Title	Procedure: Toe Brachial Pressure Index (TBPI) Testing Using Photo Plethysmography (PPG)
Background[1-8]	• Peripheral arterial disease (PAD) is a condition characterized by decreased blood flow to the limbs secondary to a narrowing or blockage of the tributary arteries • The presence of PAD is frequently associated with age greater than 70 years, diabetes, high cholesterol, hypertension, smoking, obesity, physical inactivity, and kidney disease • PAD is a predictor for cardiovascular mortality • Depending on the degree of arterial blockage or narrowing, clinical signs of PAD may vary from tingling/numbness in the affected limb, to intermittent claudication, rest pain, ulceration, gangrene, and/or amputation, • Approximately 2/3 of people with PAD are asymptomatic • Ankle Brachial Index (ABI) may be completed in order to assess individuals for PAD, but the results may be inconclusive • Inconclusive results can be due to incompressible or calcified arteries • TBI can be conducted for PAD evaluation when ABI results are abnormally high
Indications/ Precautions/ Contraindications[8]	**Indications:** • Patients with risk factors for PAD (advanced age, smoking, hypertension, diabetes, chronic kidney disease, high cholesterol, obesity, physical inactivity, etc) • Patients with signs and symptoms of PAD (see Guideline: The Assessment of People with Leg Ulcers) • Lower leg/foot wounds or lower leg edema **Precautions:** • Results may be falsely elevated if the patient cannot remain still or lie flat during the test • Should be done in collaboration with physician or nurse practitioner in patients with untreated cellulitis and suspected or untreated DVT • May be difficult to perform in the presence of severe edema, lymphedema, and painful wounds **Contraindications:** • **DO NOT** use immediately post-operatively following a superficial bypass graft without orders from the surgeon • **DO NOT** carry out if the patient has severe foot pain, recent skin graft to upper extremity, gangrene of the toes • **DO NOT** perform on patients post mastectomy or on an arm with a dialysis fistula
Procedure	NOTE: Use of the "Procedure: Toe Brachial Pressure Index (TBPI) Testing Using Photo Plethysmography (PPG)" is one part of the holistic assessment of a patient

	presenting with a leg or foot ulcer, lower limb edema, and/or signs of PAD. **Assessment** 1. Determine whether the performance of this procedure is appropriate for the patient: • Patient with a wound on their leg or foot, lower limb edema and/or signs of PAD • Has not had TBI testing conducted in the past six months • If they have had a TBI test in the last 6 months – the patient is presenting with a change in their limb or wound since the testing was completed 2. Check the person's chart to determine if a holistic assessment has been completed for their wound and/or lower leg edema. Conduct assessments if they have not been previously completed 3. Look through the person's chart for any prior ABI/TBPI results, for comparison purposes. **Planning** Expected outcomes: 1. Information from your TBPI assessment will help identify if PAD is an underlying cause of the foot/leg wound(s), leg edema, and/or signs of PAD 2. The interdisciplinary team and the patient (and/or their SDM/POA - if applicable), will be able to use the TBPI assessment information (along with the holistic foot/lower leg assessment information) to initiate/modify a person-centered plan of care which contains clear directions for staff and others who are providing the patient with care 3. Explain the procedure and purpose of the TBPI assessment to the patient and/or their SDM/POA, and obtain verbal or implied consent **Implementation** 1. Provide for privacy 2. Ensure adequate lighting 3. Have the patient remove any clothing that may restrict accurate assessment of their toe/leg pressures, i.e. shoes, socks, tight pants/shirts, sweaters, etc. Assist the patient if necessary. 4. Have the patient lie supine in a relaxed, comfortable position to facilitate the assessment. Have the patients position themselves so that their arms are at their side, palms up. **NOTE**: the person must remain in a supine position for at least 15 minutes prior to and during TBPI testing to minimize any hydrostatic pressure inaccuracies

	5. Wash your hands and put on a pair of clean gloves 6. Expose the persons antecubital spaces 7. Apply an appropriately sized blood pressure cuff on the person's RIGHT upper arm, approximately 1-2cm above the antecubital fossa **NOTE:** Cuff width must equal 20% more than the upper arm diameter or 40% of circumference around upper arm and two thirds of upper arm length. If the cuff is too narrow, the reading may be falsely high and vice versa 8. Palpate for the brachial pulse and place ultrasound gel (1/4" thick) over that area. **NOTE:** ensure there are no large air bubbles in the applied ultrasound gel, as the Doppler requires a continuous conducting medium 9. Turn the Doppler on and hold the 8MHz Doppler probe at a 45-60 degree angle to the artery (the probe itself should be pointing in the direction of the person's head) 10. Gently move the probe through the gel in a circular motion until you find the best quality pulse sound 11. Stabilize your hand/arm before inflating the blood pressure cuff to ensure that you are able to hold the probe in position as the cuff inflates/deflates 12. Inflate the blood pressure cuff until the pulse sound disappears, and then further inflate an additional 20-30mmHg. Do NOT inflate the cuff past 200 mmHg this may dislodge any plaques that may be present in the blood vessels 13. Gradually deflate the cuff (~2mmHg/sec) until the pulse sound returns, and record the pressure at which the pulse sound returns – this is the systolic pressure. **NOTE**: if it is necessary to re-inflate the cuff due to loss of sound, be sure to completely deflate the cuff before re-inflating. If the cuff is repeatedly inflated or left inflated for long periods, the systolic pressure reading may be falsely low. If the cuff is deflated too rapidly, the true systolic pressure may be missed 14. Repeat steps 7-13 on the LEFT arm. 15. Proceed to performing the toe pressures. Ensure the foot is stable; movement of the sensor or wires can cause artifact to the PPG machine 16. Attach the toe pressure probe to the Doppler 17. Place the toe cuff on the base of the hallux (second toe if appropriate e.g. 1st toe amputation, ulceration of hallux) 18. Put PPG pad on the pad of the large toe slightly towards the second toe

	and not touching the cuffs and with the wire pointing down 19. Make sure the tape will hold the PPG in place but not compress the blood vessels by being too tight 20. Turn on the Doppler machine and you should see the patient's pulse as a waveform on the chart recorder 21. Inflate slowly until you see the waveform disappear 22. Note that this will take much less pressure at the toe than at the arm and may cause the patient discomfort 23. Slowly release the pressure in the cuff at about 2mmHg/second until the waveform reappears – note the pressure at which the waveform reappears 24. Deflate the cuff completely 25. Repeat the toe pressure on the other foot 26. Remove remnants of the ultrasound gel from the person's skin 27. If necessary - assist the patient to a comfortable position help them with the reapplication of any clothing items removed for testing purposes. **NOTE**: the person may feel dizzy/lightheaded when they first sit up, so encourage them to remain seated for a few minutes before attempting to ambulate 28. If the person is to remain in bed, ensure the bed is returned to a safe height (if applicable), and ensure the patient's safety per the patient's care plan/medical orders 29. To prevent cross contamination, clean reusable equipment/surfaces touched during the procedure with warm soapy water or disinfectant wipes and allow time for the equipment to air dry thoroughly. Returning reusable equipment to the appropriate places 30. Remove and dispose of your gloves in the appropriate receptacle and wash your hands 31. Calculate the person's left and right leg TBIs, and compare with any previous results that are available 32. Discuss the findings of the assessment with the patient and/or their SDM/POA and implement referrals and interventions per your organization's standard operating procedures 33. Share the results of the Doppler testing with the Primary Care Provider and members of the interdisciplinary team **Evaluation** **How to calculate the TBPI** Divide the highest toe pressure by the highest brachial pressure. The result is the TBPI. • TBPI > 0.7 Normal indicating no arterial disease • TBPI = 0.64 - 0.7 Borderline PAD • TBPI < 0.64 - Abnormal indicating PAD

	Unexpected outcomes: 34. Doppler testing is not done according to this Procedure and results are inaccurate leading to inappropriate interventions 35. You are unable to complete the testing as the person is unable to lie flat for a period of 15 minutes pre-procedure and during the procedure, you are unable to detect pulses with the Doppler, or the application of an inflated blood pressure cuff is too painful for the person to tolerate, consider referring for vascular studies **Reassess TBPI:** 36. Every six months for patients with lower leg/foot wounds and/or lower limb edema 37. As soon as possible if a patient develops new or worsening signs or symptoms of PAD 38. As soon as possible if the patient develops lower leg/foot pain unrelated to infection or injury
References	1. Hiatt WR, Goldstone J, Smith SC Jr., et al. Atherosclerotic peripheral vascular disease symposium II: Nomenclature for vascular disease. Circulation. 2008; 118:2826. 2. Dawson DL, Hiatt WR, Creager MD, et al. Peripheral arterial disease medical care and prevention of complications. Prev. Cardiol. 2002; 5:119-130. 3. Leng GC, Lee AJ, Fowkes FG, et al. Incidence, natural history and cardiovascular events in symptomatic peripheral arterial disease in the general population. Int J Epidemiol. 1996; 25:1172-1181. 4. European Stroke Organization, Tendera M, Aboyans V, et al. ESC Guidelines on the diagnosis and treatment of peripheral artery disease. Eur Heart J. 2011; 32:2851-2906. 5. Hooi JD, Kester ADM, Stoffers HEJH, et al. Asymptomatic peripheral arterial occlusive disease predicted cardiovascular morbidity and mortality in a 7 year follow-up study. J Clin Epidemiol. 2004; 57:294-300. 6. Twine CP, Coulston J, Shandall A, et al. Angioplasty versus stenting for superficial femoral artery lesions. Cochrane Database Syst Rev. 2009;2:CD006767. 7. NHS Torbay and South Devon. Clinical Guidelines (for Podiatrists) for the Management of Peripheral Arterial Disease (PAD): Version 3. May 2017. Accessed February 11, 2018. Website: http://documents.torbayandsouthdevon.nhs.uk/TSDFT/G1850.pdf?web=1 8. British Columbia Provincial Nursing Skin and Wound Care Committee. 2013. Procedure: Ankle Brachial Index (ABI) in Adults using an Automatic ABOI System (Dopplex Ability). Available at: https://www.clwk.ca/buddydrive/file/procedure-abi-automatic-abi-system/