Munroe Regional Medical Center
Ocala, Florida
Impedance Cardiography (ICG)
Competency Statement

1. List three general descriptions of ICG (Impedance CardioGraphy).
   - ICG is a noninvasive (safe) hemodynamic monitoring tool.
   - Data is analyzed and displayed graphically as an impedance waveform. (similar to an arterial pressure waveform, but based on volume and velocity of aortic blood flow, rather than pressure).
   - ICG detects and records changes in cardiac hemodynamic function using thoracic electrical bio-impedance technology.
   - ICG measures electrical resistance changes in the thorax.

2. Describe three ways in which ICG works.
   - ICG works by measuring changes in thoracic electrical bio-impedance over changes in time in relation to the cardiac cycle.
   - A harmless, low voltage, high frequency, alternating current is introduced through the outer sensors of four paired electrodes (placed bilaterally at the root of the neck & base of thorax).
   - The circular portion of the sensor/electrode is the transmitting sensor.
   - The rectangular portion of the sensor/electrode is the detecting sensor.
   - The difference between what is transmitted and what is detected is used to determine resistance or impedance to the current.
   - With a constant current and a change in impedance over time, the monitoring technology detects the baseline and changing properties of the conducting medium, blood flow through the thorax. These properties include inherent resistance of the conducting medium (thoracic contents) and the pulsatile changes due to blood flow.
   - With each heartbeat, changes in conductivity occur as blood descends, and then leaves the aorta. These changes are measured and recorded as impedance waveform, similar to the arterial pressure waveform but based on volume rather than pressure.
   - The ECG and ICG waveforms are simultaneously recorded and processed. The ICG parameters are measured and calculated. Algorithms are used to calculate or derive heart rate, stroke volume, cardiac output, indices of contractility, and indices of workload that are displayed on the monitor screen.

3. Identify three indications for ICG.
   - Differentiating cardiogenic from pulmonary causes of dyspnea.
   - Patients with the need for fluid management.
   - Patients with the need of determination for intravenous inotropic therapy.
   - Obtaining baseline data and monitoring patient response to interventions (i.e. fluid challenge, inotropes, surgery).
   - Pre-op / Post-op assessment of patients with suspected or known cardiovascular disease.
   - Physicians may use ICG to optimize atrioventricular interval for patients with AV sequential cardiac pacemakers.
   - Physicians may use ICG to optimize the timing (AV delay) in pacemakers.

4. List three contraindications of ICG.
   - **Minute ventilation driven pacemakers** – ICG interferes with this type of pacemaker causing tachycardia, which may compromise the patient's condition.
     RN MUST obtain MD order prior to conducting ICG monitoring on patients with a permanent pacemaker.
   - Severe aortic regurgitation - interferes with proper detection of flow and may provide unreliable data.
   - Severe septic shock – severe interstitial edema may impair accurate impedance detection and provide unreliable data.

5. List three conditions limiting reliable data.
   - HR < 40; > 250
   - Height < 4'0", > 7'5"
   - Weight < 67 lbs., >340

6. Name two nursing actions needed prior to obtaining ICG data.
   - Keep monitor plugged in and printer on to avoid warm up delays.
   - Provide patient teaching prior to proceeding.
     Explain the purpose of monitoring thoracic fluid and hemodynamic status.
   - Obtain the patient's vital signs and conduct a clinical cardiovascular assessment.
     This provides a clinical correlation to the measured hemodynamic parameters.

7. Demonstrate proper placement of sensors.
   - Prepare skin for sensor placement to clean and dry, hairless skin.
   - Alcohol or benzoin will impair senses.
   - Press the cable connectors to connect to the sensors. Connecting the cables to the sensors FIRST, prior to applying the sensors to the patient is easier for the RN and more comfortable for the patient.
   - Locate the Left and Right branches of the patient cables as indicated on the cable diagram and connect the respective leads in order from top to bottom:
   - BLUE, PURPLE, GREEN, ORANGE (Remember: B – P; G - O)
   - Proper location of landmarks and accurate sensor placement is ESSENTIAL for acquiring accurate hemodynamic and thoracic fluid status data!
   - Use the root of the neck as a reference point for positioning the rectangular neck sensors, aligning the bottom portion directly superior, in line with the ear lobe.
   - Place the neck sensor with the heart symbols is lower, closer to the heart ("heart to heart").
   - Avoid the trachea, bone, or central line dressings.
   - Use the xiphoid process as a reference point for positioning the rectangular chest sensors, positioning directly inferior and along the mid-axillary line.
   - The chest sensor with the heart symbol is upward, closer to the heart ("heart to heart").
   - Verify and secure the patient cable connection to the BioZ Monitor.

8. Perform ICG Hemodynamics:
   - Press “Start Monitor,” enter patient data: HUN number, name, gender, height, weight, age, BP, CVP (default value = 6), PCWP (default value = 10).
   - Default parameters must change by 300% to have a 10% change in SVR or LVSW.
   - Ensure the patient is supine, positioned with the head of the bed less than 30 degrees elevated.
   - Mark all readings with the degree of HOB elevation to insure accuracy and consistency.
   - Place the ECG electrodes in a lead that produces an upright R wave. Press “Vector” to change
   - leads. BioZ must sense 30 similar beats.
   - Set average lower in Afib, Pacers, LBBB
   - Observe ICG and ECG waveforms displayed on monitor.
   - Hemodynamic calculations depend on artifact-free ICG and ECG waveforms.
   - The patient must be lying still to obtain optimal calculations. Provide coaching and support.
   - Print the report: Press “Print”, select “Status Report” followed by “Complete Status.”
   - When monitoring is complete, press “Stop Monitoring.”

9. Describe three important concepts in analysis of ICG parameters.
   - Assess hemodynamic parameters for trends every 2 to 4 hours, following interventions and as needed. Recognizable landmarks on the impedance ICG waveform correlate with landmarks on the ECG waveform.
   - Assess baseline and trends in thoracic fluid content (TFC).
   - TFC does NOT directly relate to PCWP. When the amount of fluid in the chest increases and the PCWP increases, the TFC also increases.
   - Normal TFC: Men 30 – 50 / 1000 ohms
     Women 21 – 37 / 1000 ohms
   - Assess baseline and changes in preload by evaluating stroke volume (SV) response to interventions (i.e., fluid challenge).

10. Describe hemodynamic parameters derived from ICG:

- **Stroke Volume (SV)** - the amount of blood the left ventricle ejects in one beat, measured in milliliters per minute (ml/min). SV can be indexed to the patient's body surface area (BSA) to yield the Stroke Volume Index (SVI).
- **Cardiac Output (CO) –** the amount of blood the left ventricle ejects into the systemic circulation in one minute, measured in liters per minute (l/min). To obtain the CO, multiply Stroke Volume (SV) by the Heart Rate (HR). CO is best understood when indexed to the patient's body size by dividing CO by the BSA to yield the Cardiac Index (CI).
- **Systemic Vascular Resistance (SVR)** – represents the force that the left ventricle must pump against in order to deliver the stroke volume into the periphery. SVR is directly proportional to blood pressure and indirectly proportional to blood flow (CO). SVR is also indexed to the patient's body size to yield the SVRI.SVR = [(MAP - CVP) / CO} x 80.
- **Velocity Index** (VI) and **Acceleration Index** (ACI) **–** are parameters specific to the BioZ monitor. VI is the maximum rate of impedance change, and is representative of aortic blood velocity ACI is the maximum rate of change of blood velocity and representative of aortic blood aortic blood acceleration. (NOT reportable to the MD, not included in documentation).
- **Thoracic Fluid Content (TFC)** – TFC is also a BioZ specific parameter representative of total fluid volume in the chest, comprised of both intra-vascular and extra-vascular fluid. TFC is calculated as the inverse of the baseline impedance measurement. Baseline impedance is directly proportional to the amount of conductive material in the chest (i.e., blood or water).
- **Pre-Ejection Period (PEP) –** the measured interval from the onset of ventricular depolarization (ECG Q-wave) to the beginning of the mechanical contraction indicated by the ICG "B" point (the first up slope of the ICG waveform).
- **Left Ventricular Ejection Time (LVET)** – the time from aortic valve opening (ICG "B" point) to aortic valve closing (ICG "X" point).
- **Systolic Time Ratio (STR)** – is inversely proportional to left ventricular function, calculated as the PEP dived by the LVET.
- **Left Cardiac Work (LCW)** – LCW parallels myocardial oxygen consumption, and is the product of blood pressure and blood flow. LCW is also indexed by the BSA.LCW is determined with the follow equation: LCW – (MAP – PCWP) x SV x 0.0144.
- **Heart Rate (HR)** – number of heartbeats / minute, measured from the ECG, R-R wave.
- **Mean Arterial Pressure (MAP)** – determined by the following equation:

MAP = (SBP + 2x DBP) / 3

11. Name three potential interference problems and interventions to solve them to insure accurate ICG results.
    - ICG data does not correspond to the patient clinical presentation.
        - Verify correct sensor placement.
        - Check sensor contact with skin.
        - Check that leads are properly connected to all sensors.
        - Validate that patient height, weight, and other data have been correctly entered.
        - Update blood pressure or MAP to update the SVR calculation.
        - Update the CVP pressure in the ICG monitor if large changes (i.e., >10mg). have occurred in the CVP or the patient has become hypotensive.
        - Verify the BioZ and Patient Cable operation with the BioZ simulator (BioMed)
    - Excessive noise or 60 - cycle interference on the ECG or ICG monitor.
        - Check that the sensors are in direct contact with skin.
        - Assist the patient in lying still to eliminate possible motion artifact.
        - Avoid monitoring patient during shivering or seizures.
    - Display screen does not show ECG or ICG waveforms.
        - Check that "off" or "on" switches are activated.
        - Check that electrode sensors are in direct contact with skin.
        - Check that the leads are properly connected to sensors and ICG monitor.

12. Describe documentation requirements for ICG results include patient response.
    - Patient/family education and response.
    - Printout is noted with degree of HOB elevation and any vasopressor doses.
    - Printout is noted with patient clinical signs & symptoms.
    - Printout is noted with the name of any MD notified of the results.
    - Printout is noted with RN signature.
    - Printout is filed under Cardiac Tests in chart.
    - Hemodynamic parameters in Care Manager: Vital Signs (annotate "ICG).
    - Response to therapeutic interventions Example:
      Cardiac Interventions: Notified MD "SBP <90 x 45 min" Rx Fluid Challenge
      Intervention Response: ICG CI 2.8 up to 3.2 following 500cc fld bolus; SBP 92.
    - Any unexpected outcomes under Cardiac Interventions / Response.

Munroe Regional Medical Center
Impedance Cardiography
Skills Check List

Y: Functions Independently **Name:**_____
N: Requires Further Assistance **Unit:**_____

date / initial

1. Lists three general descriptions of ICG (Impedance CardioGraphy). **Y / N** _____
1. Describes three ways the ICG works. **Y / N** _____
2. Identifies three indications for ICG. **Y / N** _____
3. Lists three contraindications of ICG. **Y / N** _____
4. Discusses three precautions needed to avoid unreliable data. **Y / N** _____
5. Names two nursing actions needed prior to obtaining ICG data. **Y / N** _____
7. Demonstrates proper placement of sensors. **Y / N** _____
8. Performs ICG Monitoring. **Y / N** _____
9. Describes six important concepts in analysis of ICG parameters. **Y / N** _____
10. Describes nine hemodynamic parameters derived from ICG. **Y / N** _____
11. Names three steps to ensure accurate ICG results. **Y / N** _____
12. Describes documentation requirements for ICG results with patient response. **Y / N** _____

1st ICG performed (date): _____ Reviewed by: _____

2nd ICG performed (date): _____ Reviewed by: _____

Employee Signature:_____ Date: _____
Preceptor / Clinical IV:_____ Date: _____

Jal/ICG/skills list 7/2/03