PLETHYSMOGRAPHY
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COVERAGE:

Plethysmography modalities considered medically necessary:

Thoracic Electrical Bioimpedance (a type of plethysmography) is considered medically necessary for in-patient or out-patient hospital or office places of service as this technique replaces more invasive methods (i.e. thermodilution) when used to:

- establish a baseline status on a patient with heart failure (CHF), or
- monitoring patients with congestive heart failure.

Plethysmography Modalities considered NOT medically necessary:

While Plethysmography has been used to aid in the diagnosis of peripheral vascular disease, doppler/duplex ultrasound scan has become the method of choice and gives a more accurate and definitive diagnosis. Therefore, any of the following types of plethysmography are considered NOT medically necessary:

- Segmental Plethysmography;
- Electrical Impedance Plethysmography (other than Thoracic Bioimpedance – see above); and
- Venous occlusion plethysmography performed with a Strain Gauge.

Plethysmography Modalities considered experimental or investigational:

- Inductance plethysmography
- Capacitance plethysmography
- Mechanical oscillometry
- Photoelectric plethysmography
- Bionic plethysmography.

Total Body plethysmography is considered NOT medically necessary. Examples of non-covered indications include:

- residual volume, functional residual capacity and total lung capacity as more accurate methods such as pulmonary function tests are available;
- body water and/or fat composition or lean body mass using Bioelectric Impedance, Bod Pod or Tanita methods.

DESCRIPTION:
Plethysmography is the measurement and recording (by one of several methods) of variations in the size of an organ, body part, or limb reflecting the circulation of blood to that body area.

Plethysmography techniques include:

- **Segmental** - Included under this procedure are services performed with a regional plethysmograph, differential plethysmograph, recording oscillometer (measures changes in the volume of the arteries accompanying the heart beat), and a pulse volume recorder.

- **Dynamic venous** - the measurement of changes in limb circumference in response to exercise or passive compression of the limb.

- **Electrical Impedance** - a technique for detecting blood volume changes in a body part by measuring changes in electrical resistance. It is used in the diagnosis of deep venous thrombosis. Electrodes are placed around the calf and a pneumatic cuff around the thigh is inflated just enough to cause venous occlusion and then rapidly deflated. The drop in voltage is recorded (it is smaller in a leg with deep venous thrombosis than in a normal leg).

- **Thoracic Electrical Bioimpedance** - this is a non-invasive alternative for measuring cardiac output. Bioimpedance is defined as the electrical resistance of tissue to the flow of current. For example, when small electrical signals are transmitted through the thorax, the current travels along the blood filled aorta which is the most conductive area. Changes in bioimpedance, resulting from the pulsatile changes in volume and velocity of blood in the aorta, are inversely proportional to the stroke volume (cardiac output equals the stroke volume times heart rate). Bioimpedance relies on the same technology as plethysmography and only provides a regional measure of the thorax. Other non-invasive methods for measuring cardiac output are echocardiography, transesophageal echocardiography (TEE), and doppler ultrasound. The BioZ is a device approved by the U.S. Food and Drug Administration (FDA) that measures thoracic bioimpedance.

- **Venous occlusion** - (the oldest form of plethysmography) is time consuming, cumbersome, and requires considerable training to give useful, reproducible results. With this method a strain gauge is used in the evaluation of deep venous thrombosis and chronic venous insufficiency. The strain gauge is used to record changes in limb circumference employing a rubber tube filled with a conductive fluid. As the tube expands and contracts the resistance in the fluid changes in proportion to the circumference of the limb. The
instrument consists of a chart recorder, an automatic cuff inflation and deflation system, and a recording manometer.

- **Oculoplethysmography**—is a noninvasive cerebrovascular test that indirectly measures blood flow in the ophthalmic artery and reflects the adequacy of cerebrovascular blood flow.

- **Penile Plethysmography**—a non-invasive test for measuring the variation in the volume of the penis and in the amount of the blood present or passing through it. Refer to the Medical Policy on Evaluation of Impotence for coverage information.

- **Total Body plethysmography**—The following list is made up of different types of body plethysmography that are used for:

  1. measuring residual volume, functional residual capacity and total lung capacity. The patient sits inside an airtight box, inhales or exhales to a particular volume (usually functional residual capacity {FRC}), and then a shutter drops across their breathing tube. The subject makes respiratory effort against the closed shutter causing their chest volume to expand and decompressing the air in their lungs. The increase in chest volume slightly reduces the box volume (the non-person volume of the box) and thus slightly increases the pressure in the box. A calculation is made to determine the original volume of gas present in the lungs when the shutter was closed. Body plethysmography may be appropriate for patients who have air spaces within the lungs that do not communicate with the bronchial tree. In these individuals, gas dilution methods of measurement would give an erroneously low volume reading;

  2. body composition analysis (i.e., BOD POD Body Composition System) that measures whole body mass and volume, which are then used to estimate whole body density. The patient sits in a fiberglass cabin while computerized pressure sensors determine the amount of air displaced by their bodies. Once whole body density is measured, the relative proportions of body fat and lean body mass can be calculated using population specific equations which relate body density to body fat and lean tissue masses.

  3. **in vivo** (in the living body, referring to a process or reaction occurring therein) prediction of total body water, extracellular water and intracellular water using the bioelectrical impedance system.
NOTE: Another test frequently billed as total body plethysmography is Body Composition Analyzer/Scales (Tanita). A person’s height, age, and gender are entered and the patient steps on the scales. Within seconds, weight, body mass index and body fat percentages are displayed. If more in-depth results are desired such as hydration levels, fat free mass, basal metabolism rate, a separate software package is available. This type of analysis is not true plethysmography.

- **Photoelectric Plethysmography** – involves the measurement and recording of changes in the size of a body part by the circulation of blood to that body part to determine whether or not a pulse is present.

**Rationale:**

A variety of small case series have reported inconsistent results regarding the relationship between measurements of cardiac output (CO) determined by thoracic bioelectric impedance and thermodilution techniques. For example, Belardinelli and colleagues compared the use of thoracic bioimpedance, thermodilution, and the Fick method to estimate cardiac output in 25 patients with documented coronary artery disease and a previous myocardial infarction. There was a high degree of correlation between cardiac output as measured by thoracic bioimpedance and other invasive measures. Shoemaker and colleagues reported on a multicenter trial of thoracic bioimpedance compared to thermodilution in 68 critically ill patients. Again, the changes in cardiac output as measured by thoracic bioimpedance closely tracked those measured by thermodilution. In contrast, Sageman and colleagues did not recommend the use of bioimpedance as a postoperative monitoring technique for patients who have undergone coronary artery bypass surgery. In this study of 50 patients, there was only a poor correlation between thermodilution and bioimpedance, due primarily to the postoperative distortion of the patient’s anatomy and the presence of endotracheal, mediastinal and chest tubes. In a study of 34 patients undergoing cardiac surgery, Doering and colleagues also found that there was poor agreement between thoracic bioimpedance and thermodilution in the immediate postoperative period. The largest case series (the cost study) has been published in abstract form only. In this case series, estimations of cardiac output using thermodilution methods and thoracic bioimpedance were performed in 191 patients who underwent right heart catheterization for a variety of clinical indications. Linear regression analysis revealed an overall correlation of r=0.73. The authors concluded that cardiac output can be reliably measured with either thermodilution or thoracic...
bioimpedance, and that bioimpedance has the additional value of being noninvasive.

Inductance, Capacitance, Mechanical Oscillometry and Photoelectric plethysmography have not yet reached a level of development such as to allow their routine use in the evaluation of peripheral artery disease.

Color flow Doppler/Duplex ultrasound scans are newer and preferable methods of detecting a venous thrombus with an accuracy near that of venography. Doppler ultrasound has become the method of choice when scanning for venous occlusive disease. Plethysmography cannot detect deep calf venous thrombus.

Plethysmographic methods need to be validated in randomized, controlled, clinical studies that include long term outcome measures to evaluate the clinical effectiveness in the diagnosis of venous and arterial diseases.

PRICING:
None

REFERENCES:

• Belardinelli R, Ciampani N, Costantini C et al. “Comparison of impedance cardiography with thermodilution and direct Fick methods for noninvasive measurement of stroke volume and cardiac output
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DISCLAIMER:

State and federal law, as well as contract language, including definitions and specific inclusions/exclusions, takes precedence over Medical Policy and must be considered first in determining coverage. The member’s contract benefits in effect on the date that services are rendered must be used. Any benefits are subject to the payment of premiums for the date on which services are rendered. Medical technology is constantly evolving, and we reserve the right to review and update Medical Policy periodically.

HMO Blue Texas physicians who are contracted/affiliated with a capitated IPA/medical group must contact the IPA/medical group for information regarding HMO claims/reimbursement information and other general polices and procedures.