is, after 3 to 4 days—and the patient has impaired left ventricular function, he or she is probably at long-term risk for further recurrent arrhythmias despite the use of amiodarone or other therapies and might, in fact, need an implantable defibrillator. Little data are available on this issue but are emerging in several centers. Should further boluses of amiodarone be used? As mentioned, it is best to give as much amiodarone as necessary to control the arrhythmia. In some cases, it needs to be given at very high doses.

Conclusion

It appears in the perioperative period that antiarrhythmic drugs are necessary to manage patients with life-threatening ventricular tachycardia and ventricular fibrillation when these arrhythmias are refractory or recurrent. Some antiarrhythmic drugs can have limited efficacy and have serious side effects. Despite these facts, they are included in ACLS guidelines, whereas amiodarone is not. It appears, however, from the data available that IV amiodarone is the most highly effective therapy for ventricular tachycardia and ventricular fibrillation, and its use can be lifesaving.

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CME QUESTIONS: TEST #049811

Long Island Jewish Medical Center and Johns Hopkins University School of Medicine are accredited by the Accreditation Council for Continuing Medical Education (ACCME) to sponsor continuing medical education for physicians. Long Island Jewish Medical Center, the Long Island Campus for the Albert Einstein College of Medicine, designates this continuing medical education activity for 1.0 credit hour in Category 1 of the Physician's Recognition Award of the American Medical Association. This CME activity was planned and produced in accordance with the ACCME Essentials and Standards for Commercial Support.

Instructions

After reading the article, "Ventricular Arrhythmias and the Use of Antiarrhythmic Drugs After Cardiovascular Surgery," select the best answer to each of the following questions. In order to receive 1 CME credit, at least 7 of the 10 answers must be correct. Estimated time for this activity is 1 hour. CME credits are distributed on a yearly basis.

1. The most common proarrhythmic effect of procainamide is:
 a) AV block
 b) monomorphic ventricular tachycardia
 c) polymorphic ventricular tachycardia
 d) sinus bradycardia

2. The antiarrhythmic drug for which there are the most data substantiating benefit is:
 a) bretylium
 b) amiodarone
 c) procainamide
 d) lidocaine

3. One common cause for recurrent cardiac arrest after surgery is:
 a) myocardial ischemia
 b) heart failure
 c) inotropic support
 d) antiarrhythmic drugs

4. Advanced cardiac life support guidelines mandate use of which drug for ventricular fibrillation resistant to direct current shock?
 a) lidocaine
 b) bretylium
 c) amiodarone
 d) epinephrine

5. Which antiarrhythmic drug is not associated with hypotension and negative inotropic effect?
 a) amiodarone
 b) bretylium
 c) lidocaine
 d) procainamide

6. The initial loading dose of intravenous amiodarone is:
 a) 250 mg over 25 minutes
 b) 100 mg over 15 minutes
 c) 150 mg over 10 minutes
 d) 400 mg over 20 minutes

7. Intravenous and oral amiodarone have the same electrophysiologic effects.
 a) true
 b) false

8. Lidocaine has been proven to:
 a) prevent ventricular tachycardia in heart failure patients
 b) prevent recurrent cardiac arrest in postoperative patients
 c) worsen survival in postmyocardial infarction patients
 d) be highly proarrhythmic

(CME QUESTIONS CONTINUED ON FOLLOWING PAGE)

<p>CME TEST FORM AJMC Test #049811</p>		<p>(PLEASE PRINT CLEARLY) Name _____ Address _____ City _____ State/Zip _____ Phone # _____</p>
<p>Ventricular Arrhythmias and the Use of Antiarrhythmic Drugs After Cardiovascular Surgery</p>	<p>Please circle your answers:</p>	
	1. a b c d	
	2. a b c d	
	3. a b c d	
	4. a b c d	
	5. a b c d	
	6. a b c d	
	7. a b	
	8. a b c d	
	9. a b c d	
	10. a b	
<p>(Test valid through November 15, 1999. No credit will be given after this date.)</p>		<p>Please enclose a check for \$10, payable to American Medical Publishing, and mail with this form to: The AJMC CME Test American Medical Publishing 1816 Englishtown Road, Suite 101 Old Bridge, NJ 08857</p>

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Long Island Jewish Medical Center and Johns Hopkins University School of Medicine would like to have your opinion. Please fill out the questionnaire below, tear off along the dotted line, and mail along with your CME test form. We thank you for your evaluation, which is most helpful.

On the whole, how do you rate the information presented in the article?

_____ excellent _____ good _____ fair _____ poor

Is the information presented useful in your practice?

_____ yes _____ no

Comments:

Do you have recommendations to improve this program?

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Were any portions of this program unsatisfactory or inappropriate?

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Do you find the information presented in these articles to be fair, objective, and balanced?

_____ yes _____ no

Is there subject matter you would like included in the future?

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Comments:

In your opinion, were the authors biased in their discussion of any commercial product or service?

_____ yes _____ no

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(continued from previous page)

9. **Monomorphic ventricular tachycardia**
a) is common in the perioperative period
b) requires only transient therapy to stabilize the patient
c) responds rapidly to lidocaine
d) indicates a myocardial substrate problem

10. **The risk of frequent ventricular arrhythmias is higher in the postoperative period.**
a) true
b) false