Team Name: Wound Care Team Lead: Director - Staff Development, Infection Prevention & Control/Director Home Care, Palliative Care & Seniors Approved by: Regional Lead-Acute Care & Chief Nursing Officer	Reference Number: CLI.4110.PL.022 Program Area: Across Care Areas Policy Section: General
Issue Date: December 5, 2018 Review Date: July 7 2020 Revision Date: January 19, 2024	Subject: Ankle Brachial Pressure Index (ABPI) and Toe Brachial Pressure Index (TBPI) Testing

Use of pre-printed documents: Users are to refer to the electronic version of this document located on the Southern Health-Santé Sud Health Provider Site to ensure the most current document is consulted

POLICY SUBJECT:
Ankle Brachial Pressure Index (ABPI) and Toe Brachial Pressure Index (TBPI) Testing

PURPOSE:
To provide an evidence-based standardized approach to health care providers who have been trained to perform, interpret and report results of an ABPI and TBPI as part of a comprehensive vascular assessment of the lower extremities.

BOARD POLICY REFERENCE:
Executive Limitation (EL-01) – Global Executive Restraint and Risk
Executive Limitation (EL-02) – Treatment of Client

POLICY
An ABPI/TBPI is a measure of the arterial circulation and is valid at the time it is done. The client's vascular status may change at any time after the index is taken. These changes may be acute (acute arterial occlusion) or chronic.

- The ABPI/TBPI is one part of a lower leg assessment. The assessment includes: clinical history, observation, palpation, and doppler waveform analysis. ABPI/TBPI findings are considered within the context of the complete client's health status.
  - The accuracy of an ABPI/TBPI can be affected by the length of the rest period prior to the test, blood pressure/toe cuff placement, cuff size, and the speed of inflation and deflation.
- Any treatment that may affect the vascular status of the client is done with care and caution (e.g. compression).
- An ABPI/TBPI is reassessed:
  - Annually for clients receiving compression therapy and as required when client's condition changes, and/or
  - When any of the following occur:
    - Increasing lower leg and/or foot pain unrelated to infection,

- Increasing signs of arterial insufficiency, such as delayed capillary refill, cold skin temperature, absent or diminishing peripheral pulses,
- Development of rest pain or gangrene and/or
- Non-healing, deteriorating wound.

- Initiation of moderate to high compression (greater than 10mmHg) requires an ABPI/TBPI test to be completed within 3 months.

Clinical Indications for ABPI and TBPI:

- As part of a comprehensive lower leg assessment to screen clients for the presence and/or severity of arterial compromise.
- To assist in predicting the healability of lower leg wounds.
- To assess the vascular status of clients.
- For all clients who require compression therapy.
    - Compression therapy will **NOT** be initiated until an ABPI/TBPI is completed.
        - **Exception:** compression therapy will proceed as ordered by a referring Vascular Surgeon/Vascular Medicine Specialist/Physician Specialist. The Specialist will have completed a comprehensive lower leg assessment and deemed that compression therapy can be safely applied. Any questions about the prescribed treatment are discussed with the Vascular Surgeon/Vascular Medicine Specialist/Physician Specialist prior to initiation of compression therapy.
        - If the client is under the direct care of a Vascular Surgeon, Vascular Medicine Specialist or a Physician Specialist with expertise in chronic wounds - that Specialist will determine the need for vascular testing.
- An ABPI/TBPI is not required for clients using/requiring Elasticized Tubular Bandages (ETB) at low compression (5-10mmHg) or Anti-Embolism Stockings.
    - Application of ETB is based on a lower leg assessment. If the assessment indicates signs and symptoms of venous insufficiency/venous stasis/venous hypertension and is not suggestive of arterial disease, then ETB can be applied.
    - Anti-Embolism stockings (i.e. TED stockings), are indicated for clients on bedrest and are not graduated compression stockings.
- The TBPI results are more reflective of arterial blood flow if:
    - The client has diabetes
    - There is the presence of calcified arteries indicated by:
        - Pulse audible at cuff pressure greater than 200 mmHg
        - Wide difference between ankle and brachial systolic pressures
        - ABPI greater than or equal to 1.2

Contraindications for ABPI and TBPI:

- Previous lower limb arterial vascular surgery that requires the cuff to be placed directly over the stent. This does not apply to surgery where veins have been harvested for coronary artery bypass grafting. In these situations, a TBPI can safely be completed along with listening to the pulsatility of the dorsalis pedis (DP) and posterior tibialis (TP),
- Inability of client to lay flat and still,
- Untreated cellulitis,
- When deep vein thrombosis (DVT) is suspected or untreated, and/or
- Severe ischemia, since the measurement of ABPI increases the risk of further tissue damage.
- **DO NOT** take brachial reading on the affected side of a client post mastectomy or on an arm with a dialysis fistula.

  NOTE: Calculations can be completed with one brachial reading.

Indications for Referral for Vascular Studies by Vascular Surgeon, Vascular Medicine Specialist, or Physician Specialist:

- If a trained Health Care Provider is not available to do an ABPI and TBPI,
- If client cannot lie flat and still,
- ABPI less than 0.49 or toe pressure less than 30 mmHg,
- A decrease in ABPI of greater than 0.15 within a 3 – 12 month reassessment period,
- Blood pressure difference between the arms of greater than 20 mmHg which is an indication of upper extremity arterial disease (e.g. subclavian steal syndrome),
- A non-healing lower extremity wound in presence of arterial insufficiency,
- Rest pain or gangrene,
- Toe pressures that are absent or abnormal and/or
- Any observed significant clinical change.

Establishing and Maintaining Competency:

- Initial competency is established by:
  1. Completing the ABPI/TBPI Education Module
  2. Training with a recognized Certified Wound Care Nurse and demonstrating the application of knowledge in ABPI/TBPI testing procedures and interpretation of results.
- When available, attend annual Regional ABPI/TBPI training session
- Competency in the performance of ABPI/TBPI requires the health care provider to:
  - Complete a minimum of 24 ABPI/TBPI assessments annually. Health care providers that have not performed the required number of ABPI/TBPIs will participate in a review of the procedure with a recognized Certified Wound Care Nurse.
  - Track and submit ABPI/TBPIs completed to their direct supervisor and the Southern Health Wound Care Team on a quarterly basis.

DEFINITIONS:

Ankle Brachial Pressure Index (ABPI) - A non-invasive assessment which uses a hand-held doppler to measure the arterial blood flow in the lower legs. It is used to screen clients for the presence and severity of arterial compromise. ABPI is carried out as part of the full lower leg assessment required to determine which clients need further vascular assessment and treatment.

Ankle Flare (malleolar flare) - A 'sunburst' pattern of visible capillaries from distention of small veins inferior and distal to the medial malleolus.

Atrophe Blanche - White areas of extremely thin, fragile skin dotted with tiny blood vessels; seen in clients with venous insufficiency; may be painful; these areas are at greater risk for breakdown.

Buerger's Test - Used in the assessment of arterial sufficiency. The *vascular angle*, which is also called *Buerger's angle*, is the angle to which the leg has to be raised before it becomes pale while in supine position. In a limb with a normal circulation, the toes and sole of the foot stay pink even when the limb is raised by 90 degrees. In an ischemic leg, elevation to 15 degrees or 30 degrees for 30 to 60 seconds may cause pallor. (This part of the test checks for *elevation pallor*.) A vascular angle of less than 20 degrees is indicative of severe ischemia.

Client - Any individual recipient of healthcare services, including patients and residents.

Dependent Rubor - The lower leg turns red/blue when it is in a dependent position caused by blood rushing into ischemic tissue; occurs when peripheral vessels are severely damaged and remain dilated because they are no longer able to constrict; common in advanced arterial disease.

Hemosiderin Staining - Leakage of red blood cells in surrounding tissue due to venous hypertension in the lower leg; over time presents as reddish brown skin pigmentation.

Hyperkeratosis - Hyperkeratosis is a thickening of the outer layer of the skin. This outer layer contains a tough, protective protein called keratin.

Intermittent Claudication - Is pain affecting the calf, and less commonly the thigh and buttock, which is induced by exercise and relieved by rest. Symptom severity varies from mild to severe. Occurs as a result of muscle ischemia during exercise caused by obstruction to arterial flow.

Lipodermatosclerosis - Woody, fibrous hardening of the soft tissue in the lower leg: often presents as a "champagne" shaped lower leg.

Phlebitis - Inflammation of a vein. Not generally serious if in a superficial vein. The cause is uncertain. Presenting symptoms may include pain, tenderness, edema, erythema and a cordlike mass.

Stasis Dermatitis - Occurs with chronic venous insufficiency. Pooled venous blood in the legs compromises the endothelial integrity in the microvasculature, resulting in fibrin leakage, local inflammation and local cell necrosis.

Stemmer's Sign - A test that results in either a positive or negative sign for lymphedema. To perform it, attempts are made to pinch and lift a skinfold at the base of the second toe or middle finger. If the skinfold can be pinched and lifted, Stemmer's sign is negative. If the skinfold cannot be pinched and lifted, the sign is positive. False positives never occur. However, a negative test doesn't rule out lymphedema.

Subclavian Steal Syndrome - A phenomenon of flow reversal in the vertebral artery ipsilateral (same side of the body) to a hemodynamically significant stenosis or occlusion of the subclavian artery.

Tinea Pedis - A foot infection due to a dermatophyte fungus. Thrives in warm humid conditions.

Toe Brachial Pressure Index (TBPI) - A non-invasive comparison of small vessel perfusion to the toes using a photoplethysmography (PPG). PPG is a tool which measures the intensity of light reflected from the skin surface and the red blood cells below. TBPI is indicative of arterial pulse flow in the arterioles of the area assessed.

Vasculitis - An inflammation in the blood vessels which causes changes to the vessels such as thickening, weakening, narrowing and scarring. This restricts blood flow resulting in organ and tissue damage. One or more organs may be affected. It may be acute or chronic.

IMPORTANT POINTS TO CONSIDER:

The interpretation of the assessment includes clinical criteria and quantitative test results from an ABPI and TBPI examination. Successful interpretation of the vascular examination supports treatment decisions and helps to predict treatment outcomes.

- Inaccurate readings may result from:
    - Using both brachial readings instead of higher of the two,
    - Client anxiety,
    - Open wounds,
    - Pain,
    - Client movement,
    - Poor positioning of client,
    - Poor positioning of cuff,

- Cuff too tight,
- Wrong cuff size,
- Lack of audible output,
- Repeated or prolonged cuff inflation,
- Excessive pressure from probe or moving the probe from the artery,
- Inexperienced practitioner performing the test and/or
- Inaccurate calculations.

- An ABPI of greater than 0.8 does not always indicate compression bandaging can be applied safely.

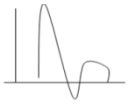
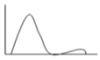
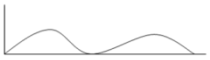
PROCEDURE:

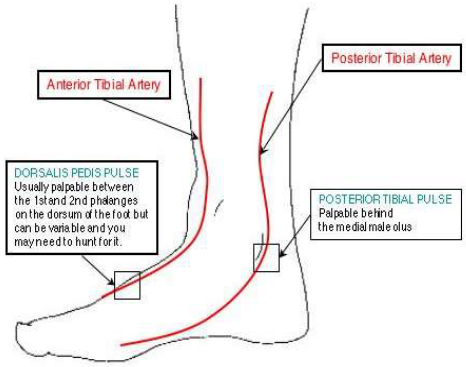
- An Ankle Brachial Pressure Index & Toe Brachial Pressure Index Request form (CLI.4110.PL.022.FORM.01) has been completed by health care provider; then received and reviewed by clinician performing ABPI/TBPI.
- ALL clients referred for ABPI/TBPI have both procedures completed/attempted at the same appointment.

<table>
<tr><th>ABPI Procedure Steps</th><th>Key Points</th></tr>
<tr><td>1. Have client to go to washroom prior to testing. Remove the client's shoes, socks or compression stockings. Roll up sleeves and pant legs. Have client lie down on a flat, comfortable surface, with a maximum of one flat pillow under their head.

Client should be on his/her back with ankles at same level as heart. As the client is lying down, apply all cuffs and the toe probes. Cover the trunk and lower extremities to prevent cooling.</td><td>Having the client in a supine position reduces any hydrostatic pressure inaccuracies.

The accuracy of an ABPI done with a handheld probe can be affected by the length of the rest period prior to the test, blood pressure cuff placement, cuff size and the speed of inflation and deflation.</td></tr>
<tr><td>2a. Have client rest in supine position in a quiet warm room for at least 15 - 30 minutes prior to beginning the test. Complete the Ankle Brachial Pressure Index (ABPI) & Toe Brachial Pressure Index (TBPI) Assessment Form CLI.4110.PL.022.FORM.03 form at this time.
2b. While client is lying flat, teach client/caregiver:
• The ABPI/TBPI procedure that will be performed
• Arterial and venous systems</td><td></td></tr>
<tr><td>3. Collect equipment & perform hand hygiene. Wear clean gloves, if indicated. Clean gloves should be worn if there is an open area, discharge, fungal toenails or a rash on the foot/ankle area.</td><td>Infection prevention and control measures</td></tr>
<tr><td>4. Place an appropriate size BP cuff that comes with the sphygmomanometer around the client's arms, legs and toes snuggly, straight and not spiral. Apply blood pressure cuff snuggly 1 – 2cm above the malleolus, permitting one finger to fit between client's leg and cuff.
<table><tr><th>Limb or Digit</th><th>Cuff width</th></tr><tr><td>Small arm</td><td>10 cm</td></tr><tr><td>Large arm</td><td>12 cm</td></tr><tr><td>Ankle</td><td>10 cm</td></tr><tr><td>Great toe</td><td>1.9cm (small toe) 2.5 cm (large toe)</td></tr></table></td><td>Cuff selection should be based upon the size of the upper limb and the leg just above the malleolus. If the cuff is too narrow, the reading may be a falsely high; if the cuff is too wide, the reading may be a falsely low.
A cuff placed too high above the malleolus may result in higher ankle pressures.
Repeatedly inflating the cuff or inflating it for long periods may cause the pressure to fall.</td></tr>
<tr><td>5. Connect ultrasound probe to unit. Turn on ultrasound unit and adjust sound.</td><td>Replace batteries in the handheld Doppler if the screen indicates a low battery or if the machine shuts off spontaneously during the procedure.</td></tr>
<tr><td>6. Palpate brachial pulse and apply ultrasound gel (quarter sized) over the pulse.</td><td>DO NOT use KY jelly as it destroys probe crystals.</td></tr>
<tr><td>7. Hold the Doppler probe like a pen, at a 45 - 60 degree angle towards the blood flow; move slowly through the gel in circular motion until a clear arterial pulse sound is heard and a steady wave form is produced on the LCD screen. Steady your hand and probe.</td><td>Whooshing sounds are usually venous; if in doubt, apply pressure below the probe with your hand and release. This will cause sound changes.</td></tr>
</table>

8. Note waveform and take a recording if applicable for Doppler unit. Otherwise, identify the waveform pattern as triphasic, biphasic or monophasic. This can be done auditorially and/or visually. • Triphasic:  Doppler signal is pulsatile, with three signals or more each beat, and higher pitched • Biphasic:  Doppler signal is lower pitched and it is difficult to hear more than two phases • Monophasic:  Difficult to hear signal, very low pitched sound	
9. Inflate the cuff, proceeding 20 mmHg over last sound heard; do not inflate cuff past 200 mmHg.	Inflating the cuff past 200 mmHg may dislodge plaques in the blood vessels.
10. Gradually deflate the cuff (2 mm/sec) until the arterial sound returns. When the sound is heard completely deflate the cuff. Record the pressure at which the sound returns. Remove the ultrasound gel from the client's arm.	If unsure of when the arterial sound started, reinflate the cuff at any time NOTE: Cuff does not need to be completely deflated.
11. Repeat steps 6-10 on the other arm. Reassess brachial systolic pressure if there is a considerable difference in both arms for accuracy and reproducibility.	In individuals free of arterial disease there should be less than or equal to 20mmHg systolic pressure difference between the two arms. Blood pressure difference between the arms of greater than 20 mmHg is an indication of upper extremity arterial disease (subclavian steal syndrome).
12. If a wound is present on the lower leg, find the pressure of the non-wounded leg first. Cover any leg wounds that are in close proximity to the cuff with a non-adherent low profile dressing. If inflation causes pain, do not inflate cuff on the affected limb. If unable to inflate the cuff, clinicians still assess pulsatility of dorsalis pedis (DP) /posterior tibialis (PT).	

TBPI Procedure Steps	Key Points
13. Locate the DP/PT pulses in the foot.  	
14. Using the same method outlined in steps 7 - 10, palpate the DP pulse; apply the gel. Using the doppler, note the pulsatility. Determine the DP systolic pressure; do not inflate cuff past 200 mmHg. Deflate the cuff. Record the systolic pressure reading. Using a tissue, move the gel from the foot.	If DP pulse is not palpable, use the doppler probe in the general area to locate the pulse sound. If the DP pulse cannot be located, use the PT pulse to calculate the ABPI. If the pulse sound does not disappear at 200 mmHg the blood vessel is calcified causing it to be non-compressible.
15. With the cuff in the same position on the same leg, palpate the PT pulse, apply the gel and using the doppler, note the pulsatility, and determine the PT systolic pressure; do not inflate cuff past 200 mmHg. Deflate the cuff. Record the systolic pressure reading. Using a tissue, remove the gel from the foot.	If PT pulse is not palpable, use the doppler probe in the general area to locate the pulse sound. If the PT pulse cannot be located, use the DP pulse to calculate the ABPI. If the pulse sound does not disappear at 200 mmHg the blood vessel is calcified causing it to be non-compressible.
16. Repeat steps 13 - 15 on the other leg.	
17. Disconnect the Doppler probe and connect the PPG probe to unit and turn on. Turn down volume when using PPG.	
18. Attach PPG sensor to plantar surface or pad of great toe (avoid callous) using tape or a Velcro strap. If great toe is missing, 2nd toe may be used but is less successful to test due to size and shape. The PPG probe should be positioned with the cords resting on the bed, not hanging down or moving, and the receiver should be positioned close to the sphygmomanometer so that both can be viewed easily during cuff inflation and deflation. Ensure tape is not around entire toe causing a tourniquet effect.	

TBPI Procedure Steps	Key Points
19. Watch monitor screen for a cyclical waveform. Reposition PPG sensor or ensure good contact with skin if a poor waveform is noted.	The PPG probe does not require ultrasound gel like the ultrasound probe. The PPG is sensitive to ambient light, so the output reading maybe poor in a brightly lit room. Cover foot with a cloth to reduce light. The PPG probe is dependent on capillary flow of the skin, therefore if the patient is cold this will result in vasoconstriction; there may be a poor reading. Ensure client is kept warm. If there is poor peripheral arterial flow, the reading would be poor, due to the lack of red blood cells available at the point of measurement.
20. Inflate the cuff until the wave form flattens and continue to inflate 20mmHg more. Initially start no higher than 100 mmHg to see if waveform flattens.	Toe cuffs are small and prone to breaking if over inflated.
21. Deflate cuff 2-3 mmHg per second, pausing after each deflation for PPG to register, until waveform returns. Record the systolic pressure reading of the toe.	Ensure the waveform that returns, is pulsatile and not a 'blip' on the screen since this could be caused by movement or artifact. Your reading will NOT be accurate if you let air out of the cuff at a steady rate because of the automatic adjustments the equipment has to make to "find" and display the arterial waveform. "Three screens" is appropriate time to determine if flow has returned.
22. Repeat and record steps 18 – 21 on the toe of the other foot.	
23. Remove cuffs and probe. Assist client to reposition and redress if required.	
24. Perform hand hygiene once the procedure is completed. Clean and disinfect all equipment. • Sensors are cleaned with alcohol swabs • Remaining equipment is cleansed with approved disinfectant wipes	

TBPI Procedure Steps	Key Points
25. Calculate the ABPI for both the right and left legs by dividing the higher ankle pressure from each leg by the higher systolic brachial pressure from the arms. The higher of the two ankle pressures for that leg **ABPI =** ---------- The higher brachial pressure of the two arms	The higher of the two brachial readings is the true reading.
26. Calculate the TBPI for both the right and left toes by dividing the toe pressure by the higher systolic brachial pressure from the arms. Toe Pressure **TBPI =** ---------- The higher brachial pressure of the two arms	The higher of the two brachial readings is the true reading.
27.Send results to the Primary Care Provider, who requested the ABPI/TBPI, using the Ankle Brachial Pressure Index (ABPI) & Toe Brachial Pressure Index (TBPI) Assessment Form CLI.4110.PL.022.FORM.01	The results of an ABPI/TBPI are used in conjunction with a review of client history, a complete lower limb assessment, and interpretation of ABPI/TBPI Chart when deciding on care. The results of the ABPI and TBPI are considered as part of a comprehensive lower leg assessment, which includes a review of client history and a physical exam.

ABPI & TBPI Interpretation Chart

ABPI	Toe Pressure	TBPI	Ankle Doppler Wave Form	Possible Diagnosis	Potential for Wound Healing	Amount of Compression	Type of Compression
Greater than 1.2				Calcified – refer to Toe Pressure results			
0.8 - 1.2	Greater than 55 mmHg	Greater than 0.6	Triphasic/ Biphasic	No significant arterial disease	Good	High (30-40 mmHg)	Coban 2; Graduated compression stockings; Comprilan; Elastisized tubular bandages
0.5 – 0.79	Greater than 40 mmHg	Greater than 0.4	Biphasic / Monophasic	Arterial disease; compression may be used with **CAUTION**	Adequate	Moderate (20-30 mmHg)	Coban 2 Lite; Graduated compression stockings; Elastisized tubular bandage
0.35 – 0.49	Less than 30 mmHg	Greater than 0.2	Biphasic / Monophasic	Arterial disease	Poor	**Refer to Vascular Specialist.** Normally **NO** compression BUT can be used with **GREAT CAUTION** ONLY if mixed venous/arterial ulcer and edema is an issue and **ONLY** if directed to do so by a **Vascular Physician.**	As per Vascular Physician's orders.
Less than 0.35	Less than 20 mmHg	Less than 0.2	Monophasic	High risk for critical limb ischemia		**NONE**. **Refer to a Vascular Specialist.**	

DOCUMENTATION:

1. Ankle Brachial Pressure Index (ABPI) and Toe Brachial Pressure Index (TBPI) Assessment Form CLI.4110.PL.022.FORM.03 (3 pages) is completed in its entirety and forwarded to the Primary Care Provider and the requestor with a copy maintained on the client file.
2. Document on the Interdisciplinary Progress Notes (IPN) or Clinical Documentation note that the ABPI and TBPI assessment was completed.

EQUIPMENT/SUPPLIES:

- Hand held doppler transducer and receiver
- 8 MHz Probe
- Sphygmomanometer
- Cuffs:
  - (4) 10 cm (ankles/arms)
  - (2) 12 cm (arms)
  - (2) 1.9 cm (toes)
  - (2) 2.5 cm (toes) UPC
  - Cuff adaptor (as needed)
- Photoplethysmography probe (PPG)
- Ultrasound transmission gel
- 10g Monofilaments
- Gauze, tissue or pads to remove transmission gel
- Paper, pen and calculator
- ABPI/TBPI Assessment Form
- Hand sanitizer
- Transpore clear tape
- Measuring tape
- Disposable gloves
- Plastic wrap (to cover any wounds)
- Alcohol pads to clean the Sphygmomanometer screen and sensors
- Disinfectant wipes
- Headphones (optional)

SUPPORTING DOCUMENTS:

CLI.4110.PL.022.FORM.01	Ankle Brachial Pressure Index (ABPI) & Toe Brachial Pressure Index (TBPI) Request
CLI.4110.PL.022.FORM.02	Ankle Brachial Pressure Index (ABPI) and Toe Brachial Pressure Index (TBPI) Client Appointment Instructions and Information
CLI.4110.PL.022.FORM.03	Ankle Brachial Pressure Index (ABPI) & Toe Brachial Pressure Index (TBPI) Assessment Form
CLI.4110.PL.022.SD.01	Ankle Brachial Pressure Index (ABPI) & Toe Brachial Pressure Index (TBPI) Education Module

REFERENCES:

Table info was Adapted from WCC Vol 4 No 1 Best Practice Recommendations for Preparing the Wound Bed: Update 2006. Sibbald et al., WRHA 2016, Alberta Health Services, Wound Care Guidelines December 2009

Asongwed ET, Chesbro SB, Karavatas SG. Peripheral Arterial Disease and the Ankle Brachial Index. WhatHome Healthcare Clinicians Need to Know. Home Health Care Nurse. Mar 2009; 27(3): 160-166.

Bonham PA. Get the LEAD Out. Noninvasive Assessment for Lower Extremity Arterial Disease Using Ankle Brachial Index and Toe Brachial Index Measurements. J WOCN. Jan/Feb 2006 p. 30-41.

British Columbia Provincial Nursing Skin and Wound Committee. Education Module Ankle Brachial Index (ABI) Procedure in Adults for Handheld Doppler & Automatic ABI System. June 2013.

Bryant, R.A. & Nix, .P. (2007). Acute & chronic wounds: Current management concepts. 3rd ed. Mosby Elsevier, PA.

Burrows C, Miller R, Townsend D, et al. (2006). Best practice recommendations for the prevention and treatment of venous leg ulcers: Update 2006. *Wound Care Canada,* 4(1): 45-55.

https://www.clwk.ca/buddydrive/file/guideline-lower-limb-venous-arterial/

https://www.medmastery.com/guides/ultrasound-clinical-guide-arteries-legs/how-interpret-ankle-brachial-index-abi-waveforms

Caruana MF, Bradbury AW, Adam DJ. The validity, reliability, reproducibility and extended utility of ankle to brachial pressure index in current vascular surgical practice. Eur J Vasc Edovasc Surg. 2005; 29(5):443-51.

Romanelli M, Valentina D, Williamson D, Paterson DM, Pope M, Sibbald RG. Measurement: Lower leg ulcer vascular and wound assessment. In Krasner DL, Rodenheaver GT, Sibbald RG. Chronic Wound Care: A Clinical Source Book for Healthcare Professionals. 4th ed. Malvern, PA: HMP Communications; 2007. p 463-480.

Ruff D. October 2003; Doppler assessment: calculating an ankle brachial pressure index. Nursing Times. 99(42): 63-65.

UpToDate. Wolters Kluwer Health. Retrieved from: http://www.uptodate.com/home

Wikipedia – Burger's test, Stemmer's Sign

Winnipeg Regional Health Authority. Home Care Nursing Procedures Manual. Retrieved from: http://home.wrha.mb.ca/

Winnipeg Regional Health Authority. Regional Wound Care Clinical Practice Guidelines. Jan 2016.

Wound Ostomy and Continence Nurses Society. (Mar/Apr 2012). Ankle brachial index. Quick reference guide for clinicians. *J WOCN*, *39*(2S), S