Ischemic Penumbra. In an ischemic stroke, there are two main areas of injury (Figure 7-5). The first area is the zone of ischemia. Because of the blockage in the artery, there is little blood flow through this area. As a result, brain tissue previously supplied by the blocked vessel is deprived of O₂, glucose, and other essential nutrients. Unless blood flow is quickly restored, nerve cells and other supporting nervous system cells will be irreversibly damaged or die (infarct) within a few minutes of the blockage.

The second area of injury is called the ischemic penumbra (“transitional zone”). The penumbra is a rim of brain tissue that surrounds the zone of ischemia. It is supplied with blood by collateral arteries that connect with branches of the blocked vessel. The size of the penumbra depends on the number and patency of the collateral arteries. Blood flow to brain tissue in this area is decreased (between 20% and 50% of normal), but not absent. Brain tissue in the penumbra is “stunned” but not yet irreversibly damaged. Because the collateral blood supply is not enough to maintain the brain’s demand for O₂ and glucose indefinitely, brain cells in the penumbra may live or die depending on how quickly blood flow is restored in the early hours of a stroke.

The time from onset of stroke symptoms until treatment is a key factor for success of any therapy. The earlier the treatment for stroke, the more favorable the results are likely to be. Blood flow needs to be restored to the affected area as quickly as possible. To date, only intravenous (IV) administration of a recombinant form of TPA (tissue plasminogen activator) (RTPA) has been proven to be effective. Intra-arterial fibrinolysis has been studied for treatment of selected patients with major stroke of less than 6 hours duration due to blockage of the middle cerebral artery. Studies have shown that intraarterial administration of fibrinolytics is associated with a reduction in mortality and an improvement in favorable outcomes after a stroke. However, it is also associated with an increased risk of hemorrhagic complications. At present, no evidence is available to show that intraarterial fibrinolytic therapy is better than IV treatment.

The window of opportunity to use IV RTPA to treat ischemic stroke patients is 3 hours. To be evaluated and receive treatment, patients need to be at a hospital within 60 minutes of symptom onset. Unfortunately, some stroke victims and their family members usually either cannot seek or fail to seek medical attention fast enough, precluding the use of RTPA.