Quinidine has been used successfully to suppress frequent episodes of VT.

Early repolarization syndrome Patients resuscitated from VF who have no structural heart disease or other identified abnormality have a higher prevalence of J-point elevation with notching in the terminal QRS. A family history of sudden death is present in some patients, suggesting a potential genetic basis. J-point elevation is also seen in some patients with the Brugada syndrome and associated with a higher risk of arrhythmias. An ICD is recommended for those who have had prior cardiac arrest. It should be noted that J-point elevation is commonly seen as a normal variant, and in the absence of specific symptoms, the clinical relevance is not known.

Catecholaminergic polymorphic VT This rare familial syndrome is due to mutations in the cardiac ryanodine receptor and, less commonly, the sarcoplasmic calcium binding protein, calsequestin 2. These mutations result in abnormal sarcoplasmic calcium handling and polymorphic ventricular arrhythmias that resemble those seen with digitalis toxicity. The VT is polymorphic or has a characteristic alternating QRS morphology termed bidirectional VT. Patients usually present during childhood with exercise- or emotion-induced palpitations, syncope, or cardiac arrest. β-Adrenergic blockers (e.g., nadolol and propranolol) and an ICD are recommended. Verapamil, flecainide, or surgical left cardiac sympathetic denervation reduces or prevents recurrent VT in some patients.

Hypertrophic cardiomyopathy (HCM) HCM is the most common genetic cardiovascular disorder, occurring in 1 in 500 individuals, and is a prominent cause of sudden death before the age of 35 years (Chap. 287). Sudden death can be due to polymorphic VT/VF. Rarely, sustained monomorphic VT occurs related to areas of ventricular scar. Risk factors include young age, nonsustained VT, failure of blood pressure to increase during exercise, recent (within 6 months) syncope, ventricular wall thickness >3 cm, and possibly the severity of LV outflow obstruction. An ICD is generally indicated for high-risk patients, but the specific risk profile warranting an ICD continues to be debated. Surgical myectomy, performed to relieve outflow obstruction, has been associated with a sudden death rate of less than 1% per year. The reported annual rate of sustained VT or sudden death after transcoronary ethanol septal ablation done to relieve outflow obstruction has been reported to range between 1 and 5%.

Genetic dilated cardiomyopathies Genetic dilated cardiomyopathies account for 30–40% of cases of nonischemic dilated cardiomyopathies. Some are associated with muscular dystrophy. Autosomal dominant, recessive, X-linked, and mitochondrial inheritance patterns are recognized. Mutations in genes coding for structural proteins of the nuclear lamina (lamin A and C) and the *SCN5A* gene are particularly associated with conduction system disease and ventricular arrhythmias. Patients can experience polymorphic VT and cardiac arrest or develop areas of scar causing sustained monomorphic VT. ICDs are recommended for those who have had a sustained VT or are at high risk due to significantly depressed ventricular function (LV ejection fraction of ≤0.35 and associated with heart failure) or a malignant family history of sudden death.

Ventricular Fibrillation VF is characterized by disordered electrical ventricular activation without identifiable QRS complexes (Fig. 277-3*E*). Spiral wave reentry and multiple circulating reentry wavefronts are possible mechanisms. Sustained polymorphic or monomorphic VT that degenerates to VF is a common cause of out-of-hospital cardiac arrest. Treatment follows ACLS guidelines with defibrillation to restore sinus rhythm. If resuscitation is successful, further evaluation is performed to identify and treat underlying heart disease and potential causes of the arrhythmia, including the possibility that monomorphic or polymorphic VT could have initiated VF. If a transient reversible cause such as acute MI is not identified, therapy to reduce the risk of sudden death with an ICD is often warranted. Chronic amiodarone therapy may be considered for individuals who are not ICD candidates.

Incessant VT and Electrical Storm VT is incessant when it continues to recur shortly after electrical, pharmacologic, or spontaneous conversion to sinus rhythm. "VT storm" or "electrical storm" refers to three or more separate episodes of VT within 24 h, most commonly encountered in patients with ICDs. Slow incessant VT is sometimes asymptomatic, but can cause heart failure or tachycardia-induced cardiomyopathy. More commonly, these presentations are life-threatening and require emergent therapy. Measures to reduce sympathetic tone, including β-adrenergic blockade, sedation, and general anesthesia, have been used effectively. Intravenous administration of amiodarone and lidocaine can be effective for suppression. Urgent catheter ablation can be lifesaving.

TREATMENT VENTRICULAR ARRHYTHMIAS

ANTIARRHYTHMIC DRUGS

Use of antiarrhythmic drugs is based on consideration of the risks and potential benefit for the individual patient. The potential to increase the frequency of VT or cause a new VT, an undesirable effect known as "proarrhythmia," is a potential risk. Many drugs have multiple effects, often blocking more than one channel. **Drug doses, metabolism, and adverse effects are summarized in Chap. 277.**

β-Adrenergic Blockers Many ventricular arrhythmias are sensitive to sympathetic stimulation, and β-adrenergic stimulation also diminishes the electrophysiologic effects of many antiarrhythmic drugs. The safety of β-blocking agents makes them the first choice of therapy for most ventricular arrhythmias. They are particularly useful for exercise-induced arrhythmias and idiopathic arrhythmias, but have limited efficacy for most arrhythmias associated with heart disease. Bradyarrhythmias are the major cardiac toxicity.

Calcium Channel Blockers The nondihydropyridine calcium channel blockers diltiazem and verapamil can be effective for some idiopathic VTs. The risk of proarrhythmia is low, but they have negative inotropic and vasodilatory effects that can aggravate hypotension.

Sodium Channel-Blocking Agents Drugs whose major effect is mediated through sodium channel blockade include mexiletine, quinidine, disopyramide, flecainide, and propafenone, which are available for chronic oral therapy (Table 277-3). Lidocaine, quinidine, and procainamide are available as intravenous formulations. Quinidine, disopyramide, and procainamide also have potassium channel-blocking effects that prolong the QT interval. These agents have potential proarrhythmic effects and, with the possible exception of quinidine, also have negative inotropic effects that may contribute to increased mortality observed in patients with prior MI. Long-term therapy is generally avoided in patients with structural heart disease but may be used to reduce symptomatic arrhythmias in patients with ICDs.

Potassium Channel-Blocking Agents Sotalol and dofetilide block the delayed rectifier potassium channel I_{Kr}, thereby prolonging the QT interval. Sotalol also has nonselective β-adrenergic blocking activity. It has a modest effect on reducing ICD shocks due to ventricular and atrial arrhythmias. Proarrhythmia with Torsade de Pointes due to QT prolongation occurs in 3–5% of patients. Both sotalol and dofetilide are excreted via the kidneys, necessitating dose adjustment or avoidance in renal insufficiency. These drugs must be avoided in patients with other risk factors for Torsade de Pointes, including QT prolongation, hypokalemia, and significant bradycardia.

Amiodarone and Dronedarone Amiodarone, which blocks multiple cardiac ionic currents and has sympatholytic activity, suppresses a variety of ventricular arrhythmias. It is administered intravenously for life-threatening arrhythmias. During chronic oral therapy, electrophysiologic effects develop over several days. It is more effective than sotalol in reducing ICD shocks and is the preferred drug for ventricular arrhythmias in patients with heart