

Introduction to Vascular Nursing Practice

OVERVIEW OF THE CONTENT

Registered nurses (RNs) practicing in the United States have professional resources that inform their thinking and decision-making and guide their practice. First, *The Code of Ethics for Nurses With Interpretive Statements* (ANA, 2015) lists the succinct provisions that establish the ethical framework for RNs across all roles, levels, and settings. *Nursing: Scope and Standards of Practice, Fourth Edition* (ANA, 2021) outlines the expectations of the professional role of the RN, includes the scope of practice statement for nursing, and identifies the Standards of Professional Nursing Practice and their accompanying competencies. *Vascular Nursing: Scope and Standards of Practice* builds on those professional resources, describes the scope of vascular nursing practice, and identifies the specialty's Standards of Practice and Standards of Professional Performance and accompanying competencies.

AUDIENCE FOR THIS PUBLICATION

RNs in every role and setting constitute the primary audience for this professional resource. Legislators, regulators, legal counsel, and the judiciary system will also want to reference this resource. Agencies, organizations, nurse administrators, and interprofessional colleagues will find this reference to be invaluable. In addition, the people, families, communities, and populations using health care and vascular nursing services can refer to this document to better understand what constitutes this specialty nursing practice and who its members are: RNs and advanced practice registered nurses (APRN).

VASCULAR NURSING PRACTICE AND THE SOCIETY FOR VASCULAR NURSING

The Society for Vascular Nursing (SVN), an international organization, was founded in 1982 for the purpose of promoting excellence in the compassionate and comprehensive management of individuals with vascular disease and their families. The years since the founding of SVN have been characterized by significant changes in health care. The associated sciences and evolving research have resulted in evidence about the causes, treatment, and prevention of vascular disease. This international association and its members continue to lead in the dissemination, implementation, and evaluation of evidence-based practices. Since the *Scope and Standards of Vascular Nursing Practice* was first published in 2004 in conjunction with ANA, SVN has achieved many milestones. See Appendix A for a list of these accomplishments.

To help the profession and the public better understand the practice of vascular nursing and value today's vascular nurses, SVN supported and charged a task force to examine historical documents, references, and resources and then create the first vascular nursing specialty's scope and standards of practice, published in 2004 (last updated in 2016). The scope of practice statement defines vascular disease and vascular nursing, but more importantly, it serves to emphasize the unique practice characteristics of the vascular nurse, moving beyond pathophysiology and diagnosis to identify and treat human responses to actual or potential alterations in vascular system function. Vascular nurses today focus their emphasis on the promotion of health, assessment for alterations of function, and implementation of strategies to assist individuals with maintaining, regaining, or improving function and preventing disability. Discussion of the practice environments and educational preparation of the vascular RN and the APRN identifies those behaviors, responsibilities, functions, and skills that involve a specific and unique body of knowledge. The scope statement provides answers to the “who,” “what,” “where,” “when,” “why,” and “how” questions about this nursing specialty.

As a complement, the standards for vascular nursing practice are generic statements that define the responsibilities of and accountability to the

profession and the public of all RNs who care for patients with vascular disease. These standards reflect the values and priorities of the profession of nursing as they relate to the specialty of vascular nursing and include a competence framework for addressing nursing practice in the care of vascular patients in any setting.

The evolving nature of vascular nursing is a reflection of technological advances, greater scientific understanding, and a growing research base. Nursing has moved beyond an era of needing only to provide good, safe care to the patient with vascular dysfunction; the present era is focused on the incorporation of science and research into evidence-based practice.

Specialties outside vascular nursing have also evolved, allowing the vascular team to focus on more complicated patients. For example, a peripherally inserted central catheter (PICC) line team, which may include an interventional radiologist, most often places PICC lines. A port is a device placed under the skin and connected to a major vein. A surgeon or interventional radiologist places ports. Both of these devices are used when the patient requires frequent or long-term intravenous therapy (greater than two weeks), including chemotherapy for persons with cancer, parenteral nutrition for persons with inflammatory bowel disease (or other conditions causing lack of nutritional absorption via the gastrointestinal tract), dialysis for persons with kidney failure, or long-term antibiotics for persons with a serious infection (including persons with HIV, who are more susceptible to opportunistic infections). A vascular surgeon may be asked to place a PICC line or a port in persons with risk factors causing difficulty in placing either device.

In persons requiring long-term renal dialysis, a vascular surgeon creates a fistula in the arm or leg to receive hemodialysis. If dialysis is short-term or the fistula has not matured, a hemodialysis catheter/port is placed. Although it is initially available only in the hospital, dialysis is most often received in an outpatient clinic or less often in the patient's home. Nephrologists order and oversee the administration of dialysis. If the patient is at home, a home care nurse or dialysis technician performs cannulation of the fistula. Sometimes, a family member is taught how to cannulate the fistula, but the patient is rarely taught this procedure.

Given rapid changes in health care delivery trends and technologies, the task of defining the scope of vascular nursing is complex. This document is intended to be futuristic and flexible in nature, allowing for responses to emerging issues and technologies in the delivery of health care as well as in the practice of vascular nursing.

SCOPE OF VASCULAR NURSING PRACTICE

Vascular nursing can be episodic, such as care for thoracic outlet syndrome and vascular trauma, or, as with many chronic diseases, can involve care over a lifetime. The same person is often seen multiple times as the peripheral arterial or venous disease progresses. When vascular nursing began, procedures were performed in the hospital, with patients arriving before the operation and staying days postoperatively, allowing time for nurses to teach, demonstrate, and reinforce. Now, most procedures are interventional or peripheral, performed in the office or specialty clinics, challenging nurses to be inventive with delivery of needed patient education. Websites, informational pamphlets, and apps increase educational options. Vascular nurses collaborate to write evidence-based standards of care and participate in multidisciplinary committees to determine best practices.

Advancements in technology, medications, research, hybrid training of vascular providers, and care-delivery models have all influenced the evolution of vascular nursing practice.

From the first open abdominal aortic aneurysm repair in 1951 (Friedman, 2001) to complex endovascular repair of thoracoabdominal aortic aneurysm; from the gold standard of carotid endarterectomy to transcrotid artery revascularization; from a variety of open lower extremity bypass procedures to countless variations of percutaneous procedures, now is the time when highly skilled vascular nurses are called to shine.

With these advancements in open surgical and percutaneous revascularization procedures come more complex care-delivery requirements for the vascular nurse. From the day of scalpels and multiple incisions to one of wires and catheters, vascular nursing knowledge requirements have

expanded exponentially. This growth has also created a platform for the development of multiple vascular specialties—vascular, cardiovascular, thoracic surgery, interventional radiology, medicine, and prevention programs—all of which require specialized training of the vascular nurse providing care in these specialty areas. Consider the treatment of venous insufficiency related to greater saphenous vein (GSV) procedures: what once required an inpatient stay for a “GSV stripping” performed in the operating room under general anesthesia has now evolved to VenaSeal or radiofrequency ablation (RFA) procedures done in the clinical setting, often without any sedation, and the patient going home a few hours after treatment. Think about the impact this shift alone has had on vascular nursing practice.

The vascular care-delivery team has also evolved and is continuously adapting to changes in reimbursement, training, staffing, and pandemic ramifications. This shift has allowed great opportunities to expand the care-delivery model and provide a more comprehensive, robust experience for the vascular patient. In this scenario, the vascular RN’s, graduate-level prepared vascular nurse’s, and vascular APRN’s responsibilities have expanded to include bedside care, leadership, case management, coordination of care, patient education, triage, participation in research studies, preparing patients for procedures by performing history and physical exams, prescribing medications and treatments, acting as first assist in the operating room, and supporting the vascular providers consisting of doctors, nurse practitioners, and physician assistants, all as their nursing license allows.

The settings in which vascular nursing practice is carried out have broadened as the requirements of care delivery have changed. From inpatient and outpatient clinical settings to skilled nursing facilities, assisted living centers, home health care, dialysis units, and now a whole new era of telehealth and virtual care-delivery models are bringing nursing case management and nurse coaching to another level. Quality initiatives, utilization reviews, cardiovascular prevention programs, research, and academia continue to play vital roles in the advancements in treating vascular diseases. Regardless of the setting, specialized vascular nursing

knowledge, skills, and training are paramount for a successful care-delivery model.

DEFINITION OF VASCULAR NURSING

Vascular nursing is a nursing specialty focused on the needs and care of individuals who have known or predicted physiological alterations of the peripheral vascular system. The practice of vascular nursing is dynamic in response to the needs of individuals with vascular disease and the impact of genetic factors, such as in Marfan syndrome, Ehlers–Danlos syndrome, factor V Leiden mutation, on vascular disease that affects the health of the entire family. Advancements in the fields of vascular medicine include direct thrombin inhibitors and factor Xa inhibitors, interventional cardiovascular radiology, and vascular surgery. Potential recipients of vascular nursing care are those individuals at risk for vascular disease as well as those individuals with known vascular system dysfunction, their families and significant others, and the society in which they live. Vascular nursing promotes and protects the health of individuals, encompassing the care of children, adults, and older adults.

Vascular nursing includes the education of individuals and their families at risk for vascular disease; health promotion, with information given at office visits, community education in senior centers, and peripheral arterial disease (PAD) screening programs; assessment for alterations of function; and implementation of strategies to assist patients with maintaining, regaining, or improving function and preventing disability. Creative care management options are required for persons with multiple types of vascular diseases, challenging nurses to think outside the normal routine. State-of-the-art treatment options are now available, even to persons with advanced vascular disease, allowing greater improvement in quality of life.

VASCULAR DISEASE DEFINED

Vascular disease encompasses a wide array of arterial, venous, and lymphatic problems and may be acute or chronic in nature. The epidemiology of vascular disease provides an overview of the magnitude of the disease

and serves to define the patient population. Major categories of the disease that produce alterations of concern to vascular nurses include cerebrovascular disease, aneurysmal disease, PAD, acute arterial disease, venous disease, lymphatic disease, vascular trauma, congenital vascular conditions, nonatherosclerotic arterial disease, wound management, pain, and diabetes mellitus. Vascular nursing care is provided to patients of all ages across the continuum of care, from acute care to community and home care.

Vascular disease affects persons more often in the later decades of life but may be present at any age. Congenital lymphedema may be diagnosed from birth through young adulthood. Younger persons may experience genetic degenerative arteriopathies, such as Ehlers–Danlos syndrome, cardiomyopathy, congestive heart failure, renovascular hypertension, Buerger’s disease, Raynaud’s syndrome, collagen vascular disease, coagulopathies, vasculitis, or acquired vascular disease from trauma related to sports injuries, accidents, or illicit intravenous drug use.

Women of child-bearing age may experience arrhythmia, cardiomyopathy, pregnancy-induced congestive heart failure, Raynaud’s syndrome, fibrodysplastic renal artery stenosis, lymphedema, and hypercoagulopathies, and they are at an increased risk for autoimmune disorders (Goldmuntz & Penn, 2021).

Aging is a known risk factor for vascular disease. The prevalence is just 1 percent among those ages 40–49 years, versus 15 percent among those older than 70 years (Aday & Matsushita, 2021; Hamczyk et al., 2020). Recent data have emerged showing that biological age, which refers to a decline in function, is a more accurate predictor of vascular disease than is chronological age. Factors known to accelerate biological aging include obesity; type 2 diabetes; chronic kidney disease; dyslipidemia; high dietary intake of saturated fat, salt, and sugar; and smoking and substance abuse. Structural changes in aging arteries include fragmentation of elastin, collagen accumulation, smooth muscle cell loss, and increased arterial stiffness (Hamczyk et al., 2020). So, although older adults are certainly at the highest risk for vascular disease, providers may be reluctant to prescribe aggressive treatments because of comorbidities, polypharmacy,

short life span, or belief that atherosclerosis is irreversible. Therefore, due to patient frailty, pharmacological management must be approached carefully in this population (Whelton et al., 2018).

ARTERIAL DISEASE

Causes of arterial disease are extremely varied. However, atherosclerosis is the underlying mechanism responsible for PAD. PAD encompasses those entities that result in arterial narrowing or occlusion in vessels other than those of the coronary and intracranial vascular beds. Although *PAD* is often used to describe disease of the circulation of the lower extremities, it is actually a term used to also encompass disease of extracranial vessels, such as the carotid arteries, upper extremity arteries, and visceral arteries, including renal and mesenteric disease. PAD places patients at a significant risk for disease sequelae, such as stroke, limb loss, or aneurysm rupture. Approximately 8.5 million Americans are affected by PAD (Virani et al., 2021).

Major risk factors for vascular disease include smoking, diabetes, dyslipidemia, and hypertension. Diabetes increases the risk of PAD by two or three times. It also leads to poorer outcomes, with 70 percent of nontraumatic lower-extremity amputations occurring in persons with diabetes. Risk of developing PAD is double in smokers. Although smoking cessation can decrease the risk of PAD, a recent study shows that it takes approximately 30 years for risk levels to decrease to that of nonsmokers (Criqui et al., 2021). Other causes of PAD include age greater than 65, male gender, family history, coronary artery disease (CAD), obesity, inflammation, hyperhomocysteinemia, a sedentary lifestyle, and a lower socioeconomic status (Conte, 2023; Gerhard-Herman et al., 2017; Virani et al., 2021).

PAD is the clinical manifestation of generalized atherosclerosis, affecting more than 230 million people worldwide (Byskosh et al., 2022; Criqui et al., 2021). Identification of these individuals is important because many go untreated and are at increased risk of concomitant coronary and cerebrovascular disease. In fact, patients with PAD alone are less likely to receive optimal treatment than those with CAD alone (Virani et al., 2021).

Individuals with lower-extremity PAD often present for treatment because of such symptoms as intermittent claudication or critical limb ischemia (CLI). CLI may take the form of rest pain, minor tissue loss (ulceration), or gangrene. Patients with PAD should undergo a thorough vascular assessment, including ankle-brachial index testing. Patients may be referred for additional imaging in the modes of ultrasound, computed tomography (CT) scan, magnetic resonance imaging, or standard angiogram. All patients with lower-extremity PAD should be treated medically, which is likely to include antiplatelet therapy, antihypertensive agents, statin therapy, glycemic control, and smoking cessation (Criqui et al., 2021).

The status of the patient's arterial disease determines the recommended course of treatment. For patients with relatively mild PAD, as in the case of intermittent claudication, medical management accompanied by supervised exercise therapy (SET) is the first line of treatment. SET, consisting of walking for 30 minutes 3 times per week, leads to improved walking performance and a decrease in claudication symptoms (Souza et al., 2020). SET also benefits participants by reducing their overall cardiovascular risk, decreasing mortality by 52 percent and morbidity by 30 percent (Rodrigues & Silva, 2020).

Although SET is an effective tool, it is also underused. Barriers to its use include the cost of supervised programs, lack of insurance coverage, and limited availability. A 2017 decision by the Centers for Medicare and Medicaid Services to cover up to 36 sessions of SET over a 12-week period for beneficiaries with PAD has enabled greater implementation of this effective treatment in clinical settings. An additional 36 sessions are available over an extended period with a new referral from a health care provider (Whipple et al., 2018). In the absence of SET programs, home- and community-based exercise therapy should be considered (Rodrigues & Silva, 2020; Sousa et al., 2020).

In cases of more severe disease, patients are referred for either endovascular or surgical intervention. In the US, 40 percent of patients with CLI undergo a surgical revascularization procedure, versus 60 percent who have an endovascular intervention. Endovascular procedures are preferred due to lower rates of mortality as well as decreased length of stay and lower cost (Criqui et al., 2021).

In addition to persons with lower-extremity PAD, vascular nurses routinely care for those with arterial aneurysms. Arterial aneurysms are known to be associated with the same risk factors as lower-extremity PAD and also have a strong hereditary factor (Anagnostakos & Lal, 2021). Smoking is the single greatest risk factor for the development of aneurysms. Although aneurysms are commonly categorized as *degenerative* or *atherosclerotic*, the former is the preferred term because there is no proven correlation between aneurysms and atherosclerosis (Lawrence & Rigberg, 2023). Abdominal aortic aneurysms (AAA) are predominantly asymptomatic until rupture. When symptoms do occur, they typically present as pain in the low back, abdomen, flank, or groin. If an AAA ruptures, for which the risk varies greatly by the size of the aneurysm, the rate of death is as high as 81 percent.

The risk for aneurysm rupture has decreased as the screening for AAA has increased. Men ages 65–75 with a history of smoking have most benefited from screening (Anagnostakos & Lal, 2021; Owens et al., 2019). Those with aneurysms of an asymptomatic nature often go undiagnosed. Others may have their aneurysms identified incidentally on physical examination, noted on other imaging for a different disease process, or discovered as part of a routine screening. Treatment of an aneurysm depends on its location and size. Some aneurysms are monitored with routine surveillance if they do not meet qualifications for repair; others are treated with surgical or endovascular repair. For most of these patients, management is directed toward early detection and appropriate endovascular or surgical intervention to prevent aneurysm rupture or thrombosis.

In addition to lower-extremity PAD and arterial aneurysmal disease, an additional focus area of many vascular nurses is care for those with carotid artery disease. Carotid artery disease is known to be associated with an increased risk of cerebrovascular accident (CVA) and transient ischemic attack (TIA) when high-grade stenosis is present. In addition to those with symptomatic carotid artery disease with CVA or TIA, many go undiagnosed with asymptomatic disease. Carotid artery disease is typically identified with routine screening ultrasound in the asymptomatic

patient. Medical management of carotid artery stenosis involves anti-platelet and statin therapy. Surgical carotid endarterectomy or such endovascular intervention as carotid artery stenting may be pursued in individuals with symptomatic disease or those with high-grade asymptomatic disease. The goals of treatment are to reduce the risk of CVA or recurrent CVA.

In addition to carotid artery disease, lower-extremity arterial disease, and aneurysms, vascular nurses encounter patients with upper-extremity arterial disease, such as thoracic outlet syndrome, subclavian steal syndrome, or hypothenar hammer syndrome. The diagnostic process of these arterial diseases is based on the patient's symptoms and physical examination and may include arterial Doppler studies, CT or magnetic resonance angiogram (MRA) scans, or angiography. These disease processes typically warrant surgical or endovascular treatment when symptomatic.

Renovascular disease includes atherosclerotic, fibromuscular, and inflammatory disorders and can lead to renovascular hypertension. Hypertension affects 75 million adults, with renovascular hypertension being one of the most common secondary causes (Nair & Vaqar, 2022). Diagnostic studies to determine the presence of renal artery stenosis for specific subgroups of individuals with suspected resistant hypertension, unexplained atrophic kidney, unexplained pulmonary edema, or unexplained acute renal failure include Doppler studies, CT and MRA scans, or standard angiography. Treatment options include endovascular options as well as open surgical repair.

Visceral artery disease to the celiac artery or superior mesenteric artery (SMA) typically presents in the form of intestinal ischemia. This disease is rare, but vascular nurses may encounter patients with acute mesenteric ischemia rising from an embolus or sudden loss of flow to one or both of the main arteries, causing severe acute onset of abdominal pain out of proportion to the physical examination findings. Acute mesenteric ischemia requires a quick diagnosis and emergency intervention to prevent intestinal ischemia. The vascular nurse may also encounter those with chronic mesenteric stenosis, which is typically atherosclerotic disease of

the SMA or celiac artery. In the case of chronic mesenteric stenosis, patients may have postprandial pain, leading to food aversion and weight loss. Endovascular or surgical treatment may be considered in these patients.

All patients presenting for treatment of their PAD should have their risk factors rigorously assessed and appropriate therapies instituted to decrease the risks of peripheral progression and cardiovascular mortality. Vascular nurses must be familiar with the disease process to effectively counsel and educate patients and their families regarding PAD prevention, detection, and treatment options as discussed above.

VENOUS DISEASE

Venous disease encompasses a wide spectrum of disorders, ranging from those with benign, primarily cosmetic concerns to those with potentially life- or limb-threatening consequences. *Venous thromboembolism* (VTE) is the collective term used to describe deep vein thrombosis and pulmonary embolism. Although accurate counts of VTE occurrence are difficult to calculate, the Centers for Disease Control and Prevention (CDC) estimates approximately 900,000 each year in the United States, presenting a challenge to the health care provider. Among people who have VTE, 25 percent will experience sudden death as the only symptom, 10 percent to 30 percent will die within one month after diagnosis, and 33 percent will have long-term complications (CDC, 2022; Patient Safety Network, 2022).

In 2020, the American Heart Association released a Call to Action to Prevent Venous Thromboembolism in Hospitalized Patients. Five areas of focus were recommended to help prevent the formation of VTE in hospitalized patients, with a goal of decreasing the occurrence of hospital-acquired VTE by 20 percent by 2030 (Henke et al., 2020).

Vascular nurses are in a key role to educate patients and fellow professionals on risk factors, effective prevention methods, and recommended therapy for venous disease. Vascular nurses are located in a variety of settings, enabling them to reach a broad spectrum of patients. Vascular

nurses educate the primary care patient on risk factors and prevention techniques prior to a long flight or implement the Joint Commission's performance measures on surgical patients, thereby helping close the gap in the prevention of VTE. Vascular nurses assist in preserving the venous system for future arteriovenous fistulae or superficial veins used in bypass procedures. Vascular nurses promote protection of the patient's veins by judicious use of peripherally inserted access devices. Treatment of venous disease consists of compression therapy, venous ablation, vein stripping, sclerotherapy, and elevation.

Other manifestations of venous pathology include superficial venous thrombophlebitis, variceal bleeding, and chronic venous insufficiency (CVI). The term *CVI* refers to a constellation of limb symptoms, including edema, pain, pigmentation changes, and disability, that can progress to chronic ulceration. The vascular nurse plays a crucial role in the non-operative management of CVI by symptom control, prevention of ulceration, and promotion of ulcer healing. The APRN who is an expert in venous ulcer care provides supervision or direction for ulcer management (topical agents, dressing techniques), assists with the implementation of medical therapies when appropriate, and provides patient education and support.

LYMPHATIC DISEASE

The lymphatic system consists of an extensive network that collects lymph from various organs and tissues and connects to an elaborate system of collecting vessels that transport the lymph to the blood stream. Lymphedema results from a malformation or obstruction of the lymphatic vessels or nodes. Lymphedema may be acquired or congenital, and it may develop secondary to another event, such as trauma, or surgical intervention, such as mastectomy. Lymphedema is caused by microcirculatory imbalances or disruptions that result in the inability of the lymphatic vessels to transport lymph fluid.

Lymphedema is classified as primary and secondary. Primary lymphedema has a much lower prevalence, at 1 in 100,000 individuals, whereas secondary lymphedema affects 1 in 1,000. Lymphedema is most widely

recognized in oncology, with 1 in 5 female survivors of breast cancer developing it (Sleigh & Manna, 2022). The true incidence may be higher, as the condition is thought to be underreported and underrecognized by caregivers. Lymphedema has no known cure. The therapeutic goals are to reduce the affected limbs' size to as near normal as possible, preserve skin integrity, maintain normal limb function, prevent complications, and teach patients how to manage the chronic condition of lymph edema. Vascular nurses are again in a critical position to provide prevention measures and to teach patients about health promotion. Treatment is complex and consists of physical therapy, compression, complex decongestive therapy, and elevation.

The APRN's role in the differential diagnosis of lymphedema includes taking a history and conducting a comprehensive physical examination. Vascular nursing interventions are aimed at reducing edema, maintaining the edema-free state, controlling infection, and providing education and emotional support.

COVID-19 AND VASCULAR PATHOPHYSIOLOGY

SARS-CoV-2 (COVID-19) emerged in 2019 to become an unprecedented global pandemic. The National Intelligence Community has updated its analysis of the origins of COVID-19 with differences in how agencies weigh intelligence reporting, scientific publications, and intelligence and scientific gaps causing variations in analytic views. "All agencies continue to assess that both a natural and laboratory-associated origin remain plausible hypotheses to explain the first human infection" (National Intelligence Council, 2023).

Although the origin of SARS-CoV-2 remains unclear, the viral coagulopathy associated with COVID-19 has been directly attributed to the inflammatory state, platelet activation, endothelial dysfunction, and blood stasis associated with COVID-19 infection (Manolis et al., 2020). Initially identified by respiratory complications, COVID-19 is now recognized as a vascular disease. The vascular endothelium plays an intricate role in

immune regulation, inflammatory equilibrium, tight junctional barriers, hemodynamic stability, and balancing thrombotic and fibrinolytic pathways (Siddiqi et al., 2020). Clinical and biomarker derangements associated with COVID-19 are classified into disruption of the immune, renin-angiotensin-aldosterone, and thrombotic balance, all of which converge on the vascular endothelium (Siddiqi et al., 2020).

Immune dysregulation results in cytokine storm, macrophage activity syndrome, and ultimately immune exhaustion in severely ill COVID-19 patients. Epithelial cell dysfunction is a result of the hyperinflammatory state. Epithelial cells are activated, which prompts proinflammatory gene expression, mobilizing more inflammatory cells with resultant vascular leak from induced vascular permeability, which changes the thrombotic potential of the intimal surface (Siddiqi et al., 2020).

Stressful states promote activated endothelial cells to release von Willebrand factor and plasminogen activator inhibitor and decrease thrombomodulin and tissue plasminogen activator, which promotes thrombus production (Siddiqi et al., 2020). P-selectin is also present after endothelial injury, promoting thrombus by platelet binding and increased inflammation (Lowenstein & Solomon, 2020). Thrombin is also generated in large quantities that do not respond to anticoagulation with heparin (Manolis et al., 2020).

The renin-angiotensin-aldosterone system (RAAS) balances vascular stability and function. The vascular influencer in the RAAS is angiotensin II. Damaging effects are induced through angiotensin II type 1 receptor activation of vasoconstrictor, inflammatory, and fibrotic pathways. COVID-19 accesses target cells via angiotensin-converting enzyme 2 (ACE2). ACE2 exerts anti-inflammatory, antioxidant, and antifibrotic properties in the RAAS through conversion of angiotensin II to angiotensin (1–7) and angiotensin I to angiotensin (1–9). Cardiac pericytes and endothelial cells generally have ACE2 present in large amounts, thus creating a direct attack (Siddiqi et al., 2020).

Early identification of COVID-19 patients with increased thrombotic risk is imperative. Markers of thrombosis need to be examined early in

COVID-19 infectious states to determine thromboembolic risk and guide thromboprophylaxis treatment. Coagulation markers that should be monitored include D-dimer (most useful marker), partial thromboplastin time and activated partial thromboplastin time, fibrinogen, fibrin/fibrinogen degradation products, von Willebrand factor, and platelet count. Platelet activation markers include thromboxane B2, P-selectin, soluble CD40 ligand, and mean platelet volume. Inflammation markers include C-reactive protein, erythrocyte sedimentation rate, procalcitonin, and ferritin. The monitoring should start with the initial diagnosis of COVID-19 and continue throughout the illness, even after patients are discharged. There is significant evidence of arterial and venous thromboembolic events in the initial discharge period after hospitalization for COVID-19 patients (Manolis et al., 2020).

Thrombotic complications are major factors in the high mortality rate of COVID-19 patients. Anticoagulation with multiple agents has been suggested: low-molecular-weight heparin or unfractionated heparin, direct oral anticoagulants, antiplatelet agents, FXII inhibitors, thrombolytic drugs, and nafamostat. Pleiotropic, anti-inflammatory, and antiviral effects are also present in some of the therapies. The optimal anticoagulation regimen remains undetermined. Randomized controlled trials are ongoing to determine the best approach in treating ICU and non-ICU patients with COVID-19, including therapeutic anticoagulation versus thromboprophylaxis. In addition to anticoagulation, other therapies being studied and considered are anticomplement agents, neutrophil extracellular trap-inhibiting agents, and interleukin-1 receptor antagonists (Manolis et al., 2020).

The National Institutes of Health issued updated guidelines in 2023 regarding anticoagulation therapy for treatment of COVID-19 patients. Refer to the current treatment guidelines for antithrombotic therapy in COVID-19 patients the National Institutes of Health.

THE IMPACT OF COVID-19 ON THE VASCULAR SURGERY COMMUNITY

Vascular patients were a vulnerable population during the COVID-19 pandemic because of the relationship between the virus, acute thrombotic events, and endothelial damage to the arterial and venous systems. Additionally, there has been a disruption of clinical routine in the vascular community secondary to reduced staffing, postponement of elective and semi-elective procedures, and reduced available resources used on the most critical patients. As a result, the Vascular Surgery COVID-19 Collaborative was launched to develop clinical research data about the impact the pandemic has had on the vascular population, management, and outcomes (D’Oria et al., 2020). The Collaborative has two specific projects: Project 1 focuses on the impact of the pandemic on scheduled vascular operations (carotid, aortic, peripheral, venous, hemodialysis), while Project 2 seeks to learn the acute thrombosis events of the virus (acute limb ischemia, acute mesenteric ischemia, symptomatic VTE, stroke) and develop management protocols for these patients (D’Oria et al., 2020). The coordinated efforts are worldwide, with more than 200 collaborators at more than 170 sites and 34 countries.

Following the global shutdown in March 2020, vascular quality improvement programs and research projects reported a significant decline in vascular procedures in Europe and the United States due to the pandemic (Aziz et al., 2021). More than 80 percent of clinical trials were delayed or not started due to several factors, including mandated institutional shutdowns and lack of patient enrollment out of self-concern. Without evidenced-based protocols on the management of elective vascular disease and acute complications related to COVID-19, the vascular community must reassess management of this patient population for routine and emergent care (Aziz et al., 2021). Vascular quality initiatives and registries are primarily procedural-based and not designed to monitor a delayed approach in the vascular patient. The real-world evidence of the registry has helped communities understand the impact of the COVID-19 pandemic. Up-to-date information will drive changes in the clinical management of the vascular patient and help the vascular community respond to the ever-changing environment in a timely fashion (Aziz et al., 2021).

COVID-19 IMPACT ON PERIPHERAL ARTERIAL DISEASE AND MANAGEMENT RECOMMENDATIONS

Available data are limited on the risk of severe COVID-19 in patients with PAD. Although vascular complications in COVID-19 patients may be underestimated, the virus is a significant risk factor for acute limb ischemia in patients with PAD (Gerotziafas et al., 2020). A 25 percent prevalence of PAD in men and women over age 70 has been largely diagnosed. As such, the VAS-European Independent Foundation in Angiology/Vascular Medicine made recommendations for general measures in patients with PAD during the COVID-19 pandemic. PAD patients are at an increased risk of worsening disease and death; therefore, general practitioners should be aware of common clinical indicators of PAD and symptomatology. Patients with vascular disease should be at the forefront to receive protection from COVID-19 infection, specifically at the primary care level, as they are at increased risk for worsening disease, venous thromboembolism, and 30-day mortality (Gerotziafas et al., 2020). See Appendix C for further recommendations.

CHARACTERISTICS OF VASCULAR NURSING PRACTICE

Vascular nurses move beyond the diagnosis of pathophysiology to identifying and treating human responses to actual or potential health problems related to phenomena affected by vascular system dysfunction. Specific phenomena that form a framework for vascular nursing practice include the following:

- *Consciousness*—This refers to awareness of and interaction with the surrounding environment as well as higher thought processes; alterations include such problems as TIAs and strokes.
- *Circulation*—This is the ability to maintain adequate blood flow/perfusion to the brain, extremities, and vital organs; alterations

include stroke, acute and chronic upper- and lower-extremity arterial and venous diseases, ulcerations, gangrene, and amputation.

- *Rest/Sleep*—Restorative function and rest are needed to promote healing and to maintain an overall sense of well-being.
- *Sensation*—This is the ability to sense and distinguish internal and external stimuli; alterations include decreased sensation related to diabetic neuropathy and pain related to the overall mechanisms for arterial, venous, and lymphatic diseases.
- *Activity*—This refers to the ability to move freely within the environment; alterations include stroke, chronic limb ischemia, gangrene, and amputation.
- *Skin integrity*—This is the maintenance of intact skin without breakdown; alterations include arterial, venous, and diabetic ulcers.
- *Adequate nutrition*—Nutritional balance is needed to maintain health, including an overall sense of well-being, the healing of surgical wounds, and the healing of lower-extremity vascular wounds.
- *Response to illness/coping*—This is the ability to form and maintain social support and relationships; alterations include social isolation and role changes secondary to vascular system disease.
- *Self-care*—This refers to the ability to provide one's own basic needs; alterations include the inability to care for one's self.

Vascular nurses rely on a specialized body of knowledge, skills, technology, and experience to respond and adapt to patient needs. Vascular nurses use the nursing process to deliver care, including assessment, diagnosis, outcomes identification, planning, implementation, and evaluation. Vascular nursing practice is characterized by interventions that promote health, assess for alterations in function, help patients regain or improve their function, and prevent further disability.

PROMOTION OF HEALTH

The vascular nurse stresses health promotion and prevention of vascular disease, reflecting nursing's long-standing commitment to the well-being of the individual, family, group, and community. The vascular nurse performs assessments, targets individuals at risk for vascular disease, and initiates interventions aimed at promoting or maintaining vascular health. Vascular nurses are in a position to educate the individual with vascular disease regarding the disease process, thereby decreasing the risk of poor outcomes, such as stroke, formation of vascular wounds, and limb loss. Vascular nurses must be familiar with the disease process to effectively counsel and educate patients and their families regarding treatment options.

Patients presenting for treatment of vascular problems should have their risk factors rigorously assessed, with appropriate therapies instituted to decrease the risks of progression of vascular complications and cardiovascular mortality. Vascular nurses practicing in a variety of inpatient and outpatient settings can assist patients with risk-factor modification, such as smoking cessation, maintaining glycemic control, normalizing high blood pressure and lipid levels, maintaining antiplatelet therapy, and fostering participation in exercise programs, thereby promoting positive patient outcomes.

Patients are encouraged in weight loss and diabetes control along with exercise to decrease vascular risk by decreasing dietary cholesterol, reducing total and saturated fat intake, and moderately decreasing sodium intake. Additionally, consumption of complex carbohydrates, fruits, vegetables, and proteins should be increased. Diet control assists in lowering drug dosing, thereby minimizing adverse side effects. Greater control of dyslipidemia, diabetes, and hypertension may slow the progression of vascular disease.

ASSESSMENT FOR ALTERATIONS IN FUNCTION

The vascular nurse performs assessments and collects data regarding the health status of the individual with vascular disease in a systematic and

ongoing manner. Collected data include not only the physical needs but also the psychosocial and spiritual needs of the individual. Out of data collection, diagnoses are formulated, measurable goals are determined, and plans of care are developed, implemented, and evaluated. Information obtained from the individual or family is communicated to other members of the care team.

MEASURES TO MAINTAIN, REGAIN, OR IMPROVE FUNCTION AND PREVENT DISABILITY

A major focus of clinical vascular nursing care involves teaching the individual or family ways to maintain, regain, or improve function as well as to prevent disability. Teaching must take into consideration the capabilities and limitations of the individual or family and collaboration with other professionals and specialists, such as dietitians. Vascular nurses focus on the overall assessment, treatment, and evaluation of individuals requiring surgical or interventional strategies to manage their arterial problem.