HealthPartners

Subject		Attachments
ECG Acquisition Procedure		☐Yes ☒ No
Key words	ECG, EKG, MUSE	**Number** GHI-PC-CLINIC LAB-PROCEDURES-ECG Acquisition Procedure v. 12-2009
Category	Provision of Care (PC)	**Effective Date** **December 2009**
Manual	HPMG Clinic Laboratory Procedure Manual	**Last Review Date** **December 2012**
Issued By	Laboratory Administration	**Next Review Date** **December 2013**
Applicable	All HealthPartners Personnel who Acquire ECG Tracings	**Origination Date** **December 1997**
		Retired Date
Review Responsibility	Laboratory Technical Consultants	**Contact** Laboratory Technical Consultants
APPROVAL(S)	Laboratory Medical Director	

I. Purpose/Principle

This procedure provides direction and ensures standardization for the acquisition of quality ECG tracings. This will facilitate rapid identification of acute myocardial infarction and life threatening arrhythmias and prompt medical treatment for HealthPartners patients.

The Electrocardiogram (ECG) is a recording of the electrical impulses associated with cardiac contraction and relaxation. It records the amount of voltage generated by the heart, and the time required for that voltage to travel through the heart. When the magnitude of voltage, represented on the vertical scale, is compared with time, represented on the horizontal scale, the result is the familiar peak and valley pattern of the ECG.

II. Policy

HealthPartners medical staff provides ECG acquisition services for all clinics during clinic hours of operation.

An ECG is a critical component of patient care. The following are indications/considerations for an ECG:

- For patients without known heart disease, the ECG is used as a screening test for coronary artery disease (CAD), cardiomyopathies, or left ventricular hypertrophy (LVH) and is then used as a baseline for future reference and comparison.

- Preoperatively, an ECG is used as a diagnostic tool to rule out silent coronary artery disease or

potential life threatening arrhythmias. This is very important as the presence of any of the above indications can cause further complications during surgery, or post operatively for our patients.

- The ECG may also provide diagnostic information in the presence of electrolyte imbalances, such as hypercalcemia (elevated blood calcium), hyperkalemia (elevated blood potassium) and hypokalemia (low blood potassium).

- In patients with known coronary artery disease, the ECG serves as a baseline exam for providers to track progression in the patient's cardiac status. The ECG is invaluable in the evaluation and treatment of patients with a variety of cardiac conditions such as acute myocardial infarction, valvular and congenital heart disease or pericardial tamponade.

- Rhythm disorders can effectively be evaluated through an ECG rhythm strip. Using the ECG, the Cardiologist can view the heart's electrical conductivity from multiple angles.

- Evaluation of pacemaker function.

III. PROCEDURE

This procedure will be divided into 7 sections:

A. Equipment: MAC 5000 or MAC 5500
B. Patient Considerations
C. ECG Acquisition process
D. Reporting Process
E. Basic Troubleshooting and Maintenance
F. Quality Assurance
G. MUSE Database Overview

A. Equipment: MAC 5000 or MAC 5500

Each clinic has a MAC 5000 or 5500 Resting ECG Analysis System. The MAC 5000/5500 is able to quickly obtain an ECG and provides an approximate interpretation of the acquired ECG (unconfirmed ECG). The machine interpretation is useful for deciding when to emergently contact the patient's physician and can serve as a guideline for healthcare workers untrained in ECG interpretation. A definitive interpretation of the ECG is required by a physician or licensed provider (confirmed ECG).

1. **Components**
   a. Each MAC 5000/5500, in addition to the CPU (screen), has an acquisition module, lead wires, Silver Mactrode electrodes and heat sensitive paper. (Acquisition modules are not generic but specific to the MAC model.

   b. The acquisition module also has 3 buttons for ease in ECG operation. The first is the button to press to record an ECG, the second is to print a rhythm strip and the 3rd is to stop the writer from printing.

   c. Additional items required to perform an ECG
      - Disposable ECG silver electrodes (conductive-adhesive with tabs): Check that the expiration date on the pouch has not been exceeded. Always keep unused cards of electrodes in their pouch with the open edge folded down or in a poly bag and store in a cool, dry location. Initial and date the pouch when opening.
      - Thermal grid recording paper. Store in a cool, dry, and dark place. Temperature should be <80°F (27°C). Humidity is between 40-65%. Do not expose to sunlight

or fluorescent lighting.
- Plug-In leadwires (set of 10 without resistors).
- Alligator Clips (set of 10)
- MAC 5000: Computer Disk for Disk Drive
- MAC 5500 has an internal hard drive. It does not use an computer disk.
- 3M Skin Prep Tape contact Lawson # 026562
- Paper or cloth gowns that open to the front for female patients
- Alcohol preps and/or chloropreps

NOTE: DO NOT TRANSPORT BLOOD DRAWING SUPPLIES ON THE ECG CARTS!.

2. **Location of ECG Carts**:
   - Apple Valley, Arden Hills, Bloomington, Brooklyn Center, Como, Coon Rapids, Health Specialty 401, store their EKG Carts in their EKG room.
   - Cottage Grove and Health Specialty 435 store their EKG carts in the hallway outside of the laboratory.
   - Health Center for Women, Parkway, Nokomis, Eagan, North Suburban Clinic Lino Lakes, North Suburban Clinic Roseville, Riverway Clinic Andover and Riverway Clinic Elk store their ECG carts in the Care Unit.
   - Health Specialty Center Adult and Seniors Clinic has an ECG cart in their Procedure room on third floor.
   - Riverway Clinic Anoka has one ECG cart on first floor in the Care Unit and one ECG cart on second floor in the Care Unit.
   - St. Paul Clinic has a spare ECG machine for use when an instrument is down at any HealthPartners Clinic location.

3. **Marquette Software Menu Systems:**
   There are 2 models of Marquette ECG machines: Models 5000 and 5500. Most of the HealthPartners Clinics have the MAC 5000. The function key numbers may differ on the different MAC systems however, the function names will designate the actual function available.

   There are two methods for selecting a menu function (F)

   1. Press the function key directly below the appropriate function, or
   2. Press the arrow direction key on the arrow pad until the appropriate function is highlighted, and then press the middle of the arrow pad to select the highlighted item. (Selected items are highlighted in grey.)

   When the Power is turned on,
   MAC 5500: select “More from the start up screen in order to go to the “Main Menu.”
   MAC 5000: select “Main Menu” on the start up screen.

   a) Main menu: Overview Functions

   The Marquette MAC 5000/5500 Resting ECG Analysis System has menus that are used to execute the tasks required to perform, edit, transmit and delete ECGs.

- **Resting ECG**: This screen appears at the start-up screen and the Patient Data Button is highlighted when the instrument is powered on. Details of the resting ECG will be given in the following section of this procedure
- ***Pediatric ECG:*** Will not be used; machine bases its interpretation of pediatric ECG on the date of birth.
- **Vector Loops:** Will not be used. (This records a 15 lead "vector cardiogram.")
- **File Manager:** Electronic File Cabinet which houses stored ECG's and will be covered in a section below.
- **Receive:** Will not be used. (This receives ECG data from other devices.)
- **More:** Used to go to additional functions or return to the previous menu
- **System Setup:** Defines system's set-up items; The password to access is: SYSTEM
- **Utilities:** Will not be used.
- **Remote Query:** Will not be used.
- **Order Manager Interface:** Used for retrieving (downloading) orders from the MUSE database. See Section III.C.2, "Downloading Orders from the MUSE CV System," (pg 10.)
- **Return:** Returns you to the previous screen before you selected "More".

Keyboard Descriptions:

- **Power switch:** Powers the system on or off
- **Function Keys:** Selects screen menu functions
- **Delete:** Erases typed characters
- **Copy:** Prints another ECG report
- **ECG (Green Key):** Records and ECG. Press to acquire a resting ECG
- **Rhythm (Green Key):** Prints continuous ECG data
- **Stop (Red Key):** Stops the writer from printing
- **Arrow Pad:** Moves the cursor left, right, up or down. Press the sent to select a highlighted menu or screen item
- **Return:** Enters information into the system
- **Information:** Provides additional user information
- **Space Bar:** Adds a space between typed characters or highlights screen items
- **Option:** Not functional at this time
- **Esc:** Returns you to the previous menu
- **Shift:** Creates a capital letter

**It is important to remember not to change any settings that you have not been trained to change.

b) Resting ECG

Selection of "*Resting ECG*" from the *Main Menu* will bring you to a Secondary Menu under "*Resting ECG*:"

"*Patient Data*" , when information is manually entered, it is necessary to complete prior to attempting to record an ECG. For a routine ECG, always fill in a patient ID number, Name, Birthdate, Location and tech code. For "STAT" ECG's, at a minimum, enter name and chart number, if possible.

Choosing "*Patient Data*" may initially prompt the user to use the *previous patient's information*. If you are performing an ECG on the same patient, you can select the "same patient" option. Otherwise, select "next patient". A box may open displaying names asking if you would like to select one. Either select a name or select cancel. A patient identification box opens and you can manually enter the needed patient

information..

Clerical accuracy is important. The Cardiology MUSE database system depends on accurate information to retrieve the patient's correct previous ECG. Inaccurate information will delay or prevent this process. In addition, the tracing will not be visible in Epic if inaccuracies are present. Order downloading is always advised to prevent these problems. The patient data form will include information listed in Section III.C.3 (c), "Manually Entering an Order into ECG Cart" (pgs 11) below.

Speed, Gain, and Filter settings should not be changed unless requested by the physician. .

More
More takes you to another menu, in which "*Pace Gain*" should not be used. "*Main Menu*" takes you back to the Main Menu and "*More*" will also take you back to the Main Menu.

c) Marquette Software File Manager Menu

This feature is the "file cabinet" of the system. It contains all of the ECGs that have been acquired on the machine until it is deleted off the File Manager.

Information from EPIC always overrides information manually entered in the ECG cart. So, if the patient name, chart number, birthdate, or order number is manually entered incorrectly into the ECG machine, it can be corrected on the cart before transmitting to MUSE or it can be corrected in MUSE. Uncorrected name/PID information will give an error message in MUSE indicating there is missing or mismatched information. These must be resolved in MUSE before the ECG is merged and confirmed. Provider information comes from EPIC. The EPIC provider will override any provider that comes from the ECG machine. Most of the ECG machines are set up to automatically transmit the ECG, once performed, into MUSE. However, if possible, edits to ECG tracings can be performed prior to MUSE transmission

Before an ECG is transmitted to MUSE, information can be edited or tracings deleted in the File Manager
To access the File Manager options, select from the list of options above the "F" keys at the bottom of the screen. The File Manager opens to another menu with options F1-F6.

1. Select: Function used to select desired patient(s)
2. Select All: Allows selection of all stored ECG's on the cart
3. Report Set-up
4. Directory: List of ECG's stored on the cart.
5. Location
6. Main Menu

Select: Allows you to scroll through the ECGs available by turning the arrows on the arrow pad. When the correct ECG is found and highlighted, the arrow pad should be pushed down toward the machine to select this ECG. The patient is selected when the line is grey. Another menu will appear at this time with options F1-F6.

1. Print: Press to print a copy of the selected ECG
2. Edit: confirms that this is the ECG you want to edit.
   Once *"Edit"* is selected, another menu will appear in the center of the monitor. The following choices will be available:

- **Patient Information:** (Select this to edit any patient name, ID, Birthdate & gender information)
- **Medications: (not to be used)**
- **Test Information:** Select this to edit referred by, technician, order number and location information
- **Questions:** Edit Diagnosis or comment information
- **ECG Measurements** (not to be used)
- **Diagnostic Statements** (not to be used)

3. Display: Shows ECG tracing on the screen
4. Transmit: Use to transmit ECG's into MUSE
5. Delete: Use to delete ECG's from the cart.
   - The instrument prompts for a password: SYSTEM
   - The following message displays: Warning, you have selected files for deletion. This is the only warning you will receive. Do you want to delete these files? Select Yes or No from the function keys below the response.
6. Return

4. **Order Manager Interface**

This feature is used for acquiring, downloading, printing and storing of ECG orders received from a MUSE CV system with a hospital information system (HIS) interface. The use of the order manager interface to obtain orders from MUSE greatly reduces the chance of mistyped patient information. See Section III.C.2, "Downloading Orders from MUSE CV System," (pg. 10).

5. Basic Set Up

System Set Up

System Set UP houses the programming for the ECG instrument. A Password is required to access System Set UP: **SYSTEM** System set-up opens to the following list of options:

Basic System
ECG
Print Set-up
Save Set-up
Restore Set-up
Main Menu

With the exception of Daylight Savings Time changes, System Set-up should not be used unless directed by Regions Biomed, a Laboratory Technical Consultant or the IS&T Helpdesk.

a. Time Changes Setup

Transition to Daylight Savings Time and back to standard time requires a manual time change in the ECG machines. All machines must be updated whenever we fall back or spring forward.

To change the time on an ECG machine the steps are as follows:
Entering is done with the center dot on the middle of the Arrow Keypad.

From the Main Menu, select "More"

1. Select "*System Setup*"
2. Type SYSTEM for password, Enter
3. Select "*Basic System*," Enter
4. Scroll down to *Date and Time*

5. Scroll down to *Current Time*
6. Highlight "*Hour*" and type in correct Hour, Enter
7. Select *Return*
8. Select *Return*. Heading should now read "*System Setup*."
9. Scroll down to "*Save Setup*."
10. Select "*Save to System*," Enter

b. Loading paper

The prelude to the low paper warning is the red streaking along the bottom of the last few ECGs. The machine's lack of paper does not mean that the ECG you acquired was lost, the machine will save it until you are able to reload the paper. The following steps are necessary to reload the paper in the ECG machine:

1. Depress the square "Internal Access" button to release the lock and open the writer door.
2. Remove any remaining sheets of paper still inside the machine.
3. Obtain refill paper in a side bin of the machine.
4. Remove outer cellophane wrapper form the paper and discard the cardboard backer.
5. With the vertically elongated circular "cue" hole in the upper left corner, (the corner closest to the Internal Access button), carefully insert the entire stack of paper fully into the machine. The paper is heat and pressure sensitive, and excessive scraping will cause streaking.
6. While holding the top sheet centered outside the paper door, close the door carefully so that the sheet does not rip.
7. When the door is fully closed, press the "Record ECG" button on the keyboard to indicate to the machine that the paper is loaded.
8. If the sheet rips or is excessively off-center and wrinkled, open the paper door again and repeat steps 6 and 7. If the paper is not positioned properly, the paper will not stop in the correct position for your report.

B. PATIENT CONSIDERATIONS

1. **Patient Identification**

Misidentification of patient can result in serious injury or death to a patient or several patients and creation of new and duplicate files in MUSE.

a) Prior to acquiring the ECG, each patient must be positively identified according to the Workflow Guidelines, by verifying patient name and birthdate with the paper order transmittal or labels.
b) If the patient is unable to read the labels, ask the patient to state his or her full name and birthdate for verbal verification. (Never ask if their name is "xxxx" as many patients will answer to any name.) A family member may also provide this information.
c) Verify patient label with patient information downloaded or manually entered into the ECG machine.

2. **Pediatric Considerations** (Pediatric patients are defined as those under the age of 17.)

a) Children

There are relatively few children who have had ECGs ordered. They may be very frightened by this procedure. Simple explanation will be the best tool for cooperation. Typically a child over one year old can be convinced that the test will not hurt, and that you are only "sticking stickers" on them. Let them feel the stickers if that would be helpful. You may have to be imaginative with your pediatric approach, but usually you will be able to acquire the ECG.

If all else fails, and the child is kicking, screaming, and thrashing and you are unable to wait it out with the leads on, you will have to let the patient's nurse/provider know that you are unable to obtain an ECG at this time. Credit the ECG in both EPIC and Sunquest.

b) Infant, Neonate, and Premature Infant

These children are too young to understand, and someone holding the baby might make it easier or make them calm enough to acquire an ECG.

c) Variations in Process with Pediatric Patients

- Cut the ECG electrodes with the scissors on the cart. Cut them in half, lengthwise, so that when they are applied they will not touch each other.
- All pediatric ECGs need to be manually faxed to Children's Heart Center. Fax cover sheets are prepared for this purpose in Lab.

3. Patient and Site Preparation:

- When possible, all patients should be offered the option of having a same gender technician perform his/her ECG.
- The patient should remove all clothing from the waist up. Female patients should be offered a paper gown which opens to the front.
- Ensure that the patient is lying comfortably with limbs extended and resting on the ECG bed.
- Gloves must be worn when patient skin is not intact, i.e. the patient has dermatitis, open sores or draining lesions.
- Per manufacturer, **Careful skin preparation is the key to an interference-free ECG**. Recommended procedures are:
  - Gently rub/abrade the area thoroughly to remove dead skin cells and assure good contact.
  - Thoroughly cleanse site with alcohol or mild soap and water to remove all oily residue, dead skin cells, or excess prep material.
  - Dry the skin completely.
  - Shave hair from electrode application sites.

- Before starting the procedure, make sure the patient is comfortable and relaxed. ---Cover the patient with a blanket if the room temperature is uncomfortable.
- Turn off cell phones.
- Remove hose/nylon stockings, if possible.

4. Additional Patient Considerations:

a) Maintaining the Patient's Dignity and Privacy

In order to perform an ECG with a minimum invasion into the patient's privacy a few guidelines must be followed.

- **Make sure curtains are closed** so that the patient is not concerned about non-medical personnel invading his/her privacy. Close blinds on windows to the outside and turn off lights if possible. Brightness can also cause AC "noise" and indirect muscle artifact.

- **Keeping as much of the patient covered as possible**. A cloth or paper gown which opens to the front is available for the female patient. A towel or sheet can also be used to augment any other means used to cover an exposed patient.

- Sensitivity is required for precordial (chest) leads for female patients. Many women are particularly sensitive about having their nipple/areolar region exposed. At a minimum make sure this area is covered.

- When lifting a woman's breast, use the back of your hand instead of cupping the bottom of the breast in the palm of your hand. Standard practice is to not place leads on top of the woman's breast.

b) Unable to lie flat:
If you encounter a patient who is unable to maintain the optimal supine (fully reclined) position, simply note in the comment field, "Best Possible, Patient Upright." This will indicate to the over-reading provider that this ECG was not obtained under ideal circumstances, and this may need to be considered in his/her analysis.

c) Wheelchair Patient:
If you encounter a patient who is in a wheelchair and the ECG is performed on the patient while in the wheelchair, simply note in the comment field, "Wheelchair Patient." This will indicate to the over-reading provider that this ECG was not obtained under ideal circumstances, and this may need to be considered in his/her analysis.

d) Uncooperative Patient
There are times that a patient simply will not be able to understand what you are doing, or they may object to having any further medical procedure done. An ECG cannot be performed on an uncooperative patient. You may say
- "*These tests are important for your health care, but you do have the right to refuse. I will let your nurse/provider know, thank you."*
- The ECG needs to be released from EPIC into Sunquest. Credit the ECG in EPIC and Sunquest according to the credit process.

e) Obese Patients:
When unable to feel intercostal spaces, measure from the collarbone to sternum and put sensors approximately halfway. Do the best possible. Note "Obese Patient" in comment field.

f) Patients wearing a Halo:
Patients wearing a metal and plaster cast in conjunction with a broken neck will make placement difficult. There may be room for your fingers to feel lightly underneath the cast. Do placement as best you can and note that sensors will be lower than usual compared to other patients. Note "Patient wearing halo" in the comment field.

g) Bandaged Patients:
Do not take bandages off patients. Only a direct patient caregiver is to do this. Note "Bandages" in the comment field.

h) Medication Patches:
Do best possible with lead placement and Note "Medication Patches" in Comment field.

5. Outside Patient Orders:

Place the order in EPIC. If the provider is not in EPIC, do one of the following:
- Get permission from a clinic provider to use them as the ordering provider
- Can use the clinic's Doc of the Day as the ordering provider
- Follow the Outside Provider Process to obtain an HMO provider number to enter the

order in EPIC.

Release the order through a lab appointment and proceed using our regular process. Use the regular process to edit and confirm the ECG. ECG's can be read by a clinic provider, Regions Cardiology or Children's Heart (if pediatric patient). Follow faxing instructions as indicated on the paper requisition

C. ECG Acquisition Process

Patient information can be entered into the ECG cart by downloading the ECG order from EPIC or manually entering the patient information into the ECG cart. Downloading orders from EPIC greatly reduces the chance of mistyped patient information. Always download if possible.

1. Equipment Preparation

a) Press "Power" to turn on the system.

- If the system starts up without displaying error messages, the system is operational.
- If the system displays error messages, turn the power off, then on again. If error messages persist, follow the process described in Section III.E below for Biomed notification (pg. 16).

b) Always check for proper lead wire connection on the machine "acquisition module." Improper connection will cause inaccuracies in the ECG. Trace each individual lead wire from its acquisition module label to the colored connector.

2. Downloading Order from MUSE CV System

a) **Access Main Menu**: using arrow pad; Select "**More**" if needed within the Main Menu until you reach "Ord Mgr Int."

b) Select "**Ord Mgr Int"**:. The Order Manager Interface opens.

c) **Select "Load Orders"**. If there are any orders currently stored in the cart, the following message will appear: "There are orders in storage. Before loading new orders, select whether you want to delete all the old orders or append the new ones."

d) **Choose** one of the following:

- If the orders on the cart have a "*" by them, the ECG order has been used. Select "**Delete All**" or "**Delete**".
- If the ECG orders on the cart have not been used, select "**Append New**."

e) **Location**: Type in the department location code(s) you want orders for, separating locations with commas if there are multiple locations. (Example: 46, 47) Press "Enter."

f) Several messages will appear during the downloading process: "Waiting to connect," "Establishing network connection," and finally a horizontal bar with "Receiving."

g) Highlight the patient or patients you need.

h) Select **Load orders** to bring over one or more patients by selecting all the orders you want to download. Selected ECG's return to Order Manager Interface with a list of the orders.

i) Select the patient by highlighting the order you want to start with and "Select". Verify that this is the correct patient.

j) The following message will appear: "Order # xxxxxxxxx for Patient last name, patient first name, Patient #xxxxxxxxx has been selected. Press either "CONTINUE" to run a test or "CANCEL" to select a different order.

k) **Continue**: takes you back to the Resting ECG Screen and the Patient Data Box is open.

l) **Patient Data Box**: Confirm Name, Chart# and Birthdate.

m) Enter initials of performing technician. Some clinics also want the diagnosis code

entered because it is helpful to the provider when reading the unconfirmed ECG.

n) Comment: Include any comments that may provide important information to the provider.

o) **Return** to open the Patient Data Screen

3. Manually Entering an order into ECG Cart

Whenever possible, before performing the ECG, an order should be placed in EPIC. Never transmit the ECG into MUSE without a patient order in EPIC.

a) From Main Menu go to Resting ECG from which F1 will open the Patient Data window - or - after powering on, MAC 5000 will display "**Patient Data**" as F1.

b) Select "**Patient Data**." A window opens to enter the manual order.

c) Enter the patient data.

- **Last Name** (transposed from the order transmittal)
- **First Name** (transposed from the order transmittal), with **Middle Initial,** if possible.
- **Healthpartners ID Number** (found directly under the name, with a leading "0" added to make this a 9 digit number.) The HP number "drives" all ECG MUSE functions.
- **Date of Birth** (request as day/month/year, 00/00/0000)
- **Gender** (Male or Female) Not needed.
- **Height/Weight:** Not Needed
- **Medications:** Not Needed
- **Referred By** ("Authorizing provider" on the order transmittal) Not needed if there is an Epic order available. May be used in clinics where the provider is given the ECG printout from the ECG machine.
- **Technician** (tech initials)
- **Order Number** (8 digit number on the order transmittal.)
- **Visit Number:** Listed as Encounter Number on ECG Requisition form
- **Location**: Should automatically default to the location. If it doesn't, it must be entered.
- **Diagnosis**: Not needed if there is an Epic order available. Some clinics add it because it provides information to the provider when they are reading the ECG.
- **Comment** (use this section to record any pertinent information, negative or positive. Use it to explain why an ECG might not be optimal.)
- **Return** (selecting this will bring you back to the Resting ECG menu, however now the patient's information will now display at the top of the screen)

4. <u>Electrode (Lead) Placement:</u> See Appendix A: Lead Placement Diagram

Chest leads require precise and proper placement in order to record accurate pictures of the heart. It is imperative that you know the correct six positions. Intercostal means "between the ribs", so the first intercostal space is between the first and second ribs. It is NOT between the clavicle (collar bone) and the first rib.

Notes for lead wire connector position:

- Positioning the lead wire connector in the gel may compromise trace quality or cause lead failure. Be sure to make connection with the non-gelled tab of the silver mactrode.
- Avoid crossing lead wires, which may cause wrong placement.
- Place the Acquisition Module on a clean towel so that there is no contact with the patient or bedding.
- Trace the colored connector from the Acquisition Module to the proper electrode to ensure it is matched to the correct label location.

12 Lead ECG electrode placement location is as follows:

- **V1** Fourth intercostal space at the right border of the sternum. **Finding this is key. If V1 is incorrect, others will also be wrong**.
- **V2** Fourth intercostal space at the left border of the sternum.
- **V3** Midway between locations V2 and V4. Place V4 first in order to correctly locate V3.
- **V4** At the mid-clavicular line in the fifth intercostal space.
- **V5** At the anterior axillary line on the same horizontal level as V4.
- **V6** At the mid-axillary line on the same horizontal level as V4 and V5.

Press a disposable electrode pad to each of the six chest positions according to the listing below. Then connect the chest leadwires (V1-V6) to their corresponding chest electrodes.

Press a disposable electrode pad to the corresponding limb leads described below. (RA=right arm (white), LA=left arm (black), RL=right leg (red), LL=left leg (green)

Right (R) and Left (L) are the <u>Patient's</u> right and left. (This is <u>opposite</u> the (R) and (L) of the person doing the ECG.)

RA and LA: Traditionally placed anywhere on the arm; alternate placement to reduce muscle artifact is midway between the elbow and the shoulder.

RL and LL: Traditionally placed a few inches above the ankle; alternate placement (will be rare) to reduce muscle artifact is on the upper leg as close to the torso as possible. If the lower extremity leads must be placed on the lower torso, this must be noted in the comment section of the ECG. Legs must remain uncrossed.

Note: Cases such as amputation or thalidomide birth defects will require lead placement on any non-bony prominent part of the extremity, or in a case of hemipelvectomy the LL and RL leads can be placed on the lower abdomen.

5. Acquiring ECG Data:

a) Routine ECG

Note: Prior to recording an ECG, the patient's name should be in the left corner of the screer

- The patient should be fully reclined for optimal results.
- The path to acquire an ECG is Main Menu → Resting ECG → Patient Data Screen
- The ECG is run when the Resting ECG option is opened and the Patient Data Screen is on the screen.
- Allow the ECG rhythm to straighten out (waves are not going up and down like hills.) When a satisfactory ECG tracing, with a flat baseline and little to no interference, appears on the ECG machine monitor, press and release the "Record ECG" button on the upper right corner of the keyboard. The monitor will display a static view of the recorded ECG.
- If this static view still appears satisfactory, press "*Continue*". If the static view is unacceptable, "*Cancel."*
- The monitor will again display the current dynamic rhythm. Press the "*Record ECG"* button twice when a satisfactory tracing is displayed.
- Press "*Continue*" (MAC 5000) or "Stop" (MAC 5500) to print and store the ECG

tracing.

- If during the analysis, the ECG machine prompts you to choose an alternate gain setting because the QRS complexes are too large, choose 5mm/mV. The machine will then print the ECG with the new gain setting. Circle the 5mm/mV at the bottom of the ECG tracing to indicate to the physician that the ECG is actually twice this size.

Completion of the ECG process

- ***Do not remove the leads from the patient until after the ECG has printed to ensure that the analysis does not include "Poor Data Quality" or "Suspect Limb Lead Reversal."*** If either of these statements is included, check all electrodes and leads and avoid crossing lead wires. The ECG must be redone, and the original should **not** be transmitted into MUSE. If it is transmitted to MUSE, it can be removed in MUSE.
- After confirming correct limb leads placement, if "Suspect Limb Lead Reversal" is still in the analysis, edit the ECG to state, "Limb leads confirmed" in comments.
- ***Always check the patient name and ID number after each procedure, against the ECG tracing obtained.***
- Remove all electrodes. (The gel adhesive will turn to gum and be very difficult to remove). This may easily damage a patient's intact skin.
- If multiple patients' orders were downloaded, press "Next Patient" and the list you downloaded will come back on the screen for you to select the next ECG order.

b) Rhythm Strips

- To obtain a rhythm strip for a patient, connect all leads as you normally would for a resting ECG. Advise the patient that s/he must remain still and quiet for a more extended period of time than a typical 6-second ECG strip.
- When a satisfactory ECG tracing, with a flat baseline and little to no interference appears on the ECG monitor, press and release the "*Record Rhythm*" key.
- The machine will continue to record the rhythm until the Stop key is pressed. Each page of ECG paper contains 11.2 seconds of information, at normal speed. Six pages of rhythm will be sufficient to obtain a one-minute rhythm strip. Rhythm strips can only be printed, not stored or transmitted to MUSE.
- Check the clock on the screen.
- If coughing or moving interrupts the rhythm strip, it will need to be repeated.
- The provider should write their interpretation on the Rhythm Strip. Date and sign it.
- Send the pages to scanning.

6. Artifact Elimination See Appendix B: ECG Machine Troubleshooting

Important Note: The manufacturer guideline is to abrade and cleanse every patient. This will have a significant impact in reducing artifact.

- Sometimes moving the extremity leads closer to the body will eliminate artifact.
- A loose electrode can also cause artifact.
  -If the artifact is primarily in Leads 1 and 2, check the patient's right arm.
  -If the artifact is primarily in Leads 1 and 3, check the patient's left arm.
  -If the artifact is primarily in Leads 2 and 3 check the patient's left leg.
  -If the artifact is in I, II, III, aVR, aVL, and/or aVF the artifact will be coming from one of the extremity leads.
  -If the artifact is only in V1-V6, the source of the artifact will be at that/those leads.
  -If interference is still a problem, straighten out the lead wires, and lay them flat along the contour of the body to prevent them from conducting AC electrical interference.
  -If you are still unable to eliminate the artifact, make sure that there are no

unnecessary appliances on in the room, for example fans, radios, TV, cell phone, etc.

a) Muscle tremor or movement. This is the most common form of artifact.
- Providing a blanket can help alleviate shivering and may stop some of this type of artifact.
- Brightness can also cause AC "noise" and indirect muscle artifact

b) A "TENS" (Trans Cutaneous Electrical Nerve Stimulator) Unit or other electrical units may be causing "60 cycle" artifact.

c) Inability to remove artifact:
If, after attempting all steps to remove artifact within reason, there is still artifact, type "Best Possible" on the comment line, and record the best tracing that can be obtained.

7. "STAT" ECG

Note: When there is a STAT EKG request, always take direction from the provider.

Information for the ECG should be downloaded into the ECG machine prior the acquisition of the ECG whenever possible. If the ECG is needed emergently and patient information is manually entered, enter the patient name and chart number. Before the ECG is transmitted into MUSE, an order must be placed in EPIC and released. If the patient information was manually entered into the cart, the ECG order must be merged in MUSE. If the provider requests a STAT interpretation from cardiology, transmit the ECG and call Regions cardiology at 651-254-1419 with this request. Give this person the information concerning the stat over-read such as patient name, clinic location and where to contact the provider. Print a copy of the ECG to Regions Result printer. A Cardiology Tech at Regions will follow through, making sure that the ECG is read, confirmed and called to the provider.

Steps to perform a STAT ECG when information is manually entered:

1. Press Power on
2. Press Patient Data
3. Press Cancel
4. Data Screen appears:
   Enter minimum information:
   - Medical Record Number
   - Name
5. Arrow down through remaining selections. Use the circle key with the right, left, up and down arrows. (If you press enter, either the key or the inside of the circle, you get stuck on birthdate)
6. Run ECG
7. Go to File Manager to update remaining patient information, location and tech number
8. Transmit

D. Reporting Process:

1. Courtesy Call Interpretations:

Adult Patients:

The following Adult Interpretive Statements should be called immediately to the provider or nurse. Follow the same procedure as the Critical Call Policy.:

- Complete Heart Block or 3rd degree A-V block

- Myocardial infarct, acute
- Mobitz type 2 AV block
- Tachycardia >120 beats/minute
- Bradycardia <40 beats/minute
- Injury (synonymous with heart injury)

The patient should be asked to remain in the clinic until his/her provider has reviewed the results. Enter a PHON1 in the computer, documenting who and when you gave the critical results to.

For clinic labs that open before providers and nurses are in the building, and there is an ECG with an instrument generated "critical" interpretation, do one of the following:

- If the patient is in distress, call 911.
- If the patient is not in distress, call the CareLine at 952-883-5883. They can provide the name and number of the Provider on call. Call this provider for direction.

Pediatric Patients:

The following Pediatric Interpretive Statements should be handled as critical values for patients 0-17 years:

- Complete Heart Block
- Supraventricular tachycardia
- Ventricular tachycardia
- Tachycardia >200 beats/minute
- Bradycardia <40 beats/minute

2. **Paper Tracing:**
The ECG tracing is performed and prints on the ECG machine.
The ECG is transmitted into MUSE.
Option 1: MUSE is set up to print the ECG along with the first previous, if available. These are given to the provider to read.
Option 2: Provider is given printout from the ECG Cart.
Provider reads ECG, making changes in the interpretation, if applicable, and writes them on the printout.
ECG is returned to the lab.
Lab edits and confirms the ECG in MUSE.

3. **Results in EPIC:**
An order number is required for the ECG to be visible in the patient medical record in EPIC. To get this order number, an order needs to be entered into the patient medical record and the test released through an appointment.

Order Number and a Visit Number are obtained by:
1. Downloading the patient information from EPIC into the ECG Cart. This is the method we should ALWAYS use unless EPIC or MUSE is down or there is an Emergency. When we download:
   a. All patient information is correct
   b. There is an order number and a visit number making sure that all workflow is correct.
   c. The preliminary report is visible in EPIC and is overwritten upon confirmation so there is always just one report in EPIC per order.
2. Manual Entry with a valid order released through an appointment:

a. The order Number, if entered on the cart from the white sheet, will be visible as the order number in MUSE. You will be able to click on it to merge the order and visit number. Beware of clerical errors which prevent the ECG from filing to EPIC and billing correctly.

3. Manual Entry with no order/appointment:
   a. Since a valid order number isn't available, MUSE generates a pseudo order number so that the preliminary ECG can be viewed in EPIC. This number looks the same but it is not an actual order number. It cannot be merged to the visit and it cannot be used for billing. This preliminary ECG will never be overwritten in EPIC upon confirmation. There will always be multiple ECG reports for the same tracing in EPIC.

4. <u>Over Reading ECG's:</u>

a) Adult ECG's:

Each ECG has a machine generated interpretation and must be over-read by a physician**.** Family Practice and Internal Medicine providers read and interpret their own ECG's. Urgent Care providers, most Advanced Practice providers, Specialty Care providers and outside providers generally do not.

1. The completed ECG, along with the first previous when available, is usually given to the ordering provider for over-reading. If an ECG is ordered from an outside provider, Urgent Care, APP or Specialty Clinic who does not read their own ECG's or the provider is not at the performing clinic, send the ECG to Regions Result Printer in Regions Cardiology, along with the first previous, if available.
2. The first previous is the ECG that was run before the current ECG. Sometimes , in order to get a good tracing, an ECG is run several times. It is difficult to stop the transmission so the first previous can be a minute or to earlier than the current. When this happens, the ECG's that were unacceptable, should be deleted from MUSE and a new serial comparison should be run. See MUSE Procedure.
3. The physician who is over-reading the ECGs will accept or edit the diagnosis made by the machine and initial this copy. This copy is returned to the lab for editing. The "Editing Lab" will confirm ECG by inputting over-reading physician name on the ECG in MUSE. If the over-reading physician has not made changes, confirm the ECG. If the physician has recorded changes, make those changes in Muse and then confirm the ECG in MUSE.

b) Advanced Practice Providers:

There is an approval process for APP's who have been appropriately trained in how to read ECG's, to be able to read their own. The APP's supervising physician must ensure that this is within the provider's scope of practice and should be confirmed by the clinic's Chief of Professional Services. Documentation of this approval is required. Contact Lab Administration to begin the approval documentation and set-up process. Once this is established the APP will be notified and they may begin billing for ECG interpretation. In such cases it is reasonable but not necessary for a physician to "over-read" the ECG's. Of course, only one charge can be submitted for the service.

c) Pediatric ECG's:

Pediatric ECG's, (typically, patients <18 years of age**)** both stat and routine will be read at the Children's Heart Center by a pediatric cardiologist. Retrieve current ECG and first previous ECG when available, and fax a copy of the ECG to Childrens Heart Center (612-813-8825). Use the clinic specific Children's Heart clinic cover sheet when faxing to Children's Heart Center. Call 612-813-8800 to make sure a cardiologist is available to read

the ECG, if stat. After the ECG has been over-read, an edited copy of the ECG will print at the performing clinic lab. The clinic lab staff will edit and confirm the ECG in MUSE.

E. Basic Equipment Troubleshooting

- Lead errors: Always check for proper lead wire connection on the machine "acquisition module." Improper connection will cause inaccuracies in the ECG. Trace each individual lead wire from its acquisition module label to the colored connector.
- Error messages: If the system displays error messages, turn the power off, then on again. If error messages persist, contact Regions Biomed.
- Positioning the lead wire connector in the gel may compromise trace quality or cause lead failure. Be sure to make connection with the non-gelled tab of the silver mactrode.
- Avoid crossing lead wires, which may cause wrong placement.
- In the downloading process, when selecting Load Orders and the list of open orders appears, if any of the orders are old, load them onto the cart and delete them. Old, unused orders on the open orders list can slow down and cause problems in the downloading process.

Biomed (Biomedical Services) at telephone extension 651-254-3971

- Responsible for "hardware" repairs, (something is broken) such as ECG cart parts or connections.
- See Attachment 3, "Basic Troubleshooting Guidelines," for suggested remedies to common ECG cart problems.

IS&T (Computer Support/Help Desk) at 952-967-6600 (or email at *IS&T Support Center*.)

- Responsible for "software" repairs, such as MUSE interface and database issues.
- Once phoned, a "ticket" is opened by IS &T for the problem resolution. Biomed may also notify IS &T for software problems.
- If MUSE error has been resolved and only EPIC needs to be repaired, please include this information in your notification to the Help Desk. This will streamline the repair.

MAC 5000 Maintenance

Note: TURN SYSTEMS OFF BEFORE INSPECTING OR CLEANING

Visual Inspection: Monthly or as needed

1. Check the case and display screen for cracks and other damage
2. Inspect all cords for fraying or other damage.
3. Inspect all plugs and connectors for bent prongs or pins. (Repair or replacement must be performed by qualified service personnel).
   - Replacement equipment and repair: Biomed Dept 651-254-3971
   - Muse Problems: Call HealthPartners IS Helpline: 952-967-6600
   - Marquette Electronics field engineer: Phone 1-800-558-7044
4. Verify that all cord and connectors are securely seated. Inspect keys and controls for proper operation.

Cleaning:

Exterior Surfaces: Monthly or as needed

Clean exterior surfaces monthly or more frequently if needed using a damp, clean, soft cloth and mild dishwashing detergent diluted with water. Avoid coming into contact with open vents, plugs and jacks of any kind, disk drive, disks, the keyboard and the writer. Dry exterior with a clean cloth or paper towel.

If soiled:

If equipment is soiled with blood or other body fluids, clean with a mild disinfectant such as

Sanicloth AF or a disinfectant bleach cloth.

ECG Pillowcase: Change Weekly or as needed
ECG Table: Disinfect daily with mild disinfectant such as Sanicloth AF.

F. Quality Assurance

a) Improving ECG Quality

"Poor Data Quality"
-Check all leads for good contact with the Patient's skin
-Check that all ECG wires are not rubbing on the leads
"Suspect Limb Lead Reversal"
-Reconfirm that the RA, LA, RL and LL leads are correctly connected. Remember to use Patient's right and left
All Leads have a printed complex, there should be no flat lines, rough or wandering baselines,on the ECG
-Check all ECG wires are properly connected to the patient
-Check all leads for good patient contact

b) Quality Review

- Overreaders will determine the quality of the ECG
- ECG's tracing that need quality improvements are returned to the lab for review. Area of concern and reason should be noted on the ECG. Technical Consultant reviews tracing with lab staff.
- Staff observe each other once per year for competency
- Advanced Practice Providers (APP's): The APP's supervising physician must ensure that this is within the provider's scope of practice and should be confirmed by the clinic's Chief of Professional Services. Once established, the APP may be set up with the necessary MUSE privileges to over read and bill for ECG's. For proper documentation of privileges, contact Laboratory Administration.

G. MUSE Database Overview

Overview: The MUSE CV computer system is the storage computer system for ECGs from Healthpartners Clinics, Regions Hospital, affiliate clinics and satellite hospitals. From MUSE, we can retrieve and print ECG's, enter provider changes to instrument interpretation, merge manually entered patient data with an interfaced order, reconcile any discrepancies in chart numbers, account numbers and patient names and confirm an ECG. With access to MUSE, the patient's previous ECG can be located.

See the ECG MUSE procedure for directions on ECG Sign On, Logs Available in MUSE, Printing ECG's from Edit List, Instructions in ECG Editing and billing.

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IV. DEFINITIONS

ECG (electrocardiogram) or EKG (electrocardiogram): A recording of the electrical activity of the heart.

Tachycardia: A heart rate over 100 beats/minute
Bradycardia: A heart beat below 60 beats/minute
Hemipelvectomy: A high level of pelvic amputation
Electrodes: Skin sensors that detect electrical activity as it passes through the heart
IS&T: Information Systems and Technology.

V. Compliance

Failure to comply with this policy or the procedures may result in disciplinary action, up to and including termination.

VI. ATTACHMENTS

1. MAC 5000 Training Documentation
2.. MUSE Location List
5. ECG MAC 5000 Job Aid
6. ECG Location Number List
7. ECG Competency

VII. OTHER RESOURCES

1. MAC 5000/5500 Resting ECG Analysis System Operator Manuals and Clinical Education and Development Kit materials
2. GE Medical Systems, Silver Mactrode Plus Storage Instructions
3. V. Ross Collins, M.D., Cardiology, HealthPartners, Inc. April 1990
4. LST ECG Procedure, Regions Hospital, November 2007
5. GHP-PC-CLINIC Lab –Procedures-Workflow Guidelines
6. ECG MUSE Procedure
7. YouTube ECG Placement Video

VIII. APPROVAL(S)

Dr. Arthur Wineman
HealthPartners Regional Assistant Medical Director

Dr. Glenn Nickele
Cardiology Clinic Medical Director

APPROVAL(S)

Laboratory Medical Director

XI. ENDORSEMENT(S) Laboratory Administration

ECG/RHYTHM STRIP
Order Code: EKG
Order Code: STRIP
EKG EPIC Code: 500073
STRIP EPIC Code: 3062

RESULTING:

WORKSHEET:
Function MEM Worksheet M_ _ (Misc)

RESPONSE:
Result with SSR (See Separate Report) on the same day that the ECG or Rhythm Strip is performed

ADDITIONAL INFORMATION:
ECG and Rhythm Strip orders must be placed in EPIC. Do not initiate the order in Misys/Sunquest. ECG's should be credited in both EPIC and Sunquest.

Unless the provider specifies a different length of time, all Rhythm Strips should be run for approximately 60 seconds (6 pages).

Note: Rhythm strips cannot be stored in MUSE. Send entire rhythm strip to the provider for review.

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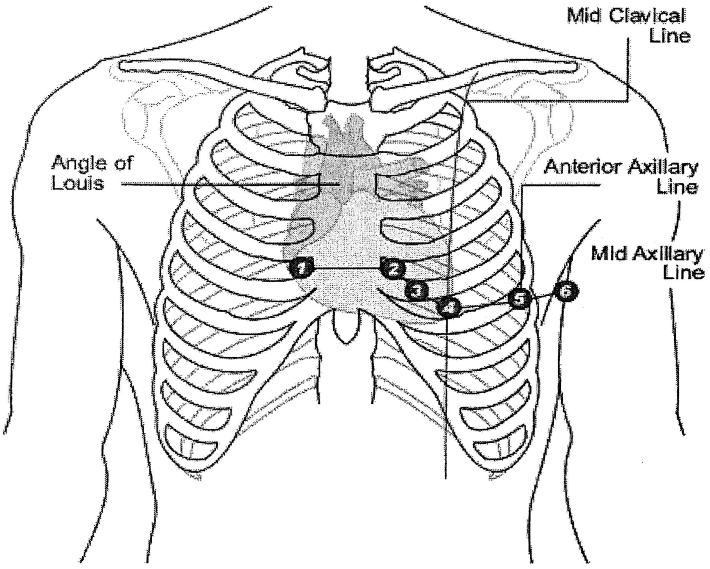
Appendix A: Lead Placement Diagram

Image: Positioning of the 6 chest leads



1	V1 Red	Fourth intercostal space at the right sternal border
2	V2 Yellow	Fourth intercostal space at the left sternal border.
3	V3 Green	Midway between location B and D.
4	V4 Blue	Mid-clavicular line in the fifth intercostal space.
5	V5 Orange	Anterior axillary line on the same horizontal level as D.
6	V6 Purple	Mid-axillary line on the same horizontal level as D and E.

LA Black	Left deltoid.
LL Red	Above left ankle. (Alternate placement, upper leg as close to torso as possible.)
RL Green	Above right ankle. (Alternate placment, upper leg as close to torso as possible.)
RA White	Right deltoid.

Appendix B: ECG Machine Troubleshooting

Basic ECG Machine Troubleshooting

Contacts: **BioMed: 651-254-3971 (Hardware Problems)** **Computer Support: 952-967-6600 (Server/Interface/Software Problems)**

Problem	Probable Cause	Remedy
Orders not saving when downloaded	Disk space not available (MAC 5000)	Delete old ECG's previously transmitted to MUSE from File Manager or Replace with a new Diskette. Order new diskettes from Central Lab.
Screen shows tracing OK then "flat lines" during acquisition	Electrodes not conducting current. Electrodes not kept in pouch with edge folder over.	Use fresh electrodes, not ones left outside of pouch.
Unable to transmit ECG acquired	Floppy disk (5000) is full and ECG is not saved.	Delete old ECG's previously transmitted to MUSE from File Manager or Replace with a new Diskette. Order new diskettes from Central Lab.
		Call Computer Support (952-967-6600)
An "Abort" message is showing on the ECG machine	The machine's charge has been depleted. Machine not plugged in when not in use.	Plug in machine. Allow to charge. Further problems: call BioMed (651-254-3971)
Incorrect date/year on tracings		If date is incorrect, problem is CART. Call BioMed (651-254-3917, may be internal battery)
Screen Message: *Writer is open. Close writer and Press ECG or Rhythm*	Sensor in paper drawer is affected by shift in paper placement. (Sensor "sees" this as an open door, even if the door is closed.)	Open the door to paper compartment, check paper is set properly, close door and press ECG button.
Artifact Patient skin prep is key to reduction of artifact!	Electrical interference	• Unplug all lines, clean electrode sites with alcohol, clean clips/connectors with alcohol • Check for cell phone, Fan, Radio, Refrigerator, or other electrical sources and eliminate if possible. • 60 cycle artifact may be caused by a "TENS" (Trans Cutaneous Electrical Nerve Stimulator) Unit

	Muscle	• Provide a blanket if patient is shivering • Abrade & cleanse patient's skin • Move extremity leads closer to body. • Make sure lead wire connector is with the non-gelled tab of the silver mactrode. Loose Electrode: Artifact in.. •Leads 1&2, check right arm •Leads 1&3, check left arm •Leads 2&3, check left leg •I, II, III, aVR, aVL, and/or aVF, check one of the extremity leads •V1-V6 only, check those leads Interference can be eliminated by: •Straighten out lead wires, lay them flat along contour of the body.
System displays error messages		Turn power off, then on again. If error messages persist contact Regions Biomed.
Biomed	Phone: 651-254-3971	Responsible for "hardware" repairs
IS&T Computer Support	Phone: 952-967-6600	• Responsible for "software" repairs such as Muse and database issues. • Once phoned a "ticket" is opened by IS&T. Biomed may also notify IS&T for software problems. • IS&T should be notified if there are multiple ECG's in MUSE for one order and ECG's need to be deleted from MUSE • If MUSE error has been resolved and only EPIC needs to be repaired, let IS&T know that only EPIC repair is needed.