Scope of Neurovascular Nursing Practice

The American Nurses Association (American Nurses Association, 2021, p. 1) defines nursing as follows:

> *Nursing integrates the art and science of caring and focuses on the protection, promotion, and optimization of health and human functioning; prevention of illness and injury; facilitation of healing; and alleviation of suffering through compassionate presence. Nursing is the diagnosis and treatment of human responses and advocacy in the care of individuals, families, groups, communities, and populations in recognition of the connection of all humanity.*

Definition of Neurovascular Nursing

Neurovascular nursing is a unique nursing specialty within the profession of nursing that builds on the foundation of nursing practice defined by the ANA, with a unique focus on the care of the person with biological, psychological, social, and spiritual alterations caused by neurovascular dysfunction that affect discrete nervous system tissues within the brain, retina, and/or spinal cord (Alexandrov, 2022). Neurovascular disease consists of conditions with a pathogenic mechanism that is of vascular origin. Collectively, neurovascular diseases causing injury of vascular origin within the brain, retina, and/or spinal cord—whether due to ischemic or hemorrhagic mechanisms—are commonly referred to as *stroke*. The former term, *cerebrovascular accident,* was officially retired in the late 1980s, as it insufficiently described what is no longer accepted as an accident and what may occur both inside and outside the cerebral cortex within nervous tissue.

The accepted contemporary scientific definition for neurovascular diseases is those disease processes resulting in loss or diminished function of brain, retinal, or spinal cord tissues due to ischemia or hemorrhage in association with vascular, nonepileptic pathogenesis that is associated with sudden symptom onset (Sacco et al., 2013). While the onset of neurovascular disease is classically “sudden,” the antecedents or risk factor predicates for neurovascular disease may develop and contribute to its recognition over the course of minutes, hours, days, months, or even years. However, once neurovascular disease manifests, rapid response is of the essence to reduce the risk of disability and/or death.

The impact of neurovascular disease includes life-threatening as well as devastating alterations of essential bodily functions tied to social independence, protection, physiologic stability, and overall quality of life (Alexandrov, 2022). The cost of stroke in the United States was nearly $53 billion in 2017–2018, including all expenses incurred by patients and family members, such as ongoing health care services, inability to work or bring in income, medications, and payments for specialty equipment (Centers for Disease Control and Prevention [CDC], 2022).

Neurovascular RNs care for individuals affected by or at risk for neurovascular disease across the life span, from birth to death. The neurovascular RN assesses, diagnoses, identifies outcomes, plans, intervenes and evaluates nursing care directed at actual or potential health problems that result from such factors as systemic arteriovascular, hematologic (e.g., thrombophilias, hemoglobinopathies), cardiac, or external and internal cranial vascular derangement producing dysfunction of the brain, retina, or spinal cord within discrete vascular territories. Recipients of neurovascular nursing care include affected or at-risk individuals and their family members and/or caregivers, as well as communities, groups, and the world’s population as a whole that are at future risk or suffering from neurovascular disease. The major aim of neurovascular nursing is to holistically care for the needs of affected or at-risk individuals through the provision of evidence-based primary and secondary prevention, acute diagnosis, treatment, stabilization, rehabilitation and recovery, health promotion, and education and through scientific inquiry and discovery.

INTEGRATING THE SCIENCE AND ART OF NEUROVASCULAR NURSING

Neurovascular nursing is built on a core body of knowledge that reflects its dual components of science and art. Neurovascular nursing requires judgment and skill based on principles of the biological, physical, behavioral, and social sciences with specific focus on neurovascular function. Neurovascular registered nurses employ critical thinking to integrate objective data with knowledge gained from an assessment of the subjective experiences of patients. Neurovascular registered nurses use critical thinking to apply the best available evidence to diagnose, treat, and promote health and continually evaluate the quality and effectiveness of nursing practice and seek to optimize outcomes.

The Science of Neurovascular Nursing

The science of neurovascular nursing arises through theoretical inquisitiveness that supports methodically developed investigations focused on a variety of phenomena affecting neurovascular patients and systems of care. Neurovascular nurse scientists use a variety of designs, including qualitative, observational, and experimental approaches to generate knowledge of who, how, why, and when nurses should intervene with new evidence-based methods to support the needs of neurovascular patients and their families/caregivers. The neurovascular nurse uses the nursing process for clinical decision making in the selection of evidence-based practice implementation.

The Art of Neurovascular Nursing

The art of neurovascular nursing is based on caring and respect for human dignity. The demonstration of this art is in implementing adapted, individualized care to specific aspects of health and illness experienced by neurovascular patients, their families, and their caregivers.

NEUROVASCULAR DISEASE

Neurovascular disease is recognized internationally as the second or third most common cause of death and as the number one cause of preventable permanent neurologic disability in adults (Powers et al., 2018; Wajngarten & Silva, 2019; Easton et al., 2009). In the United States, an estimated 800,000 acute neurovascular cases occur each year across all age groups, making neurovascular patients among the top 10 acute care diagnoses admitted to hospitals annually (Powers et al., 2018). One-third of patients with neurovascular disease require institutionalization for rehabilitation following a first-ever event, while more than two-thirds require institutionalization with long-term care after a second neurovascular event. The risk for future neurovascular disease events is in part driven by having experienced a first neurovascular event, in that poor provider assessment of each patient's unique pathogenic mechanism commonly leads to inadequate treatment and secondary prevention measures. The sequela associated with neurovascular diseases are largely recognized as the most significant life-altering medical events, associated with perceptions of poor quality of life among both survivors and their significant others (Salter et al., 2008; Teasdale & Engberg, 2005).

While neurovascular disease may occur at any age, it most commonly manifests in adults with risk factors and pathogenesis similar to cardiovascular disease (Pahigiannis et al., 2019; Benjamin et al., 2017). Perinatal stroke is defined as stroke that occurs at 20–28 weeks' gestation through 7–28 days of life; the rate of perinatal stroke for ischemic and hemorrhagic mechanisms combined is 1 per 2,700 live births (Ferriero et al., 2019). Among neonates, neurovascular disease is most commonly hemorrhagic in nature, including spontaneous intracerebral hemorrhage or primary intraventricular hemorrhage, although cardioembolic pathogenesis may also occur, in particular with anomalies of the heart and vascular system or perioperatively during emergent cardiac surgical procedures. Pediatric neurovascular disease occurs in approximately 1–2 children per 100,000, with the highest risk in children less than 5 years of age in association with cardiac anomalies that increase the risk of cardioembolic events, or congenital neurovascular system derangement including vascular malformations. Overall, Black and Asian children carry significantly higher risk for stroke than White children, with a large proportion of this risk explained by hematologic conditions that include such hemoglobinopathies as sickle cell disorder (Ferriero et al., 2019).

The development of technologies and medications has contributed dramatically to the need for neurovascular nursing specialists. In 1974, the first computed tomography (CT) scanners were placed within U.S. hospitals (Isherwood, 2005). This CT technology revolutionized neurovascular diagnosis and treatment strategies, paving the way for testing of therapeutic systemic and intracranial reperfusion through an ability to differentiate ischemic from hemorrhagic neurovascular disease subtypes and improving early diagnosis and treatment of intracranial hemorrhage, in particular, spontaneous intraparenchymal brain hemorrhages, aneurysmal subarachnoid hemorrhage (aSAH), and vascular malformations.

In the 1980s, magnetic resonance imaging (MRI) emerged in clinical practice from work that was initiated in the 1930s, enlarging our understanding of neurovascular disease pathogenesis, classification, treatment efficacy, and effectiveness, as well as disease outcomes (Viard et al., 2021). Redefinition of what constitutes a *transient ischemic attack (TIA)* was driven by MRI findings that showed that regardless of resolution of ischemic symptoms, silent infarction (stroke) may have occurred; this important finding led to retirement of the term *reversible ischemic neurologic deficit (RIND)* and the discovery that TIAs typically last less than a minute, with longer symptoms attributed to what may be silent ischemic stroke (Easton et al., 2009). Although cerebrovascular angiographic diagnostic methods were first developed in the 1920s, their widespread use in neurovascular disease was limited until the 1990s, when neurointerventional physicians made use of angiographic neuroimaging commonplace, following in the footsteps of interventional cardiologists (Edgell et al., 2012).

The advent of reperfusion therapy for acute ischemic stroke (National Institute of Neurological Disorders and Stroke [NINDS] rt-PA Stroke Study Group, 1995) created a need for widespread emergency department (ED) recognition of the time-sensitive nature of ischemic neurovascular diseases, with the combination of time, residual intraluminal blood flow, and the status of vascular collateral circuits collectively contributing to the reversibility status of brain tissue ischemia. We now know that under poor residual blood flow and collateral arterial flow states, approximately 1.9 million neuronal cells die each minute that reperfusion treatment is delayed (Saver, 2006). This need for time-sensitive care led to the development of neurovascular interdisciplinary teams capable of rapid ED response for the immediate diagnosis and provision of reperfusion treatment and other important stabilizing measures, such as control of arterial blood pressure (Alexandrov, 2022). Today, these highly specialized teams are led by neurovascular RN *stroke coordinators,* who ensure development of highly efficient and effective *neurovascular systems of care* that can provide intravenous tissue plasminogen activator drugs within a goal of 30 minutes from patient arrival to the ED, while facilitating rapid transfer of care to other areas within the hospital or outside facilities offering higher level stroke services (Alexandrov, 2020).

Acute neurovascular interdisciplinary teams work closely with and often are made up of specialized neurovascular catheterization laboratory (cath lab) interdisciplinary clinicians who are often led by specialized cath lab nurses, so that transfer to this next level of service is accomplished in a seamless manner that enables ultra-short ED arrival to cath lab procedural puncture times. The publication of seven trials focused on thrombectomy procedures for patients with arterial large vessel occlusion (LVO) ischemic stroke between 2015 and 2018 fostered the rapid proliferation of neurointerventional endovascular care throughout the world, furthering the focus on delivery of time-sensitive treatment (Berkhemer et al., 2015; Campbell et al., 2015; Goyal et al., 2015; Jovin et al., 2015; Saver et al., 2015; Nogueira et al., 2018; Albers et al., 2018).

Additionally, neurointerventional skills and equipment refinement has led to the use of endovascular management as the preferred method of treatment for occlusion of intracranial vascular anomalies, such as aneurysms and vascular malformations, dramatically reducing use of open-skull aneurysm clipping, and clinical trials have now established endovascular treatment superiority in aSAH (Derdeyn et al., 2017; Mohr et al., 2014; Molyneux et al., 2005). Unfortunately, despite advancements in aSAH medical management, approximately 10 percent of patients die prior to reaching the hospital, while only one-third will achieve a favorable functional outcome after treatment (Connolly et al., 2012). Endovascular and open surgical treatment of carotid disease has also been studied extensively, this time with clinical trials favoring open surgical treatment (carotid endarterectomy) when it is feasible (Brott et al., 2011; Brott et al., 2010). Today, the one major form of neurovascular disease that continues to evade treatment success is intraparenchymal brain hemorrhage, which is most commonly caused by severe, poorly controlled hypertension, although trials are underway to test new interventions for treatment (Greenberg et al., 2022).

One of the newest interventions being employed in North and South America, Asia, Europe, Australia, and the Middle East are mobile stroke units (MSUs). These highly specialized stroke ambulances are made up of expert interdisciplinary neurovascular teams, often led by a neurovascular RN or a neurovascular advanced practice registered nurse (APRN) who works within the prehospital sector inside a licensed and credentialed ambulance that houses CT scanning capabilities to support field diagnosis and stroke treatment decision making (Alexandrov et al., 2021; Alexandrov & Fassbender, 2020; Audebert et al., 2017). To date, MSUs have shown a superior ability to deliver safe ultra-early effective stroke treatment to neurovascular patients compared to ED-provided care because of their ability to shave off approximately 1 hour to delivery of reperfusion and blood-pressure–reducing treatments. A multisite clinical trial of MSUs conducted in the United States and another trial in Germany (Ebinger et al., 2021) have both shown that acute stroke patients who are diagnosed, treated, and transported on a MSU have significantly better outcomes at 90 days post stroke, including significantly less disability, and a greater chance to return to their pre-stroke functional status, compared to those who are transported by a regular ambulance to a hospital for diagnosis and treatment (Grotta et al., 2021).

Telemedicine systems have also become widely available throughout the world to extend neurovascular expertise within rural and underserved communities (Demaerschalk et al., 2017; Demaerschalk et al., 2010; Kiernan & Demaerschalk, 2010). Telemedicine systems generally are developed in a hub-and-spoke manner, whereby the hub system possesses sophisticated neurovascular resources and personnel, and spoke systems vary in their capabilities but are able to provide rapid diagnosis by CT and clinical localization and deliver intravenous reperfusion treatment as recommended by the hub telemedicine consultant. Transport to the hub is usually required for continued care, although in some cases, patients may be managed throughout the entire hospitalization at the spoke center using ongoing telemedicine oversight to direct the workup for the pathogenic mechanism with prescription of secondary prevention measures while also directing methods for complication avoidance. Telemedicine systems are commonly developed and implemented by neurovascular RN stroke coordinators and neurovascular APRNs, with these specialized nurses manning the camera, performing specialized neurovascular localization assessments, and providing reperfusion and stabilizing treatments remotely, or in the case of the APRN, assessing, diagnosing, and prescribing specialized neurovascular treatments for use at the remote site (Dusenbury et al., n.d.).

Neurovascular Disease Pathogenesis

Methods to categorize neurovascular pathogenesis have expanded tremendously, leading to the delivery of specialized treatment that aims to reduce the risk for future events. Table 1 identifies the four discrete categories of causation for ischemic neurovascular disease, namely, *large artery atheroma*, *cardioembolism*, *small perforating artery disease*, and *unusual neurovascular mechanisms*. A fifth category called *cryptogenic* neurovascular disease is reserved for cases where a specific cause cannot be determined; however, the uptake of MRI use in determining pathogenic mechanism and cardiac loop recorder implantation for identification of paroxysmal atrial fibrillation are now reducing the number of cases placed in this category (Alexandrov, 2022).

Table 2 identifies the classifications used for hemorrhagic neurovascular disease pathogenesis; similar to ischemic mechanisms, these discrete categories also lend themselves to specific treatments (Alexandrov, 2022). Numerous predicate diseases and/or social habits substantially increase risk for neurovascular diseases, including poor control of risk factors associated with all vascular diseases, such as hypertension, diabetes, and hypercholesterolemia, as well as cigarette smoking, secondhand smoke exposure, and obesity. Numerous cardiac structural anomalies or acquired

TABLE 1 Pathogenic Etiologic Classification of Ischemic Neurovascular Disease

Category	Causative Conditions for Actual or Potential Neurovascular Disease
Large Artery Atheroma	• Extracranial carotid artery atherosclerosis • Intracranial atherosclerosis (thrombosis or stenosis) of the large arteries of the circle of Willis • Fusiform and dolichoectatic extra- and intracranial aneurysms
Cardioembolism	• Atrial fibrillation • Atrial flutter • Left atrial appendage thrombus • Cardiac valvular dysfunction, including both mechanical and bioprosthetic cardiac valves • Patent foramen ovale and/or atrial septal defect or aneurysm with right-to-left heart shunting of peripheral venous emboli • Left ventricular thrombus • Dilated cardiomyopathy; left ventricular akinetic or hypokinetic segment • Atrial myxoma • Infective endocarditis
Small Perforating Artery (Lacunar) Disease	• Inflammation • Micro-atheroma • Endothelial dysfunction
Unusual Mechanisms	• Intracranial or pre-cerebral extracranial (neck) arterial dissection • Hematologic disorders (i.e., inherited and acquired thrombophilias; sickle cell hemoglobinopathy; hyperhomocysteinemia) • Genetic disorders (i.e., cerebral autosomal dominant arteriopathy, subcortical infarcts and leukoencephalopathy [CADASIL]; Fabry's disease; moyamoya disease) • Cerebral venous thrombosis • Idiopathic vasculitis

TABLE 2 Pathogenic Etiologic Classification of Hemorrhagic Neurovascular Disease

Category	Causative Conditions for Actual or Potential Neurovascular Disease
Primary Intraparenchymal Brain Hemorrhage (IPH)	• Primary hypertensive IPH • Amyloid angiopathy • Bleeding diathesis-hypertension induced IPH (e.g., anticoagulation; ethanol coagulopathy) • Illegal drug abuse–induced hypertensive IPH (e.g., methamphetamine; cocaine) • Neoplasm-induced IPH • Vascular malformations
Subarachnoid Hemorrhage (frequently also contains an IPH component)	• Intracranial aneurysm • Vascular malformations
Primary Intraventricular Hemorrhage	• Ruptured anterior cerebral artery or anterior communicating artery aneurysm • Vascular malformations • Primary hypertensive IPH

dysfunctions also contribute to stroke risk, including heart valvular abnormalities; patent foramen ovale and atrial septal defects with paradoxical right heart to left heart shunting; myocardial infarction; cardiomyopathies; and dysrhythmias, such as frank or paroxysmal atrial fibrillation and atrial flutter, which potentiate left atrial clot formation. Additional risk factors include obstructive sleep apnea and birth control pills, especially when taken in combination with smoking.

Risk factors that are non-modifiable include race, with the highest stroke burden found among Black Americans; age, with risk increasing as age increases; genetic conditions, including amyloid angiopathy, inherited thrombophilias, cerebral autosomal dominant arteriopathy with subcortical infarcts, and leukoencephalopathy (CADASIL), Fabry's disease, sickle cell disease, hyperhomocysteinemia, moyamoya disease, and premature birth (Alexandrov, 2022).

Credentialing in Neurovascular Disease

The rapid discovery of new neurovascular diagnoses and treatment methods has led to new credentialing pathways for physicians, hospitals, and nurses. The evolution of hospitals as stroke centers and physicians as stroke specialists employing new and evolving methods for patient management has played an important role in the development and credentialing of neurovascular nursing, driving the need for nurses with specialty skills to support the care of patients with complex holistic needs, and furthering the need for neurovascular nurses credentialed to work in advanced specialty roles in physician-underserved and stroke-burdened regions of the country.

Today, neurologists complete substantial postgraduate specialty fellowship education and training to become professionally certified as *vascular neurologists,* ultimately accepting practice and academic appointments dedicated solely to neurovascular disease diagnosis, treatment, prevention, and ongoing management (Hodgson et al., 2013). Similarly, fellowship training programs also prepare neurosurgeons as *vascular neurosurgeons* capable of performing both open skull and closed endovascular neurointerventional procedures (Accreditation Council for Graduate Medical Education, 2022). Fellowship training is also available to non-neurosurgeons interested in neurointerventional endovascular care, credentialing both *interventional neuroradiologists* and *interventional neurologists* able to perform endovascular aneurysm or vascular malformation occlusion, intravascular stenting, or thrombectomy (Accreditation Council for Graduate Medical Education, 2022; Adams et al., 2005). In the United Kingdom, where there is a shortage of neurologists, geriatricians are now completing additional postgraduate specialty fellowship education to become certified *stroke physicians* (Royal College of Physicians, 2015).

Hospitals in North America, Europe, Australia, and New Zealand and in parts of Asia, the Middle East, South and Central America, and Africa are also certifying as *stroke centers* to showcase special capabilities for the acute treatment and ongoing management of neurovascular disease patients at both basic and advanced levels (World Stroke Organisation, 2022). Table 3 describes differences in levels of stroke centers within the United States that are supported by formal certification credentialing procedures (Det Norske Veritas, 2022; The Joint Commission, 2022). Stroke center certification evolved from recommendations that emerged after the NINDS rt-PA Stroke Study (1995), when investigators proposed the development and credentialing of specialized hospitals for the primary purpose of providing intravenous reperfusion treatment to patients with acute ischemic stroke. The Brain Attack Coalition subsequently defined structures and processes associated with the provision of specialized stroke center care, creating a framework for hospital credentialing (Alberts et al., 2000; Alberts et al., 2005).

In 2003, The Joint Commission (TJC) (2022) established a process for certification of *Primary Stroke Centers (PSCs)*, and in 2012, TJC began to certify *Comprehensive Stroke Centers (CSCs)*. In 2016, TJC (2022) began credentialing for *Thrombectomy-Capable Stroke Centers (TSCs)* to serve as an intermediate level of credentialing for centers that could perform thrombectomy but lacked all the necessary structures and processes to support CSC certification. In 2017, *Acute Stroke Ready (ASR)* hospital certification was launched by TJC (2022), designating the lowest level of stroke care services for primarily rural facilities serviced by telemedicine. Det Norske Veritas (DNV) (2022) and the Accreditation Commission for Health Care (ACHC) (2022) have followed in the footsteps of TJC, offering similar levels of stroke center certification, and some state agencies also offer stroke center recognition.

Today, numerous countries across the world have adopted stroke center credentialing processes similar to those used within the United States (World Stroke Organisation, 2022). Within the United States, TJC, DNV, and ACHC have published stroke center requirements that include not only structural and process components, as well as outcome measurement requirements, but also nurse competency requirements (Det Norske Veritas, 2022; The Joint Commission, 2022) and in some cases nurse staffing requirements (Det Norske Veritas, 2022) for stroke patients. In the United States, stroke center credentialing is most commonly voluntary;

however, some states require that all hospitals admitting acute stroke patients be certified as stroke centers.

Specialized *stroke units* are a requirement at certified stroke centers, based on the work of early Norwegian and other European investigators that have consistently shown that the specialized nursing care provided on these units results in improved morbidity and mortality rates as compared to general ward nursing care (Langhorne et al., 2020; Indredavik et al., 1991). Most stroke units around the world provide care that encompasses neurocritical care unit (NCCU) services, as well as both intermediate and general care services; this allows neurovascular patients with a variety of diagnoses to advance through their hospitalization in the same unit, with the same specialist interdisciplinary providers overseeing their care until discharge. Segregation of neurovascular care in this manner has been shown to enable the development of stroke care expertise among all interdisciplinary professionals working in the environment, strengthening their knowledge and clinical skills; it also enables patients with families or caregivers undergoing similar educational needs to be taught individually as well as within a therapeutic group throughout the course of hospitalization (Langhorne et al., 2020).

International stroke units incorporate group rehabilitative processes that are similar to U.S. inpatient rehabilitation, including group meals, exercise, speech, and occupational therapy activities; however, instead of delaying this approach to discharge from acute care, these units incorporate this approach during acute hospitalization. Collectively, these processes encourage regular mobilization and social reintegration once patients' conditions have stabilized, as well as therapeutic interactions for both patients and family members/caregivers with interdisciplinary providers. However, in the United States, hospitalized services are more commonly divided between several different units, including the ED, the cath lab, the NCCU, the stroke unit, and even general medical units, with patients transferring between many different areas of service and encountering a greater risk for care fragmentation (Dusenbury, Patterson, et al., n.d.). Some United States hospitals are exploring adoption of approaches to stroke unit care that more closely resemble the European model (Alexandrov et al., 2016); however, few hospitals have adopted this approach.

TABLE 3 Levels of Stroke Center Hospital Certification in the United States

Stroke Center Level	Description
Acute Stroke Ready (ASR) Hospital	Hospitals with at least noncontrast computed tomography (CT) scanning capabilities that are operational 24 hours a day, 7 days a week; hospital must have referral and transfer agreements with higher level Stroke Center credentialed hospital(s); commonly the ASR hospital uses stroke telemedicine (telestroke) services to support diagnosis, treatment, and transfer decision making; neurovascular nursing staff competencies for stroke assessment, diagnosis, treatment, and transfer are required.
Primary Stroke Center (PSC)	Hospitals able to diagnose by clinical exam and CT imaging an acute stroke event; able to provide intravenous reperfusion treatment as indicated; may perform some aspects of advanced imaging including CT angiography (CTA), CT perfusion (CTP), or magnetic resonance imaging (MRI); hospitals may rely on telestroke services for diagnosis, treatment, and transfer decision making; neurovascular nursing staff competencies for assessment, diagnosis, treatment, ongoing management, and if necessary transfers are required; nurse staffing requirements are stipulated for acute stroke patients by Det Norske Veritas (DNV).
Thrombectomy-Capable Center (TSC)	Hospitals capable of providing thrombectomy for patients diagnosed with large vessel occlusion (LVO) ischemic stroke; house CT, CTA, CTP, MRI, catheter angiographic capabilities, and carotid duplex imaging; neurovascular nursing staff competencies for assessment, diagnosis, treatment, ongoing management, and if necessary transfers are required; nurse staffing requirements are stipulated for acute stroke patients by DNV.
Comprehensive Stroke Center (CSC)	Hospitals providing the highest level of neurovascular services for all types of patients with neurovascular disease (ischemic and hemorrhagic etiologies). Extensive neuroimaging capabilities should include CT, CTA, CTP, MRI, catheter angiographic procedures, and transcranial Doppler and carotid

(*continued*)

TABLE 3 Levels of Stroke Center Hospital Certification in the United States (*continued*)

Stroke Center Level	Description
	duplex imaging. Must operate cath labs and provide open neurosurgical capabilities to manage all guideline-directed endovascular services for ischemic and hemorrhagic stroke; must have neurocritical care units and designated stroke units, along with active programs of clinically based research that supports neurovascular clinical practice evaluation. Neurovascular nursing staff competencies include assessment, diagnosis, treatment, and ongoing management of the most complex patients as they move from emergency, to cath labs or operating rooms, neurocritical care, and stroke unit; nurse staffing requirements are stipulated for acute stroke patients by DNV.

Post-Hospitalization Neurovascular Care Transitions

Transitions in neurovascular care remain an important but challenging component of effective interdisciplinary care because of the multifaceted needs of these complex patients and often limited financial and insurance support. While transitions within the acute care setting are often easier to control, transitions beyond acute hospitalization remain challenging in the United States. End-of-life and palliative care needs in neurovascular patients may now be determined early on by sensitive prognostic measures such as the *ICH Score*, the *National Institutes of Health Stroke Scale*, and neuroimaging findings that suggest devastating outcome; these data can be used to open dialogue with patients across the life span and their family/caregivers about transition options (Creutzfeldt et al., 2018; Creutzfeldt et al., 2015); however, available options may be significantly limited by payers.

Assessments tied to rehabilitation candidacy are now a standard quality requirement for all certified stroke centers regardless of patient age, and these facilities must maintain referral partnerships to different levels and age-specific post-discharge neurovascular services (Accreditation Commission for Health Care, 2022; Det Norske Veritas, 2022; The Joint Commission, 2022). To qualify for inpatient rehabilitation, neurovascular patients must be able to manage three consecutive hours of continuous rehabilitation therapy; when this cannot be tolerated, slower forms of rehabilitation, such as skilled nursing facilities or long-term care, are considered more appropriate (Ifejika et al., 2021). Recovery from neurovascular disease–related disability has advanced dramatically over the past 30 years to include dedicated neurovascular rehabilitation units, regular mobilization protocols, robotics, and medical devices that provide neuro-stimulation and even an ability to walk despite persistent hemiplegia, although much of this work continues to evolve (Jolliffe et al., 2018; Bejarano et al., 2016). Neurovascular RNs are key advocates for promoting and initiating rehabilitation throughout all phases of stroke management, from acute care settings to the post-acute arena (Jolliffe et al., 2018; Miller et al., 2010).

Ongoing secondary prevention of neurovascular disease requires a lifelong commitment of patients and family members or caregivers in that key lifestyle changes are often required alongside best medical practices (Kleindorfer et al., 2021). Ultimately, primary prevention is the key to reducing neurovascular disease through early screening throughout life and implementation of risk-reducing therapies (Meschia et al., 2014). Specialty neurovascular clinics have arisen to support the early detection and management of important neurovascular risk factors. Community risk screenings have also become an important part of stroke center certification requirements as well as a priority among rehabilitation centers and neurovascular clinics (Accreditation Commission for Health Care, 2022; Det Norske Veritas, 2022; The Joint Commission, 2022; Wilson & Jungner, 1968). These screening events allow interdisciplinary neurovascular clinicians to engage directly with the community, where their powerful stories and teachings can capture the attention of the public and hopefully produce social habit change and improved use of preventive services that reduce future neurovascular events.

Today, multiple international guidelines support the specialty of neurovascular nursing, citing numerous evidence-based interdisciplinary processes, as well as the structural components required and the expected outcomes that should be achieved with their implementation.

CHARACTERISTICS OF NEUROVASCULAR NURSING

The American Nurses Association (ANA) Professional Nursing Model

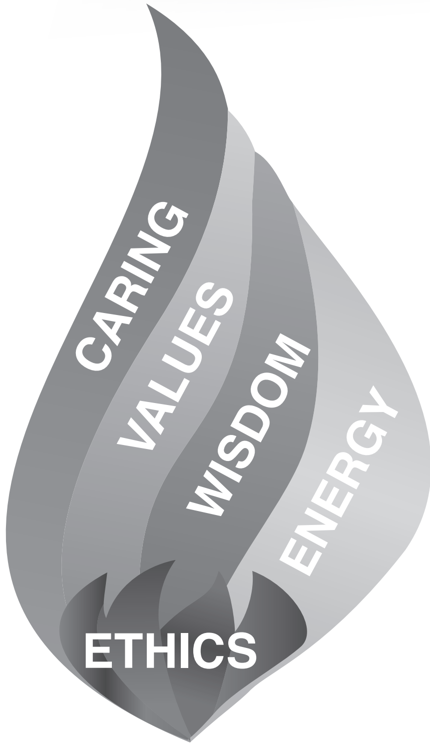
The ANA Professional Nursing Model (Figure 1) represents the synergy of nurses' caring, values, wisdom, and energy, which is anchored by ethical principles and situation ethics in nursing practice (American Nurses Association, 2021). The flame is the inner light of the nurse and of nursing, constantly evolving, transforming, and continuously lighting the way; it represents seminal nursing characteristics of courage, endurance, passion, and creativity (American Nurses Association, 2021, p. 10).

The ANA Professional Nursing Model (Figure 1) provides a framework that reflects the work and evolution of neurovascular RNs and APRNs within all settings where they are found. The "creative" portion of the model is situated on the left, with *caring* supporting the *values* that arise from the shared beliefs that ground the Nursing profession. The "logical" side of the model includes the *wisdom* and *energy* that are needed to practice as a nurse, whereas the entirety of the flame is supported by *ethics*.

Caring: This human approach promotes dignity, healing, and wholeness—the essence and heart of nursing and its practice. It occurs when there is a positive intention and action depending on context, directed toward the highest good, on behalf of the health care consumers. Caring is given freely and wholly to enhance the well-being and comfort of others while also adding to the goodness and trustworthiness of the nursing profession. The caring component of the flame represents compassion, kindness, and calm.

Values: The values component of the flame represents respect, inspiration, and empathy. Nursing and its practice are based on values including, but not limited to, compassion, presence, trustworthiness, diversity, acceptance, and accountability. These values emerge from nursing practice

FIGURE 1 The American Nurses Association Professional Nursing Model



beliefs: the importance of relationships, service, respect, willingness to bear witness, self-determination, and the pursuit of health.

Wisdom: Wisdom's component represents the movement from data to information to knowledge and eventually to wisdom in which nurses promote theory-guided, evidence-based practice, a culture of inquiry, critical thinking, and research to inform professional practice (American Nurses Association, 2021).

Energy: Energy's segment of the flame represents the energy and action sparked by nurses, as evidenced by responsibility, communication, comfort, innovation, and transcendence.

Ethics: The ethics component represents trust, confidence, and loyalty, creating calmness and security. This foundation encompasses advocacy,