# CT and MR Imaging in the Acute Ischemic Stroke Patient: A Nursing Perspective

■ Debbie Summers, MSN, ACNS-BC, CNRN; and Rachel Malloy, MSN, RN, CNRN

***ABSTRACT:*** **Historically, computed tomography (CT) head scan is the first diagnostic test for stroke-like symptoms. CT rules out hemorrhage immediately but a magnetic resonance (MR) imaging is more sensitive to early ischemia. New advances in CT and MR imaging techniques provide data to differentiate between reversible and irreversible brain damage with accurate identification of the site of arterial occlusion. The additional data may guide the stroke team in determining if the patient can safely be treated beyond the 0- to 3-hr window. Extending the window for treatment substantially increases the number of patients receiving stroke reversal. Nurses play an integral role in facilitating appropriate treatment and providing care to optimize patient's clinical outcome. The purpose of this article was to discuss the clinical application of CT and MR imaging, define its purpose in acute ischemic stroke treatment, and guide stroke nurses in understanding the advanced concepts of imaging. (J Radiol Nurs 2011;30:104-115.)**

***KEYWORDS:*** **MRI; Multimodal CT; Penumbra; Cerebral perfusion; Ischemic stroke.**

Stroke is now the fourth leading cause of death in the United States (Ovbiagele & Nguyen-Huynh, 2011). This is an improvement after five decades in third place behind heart disease and cancer (Ovbiagele & Nguyen-Huynh, 2011). The 2010 Centers for Disease Control and Prevention report, *Deaths: Preliminary Data for 2008*, found that age-adjusted stroke death rates had declined by 3.8% between 2007 and 2008 (Miniño, Xu, & Kochanek, 2010) Each year 795,000 people suffer from a stroke with an estimated direct and indirect cost of 73.7 billion dollars according to the *2010 Heart Disease and Stroke Statistics* (Lloyd-Jones et al., 2010). In 1995, intravenous (IV) recombinant tissue plasminogen activator (rt-PA) was approved by the Food and Drug Administration (FDA) for the treatment of acute ischemic stroke (AIS) within 3 hr of symptom onset (The National Institute of Neurological Disorders and Stroke rt-PA Study Group, 1995). The European Cooperative Acute Stroke Study III (ECASS III) results showed evidence of safety and efficacy in administering IV rt-PA up to 4.5 hr with additional exclusions including persons older than 80 years, those with baseline National Institute of Health Stroke Scale (NIHSS) > 25, those taking oral anticoagulants, and those with history of previous stroke and diabetes (Hacke et al., 2008; del Zoppo, Saver, Jauch, & Adams, 2009). Clinical research in endovascular AIS therapy has extended the treatment window to 6 to 8 hr (Jahan & Vinuela, 2009). Treatment options include intra-arterial (IA) rt-PA therapy up to 6 hr from symptom onset or mechanical retrieval up to 8 hr from onset (Abou-Chebl, 2011). If a patient is within the 0- to 3-hr window, IV rt-PA is the national standard of care and should be administered. Further treatment may include combined IV/IA treatment, using rt-PA or mechanical retrieval (Adams et al., 2007).

New advances in imaging has identified the concept of salvageable or viable brain tissue, also referred to as penumbra, and gives hope that stroke can be safely treated in an extended window to improve patient outcomes. To safely treat patients in an extended window of time and determine if treatment would be beneficial acute imaging must detect hemorrhage, differentiate between salvageable versus infarcted tissue, and identify intravascular thrombi (Rowley, 2001, 2005). This

*Debbie Summers, MSN, ACNS-BC, CNRN, and Rachel Malloy, MSN, RN, CNRN, are from Saint Luke's Brain and Stroke Institute at Kansas, MO.*

*Corresponding author: Debbie Summers, Saint Luke's Brain and Stroke Institute, 4401 Wornall Road, Kansas City, MO 64111. E-mail: dsummers@saint-lukes.org*

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article will discuss the clinical application of computed tomography (CT) and magnetic resonance (MR) imaging in acute stroke evaluation and nursing implications in the care of an ischemic stroke patient.

## CLINICAL SIGNIFICANCE OF PENUMBRA

Brain tissue has no neuronal energy stores and the ability to maintain neuronal viability is approximately 2 to 4 min when there is an absence of cerebral blood flow (CBF; Rowley, 2001). The collateral blood supply immediately tries to preserve the injured area by increasing blood pressure (BP) in an attempt to perfuse the brain (Rowley, 2001). In addition, blood supply may be redirected through the Circle of Willis and other collateral pathways in an attempt to supply blood to the hypoxic region (Rowley, 2001). Acute ischemia typically results in an irreversibly infarcted core area surrounded by hypoxic neuronal tissue that is called the penumbra (Figure 1; Rowley, 2001). Without revascularization to the potentially viable tissue (penumbra), the transition from ischemia to irreversible infarction depends on the availability of collateral flow and the duration of decreased blood flow (Rowley, 2001). These two factors will determine the size of infarct during an acute ischemic event. The presence of a penumbra can be evaluated by using CT and MR perfusion images and the findings are important in patient selection for extended therapies and indication of clinical outcome (Rowley, 2001).

## ROLE OF CT IN STROKE EVALUATION

The initial noncontrast CT scan of the head is the gold standard diagnostic test to identify old or sub-AIS and rule out intracerebral hemorrhage or stroke mimics such as neoplasm or infection (Lovblad & Baird, 2009).

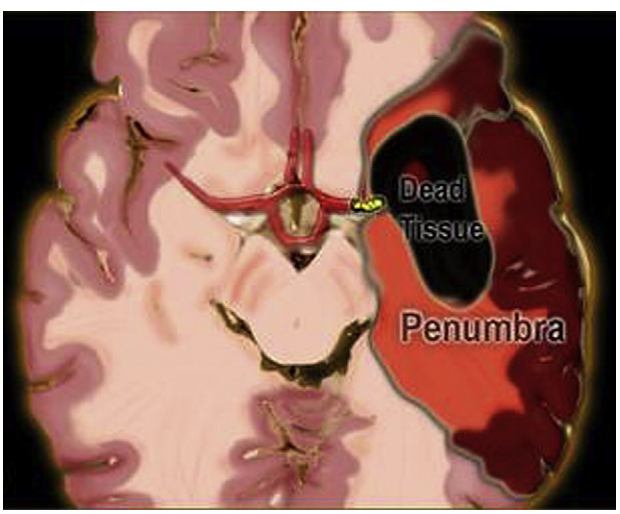


**Figure 1.** Illustration of dead tissue also called the core surrounded by viable tissue called penumbra. Color illustration online.


**Figure 2.** Hypodense tissue indicating stroke. Color illustration online.

Old or subacute ischemic tissue is seen as a hypodensity or dark area on the scan and indicates irreversible ischemic brain damage (Figure 2). Acute blood appears hyperdense or bright when compared with the surrounding brain tissue and can be observed on the noncontrast CT head immediately when the hemorrhage occurs. A subarachnoid bleed will have hyperdensity throughout the subarachnoid space (Figure 3). Although a noncontrast CT head is definitive in the early diagnoses of hemorrhagic stroke, this is not the case for ischemic stroke. Early signs of ischemia may be seen within the first 6 hr but pronounced hypodensity does not occur till 12 to 24 hr post infarct, which is beyond the window for reperfusion with thrombolytics (Ledezma, Fiebach, & Wintermark, 2009). Patients diagnosed with a hemorrhage on CT head are excluded from receiving IV rt-PA (The National Institute of Neurological Disorders and Stroke rt-PA Study Group, 1995). Patients with evidence of subacute ischemic tissue in more than one third of the middle cerebral artery (MCA) territory are also excluded from receiving rt-PA because of an increased risk of hemorrhage into the ischemic tissue (Ledezma et al., 2009).

Early in the ischemic process, the evidence of an ischemic stroke include hyperdense vessel sign, loss of insular ribbon, obscuration of lentiform nucleus, and sulcal effacement with loss of gray white matter differentiation (Sarikava & Provenzale, 2010; Figure 4). The