Diagnose and Treat
Peripheral Arterial Disease
PAD

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CBC Health Braintrust
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Established in 2004, the PAD Coalition is a public and interdisciplinary consortium dedicated to improving the health and health care of patients with PAD.

The Coalition includes 76 organizations that collectively represent more than 1,012,000 health care professionals and 500,000 consumers.
What to Expect

- Prevalence of PAD
- Risk Factors
- Non-Invasive Testing
- Abnormal Studies
- Wrap-Up
Collaboration

- **Promote** health awareness, prevention, disease management and patient education.
- **Actively involve** patient and family in care plan and delivery.
- **Encourage** collaborative practice among multidisciplinary team members
- **Improve** performance through measurement of clinical, financial and customer satisfaction outcomes.
Prevalence of PAD

- It effects approximately 10 million Americans.
- 1 out of 3 individuals over 70 years of age have PAD.
- Without proper treatment, 30% will likely die in 5 years.

SOURCE: PARTNERS Study, Principal Investigator – Dr. Alan Hirsch
Prevalence

- PAD prevalence increases with age.
- At ages > 60 years, and adjusted for risk factors, **African Americans** had PAD at rates that were approximately **two to three times** higher than non-Hispanic whites.
- PAD affects 7.2% of the U.S population aged 40 years and older in the USA in 2000.

Clinical Presentations of PAD

- **15%** Classic (Typical) Claudication
- **33%** Atypical Leg Pain (functionally limited)
- **50%** Asymptomatic
- **1%-2%** Critical Limb Ischemia
Risk Factors for PAD

- Smoking: Reduced
- Diabetes: Increased
- Hypertension: Increased
- Hypercholesterolemia: Increased
- Hyperhomocysteinemia: Increased
- C-Reactive Protein: Increased

Relative Risk:
- 0
- 1
- 2
- 3
- 4
- 5
- 6
Ethnicity and PAD: The San Diego Population Study

Fraction of Population With PAD (%)

NHW Black Hispanic Asian

NHW = Non-hispanic white.

Prevalence of PAD Increases With Age

Rotterdam Study (ABI <0.9)$^1$  
San Diego Study (PAD by noninvasive tests)$^2$


ABI = ankle-brachial index
Individuals “At Risk” for Lower Extremity PAD

- Age less than 50 years with diabetes, and one additional risk factor (e.g., smoking, dyslipidemia, hypertension, or hyperhomocysteinemia)
- Age 50 to 69 years and history of smoking or diabetes
- Age 70 years and older
- Leg symptoms with exertion (suggestive of claudication) or ischemic rest pain
- Abnormal lower extremity pulse examination
- Known atherosclerotic coronary, carotid, or renal artery disease
Diabetes & PAD

Two thirds of U.S. adults 20-74 yrs are either overweight or obese $^a$

By 2040, 100% of U.S. adults will meet the definition of “obese” $^b$

Obesity has led to Diabetes Mellitus in 6.3% of the American population (13 MM diagnosed and 5.2 MM undiagnosed)

Diabetes leads to foot ulcers (100,000 of total 600,000 per year in the U.S.) $^c$

$a$ Ogden et al JAMA 2006; 1/3 are obese.
$b$ CDC 2005 and J. Foreyt 2006 Baylor Coll Med
$c$ CDC 2002
Diabetes Increases the Risk of PAD

Impaired glucose tolerance was defined as oral glucose tolerance test value ≥140 mg/dL but <200 mg/dL.

*P<.05 vs. normal glucose tolerance.

Five Year Mortality: PAD Versus Major Cancers

**Patients (%)**

- **Prostate Cancer***: 8
- **Hodgkin's Disease***: 18
- **Breast Cancer***: 23
- **PAD†**: 32
- **Colorectal Cancer***: 39
- **Lung Cancer***: 86

Natural History of Atherosclerotic Lower Extremity PAD

PAD Population (50 years and older)

Initial clinical presentation

Asymptomatic PAD 20%-50%

Atypical leg pain 40%-50%

Claudication 10%-35%

Critical limb ischemia 1%-2%

Progressive functional impairment

1-year outcomes

Alive w/ 2 limbs 50%

Amputation 25%

CV mortality 25%

5-year outcomes

(to next slide)

Natural History of Atherosclerotic Lower Extremity PAD

For each of these PAD clinical syndromes

- Asymptomatic PAD 20%-50%
- Claudication 10%-35%
- Atypical leg pain 40%-50%

5-year outcomes

- Limb morbidity
  - Stable claudication 70%-80%
  - Worsening claudication 10%-20%
  - Critical limb ischemia 1%-2%
- CV morbidity & mortality
  - Nonfatal CV event (MI or stroke) 20%
  - Mortality 15%-30%

Amputation (see CLI data)

CLI=critical limb ischemia; CV=cardiovascular; MI=myocardial infarction

Our Role vs Limb Ischemia

- Identify Those at Risk
- Good Medical History
- Complete Physical Examination
- Appropriate Testing and Referrals
The First Tool to Establish the PAD Diagnosis: 
A Standardized Physical Examination

Pulse intensity should be assessed and should be recorded numerically as follows:

- 0 - Absent
- 1 - Diminished
- 2 - Normal
- 3 - Bounding
Non-Invasive Testing
A Collaboration
Arterial Testing
Arterial Testing

Arm Pressures
For ABI

Ankle Pressures
for ABI

PVR Measurements
The Ankle-Brachial Index

\[
\text{ABI} = \frac{\text{Lower extremity systolic pressure}}{\text{Brachial artery systolic pressure}}
\]

- Establishes the PAD diagnosis
- Identifies a population at high risk of CV ischemic events
- The ankle-brachial index is 95% sensitive and 99% specific for PAD
- The “population at risk” can be clinically and epidemiologically defined:
  - Age less than 50 years with diabetes, and one additional risk factor Age 50 to 69 years and history of smoking or diabetes
  - Age 70 years and older
  - Leg symptoms with exertion (suggestive of claudication) or ischemic rest pain
  - Abnormal lower extremity pulse examination
  - Known atherosclerotic coronary, carotid, or renal artery disease

- Toe-brachial index (TBI) useful in individuals with non-compressible pedal pulses

### Ankle-Brachial Index

<table>
<thead>
<tr>
<th>Brachial Index</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 0.9</td>
<td>Normal</td>
</tr>
<tr>
<td>0.9 to 0.75</td>
<td>Mild PVD</td>
</tr>
<tr>
<td>0.75 to 0.4</td>
<td>Moderate PVD (IC)</td>
</tr>
<tr>
<td>≤ 0.4</td>
<td>Severe Disease</td>
</tr>
</tbody>
</table>
ABI Limitations

- Incompressible arteries (elderly patients, patients with diabetes, renal failure, etc.)
- Resting ABI may be insensitive for detecting mild aorto-iliac occlusive disease
- Not designed to define degree of functional limitation
- Normal resting values in symptomatic patients may become abnormal after exercise
- **Note**: “Non-compressible” pedal arteries is a physiologic term and such arteries need not be “calcified”
Pulse Volume Recordings

- Measures blow flow within blood vessels (arteries)
- Combination with other tests
  - Segmental pressures
  - Doppler waveforms
  - Duplex ultrasound
- Abnormal findings may require other testing
  - Arteriogram
  - CT angiography
  - Magnetic Resonance angiography
Pulse Volume Recordings

Testing
- Patient semi-recumbent
- 3 to 4 blood pressure cuff’s on extremity (thigh, calves, ankle, etc.)
- Connected to machine and pulses appear as waveforms on chart.

* Shape of waveforms help diagnose possible blockage.
PVR Interpretation

- Normal
  - Sharp upstroke
  - Rapid Fall
  - Dichrotic notch or reflected wave
PVR Interpretation

- Mildly abnormal (early stenosis)
  - Loss of amplitude
  - Lacks reflected wave
PVR Interpretation

- Moderately abnormal
  - Rounded peak
  - Decreased amplitude
  - Lacks reflected wave
PVR Interpretation

Severely Abnormal
- Flat
- Barely pulsatile
Normal PVRs and Pressures
Pulse Volume Recordings
Arterial Study Report

LOWER EXTREMITY ARTERIAL TESTING

Physician: [Name]

Referring Physician: [Name]

Date of Exam: 12/12/2007

Habitual Factors:
- Diabetes: Yes
- Hypertension: Yes
- Tobacco: Yes
- Hypothyroidism: No
- Hyperkinesis: No

Associated Illnesses:
- Cardiovascular: No
- Carotid: Yes
- Pulmonary: No
- Renal: No

Notes:
- Patient is currently taking anti-hypertensive medication. Coped with symptoms of lower extremity pain.
- Extremity trauma (both sides)

Pressure Readings:

Right
- Brachial: 114 (116)
- Radial: 118 (124)
- Post-Exercise: 100 (110)
- Normal: Yes

Left
- Brachial: 121 (124)
- Radial: 100 (105)
- Post-Exercise: 100 (110)
- Normal: Yes

Interpretation:
- No evidence of significant peripheral vascular disease on either leg.
- Normal ankle-brachial index (ABI) on both sides.
- No significant difference in ABI between the two legs.

Conclusion:
- No arterial disease detected.

Physician Signature:
[Signature]

Technologist Signature:
[Signature]
Sample Patient #1

- ~ 60 Year Old Male
  - Diabetes, HTN, Smoker.
- Left leg pain when walking
- Mild right leg discomfort when walking
- Additional diagnostics confirmed inflow disease
- Patient was successfully revascularized
Right Iliac Occlusive Disease
Left Iliac artery stenosis
Left Iliac artery occlusion pre and post stenting
Bilateral Tibial Artery Disease

<table>
<thead>
<tr>
<th></th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>142 mmHg</strong></td>
<td><strong>1.0</strong></td>
<td><strong>1.0</strong></td>
</tr>
<tr>
<td><strong>64 mmHg</strong></td>
<td><strong>17 mm</strong></td>
<td><strong>15 mm</strong></td>
</tr>
<tr>
<td><strong>308 cc</strong></td>
<td><strong>RWA 8.92</strong></td>
<td><strong>RWA 8.90</strong></td>
</tr>
<tr>
<td><strong>189 mmHg</strong></td>
<td><strong>1.0</strong></td>
<td><strong>1.0</strong></td>
</tr>
<tr>
<td><strong>63 mmHg</strong></td>
<td><strong>12 mm</strong></td>
<td><strong>12 mm</strong></td>
</tr>
<tr>
<td><strong>170 cc</strong></td>
<td><strong>RWA 8.78</strong></td>
<td><strong>RWA 8.52</strong></td>
</tr>
<tr>
<td><strong>97 mmHg</strong></td>
<td><strong>1.0</strong></td>
<td><strong>1.0</strong></td>
</tr>
<tr>
<td><strong>5 mm</strong></td>
<td><strong>5 mm</strong></td>
<td><strong>4 mm</strong></td>
</tr>
<tr>
<td><strong>63 mmHg</strong></td>
<td><strong>66 cc</strong></td>
<td><strong>65 mmHg</strong></td>
</tr>
<tr>
<td><strong>68 cc</strong></td>
<td><strong>RWA 8.63</strong></td>
<td><strong>RWA 8.55</strong></td>
</tr>
<tr>
<td><strong>73 mmHg</strong></td>
<td><strong>1.0</strong></td>
<td><strong>1.0</strong></td>
</tr>
<tr>
<td><strong>2 mm</strong></td>
<td><strong>2 mm</strong></td>
<td><strong>3 mm</strong></td>
</tr>
<tr>
<td><strong>62 mmHg</strong></td>
<td><strong>Cuff Pressure 64 mmHg</strong></td>
<td><strong>Cuff Pressure 85 cc</strong></td>
</tr>
<tr>
<td><strong>78 cc</strong></td>
<td><strong>Cuff Volume</strong></td>
<td><strong>Cuff Volume</strong></td>
</tr>
<tr>
<td><strong>RWA AMB 0.47</strong></td>
<td><strong>Morphology</strong></td>
<td><strong>Morphology</strong></td>
</tr>
<tr>
<td><strong>Brachial Index</strong></td>
<td><strong>0.47</strong></td>
<td><strong>0.47</strong></td>
</tr>
</tbody>
</table>

**PULSE VOLUME RECORDINGS**
Popliteal Artery Occlusion
Factors That Increase Risk of Limb Loss in Patients With Critical Limb Ischemia

Factors that reduce blood flow to the microvascular bed
- Diabetes
- Severe renal failure
- Severely decreased cardiac output (severe heart failure or shock)
- Vasospastic diseases or concomitant conditions (e.g., Raynaud’s phenomenon, prolonged cold exposure)
- Smoking and tobacco use

Factors that increase demand for blood flow to the microvascular bed
- Infection (e.g., cellulitis, osteomyelitis)
- Skin breakdown or traumatic injury

Also see Table 5 of Hirsch AT, et al. J Am Coll Cardiol. 2006;47:e1-e192.
Objectives for Diagnostic Evaluation of Patients With Critical Limb Ischemia

- Localization of the responsible lesion(s) and measurement of relative severity
- Assessment of the hemodynamic requirements for successful revascularization (vis-à-vis proximal versus combined revascularization of multilevel disease)
- Assessment of individual patient endovascular or operative risk

Also see Table 6 of Hirsch AT, et al. J Am Coll Cardiol. 2006;47:e1-e192.
### Two Major Goals in Treating Patients With PAD

#### Limb outcomes
- Improved ability to walk
  - Increase in peak walking distance
  - Improvement in quality-of-life (QoL)
- Prevention of progression to CLI and amputation

#### Cardiovascular morbidity and mortality outcomes
- Decrease in morbidity from non-fatal MI and stroke
- Decrease in cardiovascular mortality from fatal MI and stroke
### Arterial Study Indications

<table>
<thead>
<tr>
<th>U.S. ICD-9 Codes*</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>440.21</td>
<td>Leg pain with exercise (Intermittent Claudication)</td>
</tr>
<tr>
<td>440.22</td>
<td>Leg discomfort at rest (Vascular Rest Pain)</td>
</tr>
<tr>
<td>440.23</td>
<td>Non-healing wound on foot or leg (Ulceration)</td>
</tr>
<tr>
<td>440.24</td>
<td>Advanced ulcer on foot or leg (Gangrene)</td>
</tr>
<tr>
<td>443.10</td>
<td>Embolic discoloration in toes or feet (Buerger’s Disease)</td>
</tr>
<tr>
<td>903.00</td>
<td>Injury in limb or foot involving blood vessels (Blunt Trauma)</td>
</tr>
<tr>
<td>250.70</td>
<td>Diabetic with vascular disorder (Non-compressible vessels)</td>
</tr>
<tr>
<td>443.90</td>
<td>Over age 70 with absent pedal pulses? (PVD Unspecified)</td>
</tr>
<tr>
<td>443.90</td>
<td>Over age 50, smoke and/or have diabetes, and absent pedal pulses? (PVD Unspecified)</td>
</tr>
</tbody>
</table>

* Reimbursement Policies will vary by location and carrier. Contact your local carriers to confirm which diagnostic codes are applicable.
WHAT WE MUST DO

- Good history and Physical exam
- Non-invasive testing
- Vascular Consultation
- Multidisciplinary team work
- Increase Public Awareness of PAD
PAD Coalition
A Coordinated Effort to Inform the Public about PAD
Coordinated by the Vascular Disease Foundation: 501 3c

PAD Coalition
NHLBI Public Awareness Campaign
PAD Coalition Activities and Products
Co-branded NHLBI and Coalition resources for member activities

Member activities
Member products and resources

Stay in Circulation
Take Steps to Learn About P.A.D.
Broaden Reimbursement for PAD Screening

- The ankle-brachial index (ABI) is the fundamental diagnostic tool for the diagnosis of PAD.

- Reimbursement for ABI testing is currently restricted to patients with PAD symptoms.

- Broadening the availability of the ABI – particularly to asymptomatic patients -- will result in increased detection of PAD.

- PAD Coalition working to secure a one-time PAD screening benefit under Medicare for those at high risk for having undiagnosed PAD.
Clearinghouse for PAD educational resources:

- Clinical practice tools
- Slides
- Patient education resources
- Professional meetings
- PAD Coalition news

What’s New

- **Find a P.A.D. Screening Site**: Several Coalition partners conduct screenings for P.A.D. during September, P.A.D. Awareness Month, and throughout the year. Many of these screenings are free, but space is limited. For more information on local screening programs, please click here.

- **Call for Nominations: Best P.A.D. Research Awards**: To best identify and celebrate the creation of new clinical research relevant to the pathophysiology, prevention, diagnosis, and treatment of P.A.D., the Coalition is announcing a call for nominations for the inaugural Best P.A.D. Research Award. For more information on award categories, submission instructions and selection process, please click here. Nominations are due June 1, 2007.

- **Trying to determine how your organization can support the Stay in Circulation: Take Steps to Learn About P.A.D. campaign?** We’ve got you covered. Click here for simple things that you can do to support this national effort.

- **P.A.D. Clinician Toolkit Available**: In cooperation with the P.A.D. Coalition, the
THANK YOU

padcoalition.org