HOW TO USE A DOPPLER IN YOUR PRACTICE
Disclosure

- I am a NZRN and currently work at USL Medical as a Product Manager
- USL Medical are the exclusive distributors for Huntleigh Diagnostics
- Huntleigh Diagnostics have assisted with the content of this presentation.
Peripheral Arterial Disease

- A marker for future vascular disease (CHD and stroke)
- In Europe and North America an estimated 27 million people have PAD and in the UK around 100,000 people are diagnosed every year.
  - 60% die from MI
  - 12% from stroke
  - PAD patients 6x more likely to die from CHD  
    (Belch et al, 2007, Br J Diabetes Vasc Dis 7(5): 236-239)
- In 2011, estimated that 17% of pop (102m) will be > 65 and at high risk of leg/foot ulcers
- Up to 33% inappropriate referrals to Vascular Team (back pain, neurological pain, nerve entrapment)
- Inadequate and infrequent primary care vascular assessments are performed
- Increasing aging population
- Increasing incidence of diabetes
Incidence of Diabetes in Asia Pacific Region 2013

- China: 9.6%
- New Zealand: 9%
- Australia: 4%
- Indonesia: 5.6%

Other countries and regions have varying incidences ranging from 2.5% to 10.1%.
The cause of the problem
PAD

Common Sites for PAD

- Iliac artery
- Femoral artery
- Popliteal artery
- Tibial arteries (anterior and posterior)

Plaque in the artery wall narrows blood flow to muscles.
The effect on the foot
Clinical features of the ischaemic foot

- Cold
- Pale colour
- Glass like skin
- Little callous
- Pulse-less
- Dependent rubor
- Claudication
- Rest pain
- Ulcers on edges
Risk factors for PAD development

- Increasing age (> 50 yrs old)
- Male gender
- Decreasing activity
- Smoking
- Diabetes – medial sclerosis and calcification
- Hypercholesterolemia
- Hypertension
- Previous myocardial infarction, angina, stroke, TIA’s
Guidelines

• The NSF for coronary heart disease requires general practitioners to identify all people with a diagnosis of coronary heart disease or occlusive arterial disease including stroke and peripheral vascular disease. (DOH. NSF for coronary heart disease 2000 standard 4)

• NICE and NSF Diabetes emphasised necessity to identify, manage risk factors and revascularise those with diabetes and peripheral arterial disease. (NICE CG 10: 2004 and NSF, DOH, 2001)

• “Ankle brachial pressure index should be measured in all patients suspected of peripheral arterial disease.” (Diagnosis and management of peripheral arterial disease. Sign Clinical Guidelines 89, 2006)

• ACC/AHA recommend patients with symptoms of intermittent claudication should undergo a vascular physical examination, including measurement of the ABPI (Hirsch AT, Haskal ZJ, Hertzer NR et al. Peripheral vascular disease: ACC/AHA 2005 Guidelines for the management of PAD)
Guidelines

• All patients receiving compression therapy should undergo adequate arterial assessment which should include:
  History, Examination and ABPI
(Extracts from Statements on Important Aspects, European Tissue Repair Society 2003)

• “All patients should be given the benefit of measurement of ABPI to ensure detection of arterial insufficiency” (RCN 1998)

• Arterial disease of the leg is most commonly detected by a combination of clinical examination and measurement of a reliably taken ABPI (Clinical Resource Efficiency Support Team, CREST, 1998)

• NICE recommends testing foot sensation, palpate pulses and undertake vascular assessment for higher risk patients (NICE guidelines No. 10, 2004)
Recommendations

- Doppler ABPI is recommended for excluding significant PAD before applying compression therapy. (Callam et al, 1987)
- “The Doppler ABPI must be used in conjunction with a comprehensive medical assessment”. (Moffatt, 1995)
- 23% of venous leg ulcers had significant arterial insufficiency (Bale, 1989)
- Undertake toe pressures and TBPI when ABPI > 1.3 (Brooks, 2001)
- Cuffs of the appropriate size should be deflated at 2-3mmHg/sec (BHS, 2000 & 2004)
- Growing body of evidence to undertake ABPI on patients at risk of Heel ulcers (Okuwa et al, 2005; Graham, 2005; Meaume, 2008)
Detection of PAD is paramount and potentially treatable

- Large body of evidence supporting the efficacy of ABPI as an effective diagnostic and risk assessment tool (Newman, 1999; Papamicheal, 2000; Sikkink, 1997; Zheng, 1997)
- To date, ABPI is the most effective, accurate and practical method of PAD detection (Belch et al, 2003)
- ABPI < 0.9 is 95% sensitive in detecting angiogram positive disease and almost 100% specific in excluding healthy individuals (Belch et al, 2003)
- ABPI < 0.9 is highly predictive of morbidity and mortality from cardiovascular events linked with PAD (Belch et al, 2003)
- ABPI provides the clinician with the means of identification of PAD
- ABPI also provides information regarding severity of PAD that can assist in guiding a treatment approach
Why Use Doppler for ABPI

• Palpation of foot pulses is not sufficient (Moffatt 1995)
• BP measurements at the ankle using a Stethoscope are difficult (Yao 1993)
• 10% of patients have absent Dorsalis Pedis pulses (Callam 1987)
• Addition of Doppler significantly improved the accuracy of pulse identification and resulted in more appropriate referrals (Ross 2007)
• All patients presenting with an ulcer should be screened for arterial disease by Doppler measurement of ABPI by staff who are trained to undertake this measurement. (Clinical Practice Guidelines, RCN 1998)
What is sound?

- Sound is:
  - A pressure wave
    - Amplitude (Volume or loudness)
  - Frequency (Pitch)

- Amplitude / Volume
- 4 cycles/sec
- 4 Hz
- 0.5 secs
- 1 cycle
- Time (secs)
Doppler Shift explained

- Forward Flow
- No Flow
- Reverse Flow
Doppler Assessment

- Doppler probes come in several Frequencies 2-10 MHz
- It is important to use contact gel, use at 45 degree angle
- 8MHz probe is ideal for measuring ABPI
Examination of the arterial patient

Past Medical History
- Cardiac: angina; arrhythmias; MI
- Diabetes
- Hypertension
- Renal
- Neurological: cerebrovascular; peripheral
- Injuries
- Arthritis / collagen disease
- Clotting abnormalities
Selection of Equipment

- **dopplex® D900, dopplex® SD2 dopplex® MD2**
- Correct probe transducer  (Williams 1995)
- Correct size BP cuff  (British Hypertension Society 1997)
- Appropriate ultrasound gel  (Kenney 1997)
- **dopplex® DR3 or dopplex® Printa II** for documentation
Huntleigh Doppler Range of Probe Sizes

EZ8: The new Easy8 8MHz High Sensitivity Doppler probe incorporates Wide Beam technology to allow easy location of the vessel.

It is also easier to maintain vessel contact during inflation & deflation

VP4HS: A 4MHz High Sensitivity Doppler probe for detection of deep lying vessels.

VP5HS: A 5MHz High Sensitivity Doppler probe for oedematous limbs and deep lying vessels.

VP8HS: An 8MHz High Sensitivity Doppler probe for easier detection of peripheral vessels and calcified arteries

VP10HS: A 10MHz High Sensitivity Doppler probe for detecting smaller vessels in specialist superficial applications.

EZ8 and VP5HS are recommended for ABPI measurement
Preparation of the Patient

- Explain and reassure patient of the procedure
- Ensure ambient temperature of the room is comfortable, (Moffatt 1990)
- Remove any tight clothing from both arms and stockings socks etc. from legs
- Remove any dressings from current ulcers and cover with a clear film (Kenny 1997)
- Rest the patient for 15-20 minutes (Yao 1993; Williams 1993)
- Position the patient supine (Stubbing 1996)
• Sounds of normal artery

• Sounds of normal vein
Doppler ABPI Measurements

- Position patient supine and rest for 15-20 minutes
- Measure both Brachial pressures
- Measure two pedal pressures per foot
- Calculate ABPI using highest ankle/highest brachial pressure
Brachial Pressures

Measure Right Brachial Systolic Pressure
Brachial Pressures

Measure Left Brachial Systolic Pressure
The posterior tibial pulse is located in the hollow behind the medial malleolus, and the dorsalis pedis pulse is felt between the first and second metatarsals.

(K.R Vowden, 1996)
Ankle Pressures

Measure Right Dorsalis Pedis Systolic Pressure
Ankle Pressures

Measure Right Posterior Tibial Systolic Pressure

It is important to identify and follow the protocol set by your individual hospital/clinic/health centre.
How to Calculate the ABPI

ABPI calculations
Highest ankle systolic pressure (for each leg)
Highest brachial systolic pressure

Right ABPI

Brachial
145

Posterior Tibial
80

Dorsalis Pedis
85

Left ABPI

Brachial
150

Posterior Tibial
120

Normal ABPI ratio is equal or greater than 1.00 but not greater than 1.3 (check local policy)
How to Calculate the ABPI

Highest ankle systolic pressure
Highest brachial systolic pressure

\[ \text{ABPI} = \frac{85}{150} = 0.57 \]
# How to Interpret the ABPI (PAD)

<table>
<thead>
<tr>
<th>ABPI Value</th>
<th>Status</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABPI = 0.9 - 1.3</td>
<td>Normal</td>
<td>No Action</td>
</tr>
<tr>
<td>ABPI = 0.75 – 0.89</td>
<td>Mild PAD</td>
<td>Manage Cardiovascular risk factors</td>
</tr>
<tr>
<td>ABPI = 0.4 - 0.74</td>
<td>Moderate PAD</td>
<td>Manage Cardiovascular risk factors</td>
</tr>
<tr>
<td>ABPI &lt; 0.4</td>
<td>Severe PAD</td>
<td>Refer to vascular specialist</td>
</tr>
<tr>
<td>ABPI &gt; 1.3*</td>
<td>Abnormal</td>
<td>Check for diabetes - Refer to vascular specialist</td>
</tr>
</tbody>
</table>

*For patients with diabetes, an ABPI > 1.3 may indicate PAD.

[How to Interpret the ABPI](http://www.nhlbi.nih.gov/health/dci/Diseases/pad/pad_diagnosis.html)
# How to Interpret the ABPI

(Woundcare)

<table>
<thead>
<tr>
<th>ABPI Range</th>
<th>Interpretation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABPI &gt; 1.0 - 1.3</td>
<td>Unlikely to be arterial in origin</td>
<td>Apply compression therapy</td>
</tr>
<tr>
<td>ABPI = 0.8 - 1.0</td>
<td>Mild peripheral disease</td>
<td>Apply compression therapy with caution</td>
</tr>
<tr>
<td>ABPI = 0.5 - 0.8</td>
<td>Significant arterial disease</td>
<td>Do not compress - refer to specialist</td>
</tr>
<tr>
<td>ABPI &lt; 0.5</td>
<td>Severe arterial disease</td>
<td>Do not compress - refer urgently to vascular specialist</td>
</tr>
<tr>
<td>ABPI &gt; 1.3*</td>
<td>Measure toe pressures or refer to specialist</td>
<td></td>
</tr>
</tbody>
</table>

*may vary according to local protocols *(RCN, 1998)*
It is recommended that the ABPI is checked every 12 weeks (Simon 1994)

**HOWEVER** if the patients condition changes during that time i.e. pain, the procedure should be repeated as necessary

If an ulcer re-occurs, repeat the Doppler assessment.

Do not presume it is of the same origin
Factors Affecting the Accuracy of the ABPI

- Diabetes
  - Calcification
- Renal Disease
  - Inappropriate investigation due to fluctuation of blood pressure
- Rheumatoid Arthritis
  - Vasculitic pain and calcification
- Atherosclerosis and Arteriosclerosis (Anderson 1995)
  - Hardening of arteries causing falsely elevated readings
- Cardiac Arythmias (Vowden, K.P. 1996)
  
  More difficult to assess sound
Factors Affecting the Accuracy of the ABPI

- Inadequate preparation i.e. room temperature
  - Vaso constriction
- Incorrect positioning of patient
  - Falsely elevated ankle pressures
- Inappropriate Gel
  - Interference due to air bubbles
- Incorrect size of sphyg cuff
  - Incorrect pressure measurements
- Inappropriate Doppler probe
  - Ultrasound cannot penetrate to depth of vessel
- Incorrect position of Doppler probe over vessel
  Incorrect pressure measurements
Factors Affecting the Accuracy of the ABPI

- Excessive pressure on vessel during procedure
  - *Collapses vessels*
- Releasing sphyg cuff too rapidly
  - *Risk of missing systolic pressure point*
- Prolonged inflation of the cuff/re-inflation
  - *Hyperemic effect on limb*
- Mid procedure/repeated inflation *(Vowden K. P. 1996)*
  - *Hyperemic effect on limb*
- Moving Doppler during measurement
  - *Incorrect pressure measurement*
- Inexperienced of the procedure *(Anderson 1995)*

*Practical skill requiring assessment by peers*
Contra-indications

An ABPI should not be undertaken if the patient has:

SUSPECTED DEEP VEIN THROMBOSIS

CELLULITIS

PATIENT NON-COMPLIANCE
Limitations of ABPI

- Some elderly and diabetic patients have calcified arteries
- Incompressible vessels lead to a falsely high ABPI
- Difficult on patients with Lymphoedema
- These patients should be referred for other tests
  - Toe pressures (< 30-50mmHg for definition of chronic CLI)  
    Source: Trans Atlantic Inter-Society Consensus (TASC)
  - Doppler waveform analysis
  - Pulse Volume Recording
  - Duplex Ultrasound
Doppler Waveforms and Sounds

Waveforms provide extra information to confirm clinical findings and ABPI’s

Triphasic Waveform - Normal

Biphasic Waveform – Normal with age
Doppler Waveforms and Sounds

Monophasic Waveform 1 - Abnormal
Doppler Waveforms

- Changes in waveform shape with increasing arterial disease proximal to the probe
Recommendations for Diabetics

- Calcification rarely extends to digital arteries
  (Vowden, 1999)
- Toe pressures directly relate to foot ulceration healing
  (Carter, 1993)
- “In patients with Diabetes Mellitus additional care should be taken and further arterial investigations undertaken such as toe pressures”
  (ETRS guideline 2003)
- It is now recommended to measure toe pressures in patients with Lymphoedema
  (Doherty & Moffatt, 2006)
Diabetics and Toe Pressures

Undertaking a toe pressure with Doppler
# Foot Ulcer Healing Prognosis

<table>
<thead>
<tr>
<th>Percentage probability / Toe Systolic Pressure</th>
<th>Diabetic</th>
<th>Non Diabetic Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Toe Pressure (mmHg)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-30</td>
<td>40%</td>
<td>73%</td>
</tr>
<tr>
<td>30-55</td>
<td>85%</td>
<td>100%</td>
</tr>
<tr>
<td>&gt;55</td>
<td>97%</td>
<td>100%</td>
</tr>
</tbody>
</table>

| TBPI < 0.64 | Abnormal - indicating arterial disease |
| TBPI = 0.64 - 0.7 | Borderline |
| TBPI > 0.7 | Normal - indicating no arterial disease |

(Carter, 1993)
Summary

- Beware of the limitations of ABPI
- Toe pressures and TBPI should be undertaken if ABPI > 1.3, patient is diabetic or has normal ABPI but symptoms of PAD
- ABPI is part of a holistic assessment
- Neuropathic studies should be performed on all diabetics using 10g monofilament
- Doppler waveforms provide extra information to confirm clinical findings & ABPI’s
Other useful tests

- Waveform assessment (TASC2)
- Exercise Doppler
- Segmental pressures
- Buergers test
- Slow capillary return after blanching
- Pole test
- Toe pressures (TASC2)
- Pulse Volume Recording (TASC2)
Pole Test

- Pole test for measurement of ankle pressures in patients with calcified vessels: the Doppler probe is placed over a patent pedal artery and the foot raised against a pole that is calibrated in mm Hg. The point at which the pedal signal disappears is taken as the ankle pressure.
Limitations when measuring ABPI using Doppler

- Difficult to maintain vessel contact during inflation and deflation
- A reasonable knowledge of anatomy is required
- Difficult to locate vessels
- Typical average time for ABPI is 11mins + 15-20 mins rest (Ipsilon and Get ABI Study 2006)
- Clinicians must be trained and monitored (RCN Guidelines 2006)
- Doppler ABPIs taken by junior doctors disagreed with vascular technicians by 30%. This improved to 15% after formal training (Ray et al 1994)
- Time!
Automatic ABPI measuring devices

The Huntleigh ABllity
Aim of the New Development

Develop a device that is quick and easy to use, requires minimal training, is clinically reliable, has quantifiable results and obviates the need to rest the patient, allowing early identification of PAD and intervention.
The New Dopplex Ability

Systolic Pressures and ABI

PVR Waveforms
Specially designed two chamber cuffs are used to detect systolic pressures.
Overview – Pulse Volume Recordings

The PVR waveforms are useful in identifying PAD when arteries are incompressible.

Normal

Mildly Abnormal
Pulse Volume Recordings

**Grade A: Normal**
Sharp systolic peak with prominent dicrotic notch

**Grade B: Mildly Abnormal**
Sharp peak, absent dicrotic notch; downslope is bowed away from baseline

**Grade C: Moderately Abnormal**
Flattened systolic peak, upslope and downslope time decreased and nearly equal, absent dicrotic notch

**Grade D: Severely Abnormal**
Low amplitude or absent pulse wave with equal upslope and downslope time
Recent Study

Doppler:
L = 1.32
R = 1.32

Normal Pulse Volume Recording

Davies et al, 2014
Analysis of pulse volume waveform?

RESULT: Moderate-severe PAD. Referred to vascular surgeon. Subsequently underwent successful angioplasty.

Davies et al, 2014
Summary of Clinical Study

• Good agreement between Doppler and Ability
• The Ability measurement takes significantly less time than Doppler and obviates the need for a rested patient by the simultaneous cuff inflation improving the whole patient experience
• The Ability has the potential to be used as a screening tool for PAD in primary care settings by increasing the patient throughput and its simplicity allows it to be operated by a Healthcare Support Worker.
• Allows earlier diagnosis and intervention for lifestyle changes and risk factors
• Long term
  • Improved quality of life and life expectancy
  • Reduction in hospital admissions and amputations
  • Fewer premature deaths
Advantages of Auto ABI

• Extremely easy to use and fully automatic
• Rapid bi-lateral ABI measurement in < 5mins (Doppler based ABI typically takes 30mins)
• No need to rest patient for 15mins
• ABI can now be undertaken by less skilled staff
• Only have to apply 4 cuffs
• Physiologically more accurate
• No need to remove socks and tights
• Integral printer for documentation of results and waveforms
• Automatic interpretation
• Clinically validated (Lewis et al, 2010)
NZ Health Strategy 2013

- **Target:** By 1 July 2013, at least 75% of eligible population will have had their cardiovascular risk assessed in the last five years. In 1 July 2014, the target will rise to 90%. DHBs that have already achieved this 75% goal by 1 July 2013 will actively work towards the 90% goal.

- **Results:** In Q1 of 2013/14, 69% of the national eligible population had been checked for cardiovascular conditions and diabetes in the last five years. This is an improvement of 17% compared with Q1 of 2012/13.
‘The first person who encounters the patient with peripheral arterial disease determines the outcome of the limb and sometimes the outcome of the patient as a whole. Initial evaluation is so important’.

Anton N Sidawy MD, Diabetic Limb Salvage, Washington 2007
Thank You for your attention!