CHAPTER 18

STROKE

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INTRODUCTION

Stroke is a form of cardiovascular disease affecting the blood supply to the brain. Also referred to as cerebrovascular disease or apoplexy, strokes actually represent a group of diseases that affect about one out of five people in the United States. When physicians speak of stroke, they generally mean there has been a disturbance in brain function, often permanent, caused by either a blockage or a rupture in a vessel supplying blood to the brain.

In order to function properly, nerve cells within the brain must have a continuous supply of blood, oxygen, and glucose (blood sugar). If this supply is impaired, parts of the brain may stop functioning temporarily. If the impairment is severe, or lasts long enough, brain cells die and permanent damage follows. Because the movement and functioning of various parts of the body are controlled by these cells, they are affected also. The symptoms experienced by the patient will depend on which part of the brain is affected.

Stroke is a major health problem in this country. Nearly 500,000 people in the United States have a stroke each year, and nearly a third of these people die during the first few months after their stroke, Of those who survive, about 10 percent are able to return to their previous level of activity, about 50 percent regain enough function to return home and carry on with only limited assistance, and about 40 percent remain institutionalized or require significant assistance in caring for themselves.

While the incidence of stroke has decreased a great deal over the past few decades, there is evidence that this trend may be leveling off.

Stroke is costly. The cost in human terms, to patients and their families, is impossible to estimate. The cost to the U.S. economy—in terms of medical care and lost income—amounts to over $25 billion each year.

Although stroke is often viewed as a disease of the elderly, it sometimes affects younger individuals. The incidence of stroke does increase with age, but nearly a quarter of all strokes occur in people under the age of 60.

Stroke patients are often cared for by neurologists, because of the complex nature of the symptoms caused by damage to the brain. However, strokes are very closely related to heart disease. Heart attacks (myocardial infarctions) and stroke are both caused by diseases of the blood vessels. They share many of the same risk factors, and modifying these risk factors may reduce the possibility of stroke. Many of the therapies used for cardiac disease show promise for some types of stroke. Finally, people who already have coronary disease may be at greater risk for stroke, and vice versa.

HOW THE BRAIN FUNCTIONS

To understand the signs and symptoms of stroke and why they can differ from patient to patient, it is necessary to understand a little about the brain and how

it functions. There are literally thousands of possible symptoms that can result from a stroke, depending on which blood vessels and parts of the brain are involved. It is also important to realize that except for a brief period after birth, brain cells are unable to divide and form new cells. When brain cells die, they are not replaced. This is part of the reason for the limited ability of the brain to repair itself after injury, and why recovery from stroke is only partial in many cases. While someone who suffers a heart attack, for example, can lose 10 percent of heart tissue and still run a marathon, losing 10 percent of the tissue in certain parts of the brain can result in a devastating disability.

The human brain is the most complex structure known. It is composed of 100 billion nerve cells, called neurons; each neuron may connect to thousands of other brain cells. The trillions of connections are necessary for the integrative power of the brain. They also control body movements, interpret all sensations (hearing, vision, touch, balance, pain, taste, and smell), and mediate thought and language. Different areas of the brain control different functions. (See Figure 18.1.)

Although the brain represents only 2 percent of the body's weight, it uses about 25 percent of the body's oxygen supply and 70 percent of the glucose (sugar). Unlike muscles, the brain cannot store nutrients, and thus it requires a constant supply of glucose and oxygen. If the blood supply is interrupted for as little as 30 seconds, unconsciousness results; permanent brain damage may follow in as little as four minutes. The brain's high metabolic rate, sensitivity to changes in blood flow, and dependence on continuous blood flow are what can make strokes so dangerous. Figure 18.2 shows the major arteries supplying the brain.

The brain can be divided into three areas: *brain stem,* cerebellum, and *cerebrum. The* brain stem controls many of the body's basic functions, including breathing, chewing, swallowing, and eye movements. The major pathways from the cerebrum—the thinking part of the brain—also pass through the brain stem to the body. The cerebellum, attached to the back of the brain stem, coordinates movements and balance.

The cerebrum is divided into two hemispheres, left and right. In general, the left brain receives input (sensations) from the right side of the body and controls movement on the right side, so that a stroke in the right side of the brain will cause left-sided weakness. Conversely, the right brain controls the left side of the body.

Each side of the cerebrum is further divided into four lobes. The *frontal lobes* control motor function, planning, and expression of language. The *temporal*

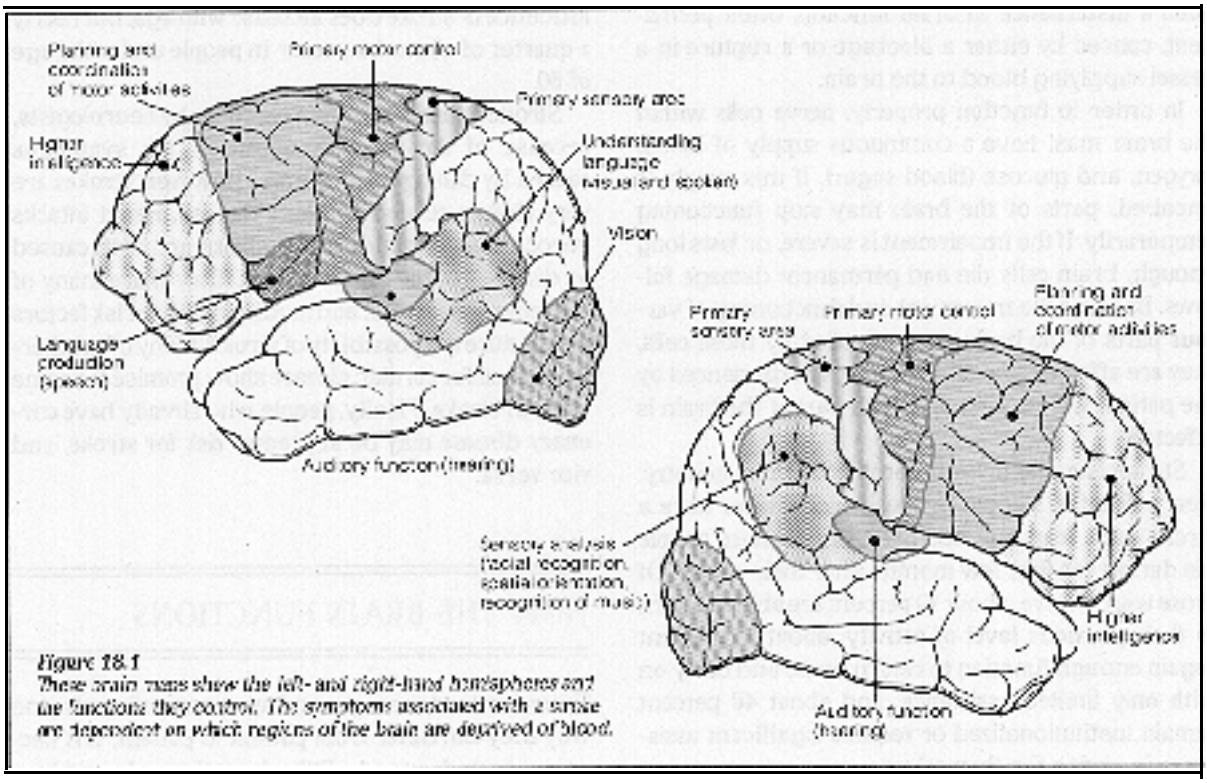


Figure 18.1
These brain maps show the left- and right-hand hemispheres and the functions they control. The symptoms associated with a stroke are dependent on which regions of the brain are deprived of blood.

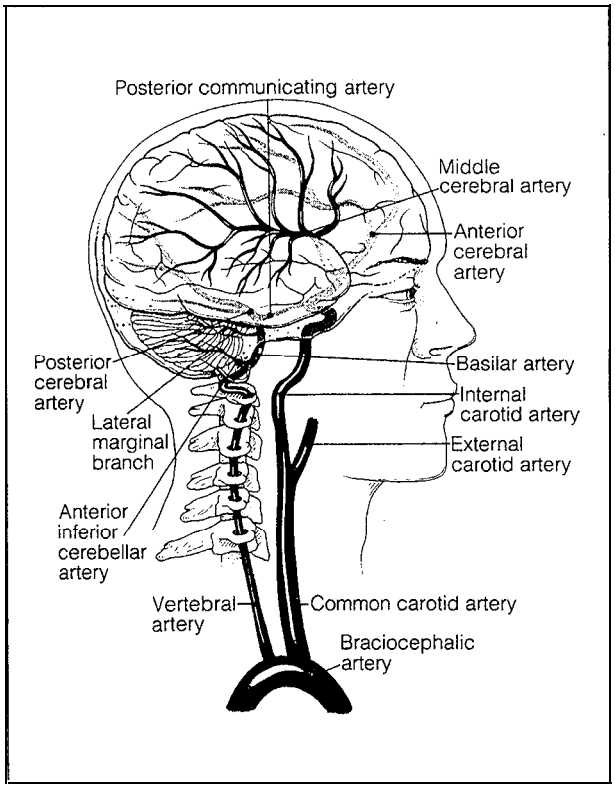


Figure 18.2
Shown are the major arteries feeding the brain. The carotid and its branches (anterior cerebral artery and middle cerebral artery) feed the front part of the brain and most of the cerebral hemispheres (top of the brain). The vertebral arteries join in the back of the head to form the basilar artery. These arteries and their branches supply the brain stem, cerebellum, and back parts of the brain.

lobes are involved with hearing, memory, and behavior. The parietal lobes interpret sensation and control understanding of language. The occipital lobes perceive and interpret vision. The right and the left sides of the cerebrum are not identical, but rather have specialized functions. In almost all right-handed people and most left-banders, the left brain is "dominant" and performs most language functions. The right side of the brain controls the abilities to understand spatial relations and recognize faces, as well as musical ability. It also helps focus attention.

RISK FACTORS AND STROKE PREVENTION

Given the devastating deficits often associated with a stroke, the need for prevention is obvious. Many of the risk factors for stroke (see box, "Stroke Risk Factors") can be treated or modified. Doing so may prevent an initial stroke or recurrent strokes, as well as decrease the risk of premature death, which is most often the result of coronary disease.

A number of stroke risk factors are the same as those for heart disease, although their relative importance varies. For example, a high blood cholesterol level is a much more significant risk for heart disease. This distinction is of little practical importance, because both coronary and stroke risk factors should be addressed in patients who are at risk for, or who have suffered, a stroke or a transient ischemic attack. (The latter, also called a TIA or a ministroke, is discussed later in this chapter.)

Three of the greatest risk factors for stroke—high blood pressure (hypertension), heart disease, and diabetes—often do not cause symptoms in their earliest stages. For this reason, it is important that all adults, but especially those with a family history of heart disease or stroke, have regular screening for

Stroke Risk Factors

Characteristics and life-style

Definite
Cigarette smoking
Excessive alcohol consumption
Drug use (cocaine, amphetamines)
Age
Sex
Race
Familial and genetic factors

Possible
Oral contraceptive use
Diet
Personality type
Geographic location
Season
Climate
Socioeconomic factors
Physical inactivity
Obesity
Abnormal blood lipids

Disease or disease markers
Hypertension
Cardiac disease
TIA
Elevated hematocrit
Diabetes mellitus
Sickle cell disease
Elevated fibrinogen concentration
Migraine headaches and migraine equivalents
Carotid bruit

these and other vascular risk factors. Routine check-ups should begin at age 20 and be repeated at least every five years, more frequently in later years or if warranted by the results of the initial screening. Blood pressure should be checked more frequently.

HIGH BLOOD PRESSURE

A major risk factor common to both coronary heart disease and stroke, high blood pressure is present in 50 to 70 percent of stroke cases, depending primarily on the type of stroke. The long-term effects of the increased pressure damage the walls of the arteries, making them more vulnerable to thickening or narrowing (atherosclerosis) or rupture.

There is no specific blood pressure reading that is considered normal, but rather a range. Most experts agree, however, that a reading greater than 140/90 mm Hg is abnormal, and anyone with such a reading should see a physician. But even mild elevations in blood pressure are associated with an increased risk for stroke. Sometimes mildly elevated blood pressure can be controlled by life-style modification, but medication is often needed. Although the patient may feel no different, control of blood pressure is associated with a marked decrease in the occurrence of stroke. (See Chapter 12.)

HEART DISEASE

Just as strokes area strong risk factor for heart disease, heart disease is a strong risk factor for stroke, although only for one type of stroke, ischemic strokes. Heart disease is associated with stroke in two ways. First, damage to the heart (as, for example, from a heart attack) may make it more likely that clots will form within the heart. These clots can break loose and travel to the brain, causing a cardioembolic stroke. Heart disease and stroke are also associated because they are both manifestations of atherosclerotic disease in the blood vessels. If the blood vessels feeding the heart (the coronary arteries) are diseased, it is likely that arteries to the brain are also affected.

Patients with evidence of coronary artery disease, congestive heart failure, left ventricular hypertrophy (enlargement of the left side of the heart), disease of the heart valves, or arrhythmias (irregular heart rhythms) have a several-fold increase in the risk of stroke.

Several recent studies suggest that people with atrial fibrillation who take daily doses of either aspirin or warfarin (Coumadin) have a reduction of up to 80 percent in their risk of stroke. These findings suggest that an estimated 20,000 to 50,000 strokes might be prevented each year if all people with this condition had prophylactic drug treatment.

SMOKING

Smoking facilitates atherosclerosis and appears to be an independent risk factor for strokes that result from a clot. It also seems to be a risk for strokes that result from cerebral hemorrhage.

Men in Framingham, Massachusetts-a community studied extensively for cardiovascular disease—who smoked more than 40 cigarettes a day had twice the stroke risk of men who smoked fewer than 10. In a large Harvard Medical School study of women, the number of cigarettes smoked was found to be directly related to stroke risk. Women smoking more than 25 cigarettes a day had a 2.7 times greater risk of stroke from a clot or embolus and a 9.8 times greater risk of a hemorrhagic stroke. Data from both the Framingham Heart Study and the Honolulu Heart Study indicate that one can significantly reduce stroke risk by stopping smoking. Five years after they stop, ex-smokers have a stroke risk equal to that of non-smokers.

DIABETES

People with diabetes are at greater risk for stroke, just as they are for heart disease. Women with diabetes are at an even greater risk than men. High blood pressure compounds the risk. Although treatment of diabetes has not been conclusively shown to reduce risk, it is known that control of high blood sugar (hyperglycemia) can reduce the severity of cerebral damage during a stroke. For this and other reasons, diabetics should keep their blood glucose levels under strict control.

CHOLESTEROL

Studies have found a link between high blood lipid levels and atherosclerosis in cerebral arteries, but it is still unclear whether high cholesterol levels significantly increase stroke risk. They do, however, increase heart disease risk, so efforts should be made to reduce them.

OBESI'IY AND INACTIVITY

Obesity and a sedentary life-style are risk factors for stroke primarily because they increase the risk of

high blood pressure, heart disease, and diabetes. They may also be independent stroke risk factors. Losing weight and following a moderate exercise regimen can help reverse these risks.

ORAL CONTRACEPTIVES AND ESTROGEN REPLACEMENT THERAPY

The role of oral contraceptives in stroke risk is still inconclusive, primarily because most research has looked at the effects of high-dose estrogen pills, and most women now use lower-dose preparations. Estrogen is believed to promote blood clotting; lower-dose estrogen preparations are thought to minimize this effect. Because studies have found no increase in current risk of stroke or heart attack in women who previously used oral contraceptives, it is believed that the pill does not promote atherosclerosis.

Several retrospective studies have suggested that oral contraceptive use is associated with an increase in stroke risk, while other studies have only found a significant risk of brain hemorrhage in women over age 35 who take the pill and smoke. Smokers who have migraine headaches and take oral contraceptives may be at a particularly high risk of stroke. Experts usually advise women who smoke not to use oral contraceptives—or better, to quit smoking.

In contrast, there is evidence to suggest that estrogen replacement therapy for postmenopausal women may slow the atherosclerotic process. In this group the use of estrogens may actually lower the risk of stroke (and heart disease).

HISTORY OF TRANSIENT ISCHEMIC ATTACKS (TIAs)

Researchers are learning that these "ministrokes" may be the most reliable warning of an imminent "full" stroke. Between 10 and 50 percent of strokes, depending on the type, are preceded by TIAs; if not treated, about one-third of all people who have a TIA goon to have a stroke within five years, TIAs are also indicators of potential coronary heart disease: Each year, 5 percent of those who have had at least one TIA have a heart attack. Anyone who has had a TIA should do whatever possible to reduce other risk factors. Drug therapy or surgery may be warranted to reduce the risk of subsequent TIAs, . stroke, or heart attack.

HEREDITY AND FAMILY HISTORY

The chance of having a stroke is higher for people who have a family history of this disease. Part of the risk is due to inherited risk factors and part to family life-styles (eating and exercise habits, for example).

The presence of inherited risk factors does not mean that risk cannot be lowered. In one study, for instance, the hereditable risk for vascular disease was mostly due to a susceptibility to the effects of cigarette smoking. When cigarette smoking was eliminated, the hereditable effect was significantly lowered.

AGE

The risk of stroke rises significantly with age. After 55, it more than doubles with each passing decade. Each year, about 1 percent of people between ages 65 and 74 have a stroke—and 5 to 8 percent of people in that age group who have had a TIA go on to stroke.

Although risk associated with advancing age cannot be changed, it is an important factor in assessing stroke risk and planning preventive therapies.

AN EARLIER STROKE

Because the same factors that caused a first stroke are likely to cause a subsequent one, the risk of stroke for someone who has already had one is increased.

CAROTID BRUIT

A bruit is a noise made by turbulent flow in a blood vessel that usually can be heard only with a stethoscope. The most common cause is a narrowing of an artery because of atherosclerosis. Bruits tend to occur in the large arteries of the body, including the carotid artery in the neck. Even in patients without other symptoms, carotid stenosis (narrowing) and carotid bruits are associated with an increased stroke rate of 5 percent each year. Over the course of a lifetime, the cumulative stroke risk may be quite high.

The increased risk associated with the presence of a carotid bruit has prompted some physicians to recommend a surgical procedure called carotid endarterectomy to open the narrowing. Initial results of this procedure have proved disappointing in terms of preventing strokes. Patients with asymptomatic bruit should, if possible, be considered for referral to a medical center that has special expertise in cerebrovascular disease and is participating in a well-designed clinical trial.

OTHER RISK FACTORS

Other factors influence stroke risk, although to a lesser extent. These include an elevated hematocrit

(number of red cells in the blood), geographic location (especially the southeastern United States, which is sometimes called the "stroke belt"), lower socioeconomic status, Type A personality (see Chapter 8), use of cocaine and amphetamines, and high alcohol consumption. Stroke deaths seem to occur more often during periods of extreme heat or cold.

TRANSIENT ISCHEMIC ATTACKS (TIAs)

A transient ischemic attack is a localized neurological problem caused by ischemia (decreased blood flow) that completely resolves within 24 hours. Most last only a few minutes. People who suffer a TIA often pass it off as nothing, especially when it goes away almost as quickly as it came. The more neurologists learn about the cause of TIAs, the more clear it becomes that a TIA presents a unique opportunity to prevent a stroke.

The importance of a TIA is not in its neurological symptoms-by definition, they disappear. Rather it is that a third of all patients will go on to have a stroke. TIAs represent about 10 percent of all cerebrovascular disease. Up to half of patients who suffer an ischemic stroke will report having had a TIA, and may never have sought treatment. TIAs also identify a group of people at high risk for heart attack. It is imperative that anyone who experiences a TIA consult a doctor for both neurological and cardiovascular evaluation. The key is to make the diagnosis and work to lower the risk.

The symptoms of a TIA are similar to those of a stroke-weakness or numbness on one side of the body, inability to speak or understand language, or lack of coordination-except they don't last as long. Any combination of the symptoms described for stroke, lasting more than a few seconds, should be considered as a possible TIA. (See box, "Common Warning Signs of Stroke and Transient Ischemic Attack.")

One additional common symptom of a TIA is transient monocular blindness, also called *amaurosis fugax* (flight of darkness). This is a brief change or distortion of vision in one eye that is often described as a misting, clouding, blurring, spottiness, or the sensation that a blind is being drawn down over the eye.

The evaluation of a patient for a TIA is similar to that for a stroke. Most patients will be hospitalized because of the concern of a subsequent stroke and the need for immediate treatment should one occur. Patients at low risk of stroke and those whose general medical condition precludes aggressive treatment may be followed on an outpatient basis.

The first step is to consider, and exclude, other disease that can mimic a TIA. (See box, "Conditions That Can Mimic a TIA.") Many of these diseases are serious neurological problems that also may require urgent treatment. After other diseases have been excluded, the physician will try to determine the mechanism of the TIA in order to help guide decisions about treatment. Most TIAs are due to either an embolus (blood clot) or restricted blood flow-often caused by a narrowing in the carotid artery. Brief TIAs (lasting less than 10 minutes) are commonly associated with carotid stenosis (artery narrowing), while longer-duration TIAs (lasting more than one hour) are more often caused by embolism.

If a TIA is due to restricted blood flow because of a carotid artery stenosis, surgery may be indicated.

Common Warning Signs of Stroke and Transient Ischemic Attack (TIA)

Because brain cells can die very quickly after a stroke, it is crucial to recognize warning signs of an impending stroke and get to a hospital quickly. Since the brain controls hundreds of activities, the range of stroke symptoms is broad. In spite of this, there are several common warning signs of stroke or TIA:

- Sudden weakness or numbness of the face, arm, and leg on one side of the body
- Loss of speech, or trouble speaking or understanding speech
- Dimness or loss of vision, particularly in only one eye or half of both eyes
- Sudden onset of blurred or double vision
- Unexplained dizziness
- Sudden onset of unsteadiness, lack of coordination, difficulty walking, or falling
- Sudden excruciating headache
- Recent change in personality or mental abilities, including memory loss

Although many of these symptoms can be caused by other diseases, the sudden onset of new neurological symptoms should prompt a person to seek immediate medical attention.

Conditions That Can Mimic a TIA

Migraine
Seizure
Hypoglycemia (low blood sugar)
Other' forms of stroke
Brain tumor
Arteriovenous malformation
Multiple sclerosis
Incipient syncope (fainting)
Orthostatic hypotension (low blood pressure)
Cardiac arrhythmia (irregular heartbeat)
Amnesia
Narcolepsy/cataplexy (disorders of excessive sleepiness)
Intracranial inflammation (e.g., brain infection)
Periodic paralysis
Pressure neuropathy (nerve compression)
Dizziness of uncertain cause
Anxiety
Hyperventilation
Labyrinthine (inner-ear) disease

If it is due to an embolus from the heart (as may occur with various abnormal heart rhythms), even if there is a carotid stenosis, surgery may not be appropriate. (For treatment options, see the discussion of long-term treatment of TIA and stroke elsewhere in this chapter.)

ISCHEMIC STROKE

There are two broad categories of stroke: *ischemic* and hemorrhage. Ischemic strokes are caused by a lack of blood flow to the brain and account for about 70 percent of all strokes. (See Figure 18.3.) Hemorrhagic strokes, discussed later in this chapter, are caused by bleeding into the brain or adjacent tissues.

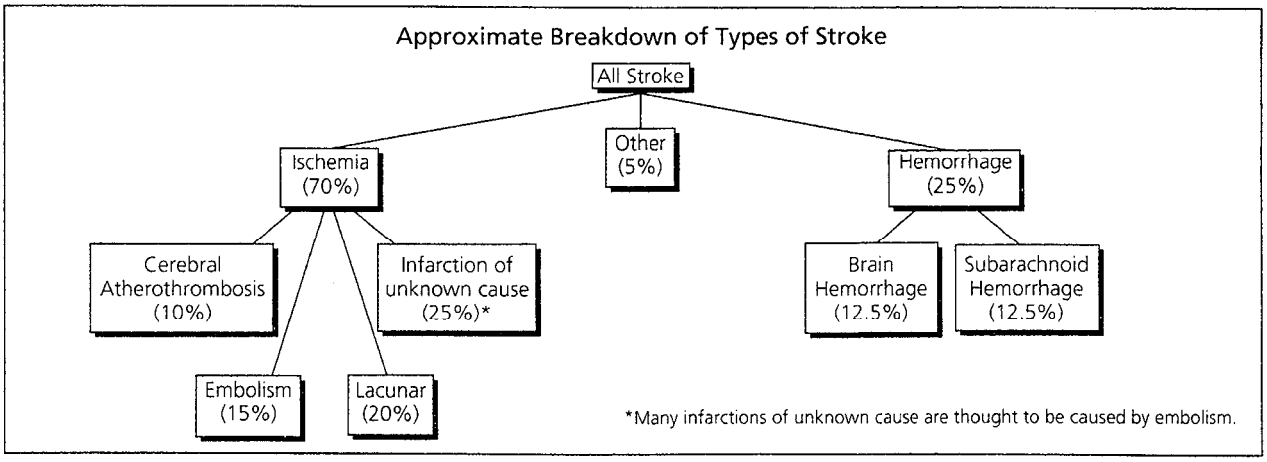
Within the category of ischemia, there are several subcategories of stroke. One common type, called cerebral atherothrombosis (also referred to as large artery disease), is caused by a clot (thrombus) that blocks blood flow in an artery. The narrowing leads to a low flow state referred to as watershed (or distal *field)* ischemia. (See Figure 18.4.) If the resulting lack of oxygen results in death of brain tissue and permanent damage, the term cerebral infarction is used.

Clots usually do not occur in healthy arteries, but tend to form at or adjacent to an area of a vessel damaged by atherosclerosis. In the atherosclerotic process, plaque—an amalgam of fatty substances, cholesterol, waste products of cells, calcium, and a blood-clotting material called fibrin-builds up as thick, irregular deposits on the inner lining of an artery. The irregular surfaces that plaque deposits create provide ideal places for clots to form and grow. In some cases, plaque deposits themselves can grow so large that they obstruct the opening (lumen) of the blood vessel and block the flow of blood. Surgery is often indicated to open these arteries.

Atherothrombic strokes are often preceded by TIAs, and they tend to occur at times when blood pressure is low—at night during sleep, or early in the morning before major activities start.

Another kind of ischemic stroke involving a clot is called a cerebral embolism or embolic stroke. This type is caused by a wandering clot (embolus) that forms in one part of the body, breaks loose (in whole or part), and travels in the bloodstream until it lodges in an artery in the brain or in a vessel leading to the brain. (See Figure 18.5.) Emboli can be formed from

Figure 18.3



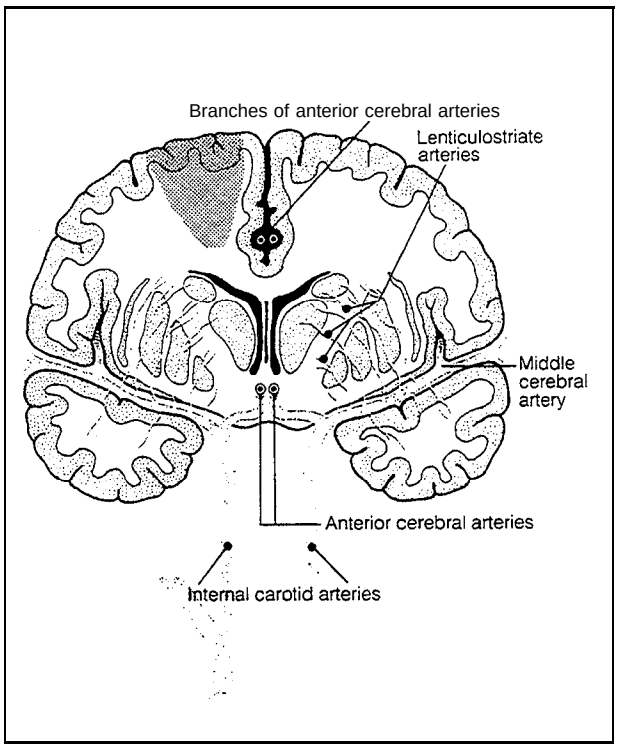


Figure 18.4
A watershed (or distal field) stroke is the result of narrowing of the large arteries feeding the brain.

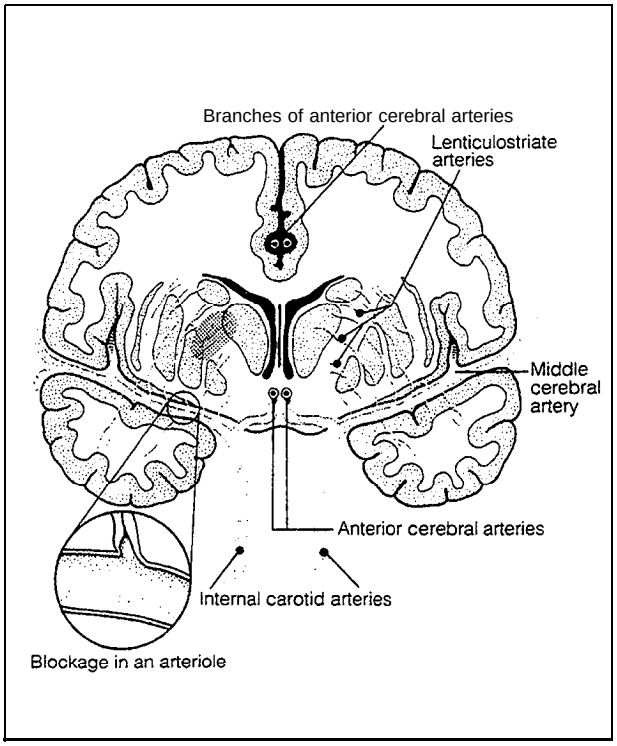
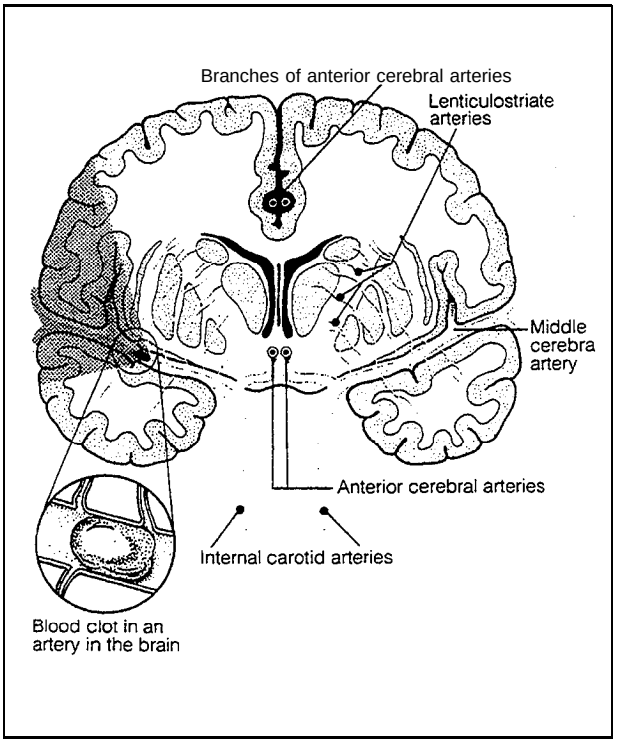


Figure 18.6
A lacunar stroke is the result of the complete blockage of an arteriole, the very small end of an artery that penetrates deep into the brain.

Figure 18.5
An embolic stroke is the result of a blood clot that forms in another part of the body and travels in the bloodstream until it lodges in an artery in the brain.



calcium, cholesterol, air, blood proteins, platelets, or by-products of an infection of the heart's inner lining (endocarditis). (See Chapter 15.) It is believed that most ernbolic strokes involve clots from the heart or the carotid arteries.

The most common cardiac conditions associated with emboli are atrial fibrillation, valvular disease, the presence of a prosthetic heart valve, endocarditis, congestive heart failure, and myocardial infarction. In atrial fibrillation, the two upper chambers of the heart (atria) quiver rather than beat effectively. Because blood is not pumped out of the atria (upper part of the heart) completely it tends to pool and form clots. One-third of all people with atrial fibrillation will have a stroke at some time, and the majority of these strokes will be embolic. Embolic strokes are probably the most common of ischemic strokes. (Many that have no proven cause are thought to be caused by embolism.) The use of anticoagulant drugs may help reduce the risk of clot formation-before or after such a stroke. (In fact, almost all people with atrial fibrillation should be on some form of long-term aspirin or anticoagulant drug therapy. See Chapter 23.)

The third form of stroke caused by blood clotting is called a lacunar infarction or lacunar stroke. These strokes are the result of occlusion (complete block-

age) of arterioles, the very small ends of the arteries that penetrate deep into the brain, (See Figure 18.6.) The small size of the vessels sometimes makes lacunar strokes difficult to diagnose; in addition, some have no noticeable symptoms. There are, however, several classic syndromes that suggest the possibility of a lacunar infarction. The most common is a *pure* motor stroke, in which damage is confined to the main cabling system for motor signals from the brain to the spinal cord (internal capsule). As a result, the patient develops one-sided weakness without other symptoms. Similarly, a lacunar stroke in the thalamus (the main sensory relay center to the brain) can cause a pure *sensory stroke.* Surgery and the use of anticoagulant drugs do not appear to help a great deal in the short-term management of people with lacunar disease. Treatment concentrates on modification of long-term risk.

In spite of the most aggressive workup available in the 1990s, the mechanism of ischemic stroke remains unknown in over a third of all cases. Many of these cases of *infarction of unknown cause* appear to be due to embolism. Refinements in imaging technology and earlier evaluation of patients may help categorize these strokes better in the future.

At present, however, much can be determined by the specific symptoms and signs that a patient manifests. Defining the mechanism of a stroke can help determine prognosis, suggest appropriate therapy, and help the physician prepare the family for what to expect. For example, patients with lacunar stroke often recover their strength better than those who suffer other types; thrombotic strokes tend to worsen during the acute period before recovery begins; and embolic strokes are associated with a high rate of recurrence within the first few weeks. “

HEMORRHAGIC STROKES

Hemorrhage accounts for about 20 to 25 percent of all strokes. In these strokes, blood seeps from a hole in a blood vessel wall into either the brain itself (intracerebral hemorrhage) or the space around the brain (subarachnoid hemorrhage).

BRAIN OR INTRACEREBRAL HEMORRHAGE

In this type of hemorrhagic stroke, blood leaks from small vessels at the base of the brain. Long-term exposure to high blood pressure is thought to weaken the walls of these small arteries, and eventually they burst. The term “cerebral” (meaning related to the part of the brain called the cerebrum) is also used.

About two-thirds of patients with an intracerebral hemorrhage have a history of hypertension; diabetes and atherosclerosis accelerate the damage. Other causes of bleeding into the brain include brain tumor, trauma, arteriovenous malformation (AVM), and stimulant drugs such as amphetamines and cocaine.

Intracerebral hemorrhage accounts for about 10 to 15 percent of all strokes. The onset of symptoms is usually acute, with severe headaches and decreased consciousness. Other symptoms depend on the size and location of the hemorrhage. One type of brain hemorrhage, *cerebellar* hemorrhage, is especially important to recognize because prompt evaluation, often followed by surgery, can be lifesaving. Cerebella hemorrhage means bleeding into the cerebellum (rather than the cerebrum)—the part of the brain that coordinates movement and balance. Its symptoms usually include disequilibrium or dizziness, incoordination (especially trouble in walking), headache, nausea, and vomiting.

Treatment and prognosis of intracerebral hemorrhage varies with the size and location of the hemorrhage within the brain and the condition of the patient. A hematoma (blood that has clotted) near the surface may be easily evacuated (removed surgically), but deep bleeding may damage critical structures within the brain and pose a higher surgical risk. Whether surgery is performed or not, medical management centers on respiratory care, blood pressure management, and minimizing pressure within the skull. Seizures sometimes follow the hemorrhage, so anticonvulsant medications are often added to the regimen.

SUBARACHNOID HEMORRHAGE

Subarachnoid hemorrhage is usually caused by an aneurysm or a vascular malformation (described below). In addition to the damage caused by the blood shooting out of the artery, damage can be further worsened by the mass of blood pushing up against adjacent areas of the brain and blood vessels, or through secondary effects of the extruded blood on the brain’s blood vessels (vasospasm).

The classic clinical feature of a subarachnoid hemorrhage is the sudden onset of an excruciating headache. It is often associated with a stiff neck, change in consciousness, nausea and vomiting, diffuse intellectual impairment, and seizures. Other symptoms

may occur, depending on the location and size of the hemorrhage.

Patients with symptoms suggestive of a subarachnoid hemorrhage should have a CT scan, which will indicate the presence of blood in about 80 percent of cases. If the CT scan is negative or equivocal, a spinal tap (lumbar puncture) should be performed to look for evidence of bleeding.

ANEURYSM

An aneurysm is an outpouching in the wall of a blood vessel that forms at a point where the wall is weak. Although the weakness may be present at birth, the aneurysm usually forms and grows later in life. The outpouching may go unnoticed for years, or may suddenly rupture, in which case it can sometimes be fatal. The peak age range for an aneurysm rupture is between 40 and 60 years old. Aneurysms sometimes run in families; some are associated with other diseases. About a quarter of patients with one aneurysm will have additional ones.

The major impact of an aneurysm is the result of the rupture and bleeding, but the event may be followed in a few days by a secondary constriction of blood vessels, known as vasospasm. The vasospasm may be so severe that it impairs blood flow to the brain and causes a secondary ischemic stroke. Some advances have been made recently in treating vasospasm by using medications such as nimodipine (Nimotop), increasing the blood volume (usually done with intravenous fluids), or using medications to increase blood pressure.

An aneurysm can be treated surgically by placing a clamp at the base. The timing and type of surgery varies with the size and location of the aneurysm, the extent of the bleeding, and the neurological status of the patient. Under ideal circumstances, the surgery should be performed within 48 hours after the hemorrhage. This eliminates the risk of rebleeding. Surgery attempted five to ten days after a subarachnoid hemorrhage may cause, or worsen, vasospasm.

Occasionally an aneurysm will be found before it ruptures. It may be found because it is has pushed against important nerves or areas of the brain, causing pain or other symptoms, or because clots formed in the pouch of the aneurysm have traveled downstream and occluded a blood vessel, causing a TIA or stroke. Surgical clipping is usually recommended for unruptured aneurysms more than 10 mm (two-fifths of an inch) in diameter.

ARTERIOVENOUS MALFORMATION

An arteriovenous malformation (AVM) is a tangle of arteries and veins without the small vessels (capillaries) that normally connect the two. The walls of the vessels are often thin and have high rates of blood flow, conditions that predispose to bleeding. AVMs may produce symptoms by bleeding, putting pressure on structures within the brain, or shunting blood away from normal areas of the brain.

Small AVMs may not need to be treated, but when they are large or they cause significant symptoms, attempts should be made to obliterate them. This can be done surgically, by using radiation, or with a relatively new radiologic technique that delivers small pellets of glue that occlude the vessels leading to, and within, the AVM. Unfortunately many AVMs tend to recur.

Despite dramatic advances in our ability to diagnose the causes of intracerebral hemorrhages, the results of treatment remain disappointing. Mortality remains high, and problems in those surviving are often severe.

OTHER FORMS OF STROKE

In addition to the major causes of stroke described above, there are a number of other causes, including the two most common ones: cardiac arrest and hematomas adjacent to the brain. In cardiac arrest, the heart stops pumping blood or does not pump effectively, and the brain is deprived of both oxygen and glucose. Although the entire brain is affected, certain areas are more vulnerable. Memory and coordination are among the most frequent deficits after this type of stroke.

Hematomas—accumulations of blood that are the result of hemorrhage—sometimes occur in the outermost covering of the brain, the subdural or epidural layers. These are usually caused by injury, but may occur spontaneously, especially in the elderly. In this type of stroke, surgery can usually correct the problem by removing the clot, and maybe lifesaving.

DIAGNOSING AND ASSESSING STROKE

Anyone experiencing symptoms of a stroke requires immediate medical help. Even if the ultimate diag-

nosis is not stroke, many diseases that can mimic a stroke are also medical emergencies.

If a physician cannot be contacted by telephone, the person should be taken to the nearest hospital emergency department at once. Many types of stroke require immediate treatment, and most of the promising new therapies for stroke are effective only if started within a few hours of the onset of symptoms.

A variety of diagnostic tools are available to the physician, from history-taking and trained observation to sophisticated radiologic imaging studies. The tests performed will vary with the type of stroke, its severity, and the planned therapies. Regardless of the tests used, the goals are the same: to exclude nonvascular reasons for the neurological symptoms and to pinpoint the cause, location, and extent of the stroke.

HISTORY AND EXAMINATION

Perhaps the most important diagnostic tool is the initial history and physical examination of the patient. Critical details about the medical history may have to be obtained from a family member if the patient is disoriented or unable to speak.

During the examination, the physician will test a variety of neurological functions: orientation, memory, emotional control, motor skills, tactile sensation, hearing, vision, and the ability to read, write, and speak. Using knowledge of brain anatomy and function, a neurologist can usually identify the area of the brain that is damaged by noting the specific symptoms. For example, difficulty with walking and balance is likely due to damage to the cerebellum. Specific deficits on one side of the body point to damage in the opposite cerebral hemisphere.

The general examination should also include a search for evidence of high blood pressure, coronary heart disease, or disease in other parts of the vascular system. Using findings from the history, neurological examination, and general examination, the physician will formulate an initial opinion about the location and type of stroke. Laboratory and radiological tests will then be ordered to help confirm or exclude the physician's initial suspicions.

LABORATORY TESTS

Tests are usually done on samples of blood, urine, and, occasionally, cerebrospinal fluid (fluid around the brain and spinal cord). They focus initially on excluding conditions that can mimic or worsen a stroke, such as infection or low levels of blood sugar. Screening may also be done for diabetes, elevated blood cholesterol, bleeding disorders, and abnormalities in blood proteins—risk factors for cardiac disease and recurrent stroke.

IMAGING STUDIES

Computed tomography (CT) scans and magnetic resonance imaging (MRI) are techniques that produce anatomic pictures of the brain. Computed tomography scans use multiple X-rays and computer reconstruction to create cross-sectional images of internal structures. Magnetic resonance imaging uses magnetic fields to create images. Each has advantages in different circumstances. Because these scans can delineate (and thus help exclude) such conditions as tumors, abscesses, and bleeding from trauma, they are often done early after a stroke. They can usually differentiate ischemic strokes from those that are due to bleeding.

The studies are often repeated several days after the onset of a stroke to determine its size and because the full extent of the damage may not be seen until then. If a patient's condition worsens, the tests may be repeated in order to help determine the cause of the deterioration.

Magnetic resonance devices are also capable of spectroscopically (based on spectrums of light) measuring chemicals within the brain. These measurements may be important in determining the mechanism of a stroke and the prognosis and best therapy for a particular stroke victim.

CARDIAC EVALUATION

An electrocardiogram (ECG) is usually the first step in a cardiac evaluation. An ultrasound examination (echocardiogram) of the heart may help pinpoint a source of an embolus.

ANGIOGRAPHY

Angiography involves the injection of a dye or contrast medium into an artery in order to study the blood vessels via X-ray pictures. It can be used to detect many of the abnormalities that cause stroke, including narrowing or occlusion of a blood vessel, embolus, atherosclerosis, dissections, arteriovenous malformations, and aneurysms.

Because angiography is an invasive technique, in that it introduces instruments and substances into the body, it may be associated with serious complica-

tions. These include inducing or worsening a stroke, allergic reactions to the contrast medium, and, very rarely, death.

Newer techniques using magnetic resonance imaging can be used to produce an angiogram noninvasively. As these images continue to improve in quality, they may replace conventional angiography.

ULTRASOUND

Ultrasound is a noninvasive technique that uses sound waves and their echoes to visualize structures and blood flow within the body. Two types of ultrasound are used in stroke diagnosis carotid ultrasound (to measure flow in the carotid arteries) and transcranial Doppler (to measure flow in the intracranial arteries). Although the anatomical information it produces is not as precise as that obtained through angiography, ultrasound has the advantages of being painless and risk-free. It is often used to screen patients before invasive studies are done.

BLOOD-FLOW STUDIES

Blood-flow techniques-such as positron emission tomography (PET), single-photon-emission computed tomography (SPECT), and xenon inhalation—provide information on blood flow in the brain. These tests may show changes immediately after the onset of stroke symptoms, while computed tomography or magnetic resonance imaging may remain negative for several hours or days after a stroke.

The role of these tests is still being defined, and they are generally available only in large medical centers. They may be useful in determining the mechanism of a stroke (e.g., carotid stenosis) or determining prognosis early in the hospitalization.

STROKE TREATMENT

The primary goals of stroke treatment have changed, thanks to new drug therapy. Doctors now attempt to halt the progression of the stroke and to prevent recurrence. In years past, when it was believed that all brain cells died after about four minutes without blood flow, stroke was considered to be largely untreatable. Spurred on by observations in animals that at least partial recovery can occur after even an hour of complete ischemia (lack of oxygen), researchers have discovered that regions of the brain with very minimal blood flow can survive-although they do not function normally-for several hours or perhaps days. These viable cells surrounding an infarct, called the “ischemic penumbra," are the focus of numerous experimental drug therapies aimed at restoring blood flow or preserving cell function.

As researchers learn more about the mechanisms of stroke, they are realizing that it is not simply a lack of blood flow that causes death of tissue; a progression of other processes (including inflammation and toxic buildup), called the ischemic cascade, may play an even greater role in causing lasting necrologic damage. Doctors believe that if they can interrupt this cascade, they may be able to prevent the devastating brain damage that was once the inevitable consequence of stroke.

TREATMENT OF ACUTE STROKE

Most treatment of stroke during the acute phase centers on maintaining fluids and electrolytes (chemical substances in the blood, such as sodium and potassium), avoiding low blood pressure (hypotension), and avoiding the secondary complications of stroke and paralysis. The latter includes pneumonia, urinary tract infections, muscle contractures, and pressure breakdown of the skin (bedsores). The physician will also attempt to anticipate and avert deterioration after a stroke. This will require constant monitoring and evaluation and may necessitate a number of laboratory tests.

Anticoagulant medications such as heparin are sometimes used to treat an acute ischemic stroke. While heparin does not dissolve existing clots, it can prevent the formation of new ones. Thus it may help prevent subsequent strokes, which occur in up to 20 percent of ischemic stroke cases.

Because heparin can increase some patients’ tendency to bleed, its use is often restricted to those with the highest risk of recurrent stroke: patients with a progressing stroke, more than one TIA, or a cardiac source of embolism (often seen with myocardial infarction, atrial fibrillation, or valvular diseases). Related drugs known as heparinoids are now being evaluated and appear to be at least as effective, with a lower risk of bleeding.

Surgery is usually not used to treat an acute stroke, although it maybe indicated for a hemorrhagic stroke (subarachnoid and brain hemorrhages) or a recent blockage of a carotid artery.

LONG-TERM TREATMENT OF TIA AND STROKE

After the acute phase of a TIA or stroke has passed, emphasis is placed not only on recovery and rehabilitation but also on preventing further vascular events, including ischemic stroke and myocardial infarction. Therapy may include modification of risk factors, drugs, or surgery, or a combination.

Risk factors are discussed earlier in this chapter. Treatment of high blood pressure and diabetes, along with smoking cessation, are probably the most important. The effects on stroke risk of modifying other factors–controlling weight, lowering cholesterol, and moderating alcohol intake—are not as well studied, but these modifications are generally recommended. Treatment of additional risk factors is best considered on an individual basis in consultation with a physician,

ANTIPLATELET MEDICATIONS

Platelets are cell fragments that circulate in the blood and play a key role in the formation of clots. Medications that inhibit platelet function, such as aspirin, lessen the tendency of blood to clot. Patients at high risk of stroke are known to benefit in several ways from taking aspirin daily. Aspirin therapy lowers the risk of stroke and stroke-related death.

Unfortunately, aspirin therapy is complicated by the fact that the optimal dose is unknown. If the dose is too low, the aspirin will not have an effect on the platelets; if it is too high, it may cause the blood vessel walls to release chemicals, resulting in the formation of more clots. Most authorities recommend between 325 and 1,200 mg aspirin per day (one to four tablets), a higher dose than that usually recommended to prevent a heart attack. More recent evidence suggests that doses as low as 80 mg per day may also have a protective effect.

Although aspirin has been shown to reduce the risk of stroke, it may not' be appropriate for all patients, For example, it should not be used in patients whose blood pressure is not normal. Before beginning any treatment, even as simple as aspirin therapy, a patient should consult his or her physician. Aspirin should always be part of a larger program directed at all aspects of vascular disease prevention.

Ticlopidine, a relatively new antiplatelet medication, appears to be about 15 percent more effective than aspirin in reducing the risk of stroke in people who have had a TIA or minor stroke. This slight improvement in efficacy must be weighed against more serious side effects such as rash, diarrhea, and lowered white cell counts, and higher cost.

ANTICOAGULANTS

Like antiplatelet medications, anticoagulant drugs also interfere with the clotting mechanism, in this case by affecting the action of enzymes necessary for clotting. A commonly used anticoagulant is warfarin (Coumadin). Because it is a more powerful drug than aspirin, it is usually recommended only when aspirin therapy has failed or when it is clear that the source of the clots is the heart (e.g., when the patient has atrial fibrillation or has had a myocardial infarction or valvular heart disease).

Patients taking warfarin must be carefully monitored via periodic blood tests, known as prothrombin time tests, that measure the speed of clotting. Without monitoring, the dosage may be too low, increasing the risk of stroke, or too high, increasing the risk of bleeding complications. Patients also need to be aware that certain medications and foods (leafy green vegetables such as spinach and other foods high in Vitamin C) can alter the effectiveness of warfarin. However, dietary restrictions are not usually advised for patients on anticoagulants.

SURGERY

The goal in surgery is to provide a pathway for blood to get to the brain. This is most commonly done using a procedure known as carotid endarterectomy, in which a stenosis (narrowing) or ulceration of an atherosclerotic plaque in the carotid artery is removed.

Similar interim results were released in 1991 from two large studies of carotid endarterectomy. Participants in the study had experienced either a recent TIA or a nondisabling stroke, and each had a carotid-artery blockage of more than 70 percent. Participants who underwent endarterectomies showed a sixfold reduction in strokes, compared to those who did not have surgery. This dramatic result suggests that carotid surgery is likely to play a key role in the prevention of recurrent stroke in the coming years.

There are, however, several important points that should be made in interpreting these results. First, the carotid narrowing must be in a particular portion of the artery. For example, if a patient has a small stroke in the left brain hemisphere, this is not an indication for surgery on a narrowed right carotid artery. Secondly, these studies were carried out at leading medical centers that have low complication rates. Thus, the results suggest that carotid surgery, in the best of circumstances, reduces the risk of stroke. Whether this will hold true for all hospitals remains to be demonstrated. Finally, as physicians

better understand stroke risk factors, it maybe possible to use even more precise criteria to select patients for surgery. For example, even considering the group of people with the most severe carotid narrowing, there are many who will not have a stroke. Using risk stratification models and blood flow measurements, it maybe possible to identify people who do not require surgery, even though they may have a carotid-artery blockage of more than 90 percent.

Despite the encouraging results of these two studies, there are still no answers for people with a carotid artery narrowing of less than 70 percent or for those who have not yet had a stroke or TIA. These questions are being investigated actively in clinical studies, and results should be available in the next few years.

Although conceptually appealing, the removal of a carotid stenosis is not without risk: There is a 10 percent complication rate across the United States. There is evidence to suggest that only medical centers where the complications and mortality rates are less than 6 percent should be performing the procedure.

Another way of providing blood to the brain is via a procedure known as extracranial-intracranial bypass, which involves connecting an artery from the scalp to one on the surface of the brain through a surgical opening in the skull. This procedure was recently tested in a large cooperative trial and was not demonstrated to be beneficial; it is not recommended at this time.

RECOVERY FROM A STROKE

Recovery after a stroke is dependent on many factors: the specific site of the brain injury, the general health of the patient, his or her personality and will, family support, and the care received. The best recovery is usually seen in a patient who has had a small ischemic stroke. Large subarachnoid hemorrhages pose the most difficult challenge for recovery. Nevertheless, there are few solid rules for prognosis, and each case should be considered on an individual basis.

Caring for a patient after a stroke is a multifaceted and often complex process. The care must include helping the patient recover from deficits (such as weakness of an arm or leg or an inability to speak clearly) and learn to function with any losses, dealing with the patient's emotional issues and those of the family, and preventing recurrent strokes.

REHABILITATION

In the immediate poststroke period, medical personnel care for the patient's physical needs in order to reduce the risk of complications. Patients who have difficulty swallowing, for example, may need to be fed intravenously until they are able to swallow water and food adequately. Most patients will be able to get out of bed for increasingly longer periods within two to three days and be able to leave the hospital in ten days to two weeks.

Planning for rehabilitation should begin as soon after the stroke as possible. Early attention to weak limbs can greatly improve the chances of a successful recovery. Simple measures such as frequent position changes while in bed and exercise of the paralyzed areas (including moving the arms and legs by physical therapists, nurses, and family members) can improve the circulation, maintain joint flexibility, maintain normal muscle tone, and get the family and patient involved in the recovery process. Physical therapy generally starts within four or five days after the stroke.

The rehabilitation process becomes more active as the patient becomes medically stable (usually within a day or two). Passive range-of-motion exercises, in which a family member, nurse, or physical therapist performs most of the movement, are replaced by active range-of-motion routines, in which the patient strives to regain strength in the affected limbs.

The efforts of the rehabilitation team also must focus on the mental aspects of recovery-not only to help patients overcome deficits in knowledge or memory, but also to help prepare them for the long recovery process and encourage them to lead lives as full as possible with the abilities they retain. It is important to keep in mind that many people have fought their way back from a stroke and continued to lead useful and fulfilling lives. Patients with the ability to make decisions should be included in family decision-making.

No program can succeed without a strong desire by the patient to be independent. Nevertheless, family involvement is also a key ingredient in a successful rehabilitation program. The family can provide a positive environment for the patient, nurturing the desire to be independent while reassuring the patient that he or she is still wanted, needed, and loved. Often giving a patient something to do, and to live for, is half the battle.

The family is also important because although most patients are able to leave rehabilitation facilities to return to their families, often they continue to have

Possible Consequences of Left- and Right-Brain Injury

Damage to the left side of the brain

Right-side paralysis
Speech and language deficits
Slow, cautious behavior
Memory problems related to language
Right-side neglect (less common than left-side; see below)

Damage to the right side of the brain

Left-side paralysis
Spatial-perceptual problems
Left-side neglect
Quick, impulsive behavior
Memory problems related to performance

some problems and their recovery process must continue at home. Family members should take as much of the responsibility for physical therapy at home as is practical. A nurse or physical therapist visiting the home for a few hours a week cannot alone provide the sustained encouragement and the level of activity needed to facilitate recovery.

Beyond the patient and family, rehabilitation is a team effort with input from physiatrists (rehabilitation physicians), neurologists, nurses, physical therapists, occupational therapists, speech therapists, and social workers. Their common goal is to help the patient and family achieve the maximal level of functioning possible.

Most stroke patients will need several types of therapy, described below, but the mix and amount of each will be tailored to the patient's needs and symptoms. Although symptoms of brain damage vary widely, some generalizations can be made. A common way of characterizing stroke injury is by the side of the brain affected. An injury to the right side of the brain that results in paralysis—temporary or permanent—will affect the left side of the body. Conversely, right-sided paralysis is the result of injury to the left side of the brain. Certain language problems and changes in behavior are also associated with left- or right-side damage. (See box, "Possible Consequences of Left- and Right-Brain Injury.")

PHYSICAL THERAPY

The primary objective of physical therapy is to help patients who are partially paralyzed learn to walk again. Starting slowly, the therapist will first work with the patient on simple exercises to increase range of motion and muscle tone. Once the patient is able to turn over and sit up unsupported, the therapist usually will have the patient try to start walking. A patient learns to walk while holding on to a bar for support, and then with the aid of a quadruped cane (one with a sturdy four-footed base) and, usually, ankle-foot braces for stability. An estimated 75 percent of all stroke survivors are eventually able to walk independently and will regain most of their ability by the end of the first month.

OCCUPATIONAL THERAPY

Although the ultimate goal is to help the patient resume some sort of employment, if possible, occupational therapy encompasses all aspects of everyday life. Occupational therapists help patients regain the muscular coordination necessary to perform basic activities such as dressing, bathing, and using the toilet. A patient who is paralyzed on one side is taught how to maneuver clothing using the able side of the body, and is advised about clothing styles-such as pullover rather than buttoned shirts-that are easiest to maneuver. Patients are taught how to use a wheelchair, and how to transfer from bed to wheelchair and vice versa. The occupational therapist will also advise the family about changes that can make a patient's move back home easier and safer: handrails in the bathtub and by the toilet, a raised toilet seat, and ramps in place of stairs, and widened doorways to accommodate a wheelchair, if one is still necessary.

SPEECH THERAPY

Two disorders that may occur after a stroke are *aphasia* (difficulty with language) and *dysarthria* (difficulty with articulation). Aphasia and dysarthria are not necessarily associated with a loss of the ability to think or understand.

Dysarthria is caused by weakness or paralysis of muscles in the face, mouth, neck, or throat. It can result in slow, labored speech, slurring of words, or a change in voice quality. Often the paralysis of the face muscles causes drooping of one side of the face and perhaps drooling.

Most stroke patients with left-brain injury have some degree of aphasia. It manifests itself in different ways in different patients; there may be difficulty making oneself understood, comprehending others' words, or reading, writing, or doing arithmetic. The complexity of the problem mirrors the complexity of

the communication process, which involves on the one hand organizing thought, finding the words to express it, and producing the words, and on the other hand perceiving that someone wants to say something to you, following the words as they are spoken, and then comprehending the message in its entirety.

Aphasia may be equally frustrating for the patient and the family and friends, who may feel they can no longer communicate with the patient. Imagine waking up into a world where you mean to say one thing and something completely different comes out of your mouth, or one where your family seems to be speaking a foreign language that you cannot comprehend. This is what an aphasic patient may experience. But with the help of a speech therapist and a cooperative family, a stroke survivor has an excellent chance of regaining communication skills. If the patient is not able to produce speech specifically, that does not mean he or she cannot use and comprehend language in the larger sense of the word, which encompasses other communication tools such as gestures, movements, facial expressions, and noises.

A speech therapist should lay the groundwork while the patient is in the hospital, first working to obtain from the patient reliable (verbal or nonverbal) yes or no responses to questions. Then the therapist uses a variety of techniques, including repetition and pointing to pictures, to reestablish the fundamentals of language. In most cases, the knowledge of language hasn't been eradicated, and patients just need to regain their ability to recall what they have learned in the past. As with other memory losses, the patient will often regain ability to remember events that happened in the distant past, but will not be as able to remember things that happened in the very recent past—where he or she left a hat ten minutes ago.

ADJUSTING AFTER A STROKE

Rehabilitation may continue on an outpatient basis after the patient has returned home, and recovery may continue for months or even years. The most dramatic changes occur in the first three to six months or so; smaller changes may continue for long afterward.

There are no clear guidelines for how much activity benefits stroke patients and how hard to push them. They should be pushed hard enough to be challenged, but not so hard as to be continually frustrated. Recovery from a stroke can be a painfully slow process. Both family and patient should take time to note successful efforts, and family members need to offer positive feedback, encouragement, and praise.

The stroke does not just happen to the patient-it happens to the family as well. Understanding how strokes can affect patients will make it easier for families to deal with the recovery process. Some of the major behavioral, cognitive, and emotional effects are discussed below.

APHASIA

The lack of ability to communicate may sometimes improve rapidly—within a few days or a week—but in many cases, recovery is a long process. The recovering aphasic patient needs stimulating and understanding companionship. In addition to helping these people feel loved and supported, engaging them in conversation and activity reinforces language skills. A patient who is left alone with little to do will progress much more slowly than one who is made to feel a part of the family, or has simple, arousing things to do, such as looking through a picture magazine.

Just as parents can grasp what toddlers mean when they gurgle or grunt or use made-up words, family members can often learn to understand the patient's limited, disjointed, or inappropriate speech during the first few weeks after the stroke. Patients may say "car" when they mean "couch," and may not realize that they are not being understood. They may use swear words that they never uttered before the stroke, or repeat the same word over and over. Family and friends can learn to speak slowly, use simple words and short sentences, and repeat them if necessary. A variety of computer software designed to help in language retraining is now available,

It is important for the family and friends neither to overestimate nor underestimate what the recovering patient understands. If the patient says yes or smiles and nods in agreement with something that is said, he or she may be responding to the speaker's facial expression or expressing pleasure about being spoken to. A speaker who consistently overestimates what the patient understands will become annoyed that the patient doesn't follow through and may decide that the patient is forgetful or uncooperative. Or the speaker may talk too much, thus overloading the patient and interfering with any understanding the patient may have. Unrealistically high expectations about what the patient should be able to do can be

Tips on Communicating with Stroke Survivors

When someone has difficulty speaking or finding the right words

- Help the patient point to the object he or she is trying to name, gesture the meaning of the word, or use other words to describe it.
- Respond positively to any nonverbal or verbal effort to communicate.
- Provide sentences to complete, such as "You said you're hungry for a ——?"
- Do not be bothered by slurred speech; accept the patient as he or she is every step of the way.
- Encourage talking as much as possible. The more words the patient uses, the more likely will be the recovery of speech.
- Work learning games into activities, such as asking the patient to name the foods he wants to eat, rather than using drills or doing obvious exercises like reciting the alphabet or counting.
- Write the name of an object in large letters as you show it to the patient.
- Once a patient learns a noun, such as "coffee," introduce the verb associated with it—such as "drink coffee," "drive car," "brush hair."

When someone has difficulty understanding speech

- Use short, concrete sentences, leaving out unnecessary words. For example, instead of saying "I'm going to go to the store now to buy some bread," say "Going, store, bread."
- Speak slowly and pause between sentences.
- Use visual aids such as pictures, or point to objects.
- Gesture as you speak.
- Keep background noise to a minimum when speaking.
- Do not shout.
- If the patient seems not to understand you, repeat or rephrase your request.
- Emphasize key words.

When someone has difficulty reading

- Buy simple books with large type and read them aloud to the patient until he or she is ready to try reading aloud.
- Show a picture of a written word.
- Underline key words.
- Gesture the meaning as the patient reads a difficult word.

When someone has difficulty writing

- The patient should start off printing very large letters, especially if paralysis means having to learn to write with the hand opposite from the one he or she is used to.
- Have the patient copy letters and words.
- Write words as you say them.
- Have an alphabet board visible when the patient is trying to write to help locate letters he or she is having difficulty recalling.

very frustrating for both patient and family. On the other hand, if the patient's cues that he or she does understand are missed, family members are less likely to continue to engage the patient in communication, which can have devastating effects on emotions and recovery. To avoid either extreme, family members need to be sensitive to nonverbal cues as well as verbal responses and to test understanding occasionally by saying something improbable and noting the patient's response. (See box, "Tips on Communicating with Stroke Survivors.")

OTHER NECROLOGIC DEFICITS

Family members can also help lessen the impact of other necrologic-behavioral changes. If patients have difficulty remembering recent events, it is important to remind them of their recent successes in regaining functions. Patients with left-brain damage (with or without right-sided paralysis) are often slow, cautious, and disorganized when faced with an unfamiliar situation-even if their behavioral style was quite different before the stroke. Family members can help the patient by giving positive feedback for things done correctly. Patients with right-brain damage, on the other hand, tend to act impulsively and hastily; they are often poor judges of their own abilities and safety. Family members can help by reminding patients to take things slowly and carefully.

Some stroke patients suffer a loss of half of their visual field in each eye. Some patients, particularly those with right-brain damage, also have one-sided neglect: they do not compensate for their visual loss by turning their heads. Rather, they ignore everything—including objects and even sensations—on the side of the body where vision is impaired. Often a patient will not even recognize an arm or leg as being part of his body. People may have to approach patients from their unimpaired side in order to be noticed. Putting objects on the patient's good side—

such as clothes only on one side of the closet—can make management easier.

Deficits in spatial relations-judging the size, position, distance, or speed of objects, for example—are common among people with right-brain damage. This can create problems for self-care, making it difficult for a person to button a blouse correctly, steer a wheelchair without bumping into obstacles, read a newspaper without losing his or her place, or even sip soup from a spoon.

Other common, but not universal, problems that may occur following a stroke include:

- Poor concentration
- Poor judgment of time
- Disturbed sleep cycles
- Impaired memory
- Impaired judgment
- Loss of sexual desire
- Poor emotional control
- Depression

EMOTIONAL IMPAIRMENT

Often families and patient focus on the physical impairments after a stroke. These are readily apparent and easily understood. But the brain is also responsible for our thoughts and emotions. It is this aspect of damage after a stroke that is often the most difficult to deal with.

People who have recently suffered a stroke may have a loss of emotional control because of damage in the area of the brain that controls emotions. As a result, they may cry or laugh suddenly, often inappropriately, at times when they do not feel especially sad or happy. Some patients may become irritated and express anger with little provocation. Simply distracting the patient can often interrupt the emotional behavior.

On the other hand, true depression is not uncommon in stroke patients, whose lives have been changed drastically and who feel discouraged or hopeless. In part this can be a natural reaction to a devastating disease and the often slow and difficult recovery process. Often it is also caused by damage to areas of the brain and by neurochemicals responsible for mood and motivation. Signs of depression include excessive crying (which cannot be easily interrupted], fatigue, sleep and eating disorders, and loss of interest in activities. Support from family members and an emphasis on the positive progress that has been made—without ignoring the existence of deficits-can be helpful. Antidepressant medications can be prescribed for patients whose downheartedness is hampering their progress.

Problems such as sexual dysfunction, loss of self--esteem, and difficulties in family relationships are best dealt with openly and with the help of trained medical personnel. These are important issues for quality of life following a stroke and should not be ignored. The important thing to remember is that many of these conditions can be helped. Sometimes just the knowledge that this is a common problem and that it is often self-limited is enough to get the patient and family back on track. In more serious cases, therapy (personal or family) and medications may be necessary. The key is to speak frankly and keep the physician and other health care personnel informed.

PHYSICAL ACCOMMODATIONS

Planning for returning home after a stroke may require some physical adjustments in the house. Many of these are simple and can be done by the family (rubber shower mats, soap enclosed in a cloth pouch to avoid slipping, handgrips, and removal of small scatter rugs); others may require more detailed planning and construction (ramps, lowered counters, high toilets, changing the height and location of light switches). Useful devices such as one-handed card holders, rocker knives, nonskid mixing bowls, and modified telephones can be purchased, often through specialized catalogs. These modifications are best planned in conjunction with occupational therapists and by sharing experience with other families through local support groups, such as stroke clubs.

TOWARD THE FUTURE

Several exciting approaches to stroke therapy are under investigation. All are in, or near, clinical testing in humans.

One investigational approach is thrombclytic therapy—the use of drugs such as t-PA {tissue plasminogen activator) to dissolve a clot and reopen the occluded vessel causing the stroke. This therapy has already proved successful in treating heart attacks

and shows promising early results in stroke patients. The major drawback is an increased risk of bleeding.

Another approach is to route blood flow around the occlusion through small collateral vessels, after making these vessels larger by, for example, using vasodilating agents such as calcium channel blockers. An alternative is to lower the viscosity (thickness) of the blood (by, for example, adding plasma expanders) in order to make the flow through the small vessels easier.

Researchers are also attempting to determine the chemical reactions that lead to permanent damage during a stroke. Once these are understood, it may be possible to inhibit these harmful reactions selectively and lessen the damage. Calcium-channel-blocking drugs, already being used to treat other cardiovascular conditions, may help reduce the damage caused by a stroke.

Other drugs being investigated also work to protect the nerve cells. These include the NMDA-receptor blockers.

One of the newest areas of investigation is restorative neurology, which studies how the brain and nerves repair themselves after injury. Current medical wisdom says that in adults, nerve cells do not divide in order to create new cells, so that damaged brain cells cannot be replaced. This maybe only partially true. While cell regrowth is not yet possible, it may be possible to influence how neurons communicate with each other after injury.

Nerve cells are "connected" to thousands of other nerve cells through connections called synapses, which change after injury to the brain. It appears that gangliosides, a class of molecules on the surface of neurons, help new synapses form. By giving stroke patients extra amounts of gangliosides, it may be possible to increase the number of synapses, permitting the brain to develop a wider variety of compensatory brain circuits and minimize the deficits. This therapy, now in clinical trials, would not change the size of the stroke, but could improve outcome for the patient.

SUMMARY

Neurology is on the verge of major breakthroughs in stroke treatment that hold promise for being able to drastically reduce the effects of stroke. But despite advances in treatment, prevention remains the most effective way of decreasing the national burden caused by strokes. Patients at risk must work with their doctors to reduce their likelihood of falling victim to a disabling stroke. Life-style changes and better management of high blood pressure have already been responsible, along with better treatment of strokes when they do occur, for a more than 50 percent decrease in stroke deaths over the past 20 years.