# Collaborative Care

**WILLIAM ROGERS, JOHN MARTIN, MD,** and **WILLIAM GOLD, MD,** discuss technology-supported collaborative care in the diagnosis and management of peripheral arterial disease (PAD)

There is a growing demand from policymakers and payers for transformative change in how healthcare is delivered in this country. A fragmented healthcare system, variations in resource availability and practice patterns, and lack of effective communication between providers have led to inefficiencies that threaten access to high quality healthcare for Americans. One of the keys to successful innovation that will lead to more effective healthcare is the creation of technology that supports collaboration and moves people - especially those suffering from complex chronic condition — through a seamless care continuum. The PADnet vascular disease diagnosis and management system is an example of how technology can support and encourage providers across specialty types to find disease early, communicate, and collaborate on patient care.

## THE SCOURGE OF PAD

PAD is the vascular dysfunction in the limbs caused by the build-up of atherosclerotic plaque. PAD in the limbs manifests itself in the same way as other areas of the body where arterial plaque compromises blood flow, such as coronary artery disease, cerebral artery disease, and the syndromes associated with damage to the microvasculature of the kidneys and eyes. Diabetes, hypertension, high cholesterol, smoking, advanced age, and genetic factors significantly increase the risk for developing PAD. Diabetes and cigarette smoking are particularly strong risk factors for PAD.

It is estimated that 12 million people in the United States have PAD with a projected increase to 16 million by the year 2030.[1] Untreated PAD can lead to functional impairment of the limbs, non-healing wounds, gangrene and in some cases, amputation and death. There are approximately 160,000 non-trauma related amputations per year in the United States, most attributable to PAD.[2]

The five-year morbidity rate (heart attack, stroke, or death) for those diagnosed with PAD is 20 percent – 30 percent if the person has both PAD and diabetes.[3] One study found that coronary artery disease (CAD) exists in 90 percent of those previously diagnosed with PAD when angiography was used to diagnose the CAD.[4] This same study also found that the presence of PAD may be a stronger predictor of cerebrovascular disease than the presence of coronary artery disease.[5]

Only 2.5 percent of those suspected of having PAD have a confirmed diagnosis,[6] and only 25 percent of those diagnosed are undergoing treatment.[vii] Patients with peripheral arterial disease (PAD) are at triple the risk of mortality and six times the risk of death from heart attack than those without the disease, and yet, "PAD is probably the most under-diagnosed and least aggressively managed atherosclerotic disease."[8]

## THE IMPORTANCE OF EARLY DIAGNOSIS

Because PAD signs and symptoms can manifest themselves much earlier than coronary symptoms, there is an excellent opportunity to significantly reduce the human suffering and health system costs associated with both of these diseases with a focused effort to find PAD early in the disease process, and adoption of care guidelines to improve outcomes.

Under the current PAD diagnosis models that require referrals to specialists and inhibit communication between providers, diagnosis is often made very late in the progression of the disease, when significant tissue damage has already occurred. The costs of PAD can be significantly reduced through earlier diagnosis and appropriate non-invasive treatment approaches.

Those with diabetes and PAD (these diseases often occur together) may not feel the painful effects of compromised blood flow or tissue damage caused by PAD because of diabetic nerve damage. Patients often do not know that they are suffering such symptoms, attributing their leg pain and walking difficulty to "old age." Primary care providers, especially podiatrists, are almost always the first to see the signs and symptoms of PAD. Supporting primary care providers in identifying patients early in the disease process, overseeing the diagnostic process and monitoring patient progress is critical in preventing costly "downstream" conditions and associated physical dysfunction.

## THE PADNET COLLABORATIVE CARE SYSTEM

The PADnet collaborative care system was created to support early detection and effective treatment for PAD through collaboration between primary care providers, podiatric physicians, and cardiovascular and interventional specialists to diagnose and treat PAD. The diagnostic technology used in the PADnet system is well established and has been used in vascular laboratory setting for decades. The innovation comes in simplifying the technology to make it more appropriate for use by primary care medical staff, and in creating a communication and data access system that allows providers across specialty types to access patient information, report patient progress, and share recommendations to improve efficiency and quality of care.

## DIAGNOSTIC TECHNOLOGY

A diagnosis of PAD using the PADnet+ system is made by measuring changes in blood flow through the limbs during the cardiac cycle, and by measuring the differential blood pressures between the brachia (arm) and ankle bilaterally (the ankle/brachial blood pressure index). Using pneumo (air) plethysmography, pulse volume recording (PVR) waveforms are produced that can be displayed for evaluation to diagnose obstructive arterial disease. Air cuffs placed at the thigh, calf, and ankle are connected to a plethysmograph which produces a recording of the volume changes in each leg during the cardiac cycle. These PVR waveforms detect volume changes as blood flows through the limb to see patterns of arterial flow diagnostic of peripheral arterial disease. The value of pneumo-plethysmography for producing pulse volume recorded measures of blood volume for diagnostic purposes has been well established.[9][10][11][12]

PVR waveforms alone produce an 85 percent diagnostic accuracy rate when compared with angiography. Combining the PVR waveforms with a calculation of the ankle/brachial blood pressure index (ABI) increases the diagnostic accuracy of non-invasive vascular studies to above 95 percent compared to angiography.[13] To calculate an ABI, systolic pressures are measured in the brachia (arm) and ankle and the ankle measurement is divided by the

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brachial measurement. If the index is less than .90, a preliminary diagnosis of PAD may be confirmed. In a vascular lab, these ABI pressure readings are commonly performed using a hand-held Doppler devise, listening for the return of normal flow as the blood pressure cuff is released. The accuracy of Doppler measurement depends heavily on the ability of the technologist to operate the Doppler equipment correctly, and results can be unreliable when used in a primary care setting.

The PADnet system uses a less operator-dependent, and therefore more primary care-appropriate, method of calculating an accurate ABI through automated oscillometric blood pressure measurement. Simultaneous to the PVR waveform generation, the PADnet system measures blood pressures in the arms (brachia) and the ankles using oscillometry. The calculation of the

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ABI is done automatically as the test is being conducted. The reliability and diagnostic value of oscillometry in measuring the systolic pressure used to calculate the ABI has also been well established.[14][15][16][17][18][19][20]

Equivalency studies performed in vascular centers that participate in the PADnet program have consistently shown that the PADnet system produces test results that are equivalent to those of the standard equipment used in vascular laboratories to produce PVR waveform and ABI calculations.

## THE PADNET COLLABORATIVE CARE PLATFORM

In order to create optimal healthcare system efficiency, collaboration between primary care and specialists to diagnose and treat disease is crucial. The PADnet system supports collaborative diagnosis and care management through an electronic data exchange platform that allows primary care and diagnosing specialists to work together to diagnose, create treatment plans, monitor patient progress, and access patient education tools.

Through the PADnet collaborative care system, primary care providers (PCPs) perform diagnostic tests that are uploaded to a secure Web site. The specialist of that PCP's choosing (usually a cardiologist, vascular surgeon or interventional radiologist in their community) is notified that there is a test to be interpreted. The specialist opens the patient's test file, reads the patient history, diagnostic test results, and images, and renders a diagnosis. Through the Web site, the specialist reports the diagnosis and recommendations for next steps back to the PCP. All patient histories, test data, images and specialist reports are maintained on the secure PADnet data server, and are available to the specialist and PCP at all times. Care guidelines and patient education materials can also be easily made available through the PADnet Web site to all providers participating in the system.

The PADnet data interchange has been carefully developed so that all patient data housed in the PADnet Central data warehouse will be easily downloadable to HL-7 compatible electronic medical records systems as they are adopted.

## A MODEL FOR THE FUTURE

Perhaps the greatest barrier to effective transformation of the American healthcare system through innovative technology development is in the outdated policies of an American healthcare system that is slow to keep up with innovation. For example, there is a great temptation to wait for the widespread adoption of electronic medical records (EMRs) to initiate truly collaborative care models. However, EMR adoption has been slow, either because of the prohibitive cost, or due to concern over what the government will require of the EMR systems in the future. Outdated medical policies of insurers and Medicare carriers can also serve as a barrier to collaborative care by restricting the providers and locations where diagnostic testing may be performed. The PADnet system is proof that collaboration between providers all along the continuum of care is possible now through web-based data transactions. Our challenge is to assure that as innovations such as this become available, the medical policies of the future allow and encourage providers to work collaboratively to transform the American healthcare system. **FH**

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