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Time Lost is Brain Lost: Impact of Ischemic Stroke

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Introduction

Stroke is the leading cause of functional impairment in the United States. Annually, 795,000 stokes occur with a mean lifetime cost estimated at $140,000 per person (Meschia et al., 2014). Every 40 seconds someone suffers a stroke, while every 240 seconds a stroke death occurs (Niemi, McErlane, & Tillett, 2013).

Stroke is the broad term often used to describe a neurological emergency, of either ischemic or hemorrhagic etiology, affecting blood flow to the brain. Both are medical emergencies requiring time sensitive medical intervention (Elder, Lemon, & Costello, 2015). Treatment modalities are comprehensively different; therefore, being able to differentiate early signs and symptoms are imperative for healthcare professionals.

Neurovascular imaging is required to differentiate between an ischemic or a hemorrhagic stroke. Use of a non-contrast computed tomography (CT) is fast and readily available to rule out hemorrhagic stroke or rule in a major ischemic stroke. Magnetic resonance imaging (MRI) has greater spatial resolution to diagnose minor ischemic strokes.

The topic of ischemic stroke was chosen in the interest of an upcoming Joint Commission Primary Stroke Center (PSC) accreditation survey.

Pathophysiology

Ischemic stroke deprives basic brain metabolic needs of oxygen and glucose. Cerebral ischemia develops from vascular blocking lesions commonly caused by atherosclerosis from lipid aggregation and inflammation. According to Holm et al. (2011), identified cytosolic fatty acid binding proteins are thought to play an important role in macrophage cholesterol interchange, affiliated inflammation, and plaque instability. Forty percent of all ischemic strokes are atherosclerotic in nature and 20 percent are due to thrombi or emboli (fibrin, platelets, or cholesterol crystals).

According to Davis, Miyares, and Dietrich (2015), excessive circulating lipids cause endothelial dysfunction by accumulating within extracellular matrix after continued exposure to free radicals, excess catecholamines, and inflammation increasing endothelium permeability. Combinations of innate and adaptive immune systems, vascular smooth muscle proliferation, and remodeling of extracellular matrix create atherosclerotic plaque. Plaque rupture leads to a cascade of events:

- Platelets activate following a plaque rupture forming a thrombus.
- Consecutively platelets adhere to the endothelial site injury inhibiting excess blood loss creating a plug formation of thrombin and thromboplastin.
- Following adhesion to injury site platelets become activated with the assistance of local tissue factor and release agonists thromboxane A2 and adenosine diphosphate (ADP) from platelet granules to enhance aggregation.
- G protein contributes by activating glycoprotein IIb/IIIa enhancing the thrombotic response.
- Activated platelets prompt glycoprotein IIb/IIIa receptors, crosslinking nearby platelets functioning like nets to trap additional blood cells and debris.
- Cascade of events induces thrombus growth as additional platelets release additional thromboplastic fibrin proteins.
- Thrombus growth reduces the lumen diameter restricting blood flow causing ischemia (figure 2).
- Ischemic neuron cells lead to ATP loss and glutamine release from synapses causing sodium and calcium ion gate porosity.
- Reactive oxygen species and inflammation lead to cytotoxicity-mediated cytokines.
- Microglia cells produce inflammatory cytokines, including interleuklin-1β (IL-β) and TNF-α (an immunomodulatory molecule linked to atherosclerosis and stroke), cascading to cell death activated by apoptosis.

Neurological functioning may alter with a 70 percent reduction in blood flow. However, patients can remain asymptomatic until there is a sudden reduction in blood flow created by a complete obstruction. When the brain is not adequately perfused with blood and deprived of oxygen and glucose as well as failure to remove lactic acid and carbon dioxide, nerve cells begin to die. Local edema results, compressing capillaries enlarging the ischemic area and reducing neuronal activity. Blood flow is still sufficient to keep tissue alive as witness by symptom recovery as oxygenated blood flow is increased. However, if swelling is severe, symptoms of increased intracranial pressure may occur. Various neurological, neuropsychiatric, and neuropsychological abnormities result depending on length of time and exact location of ischemia. Complete blood deprivation greater than three minutes produce neuronal, glial, and vascular necrosis and irreversible brain damage. A full symptomatic infarct may take minutes, hours, or even days to develop.

Case Study

A 66 year-old Caucasian female arrives via EMS at 12:25 pm with stroke presentation. Care team, including a physician, await patient arrival at the bedside. Background history: 11:00 am, the patient's spouse ran an errand. He returned 55 minutes later finding her lying on the floor. The patient exhibited slurred speech, right facial droop, and right hemiplegia with a National Institutes of Health Stroke Scale (NIHSS) of 19 upon arrival. No apparent signs of trauma noted. Medical history includes three positive modifiable risk factors: diabetes mellitus, hyperlipidemia, and hypertension. Current medications include: Metformin, Hydrochlorothiazide, and Simvastatin. Physical exam is unremarkable with B/P 146/86, HR 82, R 18, 99% SPO2 on room air.

A standard brain attack treatment order set was utilized. Lab results within normal limits include: electrolytes, renal, complete blood count with platelet count, cardiac markers, prothrombin time, international normalized ration, and activated thromboplastin time. Blood glucose was elevated at 120 mg/dL. CT scan at 12:35 pm with 12:40 pm read indicating absence of intracranial hemorrhage.

The patient has no contraindications to tissue plasminogen activator (tPA) and the patient's spouse agrees to treatment after outweighing risks and potential benefits of tPA administration. Drug was administered at 1:00 pm, 120 minutes after the patient was last seen normal. Drug administration was complete at 2:00 upon admission to the stroke unit. During the first 24 hours the patient regained strength in the right upper and lower extremities. Facial droop and slurred speech resolved, sensory exam is normal and repeat CT scan is negative prior to discharge.

Summary: The patient's modifiable risk factors were well controlled with current medications. A positive outcome resulted from rapid identification by the spouse, calling 911, and arriving within 85 minutes from last known normal permitted tPA administration as established by the American Heart Association (AHA)/American Stroke Association (ASA) guidelines of within three hours of symptom onset. National Institutes of Neurological Disorders and Stroke (NINDS) has established time frames for ED stroke care (Jauch et al., 2013). A positive outcome resulted from use of a standard treatment order set (handout), and guidelines established by AHA/ASA and NINDS.

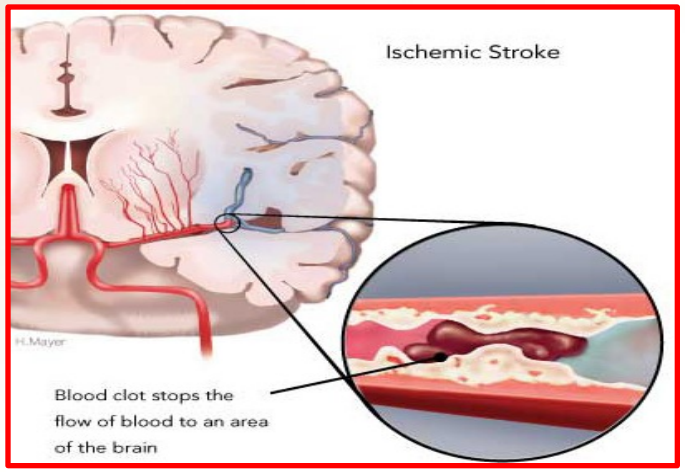

Figure 2 Heart and Stroke Foundation, 2014.

Conclusions

Stroke affects men and women equally in the United States, predominantly ischemic stroke. Oxidative stress and brain inflammation contribute to the pathophysiology of cerebral injury leading to cell apoptosis and death (Pascotini et al., 2015). Immune responses within the CNS and systemic inflammatory events play important roles in the progression, repair and stroke recovery.

Decreasing modifiable risk factors, public education and recognition, along with rapid relief of an arterial occlusion to restoration of prevalent blood flow will decrease the morbidity and mortality associated with ischemic stroke. For every minute of treatment delay, 1.9 million neurons, 14 billion synapses and 12 km of myelinated fibers are destroyed (Musuka et al., 2015, p. 891).

Research to reduce door to treatment times continues. According to Aston (2015), collaboration between hospitals and EMS providers proved beneficial by reducing time to treatment. Current research is examining benefits of placing CT scanners in ambulances with telemedicine support to paramedics administering tPA enroute. Field tPA administration will facilitate a direct angiography approach replacing time spent in ED's (Musuka et al., 2015).

The ASA recommends genetic and pharmacogenetic testing for future research in stroke prevention (Meschia et al., 2014).

Figure 1 American Stroke Association, 2016.

Signs & Symptoms

Stroke symptoms appear as sudden onset of neurologic deficits. Individuals experiencing any of the following symptoms should seek medical care immediately:

- sudden weakness of the face, arm, or leg, most often on one side of the body
- hemiparesis
- diplopia
- bulbar palsies
- dysphagia
- unilateral dysmetria and incoordination
- reduced level of consciousness.

Implications for Nursing

As an advance practice nurse (APN), a thorough understanding of the sequela of modifiable risk factors such as long-term coronary artery disease, left ventricular hypertrophy, congestive heart failure, hypertension, atrial fibrillation, diabetes, smoking, dyslipidemia, carotid stenosis, sickle cell disease, postmenopausal hormone therapy, diet, and obesity cannot be overemphasized. Hyperglycemia amplifies the degree of severity of ischemic injury contributing to poor neurological recovery and should be closely monitored by routine HbA1C testing. Hypertension reduces arterial elasticity, erodes endothelial cell lining and induces roughening of vessel walls making HTN the leading risk factor for stroke and should be measured routinely (Meschia et al., 2014). Reducing modifiable risk factors such as HTN, hypercholesterolemia, smoking, physical inactivity and obesity, should begin with education.

Education utilizing e-health and mobile messaging tools could include recognition of early signs and symptoms of this life-altering event to reduce morbidly and mortality associated with a stroke as well as strict instructions to call Emergency Medical Services (EMS) (Rasura et al., 2014). Patients arriving within three hours of symptoms achieved better outcomes than those seeking delayed care.

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HANDOUT

Use of Standard Treatment Order Set

According to Elder et al. “Current guidelines for ischemic stroke advocate the use of intravenous (tPA), the early use of thromboembolism (VTE) prophylaxis, anticoagulation in patient with atrial fibrillation (afib), and lipid lowering therapy.” (2015, para. 1). The Joint Commission (JC) requires eight mandatory standards and two optional standards for hospitals to receive Primary Stroke Center (PSC) status:

- Venous thromboembolism (VTE) prophylaxis
- Anticoagulation therapy for afib or flutter
- Thrombolytic therapy
- Antithrombotic therapy by end of hospital day two
- Discharged on statin therapy
- Discharged on antithrombotic therapy
- Receive stroke education
- Assessment for rehabilitation
- Screening for dysphagia
- Smoking cessation services

Order sets ensure compliance with quality indicators, decrease length of stay and decrease overall costs. Order sets created by multidisciplinary stroke experts should follow American Heart Association (AHA)/American Stroke Association (ASA) guidelines. Incorporating order sets in the electronic medical records (EMR) whenever possible will prevent modifications or exclusions. Elder et al. (2015) performed a retrospective study reporting that adherence to national guidelines increased with standard order set use. Current AHA stroke guidelines recommend Emergency Medical Service (EMS) transport suspected stroke patients to the closest PSC unless contraindicated (Jauch et al., 2013) .

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