PROCEDURE

TITLE: NONINVASIVE HEMODYNAMIC MONITORING: IMPEDANCE CARDIOGRAPHY (BIOZ)

PURPOSE: To outline the nursing steps to apply impedance cardiography.

SUPPORTIVE DATA: Impedance cardiography (ICG) is a continuous, noninvasive method to obtain hemodynamic data (cardiac output, left ventricular preload, afterload and contractility) and assess thoracic fluid status.

EQUIPMENT LIST:

1. Impedance cardiography monitor.
2. Impedance cardiography monitor cable
3. Patient interface lead array
4. ICG electrodes
5. ECG electrodes
6. Thoracic-length measurement calipers (manufacturer dependent)
7. Blood pressure measuring device (to obtain systemic vascular resistance)

CONTENT:	PROCEDURE STEPS:	KEY POINTS
	1. Wash hands and don gloves	Reduce transmission of microorganisms; standard precautions
	2. Turn on ICG monitor, and enter patient data: A. Name B. Height and weight C. Adult D. Gender E. CVP (or use default CVP value) F. Blood pressure	Data are used to calculate hemodynamic parameters and indexed values, such as cardiac index and stroke volume index. A noninvasive blood pressure device may be **slaved** into the ICG monitor for automatic blood pressure and systemic vascular resistance (SVR) updates, thus making manual entry of blood pressure unnecessary. Data requirements may vary by manufacturer.
	3. Note the thoracic length calculated by the monitor.	A thoracic length is calculated based on patient height and will appear on the patient data screen. The thoracic length is important to ensure accurate electrode placement.
	4. Ensure that the patient is in the supine position with the head of the bed less than 30 degrees.	Flat position straightens torso and affords better exposure for accurate electrode placement. Options for patients who do not tolerate the nearly supine position include sitting upright at 90 degrees or standing position..
	5. Identify the landmarks for placement of the *upper thoracic ICG electrodes*. Place the *dot*, or sensing portion of the electrode in line with the ears at the junction of the shoulders and the base of the	Upper ICG electrode sets are placed to define the upper limit of the thorax. Dot portions should be placed 180 degrees opposite from each other to obtain the optimal signal and accurate measurements. Proper placement of dot portion at the juncture of the shoulder and neck is critical to accurate data acquisition. The

neck. Place the upper thoracic dot electrodes directly opposite from each other.	dot portion of the electrodes should not be placed on the sides of the neck. **NOTE:** The dot portions are placed below the ears in the location at the base of the neck, where a necklace would naturally rest.
6. Place the *strip* of current emitting portion of the upper electrode at least 5 cm above the dot portion.	Signal strength is improved by placing the strip portion at a distance greater than 5 cm above the dot portion of the upper thoracic electrodes. Increasing the distance between the dot and strip portions improves signal strength; thus placing the upper strips just below the ears or on the forehead will enhance the signal. Separation of the sending (strip) and sensing (dot) portions of the electrode allows greater distance between the dot and strip and maintains the minimum 5 cm separation if the patient bends his or her head and neck toward the shoulder
7. Not the proper thoracic length provided on the patient data screen of the monitor. Using the thoracic length caliper and keeping the ruled edge parallel to the spine, measure down from one of the upper thoracic dot electrodes to identify the position for the *lower thoracic dot electrode*. Place the *dot* (sensing) portion of electrode in the midaxillary line at the distance identified by the calipers with the strip (current-emitting) portion of the electrode below the dot port. **NOTE**: Thoracic length measurement is manufacturer dependent.	Lower ICG electrode sets are placed to define the lower limit of the thorax. The anatomic landmark for the lower thoracic dot electrodes is the point lateral to the junction of the sternum and xiphoid process. *Accurate thoracic length and electrode placement are critical for accurate stroke volume calculation.* Thoracic length that is too long due to placement of the lower thoracic electrode too low causes an overestimation of stroke volume and cardiac output, and vice versa, and all parameters can be affected by abdominal contents causing erroneous data. Alternate method for placement of lower thoracic electrodes; identify the junction of the sternum and xiphoid process, and place the dot (sensing) portion of the ICG electrode **directly lateral** to that point. This method may be difficult in some patient due to their anatomy, obesity or location of dressings; for example, over a sternotomy incision. Proper placement of the dot portion at the level of the sternal-xiphoid junction is critical to accurate data acquisition.
8. Repeat the thoracic length measurement with the caliper on the opposite side of thorax and place the lower ICG electrode.	Dot portions should be placed 180 degrees opposite from each other to obtain the optimal signal and accurate measurements. ICG electrodes are typically placed on opposite sides at the base of the neck and lateral from the sternal-xiphoid junction. Dressing or skin tears may necessitate rotating electrode placement to a more anterior to posterior position. If using an alternative electrode placement method, again locate the sternal-xiphoid junction and place the second set of lower thoracic electrodes **directly lateral to** that point, 180 degrees opposite the initially placed

	set.
9. Ensure accurate thoracic length and correct electrode placement on opposite sides of the thorax. (*Level V: Clinical studies in more than one or two different patient populations and situations to support recommendations)*.	Proper electrode placement is essential for acquisition of accurate hemodynamic and thoracic fluid status data.
10. If ECG electrodes are not integrated into the impedance electrodes, place the ECG electrodes in a led that produces an upright R wave.	An upright R wave is necessary for signal processing. The best leads for producing an upright R wave are leads II and V. Placing all three electrodes closer together on the chest may improve the amplitude of the R wave. If a pacemaker is in use, the R wave must be larger than the pacer spike. Be careful to not reverse the CG polarity, which would produce a downward R wave and upright S wave. The ECG obtained from the ICG monitor is not for diagnostic use, but is important for hemodynamic calculations.
11. Attach the upper ICG electrodes to the short patient leads and the lower ICG electrodes to the longer patient leads (black to black, white to white). Connect the ECG leads and ICG lead array to the monitoring cable and monitor.	
12. Observe dZ/dt wave form and ECG displayed on monitor.	Hemodynamic calculations depend on artifact-free ICG and ECG signals. DZ/dt should be >0.3 ohms. R wave of ECG must be upright.