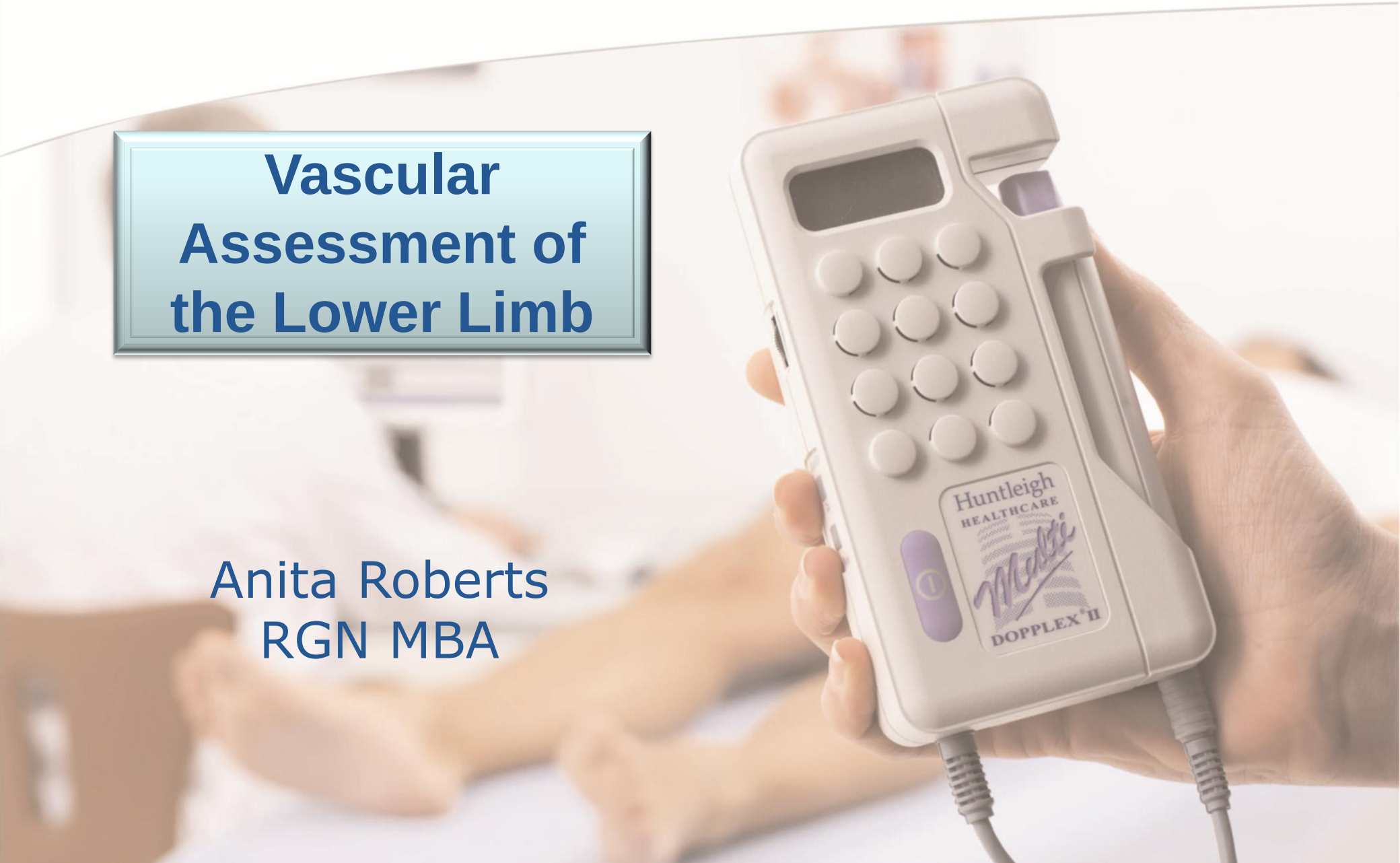

LIVERPOOL FC
CHAMPIONS OF EUROPE 2005
LIVERPOOL FC
2005 UEFA CHAMPIONS
LEAGUE WINNERS
THE HOMECOMING
26TH MAY, 2005

Vascular Assessment of the Lower Limb



Anita Roberts
RGN MBA

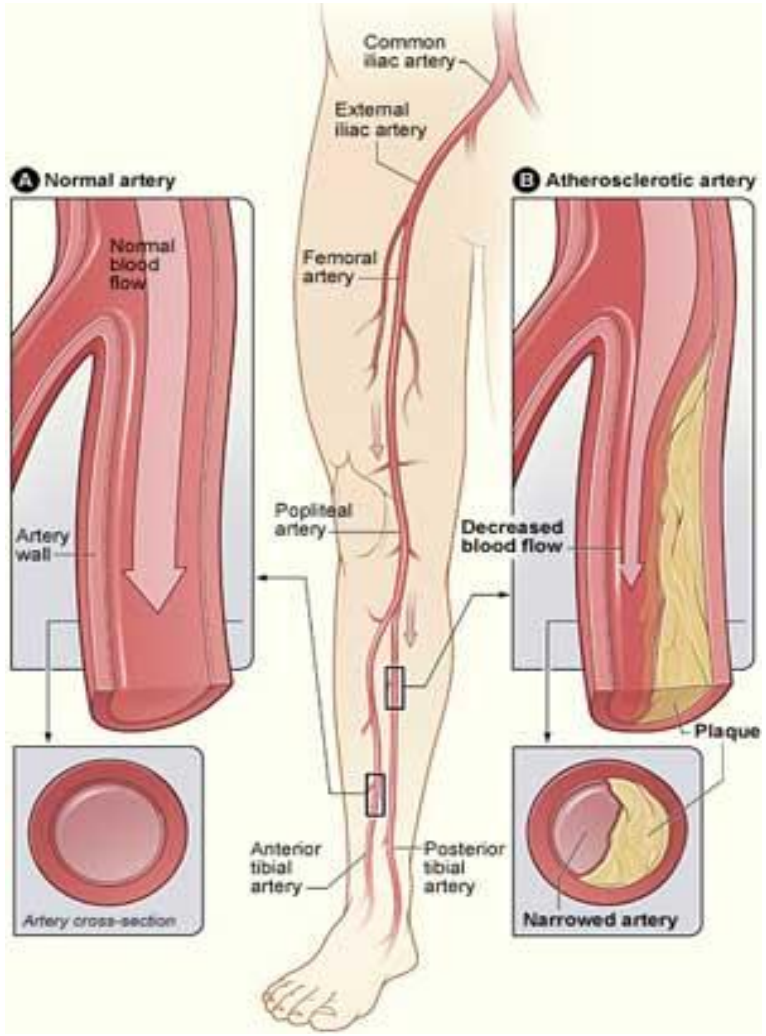
Peripheral Arterial Disease

- 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 primary care vascular assessments

The cause of the problem



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

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 re-vascularise 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)
- Second European Consensus Document for the diabetic foot suggests further non-invasive tests should be undertaken and includes ABPI (1999)

‘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

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
- 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)
- 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)

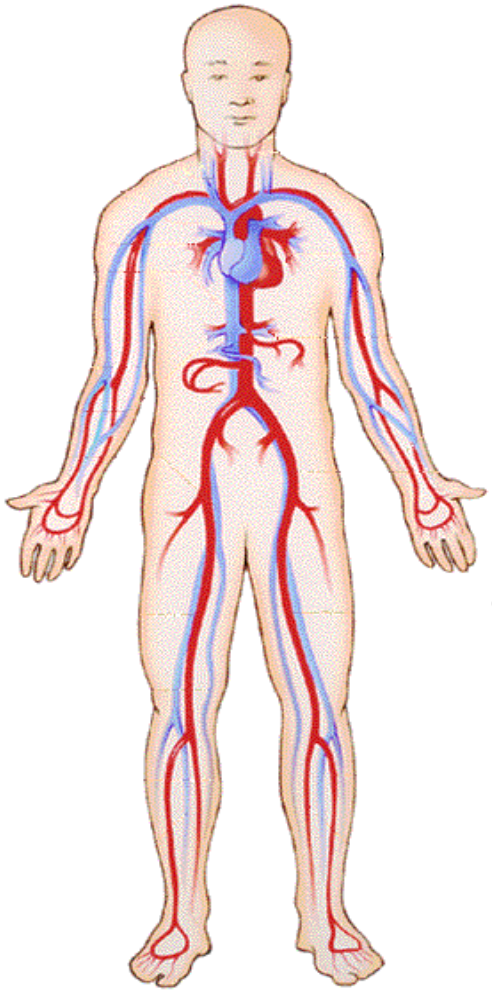
Selection of Equipment

- **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

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**

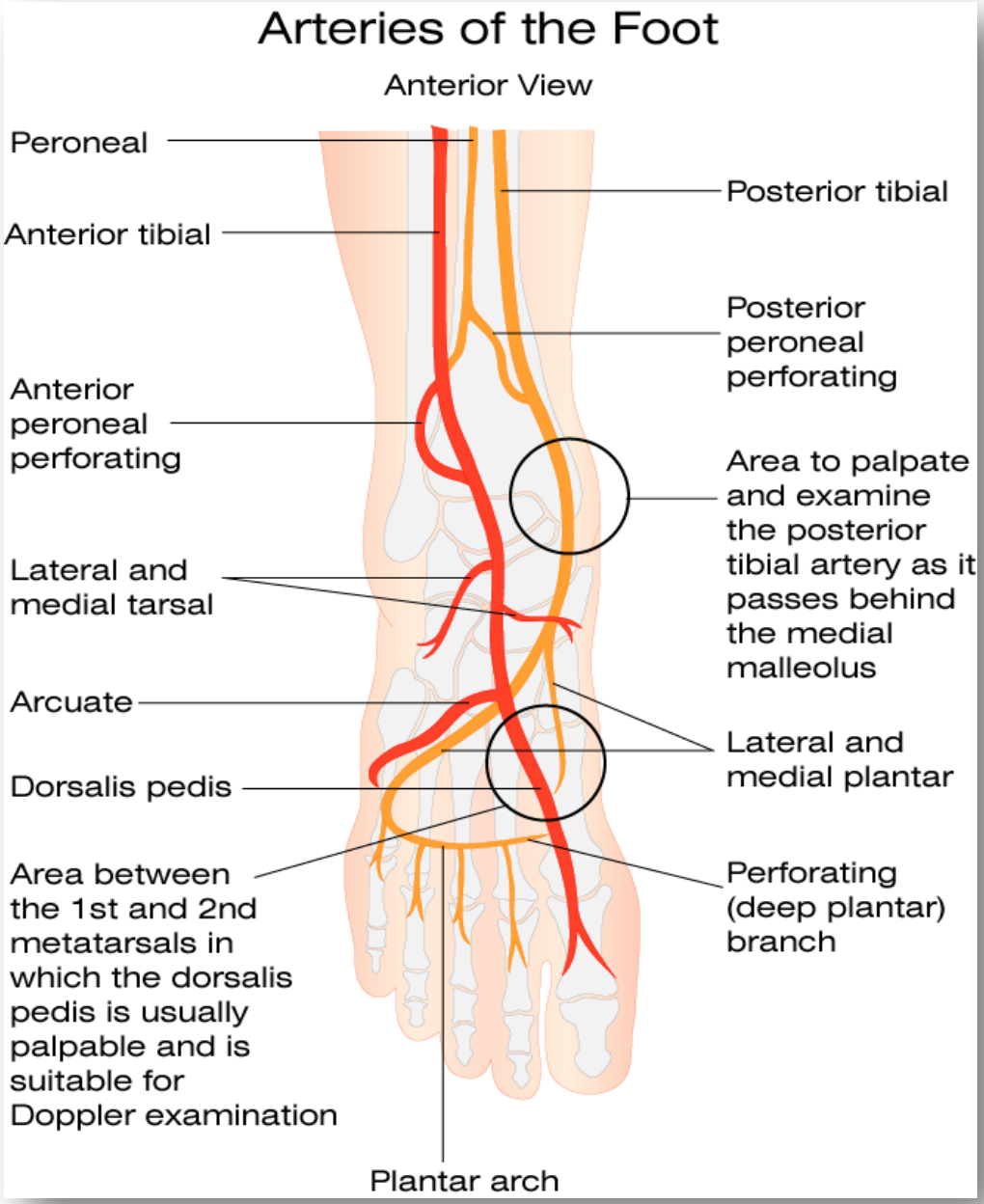
Brachial Pressures

Measure Right Brachial Systolic Pressure

Brachial Pressures

Measure Left Brachial Systolic Pressure

Arteries of the Foot



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

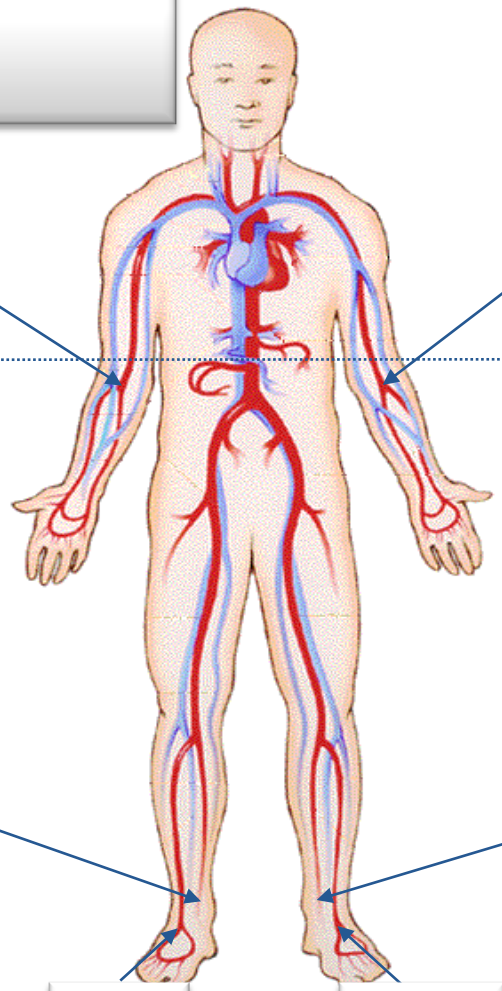
= 85 / 150

= 0.57

Left ABPI

= 120 / 150

= 0.80



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** = **85** / **150**

Ankle Pressure (mmHg)

Brachial Pressure (mmHg)	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200
230	0.17	0.20	0.22	0.24	0.26	0.28	0.30	0.33	0.35	0.37	0.39	0.41	0.43	0.46	0.48	0.50	0.52	0.54	0.57	0.59	0.61	0.63	0.65	0.67	0.70	0.72	0.74	0.76	0.78	0.80	0.83	0.85	0.87
225	0.18	0.20	0.22	0.24	0.27	0.29	0.31	0.33	0.36	0.38	0.40	0.42	0.44	0.47	0.49	0.51	0.53	0.56	0.58	0.60	0.62	0.64	0.67	0.69	0.71	0.73	0.76	0.78	0.80	0.82	0.84	0.87	0.89
220	0.18	0.20	0.23	0.25	0.27	0.30	0.32	0.34	0.36	0.39	0.41	0.43	0.45	0.48	0.50	0.52	0.55	0.57	0.59	0.61	0.64	0.66	0.68	0.70	0.73	0.75	0.77	0.80	0.82	0.84	0.86	0.89	0.91
215	0.19	0.21	0.23	0.26	0.28	0.30	0.33	0.35	0.37	0.40	0.42	0.44	0.47	0.49	0.51	0.53	0.56	0.58	0.60	0.63	0.65	0.67	0.70	0.72	0.74	0.77	0.79	0.81	0.84	0.86	0.88	0.91	0.93
210	0.19	0.21	0.24	0.26	0.29	0.31	0.33	0.36	0.38	0.40	0.43	0.45	0.48	0.50	0.52	0.55	0.57	0.60	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93	0.95
205	0.20	0.22	0.24	0.27	0.29	0.32	0.34	0.37	0.39	0.41	0.44	0.46	0.49	0.51	0.54	0.56	0.59	0.61	0.63	0.66	0.68	0.71	0.73	0.76	0.78	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98
200	0.20	0.23	0.25	0.28	0.30	0.33	0.35	0.38	0.40	0.43	0.45	0.48	0.50	0.53	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00
195	0.21	0.23	0.26	0.28	0.31	0.33	0.36	0.38	0.41	0.44	0.46	0.49	0.51	0.54	0.56	0.59	0.62	0.64	0.67	0.69	0.72	0.74	0.77	0.79	0.82	0.85	0.87	0.90	0.92	0.95	0.97	1.00	1.03
190	0.21	0.24	0.26	0.29	0.32	0.34	0.37	0.39	0.42	0.45	0.47	0.50	0.53	0.55	0.58	0.61	0.63	0.66	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.03	1.05
185	0.22	0.24	0.27	0.30	0.32	0.35	0.38	0.41	0.43	0.46	0.49	0.51	0.54	0.57	0.59	0.62	0.65	0.68	0.70	0.73	0.76	0.78	0.81	0.84	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08
180	0.22	0.25	0.28	0.31	0.33	0.36	0.39	0.42	0.44	0.47	0.50	0.53	0.56	0.58	0.61	0.64	0.67	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.89	0.92	0.94	0.97	1.00	1.03	1.06	1.08	1.11
175	0.23	0.26	0.29	0.31	0.34	0.37	0.40	0.43	0.46	0.49	0.51	0.54	0.57	0.60	0.63	0.66	0.69	0.71	0.74	0.77	0.80	0.83	0.86	0.89	0.91	0.94	0.97	1.00	1.03	1.06	1.09	1.11	1.14
170	0.24	0.26	0.29	0.32	0.35	0.38	0.41	0.44	0.47	0.50	0.53	0.56	0.59	0.62	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.18
165	0.24	0.27	0.30	0.33	0.36	0.39	0.42	0.45	0.48	0.52	0.55	0.58	0.61	0.64	0.67	0.70	0.73	0.76	0.79	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.18	1.21
160	0.25	0.28	0.31	0.34	0.38	0.41	0.44	0.47	0.50	0.53	0.56	0.59	0.63	0.66	0.69	0.72	0.75	0.78	0.81	0.84	0.88	0.91	0.94	0.97	1.00	1.03	1.06	1.09	1.13	1.16	1.19	1.22	1.25
155	0.26	0.29	0.32	0.35	0.39	0.42	0.45	0.48	0.52	0.55	0.58	0.61	0.65	0.68	0.71	0.74	0.77	0.81	0.84	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.10	1.13	1.16	1.19	1.23	1.26	1.29
150	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80	0.83	0.87	0.90	0.93	0.97	1.00	1.03	1.07	1.10	1.13	1.17	1.20	1.23	1.27	1.30	1.33
145	0.28	0.31	0.34	0.38	0.41	0.45	0.48	0.52	0.55	0.59	0.62	0.66	0.69	0.72	0.76	0.79	0.83	0.86	0.90	0.93	0.97	1.00	1.03	1.07	1.10	1.14	1.17	1.21	1.24	1.28	1.31	1.34	1.38
140	0.29	0.32	0.36	0.39	0.43	0.46	0.50	0.54	0.57	0.61	0.64	0.68	0.71	0.75	0.79	0.82	0.86	0.89	0.93	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.25	1.29	1.32	1.36	1.39	1.43
135	0.30	0.33	0.37	0.41	0.44	0.48	0.52	0.56	0.59	0.63	0.67	0.70	0.74	0.78	0.81	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.11	1.15	1.19	1.22	1.26	1.30	1.33	1.37	1.41	1.44	1.48
130	0.31	0.35	0.38	0.42	0.46	0.50	0.54	0.58	0.62	0.65	0.69	0.73	0.77	0.81	0.85	0.88	0.92	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.23	1.27	1.31	1.35	1.38	1.42	1.46	1.50	1.54
125	0.32	0.36	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.68	0.72	0.76	0.80	0.84	0.88	0.92	0.96	1.00	1.04	1.08	1.12	1.16	1.20	1.24	1.28	1.32	1.36	1.40	1.44	1.48	1.52	1.56	1.60
120	0.33	0.38	0.42	0.46	0.50	0.54	0.58	0.63	0.67	0.71	0.75	0.79	0.83	0.88	0.92	0.96	1.00	1.04	1.08	1.13	1.17	1.21	1.25	1.29	1.33	1.38	1.42	1.46	1.50	1.54	1.58	1.63	1.67
115	0.35	0.39	0.43	0.48	0.52	0.57	0.61	0.65	0.70	0.74	0.78	0.83	0.87	0.91	0.96	1.00	1.04	1.09	1.13	1.17	1.22	1.26	1.30	1.35	1.39	1.43	1.48	1.52	1.57	1.61	1.65	1.70	1.74
110	0.36	0.41	0.45	0.50	0.55	0.59	0.64	0.68	0.73	0.77	0.82	0.86	0.91	0.95	1.00	1.05	1.09	1.14	1.18	1.23	1.27	1.32	1.36	1.41	1.45	1.50	1.55	1.59	1.64	1.68	1.73	1.77	1.82
105	0.38	0.43	0.48	0.52	0.57	0.62	0.67	0.71	0.76	0.81	0.86	0.90	0.95	1.00	1.05	1.10	1.14	1.19	1.24	1.29	1.33	1.38	1.43	1.48	1.52	1.57	1.62	1.67	1.71	1.76	1.81	1.86	1.90
100	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80	1.85	1.90	1.95	2.00
95	0.42	0.47	0.53	0.58	0.63	0.68	0.74	0.79	0.84	0.89	0.95	1.00	1.05	1.11	1.16	1.21	1.26	1.32	1.37	1.42	1.47	1.53	1.58	1.63	1.68	1.74	1.79	1.84	1.89	1.95	2.00	2.05	2.11
90	0.44	0.50	0.56	0.61	0.67	0.72	0.78	0.83	0.89	0.94	1.00	1.06	1.11	1.17	1.22	1.28	1.33	1.39	1.44	1.50	1.56	1.61	1.67	1.72	1.78	1.83	1.89	1.94	2.00	2.06	2.11	2.17	2.22

ABPI = 0.57

TASC II Document on the Management of Peripheral Arterial Diesease. European Journal of Vascular and Endovascular Surgery, Volume 33,Issue 1, Pages 1-2 D. Adam, A. Bradbury. 2006.

Download your own guide at www.huntleigh-diagnostics.com

How to Interpret the ABPI

(PAD)

ABPI Value	Status	Action
ABPI = 0.9 - 1.3	Normal	No Action
ABPI = 0.75 – 0.89	Mild PAD	Manage Cardiovascular risk factors
ABPI = 0.4 - 0.74	Moderate PAD	Manage Cardiovascular risk factors
ABPI < 0.4	Severe PAD	Refer to vascular specialist
ABPI > 1.3*	Abnormal	Check for diabetes - Refer to vascular specialist

TASC II Document on the Management of Peripheral Arterial Diesease. European Journal of Vascular and Endovascular Surgery, Volume 33,Issue 1, Pages 1-2 D. Adam, A. Bradbury. 2006.

http://www.nhlbi.nih.gov/health/dci/Diseases/pad/pad_diagnosis.html

How to Interpret the ABPI

(woundcare)

ABPI > 1.0 - 1.3	Unlikely to be arterial in origin	Apply compression therapy
ABPI = 0.8 - 1.0	Mild peripheral disease	Apply compression therapy with caution
ABPI = 0.5 - 0.8	Significant arterial disease	Do not compress - refer to specialist
ABPI < 0.5	Severe arterial disease	Do not compress - refer urgently to vascular specialist.
ABPI > 1.3*	Measure toe pressures or refer to specialist	

(RCN, 1998)

*may vary according to local protocols

Repeat ABPI Checks

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

- Inexperience 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

Problems with 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)

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

Belch et al, 2003

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.

Two Chamber Cuffs

Specially designed two chamber cuffs are used to detect systolic pressures

duo sense™ TECHNOLOGY

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)

Clinically Proven

A comparison between a new automatic system and the Doppler method for obtaining ankle brachial pressure index

Jane E. A Lewis, Melinda J Hawkins, Phillip R Barree, Scott C Cawley & Sue M Dayananda, Cardiff and Vale University Health Board, St David's Hospital, Cowbridge Road East, Cardiff, CF11 9XB

Presented at: Wounds UK, 2009
FIP Amsterdam, 2010
EWMA Geneva, 2010

- Purpose of the study

  To evaluate the efficacy of the Ability unit for its agreement, reproducibility and time taken to conduct the test when compared with the current gold standard Doppler method for obtaining ABPI's

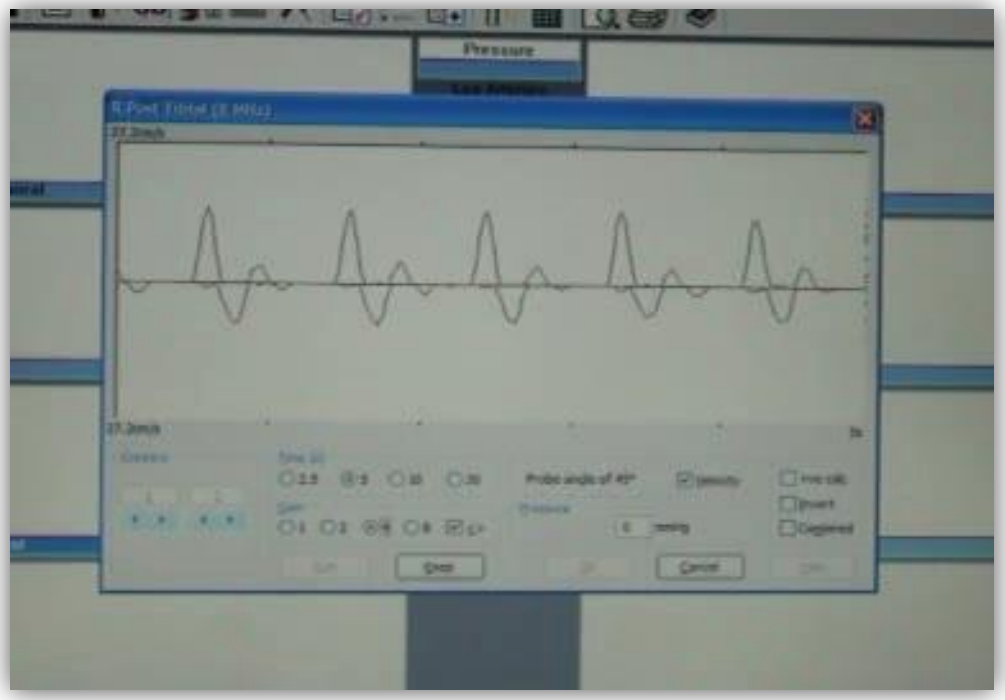
Summary of Clinical Study

- 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

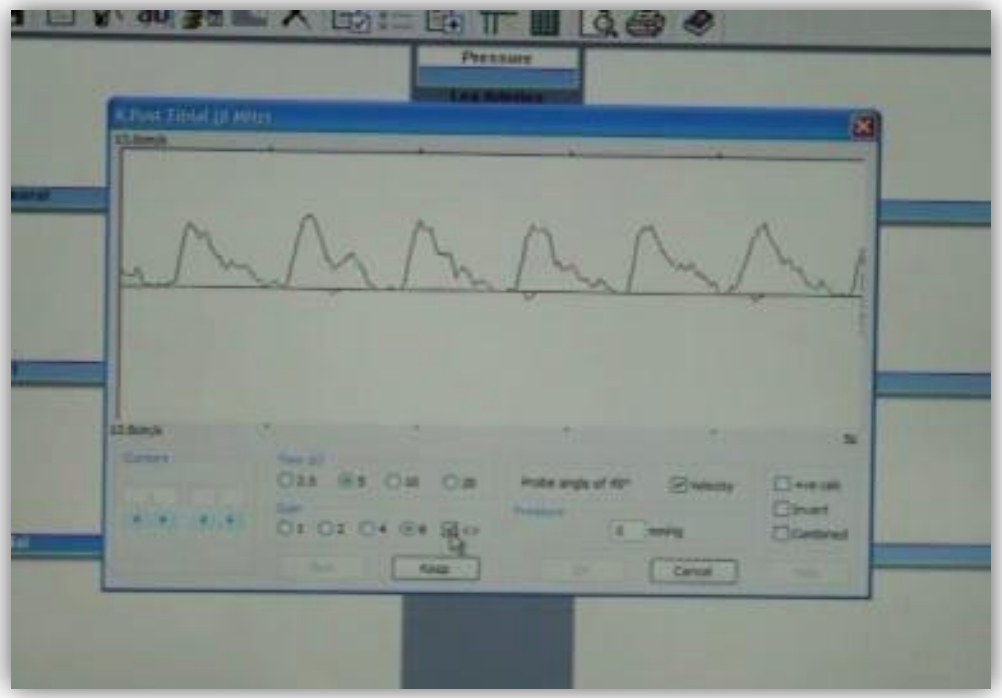
Doppler Waveforms and Sounds

- Waveforms provide extra information to confirm clinical findings and ABPI's

Triphasic Waveform - Normal

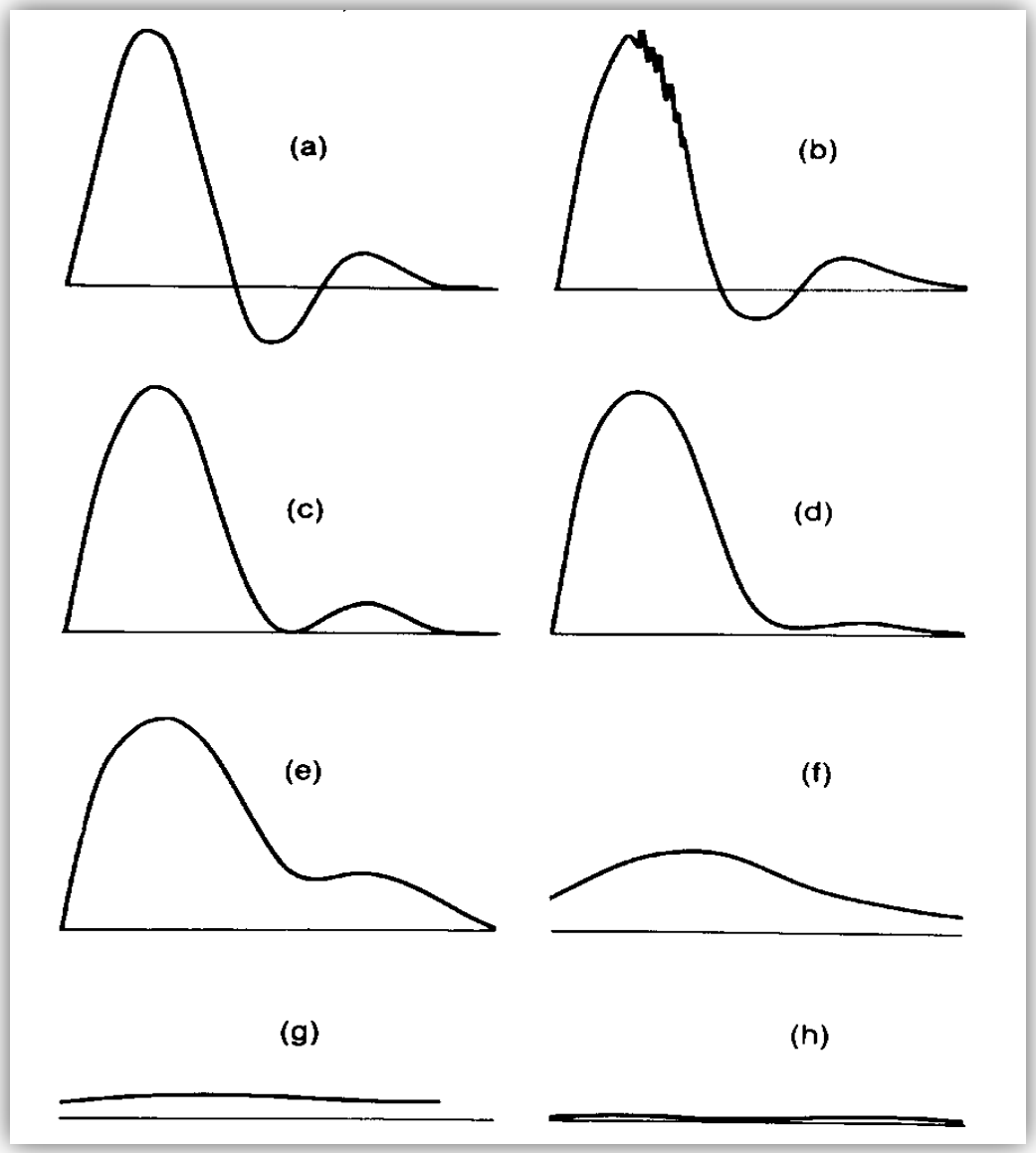


Monophasic Waveform - Abnormal



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

Percentage probability / Toe Systolic Pressure		
Toe Pressure (mmHg)	Diabetic	Non Diabetic Patient
20-30	40%	73%
30-55	85%	100%
>55	97%	100%

TBPI < 0.64 Abnormal - indicating arterial disease

TBPI = 0.64 - 0.7 Borderline

TBPI > 0.7 Normal - indicating no arterial disease

(Carter, 1993)

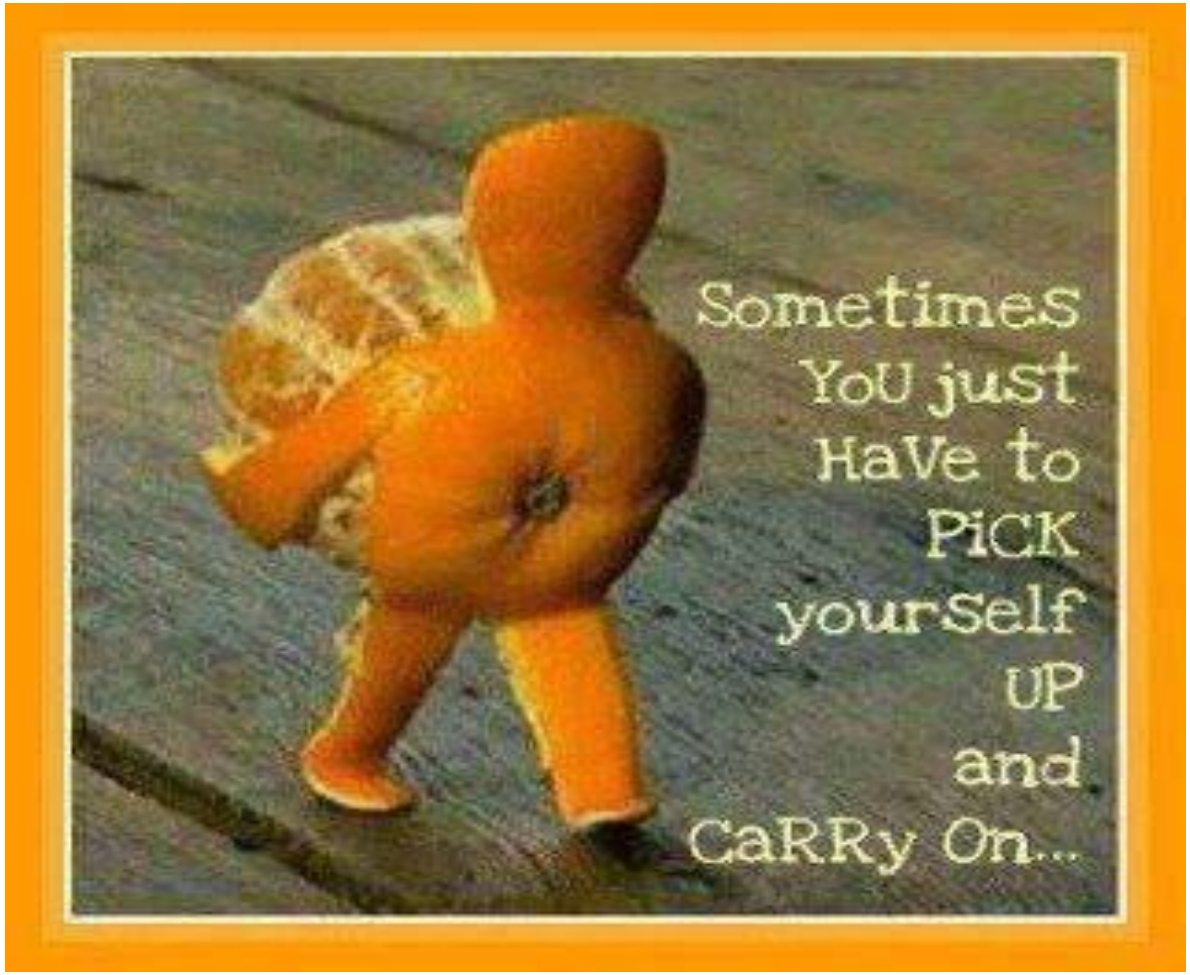
Diabetics and Toe Pressures

Arterial PPG is the preferred technique to measure toe pressures

(Vowden, 2002)

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 of a leg or foot ulcer
- Neuropathic studies should be performed on all diabetics using 10g monofilament
- Doppler waveforms provide extra information to confirm clinical findings & ABPI's


Sometimes
YoU just
HaVe to
PiCK
yourSelf
UP
and
CaRRy On...