Non-Invasive Lower Extremity Arterial Testing Documentation, Coding and Compliance Issues for the Health Care Provider

- Paul Kesselman DPM DABFAS
- CEO PARK DPM
- Drkesselman@pakdpm.com
- Consultant to many medical manufacturers
- Partner www.codinghelpline.com

Disclosures

- Dr. Kesselman has been a consultant for Koven Technology LLC

- This continuing education activity is managed and accredited by PRESENT e-Learning Systems. PRESENT e-Learning Systems Staff, as well as planners and reviewers, have no relevant financial interests to disclose. Conflict of interest, when present, was resolved through peer review of content by a non-conflicting reviewer.

- CPT-4 Codes are licensed by AMA and are used solely for illustrative purposes. Check your CPT references for more information.

Dr. Paul Kesselman was in clinical practice for over thirty-five years. He is board certified by the ABFAS.

Performing NIVT Since 1980.

Experienced consultant to manufacturers of NIVT

Specific products noted are incidental & for illustrative purposes only. Such mention should not infer an endorsement of any brand/model.

Not an employee of CMS or any third- party payer.

Chair APMA DME Workgroup, Member APMA Health Policy Committee, Consultant to PICA, Member NYSPMA Ins. Com.

Objectives:

- Instrumentation and Testing
- LCD & LCA Requirements
- Charting
- Wave Form Analysis (Doppler, PVR, PPG)
- Pathology
- Reporting
- Coding
- Other Testing

Experience in NIVT

Started in 1979-1980

Taken many courses in NIV

Taught NIVT

Written Articles on NIVT

Studied the Coverage Policies

Successfully Resolved Audits on NIVT

Consultant to NIVT Companies

What to Look For?

Performance Requires Expertise & Experience

Take a Course Prior to Purchase

Selection of Instrumentation –Wide Choice

Equipment Work with laptop/tablet/phone

Portable and Easy to Use

Print Reports and/or import to your EHR

Arterial vs Venous Insufficiency

- Blood flow towards tissues
- Diminished Pulses
- Sharp/Stabbing Pain worsens with activity and limb elevation
- Interference with nutrients and O2 arriving to tissues
- Result: Pain, ischemic ulcers
- Potential gangrene, loss of limb

- Decreased return flow to heart
- Venous Congestion
- Pulses present
- Edema, skin changes, stasis ulcers
- Improved with leg elevation

Characteristics of Arterial vs. Venous Disorders

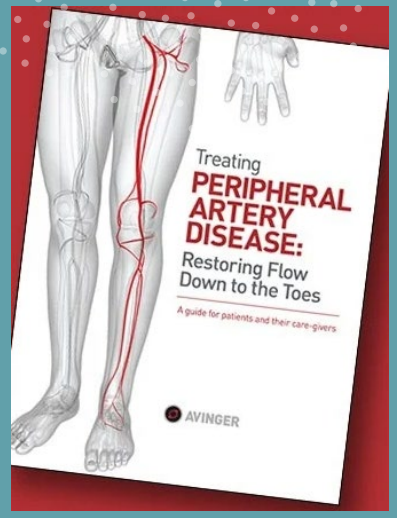
	Arterial Disease	Venous Disease
Skin	cool to cold, lack of hair, xerosis	warm, tough thick/indurated
	pallor on elevation, dependent	mottled, pigmented
	rubor, shiny (mirror like)	
Pain	sharp. Stabbing	achy, cramping, early stages
	activity worsens, intermittent	walking helps, compression and
	claudication, dependency may	elevation reduces pain
	alleviate pain, rest pain only of severe	
	if severe	
Ulcers	very painful, grey base	painful, pink, usually found on
	pale, usually found on heel,	medial side of ankle
	distal toes and dorsal feet	
Pulses	often non palpable, absent or diminished	usually present
Edema	Absent or reduced, Infrequent	frequent, surrounding ulcer, end of day

	Neurogenic vs Vascular Claudication	
Characteristic	Neurogenic	Vascular
Relieving	Sitting or bending forward, lying on side	Relief with Resting (Stop walking)
	Shopping Cart Sign: Yes	Shopping Cart Sign: Negative
Laterality	Bilateral	Usually bilateral if fem-pop; bilateral if il-femoral
Physical Exam	Pulses Present Skin Normal	If Arterial: Pulses Diminished; Skin Pale; Hair Loss
		If Venous: Pulses Present, Skin Indurated & Pitting

PAD Classification

Fontaine		Rutherford		
Stage	Clinical	Grade	Category	Clinical
I	Asymptomatic	0	0	Asymptomatic
IIa	Mild Claudication	1	1	Mild Claudication
11b	Moderate to severe claudication	1	2	Moderate Claudication
		1	3	Severe Claudication
III	Ischemic Rest Pain	II	4	Ischemic Rest Pain
IV	Ulceration or gangrene	III	5	Minor Tissue Loss
		III	6	Major Tissue Loss

- Continually Re Educate!!!
- Anatomy & Physiology
- What is Normal vs Abnormal?



Where We Were and Where We Currently Are?

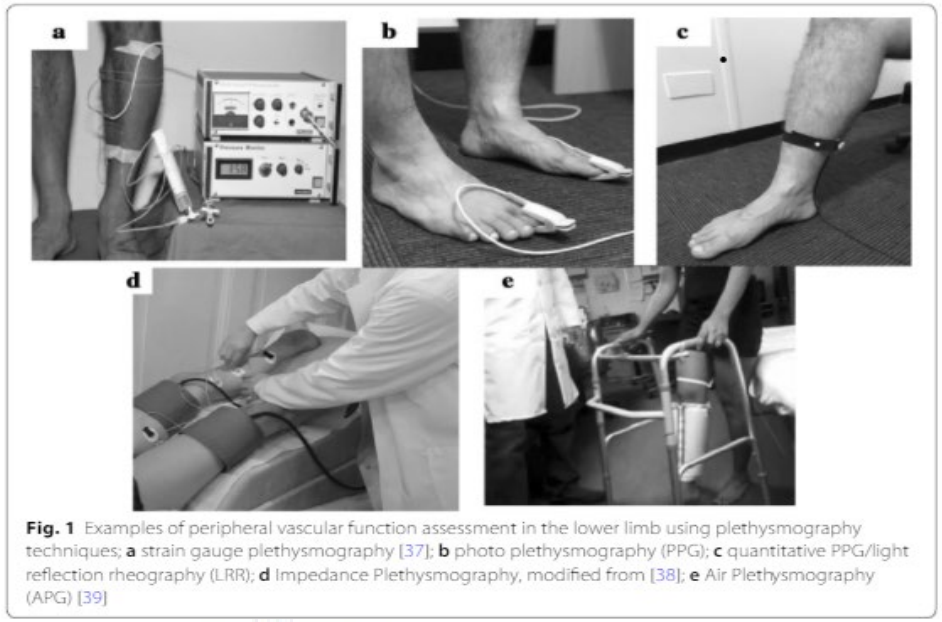


Fig. 1 Examples of peripheral vascular function assessment in the lower limb using plethysmography techniques; **a** strain gauge plethysmography [37]; **b** photo plethysmography (PPG); **c** quantitative PPG/light reflection rheography (LRR); **d** Impedance Plethysmography, modified from [38]; **e** Air Plethysmography (APG) [39]

National Government Services

JURISDICTION K - PART B
IN NEW YORK

Enter keywords or phrases | Search >

Contact Us | Subscribe to Email Updates | NGSConnex

ENROLLMENT | CLAIMS & APPEALS | MEDICAL POLICY & REVIEW | EDUCATION | Overpayment | Provider Resources

- Medical Policy Center
- Policy Education Topics
- CERT
- Fraud & Abuse
- Medical Review
- Recovery Audit

Top LCDs/Policies

- Noninvasive Vascular Studies (L33627) EXT
- Transthoracic Echocardiography (TTE) (L33577) EXT
- Routine Foot Care and Debridement of Nails (L33636) EXT
- Ophthalmology: Posterior Segment Imaging (Extended Ophthalmoscopy and Fundus Photography) (L33567) EXT
- Scanning Computerized Ophthalmic Diagnostic Imaging (SCODI) (L34380) EXT

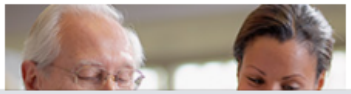
- *CERT Denial Finder*
- *ADR Timeline Calculator*
- *RA Timeliness Calculator*

WELCOME *to*

NGSMedicare.com for Part B providers and suppliers

Medicare **Part B providers** administer medically-necessary and preventive services for beneficiaries by diagnosing and treating medical conditions or preventing illness or detecting it at an early stage.

1 2 3 4



Log in to NGSConnex | Use the IVR System | *Fee Schedule Lookup*

Coverage Issues

- Understand MCR-LCD & LCA’s
- Third-Party Payer Rules
- Will they pay DPM’s?
- Do you need to have specialty credentialing?
- Are there coverage limitations?
- What are your liability issues?
- State Scope of Practice Issues?

Medicare (e.g., NGS)

- Complex LCD and LCA
- The LCD Contains The Requirements for Testing (Patient and Tester)
- The LCA Contains the CPT and Relevant ICD10

Indications for NIVT

Medically necessary if the ordering physician has reasonable expectation that their outcomes will potentially impact the clinical management of the patient.

Significant signs/symptoms of arterial or venous disease are present; and/or

The information is necessary for appropriate medical and/or surgical management; and/or

The test is **not** redundant of other diagnostic procedures that must be performed.

Non-invasive studies of the arterial system are utilized when invasive correction is contemplated or when vessels are being harvested for potential use as grafts.

Requirement Implications

- All non-invasive vascular diagnostic studies must be performed under at least one of the following settings: (1) A- performed by a physician who is competent in diagnostic vascular studies or B- under the general supervision of physicians who have demonstrated minimum entry level competency by being credentialed in vascular technology, or (2) performed by a technician who is certified in vascular technology, or (3) performed in facilities with laboratories accredited in vascular technology.

Requirement Implications

Your reports will be held to the same standards as a vascular surgeon, registered vascular technologist, etc.

You must be able to prove competency in both performing testing (they must be accurate and interpretable) and reporting

Take a course and practice practice practice

Read articles and have them as a reference guide (cite them in your reports)

Coverage Issues to Consider

Medically Necessary only if the outcome will potentially impact the clinical course of the patient.

Includes patient care required to perform the studies, supervision of the studies, interpretation of study results with hard copy output or imaging.

The use of any Doppler device that produces a record that **<u>does not</u>** permit analysis of bidirectional vascular flow or that **does not provide a hard copy printout** is part of the physical exam of the vascular system and is not reported separately.

Digital Storage of Files is Acceptable!

NO LCD??

Search adjacent Medicare MAC or Private 3rd PP

Each Body Part Imaged Has Its Own Requirements

- **Peripheral Arterial Exams Covered Include:** Duplex scans; Doppler waveform or spectral analysis; volume, impedance or strain gauge plethysmography; and transcutaneous oxygen tension measurement.

Covered Indications

- Clinical Evidence of Limb Ischemia
- Patient is candidate for invasive/therapeutic procedures
- Severe enough claudication that it interferes with ADL
- Pain with elevation and reduced with dependency
- Tissue loss, gangrene, potential for gangrene in the absence of pulses
- Aneurysmal Disease
- Potential or Known Presence of Emboli
- Blunt or penetrating trauma
- Follow up grafts or other procedures

NIVS (Arterial) Indications:

- **Duplex scanning and physiologic studies may be reimbursed during the same encounter if the physiologic studies are abnormal and/or to evaluate vascular trauma, thromboembolic events or aneurysmal disease, if the physician/provider can document medical necessity in the patient's medical record.**

- **Non-invasive studies of the arterial system are to be utilized when invasive correction is contemplated, or severity of findings dictate non-invasive study follow-up.**

NIVS Not Covered

Screening of the asymptomatic patient is not covered by Medicare. (Elective Foot Sx?)

Vague Symptoms and anatomically imprecise terms:

Burning of the feet”,” pain in the limb”, and “edema” should be avoided, and more precise anatomic and pathologic descriptions included.

Local Carrier Article CPT and ICD10 Issues (Group 3 Codes)

- 9392**2** 2 Level Test (Foot and Ankle)
- 9392**3** 3 Level Test(Foot, Ankle, Lower Leg)
- State Scope of Practice and LCD Often Limit DPM to 93922
- ICD10 Very Extensive List

CPT 93922

- **<u>LIMITED BILATERAL</u>** NONINVASIVE PHYSIOLOGIC STUDIES OF UPPER OR LOWER EXTREMITY ARTERIES, (EG, FOR LOWER EXTREMITY: **ANKLE/BRACHIAL INDICES AT DISTAL POSTERIOR TIBIAL AND ANTERIOR TIBIAL/DORSALIS PEDIS ARTERIES PLUS BIDIRECTIONAL, DOPPLER WAVEFORM RECORDING AND ANALYSIS AT 1-2 LEVELS,** OR ANKLE/BRACHIAL INDICES AT DISTAL POSTERIOR TIBIAL AND ANTERIOR TIBIAL/DORSALIS PEDIS ARTERIES PLUS VOLUME PLETHYSMOGRAPHY AT **1-2** LEVELS, OR ANKLE/BRACHIAL INDICES AT DISTAL POSTERIOR TIBIAL AND ANTERIOR TIBIAL/DORSALIS PEDIS

93923

- **COMPLETE BILATERAL NONINVASIVE PHYSIOLOGIC STUDIES OF UPPER OR LOWER EXTREMITY ARTERIES, 3 OR MORE LEVELS** (EG, FOR LOWER EXTREMITY: **ANKLE/BRACHIAL INDICES AT DISTAL POSTERIOR TIBIAL AND ANTERIOR TIBIAL/DORSALIS PEDIS ARTERIES PLUS SEGMENTAL BLOOD PRESSURE MEASUREMENTS WITH BIDIRECTIONAL DOPPLER WAVEFORM RECORDING AND ANALYSIS,** AT 3 OR MORE LEVELS, OR ANKLE/BRACHIAL INDICES AT DISTAL POSTERIOR TIBIAL AND ANTERIOR TIBIAL/DORSALIS PEDIS ARTERIES PLUS SEGMENTAL VOLUME PLETHYSMOGRAPHY AT 3 OR MORE LEVELS, OR ANKLE/BRACHIAL INDICES AT DISTAL POSTERIOR TIBIAL AND ANTERIOR TIBIAL/DORSALIS PEDIS ARTERIES PLUS SEGMENTAL TRANSCUTANEOUS OXYGEN TENSION MEASUREMENTS AT 3 OR MORE LEVELS), OR SINGLE LEVEL STUDY WITH PROVOCATIVE FUNCTIONAL MANEUVERS (EG, MEASUREMENTS WITH POSTURAL PROVOCATIVE TESTS, OR MEASUREMENTS WITH REACTIVE HYPEREMIA)

93924

- Essentially is 93923 w/ Treadmill Testing
- Rarely Done by DPMs or PCP
- Usually Reserved for Vascular or Cardiac Lab
- Indications: Resting study inconsistent with symptoms and/or symptoms worse with activity.
- Lower extremity stress test.

Hundreds of Covered ICD10 for NIVS

Vague

- **I73.89 PAD:**
- **Other specified PVD**

Specific

I70.633	**Atherosclerosis of nonbiological bypass graft(s) of the right leg with ulceration of ankle**

ICD10 (Group 3 Codes)

I70.234	ASO of native arteries of right leg with ulceration of heel and midfoot
I70.235	ASO of native arteries of right leg with ulceration of other part of foot

I70.244	ASO of native arteries of left leg with ulceration of heel and midfoot
I70.245	ASO native arteries of left leg with ulceration of other part of foot

More ICD10 Codes

E10.59	Type 1 diabetes mellitus with other circulatory complications
E11.59	Type 2 diabetes mellitus with other circulatory complications
E13.59	Other specified diabetes mellitus with other circulatory complications

DFU E9/10/11.621 not listed & not covered

I70.211	Atherosclerosis of native arteries of extremities with intermittent claudication, right leg
I70.212	Atherosclerosis of native arteries of extremities with intermittent claudication, left leg
I70.213	Atherosclerosis of native arteries of extremities with intermittent claudication bilateral legs

Chart Documentation Must Meet LCD Requirements

- **Do These Clinical Examples Meet the LCD Clinical Requirements?**
- **“ 75 y/o female to undergo elective bunionectomy and needs PAD Testing”**
- **“75-year-old female with cold feet with a 4 yr. PPD smoking hx …… Digits are cyanotic, hair growth sparse, skin xerotic…**
- **66-year-old male with 20 YR HX of IDDM A1c 12 and DFU RT 2nd toe w(or w/o) Wagner 2 wound…..**
- **80 yr. old male with ingrown toenail with n palpable pulses, delayed CFT, wishes to undergo matrixectomy**…..

Chart Documentation Does Your Testing Meet the Requirements?

- Is the Doppler Bidirectional
- Did You Measure ABI, TBI?
- Can you provide a reliable interpretation?
- Can your report be printed?
- Are your normal values listed?

How to calculate ABI

Use same method to take brachial and ankle pressure (doppler)

Fraction is ABI (Anything >0.9 is normal) But be careful!!!!

Wave Form Analysis is Equally if Not More Important

Date: 12/31/2018
Time: 12:13:38 PM

Symptoms/Diagnosis Report

ID: 6274
Name [redacted]
Facility: Paul Kesselman
Requesting Physician: Paul Kesselman DPM

Sex: MALE
Age:

Diagnosed Conditions

- [ ] Diabetes: years
- [x] Hypertension: years
- [x] Hyperlipidemia
- [x] Previous Vascular Surgery
- [ ] Stroke(TIA)
- [x] Heart Disease
- [ ] Angina
- [ ] Syncope
- [ ] Headaches
- [ ] Vertigo
- [ ] COPD
- [ ] Other 2
- [ ] Other left hallux wound

Risk Factors

- [x] Cigarette/Tobacco Use: ___ years smoked,___ packs per day,30 years quit
- [ ] Sedentary
- [ ] Oral Contraceptives
- [ ] Other 1
- [ ] Other 2
- [ ] Other 3

Current Signs & Symptoms

	Right Leg	Left Leg		Right Leg	Left Leg		Right Arm	Left Arm
Extremity Weakness	☑	☑	Rest Pain	☐	☐	Pain	☐	☐
Limb Hair Loss	☑	☑	Claudication	☑	☑	Aching	☐	☐
Skin Color Changes	☑	☑	**Pain Location :**			**Pain Location :**		
Stasis Dermatitis	☑	☑	Thigh/Buttock	☐	☐	Head	☐	☐
Trophic Nails	☑	☑	Calf	☐	☐	Neck	☐	☐
Gangrene	☐	☐	Arch	☐	☐	Shoulder	☐	☐
Edema	☑	☑	Toe	☐	☐	Upper Arm	☐	☐
Cellulitis	☐	☐	**Pain Relieved By :**			Forearm	☐	☐
Rubor	☐	☐	Rest	☐	☐	Hand	☐	☐
Ulcerations	☐	☑	Exercise	☐	☐	Finger	☐	☐
Other 1Elevation Pallor	☑	☑	Legs Elevated	☐	☐	Other 3	☐	☐
Other 2	☐	☐	Legs Down	☐	☐	Other 4	☐	☐

Notes:

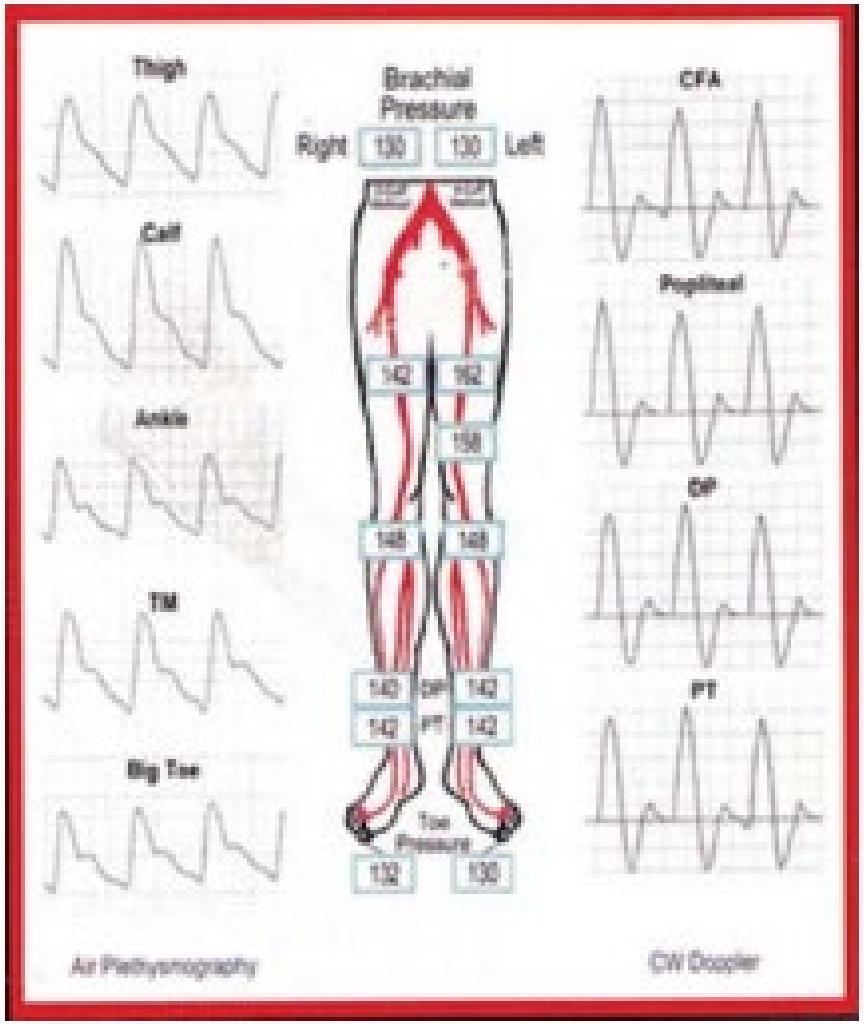
Significant distal disease

Refer to Dr Szcumacher for further vascular evaluation

Paul Kesselman DPM

Digitally signed by Paul Kesselman DPM
DN: cn=Paul Kesselman DPM, o, ou, email=[redacted], c=US
Date: 2018.12.31 12:18:23 -05'00'

Arterial Doppler Wave Forms



ANALYSIS OF LOWER EXTREMITY DOPPLER ARTERIAL WAVEFORM PATTERNS

The Doppler arterial waveforms obtained from the lower extremity may be classified into six categories as an aid in interpretation.

TYPE	TYPICAL WAVEFORM	FINDINGS
0		The contour exhibits a steeply rising upslope at the onset of systole, rapid systolic downslope, and reverse flow (below baseline). doppler sounds are loud and sharp. Normal peak forward velocity = 30 +/- 10 cm at the dorsalic pedis artery.
I		The contour demonstrates a stong but diminished systolic component and loss of reverse flow. The width of systolic pulse is broadened. The Doppler sounds are diminished very little as compared to the type "0" pattern.
II		The contour shows prolongation of both the upstroke and the downstroke and diminished waveform amplitude (flattening). Doppler sounds are heard during systole and continuing through all or most of diastole.
III		The contour exhibits slowly rising velocity during systole, and the amplitude of the waveform is reduced. Doppler sounds are not sharp even during systole.
IV		The amplitude of the waveform and the Doppler sounds is greatly reduced.
V		The amplitude of the waveform is extremely reduced. The contour is hardly recognizable as an arterial blood flow waveform. The Doppler sounds are very faint.

Normal Peak Forward Velocity in Cm/Sec

Femoral Artery	40.7 +/- 10.9 (from 29.8 cm/sec to 51.5 cm/sec
Posterior Tibial Artery	16.0 +/- 10.0 (from 6 cm/sec to 26 m/sec)
Dorsalis Pedis Artery	16.8 +/- 5.7 (from 11.1 cm/sec to 22.5 cm/sec)

Arterial Sounds?

- Normal Sound
- High Pitch
- Tidal Wave
- What Augments These?
- Learning to Interpret these sounds is critically important
- Many You Tube Video/Audio To Assist

Basic Arterial Sounds of Lower Extremity

Performing an ABI:

https://www.youtube.com/watch?v=ZyqznHqAFkk

1. A sharp rise in the upstroke (A) representing the systolic pulse.
2. A more gradual decline (B) during diastole, sometimes with bowing during diastole.
3. A dicrotic notch in the diastolic down stroke (C).

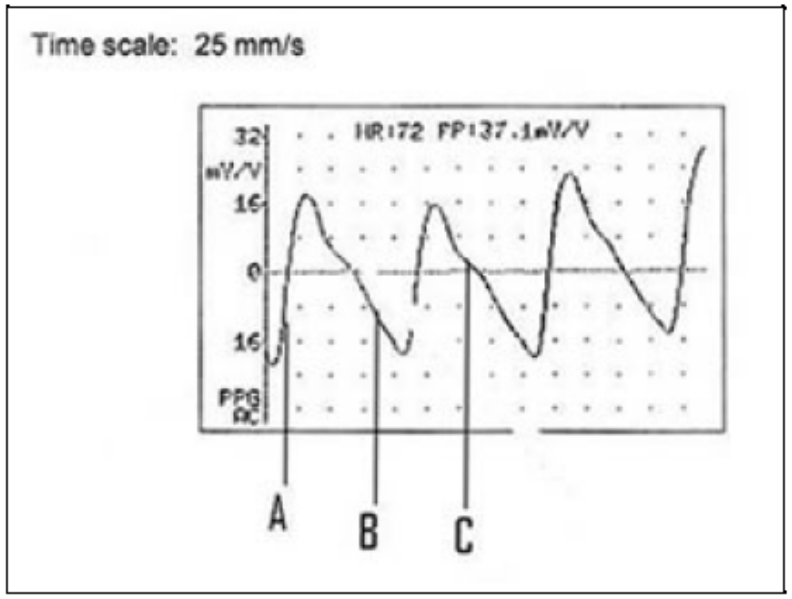


Table 4: Normal PPG

Digital Photoplethysmography

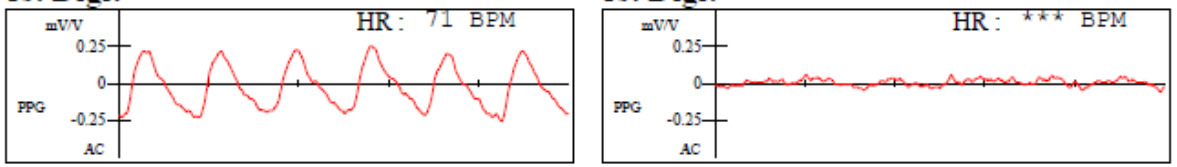
Date: 02/26/2014
Time: 8:44:48 AM

PPG Toe Pressures Report

ID: 5697
Name: Amele Thomas
Facility: Paul Kesselman
Requesting Physician: Paul Kesselman

Sex: FEMALE
Age: 73

Right		Left	
	1sec/div.		
1st Digit	PP : 0.4 mV/V HR : 71 BPM	1st Digit	PP : ***.* mV/V HR : *** BPM
2nd Digit	Peak Velocity : ***.* cm/s HR : *** BPM	2nd Digit	Peak Velocity : ***.* cm/s HR : *** BPM
3rd Digit	Peak Velocity : ***.* cm/s HR : *** BPM	3rd Digit	Peak Velocity : ***.* cm/s HR : *** BPM
4th Digit	Peak Velocity : ***.* cm/s HR : *** BPM	4th Digit	Peak Velocity : ***.* cm/s HR : *** BPM
5th Digit	Peak Velocity : ***.* cm/s HR : *** BPM	5th Digit	Peak Velocity : ***.* cm/s HR : *** BPM



- Photoelectronic beam off Hemoglobin
- Take Wave form
- Inflate Cuff
- Pressure Read When Flow Returns

Digital Pulse Volume Recording (PVR)

- PV Arterial detect arterial occlusive conditions in the lower extremities through analysis of waveform patterns method
- Sensitive for distal digital studies & useful in patients whom vessel wall calcification prevents accurate Doppler signal processing and occlusion-cuff pressure measurements.

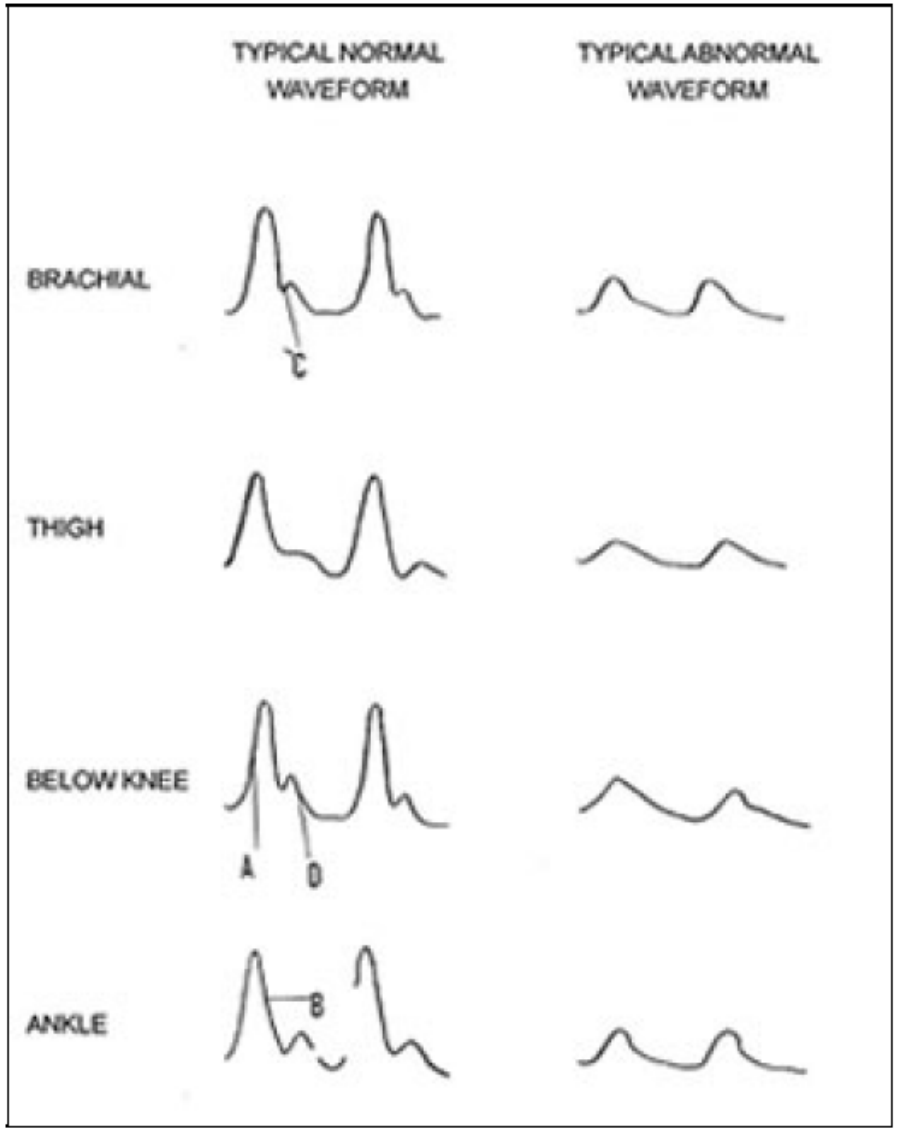


Table 5: PV Arterial Patterns

Digital PVR Tracings

- Typical appearances of a normal PV Arterial are characterized by:
- Rapid upstroke (A) during systole with a sharp peak at maximum amplitude.
- A more gradual down stroke (B) following peak amplitude.
- A dicrotic notch (C) midway in the down slope. The dicrotic notch is prominent feature of PV waveforms obtained from arm arteries.
- After the dicrotic notch, the pattern curves or bows (D) toward the baseline.

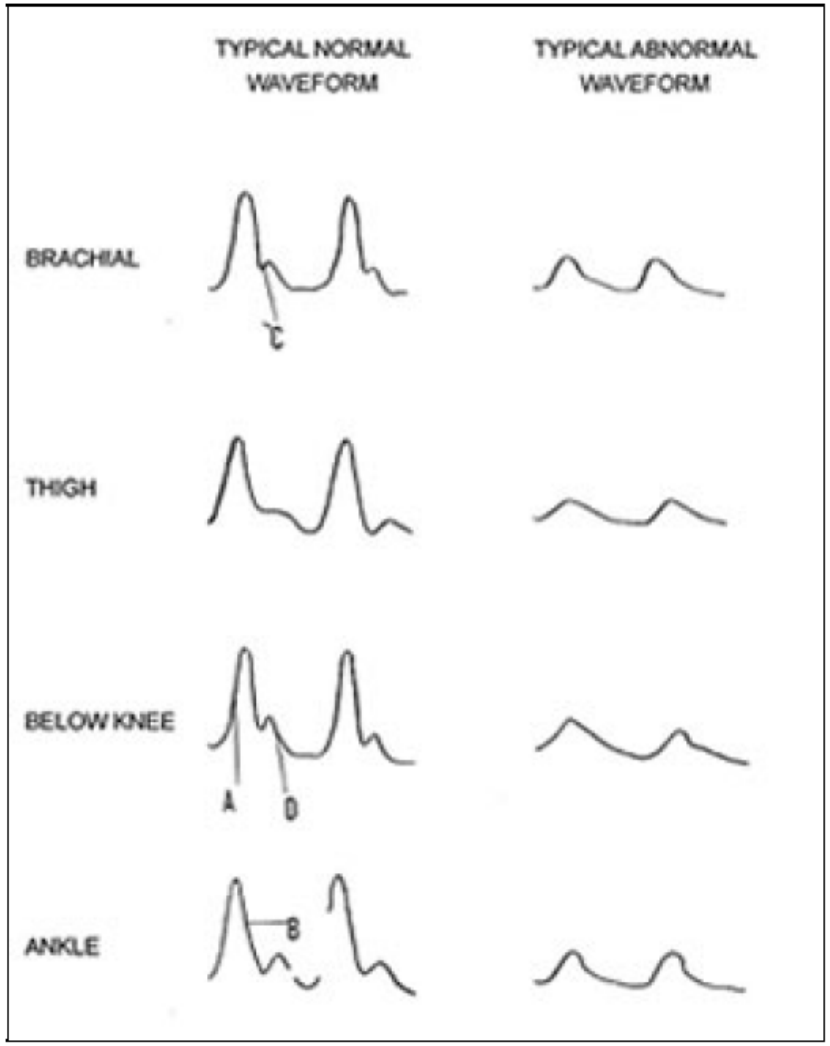
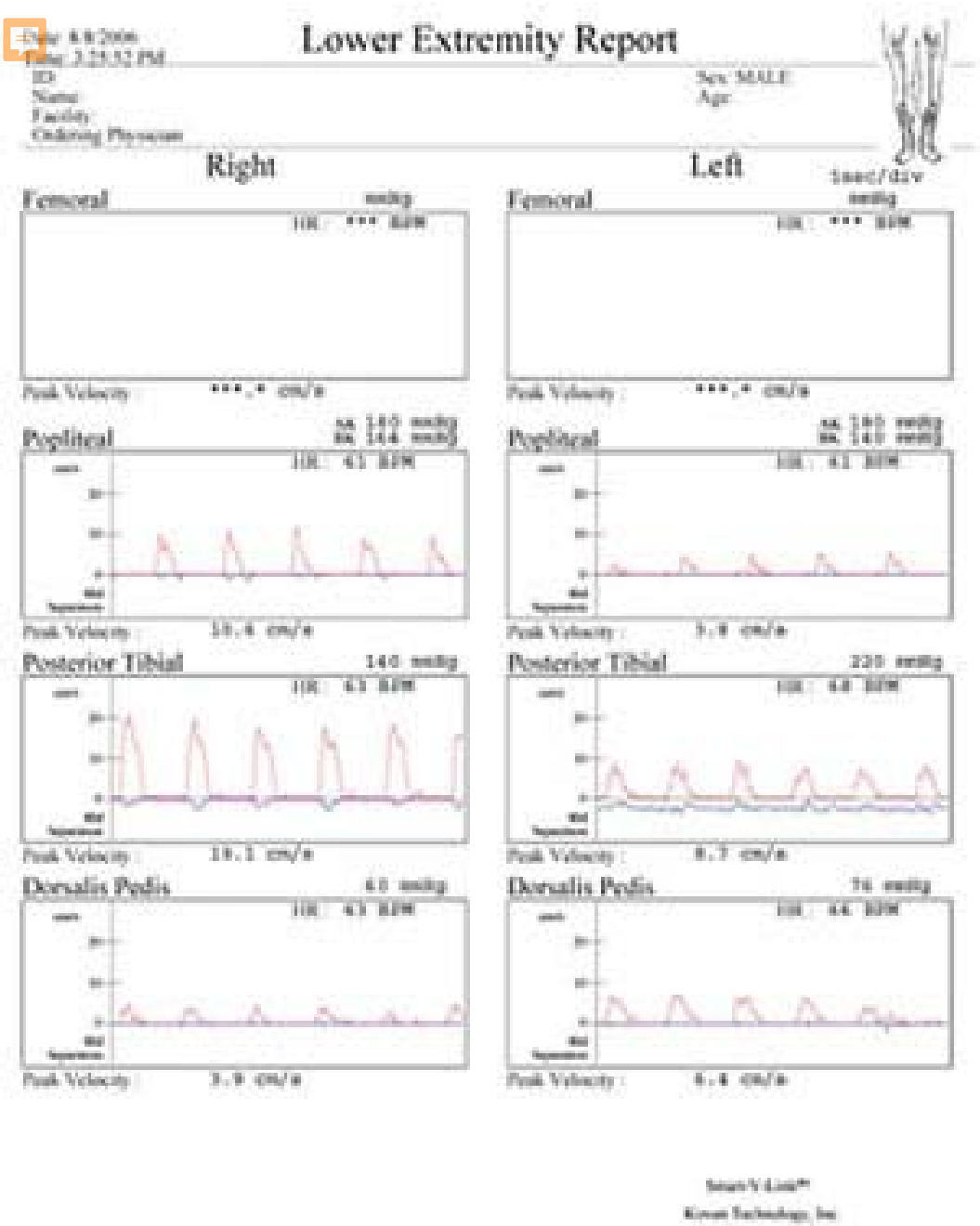
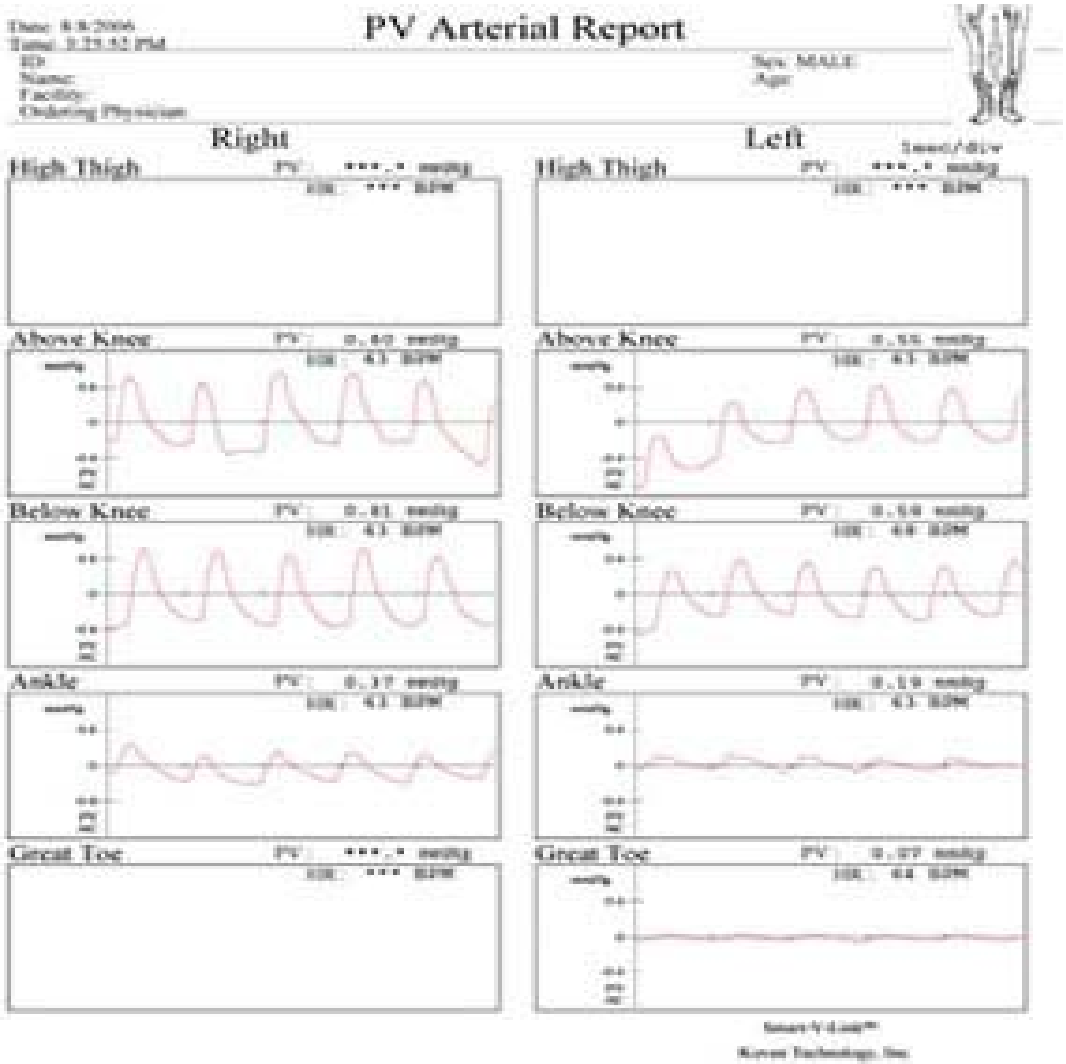


Table 5: PV Arterial Patterns

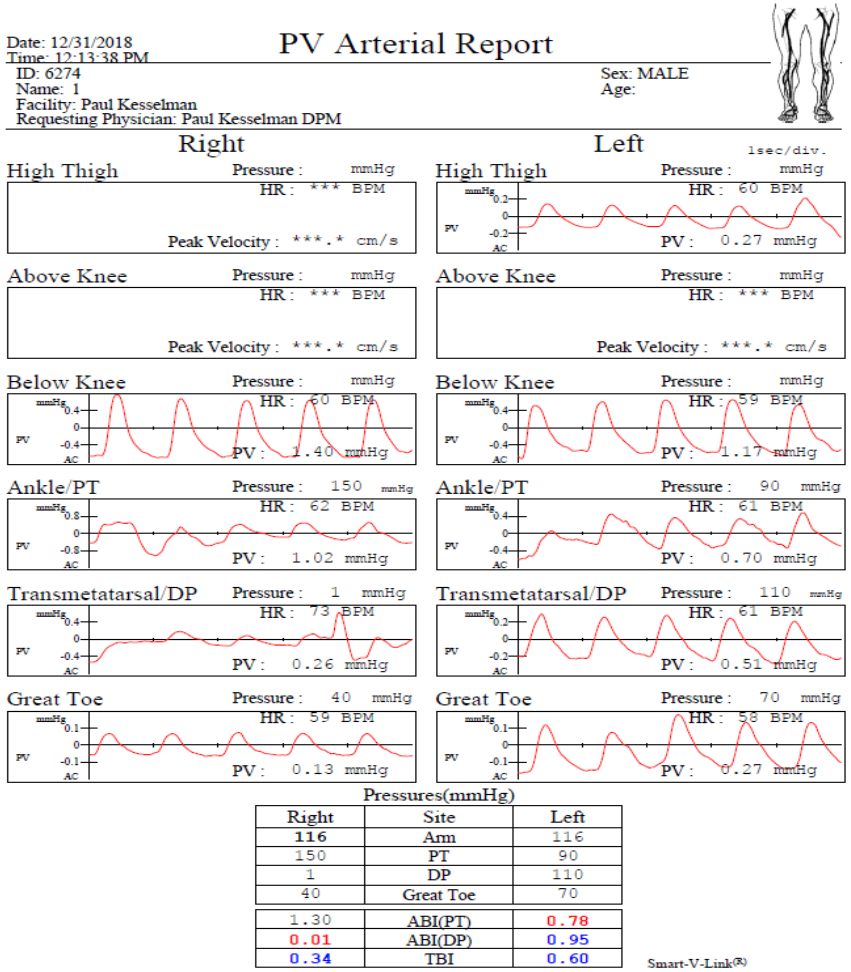


Abnormal Doppler



Abnormal PVR

- Doppler: Obtain Wave Form
- Pressure Obtained as with Brachial
- PVR: Inflate to Brachial Pressure:
- Reading taken when Venous Flow only is obstructed



PV Arterial Report

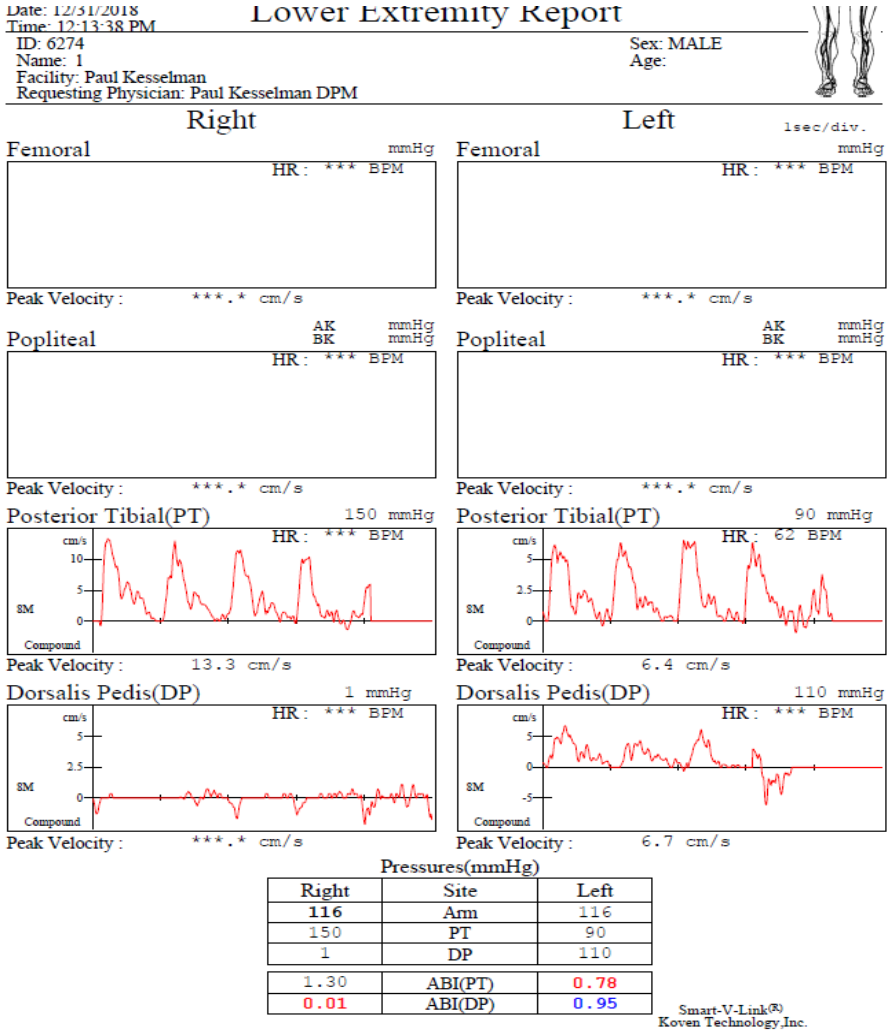
Date: 12/31/2018
Time: 12:13:38 PM
ID: 6274
Name: 1
Facility: Paul Kesselman
Requesting Physician: Paul Kesselman DPM
Sex: MALE
Age:

	Right		Left
High Thigh	Pressure : mmHg HR : *** BPM Peak Velocity : ***.* cm/s		High Thigh Pressure : mmHg HR : 60 BPM PV : 0.27 mmHg
Above Knee	Pressure : mmHg HR : *** BPM Peak Velocity : ***.* cm/s		Above Knee Pressure : mmHg HR : *** BPM Peak Velocity : ***.* cm/s
Below Knee	Pressure : mmHg HR : 60 BPM PV : 1.40 mmHg		Below Knee Pressure : mmHg HR : 59 BPM PV : 1.17 mmHg
Ankle/PT	Pressure : 150 mmHg HR : 62 BPM PV : 1.02 mmHg		Ankle/PT Pressure : 90 mmHg HR : 61 BPM PV : 0.70 mmHg
Transmetatarsal/DP	Pressure : 1 mmHg HR : 73 BPM PV : 0.26 mmHg		Transmetatarsal/DP Pressure : 110 mmHg HR : 61 BPM PV : 0.51 mmHg
Great Toe	Pressure : 40 mmHg HR : 59 BPM PV : 0.13 mmHg		Great Toe Pressure : 70 mmHg HR : 58 BPM PV : 0.27 mmHg

Pressures(mmHg)

Right	Site	Left
116	Arm	116
150	PT	90
1	DP	110
40	Great Toe	70
1.30	ABI(PT)	0.78
0.01	ABI(DP)	0.95
0.34	TBI	0.60

Smart-V-Link®



Lower Extremity Report

Date: 12/31/2018
Time: 12:13:38 PM
ID: 6274
Name: 1
Facility: Paul Kesselman
Requesting Physician: Paul Kesselman DPM
Sex: MALE
Age:

	Right	Left
Femoral	mmHg HR : *** BPM Peak Velocity : ***.* cm/s	Femoral mmHg HR : *** BPM Peak Velocity : ***.* cm/s
Popliteal	AK mmHg BK mmHg HR : *** BPM Peak Velocity : ***.* cm/s	Popliteal AK mmHg BK mmHg HR : *** BPM Peak Velocity : ***.* cm/s
Posterior Tibial(PT)	150 mmHg HR : *** BPM Peak Velocity : 13.3 cm/s	Posterior Tibial(PT) 90 mmHg HR : 62 BPM Peak Velocity : 6.4 cm/s
Dorsalis Pedis(DP)	1 mmHg HR : *** BPM Peak Velocity : ***.* cm/s	Dorsalis Pedis(DP) 110 mmHg HR : *** BPM Peak Velocity : 6.7 cm/s

1sec/div.

Pressures(mmHg)

Right	Site	Left
116	Arm	116
150	PT	90
1	DP	110
1.30	ABI(PT)	0.78
0.01	ABI(DP)	0.95

Smart-V-Link®
Koven Technology,Inc.

Arterial Duplex:

- Rarely Performed by DPMs or PCP
- Use primarily by Vascular Labs and Vascular Surgeons
- Provide 3D view of artery to see plaques and occlusions
- Can determine flow velocity
- 93925: Complete Bilateral
- 93926: Unilateral of Limited Study

Normal Duplex Velocities

Artery	Peak Velocity ±SD (cm/s)	Diameter ±SD (cm)
External iliac	119 ±22	0.79 ±0.13
Common femoral	114 ±25	0.82 ±0.14
Superficial femoral (proximal)	91 ±14	0.60 ±0.12
Superficial femoral (distal)	94 ±14	0.54 ±0.11
Popliteal	69 ±14	0.52 ±0.11

Journal of Vascular Surgery Volume 63 Number 3 Crawford et al

Table II. Confidence intervals in severe peripheral arterial disease (*PAD*) compared with non-PAD controls

	PAD, cm/s	*Controls, cm/s*	P
Artery			
Profunda femoris	113.9-149.1	85.5-106.9	.001
Popliteal	56.2-73.0	69.1-83.2	.037
AT	37.1-50.2	59.5-71.3	<.001
PT	34.6-52.1	66.9-81.3	<.001
Peroneal	28.7-40.0	48.3-59.4	<.001
Tibial parameters			
PAV	43.9-62.5	78.8-95.9	<.001
AAV	31.9-42.8	59.0-69.9	<.001
MTV	36.1-48.8	60.2-70.7	<.001
API	0.34-0.52	0.68-0.82	<.001
Femoral-AT gradient	85.0-118.4	41.8-64.2	<.001
Femoral-PT gradient	79.0-116.0	35.4-60.6	<.001

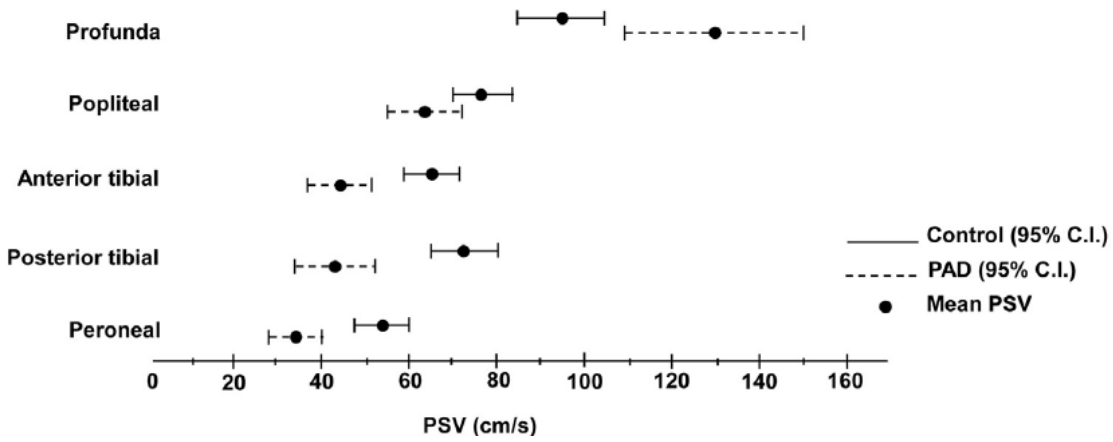
AAV, Average ankle velocity; *API*, ankle-profunda index; *AT*, anterior tibial artery; *MTV*, mean tibial velocity; *PAV*, peak ankle velocity; *PT*, posterior tibial artery.

PAV is the maximum peak systolic velocity (PSV) measured from the distal segment of the PT, AT, or peroneal artery. AAV is the average of the distal PSVs of the PT, AT, and peroneal arteries. MTV is the mean of the proximal, mid, and distal segment of each tibial artery averaged together. API is the AAV divided by the PSV of the proximal profunda artery. Femoral-AT or femoral-PT gradient is the absolute drop in PSV from the common femoral to the distal AT or PT PSV.

Radiology Key: Ultrasound Assessment of the Lower Extremity Arteries

Duplex Extremity Flow Patterns

- Journal of Vascular Surgery Volume 63 Number 3 Crawford et al



Vessel Patency Based on Duplex

- University of Washington Duplex Criteria for Classification of Lower Extremity Arterial Stenosis.

Disease Severity	Spectral Waveform Features
Normal	Triphasic waveform No spectral broadening
1%–19% diameter reduction	Triphasic waveform with minimal spectral broadening Peak systolic velocity is increased <30% relative to the adjacent proximal segment Proximal and distal waveforms remain normal
20%–49% diameter reduction	Triphasic waveform usually maintained (although reverse flow component may be diminished) Spectral broadening is prominent with filling in of the clear area under the systolic peak Peak systolic velocity is increased 30%–100% relative to the adjacent proximal segment Proximal and distal waveforms remain normal
50%–99% diameter reduction	Monophasic waveform with loss of the reverse flow component and forward flow throughout the cardiac cycle Extensive spectral broadening Peak systolic velocity is increased >100% relative to the adjacent proximal segment Distal waveform is monophasic with reduced systolic velocity
Occlusion	No flow is detected within the imaged arterial segment Preocclusive “thump” may be heard just proximal to the site of occlusion Distal (collateral) waveforms are monophasic with reduced systolic velocities

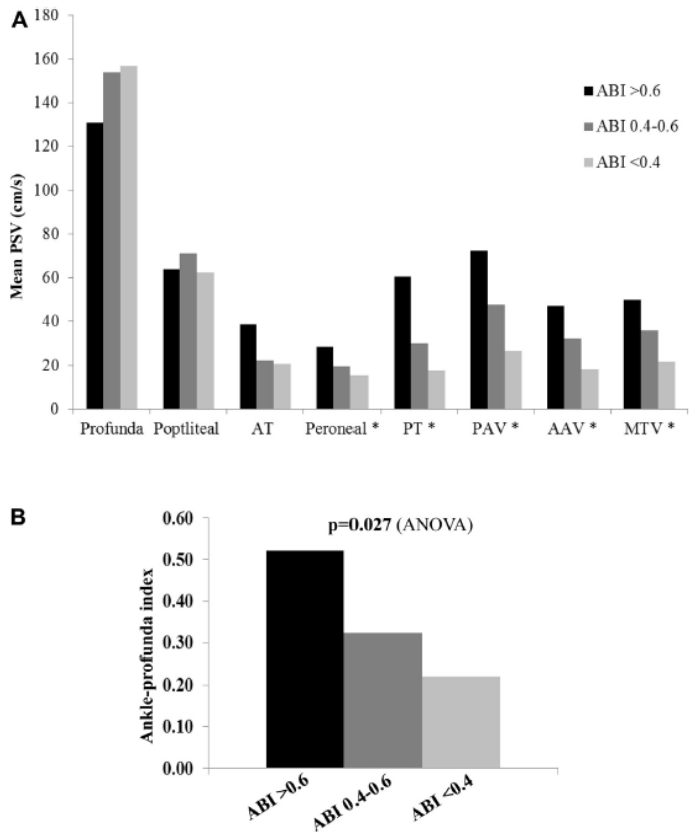


Fig 3. A, Tibial velocities and tibial parameters by ankle-brachial index (*ABI*). $^{*}P < .05$ by analysis of variance (*ANOVA*). *AAV,* Average ankle velocity; *AT,* anterior tibial artery; *MTV,* mean tibial velocity; *PAV,* peak ankle velocity; *PSV,* peak systolic velocity; *PT,* posterior tibial artery. PAV is the maximum PSV measured from the distal segment of the PT, AT, or peroneal artery. AAV is the average of the distal PSVs of the PT, AT, and peroneal arteries. MTV is the mean of the proximal, mid, and distal segment of each tibial artery averaged together. API is the AAV divided by the PSV of the proximal profunda artery. **B,** Ankle-profunda index (API) by ABI. API is calculated by first calculating the AAV, which is the mean of the distal PSVs of the PT, AT, and peroneal arteries. The AAV is then divided by the PSV of the proximal profunda artery, yielding the API.

- Velocities by ABI Patterns

Arterial Duplex Practical Tips

- Normal lower extremity arterial spectral waveforms demonstrate a triphasic flow pattern, and the blood flow speed decreases steadily from the iliac arteries to the calf arteries.
- Occlusive lesions disrupt the normal laminar flow pattern and produce increases in velocity and filling-in of the clear systolic window described as *spectral broadening*.
- Loss of the reverse flow component is seen with severe (>50%) arterial stenoses and may also be seen in normal arteries with vigorous exercise, reactive hyperemia, or limb warming.
- Spectral waveforms obtained distal to a severe stenosis or occlusion are generally monophasic and damped with reduced velocity. slow upstroke and small systolic amplitude w/peak rounding. This is referred to as a tardus-parvus flow pattern.

https://www.youtube.com/watch?v=f87CIHBNSEw

Skin Perfusion Pressure Testing
"Zone Mapping"

PAD-IQ measures skin perfusion using a laser Doppler sensor and a pressure cuff to evaluate reactive hyperemia.

To measure **Skin Perfusion Pressure (SPP),** a pressure cuff is first automatically inflated to occlude arterial bed blood flow; this is verified by PAD-IQ by determining when perfusion has stopped

PAD-IQ measures skin perfusion using a laser Doppler sensor and a pressure cuff to evaluate reactive hyperemia.

The pressure is then automatically released at a controlled rate while the cuff pressure and skin perfusion are measured

A graph displays pressure and perfusion during cuff deflation and indicates the pressure at which skin perfusion is found to return. SPP replaces the need for TcP02 measurements

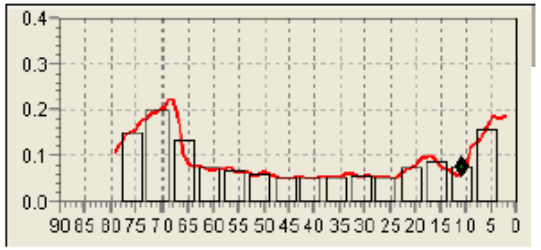
SPP is a better predictor of wound healing outcomes than TcP02

PAD-IQ is faster and easier to use compared to TcP02

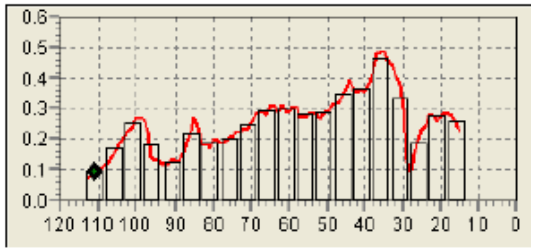
PAD-IQ helps identify which angiosomes are affected by PAD

Microvascular Testing

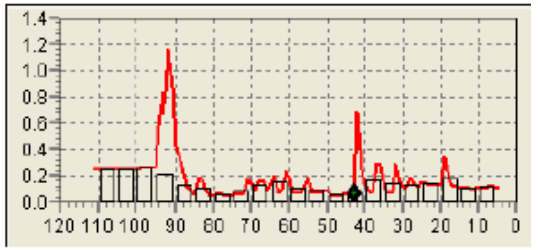
Skin Perfusion Pressure & Laser Doppler



Left Digit - Hallux 11 mmHg

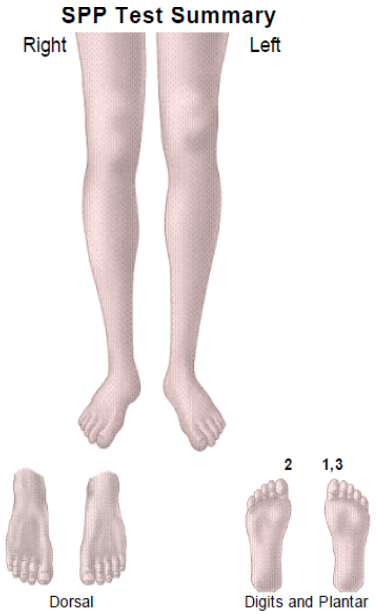


Right Digit - Hallux 111 mmHg



Left Digit - Hallux 43 mmHg

SPP Test Summary



PVR Test Summary

SPP Measurements (values in mmHg) Extremities Warmed

1. Left Digit - Hallux	11
2. Right Digit - Hallux	111
3. Left Digit - Hallux	43

PVR Measurements Extremities Warmed

Interpretation of SPP and ABI Values*

SPP	ABI	Interpretation (Typical)
< 30		CLI, non healing wound
> 30		Wound healing likely
	< .3	Severe disease
	.3-.5	Moderate disease
	.5-.9	Mild disease
	.9-1.3	Normal

* TASC Working Group, JVS, 2000; 31:S270
McDermott MM et al. J Gen Int Med 1994;9:445-9

Definitions and classifications of blood pressure levels (mmHg)

Category	Systolic	Diastolic
Optimal	< 120	< 80
Normal	120 - 129	80 - 84
High normal	130 - 139	85 - 89
Grade 1 hypertension (mild)	140 - 159	90 - 99
Grade 2 hypertension (moderate)	160 - 179	100 - 109
Grade 3 hypertension (severe)	>= 180	>= 110
Isolated systolic hypertension	>= 140	< 90

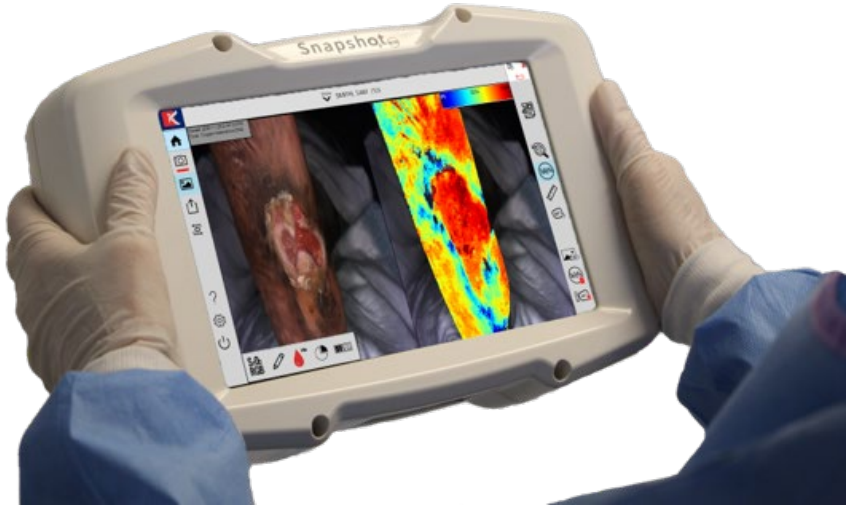
2003 ESH/ESC Hypertension Guidelines
J. Hypertension 2003, Vol 21 No. 10, p. 1780

2 of 4

>50=WNL
30-50 High % to heal
<30 Ischemia

Other Non-Invasive Testing NIRS

- Approximate value of oxygen saturation (StO2),
- Relative oxyhemoglobin level (HbO2), and
- Relative deoxyhemoglobin (Hb) level in superficial tissue.
- 0640T= First Site
- 0859=Each additional site



Non-Invasive Lower Extremity Venous Testing

- Color Duplex Ultrasound has replaced older physiologic testing
- Testing Done to R/O DVT and is urgent if not emergent med.
- Testing to define incompetent valve and provide prognosis/tx.
- Much more complex to perform than arterial
- Much more expensive to perform than arterial
- Older Venous Physiologic Testing CPT Are Eliminated

Device Compliance Issues

- Arterial and Venous
- Biphasic doppler PPG PCR, Wave Forms Arterial
- Color Wave Forms for Venous
- Optional: Audio Recording for Both
- Written Reports
- Check with other labs in the area or vascular surgeons
- Check company website regarding educational opportunities

Device Options to Look For

- Software eliminates paper strips
- Auto Inflation Cuffs
- Portability

Conclusion

- Expertise Needed To Perform & Interpret
- Liability Issues-
- All specialties no matter the degree must answer to the same level of credibility
- Charting & Reports Must Support Med. Necessity
- Written, Signed, Dated Reports
- Practice Marketing Issues


Time for
Questions