

PACEMAKERS AND ANTITACHYCARDIA DEVICES

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INTRODUCTION

The heart's natural pacemaker is an electrical timing device that controls the rate of the heart's muscular contractions, enabling the heart to pump blood under the wide range of demands encountered in daily life, from sprinting for a taxi to sleeping late on a Sunday morning. Everyone's heart speeds up or slows down under different conditions and may on occasion appear to flutter or skip a beat. These palpitations are almost always minor and transitory. However, sometimes the heart's electrical system malfunctions and serious rhythm disorders result. These cardiac arrhythmias can be debilitating and even life-threatening, but the ready availability of artificial pacemakers and the recent advent of implantable defibrillator have revolutionized their treatment. Today, physicians can help patients with electronic devices that directly counteract these serious rhythm disturbances. (See Chapter 16.)

Implantable electronic devices have been developed to treat both abnormally slow heart rates (bradycardias) and excessively rapid heart rates (tachycardias). Such rhythm disorders arise because of disruptions in the normal production or transmis-

sion of electrical impulses within the heart. The heart's natural pacemaker is the sinus node (SN), located in the upper right atrium near the point where blood returning from the head and limbs reenters the heart. Specialized cells in this node emit electrical impulses at the rate of about 70 per minute. These impulses spread throughout the atria and travel to the ventricles via the atrioventricular node (AV node). This electrical system ensures that the impulses reach the right part of the heart at the right time and at the right pace, coordinating the contraction of the heart muscle so that it can pump effectively.

When the sinus node fails to generate impulses, or transmission is blocked in some part of the electrical system, an abnormally slow heart rate can result. Assuming that this bradycardia is not the side effect of a medication or produced by some other reversible condition, the most likely cause is disease in the sinus node, the AV node, or some other part of the conduction pathway. If the patient is experiencing symptoms and the heart rate is extremely slow (below 45 or 50), the condition maybe markedly improved by an artificial pacemaker. There are, however, many people who function normally with slow heart rates of 40–50 and evidence of some degree of heart block. Pacemakers should be reserved for those with symptoms and advanced degrees of block,

PACEMAKERS

Since their introduction in the 1960s, pacemakers have steadily shrunk in size and grown in sophistication, yet the basic principles of their operation remain the same. The job of the pacemaker is to maintain a minimum safe heart rate by delivering to the pumping chambers appropriately timed electrical impulses that replace the heart's normal rhythmic pulses. The device designed to perform this life-sustaining role typically consists of a power source about the size of a silver dollar (containing the battery), control circuits, and wires, or "leads," that connect the power source to the chambers of the heart. The leads are placed in contact with the right atrium or the right ventricle, or both. They allow the pacemaker to sense and stimulate in various combinations, depending on where the pacing is required. (See box, "The Pacemaker Alphabet.")

The Pacemaker Alphabet

Pacemakers are often referred to by a three-letter code that denotes how and where they operate.

- The first letter tells which heart chamber can be paced (controlled by the pacemaker). The letter may be A for atrium, V for ventricle, or D for dual (both).
- The second letter denotes the chamber in which the pacemaker is able to sense a natural impulse. This letter may also be A, V, or D.
- The third letter tells whether the pacemaker's response to sensing an impulse is to inhibit or trigger an impulse, or both. The letter may be I for inhibit, T for trigger, or D for dual.

The majority of pacemakers are either one of two types, VI or DDD. In the VI, known as a demand pacemaker, the first V means that it is the ventricle that is paced, the second V means that it is in the ventricle that the natural impulse is sensed, and the I means that the pacemaker inhibits its own impulse whenever it senses a natural impulse. In the DDD (known as a universal pacemaker), the first D means that it is either the atrium or the ventricle that is paced, or both, the second D means that it is in either the atrium, the ventricle, or both that the natural impulse is sensed, and the third D means that the pacemaker either inhibits or triggers an impulse, depending on what it has sensed.

A physician will prescribe a pacemaker with a pacing mode and rate that is best suited to the patient's needs, taking into account the patient's age and activity level, as well as the nature and degree of malfunction.

DEMAND PACEMAKERS

A ventricular demand pacemaker, which aids a patient who has a slow ventricular rate caused by blockage of the electrical impulses to the ventricles, employs the most basic pacing mode; the device consists of a pacemaker with a single lead to the right ventricle. "Demand signifies that the device will provide impulses only when they are needed.

The pacemaker is individually programmed to maintain the patient's natural, intrinsic ventricular rate, which usually falls between 50 and 70 beats per minute. If the patient is completely dependent upon the pacemaker, the rate might be set as high as 80 to 90 beats per minute to meet the demands of daily exertion. If the pacemaker senses that the ventricles are being stimulated at their normal pace, then it does not deliver an impulse. Otherwise the pacemaker stimulates the ventricle at a fixed pace until a normal impulse inhibits the device.

DUAL-CHAMBER PACEMAKERS

For patients whose heart disease or life-style requires a more adaptable device, pacemakers have been developed that respond with different heart rates to varying demands on the heart. Called dual-chamber pacemakers, they stimulate the ventricles at the rate sensed in the atria and can enable even a patient with complete heart block (that is, a condition in which no impulses are getting through from the upper to the lower heart chamber) to enjoy fairly vigorous exercise. The most flexible dual-chamber device is the fully automatic or universal pacemaker, which senses and paces in both the right atrium and the right ventricle. In addition to compensating for failure of normal sinus rhythm and heart block, the universal pacemaker synchronizes the atrial and ventricular rates. This feature ensures that the atria always beat just before the ventricles, maintaining the atria's role as priming pumps that increase the volume of blood in the ventricles. Supplemental pumping can be especially important for patients whose own pumping

function has fallen dangerously low because of heart disease, such as severe congestive heart failure.

Once implanted, most pacemakers can be reprogrammed from outside the body, using a wand that transmits signals to the pacemaker when held over it. Programmability enables a doctor to adjust the pacemaker's overall operation to changes in the patient's needs. Some pacemakers can also transmit information about heart rate and electrical activity that may be useful in diagnosis. Researchers are also working on alternative sensing devices to make pacemakers more responsive to changing demands on the heart. One such device employs a motion-sensor that vibrates in response to changes in the patient's motion. The device can be programmed for different degrees of sensitivity. Sensing devices have also been developed that respond to other physiological changes related to heart rate, such as blood temperature or acidity, cardiac output or pressure, or respiratory rate.

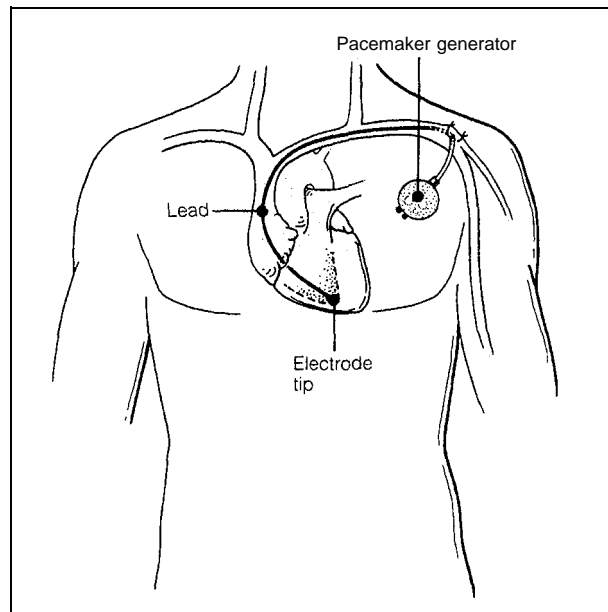


Figure 26.1
The pacemaker generator ("battery") is implanted under the skin on the upper portion of the chest, and the leads are threaded through a vein to the appropriate chambers of the right side of the heart. The model illustrated is one of a number in use.

PACEMAKER IMPLANTATION

Pacemaker implantation is a surgical procedure that is performed under local anesthesia and requires only a brief hospitalization. First, a catheter is inserted into the chest, usually through the subclavian vein, which is located below the collarbone and above the heart. The pacemaker's leads are then threaded through the catheter to the appropriate chamber or chambers of the heart. (See Figure 26.1.) The electrodes are maneuvered into contact with the inner surface of the atrium or ventricle. Finally the surgeon makes a small "pocket" in the pad of flesh (under the skin) on the upper portion of the chest wall to hold the power source. This pocket is then closed with stitches, leaving a small scar. The battery can usually be felt easily through the skin.

Complications related to implantation occur in only a few cases, and are typically those inherent in catheterization, such as bleeding, a punctured vein, infection, or a collapsed lung. Patients usually remain in the hospital for two or three days of evaluation to ensure that the pacemaker is working properly. Most people can resume a full schedule and return to work or school after two weeks. Accustomed sexual activity can also be resumed. A few activities will be restricted for about eight weeks.

All patients with pacemakers should have regular follow-up visits with their doctors to verify that the device is performing optimally. The increasing complexity of programmable pacemakers requires physicians to keep thorough and accurate records of the patient's pacemaker settings so that consistent follow-up is assured should the patient come under the care of a different doctor. Simple devices are available that allow the physician to test the function of the pacemaker battery. The lithium batteries typically last eight to ten years and can be replaced by reopening the pacemaker pouch under local anesthesia. This is a relatively minor surgical procedure that does not require hospitalization.

RARE COMPLICATIONS

Freed of their debilitating bradycardia symptoms, the vast majority of patients feel liberated by their pacemakers and remain satisfied with the devices. Nevertheless, anyone with a pacemaker should be alert to any symptoms or signs that might indicate malfunction. (See box, "Indications of Problems with Pacemakers.")

It is rare for a pacemaker to fail outright. In 1 to 2 percent of cases, leads may become dislodged and require reinsertion with a repeat catheterization.

Indications of Problems with Pacemakers

In the unlikely event that your pacemaker is not functioning properly you may experience any of the following signs and symptoms:

- Recurrence of original symptoms
- Shortness of breath or difficult breathing
- Dizziness or fainting
- Prolonged weakness or fatigue
- Chest pain
- Swelling of ankles, lower legs, wrists, or lower arms
- Muscle twitching
- Prolonged or excessive hiccupping
- Redness or drainage at the incision site
- Prolonged fever

If any of these symptoms occur, check your pulse and notify your physician as soon as possible.

Some patients exhibit “twiddler’s syndrome,” in which the patient tends to fiddle with the pacemaker in its pocket, which causes the device to rotate and sometimes dislodge or break the leads that go into the heart wall. For this reason, patients should consciously avoid “fiddling” with their pacemakers.

Pacemakers may occasionally sense and respond to outside signals that have nothing to do with demands on the heart, such as electrical activity in the muscles of the chest. Feelings of dizziness or light-headedness may indicate that the device is not working properly and should be reported to the doctor.

Other complications that may arise include pacemaker pocket infection, the main symptom of which is reddening and tenderness at the site of the pocket. Such infection occurs in only about 2 percent of cases. Patients with single-chamber ventricular-pacing devices may experience a complication known as pacemaker syndrome, in which a lack of coordination between the upper and lower chambers reduces blood flow, resulting in fatigue and dizziness. Pacemaker syndrome can often be relieved by replacing the pacemaker with a dual-chamber device.

A problem sometimes found with dual-chamber pacemakers is an actual pacemaker-induced rapid heartbeat or tachycardia. The tachycardia results when the pacemaker stimulates the ventricle too early in the cardiac cycle (the sequence of events making

up a complete heartbeat). The premature electrical impulse can flow backward over the AV node to the atria, triggering an atrial tachycardia in the same fashion as a premature ventricular contraction. Most new pacemakers have specific settings designed to prevent pacemaker-mediated tachycardia.

LIVING WITH A PACEMAKER

THE RECOVERY PERIOD

Most people adapt to their pacemakers quickly and soon find that they are hardly aware of them. For the first eight weeks, however, they need to take extra precautions. During this time, strenuous movement may dislodge a lead. Therefore the patient is advised to be careful moving the arm on the side in which the pacemaker has been implanted. The arm should not be raised above the head except to wash or dress. Sudden jerky actions should also be avoided. Activities that are prohibited for the first eight weeks include swimming, bowling, tennis, vacuum cleaning, carrying heavy laundry or trash, chopping wood, mowing or raking the lawn, and shoveling snow. After eight weeks, the lead becomes well set in the heart wall and the chance of dislodging it is decreased the prohibited activities can then be gradually resumed.

CHECKING THE PULSE

Many physicians feel that checking the pulse regularly is not necessary. Other symptoms will serve as an alert if there is a problem. If an individual takes comfort in checking his or her pulse regularly, it should be taken for one full minute once a day at rest and at the end of any prolonged period of exercise. The pulse can be felt with the middle and index fingers on the inside of the wrist or on the carotid arteries on either side of the neck just under the jaw.

Each patient will have received from the physician an indication of his or her normal pulse rate range. If the pulse rate is five or more beats less than the lower end of the range and the individual is experiencing symptoms, the first step is to call the telephone monitoring clinic, if the patient is enrolled. Otherwise, the physician should be called, and if he or she is not available, the patient should be taken to the nearest hospital emergency room.

A pulse rate that is faster than the preset range is

not cause for alarm. On the contrary, it is a sign that the heart is probably beating on its own without using the pacemaker. However, if the pulse rate is consistently more than 100 beats a minute at rest, the physician should be notified.

CHECKING THE PACEMAKER SYSTEM

The entire pacemaker system—the battery and the leads—should be checked periodically. At Yale–New Haven Hospital, patients are scheduled for their first check approximately two weeks after implantation, followed by checks at three and six months. If they are to be enrolled in a telephone call-in service, office checks will be required only once a year; if not, checks will be scheduled every six months for the life of the pacemaker.

It is possible to check the pacemaker by telephone. Patients enrolled in a call-in service will receive a special transmitter that relays an electrocardiogram and the pacer rate over the telephone line. Although telephone service is not appropriate for some patients (such as infants and some elderly people), it is very convenient for those who can use it. According to current Medicare guidelines, pacemakers can be checked by phone every eight weeks for the first 37 months, then every four weeks for the life of the device. There is an expense involved in this approach, and some physicians do not believe that even a phone check is necessary more often than every four months or so during the first three to four years after the pacemaker is implanted.

USING ELECTRICAL APPLIANCES AND EQUIPMENT

Pacemakers being implanted now are well insulated and should not pose a problem around household appliances kept in good repair. The one exception may be older models of appliances or microwave ovens that are not well insulated. Even these can generally be used as long as the pacemaker patient avoids standing directly in front of one while it is operating. Just about any household appliance, from kitchen tools to hairdryers, radios, televisions, stereos, heating pads, and electric blankets, can be used without fear of problems. Office equipment, including copiers and computers, as well as woodworking and light metalworking shop tools, can also be used without concern. A few common-sense rules apply, however. All appliances should be kept in good working order to avoid electrical shock; repeatedly turning equipment on and off should be avoided. If electrical in-

terference is suspected, the individual should turn off the machine or move out of range.

ENVIRONMENTAL PRECAUTIONS

External sources of electrical signals such as antennas, high-voltage equipment, and heavy-duty electrical machinery can sometimes disrupt pacemaker functioning. The problem arises because a pacemaker may act as an antenna and pick up electrical signals from the environment. Unipolar pacemakers (in which pacemaker is the positive pole and the lead is the negative, forming a relatively larger antenna) are more likely to be affected. Most cardiologists therefore prescribe devices with bipolar sensing leads. Bipolar pacemakers have the negative and positive poles spaced closely together at the end of the lead, making them less likely to pick up the wrong signals. With the addition of improved insulation and shielding, the newer pacemakers are affected by only the strongest electrical fields, such as those around an industrial engine or a radio transmitter. Patients with pacemakers should also not be subjected to electrocautery during surgery if possible, since the large voltages involved can adversely affect their devices.

Magnetic fields may also pose problems. Passing through the magnetic field of an airport metal detector, for example, can reprogram the pacemaker and distort its ability to synchronize beats for the upper and lower chamber. In this state, the pacemaker will stop sensing properly, although it will continue to pace at a fixed rate sufficient to protect the patient until he or she can see a doctor. Nevertheless, *pacemaker patients should avoid metal detectors.* (Airport security personnel are accustomed to dealing with this problem and will perform a physical check instead.) In addition, pacemaker patients should not have magnetic resonance imaging (MRI) scans, because the exceedingly strong magnetic fields involved can dislodge pacemakers.

AUTOMATIC IMPLANTABLE CARDIOVERTERDEFIBRILLATORS

The use of electronic devices to treat life-threatening tachycardias is a relatively new and rapidly developing field. Although commonly called implantable defibrillators, these devices frequently supplement defibrillation with other modes of tachycardia termination. Since the first devices to counteract poten-

tially lethal heart rhythm disorders were introduced in 1981, they have proved their ability to prevent sudden death caused by cardiac arrest. In patients at high risk for life-threatening arrhythmias, the rate of sudden death is only 1 to 4 percent among those who have had the device implanted, compared with 10 to 15 percent for those patients receiving drug treatment. Keep in mind, however, that these patients represent only a very small fraction of the population.

The technical name for the most common anti-tachycardia device is automatic implantable cardioverter defibrillator (AICD). Unlike pacemakers, which work to keep the patient's heart rate sufficiently high in one or both heart chambers, these implantable defibrillators slow down or halt excessively rapid heart rates that arise specifically in the ventricles. The aim is to prevent ventricular fibrillation, a state in which the ventricles contract in a completely unsynchronized, uncoordinated, or quivering manner that is insufficient to cause heart muscle contraction and the pumping of blood. This total lack of rhythm results in cardiac arrest, which can be fatal within minutes if there is no emergency intervention.

The typical candidate for an implantable defibrillator is a patient with a history of serious recurrent ventricular arrhythmias, indicating a high risk for sudden death. If drug therapy does not suppress the dangerous arrhythmias, then the patient may benefit from an implantable defibrillator. Often, patients who receive these devices are among the 20 percent of victims fortunate enough to have survived cardiac arrest.

Electrophysiology studies (EPS), in which electrodes are threaded via a catheter through veins to the heart and used to evaluate a patient's arrhythmia, are essential for anyone who might require an implantable defibrillator. Cardiologists use this diagnostic test to determine the types of arrhythmias to which the patient is susceptible and to localize any sites of poor conduction that may trigger a tachycardia. Electrophysiology studies are also used to evaluate medications and to test for any previously undetected heart problems. In rare instances, a patient undergoing electrophysiology studies to diagnose other arrhythmias may be found to be a good candidate for an implantable defibrillator, even though he or she has not experienced episodes of ventricular tachycardia that produced noticeable symptoms. Although patients may initially find the news that they need an implantable defibrillator upsetting, the overwhelming majority end up feeling thankful for their devices, which can help them to live free of the fear of sudden death.

HOW IMPLANTABLE DEFIBRILLATORS WORK

Implantable defibrillators use one or more of three basic modes of operation: antitachycardia pacing, low-energy cardioversion (a shock that restores normal heart rhythm), and defibrillation. Most devices in use today employ high-energy defibrillation for ventricular tachycardia or fibrillation. Experimental devices now undergoing clinical trials supplement this defense with antitachycardia pacing.

Antitachycardia pacing should not be confused with the pacing to treat bradycardia that is discussed earlier in this chapter. Rather, it short-circuits the rapid ventricular rhythms by sending brief bursts of impulses to the heart muscle at a pace faster than the already accelerated ventricular rate. The aim is to depolarize the heart muscle at the right moment, interrupting the abnormal rhythm and thereby halting the tachycardia. The tachycardia ceases within a few seconds, with no pain and little stress to the patient. A device can safely induce antitachycardia pacing hundreds of times per day if necessary, with little drain on its power source. This makes antitachycardia pacing especially attractive for patients who have frequent ventricular tachycardias that have not been controlled by medical therapy.

Low-energy cardioversion and defibrillation work differently from antitachycardia pacing. A device employing low-energy cardioversion to counteract ventricular tachycardia does so by delivering a mild shock to the heart muscle, in the range of 0.5 to 2 joules (a unit of energy). The shock depolarizes a small section of the ventricle, breaking the abnormal rhythm causing the tachycardia. Low-energy cardioversion is generally more reliable than antitachycardia pacing.

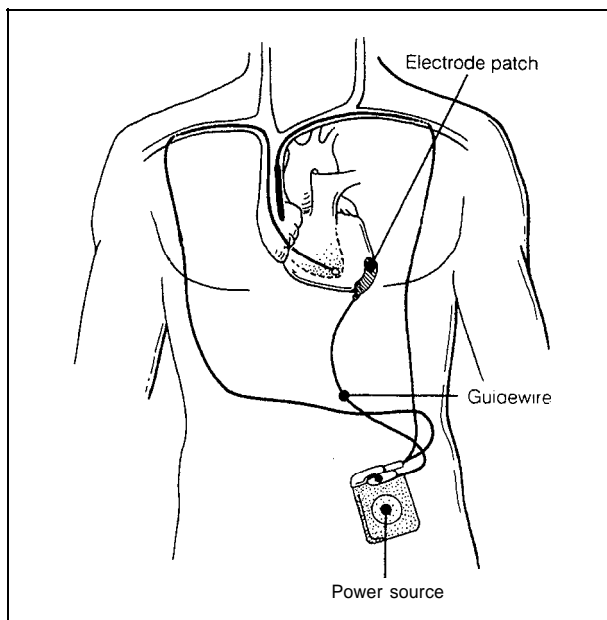
A low-energy shock, however, will not stop ventricular fibrillation, in which many currents flow through the heart muscle in a chaotic fashion. When an implantable defibrillator senses such a dangerous arrhythmia, it defibrillates just like the external electronic defibrillator used to revive patients in emergency care for cardiac arrest. Defibrillation requires a minimum 10-to-15-joule shock, but most devices deliver 30 joules to allow a margin of safety. Devices typically can give up to five shocks, pausing between each one to sense if the arrhythmia has been checked. This sequence can be repeated more than 100 times over the lifetime of the defibrillator.

Successful defibrillation will save the patient from sudden death, but there is no escaping the fact that the experience of receiving a shock can be distressing. Patients whose devices have fired often describe the shock as similar to a kick in the chest. Many patients lose consciousness from the arrhythmia in the 15 to 20 seconds required for the device to charge up and deliver the shock. Though some patients may be fearful of this experience, the vast majority find their devices reassuring. Currently, about half of patients with implantable defibrillator must also take antiarrhythmic drugs to cut down on extra ventricular contractions and suppress ventricular flutter and fibrillation, as well as other arrhythmias that might cause the device to fire too often or unnecessarily.

DEFIBRILLATOR IMPLANTATION

The defibrillation device is usually implanted using procedure called a thoracotomy (surgical opening of the chest), a more complicated operation than that required for pacemaker implantation. During the operation, two approximately 2-by-3-inch electrode patches are affixed to the outer wall of the ventricle. These patches, attached by guide wires to the device's

Figure 26.2
The power source (generator) of the defibrillator is implanted in a pocket underneath the skin on either side of the abdomen. Connected to the power source are leads, for heart rate monitoring and defibrillation, which are tunneled under the skin, up through the diaphragm to the heart. Electrode patches, affixed to the outer wall of the left ventricle, and the superior vena cava lead are used for defibrillation,



battery, will deliver the charge if the device is called on to defibrillate. The wires are then tunneled under the skin through the diaphragm to the abdomen. The power source and circuitry of the AICD are contained in a device a little larger than a deck of cards and weighing about 8 ounces; this is implanted in a pocket underneath the skin of the abdomen. This is easily felt through the skin. Some patients may find the power pack unsightly; future devices promise to be smaller and less obtrusive. (See Figure 26.2.)

Once the chest is opened for the defibrillator implantation, other desirable heart surgery, such as coronary arterial bypass, may be performed, because many candidates for an implantable defibrillator also suffer from coronary heart disease. After the defibrillator patches are in place, such operations become more difficult.

For some patients, a defibrillator maybe implanted by using a sternotomy procedure, in which the main incision is made lengthwise over the breastbone, or a subxiphoid procedure, in which the main incision is made lengthwise below and slightly to the left of the breastbone. In both of these, a small incision near the collarbone may also be made.

After surgery, patients will usually spend a day or two in the coronary care unit, where they can be carefully monitored. Recovery will continue for another seven to ten days in the hospital (longer if other surgery is required), during which time activities are gradually resumed. The cardiologist may order a 24-hour ambulatory electrocardiogram (Helter monitor), electrophysiologic studies, exercise stress test, or a combination of several tests. (See Chapter 9.)

By the end of the week, the stitches are usually removed and, if all tests are completed, the patient is released to continue recuperating at home, generally for another six to eight weeks. The same general precautions recommended for pacemaker patients during the recovery period (see the earlier discussion of living with a pacemaker) are advised for patients with implantable defibrillator.

COMPLICATIONS

Implantable defibrillator save lives, but the devices carry some risks. Implantation thoracotomy is a major operation that has a significant, though small, mortality rate of 1 to 2 percent. Patients usually spend at least one week in the hospital (longer if other surgery is required) and another six to eight weeks recovering at home. In 4 to 5 percent of cases, infection requires removal of the device, an operation that often requires a repeat thoracotomy. A very few cases

of scarring around the patch site that constricts the heart muscle have been reported as well. Although shocks delivered by the devices do not cause any apparent damage to the heart, inappropriate discharges will remain a potential problem until sensing capabilities are refined.

Implantable defibrillator may also impose lifestyle limitations. Because of the risk of fainting during defibrillation, patients with these devices may not be able to drive or operate heavy machinery. Regular follow-up exams must be performed at specialized clinics, which may mean travel over long distances. The power packs must be replaced every three to seven years, a procedure done under local anesthesia during a brief hospital stay or on an outpatient basis.

Most patients willingly trade these disadvantages for the reassurance that an implantable defibrillator can save them from fatal cardiac arrest. Patients typically express the hope that their device will never go off, but say they are glad to know it is there, just in case. Some 8,000 to 10,000 people in the United States now have implantable defibrillators. Of the 400,000 people who die each year from cardiac arrest, 30 percent of those at risk for sudden death can now be identified ahead of time, and may benefit from an implantable defibrillator. Those patients who still require antiarrhythmic drugs can take them in much lower doses, reducing side effects.

Future prospects for these devices are promising. Current devices requiring extensive surgery for implantation will eventually be replaced by defibrillator with leads that can be installed through the veins and electrode patches that are placed beneath the skin, making implantation no more invasive than pacemaker installation. Even so, today's implantable defibrillator represents a real triumph over life-threatening arrhythmias, enabling doctors to offer patients who might otherwise feel helpless before the risk of sudden death genuine assurance of enjoying a longer life.

LIVING WITH AN IMPLANTABLE DEFIBRILLATOR

ENVIRONMENTAL PRECAUTIONS

Patients with an implantable defibrillator should avoid strong electromagnetic fields, such as may be found surrounding heavy industrial equipment, arc

welders, and transmitting antennas. In such an environment, the device may begin to generate beeping sounds as if it is being tested, or it may actually turn off. If this happens, the patient should move away from the equipment and call his or her physician for instructions as soon as possible.

INFORMING THE PHYSICIAN

The patient should inform his or her cardiologist each time a shock is received from the device. The physician should also be told about any symptoms of ventricular arrhythmias such as nausea, fainting, periods of unconsciousness, or an extremely rapid pulse rate. It is possible for the device to fire without the patient's experiencing symptoms of a rhythm disturbance. Conversely, the patient may experience symptoms of abnormal rhythm without the defibrillator issuing a shock. This may happen if the heart rate is too slow for the device to recognize.

ALERTING OTHERS

Patients with implantable defibrillator should always carry an identification card or, better yet, wear a Medic Alert identification (available from the non-profit Medic Alert Foundation as a bracelet or on a neck chain). Family and coworkers should be made aware of the condition and told what to expect if the device fires. For example, the shock, although mild, can be felt on the patient's skin on the chest and back. Other physicians, dentists, and any emergency care personnel (should the patient be transported to the hospital after a shock from the device) should be informed as well. Certain procedures such as diathermy (artificial raising of body temperature to high levels) and electrocautery treatments are contraindicated for patients with implantable defibrillators.

TESTING IMPLANTABLE DEFIBRILLATOR

In general, implantable defibrillator are tested every two months, although the cardiologist may set a different schedule. The test, which consists of checking the pulse generator and the leads, is done in the physician's office or clinic. A sensing device is used that discharges the pulse generator from outside the body to ensure that it is working properly. The patient does not feel a shock, however, since the shock stays inside the pulse generator. The test is usually not uncomfortable and the patient should report any discomfort to the physician.