

PERIPHERAL NEUROPATHY: VIBRATION PERCEPTION THRESHOLD

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PERIPHERAL NEUROPATHY: VIBRATION PERCEPTION THRESHOLD

1. Peripheral neuropathy background and rationale

Decrements in peripheral nerve function are known to increase both with advancing age and in the presence of diabetes mellitus. Since peripheral neuropathy (PN) involves both sensory and motor functions, PN may be associated with decrements in balance, strength and mobility, all disability-related outcomes that are central to the scientific objectives of Health ABC. Supporting a potential association between PN and various aspects of physical function in old age are several small studies in older adults that have suggested these effects. PN may be related both to performance tests and strength measures in the lower extremity, and are of equal scientific importance in older individuals with and without diabetes. Measures of PN in Health ABC include standard tests that have been used in other epidemiologic studies, and involve measurement of both sensory and motor nerve function. PN measurements are divided into three parts:

- Quantitative sensory testing (QST) of the great toe using the Medoc vibration device,
- Nerve conduction (NC) studies using the NeuroMax 8 to measure several parameters associated with the peroneal nerve, and
- Testing of loss of protective sensation using the monofilament.

QUANTITATIVE SENSORY TESTING

General description of vibration threshold testing with the Medoc VSA-3000.

Quantitative sensory testing is the use of precisely measured and repeatable sensory stimuli to determine the absolute threshold of sensation within specific somatosensory modalities. When properly performed, QST can increase the sensitivity and reliability of the clinical assessment of sensory function. The principal strengths of QST include simplicity, permitting testing by non-professional personnel, and the availability of mean and standard deviation values that are accurate and age-controlled. QST is especially recommended for rapid screening of large populations and/or for the longitudinal evaluation of participants. QST is a non-invasive, pain-free technique.

For QST in Health ABC, vibration perception threshold will be measured using the *method of limits*. In this quick method, the seated participant places the plantar surface of the right great toe on a small vibrating surface located on the measurement device. The vibration intensity increases from a defined starting point, until the participant ‘stops’ the stimulus by pushing a button on a hand-held indicator (‘clicker’) as soon as they perceive the vibration. The vibration is created by an electromagnet at a rate of 100Hz,

and the vibration increases by precise computer control of the voltage. The computer presents vibration amplitude in microns, the standard unit for this measurement. These values are calculated by the computer, based on a predetermined voltage-amplitude calibration table.

The method of limits is “time inclusive,” since it includes participants’ reaction time. The rate at which the vibration increases is set at 0.8 microns per second in order to reduce measurement error resulting from differential rates of increase. To administer the protocol, the participant needs to have their sock removed from the right leg, and the pant leg rolled up to the calf. The foot should be warmed to at least 30°C. Several trials are performed, and the mean of the peak values is taken as the threshold. The Health ABC protocol includes five trials to limit measurement variability.

The Medoc VSA-3000 Vibratory Sensory Analyzer is the device that will be used to measure vibration perception threshold in Health ABC. The Medoc is a portable device composed of a foot & hand support stimulator, a power supply, a hand-held ‘clicker,’ and Windows-based operating software. Data are stored in the computer, and will be exported to an IBM-compatible computer. The Medoc has numerous settings for vibration threshold studies. For Health ABC, the device will be set to use the “Method of Limits.” The vibrating rod on the Medoc is designed in order to provide a standard 50g force against the plantar aspect of the great toe, limiting measurement variability due to participant’s foot pressure on the rod.

2. Equipment and supplies

- Surface thermistor
- Medoc VSA-3000 Vibratory Sensory Analyzer
- Heating pad
- Laptop or desktop hook-up for data storage
- Alcohol wipes
- Lab towels (“plasback” or plain)
- Paper foot pads (Sahara exam paper)
- Bean bag
- Examination gloves
- Sani Wipes

3. Safety issues and exclusions

Participants are excluded if they are missing both great toes (e.g., both great toes have been amputated).

4. Participant preparation

The surface of the Medoc should be thoroughly cleaned with Sani Wipes between participants. Testing is done on bare skin on the center of the bottom of the great toe on the right foot. Have the participant remove socks, stockings, etc., and roll up pant leg to mid calf. Contraindications for testing on the right toe include amputation, ulcer, trauma, and surgery. If a contraindication is present, test on the left toe, and record on the data collection form why the right toe was not tested.

Prior to testing, measure the surface temperature of the dorsum of the foot with the surface thermistor (see figure below). The thermistor should be held approximately 4 inches from the foot.



Skin temperature should be at least 30°C. If the foot is below this temperature, use the heating pad (set at 107° F or 41.7°C) to warm the foot until it reaches 30°C, and record the second measurement on the data collection form. If you are unable to warm the foot adequately after 5 minutes, record the surface temperature on the data form and perform the test. Leave the fields for the second temperature measurement (called “Foot temperature following heating”) blank if the participant’s initial foot temperature was at least 30°C.

Prior to testing, participants should be given an opportunity to become familiar with the testing apparatus and with the expected vibratory sensations. During this period, the examiner can instruct the participant as to the way in which to place the foot on the vibrating rod. In addition to familiarizing the participant with the equipment and

testing procedure, the adaptation period will also allow the examiner to determine the Start Level, using the “Manual” protocol.

5. Detailed measurement procedures

Before testing the participant, ask the series of questions about leg cramps and neurologic symptoms on the Peripheral Neuropathy: Leg Cramps and Neurologic Symptoms data collection form in the Year 4 Clinic Visit Workbook.

Start QST Hardware

Click on WinTSA icon.

Wait for initialization.

After initialization, pick Vibratory Stimulator mode on the left of the screen at the bottom.

Click “Test (perform a test).”

Click “ADD” (for a new participant).

Enter only the acrostic, ID#, year of birth, gender and examiner ID#.

Click “OK.”

Click “Continue” twice until you reach “Program type” screen which includes “Levels,” “Limits,” and “Manual.”

Highlight “Manual” and click “Continue.”

Look at settings for the “Manual” test. Confirm that settings are as follows:

“Start” = “0.”

“Rate” = “5.”

“Destination” = “130.”

Begin preparing the participant for the test.

Script: “I need to make sure that your foot is warm enough to do this next test. I’m going to measure the temperature of your foot before we start.”

Script: “Now we’ll begin the next test. The vibration will start very softly and get stronger. As soon as you feel the vibration, push the button to indicate that you have felt the vibration. **(Show the mouse and indicate how to push the button.)** We will do this several times in a row. After you press the button, there will be a delay before the next vibration starts. Each time you feel the vibration, just press the button right away to indicate that you have felt the vibration. The vibration will stop immediately. Over the next few minutes, you may feel the vibration several times. Just try to pay attention to your toe, and each time you feel the vibration, push the button. Remember that we want to know when you first begin to feel it. If you don’t feel it we don’t want you to guess. Again, please close your eyes before we begin the test. Ready?”

Administer the test by clicking "Run." When last stimulation is felt, the examiner should record “Avg” and “Var” from the screen (upper left corner) on the data collection form. After the last stimulation, hit SAVE!

Note: If the participant does not feel the maximum stimulation (130 microns) after two trials, you may stop the test. Indicate on Question #26 on the data collection form (page 11 in the Year 4 Clinic Visit Workbook) that two trials were completed and that the participant was unable to feel the vibration. Go to the peroneal motor nerve conduction test.

After the test is completed, measure the participant’s post-test skin temperature on the dorsum of the foot, again holding the thermistor approximately 4 inches from the surface of the foot.

Record the foot temperature on the data collection form.

Record the number of trials that were completed on Question #26 (page 11 of the Year 4 clinic visit Workbook).

Record the results from the upper left corner of the computer screen, (AVG value) in microns, onto the data collection form (Question #27), in the field labeled, “Record average result from the computer screen.”

Record the variance (VAR value) from the upper left corner of the computer screen onto the data collection form (Question #28) in the field labeled, “Record variance from computer screen.” If the variance is 1000 microns or greater, flag for quality control.

Thank the participant.

- Attend Health ABC training session on measurement techniques
- Practice measurement protocol on other staff or volunteers
- Discuss problems and questions with local expert or QC officer

9.2 Certification requirements

- Complete training requirements
- Conduct exam on four volunteers, two of whom should be re-tested.
(Volunteers need not be age-eligible for Health ABC.)

9.3 Quality assurance checklist

- Main points of script correctly and clearly delivered
- Correctly warms foot, if necessary, before administration of protocol
- Correctly describes testing procedure
- Correctly demonstrates use of the mouse
- Conducts acclimation period / practice tests correctly
- Correctly collects four threshold measurements using the method of limits
- Correctly stores data in computer for subsequent downloading
- Reviews form for completeness following completion of test
- Acceptable test-retest results