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Instructor Guide

HeartStart MRx

HEARTSTART
DEFIBRILLATORS

Notice

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The HeartStart MRx complies with the requirements of the Medical Device Directive 93/42/EEC and carries the CE 0123 mark accordingly.

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Warning

Radio frequency (RF) interference from nearby transmitting devices may degrade the performance of the HeartStart MRx. Electromagnetic compatibility with surrounding devices should be assessed prior to using the monitor/defibrillator.

This Instructor Guide contain the following conventions:

"Voice"	represents voice prompt messages
Text	represents messages that appear on the display
Text	represents bolded directions to the instructor that appear in the guide and options that appear on MRx menus
[Soft key]	represents soft key labels that appear on the display above the button to which they correspond.

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1

Introduction

This instructor guide is designed to assist you in the delivery of end-user training on the HeartStart MRx. It provides directions and suggestions for teaching the safe and proper operation of the device, and is intended only for ACLS personnel thoroughly trained in the use of the device.

Instruction Time

It is estimated that this course will require 2-5 hours to complete, depending on class size, location, number of devices available for training, optional device parameters purchased, and student knowledge and needs.

Guide Structure

This guide is divided into sixteen (16) lessons, as follows:

- Getting Acquainted
- ECG and Arrhythmia Monitoring
- Semi-Automated External Defibrillation
- Manual Defibrillation and Cardioversion
- Q-CPR™*
- Noninvasive Pacing*
- Pulse Oximetry*
- Noninvasive Blood Pressure*
- Monitoring Carbon Dioxide*
- Invasive Pressures*
- Temperature*
- 12-Lead ECG*
- 12-Lead ECG via Bluetooth Transmission*
- Vital Signs Trending
- Data Management
- Maintenance

* This is an optional parameter with the MRx, so ensure you teach only the lessons that match the organization's device configuration.

Preparation

Prior to each class:

- Contact the organization's training coordinator to schedule training, if applicable. Suggest train-the-trainer sessions. Make sure students understand that they must be free from other responsibilities at the scheduled time for the duration of the course. A maximum of 10 students is recommended for each class.
- Talk to the training coordinator (if applicable) about which device functions students will be using on the job (AED Mode, Manual Mode, Pacing, SpO_2, etc.). Use this information to select the appropriate lessons and determine your lesson presentation.
- Recommend to the training coordinator that students watch the latest version of the HeartStart MRx User Training Video or DVD prior to the instructor-based training, if available. Also, suggest taking the HeartStart MRx Web-based User Training prior to or after the instructor-based training.
- Determine the number of devices needed for training and make arrangements to have them set up at the scheduled time, if possible. Try not to exceed grouping 2-3 students per device.
- Determine who in the organization makes decisions about configuration. Arrange a time to discuss the organization's desired configuration and set up the devices used in training to that configuration. Use the configuration worksheet available on the User Documentation CD-ROM to help you complete the configuration procedure.
- Perform an Operational Check on each device to be used in training prior to training. Refer to the latest version of the HeartStart MRx Instructions For Use to complete the Op Check, if necessary.
- Try to have fully charged batteries and external power available if needed.
- Try to have one simulator for each device to be used in training, as well as extra batteries for the simulators.
- Try to have appropriate sets of parameter accessories, cables, etc. for each device.
- Try to have one copy of the latest HeartStart MRx User Training Workbook available for each student, if possible. The workbook contains a similar lesson flow to the guide, but only a summary of the content. Students can use the workbook to follow your instruction. Be sure to familiarize yourself with the workbook before you teach. It is available on the User Documentation CD-ROM that comes with the MRx.
- As appropriate and if possible, try to have one copy of each application note available for each student either before, during, or after the training. These notes relate to several lessons in the guide. They can be found on the User Documentation CD-ROM, as well as:
  - www.medical.philips.com/goto/productdocumentation
- If possible, try to have one set of latest version of the HeartStart MRx Quick Reference Cards available for the training.

Teaching Guidelines

Consider the following guidelines for delivering the MRx training.

- Have students identify themselves and their role and/or responsibilities. This information gives you a better idea of what lessons/topics are suitable or most important for your audience.
- Provide a brief overview of the course structure and what is covered in each lesson.
- Advise students to read the HeartStart MRx Instructions For Use for details on device features and information not covered in the classroom:
  - Device intended use
  - Device and accessory set-up
  - Configuration
  - Device disposal
  - Troubleshooting
  - Specifications and safety
- For each lesson:
  - **Introduce** the learning objectives (as listed in the guide), advise on how much time it will take to complete a lesson, and point out what related resources (e.g., application notes) are available to students for further education.
  - **Present** the lesson content. Annotate and/or highlight material (in your copy of the guide) to ensure you stress information that you feel is important to your students' needs. Note that instructor directions are in **bold**. Look for ***suggestions*** that raise the level of student interaction. There is also space for additional points or notes to be made at a topical level, depending on students' needs.
  - **Review** the content presented by completing the review questions at the end of each lesson. Note that answers to the questions are in bold.
- Periodically ask for questions to ensure comprehension.
- Periodically ask questions to engage students and increase learning effectiveness.
- Take breaks over the course of the training (if time allows) to ensure learning effectiveness.
- At the completion of a class, use the Skills Checklist to test students on various functions and features of the MRx.

Safety Considerations

Some warnings and cautions specific to a particular feature of the HeartStart MRx are provided in this guide; however, you and students should reference the Instructions For Use for a complete description of all safety warnings and cautions. Nonetheless, reinforce the fact that the MRx is a live device that can deliver high-energy therapy and should not be used by untrained personnel. Operation by untrained personnel can result in injury or death.

Additional Documentation and Training

Available documentation and training for the HeartStart MRx includes:

- HeartStart MRx Instructions for Use - provides the most comprehensive review of MRx functionality and operation for students. It is available on the User Documentation CD-ROM or may be purchased in hardcopy form.
- HeartStart MRx Quick Reference Cards - provide visual, step-by-step summaries of key functions, parameters, and related operation
  - Controls, Connections and Indicators
  - Ready For Use Indicator
  - Using Alarms
  - Monitoring ECG
  - Monitoring SpO_2
  - Monitoring NBP
  - Monitoring CO_2
  - Monitoring Invasive PressuresNoninvasive Pacing
  - Q-CPR
  - 12-Lead ECG
  - Operational Check
- HeartStart MRx Web-based User Training - provides a comprehensive self-paced training on the same content found in the instructor guide. It is located on Philips Medical Systems' web site at: www.medical.philips.com/goto/mrxtraining.

Students need to enter the training access password **meetMRx** to get started.

- HeartStart MRx User Training Video - provides a 50-minute overview of MRx functions, features, and operation. The video serves as valuable preparation for the classroom or as a refresher after the training.
- Application Notes
  - *Arrhythmia Monitoring Algorithm*
  - *AED Algorithm*
  - *SMART Biphasic*
  - *Noninvasive Pacing*
  - *Philips Pulse Oximetry*
  - *Noninvasive Blood Pressure Monitoring*
  - *Uses of Capnography - The Microstream® Method*
  - *Q-CPR™ Measurement and Feedback*
- 12-Lead Algorithm Data Sheet
- *Philips 12-Lead Algorithm Physician's Guide*, available from IntelliVue Information Center - User Materials under Patient Monitoring at http://www3.medical.philips.com/en-us/doc_downloads/docdownload.asp

2

Getting Acquainted

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson provides an overview of the HeartStart MRx controls, indicators, operational modes, and display views. It also provides general information on use of the device.

Objectives

Upon completion of this lesson, students should be able to:

1. Identify the physical features, controls, and indicators of the MRx.
2. Identify the purpose of various controls and indicators.
3. Identify the display view characteristics associated with MRx's operating modes.
4. Identify the correct procedure for responding to an alarm.

Time

15-25 minutes

Accessories Recommended

- Simulator
- Hands-free cable
- Multifunction electrode pads
- 3-, 5-, or 10-Lead monitoring electrodes
- Optional Pacing, SpO_2, CO_2, NBP, invasive pressure, temperature, and/or Q-CPR parameter accessories

Lesson Presentation

Overview

Describe the high-level features of the MRx.

- It is designed for a variety of needs.
- It has controls, indicators, and menus organized to facilitate ease of use.
- It displays information specific to the current task.

Basic Orientation

Introduce the physical features, controls, and indicators on the front, left, right, top, and back panels of the MRx. Also, discuss the lithium ion battery.

Suggestion: **Have students identify the features, controls, and indicators on their devices and the battery while following your orientation.**

NOTE: Consider not turning on the MRx during your initial orientation so students focus on each panel and NOT the display. Then, turn on the device to illustrate display output of features and controls.

Front Panel

Controls and indicators on the front panel are organized by function, with the most general function buttons located along the left and bottom sides of the display, defibrillation controls to the right of the display, and soft keys immediately below the display.

Therapy Knob

Serves as the MRx power switch and can be set to:

- **AED** - to enable AED Mode for semi-automated external defibrillation and optional Q-CPR parameter.
- **Off**
- **Monitor** - to enable Monitor Mode for 3- or 5-Lead ECG monitoring, optional 12-Lead ECG acquisition, or monitoring of optional parameters such as SpO_2, CO_2, and NBP.
- **Pacer** (optional) - to enable Pacer Mode for demand or fixed mode pacing.
- **Manual Defib** - to enable Manual Mode for asynchronous or synchronous defibrillation (cardioversion) at the selected energy setting and optional Q-CPR parameter.

  Energy settings are 1-9, 10, 15, 20, 30, 50, 70, 100, 120, 150, 170, and 200 Joules. If the device is equipped with optional Pacing, energy settings are 1-10, 15, 20, 30, 50, 70, 100, 120, 150, 170, and 200 Joules.

General Function Buttons

Control monitoring or non-critical resuscitation activities

- **Mark Event** - inserts a time-stamped annotation in the Event Summary Report to note events as they occur, including drug administration. A Mark Event button label appears at the top left corner of the display.
- **Lead Select** - changes the ECG lead in Wave Sector 1; cycles through the available ECG waves, changing the displayed wave and label. The list of available ECG waves is based on the current lead set and device configuration, and includes pads or paddles if the corresponding cable is connected to the MRx.
- **Alarm Pause** - pauses all visual and audible physiological alarms and audible inops for the configured time interval. At the end of the pause interval, each alarm returns to its previous setting (On or Off). Also returns alarms to their previous settings.
- **Print** - initiates a continuous print-out of the primary ECG and the waveform displayed in Wave Sector 2, either real-time or with a 10-second delay, depending on device configuration.
- **Summary** - displays a menu from which you can print the current or most recent Event Summary report or Vital Signs Trending Report.
- **Menu Select** - brings up the current menu or confirms a menu selection.
- **Navigation** - display the current menu just like Menu Select button does; move to the next or previous item in a list; increase or decrease numbers or values in a sequence; may be held down to accelerate through the available choices.

Defibrillation Controls

- **Therapy Knob** - enables AED or selects an energy for Manual Mode defibrillation or cardioversion.
- **Charge** - charges the defibrillator to the selected Manual Defib energy setting. Used only in Manual Mode. Defibrillator charges automatically in AED Mode.
- **Shock**
  - delivers a shock through multifunction electrode pads or switchless internal paddles. In AED Mode, a 150J shock is delivered. In Manual Mode, the shock is delivered at the selected energy setting.
  - When external paddles or switched internal paddles are used, once the MRx is fully charged, the shock is delivered by pressing the Shock button(s) on the paddles.

  NOTE: Internal paddles should only be discussed with clinicians dealing with open chest defibrillation.
- **Sync** - toggles between asynchronous and synchronous (cardioversion) defibrillation.

Soft Keys

Perform functions presented as labels appearing immediately above the keys on the display. Labels (and related functions) change based on the mode of operation.

Indicators

Provide a visual display of device status

Ready For Use (RFU)

- A blinking black hourglass symbol indicates:
  - Shock, pacing, and ECG functions are ready for use.
  - Sufficient battery power is available for device operation.
  - An installed battery is being charged, assuming the presence of external power (AC or DC).
- A blinking red "X" and a periodic audio chirp indicate:
  - No battery is present or a low battery condition.
  - The device can be used in a low battery condition, but its operation time is limited. If the device is running only on external power, it takes longer to charge. If a battery is inserted and charging, the audio chirp is not present.
- A solid red "X" and a periodic audio chirp indicate:
  - A failure that may prevent delivery of defibrillation therapy, pacing, or ECG acquisition. When turned on, the device displays an error message for the first critical failure detected. Consider doing an Operational Check if the device is in this state to isolate the failure.
- A solid red "X" without periodic audio chirps indicates:
  - Either no power is available or a catastrophic failure has occurred.
  - The device cannot power on. If, after power is supplied, the indicator reverts to the blinking black hourglass symbol, the device is once again ready for use.

Note the following: The RFU indicator may briefly display a solid red "X" when initially turning the device on, when switching between clinical and non-clinical operating modes, and at the start of any automated test.

External Power - lights green if power is being provided by an external AC or DC power source; momentarily goes out when charging for defibrillation with a charged battery installed, as the device switches power source to the battery for a faster charge time.

The front panel also includes the printer door and latch, speaker (for audible alarms and AED voice prompts), and the display (covered in detail later).

Side Panels

- The left panel has:
  - Ports for monitoring cables (if ordered), including ECG (for 3-, 5-, or 10-Lead patient cable), pulse oximetry (SpO2), noninvasive blood pressure (NBP), two invasive pressures, temperature, and carbon dioxide (CO_2)*.

    * For CO_2, there is an Inlet port for monitoring tubing and an Outlet port when administering anesthetic gases.
  - An ECG Out jack to connect to an external monitor.
- The right panel has:
  - A therapy port for paddles (external or internal) or multifunction electrode pads and/or Q-CPR Compression Sensor.
  - A slot for a data card to transfer patient information.

Top Panel

The top panel has a handle and basic operating instructions. Optional external (adult/pedi) paddles also reside here, if present.

NOTE: Be sure to demonstrate access to the pediatric paddles.

Back Panel

The back panel has:

- Two compartments for lithium ion batteries. Compartment B also used to connect an AC power module.

NOTE: Be sure to demonstrate how to take batteries in and out of the compartments.

- A DC Power Input port.
- An RS-232 serial port for 12-Lead ECG transmission.
- A LAN port for future use.

M3538A Lithium Ion Battery

- Has a fuel gauge with 5 LED indicators, each representing a charge of approximately 20% of capacity. Press the fuel gauge button to illuminate the fuel gauge.
- Should be used as the primary power source, with AC/DC as a secondary source, if desired. If an AC/DC power module is used as the only power source, the MRx takes longer to charge to the desired energy level and, in the event of power loss, all settings reset to the default settings and a new incident is created when power is returned. All stored data remains intact and can be found by retrieving the previous incident. Keep your unit charged.
- A new, fully-charged M3538A battery, operating at room temperature 25°C(77°F), provides approximately 5 hours of monitoring, with ECG, SpO_2, CO_2, temperature, two invasive pressures monitored continuously, NBP measured every 15 minutes, and 20 200J discharges. A fully charged new battery provides approximately 3.5 hours of monitoring, with ECG, SpO_2, CO_2, temperature, two invasive pressures monitored continuously, NBP measured every 15 minutes, and pacing at 180ppm at 160mA.
- Battery life depends on the frequency and duration of use. When properly cared for, useful life is approximately 2 years. To optimize performance, a fully (or nearly fully) discharged battery should be charged as soon as possible.

Additional points/notes:

Display View

Introduce the display view characteristics of the MRx, starting with a brief look at the various operating modes. Attach a simulator (set to a normal sinus rhythm), 3-, 5-, or 10-Lead ECG set, and all available parameter accessories to the MRx. Feel free to switch between modes to illustrate display view characteristics; however, consider spending most of your time in Monitor Mode, as it provides the most comprehensive view. You will cover details of the AED, Code, and Pacing views in related lessons later in this guide.

Suggestion: **Have students set up their devices with accessories they will use and turn them on to the operating mode(s) you cover to follow your display view introduction. Ask students what they see in each display view you cover versus just telling them what they see.**

Operating Modes

The MRx has four clinical modes of operation, each with a customized display view function being performed:

Mode of Operation	Display View	Description
Monitor Mode	Monitoring View or 12-Lead View	Monitors ECG, takes an optional 12-lead ECG, and monitors optional parameters such as SpO_2, $EtCO_2$, NBP, Invasive Pressures, and Temperature, and for viewing Vitals Signs Trending data
AED Mode	AED View	Analyzes ECG and, if necessary, performs semi-automated external defibrillation and optional Q-CPR
Manual Defib Mode	Code View	Performs asynchronous and synchronous defibrillation (cardioversion) and optional Q-CPR, and monitors ECG
Pacer Mode	Pacing View	Performs demand or fixed mode pacing, and monitors ECG

Note: Upon returning to a clinical mode from a non-clinical mode such as Configuration or Data Management, all settings are re-set to the device's default values.

Password Security

Access to Manual Defib Mode and Pacer Mode may be password protected if configured. If enabled, you are prompted to enter the password when you move the Therapy Knob to either the Pacer position or an energy selection. Use the Navigation buttons to select the password numbers, select **Done**, and then press Menu Select to complete the entry. The Charge button and the **[Start Pacing]** soft key remain inactive until the password is entered. AED Mode is always available without a password.

Note the following: Use of the Manual Therapy Security password requires the clinician to know and remember the password, as defined in Configuration. Failure to enter the correct password prevents manual defibrillation delivery or pacing therapy. Prior to selecting this Configuration option, review this potential risk with your Risk Manager.

Display Layout

The MRx display layout is segmented as follows:

General Status

At the top, this area contains:

- Mark Event button label
- Date and time
- Battery icons
  - Labeled “A” and “B” to match battery compartments on back panel.
  - Display current available battery power, ranging from hollow (fully discharged) to full (fully charged). If an AC Power Module is in Compartment B, the No Battery icon is displayed.
- Audio recording icon - If the option is enabled, an audio recording icon displays to the left of the battery icons in all clinical modes to indicate the audio recording status.
- Patient information

  Some modes of operation permit patient information entry via a menu choice. If no information is entered, the patient category is defaulted to *Adult*, unless configured otherwise, and the pacing status is set to *Non-Paced*, unless the Paced status has been previously set to Paced for an internally paced patient or the MRx is pacing the patient. In Pacer Mode, Paced status is not displayed.
- Patient name -If entered, the patient’s name will appear above the patient type and paced status.
- Inop statements - appear in top left of display if equipment problems occur
- ECG/HR alarm status - alarm messages communicate arrhythmia alarms, as well as overall alarm status (alarms off, alarms paused)
- Event Timer - communicates elapsed time for the current patient incident

Wave Sectors

- MRx displays up to 4 wave sectors with a predetermined waveform, when powered on in Monitor, Manual, or Pacer Mode.
- A dashed line (in a wave sector) or empty wave sector indicates waveform source not connected to MRx.
- Sectors may contain a variety of information, as appropriate to the parameter, view, and task; ECG wave sectors contain a calibration bar.

Wave Sector 1

- Will only contain an ECG waveform (used by the arrhythmia, heart rate derivation, and AED analysis algorithms); the waveform may be acquired through the therapy port for pads/paddles or the monitoring port for 3-, 5-, or 10-Lead electrodes.
- If the configured source is not connected to the device when turned on, the first valid ECG source is displayed in Wave Sector 1. Once the source is available, it automatically populates Wave Sector 1.
- The displayed lead/source is controlled primarily by the Lead Select button, although the **Displayed Waves** menu can be used.
- This sector includes R-wave detection.
- When monitoring using a 3-lead ECG set, the MRx displays only one ECG lead at a time.
- If Pads are configured as the primary ECG source for Wave Sector 1, the ECG patient cable must be connected to the MRx and to the monitoring electrodes in order to change the ECG source to a Leads selection.

Wave Sectors 2-4

- Automatically populate when parameter sources (cables/tubing) are connected to the MRx. Q-CPR compression waveform automatically populates on 150J Manual Defib Mode setting.
- If parameter source is the configured choice of a particular wave sector, it is displayed in that sector.
- If you connect a parameter source that is not configured to be displayed, it displays in the first empty wave sector. If you subsequently connect the configured parameter source, it replaces the current parameter. For invasive pressures, you should label your waveforms as they are connected to avoid possible confusion..
- Displayed lead/source is controlled by the **Displayed Waves** menu.
- Wave Sectors 2 and 4 may contain a cascaded ECG.

Parameter Blocks

- Provide measurements for displayed waveforms and monitored parameters. The position of most parameters are in fixed locations depending upon the options which were included in your HeartStart MRx.
- Block 1 always contains heart rate and HR alarm settings; may display Pulse, Temp, and NBP schedule, measurements, and alarm settings.
- Block 2 may contain Invasive Pressures, SpO_2, $EtCO_2$, and Airway Respiration Rate (AwRR) measurements and related high/low alarm limit settings; "-?-" is displayed until a valid measurement is obtained; settings may contain the Alarms Off icon. Block 2 may also contain Q-CPR compression and ventilation values.
- Invasive Pressures, Temp, SpO_2, and $EtCO_2$ measurements are activated when associated cable/tubing is connected; if a cable/tubing is disconnected, a prompt message requests approval to turn off the measurement.
- Alarm messages appear in the space above each numeric value, replacing a parameter label.

Suggestion: **Have students disconnect and reconnect parameter accessories to see how parameter blocks are affected. Ask students what they see when detaching and attaching an accessory cable or tubing.**

Soft Key Labels

- Correspond to soft key buttons.
- Change according to the current display view and function.
- Grey text labels indicate inactive soft keys (e.g., Disarm in Manual Mode).

Suggestion: **Switch between modes to show different labels, with students following along.**

Display Menus

- Provide controls and options specific to each function.
- Accessible through Menu Select and Navigation buttons.
- Used to adjust volume, select waveforms for display, set alarms, schedule measurements, enter patient information, perform an Operational Check, generate reports, etc.
- Press Menu Select button to activate selections; select *Exit* to close menus without activating selections.

Suggestion: **Access different menu options to illustrate various menu functionality (e.g., changing waveform for a sector, the patient's age, alarm limits, etc.). If you access the Patient Info menu, point out that a patient's full name is entered using 2 alphabetical lists, one to enter last name, followed by another to enter first name. When each name is complete, select Done. When entering names, follow your organization's or HIPPA regulations.**

Message Windows

- Provide status information.
- Alert you to an error or a potential problem.
- Direct you to take action.
- Use the Navigation and Menu Select buttons to respond to messages.

High Contrast Display

- Provides a High Contrast view to optimize visibility of the MRx display when used in bright sunlight.
- Display appears with a yellow background and all other screen elements appearing in black or shades of gray.
- Select **High Contrast On** from the Main Menu to enable the feature.

Note the following: The High Contrast view does not display the colors red or blue, therefore, be sure the MRx is configured correctly with the appropriate parameter color settings.

Suggestion: **Have students set their devices to the High Contrast view any time during your discussion.**

Additional points/notes:

Responding to Alarms

Create an alarm condition and cover the following steps to respond to the condition.

1. Attend to the patient.
2. Identify the alarm(s) indicated.
3. Silence the alarm(s). When a physiological alarm is announced, the Audio Pause label displays above the Navigation and Menu Select buttons. Pressing any of these buttons silences the audio for all active alarms while you are attending to the patient. If the alarming condition continues to exist, it will re-alarm in two minutes. Silencing a specific alarm does not prevent another alarm condition from sounding. If you also silence the second alarm, it resets the two-minute audio pause for all active alarms.

   When an INOP is announced without a concurrent physiological alarm, the Audio Off label displays above the Navigation and Menu Select buttons. Pressing any of these buttons silences the audio for all active alarms while you are attending to the patient. INOPs do not reannunciate after pressing audio off.
4. Address the alarm condition with one of the following options:
   - **Acknowledge** - For latching alarms, acknowledge clears the alarm condition when the condition no longer exists.
   - **New Limits** - Adjust the parameter limits accordingly.
   - **Alarms Off** - Turns the monitoring parameter's alarms off and prevents real-time print strips. The alarm message is no longer displayed, and the Alarm Off icon appears next to the parameter value.

     Note the following: Turning off alarms turns them off indefinitely.
   - Although the Alarm Pause button can be used when responding to alarms, the response procedures described above are recommended. Alarm Pause removes audio and visual indications of active alarm conditions as well as inhibiting indications of new alarm conditions.
   - A potential hazard exists if different alarm limits are used for the same or similar equipment in any single area.
   - Confirm the alarm limits are appropriate for the patient each time there is a new patient incident.

– Do not set alarm limits to such extreme values that render the alarm system useless.

Suggestion: **Note that you will also cover alarm limits in detail in the *ECG and Arrhythmia Monitoring* lesson later in the training and students will be able to practice with alarm conditions at that time.**

Additional points/notes:

Continued Use

Cover the characteristics associated with MRx's continued use feature.

- Activated once a patient event is started.
- Facilitates continued treatment of the same patient by retaining current settings and the patient record when the MRx is turned off for less than 10 seconds or switching between modes (e.g., Monitor, AED, and Manual Defib).
- MRx retains the most recent settings, including:
  - Alarm settings
  - Wave Sector settings
  - Event Timer
  - QRS, alarm tone, and voice prompt volumes
  - ECG gain
  - Pacing settings
  - Patient record in the Event Summary Report; new data is appended to the record
- This feature will not function if all power sources (battery and external AC/DC power modules) are removed from the device, even briefly.

Suggestion: **Have students shut off MRx and turn it back on within 10 seconds. Then, ask them to state some of the settings that are retained. Consider having students complete this task before giving them the above list of retained settings.**

Printing Waveforms

Describe waveform printing characteristics and procedures.

- Obtain a continuous printout of the primary ECG and one additional waveform on a 50mm printer.
- Obtain a continuous printout of the primary ECG and two additional waveform on a 75mm printer.
- Certain waveforms (including invasive pressures and CO_2) include scale indications on the printout.
- Printouts are generated either real-time or with a 10-second delay, depending on your configuration.

To change wave forms for the second wave printed with a 50mm printer:

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Printed Waves** option and press Menu Select.
3. Using the Navigation buttons, select the wave form you want to print in Wave 2 and press Menu Select.

To change wave forms for the second or third wave printed with a 75mm printer:

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Printed Waves** option and press Menu Select.
3. Using the Navigation buttons, select **Wave 2** or **Wave 3** and press Menu Select.
4. Using the Navigation buttons, select the wave form you want printed and press Menu Select.
5. Repeat Steps 2 through 4 for the other printed wave.

Return to Owner

Discuss the Return to Owner feature and demonstrate how to enable and disable it.

- Lets the MRx owner specify a loan period, after which the MRx borrower is reminded to return the device to its owner.
- Password protected in Configuration. Each device should have a unique password.
- Monitoring and defibrillation functions are suspended while the Return to Owner set-up screen is displayed. Alarms Off is indicated on the display. Monitoring and defibrillation functions will return when exiting the Return to Owner screen
- The appearance of the loan expiration message does not disable monitoring and defibrillation functionality.

To enable this feature:

1. Press the Menu Select button.
2. Select **Other** and press Menu Select.
3. Select **Return To Owner** and press Menu Select.
4. Press the **`[Activate]`** soft key.

5. Enter the number of days in the loan period and press Menu Select.
6. Press the **[Exit Return-To]** soft key.

To disable this feature:

1. Press the Menu Select button.
2. Select **Other** and press Menu Select.
3. Select **Return To Owner** and press Menu Select.
4. Press the **[Deactivate]** soft key.
5. Enter the password and press Menu Select.
6. Press the **[Exit Return-To]** soft key.

Additional points/notes:

Carrying Case and Accessory Pouch Assembly

This topic should be covered for only customers who have carrying cases and accessory pouches, as appropriate. Discuss the following procedures for carrying case assembly and recommended accessory placement.

1. Disconnect all external power and remove all batteries.
2. Lower the device into the sleeve of the carry case. The rear base of the device fits in the sleeve socket.

Paddle Tray

a. If paddles are connected, disconnect them from the Therapy port and remove them from the paddle tray.

b. Remove the four T-15 screws from the tray plates.

c. Gently lift the paddle tray up, leaving all wires connected.

Handle Only

a. Remove the handle cover by pushing in on either side of the handle cover and lifting up.

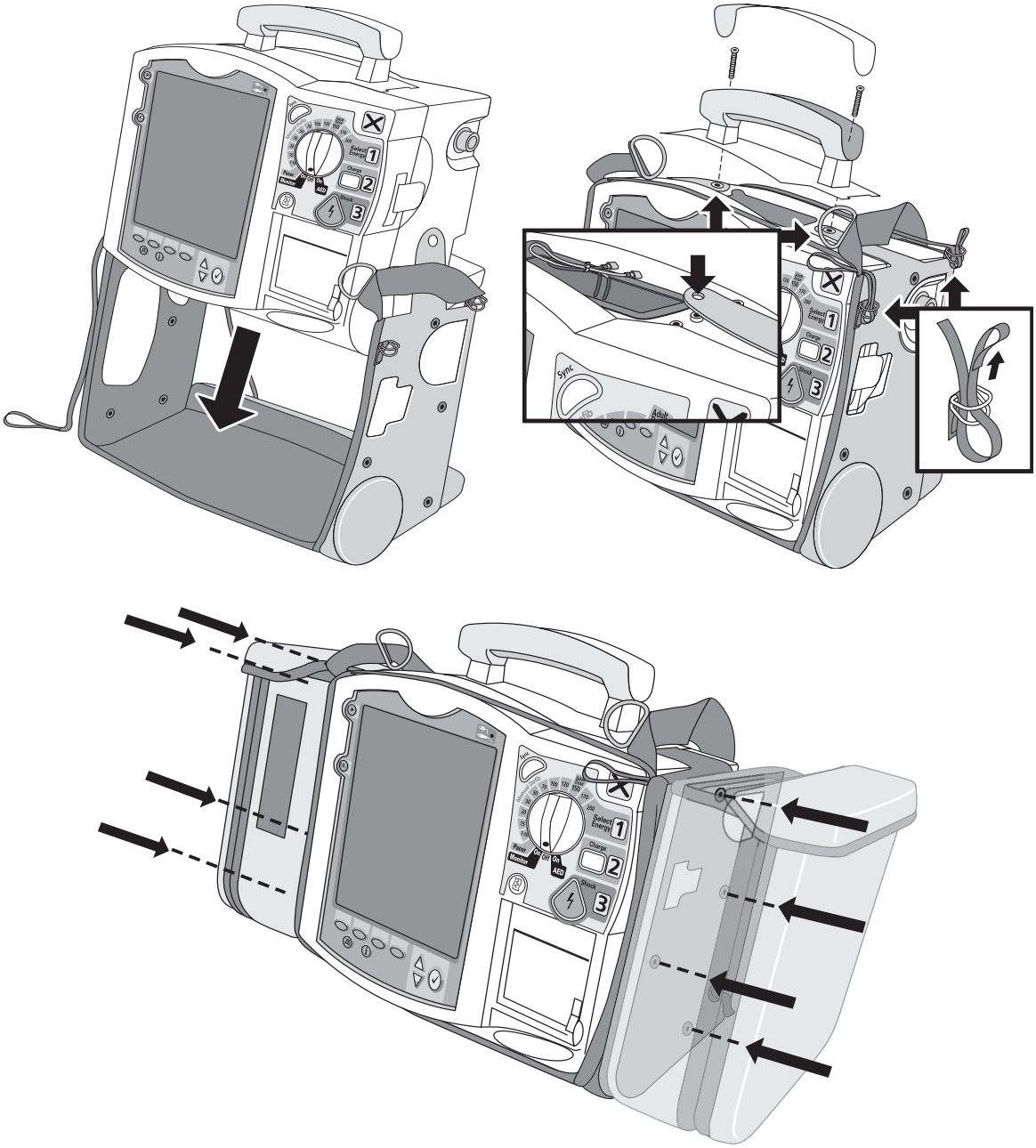
b. Remove the two T-15 screws.

c. Remove the handle.

d. Gently lift the cap plate up.

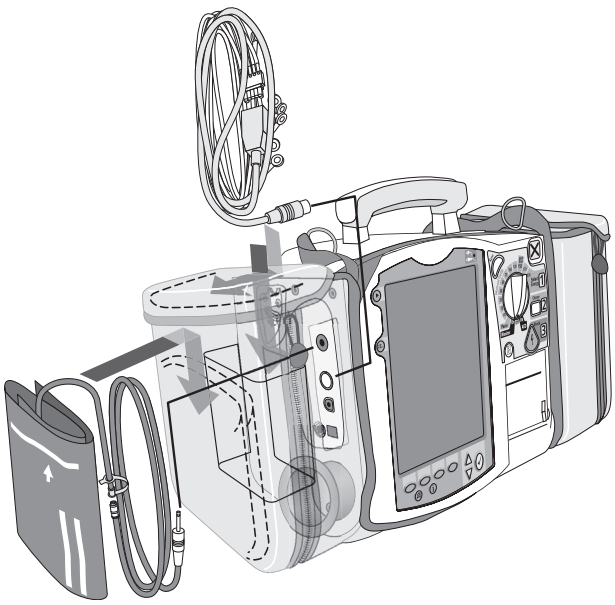
3. Fold the two sleeve flaps over the top of the device, positioning them so that the screw holes are exposed.
4. Replace the paddle tray or cap plate, as appropriate, so that the molded openings fit over the sleeve flaps.
5. Secure the front and rear cinch straps using the metal rings provided.
6. Perform an Operational Check on the MRx.
7. Attach the side pouches using the snaps located inside the pouch pockets.

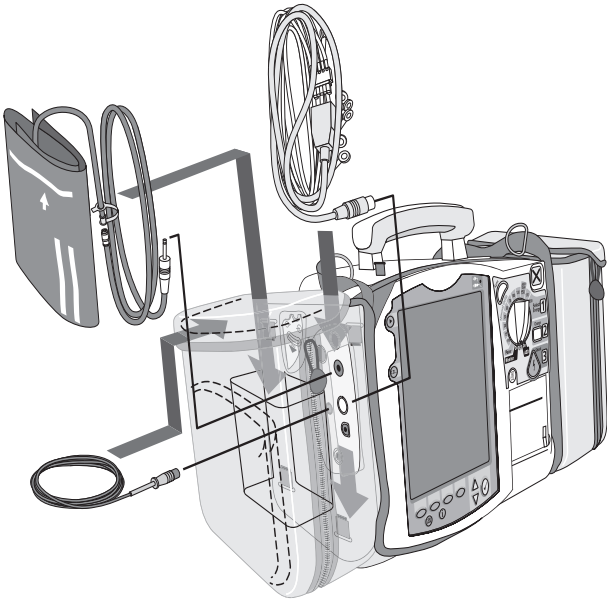
The following illustrations show carrying case and accessory pouch assembly.


Select Energy
1
Charge
2
Shock
3
Sync
Adult

Storing Accessories

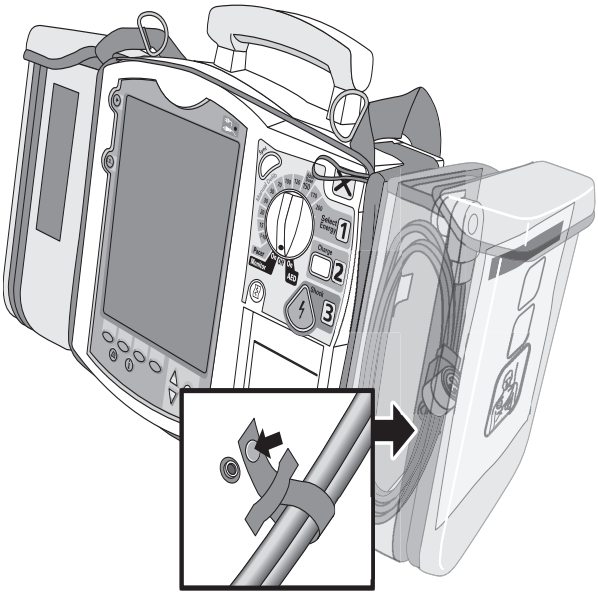
1. Store parameter cabling and accessories as shown below.

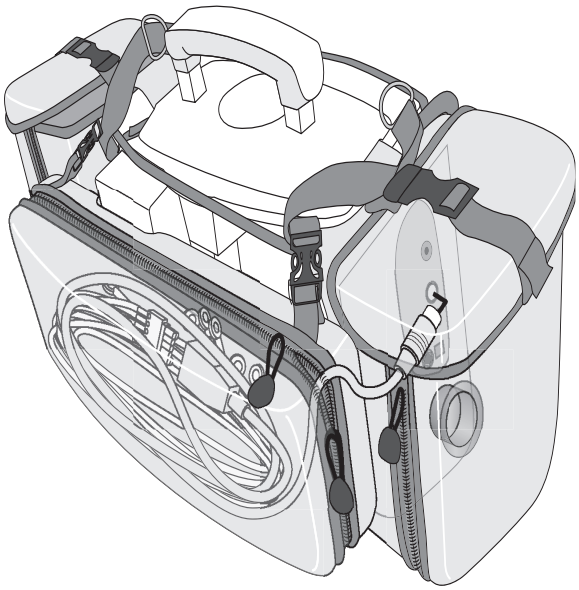




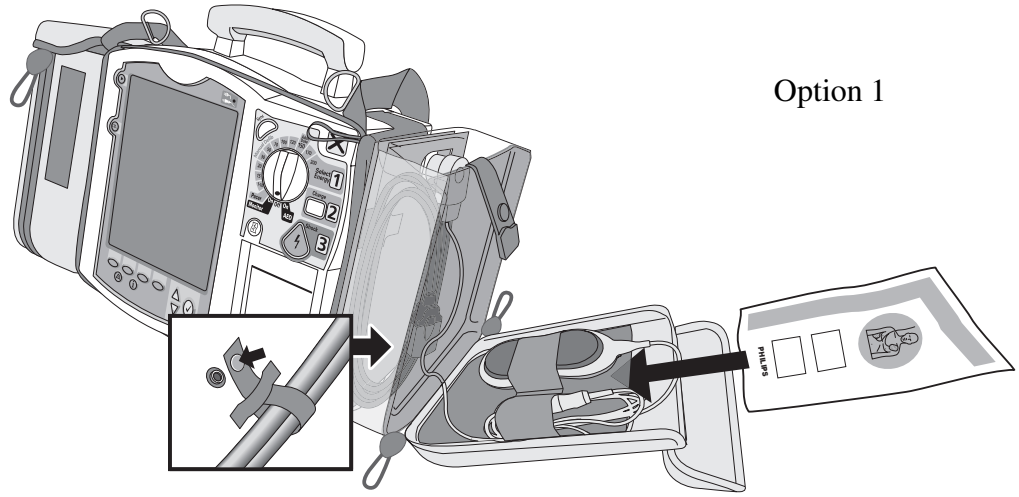
2. Attach the Therapy cable and route it through the cable fastener loop, securing the cable just below the strain relief. (See below left.)
3. Attach the rear pouch using the buckles provided. (See below right.)

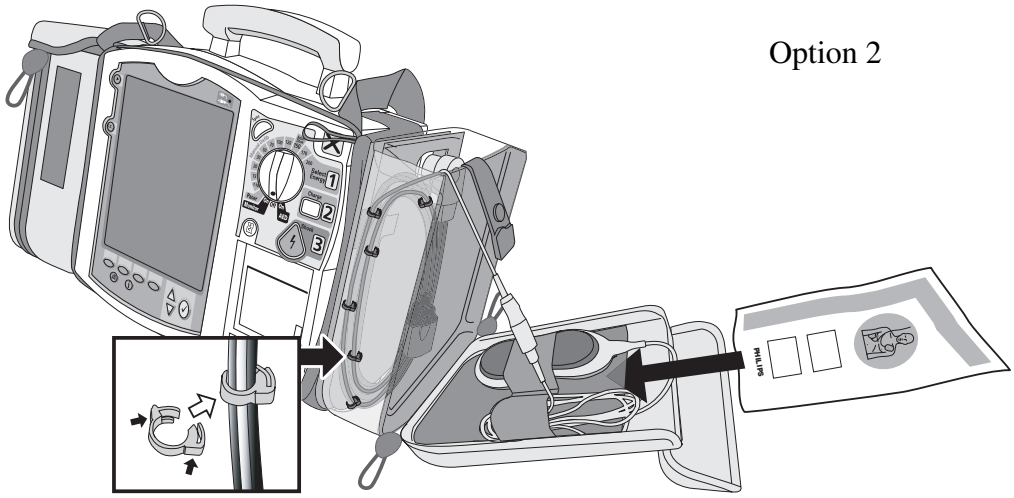
Note: Depressions are provided on the inside of the rear pouch should you wish to make a cut-out to accommodate external power.





Here are recommended carry bag storage instructions for Q-CPR accessories for easy access.





Suggestion: **Have students set up the carrying case and accessory pouches during your instruction.**

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold.)

1. Identify at least three controls or buttons on the MRx involved with defibrillation. (**Therapy Knob, Charge button, Shock button, Sync button**)
2. What does a solid red "X" and periodic audio chirp indicate on the RFU?
   a. No battery is present (blinking red "X" and chirp)
   b. No power is available (solid red "X" and no chirp)
   c. A low battery condition (blinking red "X" and chirp)
   d. Defibrillation therapy may not be available
3. The arrhythmia algorithm uses the ECG in which Wave Sector for analysis?
   a. 1
   b. 2
   c. 3
   d. all of the above
4. True or false? You can select the ECG lead for Wave Sector 2 using either the Lead Select button or **Displayed Waves** menu. (**False - You can only use the Displayed Waves menu to select the ECG lead for Wave Sector 2.**)
5. True or false? You should respond to alarms primarily by pressing the Alarm Pause button. (**F - You should respond to alarms by acknowledging them and changing limits, if needed vs. pressing the Alarm Pause button.**)

3

ECG and Arrhythmia Monitoring

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes the basic ECG and arrhythmia monitoring functions of the HeartStart MRx.

Objectives

Upon completion of this lesson, students should be able to:

1. Locate pertinent information in Monitor View.
2. Prepare a patient for ECG and arrhythmia monitoring.
3. Set heart rate and arrhythmia alarms.
4. Display an annotated ECG.
5. Initiate manual relearning.

Time

10-20 minutes

Accessories Recommended

- Simulator
- Hands-free cable
- Multifunction electrode pads
- 3-, 5-, or 10-Lead monitoring electrodes

Clinical Resources

- *Arrhythmia Monitoring Algorithm* Application Note (M3535-95100)

Lesson Presentation

Overview

Introduce MRx's Monitor Mode specific to ECG and arrhythmia monitoring.

- Monitor Mode monitors ECG and arrhythmia using multifunction electrode pads or 3-, 5-, or 10-Lead ECG sets.
- The MRx uses the ST/AR Basic Arrhythmia Algorithm for arrhythmia analysis.
- Monitor Mode generates heart rate and arrhythmia alarms, communicating patient status.

Monitor View

Attach multifunction electrode pads or 3-, 5-, or 10-Lead ECG set to the simulator and the MRx, attach parameter accessories (as appropriate), turn the Therapy Knob to Monitor, and discuss Monitor View characteristics.

- Monitor View displays up to four ECG waves or combination of ECG, pads/paddles, and parameter waves.
- Monitor View displays heart rate/parameter numeric values and active alarm settings.
- Change the primary lead with the Lead Select button.
- Change leads through the **Displayed Waves** menu.
- The first valid ECG source acquired displays in Wave Sector 1; it is replaced by the configured primary lead as soon as it is acquired.
- The ECG lead source in Wave Sector 1 determines heart rate and monitor arrhythmia.

Suggestion: **Ask students to point out characteristics instead of YOU stating them.**

Additional points/notes:

Preparation

Discuss monitoring preparation using multifunction electrode pads or electrodes.

Multifunction electrode pads

1. Prepare the patient's chest (i.e., remove clothing, remove moisture from chest, and remove excessive hair).
2. Apply multifunction electrode pads to the patient according to the pads package directions or your organization's protocol.
3. If not pre-connected, insert the pads cable into the green Therapy port. **DEMONSTRATE**
4. Connect the pads to the pads cable. **DEMONSTRATE**

Suggestion: **Have students complete steps 4 and 5.**

Electrodes

1. Prepare the patient's skin at the appropriate electrode sites.
   - If necessary, clip hair at the electrode sites (or shave sites if needed).
   - Clean and abrade the skin at each electrode site.
   - Dry the electrode sites briskly to increase capillary blood flow in the tissues and to remove oil and skin cells.
2. Attach the snaps to the electrodes.
3. Apply the electrodes.

Note: Review typical electrode placement for a 3-, 5-, V/C, and 10-Lead ECG set, and lead selection for an accurate QRS complex detection, as appropriate.

4. If not pre-connected, connect the ECG patient cable. **DEMONSTRATE**

Suggestion: **Have students complete step 4.**

Additional points/notes:

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Lead Choices

Review the choice of leads available for 3-, 5-, and 10-Lead ECG sets if connected to the MRx.

If you are using:	These leads are available:	The maximum number of leads displayed is:
a 3-Lead ECG set	I, II, III	One
a 5-Lead ECG set	I, II, III, aVR, aVL, aVF, V	Four
a 10-Lead ECG set	I, II, III, aVR, aVL, aVF, V1-V6	Four

Lead Selection

Discuss the guidelines for lead selection.

- Select a suitable lead for monitoring so that a QRS complex can be accurately detected.
- For non-paced patients, the:
  - QRS complex should be tall and narrow (recommended amplitude > 0.5mV).
  - R-wave should be above or below the baseline (but not biphasic).
  - P-wave should be smaller than 1/5 R-wave height.
  - T-wave should be smaller than 1/3 R-wave height.
- For paced patients with internal/transvenous pacemakers, in addition to the above, the pace pulse should be:
  - not wider than the normal QRS complex.
  - large enough to be detected (half the height the height of the QRS complex), with minimal re-polarization.
- Adjusting the ECG wave size on the display does not affect the ECG signal which is used for arrhythmia analysis.

The ECG lead for Wave Sector 1 is selected through the Lead Select button or through the **Displayed Waves** menu. **Demonstrate ECG lead selection for Wave Sectors 2-4, which is accomplished through the Displayed Waves menu.**

1. Press the Menu Select button.
2. Select **Displayed Waves** and press Menu Select.
3. Select the appropriate Wave Sector and press Menu Select.
4. Select the desired lead and press Menu Select.

Practice Exercise 1

Have students attach a simulator and 3-, 5-, and 10-Lead ECG set to the MRx (5- or 10-Lead set preferred), set the simulator to a normal sinus rhythm, and complete a variety of lead selections for Wave Sectors 2, 3, and 4, as appropriate. Try adding a parameter to see how a wave sector is affected. Pose the following questions:

1. How do Wave 2, 3, and/or 4 menus differ from each other in terms of available leads? From Wave 1 menu?
2. What wave size(s) provide the clearest wave form?
3. What happens when you add a parameter?

Additional points/notes:

Heart Rate and Arrhythmia Alarms

Introduction

Set the simulator and the MRx to produce a variety of alarm conditions and discuss MRx alarm characteristics, latching, and INOP messages, as follows.

- Alarm conditions are detected by comparing ECG data to a set of pre-defined criteria.
- Alarms are triggered by rate exceeding threshold, abnormal rhythm, or ectopic event.
- Alarm messages appear in the alarm status area located just above the HR numeric; accompanied by both audible and visual alert signals.
- Multiple alarm conditions are possible; the most serious or highest priority alarm condition takes priority (i.e., is announced first) and overrides lower priority alarms (e.g., extreme BRADY over low HR).
- Because the ST/AR Basic Arrhythmia Algorithm is the HeartStart MRx's cardiotach source and is needed to generate heart rate and heart rate alarms, the algorithm can never be disabled. However, if desired, arrhythmia and heart rate alarms can be turned off.

Arrhythmia Alarm Latching

Review the arrhythmia alarm categories.

- Latching alarms are announced and remain present, regardless of whether the alarm condition still exists, until either acknowledged or a higher priority condition occurs.
- Non-latching alarms are automatically removed when a condition no longer exists.

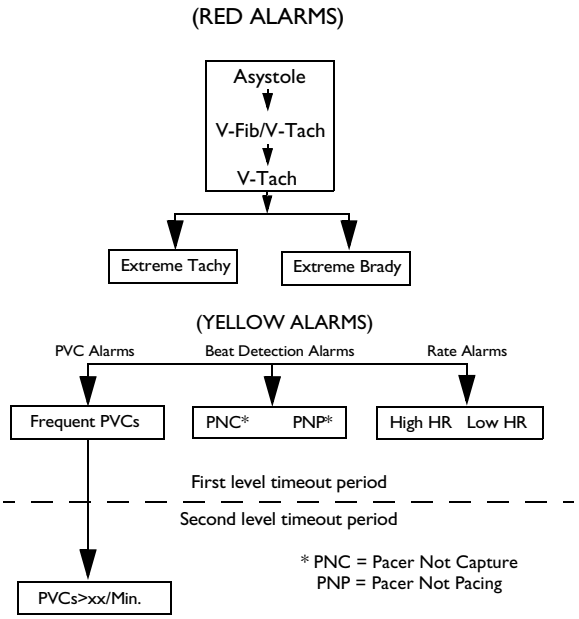
HR/Arrhythmia Red Alarms

Alarm Message	Condition	Indicator	Latching/ Non-Latching
Asystole	No detectable beats for four seconds in the absence of Vfib	Red alarm message, alarm tone	Latching
VFIB/VTACH	A fibrillatory wave detected for four seconds	Red alarm message, alarm tone	Latching
VTACH	Consecutive PVCs and HR exceed defined limits	Red alarm message, alarm tone	Latching
Extreme Brady	10 bpm below HR Low limit, capped at 30 bpm	Red alarm message, alarm tone	Latching
Extreme Tachy	20 bpm above HR High limit capped at 200 bpm (adult) or 240 bpm (pedi)	Red alarm message, alarm tone	Latching

HR/Arrhythmia Yellow Alarms

Alarm Message	Condition	Indication	Latching/ Non-Latching
HR High	The HR exceeds the configured HR high limit	Yellow alarm message, alarm tone	Non-Latching
HR Low	The HR is below the configured HR low limit	Yellow alarm message, alarm tone	Non-Latching
PVC/min. High (value > limit)	The number of detected PVCs in a minute exceeds the limit of 15 (adult/pedi)	Yellow alarm message, alarm tone	Non-Latching
Pacer Not Capture	No QRS following a pacer pulse	Yellow alarm message, alarm tone	Latching
Pacer Not Pacing	No QRS or pacer pulse detected	Yellow alarm message, alarm tone	Latching

Alarm Chain for Basic Arrhythmia Monitoring



INOP Messages

Review INOP messages. Produce only 1-2 messages for reference purposes.

- Communicate conditions preventing ECG monitoring or analysis.
- Displayed just above the HR/Arrhythmia alarm status area.
- Multiple messages alternate every 2 seconds.

Alarm Message	Condition	Indication
Cannot Analyze ECG	Cannot reliably monitor the ECG in Wave Sector 1.	INOP message, INOP tone
ECG Cable Failure	During the Operational Check, a short has been detected between a lead wire and ground.	INOP message, INOP tone
Leads Off	An electrode used for Wave Sector 1 may be off or not attached securely.	INOP message, INOP tone, dashed line
Pads /Paddles Off	The multifunction electrode pads used as the source for the Wave Sector 1 may be off or not attached securely.	INOP message, INOP tone
ECG Unplugged	The primary ECG is derived from leads and the ECG cable is not connected.	INOP message, INOP tone
ECG Equip Malfunction	A malfunction has occurred in the ECG hardware.	INOP message, INOP tone
Pads/Paddles Cable Failure	During the Operational Check, a failure was detected in the pads or paddles cable during the pads/paddles ECG test.	INOP message, INOP tone
Pads ECG Equip Malfunction	A device hardware failure was detected.	INOP message, INOP tone

Practice Exercise 2

Have students set the simulator and MRx to produce a variety of latching, non-latching, and INOP conditions, as appropriate. Pose the following questions:

1. What do you see and hear when a red alarm goes off? A yellow alarm? An INOP message?
2. If you acknowledge the Alarm Pause message in response to an alarm, will you be alerted if the patient's condition persists or recurs?

Additional points/notes:

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Setting Alarms

Introduce setting alarms.

- Alarms are automatically enabled in Monitor and Pacer Modes.
- In Manual Defib Mode, alarms are automatically enabled if the Sync function is enabled. If the Sync function is not enabled, alarms are enabled using the Alarm Pause button.
- Alarms alert you when values exceed or fall below defined limits.
- Heart rate (HR) and VTACH alarm settings are as configured but may be changed during operation for the current patient.
- The PVC rate limit setting may only be changed in response to a PVC rate alarm condition.
- Other HR and arrhythmia alarms may not be changed.

Changing Heart Rate or VTACH Alarm Limits

Demonstrate the steps to change HR or VTACH limits.

1. Press the Menu Select button.
2. Select **Measurements/Alarms** and press Menu Select.
3. Select **HR/Arrhythmia** and press Menu Select.
4. Select **HR Limits** and press Menu Select.
5. Select new values and press Menu Select.
6. Select **VTACH Limits** and press Menu Select.
7. Select new values and press Menu Select.

Enabling/Disabling Heart Rate and Arrhythmia Alarms

Demonstrate the steps to enable or disable HR and arrhythmia alarms.

1. Press Menu Select.
2. Select **Measurements/Alarms** and press Menu Select.
3. Select **HR/Arrhythmia** and press Menu Select.
4. Select **Alarms On/Off** and press Menu Select.

Note the following: Disabling alarms prevent all alarms associated with HR measurements from being annunciated. If an alarm condition occurs, no alarm indication will be given.

Responding to HR and Arrhythmia Alarms

Discuss and demonstrate how to respond to alarms.

- The Audio Pause label appears when an alarm is announced.
- Menu Select or Navigation buttons silence alarm audio.
- Two minutes after being paused, if an alarm condition still exists, the alarm audio re-sounds.
- Respond to an HR or Arrhythmia alarm, as follows:

1. **Acknowledge** the alarm condition.
2. Adjust the limits using the **New Limits** menu.

Practice Exercise 3

Have students change HR or VTACH limits, and enable/disable and respond to HR and arrhythmia alarms.

Additional points/notes:

Displaying an Annotated ECG

Demonstrate how to display an annotated ECG.

- Beat labels appear in Wave Sector 2 based on the ST/AR Algorithm analysis.
- Beat labels appear in Wave Sector 1 after a six second delay.
- Below are the various beat labels with related descriptions.

Label	Description	Displayed Location
N	Normal	Above QRS
V	Ventricular Ectopic	Above QRS
P	Paced	Above QRS
'	Pacer spike	Above the waveform where the pacer spike is detected. (If the patient is both atrially and ventricularly paced, the display will show two ' marks above the waveform aligned with the atrial and ventricular pacing.)
L	Learning Patient's ECG	Above QRS
A	Artifact (noisy episode)	Above the waveform where the noise is detected.
?	Insufficient information to classify beats	Above QRS
I	Inoperative condition (e.g. LEAD OFF)	Above the waveform at start of INOP, every second of INOP, and at end of INOP
M	Pause, Missed Beat, No QRS at beginning of asystole	Above the waveform where the condition is detected

To display an annotated ECG:

1. Press Menu Select.
2. Select **Displayed Waves** and press Menu Select.
3. Select **Wave 2** and press Menu Select.
4. Select **Annotated ECG** and press Menu Select.

Practice Exercise 4

Have students display an annotated ECG. Pose the following question:

1. Where does the annotation first appear?

Additional points/notes:

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Arrhythmia Learning/Relearning

Discuss and demonstrate how the MRx learns and relearns automatically and manually.

- To ensure the ST/AR Algorithm can properly analyze the patient's normal and/or paced complexes, MRx *automatically* performs arrhythmia learning/relearning:
  - when the Therapy Knob is turned to **Monitor**, **Pacer**, or **Manual Defib**.
  - when there is a change in the lead selection for Wave Sector 1.
  - after the correction of a "Leads or Pads Off" INOP condition that has been active longer than 60 seconds.
- Initiate *manual* relearning if beat detection is not occurring or if beat classification is incorrect and results in a false alarm. To initiate relearning manually:

1. Press Menu Select.
2. Select **Measurements/Alarms** and press Menu Select.
3. Select **HR/Arrhythmia** and press Menu Select.
4. Select **Relearn Rhythm** and press Menu Select.

The messages "Learning ECG" and "Learning Rhythm" appear in the rhythm status area of the display.

Practice Exercise 5

Have students complete the steps to initiate manual relearning, as appropriate.

Additional points/notes:

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Review

Have students answer the following questions individually or as a group. (Correct answers are in bold. Consider having students correct FALSE statements to ensure comprehension.)

1. Identify the Monitoring View elements. (**4 wave sectors, INOP area, ECG/HR alarms, HR values, alarm settings**)
2. True or false? You can select the ECG lead for Wave Sectors 1-4 using the Lead Select button. (**F - The Lead Select button can only be used with Sector 1.**)
3. Which of the following alarms can ONLY be changed while IN RESPONSE TO AN ALARM CONDITION?
   a. HR
   b. PVC
   c. VTACH
4. Which of the following statement(s) are TRUE?
   a. All arrhythmia alarms are classified as "latching" alarms. (F - Some are non-latching.)
   b. Yellow alarms can communicate equipment failures. (F - INOP messages do this.)
   c. Alarms are enabled as soon as you enter Manual Defib Mode if the Sync function is enabled. (**T**)
   d. Menu Select AND Navigation buttons can acknowledge alarms. (**T**)
5. True or false? The MRx automatically performs arrhythmia learning/relearning when there is a lead selection change for Wave Sector 1 or 2. (**F - Automatic relearning takes places when there is a lead change for Wave Sector 1 only.**)

4

Semi-Automated External Defibrillation

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to use AED Mode. It highlights the AED display view and explains the steps and associated prompts that guide users through the defibrillation process.

Objectives

Upon completion of this lesson, students should be able to:

1. Locate pertinent information in AED View.
2. Prepare a patient for AED defibrillation.
3. Defibrillate in AED Mode.

Time

10-15 minutes

Accessories Recommended

- Simulator
- Hands-free cable
- Multifunction electrode pads

Clinical Resources

- *AED Algorithm* Application Note (M3500-91040)
- *SMART Biphasic* Application Note (M3535-91040)

Lesson Presentation

Overview

Introduce the Semi-Automated External Defibrillation (AED) Mode.

- AED Mode guides users through standard treatment algorithms for cardiac arrest.
- It includes voice and screen prompts for defibrillation preparation, ECG analysis, and shock delivery.
- You can customize AED Mode configuration to meet your organization's needs.
- AED Mode is not intended for children under 8 years of age. For children 8 years of age and older, the American Heart Association recommends that standard operating procedures for AEDs be followed.
- AED Mode may include Q-CPR measurement and feedback, if so equipped. (See the Q-CPR lesson for details.)

AED View

Connect a simulator to the MRx, set it to normal sinus rhythm (NSR), and turn the Therapy Knob to AED. Then, introduce the unique AED View characteristics.

- Enlarged ECG (Wave Sectors 1 and 2 combined)
- Enlarged Event Timer
- Shock Counter (with total number of shocks delivered in AED/Manual Defib Modes)
- Text message window, accompanied by related voice prompts

Suggestion: **Ask students to point out characteristics instead of YOU stating them.**

Additional points/notes:

Preparation

Discuss the AED defibrillation preparation.

1. Confirm the patient's condition (i.e., unresponsive, not breathing, and/or pulseless).
2. Prepare the patient's chest. Wipe moisture away and, if necessary, clip or shave excessive chest hair.
3. Apply multifunction electrode pads to the patient as directed on the pads package, using the **anterior-anterior** electrode placement.

Note the following: The AED algorithm used by the MRx has not been validated using anterior-posterior pads placement.

4. If not pre-connected, insert the pads cable into the green Therapy port. **DEMONSTRATE**
5. Connect the pads to the pads cable. **DEMONSTRATE**

***Suggestion*: Have students complete steps 4 and 5.**

Additional points/notes:

AED Mode

Demonstrate the AED defibrillation steps with the simulator set to VF (V-Fib).

1. Turn the Therapy Knob to **AED**.
2. Follow the voice and screen prompts.
3. Press the orange Shock button, if prompted.

Mention the following AED Mode characteristics during the demonstration.

- Device capabilities are limited to those essential to AED.
- Only the ECG acquired through pads is displayed. No other parameters appear.
- Shockable rhythms are VTACH-High and V-Fib.
- Previously-set alarms and scheduled measurements are indefinitely paused.
- Entry of patient information is disabled.
- Sync, Lead Select, and Alarm Pause buttons are inactive.
- The voice prompt volume is easily adjusted.

Suggestion: **Ask students to help point out characteristics instead of YOU stating them all.**

Additional points/notes:

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Turn the Therapy Knob to AED

When the MRx is turned to **AED**, it checks for proper pads cable and pads connection, as follows.

If the:	you are prompted to:
pads cable is not properly attached	*Connect Pads Cable*
- pads are not connected to the pads cable, - pads are not applied to the patient, or - pads are not making proper contact with the patient's skin	*Apply Pads* and *Plug in Connector*

Practice Exercise 1

Have students turn the Therapy Knob to AED without a pads cable and/or pads connected to see what prompts are generated.

Additional points/notes:

Follow the Screen and Voice Prompts

Next, connect the pads and pads cable, set the simulator to a shockable rhythm (e.g., VF), and complete the defibrillation process (steps 2 and 3).

Note the following:

- Once an ECG is detected, MRx automatically analyzes the patient's heart rhythm and warns not to touch the patient.

If:	you get the message:
artifact interferes with analysis	*Analyzing Interrupted, Do Not Touch the Patient*
artifact persists	*Cannot Analyze* and *Paused. Attend To Patient*

- Analysis is suspended during pause time. Ensure good pads contact and minimize movement. Analysis resumes automatically after 30 seconds or when you press **`[Resume Analyzing]`**.

Discuss impedance related to patient preparation and pads and paddles placement, and its impact on delivering an effective shock.

- Impedance is the resistance between the defibrillator's multifunction electrode pads or paddles that the defibrillator must overcome to deliver an effective discharge of energy. The degree of impedance differs from patient to patient and is affected by several factors including the presence of chest hair, moisture, hand lotions or powders on the skin.
- The MRx's low-energy SMART Biphasic waveform is an impedance-compensating waveform designed to be effective across a wide range of patients, with no influence of body weight on shock success. However, if you receive a "**No Shock Delivered**" message, check that the patient's skin has been washed and dried and that any chest hair has been clipped. If the message persists, change the pads and/or the pads cable.

***Suggestion*: Reference and read through the *SMART Biphasic* Application Note (M3535-91040) for further details on the SMART Biphasic waveform, as appropriate.**

Shock Advised

Mention that if a shockable rhythm is detected, the MRx:

- Automatically charges to 150J.
- Generates voice and screen prompts and a steady high-pitched tone.
- Displays a flashing Orange Shock button when fully charged.
- Analyzes heart rhythm while charging.
- Disarms if a rhythm change is detected before a shock is delivered and no longer appropriate.

Note the following: You can disarm a fully charged device by turning the Therapy Knob to **Off** or by pressing the **`[Pause for CPR]`** soft key. Resume monitoring by turning the Therapy Knob back to **AED**.

Additional points/notes:

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Press the Orange Shock Button, if Prompted

Now complete the Shock step. Note the following:

- MRx prompts *Deliver Shock Now; Press the Orange Button Now* once charging is complete.
- No one should be touching patient or anything connected to patient. Call out clearly and loudly "Stay Clear!" Then, press the orange Shock button.
- The *Shock Delivered* message confirms shock delivery.
- The shock counter gets updated.
- An annotated strip is automatically printed.
- MRx prompts *Paused. If Needed, Begin CPR*, and commences analysis at the completion of the pause period or when you press the **[Resume Analyzing]** soft key.
- The CPR pause length is defined by the configured CPR timer period. Q-CPR may be activated if the MRx is equipped with this option.

Practice Exercise 2

Have students attach a simulator to the MRx, set it to a shockable rhythm (e.g., VF), and complete defibrillation (with one shock). Pose the following questions:

1. What screen prompts do you see and voice prompts do you hear initially?
2. How do you know the device is ready to deliver a charge?
3. What do you see and hear after delivering a shock?
4. What happens when you press the **[Resume Analyzing]** soft key?

Additional points/notes:

No Shock Advised (NSA)

Finally, set the simulator to a normal sinus rhythm (NSR). Tell users how their MRx is configured for NSA (Monitor or a pause time setting). Mention that if a shockable rhythm is not detected, MRx:

- Informs that *No shock advised*

If the NSA is set to:	MRx:
Monitor	• monitors the ECG and periodically prompts *If needed, press Pause and begin CPR.*
Pause Time	• suspends analysis, during which time you can administer CPR and attend to the patient. • displays a Pause status bar and resumes analysis at the completion of the pause period.

Practice Exercise 3

Have students set the simulator to NSR. Consider both *Monitor* and *Pause Time* configuration choices. Pose the following questions:

1. What screen prompts do you see and voice prompts do you hear?
2. What happens when you press the **`[Pause for CPR]`** soft key?

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold.)

1. Identify the AED View elements. (**Event timer, enlarged ECG, shock counter, message window**)
2. Apply multifunction electrode pads using anterior-posterior placement for AED. (**F - anterior-anterior**)
3. What are the three basic steps for AED using the MRx?
   a. **Turn the Therapy Knob to AED.**
   b. **Follow the voice and screen prompts.**
   c. **Press the orange Shock button, if prompted.**
4. Which of the following statement(s) about AED Mode are TRUE?
   a. The MRx automatically checks for proper pads cable and pads connection. (**T**)
   b. If artifact interferes with ECG analysis and persists, analysis will suspend but resume automatically after 60 seconds. (F - Analysis resumes automatically after 30 seconds.)
   c. The MRx automatically disarms if a shock becomes unnecessary. (**T**)
   d. The MRx automatically analyzes the patient's heart rhythm after a shock is delivered. (**T**)

5

Manual Defibrillation and Cardioversion

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson explains how to prepare for and perform manual asynchronous and synchronous (cardioversion) defibrillation using multifunction electrode pads and external/internal paddles.

Objectives

Upon completion of this lesson, students should be able to:

1. Locate pertinent information in Code View.
2. Prepare a patient for asynchronous and synchronous defibrillation.
3. Perform asynchronous and synchronous defibrillation.

Time

10-20 minutes

Accessories Recommended

- Simulator
- Hands-free cable
- Multifunction electrode pads
- External paddles
- Internal paddles (include M4740A Paddle Adapter Cable for switchless paddles)
- 3-, 5-, or 10-Lead monitoring electrodes

Clinical Resources

- *SMART Biphasic* Application Note (M3535-91040)

Lesson Presentation

Manual Mode

Introduce the Manual Defib Mode.

- The entire defibrillation process is under your control (i.e., you assess the ECG, decide if defibrillation or cardioversion is indicated, select the appropriate energy setting, charge the device, and deliver the shock).
- Text messages are present; voice prompts are not present.
- Defibrillation is always performed through paddles or pads.
- You can monitor the ECG using an alternate ECG source (3-, 5-, or 10-Lead monitoring electrodes).
- You should be ACLS certified to use this mode.
- This mode may be password protected, as defined in Configuration.
- This mode may include Q-CPR measurement and feedback, if equipped on the MRx.

Code View

Connect a simulator to the MRx, set it to a normal sinus rhythm (NSR), and turn the Therapy Knob to Manual Defib on the MRx. Introduce the unique Code View characteristics.

- Enlarged Event Timer
- Heart rate
- Enlarged ECG (Wave Sectors 1 and 2 combined)
- Shock counter (with total number of shocks delivered in AED/Manual Defib Modes)
- Text message window

Suggestion: **Ask students to point out characteristics instead of YOU stating them.**

Additional points/notes:

Manual Defibrillation Preparation

Discuss defibrillation preparation using multifunction electrode pads, external paddles, and/or internal paddles.

Multifunction electrode pads

1. Confirm the patient's condition (i.e., unresponsive, not breathing, and/or pulseless).
2. Prepare the patient's chest (i.e., remove clothing, remove moisture from chest, and remove excessive hair).
3. Apply multifunction electrode pads to the patient according to pads package directions or organization's protocol.
4. If not pre-connected, insert the pads cable into the green Therapy port. **DEMONSTRATE**
5. Connect the pads to the pads cable. **DEMONSTRATE**

Suggestion: **Have students complete steps 4 and 5.**

External paddles

1. Confirm the patient's condition (i.e., unresponsive, not breathing, and/or pulseless).
2. If not pre-connected, insert the paddles cable into the green Therapy port. **DEMONSTRATE**
3. Remove the paddles from the paddle tray. **DEMONSTRATE**
4. Apply the paddles to the patient's bare chest, using the anterior-anterior placement or your organization's protocol.

Suggestion: **In your demonstration, mention the patient contact indicator (PCI) on the sternum paddle and how once proper contact is made, the PCI shows a green LED. Also, include access to the pediatric paddles. Have students complete steps 2 and 3. Consider discussing impedance related to patient preparation and pads and paddles placement, and its impact on delivering an effective shock.**

- Impedance is the resistance between the defibrillator's pads or paddles that the defibrillator must overcome to deliver an effective discharge of energy. The degree of impedance differs from patient to patient and is affected by several factors, including the presence of chest hair, moisture, and lotions or powders on the skin.
- The low-energy SMART Biphasic waveform is an impedance-compensating waveform that is designed to be effective across a wide range of patients. However, if you receive a "No Shock Delivered" message, check that the patient's skin has been washed and dried and that any chest hair has been clipped. If the message persists, change the pads and/or the pads cable.

Internal Paddles

1. Select the appropriate switched or switchless paddle electrode size.
2. If using switchless paddles, connect the paddles to the M4740A Paddle Adapter Cable. **DEMONSTRATE**
3. Connect the paddles cable (or the paddle adapter cable) to the MRx. **DEMONSTRATE**

Additional points/notes:

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Manual Defibrillation

Start with a brief demonstration of the manual defibrillation steps with a simulator set to VF (VFib).

1. Turn the Therapy Knob to **Manual Defib** and select an energy setting.
2. Press the Charge button on the MRx (or external paddle).
3. Make sure no one is touching patient or anything connected to patient before shock; call out loudly and clearly "Stay Clear".
4. Press the orange Shock button on the MRx (or the buttons on both external paddles).

Mention the following Manual Mode characteristics during the demonstration.

- The energy range is 1 to 200J, with 150J the recommended level for adult patients; 50J is maximum energy for internal paddles.
- 1-10 (or 1-9) energy setting displays the **Select Energy** menu, with a default setting of 6J; use the Navigation buttons to increase or decrease the desired setting and the Menu Select button to complete your selection.
- The energy selection in the Shock Status area changes and a continuous, low-pitch charging tone sounds as the defibrillator charges.
- The current energy displays and a continuous, high-pitch 'charge done' tone sounds at the end of the charge.
- Monitoring alarms are indefinitely paused once energy is selected for defibrillation; alarms are active once the Therapy Knob is moved to **Monitor** or **Pacer**, or if the Alarm Pause button is pressed.
- Automatic NBP measurements are discontinued once energy is selected; manual NBP measurement can be requested and displayed in its normal position on the display.
- Selected energy can be increased or decreased at any time during charging or after charging is complete; the defibrillator charges to the selected energy level automatically.
- Press [**Disarm**] to disarm the device; if the Shock button is not pressed within the time period specified in the Time to Auto Disarm configuration setting, the MRx disarms automatically.
- Do not leave patients unattended when the MRx is in Manual Defib Mode with pads applied to the patient.

Suggestion: **Ask students to help point out characteristics instead of YOU stating them all.**

Practice Exercise 1

Have students attach a simulator and parameter accessories (if appropriate) to the MRx, set the simulator to a shockable rhythm (e.g., VF), and complete manual defibrillation (with 1 shock). Try changing the energy level during and/or after a charge. Pose the following questions:

1. What do you see and hear during a charge?
2. How do you know the device is ready to deliver a charge?
3. What do you see and hear after delivering a shock?
4. How do you know if alarms are active?
5. What happens when you press the **`[Disarm]`** soft key?

Additional points/notes:

Synchronized Cardioversion

Introduce synchronized cardioversion.

- Synch cardioversion allows synchronized shock delivery with the ECG R-wave monitored in Wave Sector 1.
- It can be performed through either multifunction electrode pads or external paddles.
- You should monitor ECG through 3-, 5-, or 10-Lead monitoring electrodes when using external paddles.

Preparation

Discuss cardioversion preparation.

1. Perform the tasks as described in the previous ***Manual Defibrillation Preparation*** topic.
2. If monitoring through a 3-, 5-, or 10-Lead ECG cable, plug the cable into MRx's ECG port, and apply monitoring electrodes to the patient.
3. Use the Lead Select button to select pads, paddles, or a lead from attached monitoring electrodes.

***Suggestion*: Have students complete steps 2 (using a simulator) and 3.**

Additional points/notes:

Synchronized Shock Delivery

Demonstrate synchronized cardioversion with a simulator set to AFib.

1. Turn the Therapy Knob to **Monitor** and press the Sync button.
2. Confirm that the Sync marker appears with each R-wave. If the marker does not appear, select another lead.
3. Turn the Therapy Knob to **Manual Defib** and select an energy setting.
4. Press the Charge button on the MRx (or external paddle).
5. Make sure no one is touching the patient or anything connected to the patient before delivering a shock.; call out loudly and clearly "Stay Clear".
6. Press **and hold** the Shock button on the MRx (or orange buttons on both paddles). The shock will be delivered when the next R-wave is detected.

Mention the following cardioversion characteristics during the demonstration.

- The selected energy can be changed at any time during charging or after charging is complete; the MRx charges to the selected energy level automatically.
- Press [**`Disarm`**] to disarm the defibrillator; if the Shock button is not pressed within the time period specified in the Time to Auto Disarm configuration setting, the MRx disarms automatically.
- **This point is important to emphasize:** Continue to hold the Shock button (or the paddle shock buttons) until the shock is delivered so the defibrillator shocks the next detected R-wave.
- Confirm sync markers on the R-wave are appropriate and repeat above steps 4-6 to deliver additional synchronized shocks, assuming Sync is enabled. If Sync is off, complete steps 1-6.
- The Sync function can be configured to either be enabled or disabled after each shock is delivered. If enabled and the Therapy Knob is moved to either **Monitor** or **Pacer**, the Sync function is still active. If the Therapy Knob is moved to either **Off** or **AED**, the Sync function is disabled.
- Press the Sync button again to turn off the Sync function.
- **This point is important to emphasize:** REMEMBER to turn Sync off if manual defibrillation is required.

Suggestion: **Ask students to help point out characteristics instead of YOU stating them all.**

Practice Exercise 2

Have students attach a simulator and pads to the MRx, set the simulator to a shockable rhythm (e.g., VF), and complete synchronized cardioversion. Pose the following questions:

1. What do you see when you press the Sync button?
2. How do you know if sync is active?
3. How long do you need to press the Shock button?
4. Once in Sync mode, what happens when you turn the Therapy Knob to a position other than **Manual Defib**?
5. What happens when you press the Sync button again?

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold.)

1. Identify the Code View elements. (**Event timer, heart rate, enlarged ECG, shock counter**)
2. What are the three basic steps for manual defibrillation using the MRx?
   a. **Turn the Therapy Knob to Manual Defib on a desired energy level.**
   b. **Press the Charge button.**
   c. **Press the Shock button.**
3. Which of the following statement(s) indicate that the MRx is ready to deliver a shock via pads?
   a. The device sounds a continuous high-pitched tone. (**Y**)
   b. The Charged value on the display matches the Therapy Knob setting. (**Y**)
   c. The disarm soft key is disabled. (N)
   d. The Shock button flashes. (**Y**)
4. What are the four basic steps for synchronized cardioversion using the MRx?
   a. **Turn the Therapy Knob to Monitor and press the Sync button.**
   b. **Turn the Therapy Knob to Manual Defib on a desired energy level.**
   c. **Press the Charge button.**
   d. **Press and hold the Shock button.**

6

Q-CPR™

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to set-up and use the Q-CPR™ option available on the HeartStart MRx.

Objectives

Upon completion of this lesson, students should be able to:

1. Identify intended use and preparation for use related to Q-CPR.
2. Identify characteristics related to Q-CPR in Manual Defib and AED Modes.

Time

15-20 minutes

Accessories Recommended

- Pads/CPR cable
- Compression sensor
- Compression sensor adhesive pads
- Philips multifunction electrode pads
- Ambu bag
- Resusci Anne manikin (to perform compressions only)

Note: To perform and measure both compressions and ventilations, the Resusci Anne SkillReporter manikin and Q-CPR Trainer are required.

Clinical Resources

- *Q-CPR™ Measurement and Feedback* Application Note (M3535-91980)

Note: Q-CPR™ is a trademark of Laerdal Medical.

Lesson Presentation

Overview

Introduce the Q-CPR option and its intended use.

- Q-CPR offers real-time measurement and corrective feedback on compression rate, depth, and duration, as well as ventilation rate, volume, and flow rate (inflation time). It also provides notification of CPR inactivity.
- Compressions are measured through the signal acquired by the Compression Sensor. Ventilation data is acquired through multifunction defib electrode pads in conjunction with signals from the sensor.
- Q-CPR is intended for use with only the HeartStart MRx and available in Manual Defib Mode and AED Mode. Both modes provide audio prompts and visual indicators when CPR performance deviates outside of target ranges and in accordance with AHA/ERC guidelines.
- Q-CPR is contraindicated for use:
  - on neonatal and pediatric patients (under 8 years of age or weighing less than 25 kg).
  - when CPR is contraindicated.
  - in a moving environment (e.g., ambulance). Additional movement introduced during patient transport may reduce compression and ventilation measurement accuracy. If Q-CPR must be used in a moving environment, do not rely on the Q-CPR feedback during such conditions. There is no need to remove the Compression Sensor from the patient.
  - with any other CPR compression devices (aside from the Q-CPR Compression Sensor)
- Events related to Q-CPR are not stored in the HeartStart MRx Event Summary.
- There is a Q-CPR Data Capture option available that allows you to capture data on CPR quality from the HeartStart MRx using the Q-CPR option. The Q-CPR Data Capture option stores CPR-related data for retrospective review and analysis using Q-CPR Review software available from Laerdal Medical Corporation. (See the *Q-CPR Review Directions for Use* for more information on Q-CPR Review software.)

Additional points/notes:

Q-CPR Preparation

Discuss cable connections and preparation for Q-CPR.

Pads/CPR Cable to the MRx

The Q-CPR option requires the use of the Pads/CPR cable (M4763A). To connect the Pads/CPR cable:

1. Align the white pointer on the cable with the white arrow on the green Therapy port and insert the cable into the port. Push until you hear it click into place. **DEMONSTRATE**

***Suggestion*: Have students complete this step.**

Note the following, as appropriate:

- Pre-connect the Pads/CPR cable to the MRx (prior to a resuscitation event or rescue) to save on set-up time.
- The Q-CPR option requires the Pads/CPR cable to be connected to the HeartStart MRx. CPR feedback is not available if the standard pads or paddles cable is connected.

Compression Sensor to the Pads/CPR Cable

1. Align the key marker on the Compression Sensor cable with the key marker on the receptacle end of the Pads/CPR cable. Push until you hear it click into place. **DEMONSTRATE**

***Suggestion*: Have students complete this step.**

Note the following:

Pre-connect the Compression Sensor cable to the Pads/CPR cable to save time on set-up.

Compression Sensor Adhesive Pad

1. Peel the white rear liner from the bottom of the Compression Sensor Adhesive Pad. (The rear liner is blank.) **DEMONSTRATE**
2. Align the Compression Sensor Adhesive Pad with the yellow area of the Sensor and press into place. **DEMONSTRATE**

***Suggestion*: Have students complete steps 1 and 2.**

Note the following:

- The Compression Sensor Adhesive Pad is intended for single-patient use only.
- Pre-attach the Compression Sensor Adhesive Pad to the Compression Sensor to save time on set-up. For pre-connection storage, refer to the Setting Up section of the *MRx Instructions for Use*.

Multifunction Electrode Pads

1. Check the expiration date on the pads package and inspect the packaging for any damage.
2. Prepare the patient's chest.
3. Apply the pads to the patient as directed on the pads package, using the **anterior-anterior** placement. **DEMONSTRATE (if manikin available)**
4. Connect the pads to the Pads/CPR cable. **DEMONSTRATE**

***Suggestion*: Have students complete steps 3 (if a manikin is available) and 4.**

Note the following:

- The ventilation algorithm used by Q-CPR requires an anterior-anterior pads placement. Anterior-posterior pad placement should not be used.
- Pads need to be applied securely and maintain good contact to ensure a good signal for ventilation detection. The inop message *Poor Pads Contact* or *Pads Off* displays if there is a contact problem.

Compression Sensor on the Patient

1. Ensure the patient's skin is clean and dry. If necessary, clip or shave the hair from the sternum area.
2. Peel the green liner away from the Compression Sensor Adhesive Pad using the yellow pull tab on the top liner. **DEMONSTRATE**
3. Position the Compression Sensor on the patient as shown in the graphic displayed on the green liner. The proper location is on the lower half of the sternum, which is at the normal CPR hand location. **DEMONSTRATE**
4. When the Compression Sensor is on the patient's chest, the flat grey surface should be facing up. Place the heel of your hand on the flat grey surface in the same way that you would position your hand on the patient's chest if performing CPR without the Compression Sensor. Perform compressions according to AHA/ERC guidelines. **DEMONSTRATE (with shallow, simulated compressions if on a person and full compressions if on a manikin)**

***Suggestion*: Have students complete steps 2-4.**

Note the following:

- Do not apply the Compression Sensor to an open wound or recent incision site.
- CPR is best performed when the patient is lying on a firm surface. If the patient is on a compliant surface such as a mattress, the patient should be placed on a backboard.
- The accuracy of ventilation feedback may be decreased when the patient is handled or moved, or when the Q-CPR option is used on patients with certain conditions such as trauma, seizures, reduced lung volume, or high cardiac ejections.

Practice Exercise 1

Have students make all cable attachments and then detach a cable (e.g., Pads/CPR or Compression Sensor cable) to see what inop is produced. For example, the message *Connect Pads/CPR Cable* displays if not pre-connected. Loosen a multifunction pad to see what inop is produced (e.g., *Poor Pads Contact* or *Pads Off*. Make sure students attach the Compression Sensor pad properly and the Compression Sensor is placed properly on the patient (or manikin).

Additional points/notes:

Q-CPR in Manual Defib Mode

Demonstrate Q-CPR in manual defibrillation mode with a simulator set to VF (VFib).

1. Turn the Therapy Knob to **Manual Defib** and select the 150J energy setting to automatically display the Q-CPR sub view.

Note the following:

- The Sync function must be disabled, the patient category must be Adult, and patient age must be equal to or greater than 8 years old to automatically display the Q-CPR sub view.
- If Manual Therapy Security is enabled, the CPR sub view is not automatically displayed. The CPR sub view is automatically displayed after the Manual Therapy Security password is entered.
- When the Therapy Knob is set on any other Manual Defib setting, patient category is Adult, and patient age is equal to or greater than 8 years old, the first CPR compression displays the Q-CPR sub view.

Mention the following Manual Defib Q-CPR view characteristics while performing CPR (preferably on a manikin). Consider enlisting two students to perform compressions and ventilations so that you can focus on discussion of the characteristics.

- Wave forms for ECG, invasive pressure (ABP, ART Ao or PAP), and CO_2 parameters can be viewed during the use of Q-CPR. If an ABP, ART Ao or PAP pressure measurement is active, the waveform always appears in Wave Sector 3 and the pressure value displays in Parameter Block 2. If two pressures labeled ABP, ART, Ao or PAP are available, the label assigned to Pressure 1 is displayed. If no pressure is active, then the compression waveform appears in Wave Sector 3. Parameter Block 2 displays compression and ventilation measurement information. The $EtCO_2$ waveform will appear in Wave Sector 4 if present. AwRR numeric values are not displayed.

Compression waveform

- The compression waveform appears in Wave Sector 3, is labeled **Comp**, and represents approximately 10 seconds of compressions.
- As the chest is compressed, the chest compression is shown as a downward stroke of the wave, rebounding up to a baseline as compression pressure is released.
- The wave sector contains horizontal lines drawn at 38 mm and 51 mm (or 1.5” and 2”) that define a target zone for appropriate chest compression depth. Good compression depth is achieved when the peak, or minimum value, of the waveform appears between the lines.
- An asterisk (*) annotates when pressure is not released between compressions, also referred to as “leaning”.
- If the Compression Sensor signal becomes invalid (e.g. the sensor is disconnected), the waveform appears as a dashed baseline. ***Suggestion*: Disconnect the sensor to display the dashed baseline.**

Parameter Block 2

- Parameter Block 2 displays numeric values for compression and ventilation rates. Both rates are a moving average rate, measured per minute. Based on the Q-CPR algorithm, the target compression rate is 100 compressions per minute within an acceptable range of 90-120 compressions per minute. The acceptable range for ventilation rate while CPR is being administered is 4-16 ventilations per minute (to reflect 2005 resuscitation guidelines)
- The acceptable range for ventilation rate following 60 seconds without compressions (such as while rescue breathing is being administered) is 9-16 ventilations per minute.
- The ventilation volume icon depicts an approximate level of ventilation volume. A set of lungs graphically shows four states of the ventilation's magnitude: empty, one-third full, two-thirds full, and full. After a brief display, the icon returns to the empty state. Lungs marked with a "?" indicate when ventilation cannot be measured.

  Note the following: The graphical lungs do not signify the actual filling or presence of both lungs in the patient. The actual ventilation volume associated with filling of the lung icon varies from patient to patient. Actual lung expansion is based upon chest rise and checking bilateral breath sounds.
- The No Flow Time value represents time without a detectable chest compression, beginning at 2 seconds and incremented with each additional second. A voice prompt is given every 15 seconds that compression activity is not detected. The No Flow Time value is reset when a compression occurs or when the Shock button on the HeartStart MRx is pressed. If the No Flow Time value exceeds 1 minute, it is assumed that CPR compression activity has stopped intentionally and the value is cleared.
- If monitoring CO_2, the $EtCO_2$ numeric value is displayed in Parameter Block 2, along with its alarms off indicator.

Note the following:

- SpO_2 monitoring functionality is not available during Q-CPR use.
- Compression, ventilation, and No Flow measurement values are printed in the annotation area of the ECG printed strip. ***Suggestion*: Print a strip to exhibit the values.**

Soft Keys

Toggle between the soft keys in manual defibrillation mode and discuss the following characteristics.

- The Q-CPR sub view is manually displayed by pressing the **`[Start CPR]`** soft key from any energy setting (excluding 150J). This soft key is then labeled **`[Stop CPR]`** and may be used to switch between the Q-CPR sub view and the standard Code View. The Q-CPR sub view and **`[Stop CPR]`** soft key display automatically upon the first CPR compression from any energy setting (excluding 150J).
- If the Sync button is pressed to initiate synchronized cardioversion, Q-CPR is deactivated. Reactivate Q-CPR by pressing the **`[Start CPR]`** soft key or performing chest compressions.
- If the Alarm Pause button is used to turn alarms on, Q-CPR is deactivated.

- The **[Intubate]** soft key displays in the Q-CPR view in both Manual Defib Mode and AED Mode. When intubation is indicated by pressing the **[Intubate]** soft key, the soft key then becomes inactive and its label changes to **[Intubated]**.

  Note the following:
  - When intubation is indicated, the *Ventilate Less Forcefully* and *Ventilate a Little Less Forcefully* audio feedback is suppressed.
  - The Q-CPR option should not be used to verify placement of airway adjuncts, such as endotracheal tubes and laryngeal masks.

Suggestion: **Ask students to help point out compression waveform, parameter block, and soft key characteristics instead of YOU stating all characteristics.**

Practice Exercise 2

Have students turn to 150J manual defibrillation setting and practice performing CPR alone and with another student on a manikin (to experience 1- and 2-rescue person situations) according to AHA guidelines for compression-to-ventilation ratio. Make sure each student has proper hand, arm, and body position to perform CPR. Also, press the Sync button to show what happens to Q-CPR when you switch to synchronized cardioversion or the Alarm Pause button to show what happens to Q-CPR. Pose the following questions:

1. What voice prompts do you hear when performing CPR? What is the most frequently heard prompt? (Note: The prompt will vary depending on the student.)
2. How long can you perform CPR without getting a voice prompt? How long could you perform CPR before getting totally fatigued?
3. What range of compression and ventilation rates do you achieve?
4. How full does the ventilation (lungs) icon get when you do ventilations?
5. How often do you get 'No Flow' times and how long are those times?
6. What happens to Q-CPR when you press the Sync and or Alarm Pause buttons?

Additional points/notes:

Q-CPR in AED Mode

Demonstrate Q-CPR in AED mode. Turn the Therapy Knob to AED, press the Pause for CPR soft key, and mention the following AED Q-CPR view characteristics while performing CPR. Consider enlisting two students to perform compressions and ventilations so that you can focus on discussion of Q-CPR characteristics.

- In AED Mode, Q-CPR provides CPR feedback automatically during the CPR Pause period of the AED protocol or manually when the **`[Pause for CPR]`** soft key is pressed.
- If your No Shock Advised (NSA) Action configuration item is set to provide a CPR Pause interval, Q-CPR can be activated by delivering a compression with the Compression Sensor.
- AED Mode issues voice prompts like Manual Defib Mode; however, it also displays the same prompts as momentary text messages. For details on all Manual Defib and AED Mode feedback prompts, refer to the CPR Feedback Prompts section of the *Q-CPR Instructions for Use Addendum*.
- A configurable CPR Timer status bar is also displayed. The time period of the CPR Timer is determined by the Configuration setting for CPR Pause Time.
- The Q-CPR view in AED Mode displays only the ECG waveform. There is no compression waveform.

Suggestion: **Ask students to help point out characteristics instead of YOU stating them all.**

Practice Exercise 3

Have students turn to AED Mode and practice performing CPR alone and with a another student on a manikin (to experience a 1- and 2-rescue person situation) according to AHA guidelines for compression-to-ventilation ratio. Make sure each student has proper hand, arm, and body position to perform CPR. Pose the following questions:

1. What voice and text prompts do you get when performing CPR? What is the most frequent voice or text prompt produced? (Note: The prompt will vary depending on the student.)
2. How long can you perform CPR without getting a voice or text prompt? How long could you perform CPR before getting totally fatigued?

Additional points/notes:

CPR Feedback Volume Adjustment

Turn the MRx Therapy Knob to a Manual Defib setting (e.g., 150J) and demonstrate the volume adjustment. Press the Start CPR soft key and mute the voice prompts.

To mute the CPR feedback voice prompts (once you start CPR):

1. Press Menu Select.
2. Select **Mute CPR Voice** and press Menu Select.

Note the following: When muted, a *CPR Voice Muted* text message displays in the middle of the compression waveform, and CPR inactivity time is indicated by an audible tone.

To resume voice prompts set at the previously selected volume:

1. Press Menu Select.
2. Select **Resume CPR Voice** and press Menu Select.

To adjust the volume of CPR feedback voice prompts:

1. Press the Menu Select button.
2. Select **Volume** and press Menu Select.
3. Select **Voice** and press Menu Select.
4. Select the desired volume level and press Menu Select.

A sample voice prompt is annunciated to confirm your selection.

Suggestion: **Have students complete the above volume adjustment steps during or after your demonstration.**

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold.)

1. True or false? Q-CPR can be used on patients 8 years and older. (**T**)
2. True or false? The multifunction pads should be placed in an anterior/posterior position to ensure the ventilation algorithm interprets ventilations properly. (**F - The pads need to be in an anterior/anterior position for interpretation.**)
3. True or false? The compression sensor should be positioned on the upper half of the patient's sternum to perform compressions. (**F - The sensor should be placed on the lower half of the sternum, at the normal CPR hand location.**)
4. True or false? In Manual Defib Mode, good compression depth is indicated by the downward "peak" of the waveform appearing between the horizontal lines representing the target zone. (**T**)
5. True or false? The ventilation volume icon indicates ventilation has been detected but not the actual filling of both lungs. (**T**)
6. True or false? Only AED Mode provides voice and text prompts associated with compression and ventilation activity. (**T**)

7

Noninvasive Pacing

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes the noninvasive transcutaneous pacing option available with the HeartStart MRx and how to perform pacing.

Objectives

Upon completion of this lesson, students should be able to:

1. Identify pertinent information in Pacing View.
2. Prepare a patient for pacing.
3. Perform demand or fixed mode pacing.

Time

10-20 minutes

Accessories Recommended

- Simulator
- Hands-free cable
- Multifunction electrode pads
- 3-, 5-, or 10-Lead monitoring electrodes

Clinical Resources

Noninvasive Pacing Application Note (M3500-91060)

Lesson Presentation

Pacer Mode

Introduce the Pacer Mode.

- Pacer Mode delivers pace pulses to the heart through multifunction electrode pads.
- The ECG strip and Event Summary are easily annotated (using the Mark Event button) in Pacer Mode.
- Waveforms, ECG monitoring, measurements, and most alarms (from Monitor or Manual Defib Mode) remain active and retain their settings while in Pacer Mode.
  - The waveform in Wave Sector 4 is replaced by the pacing status bar.
  - Arrhythmia alarms for Pacer Not Pacing and Pacer Not Capture (associated with non-transcutaneous pacing) are off in Pacer Mode. All other red and yellow alarms are active if enabled and their limits may be changed while in Pacer Mode. ECG INOPs are also annunciated.
  - If the ECG source for Wave Sector 1 becomes invalid (e.g., a Leads Off condition or the ECG cable is disconnected) in demand mode pacing, a latching red alarm is generated along with a **Pacing Stopped. Leads Off.** message, and pacing is stopped. Once the condition is corrected, resume pacing by pressing the **[Resume Pacing]** soft key.
  - Also, while in demand mode, if you are using a 3-lead ECG set and the lead in Wave Sector 1 is changed, a latching red alarm is generated as well as a **Pacing Stopped. Leads Off.** message, and pacing is stopped. Once the condition is corrected, resume pacing by pressing the **[Resume Pacing]** soft key.
  - If a Pads Off condition occurs or the pads cable is disconnected, a latching red alarm and **Pacing Stopped.** [**Pads Off.**] [**Pads Cable Off.**] message is generated and pacing is stopped. Once the condition is corrected, resume pacing by pressing the **[Resume Pacing]** soft key.

  Note the following: The Pacing Stopped red alarm cannot be disabled.
  - Heart rate displays and alarms can be unreliable during pacing, so keep close observation on the patient. Do not rely on the indicated heart rate or related alarms as a measure of the patient's perfusion status.
  - When pacing is stopped due to a power interruption, a red *Pacing Stopped. Power Interrupted* alert will appear on the MRx display when power is eventually restored.
- For treatment of patients with implantable devices (permanent pacemakers or cardioverter-defibrillators), consult a physician and the instructions for use provided by the device's manufacturer.
- The use of Pacer Mode may be password protected, as defined in Configuration.

Pacing View

Turn the Therapy Knob to Pacer on the MRx and introduce the unique Pacing View characteristics.

- A status block appears in Wave Sector 4. The first line communicates status (active or paused) or pacing by batteries (if configured) and the second line identifies the pacing mode (demand or fixed), pacing rate (ppm), and pacing output (mA).
- Soft keys set the pacing status (Start/Pause/Resume) and adjust the pacer rate and output.
- White R-wave markers appear on the ECG waveform until capture occurs (if pacing in demand mode); R-wave markers do not appear on pace beats.
- White pacing markers appears on the Wave Sector 1 ECG waveform with each pacer pulse delivery.

Suggestion: **Ask students to point out characteristics instead of YOU stating them.**

Additional points/notes:

Demand vs. Fixed Mode

Introduce demand and fixed mode pacing.

Demand mode

- Pace pulses are delivered when the patient's heart rate is lower than the selected pacing rate.
- Use this mode whenever possible.
- MRx requires a 3-, 5-, or 10-Lead ECG cable and monitoring electrodes as the ECG source while pace pulses are delivered through pads.
- 'Pads' is not displayed in Wave Sector 1. The monitored lead is displayed in Wave Sector 1.

Fixed mode

- Pace pulses are delivered at the selected rate.
- Use when motion artifact or other ECG noise makes R-wave detection unreliable or when monitoring electrodes are not available.

Note the following: The ECG derived from pads need not be displayed in a wave sector to deliver pacing therapy.

Additional points/notes:

Preparation

Demonstrate preparation for pacing.

1. Prepare the patient's chest. Wipe moisture away and, if necessary, clip or shave excessive chest hair.
2. Apply multifunction electrode pads to the patient as directed on the pads packaging or according to your organization's protocol.
3. If not pre-connected, connect the pads cable to the green Therapy port on the MRx. **DEMONSTRATE**
4. Connect the pads connector to the pads cable. **DEMONSTRATE**
5. If pacing in demand mode, apply monitoring electrodes and connect the ECG cable to the ECG port on the MRx. **DEMONSTRATE the ECG cable connection.**

Note the following: If pacing for long periods of time, check the patient's skin; apply new multifunction electrode pads, as necessary. Reposition new pads (in a slightly different location) to help prevent skin burns. Refer to the manufacturer's documentation for replacement recommendations.

Suggestion: **Have students complete steps 2-4, using a simulator.**

Additional points/notes:

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Demand Mode Pacing

Demonstrate how to pace in demand mode.

1. Turn the Therapy Knob to the **Pacer** position.
   Note the following:
   a. The message *Pacing Paused* appears in the status block, indicating that the pacing function is enabled, though pace pulses are not being delivered.
   b. Pacing is enabled in demand mode, with the configured lead displayed in Wave Sector 1. If the configured lead is set to Pads, Lead II or the first available monitoring lead is displayed in place of Pads.
2. Press the Lead Select button to select the best lead with an easily detectable R-wave.
3. Verify white R-wave markers appear above or on the ECG waveform, with a single marker for each R-wave. If no R-wave markers appear coinciding with the R-wave, select another lead.
4. Press the [**Pacer Rate**] soft key and use the Navigation and Menu Select buttons to select the desired number of pace pulses per minute. The initial rate is configurable.
5. If needed, adjust the initial pacer output before you start pacing. Press the [**Pacer Output**] soft key and use the Navigation and Menu Select buttons to select the desired output. The initial output is configurable and has a default setting of 30mA.
6. Press [**Start Pacing**]. The message *Pacing* appears.
7. Verify white pacing markers appear above or on the ECG waveform.
8. Press [**Pacer Output**]. Then use the Navigation and Menu Select buttons to:
   a. increase the output until cardiac capture occurs. Capture is indicated by the appearance of a QRS complex after each pacing marker.
   b. decrease the output to the lowest level that still maintains capture.
9. Verify the presence of a peripheral pulse.

To stop delivery of pace pulses, press [**Pause Pacing**]. Once paused, press [**Resume Pacing**] to resume delivery. You may also stop delivery of pace pulses by moving the Therapy Knob off the **Pacer** position.

Note the following, as appropriate:

- The ECG cable must be directly connected to the MRx when in demand mode. If a sync cable is used, connect the cable using the ECG Out port on the MRx and the ECG In port on the Philips bedside monitor.
- If you are pacing with battery power and the Low Battery Alarm sounds, connect the device to external power or insert a fully charged battery.
- Routinely assess the patient's peripheral pulses.
- When pacing in demand mode, the ECG cable must be directly connected from the patient to the HeartStart MRx.

- Pacing will not start if a pads connection or patient contact problem exists; pace pulses will not be delivered if a monitoring electrodes connection problem exists. An inop message alerts you to either connection problem. For the pads problem, you should check the pads cable is connected, the pads are properly applied, or apply new pads, as needed. For the electrode problem, ensure the ECG cable is connected, the electrodes are applied properly, or reduce patient motion. Resume pacing once either problem is corrected.

Practice Exercise 1

Have students attach pads and electrodes to the MRx and a simulator, set the simulator to bradycardia, and complete demand mode pacing. Pose the following questions:

1. What display changes do you see when completing each step (i.e., turn on pacing, set pacing status, adjust pacer rate and output, and stop pacing)?
2. How do you know when pace pulses are being delivered?

Additional points/notes:

Fixed Mode Pacing

Demonstrate how to pace in fixed mode.

1. Turn the Therapy Knob to **Pacer**.
   Note the following: The message *Pacing Paused* appears in the status block, indicating that the pacing function is enabled, though pace pulses are not being delivered.
2. Change the pacer mode to **Fixed**, using the **Pacer Mode** menu off the Main Menu.
3. Press the Lead Select button to select the desired lead for viewing.

Note that the remaining steps are similar to demand mode pacing.

4. Press [**`Pacer Rate`**] and use the Navigation and Menu Select buttons to select the desired number of pace pulses per minute. The initial rate is configurable.
5. If needed, adjust the initial pacer output by pressing [**`Pacer Output`**] and using the Navigation and Menu Select buttons to select the desired output. The initial output is configurable.
6. Press [**`Start Pacing`**].
7. Verify the presence of a peripheral pulse.
8. Press [**`Pacer Output`**] and use the Navigation and Menu Select buttons to adjust the output, as needed.
9. To pause or stop pacing:
   – Press [**`Pause Pacing`**] or
   – Move the Therapy Knob off the **Pacer** position.

Practice Exercise 2

Have students attach pads and electrodes to the MRx and a simulator, set the simulator to bradycardia, and complete fixed mode pacing. Pose the following questions:

1. What display changes do you see when completing each step (i.e., turn on pacing, set pacing status, adjust pacer rate and output, and stop pacing)?
2. How do you know when pace pulses are being delivered?

Additional points/notes:

Defibrillating During Pacing

Discuss how switching to Manual or AED Mode affects pacing.

- Once the Therapy Knob is moved from **Pacer** to **Manual Defib** or **AED**, pacing is stopped.
- To resume pacing after defibrillation, repeat the pacing procedure. When pacing is resumed, pacing settings selected prior to defibrillation (mode, rate, and output) are retained. Be sure to confirm that cardiac capture has been maintained.
- Turn off pacing before defibrillating with a second defibrillator to prevent damage to the MRx.

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold. Consider having students correct FALSE statements to ensure comprehension.)

1. Which of the following statement(s) are TRUE related to pacing with the MRx?

   a. The device requires a 3-, 5- or 10-Lead ECG cable and monitoring electrodes during demand mode pacing. (T)

   b. The device always delivers pace pulses in demand mode. (F - In demand mode, pace pulses are delivered when the patient's heart rate is lower than the selected pacing rate.)

   c. The Pacing status area indicates pacing mode, status, rate, and output. (T)

   d. If you exit Pacer Mode to defibrillate and then return to Pacer Mode, the settings from the previous pacing session must be re-entered. (F - The settings remain in effect.)

2. Which ONE of the following steps should be performed before pacing is initiated in demand mode?

   a. Verify that a white pacing marker appears in front of each QRS complex.

   b. Verify that white R-wave markers appear above or on the ECG waveform.

   c. Increase pacer output until capture occurs.

   d. Decrease pacer output to the lowest level that still maintains capture.

8

Pulse Oximetry Monitoring

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to use the HeartStart MRx to monitor Pulse Oximetry (SpO_2).

Objectives

Upon completion of this lesson, students should be able to:

1. Monitor SpO_2.
2. Set SpO_2 and pulse rate alarms.

Time

10-15 minutes

Accessories Recommended

- SpO_2 sensor

Clinical Resources

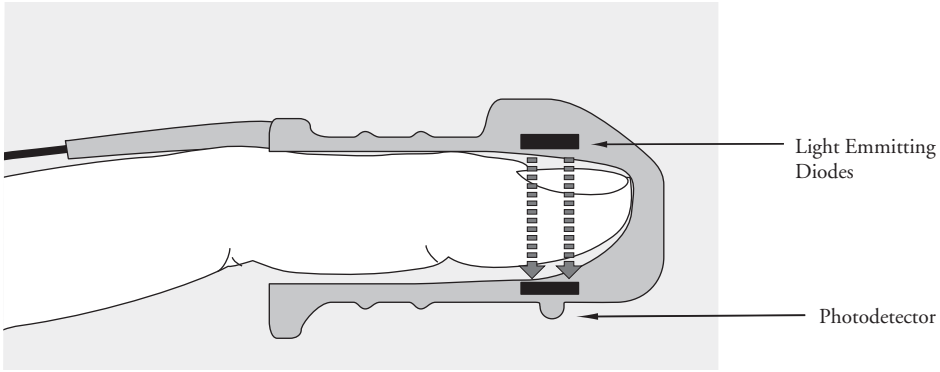
- *Philips Pulse Oximetry* Application Note (M3535-92901)

Lesson Presentation

Overview

Discuss pulse oximetry respective to its use with the MRx.

- Pulse oximetry is a noninvasive method of continuously measuring oxygen saturation (SpO_2) in arterial blood; SpO_2 reading indicates percentage of hemoglobin molecules in the arterial blood saturated with oxygen.
- A pulse oximetry sensor sends light through patient tissue to a receiver on the other side of the sensor. Light emitting diodes transmit red and infrared light through peripheral areas of the body, such as a finger.



A photodetector positioned opposite the light emitting diodes compares light absorption before and after pulsation. The amount of light getting through reflects the blood flow in the arterioles. This measurement of light absorption during pulsation is translated into an oxygen saturation percentage and an SpO_2 value is displayed.

- For accurate SpO_2 measurements, the following conditions must apply:
  - The patient must have perfusion in that extremity.
  - The light emitter and the photodetector must be directly opposite each other.
  - All of the light from the emitter must pass through the patient's tissue.
  - The sensor site should be free of vibration and excessive motion.
  - Power cables should be kept away from the sensor cable and connector.
- You can monitor SpO_2 in Monitor, Manual Defib, or Pacer Modes on the MRx. When using the Q-CPR option, SpO_2 monitoring functionality is not available.

Selecting a Sensor

Discuss the criteria for selecting a sensor.

- The most important factor when selecting a sensor is the position of the light emitting diodes in relation to the photodetector. When a sensor is applied, the diodes and the photodetector must be opposite each other. Select a sensor appropriate for the patient's weight.
- Select a sensor site with adequate perfusion. Improve perfusion at the site by rubbing or warming the site.
- Avoid application to sites with edematous tissue.

- Reusable sensors may be reused on different patients after they have been cleaned and disinfected. (See the manufacturer's instructions supplied with the sensor.)
- Disposable sensors should be used only once and then discarded. They may be relocated to another sensor site on the patient if the first location does not give the desired results. These sensors must not be reused on different patients.

Applying the Sensor

Follow the manufacturer's directions for applying and using the sensor, making sure to observe any warnings or cautions. For the best results:

- Make sure the sensor is dry.
- If the patient is moving, secure the sensor cable loosely to the patient.
- Make sure the transducer is not too tight. Too much pressure can cause venous pulsation or can impede the blood flow, resulting in low readings.
- Keep power cables away from the sensor cable and connection.
- Avoid placing the sensor in an environment with bright lights. If necessary, cover the sensor with opaque material.
- Avoid placing the sensor on an extremity with an arterial catheter, blood pressure cuff, or intravenous infusion line.
- Failure to apply the sensor properly may reduce the accuracy of the SpO_2 measurement.
- Inspect the sensor application site at least every two hours for changes in skin quality, correct optical alignment, and proper sensor application. If skin quality is compromised, change the sensor site. Change the application site at least every four hours. More frequent checking may be required due to an individual patient's condition.
- Using an SpO_2 sensor during MR imaging can cause severe burns. Minimize this risk by positioning the cable so that no inductive loops are formed. If the sensor does not appear to be operating properly, remove it immediately from the patient.

Additional points/notes:

Monitoring SpO_2

Attach an SpO_2 sensor cable to the MRx, the sensor to yourself, and demonstrate preparation for monitor SpO_2.

1. Connect the appropriate sensor cable to the MRx.
2. Apply the sensor to the patient. If a finger sensor is used, the cable should come down the back of the hand.
3. Turn the Therapy Knob to **Monitor**.

Suggestion: **Have students complete the above steps during or after your demonstration.**

Discuss SpO_2 display characteristics.

- A -?- displays in Parameter Block 2 while oxygen saturation is initially measured and an SpO_2 value is calculated; a value replaces -?- and is updated continuously as the patient's oxygen saturation changes.
- Alarm limits display to the right of the value if SpO_2 alarms are turned on; alarms are "on" by default.
- The Alarms Off symbol displays if SpO_2 alarms are turned off.
- The patient's pulse rate (derived from pulse oximetry) is displayed in Parameter Block 1.
- Alarm limits display to the right of the pulse rate value if pulse rate alarms are turned on; alarms are "off" by default.
- The Alarms Off symbol displays if pulse rate alarms are turned off.

Suggestion: **Ask students to point out characteristics instead of YOU stating them.**

Additional points/notes:

Pleth Wave

Mention the following characteristics associated with the pleth wave.

- The wave displays in the configured Wave Sector, if available; otherwise, the wave fills the first available empty Wave Sector.
- The wave is drawn at an approximate speed of 25 mm/second.
- The wave is auto scaled to grid lines when signal quality is good.
- Wave size is proportionately decreased when signal quality is poor.
- The wave continues to display when the Therapy Knob is moved to **Manual Defib**, as long as it is not located in Wave Sector 2 or you're in Q-CPR View. The SpO_2 value is also retained in manual Defib Mode but not in Q-CPR View.
- The pacing status bar replaces the wave in Wave Sector 4 when the Therapy Knob is moved to **Pacer**; however, SpO_2 and Pulse values and alarm settings are retained.
- SpO_2 and pulse information is no longer monitored when the Therapy Knob is moved to **AED**.

Additional points/notes:

Setting SpO_2 Alarms

Mention the following SpO_2 alarm characteristics.

- Alarms sound if measurements fall outside the configured high or low SpO_2 limits or below the configured SpO_2 Desat limit.
- SpO_2 alarms are all categorized as "non-latching" alarms, meaning they are automatically removed when their alarm condition no longer exists.
- Alarms are enabled unless turned off during use; they remain disabled until re-enabled.
- If an alarm condition occurs when alarms are disabled, no alarm indication is given.

Changing Alarm Limits

Demonstrate how to change the SpO_2 alarm limits.

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Measurements/Alarms** menu and press Menu Select.
3. Select **SpO_2** and press Menu Select.
4. Select **SpO_2 Limits** and press Menu Select.
5. Using the Navigation buttons, select the new high limit value and press Menu Select.
6. Select the new low limit value and press Menu Select.

Desat Alarm

Discuss the following Desat alarm characteristics.

- This alarm provides an additional limit setting below the low limit setting to notify you of potentially life threatening decreases in oxygen saturation.
- If the SpO_2 low limit is set below the preset Desat limit, the Desat limit automatically adjusts to the low limit value; if the SpO_2 reading falls below the low limit, the Desat limit alarm sounds.

Enabling/Disabling Alarms

Demonstrate how to enable the SpO_2 alarms.

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Measurements/Alarms** menu and press Menu Select.
3. Select **SpO_2** and press Menu Select.
4. Select **Alarms On/Off** and press Menu Select.

Note the following: SpO_2 INOP messages are suppressed for up to 60 seconds while an NBP measurement is in progress.

Practice Exercise 1

Have students change SpO_2 limits, and enable/disable and respond to related alarms. Pose the following questions:

1. What happens when you change a limit? Disable an alarm? Respond to an alarm?

Additional points/notes:

Setting Pulse Rate Alarms

Mention the following pulse rate alarm characteristics.

- Alarms sound if measurements fall outside the configured high and low pulse rate limits.
- Pulse rate alarms are all categorized as "non-latching" alarms, meaning they are automatically removed when their alarm condition no longer exists.
- Alarms are disabled unless enabled during use.
- Limits can be changed during use.

Changing Pulse Rate Alarm Limits

Demonstrate how to change pulse rate alarm limits.

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Measurements/Alarms** menu and press Menu Select.
3. Select **Pulse** and press Menu Select.
4. Select **Pulse Limits** and press Menu Select.
5. Using the Navigation buttons, select the new high limit value and press Menu Select.
6. Select the new low limit value and press Menu Select.

Enabling/Disabling Pulse Rate Alarms

Demonstrate how to enable pulse rate alarms.

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Measurements/Alarms** menu and press Menu Select.
3. Select **Pulse** and press Menu Select.
4. Select **Alarms On/Off** and press Menu Select.

Practice Exercise 2

Have students change pulse rate limits, and enable/disable and respond to related alarms. Pose the following questions:

1. What happens when you change a limit? Disable an alarm? Respond to an alarm?

Disabling the SpO_2 Monitoring Function

Demonstrate how to disable the SpO_2 monitoring function.

- Disconnect the sensor cable from the SpO_2 port. The message *SpO_2 Unplugged. Turn off SpO_2?* appears. Select **Yes** and press the Menu Select button.
- Should the sensor cable be disconnected accidentally, the message *SpO_2 Unplugged. Turn off SpO_2?* appears. Select **No** and press Menu Select. Then, secure the connection to re-enable the function.

Additional points/notes:

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Review

Have students answer the following questions individually or as a group. (Correct answers are in bold.)

1. True or false? You can monitor SpO_2 in all MRx modes (Monitor, Manual Defib, AED or Pacer). (**F - Not AED**)
2. True or false? The pleth wave is auto scaled to grid lines when the signal quality is poor. (**F - The wave is auto scaled with a good signal.**)
3. True or false? SpO_2 alarms are off unless turned on during use while pulse rate alarms are on unless turned off during use. (**F - SpO_2 alarms are on unless turned off during use while pulse rate alarms are off unless turned on.**)
4. How many seconds are SpO_2 INOP messages suppressed during an NBP measurement?
   a. 15
   b. 30
   c. 45
   d. 60

9

Noninvasive Blood Pressure Monitoring

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to monitor noninvasive blood pressure (NBP) with the HeartStart MRx.

Objectives

Upon completion of this lesson, students should be able to:

1. Monitor NBP.
2. Set NBP alarms.

Time

10-15 minutes

Accessories Recommended

- NBP cuff

Clinical Resources

- *Noninvasive Blood Pressure Monitoring* Application Note (5968-8948E)

Lesson Presentation

Overview

Review NBP characteristics respective to its use with the MRx.

- MRx measures blood pressure (for adults/pediatrics) using the oscillometric method.
- NBP may be measured in Monitor, Pacer, or Manual Defib Modes.
- NBP measurements can be taken automatically on a schedule or manually on demand.
- Alarms signal changes in the patient's condition.
- Systolic, diastolic, and mean pressure, measurement schedule (manual or automatic intervals), and a time stamp are displayed in Parameter Block 1.
- If enabled, NBP alarm limits appear next to the NBP value and the alarm source (systolic, diastolic, or mean) is displayed above the limits.
- If alarms are disabled, the Alarms Off symbol replaces the limits.
- Initial cuff inflation pressure =160 mmHg (adult) or 120 mmHg (pediatric) for first time measurement; next pressure = 35-40 mmHg above systolic measurement, with a minimum inflation pressure of 120 mmHg.
- If the systolic pressure is higher than the inflation pressure, the inflation pressure is automatically increased by 35-40 mmHg and another measurement is attempted.
- The maximum inflation pressure = 280 mmHg; maximum systolic value = 260 mmHg.

Additional points/notes:

Preparing to Measure NBP

Demonstrate NBP measurement preparation using the NBP cuff.

1. Select the appropriately sized cuff for the patient.
2. Attach the cuff to the NBP tubing.
3. Insert the NBP tubing into the NBP port on the MRx.
4. Apply the blood pressure cuff to the patient's arm.
5. Place the limb used for taking the measurement at the same level as the patient's heart.

Note the following:

- Do not perform NBP monitoring on patients whose upper arm circumference is less than 13 cm. Doing so may result in inaccurate measurements.
- When using the MRx aboard aircraft, NBP measurements should only be taken while on the ground or once cruising altitude is reached to ensure accuracy.

Suggestion: **Have students complete the above steps during or after your demonstration.**

Additional points/notes:

Measuring NBP

Demonstrate the steps to measure NBP.

1. Press the [**Start NBP**] soft key.

Note the following:

- NBP values display when the measurement is complete.
- You need to press [**Start NBP**] for every manual measurement.
- Automatic measurement is repeated at configured intervals after pressing [**Start NBP**].
- Additional manual measurements may be taken without affecting the automatic measurement schedule.

2. Press the [**Stop NBP**] soft key to stop an NBP reading.

Changing the NBP Schedule

Demonstrate how to change the NBP schedule and/or the interval of automatic measurements for the current patient.

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Measurements/Alarms** menu and press Menu Select.
3. Select **NBP** and press Menu Select.
4. Select **NBP Schedule** and press Menu Select.
5. Using the Navigation buttons, select the desired interval and press Menu Select.

Note the following:

- If the automatic measurement schedule is changed, the new time interval is applied to the start time of the last measurement. If the new time interval is less than or the same as the time since the last measurement, a measurement begins immediately.
- Interval choices are presented in the format “qx”, indicating measurements are taken every “x” minutes from the time you first press [**Start NBP**].
- If no subsequent measurements are taken, NBP values will be removed from the display after 60 minutes but can still be obtained through Vital Signs Trending.

Practice Exercise 1

Have students complete manual and automatic NBP measurements, including changing the NBP schedule. Pose the following questions:

1. What displays when you start a measurement? Stop a measurement?
2. How does the display differ between a manual and automatic measurement?

Additional points/notes:

Alarms

Mention the following NBP alarm characteristics.

- An alarm sounds when a measurement (systolic, diastolic, or mean) falls outside the configured high or low limits.
- NBP alarms are all categorized as "non-latching" alarms, meaning they are automatically removed when their alarm condition no longer exists.
- The alarm source and limits can be changed during use.
- Alarms are enabled unless disabled; once disabled, alarms remain disabled until enabled.
- If an alarm condition occurs when alarms are disabled, no alarm indication is given.

Changing NBP Alarms

Demonstrate how to change the NBP alarm source and/or limits.

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Measurements/Alarms** menu and press Menu Select.
3. Select **NBP** and press Menu Select.
4. Select **NBP Limits** and press Menu Select.
5. Select the desired source for the alarm (**Systolic**, **Diastolic**, or **Mean**) and press Menu Select.
6. Using the Navigation buttons, increase or decrease the high limit value and press Menu Select.
7. Set the new low limit value and press Menu Select.

Enabling/Disabling NBP Alarms

Demonstrate how to enable/disable NBP alarms.

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select **NBP** and press Menu Select.
4. Select **Alarms On/Off** and press Menu Select.

Practice Exercise 2

Have students change NBP alarm limits, and enable/disable and respond to related alarms. Pose the following questions:

1. What happens when you change a limit? Disable an alarm? Respond to an alarm?

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold.)

1. Which of the following items can display when monitoring NBP?

   a. Systolic and diastolic pressure

   b. Alarm limits

   c. Automatic measurement schedule

   d. Time stamp

2. You can take manual measurements during an automatic measurement schedule. (**T**)

3. NBP alarms are enabled unless disabled. (**T**)

10

Carbon Dioxide Monitoring

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to monitor carbon dioxide (CO_2) and measure end-tidal carbon dioxide ($EtCO_2$) and Airway Respiration Rate (AwRR) with the HeartStart MRx using the Microstream® (sidestream) method.

Objectives

Upon completion of this lesson, students should be able to:

1. Monitor CO_2.
2. Set $EtCO_2$ and AwRR alarms.

Time

10-15 minutes

Accessories Recommended

- Nasal FilterLine® or Smart CapnoLine™

Clinical Resources

- *Uses of Capnography - The Microstream® Method* Application Note (M3535-93901)

Note: Microstream® and FilterLine® are trademarks of Oridion Medical Ltd.

Lesson Presentation

Overview

Briefly review the CO_2 monitoring function.

- It measures the partial pressure of CO_2 in a sample of the patient's exhaled breath (with the appropriate FilterLine and, if necessary, airway adapter).
- It monitors in both intubated and non-intubated patients.
- It is available in Monitor, Pacer, and Manual Defib Modes.
- It provides $EtCO_2$ and AwRR values, and a CO_2 waveform.
- $EtCO_2$ and AwRR alarm limits appear next to related values.

Additional points/notes:

Preparing to Measure $EtCO_2$

Demonstrate the following preparation to measure $EtCO_2$.

1. Select the appropriate Microstream accessories based on the type and airway status of the patient.
2. Set up the Microstream accessories.
3. Attach the FilterLine tubing to the CO_2 Inlet port.

Note the following:

- When using the nasal FilterLine, if one or both nostrils are partially or completely blocked, or the patient is breathing through the mouth, the displayed $EtCO_2$ values may be significantly low.
- Should the FilterLine or exhaust tubing be blocked when the MRx is turned on, the CO_2 Check Exhaust INOP message displays. Should the blockage occur during CO_2 monitoring, the CO_2 waveform appears as a flat line, and if alarms are on, an apnea alarm sounds.
- Use only Microstream accessories to ensure correct functioning of the CO_2 sidestream measurement.
- Due to a measurement delay, do not use Microstream (sidestream) CO_2 as a direct reference for determining the end expiratory point in the pressure curve.
- The Outlet port is used for removing anesthetic gases from MRx.

Suggestion: **Have students complete the appropriate above steps during or after your demonstration.**

Additional points/notes:

Measuring $EtCO_2$

Cover the following display characteristics related to $EtCO_2$ measurement.

- The measurement is automatically turned on when the FilterLine is connected to the CO_2 Inlet port.
- The CO_2 waveform displays in the configured Wave Sector, if available; otherwise, the wave fills the first available empty Wave Sector.
- $EtCO_2$ and AwRR values display in Parameter Block 2.

Suggestion: **Ask students to point out characteristics instead of YOU stating them.**

Setting Up the $EtCO_2$ and AwRR Alarms

Mention the following $EtCO_2$ and AwRR alarm characteristics.

- Alarms sound if measurements fall outside the configured high and low limits for $EtCO_2$ and AwRR, and for Apnea time. A red alarm occurs for Apnea time measurement outside the configured limits.
- $EtCO_2$ and AwRR alarms are all categorized as "non-latching" alarms, meaning they are automatically removed when their alarm condition no longer exists.
- Alarms are enabled unless turned off during use; they remain disabled until re-enabled.
- If an alarm condition occurs when alarms are disabled, no alarm indication is given.

Changing $EtCO_2$ Alarm Limits

Demonstrate how to change the $EtCO_2$ alarm limits.

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Measurements/Alarms** menu and press Menu Select.
3. Select **$EtCO_2$** and press Menu Select.
4. Select **$EtCO_2$ Limits** and press Menu Select.
5. Using the Navigation buttons, increase or decrease the high limit value and press Menu Select.
6. Set the new low limit value and press Menu Select.

Enabling/Disabling $EtCO_2$ Alarms

Demonstrate how to enable or disable the $EtCO_2$ alarms.

1. Press Menu Select. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
2. Select **$EtCO_2$** and press Menu Select.
3. Select **Alarms On/Off** and press Menu Select.

Changing AwRR Alarm Limits

Demonstrate how to change the AwRR alarm limits.

1. Press Menu Select.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select **AwRR** and press Menu Select.
4. Select **AwRR Limits** and press Menu Select.
5. Using the Navigation Buttons, increase or decrease the high limit value and press Menu Select.
6. Set the new low limit value and press Menu Select.

Changing Apnea Time Alarm Limit

Demonstrate how to change the Apnea Time alarm limit.

1. Press Menu Select.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select **AwRR** and press Menu Select.
4. Select **Apnea Time** and press Menu Select.
5. Using the Navigation buttons, increase or decrease the limit and press Menu Select.

Enabling/Disabling AwRR Alarms

Demonstrate how to enable the AwRR alarms.

1. Press Menu Select.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select **AwRR** and press Menu Select.
4. Select **Alarms On/Off** and press Menu Select.

Practice Exercise 1

Have students change $EtCO_2$, AwRR, and Apnea Time limits, and enable/disable and respond to related alarms. Pose the following questions:

1. What happens when you change a limit? Disable an alarm? Respond to an alarm?
2. If the CO_2 waveform is not displayed, how do you display it in the desired wave sector?

Additional points/notes:

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Disabling $EtCO_2$ Monitoring

Demonstrate how to disable $EtCO_2$ monitoring.

- Disconnect the FilterLine from the CO_2 inlet port. The message *CO2 Unplugged. Turn off EtCO2?* appears. Select **Yes** and press Menu Select.
- Should the FilterLine be disconnected accidentally, select **No** in response to the message and press Menu Select. Then, secure the connection to re-enable the function.

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold.)

1. True or false? $EtCO_2$ values may be significantly low if a patient is breathing through their mouth when using a nasal FilterLine. (**T**)
2. True or false? The CO_2 waveform only displays in Wave Sector 3. (**F- It displays where it is configured to display; it fills the first available empty wave sector if the configured wave sector is full.**)
3. True or false? FilterLine or exhaust tubing blockage can generate an apnea alarm. (**T**)
4. True or false? AwRR alarms are disabled unless enabled during use. (**F - They are "on" unless turned "off" during use.**)

11

Invasive Pressures Monitoring

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to monitor invasive pressures using the HeartStart MRx.

Objectives

Upon completion of this lesson, students should be able to:

1. Set up a pressure measurement.
2. Select a pressure to monitor.
3. Zero the pressure transducer.
4. Set pressure alarms and view related settings.
5. Identify how pulse works with the Invasive Pressures option.

Time

10-20 minutes

Accessories Recommended

- Simulator (e.g., Dale14 multiparameter simulator- p/n# 2249138 from Dale Technology)
- Invasive pressure cables (connecting the simulator to the MRx)

Clinical Resources

- *Hemodynamic Monitoring* course found at Philips' Online Learning Center

Lesson Presentation

Overview

Introduce the Invasive Pressures option associated with the MRx. Briefly illustrate the points below or wait until the appropriate topic presentation.

- Two channels of real-time continuous invasive pressure measurements and waveforms are available in Monitor, Manual Defib and Pacer Modes.
- Systolic, diastolic and mean pressure values display for pulsatile pressure signals. Only the mean value displays for non-pulsatile pressure signals.
- Alarms alert you to a change in the patient's condition.

Pressure Measurement Set-up

Explain or, if possible and applicable, demonstrate how to set up appropriate medical equipment (i.e., pressure cable, transducer, flush solution, and catheter) to display a pressure measurement on the MRx. Alternatively, have a simulator and appropriate invasive pressure cable(s) set up.

1. Turn the HeartStart MRx to **Monitor**.
2. Connect the pressure cable to the MRx.

The MRx performs a check of invasive pressure functionality when the MRx is turned on.

3. Connect the pressure cable to the transducer.
4. Prepare the flush solution.
5. Flush the system to expel air from the tubing. Make sure the stopcocks and transducer are also free of air bubbles.

Note the following: If air bubbles appear in the tubing system, flush the system with infusion solution again; otherwise, air bubbles may lead to an incorrect reading.

6. Connect the pressure line to the patient catheter.
7. If you are using an infusion pressure cuff with the pressure line, attach the pressure cuff to the fluid to be infused. Inflate it according to your hospital's standard procedure and then begin the infusion. Position the transducer so that it is level with the heart, approximately at the level of the midaxillary line.

Note the following: If measuring intracranial pressure (ICP) with a sitting patient, level the transducer with the top of the patient's ear; otherwise, incorrect leveling may lead to an incorrect reading.

***Suggestion*: Ask students to describe any issues they have with setting up equipment to measure invasive pressures and how they troubleshoot it.**

Additional points/notes:

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Selecting a Pressure to Monitor

Demonstrate how to select a pressure to monitor on the MRx.

- You need to assign a label to each pressure channel as it is connected. Channels are identified as Press 1 and Press 2.
- Once you select a label, the MRx uses that label's stored information (color, alarm source and limits, scale) as the default. Check each pressure channel label as the cable is connected and make changes as appropriate.

To select a pressure label:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select **Press 1** (or **Press 2**) and press Menu Select.
4. Select **Label** and press Menu Select.
5. Select the appropriate label from the list provided (see pressure label list below) and press Menu Select.
6. Verify and change the size of your scale, as appropriate. (**Reference the "Pressure Waves" topic, as needed.**)
7. Verify and change the alarm source type, as appropriate. (**Reference the "Alarms" topic, as needed.**)
8. Set the high and low alarm limits.

Repeat the above steps to label the other pressure channel.

Suggestion: **Have students complete the above steps during or after your demonstration.**

Note the following: Changing a pressure label activates scales and alarm settings associated with the new label. Controls for scale and alarm settings appear after selecting a label to either confirm or adjust the value.

Mention all the available pressure labels listed in the following table.

Label	Description	Label	Description
ABP	Arterial Blood Pressure	LAP	Left Atrial Pressure
ART	Arterial Blood Pressure	PAP	Pulmonary Artery Pressure
Ao	Aortic Pressure	RAP	Right Atrial Pressure
CVP	Central Venous Pressure	P1	Non-specific pressure label (Channel 1)
ICP	Intracranial Pressure*	P2	Non-specific pressure label (Channel 2)

***Important notice to students:** Cerebral Perfusion Pressure (CPP) is automatically displayed with ICP when one pressure is already set to ABP, ART or Ao and the other pressure is set to ICP. CPP will be displayed in the same color as ICP. Only one of the ICP or CPP alarms can be enabled at the same time.

Note the following, as appropriate:

- When selecting a pressure label for a pressure channel, the label assigned to the other pressure channel appears in your options list only if the other channel is not connected to a transducer. If you select the same label as the other channel, the label for the other channel changes to a non-specific label (P1 or P2). If you decide to re-label the first channel, the other channel's label remains non-specific (P1 or P2).
- To monitor a pressure from an arterial waveform when using an intra-aortic balloon pump, connect your invasive pressure device directly to the balloon pump.

Pressure Waves

Demonstrate how to adjust a pressure wave scale.

Each pressure label has a set of scales for the pressure wave. To select a pressure wave and the associated scale for the display or printed strip:

1. Press the Menu Select button.
2. Using the Navigation buttons, highlight **Displayed Waves** and press Menu Select.
3. Select Wave Position (**Wave 1**, **Wave 2**, **Wave 3** or **Wave 4**) and press Menu Select.
4. Select the appropriate wave and press Menu Select.
5. Select the appropriate scale and press Menu Select.

Available scales in mmHg:
300, 240, 180, 150, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, -5, -10, -15, and -20.

Available scales in kPa:
38.0, 32.0, 26.0, 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 13.0, 12.0, 11.0, 10.0, 9.0, 8.0, 7.0, 6.0, 5.0, 4.0, 3.0, 2.0, -1.0, -1.5, -2.0, -2.5.

***Suggestion*: Have students complete the above steps during or after your demonstration.**

Note the following: A positive scale sets the top gridline to your selected scale and the bottom to zero. A negative scale sets the bottom gridline to the selected negative unit and the middle gridline to zero.

Practice Exercise 1

Have students attach a simulator and pressure cable(s) to the MRx, select different pressure waves and associated scales, and display and print out the results, as appropriate. Pose the following questions:

1. How does the display (or printout) differ from one pressure wave to another? From Wave 1 menu?
2. What wave scale(s) provide the clearest wave form? NOTE: The answer may depend on what the simulator is set to.
3. How would you assign a specific label to pressure channel 1 if it is already assigned to channel 2? (Answer - You could unplug the channel 2 pressure cable or, depending on the circumstance, you might want to change the channel 2 pressure first. If you unplug the cable, you'll have to re-zero, which is covered next.)

Additional points/notes:

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Zeroing the Pressure Transducer

Introduce zeroing the pressure transducer and demonstrate the steps to zero a pressure on the MRx.

- The MRx requires a valid zero on a pressure channel to avoid inaccurate pressure readings. Zero a pressure according to your hospital policy - at least once per day. Also, re-zero:
  - Every time you reconnect the transducer cable to the MRx
  - After a patient is moved
  - During changes in altitude when using the MRx aboard an aircraft. Re-zero when reaching a cruising altitude
  - When you use a new transducer or tubing
  - When you think the pressure readings are not correct

Note the following: The numeric value is invalid (displayed as -?-) when the transducer is plugged in until zeroed successfully.

- Zero an assigned pressure channel through the Menu Select button or a soft key (when in Monitor Mode.) Zero pressure channels separately or together.

Note the following: Before zeroing a pressure, vent pressure transducers to atmospheric pressure and close the stopcock to the patient.

Zeroing Using the Menu Select Button

Demonstrate zeroing using the Menu Select button.

1. Place the transducer at the appropriate level for the measurement site.
2. Close the transducer stopcock to the patient and vent the transducer to atmospheric pressure.
3. Press the Menu Select button.
4. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
5. Select the pressure label you wish to zero.
6. Press **Zero** and press Menu Select. Zeroing begins.

Suggestion: **Have students complete the above steps during or after your demonstration. Ask what message they see if the process is successful - *Pressure label* *zero done at* *date/time* (for example: ABP zero done at 25Jan2006, 9:26).**

Zeroing in Monitor Mode

Demonstrate zeroing using the soft key in Monitor Mode.

1. Place the transducer at the appropriate level for the measurement site.
2. Close the transducer stopcock to the patient and vent the transducer to atmospheric pressure.
3. Press the soft key under the **`[Zero Pressure]`** label.
4. Using the Navigation buttons, select the pressure(s) you wish to zero from the **Zero** menu and press Menu Select. Zeroing begins.

Note the following: Invasive pressure alarms and pulse alarms (if they are derived from invasive pressure readings) are temporarily turned off while the transducer is zeroing. The alarms will turn back on 30 seconds after zeroing is complete.

Suggestion: **Have students complete the above steps during or after your demonstration. Ask what message they see if the process is successful - *Pressure label* *zero done at* *date/time*.**

Mention the *Unable to zero* message that displays if the process is unsuccessful, some of the probable cause messages, and related corrective actions, as needed.

Probable Cause Message	Corrective Action
Equipment Malfunction	Hardware is faulty. Contact your service personnel.
Excessive Offset	Make sure the transducer is vented to the air and try again. If this doesn't work, replace the transducer cable and try again. If it still doesn't zero, replace the transducer and try again. If it still will not zero, contact your service personnel.
Unstable Signal	
No Transducer	Reconfirm that the transducer is connected and try again. If this doesn't work, replace the transducer.
Pulsatile Pressure	Make sure that the transducer is vented to air and not the patient. Try again.

Note the following: Upon successful completion of the process, close the stopcock to atmospheric pressure, which opens the stopcock to the patient.

Last Zero

Demonstrate viewing dates and times for a channel's last zero.

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select the pressure label (**channel: label**) you want and press Menu Select.
4. The last zero dates and times are displayed.

Calibration

Briefly introduce MRx's calibration functionality.

The MRx allows you to input the calibration factor (see documentation supplied by the transducer's manufacturer) of a new transducer plugged into the pressure line. Please refer students to the Calibration topic of the **Invasive Pressures** chapter in the *HeartStart MRx Instructions for Use* for details on:

- setting a known calibration factor on the MRx
- perform a mercury calibration on the reusable CPJ840J6 transducer
- calibration confirmation
- viewing a mercury calibration date and time
- suppressing alarms associated with non-physiological artifact.

Suggestion: **Have the Instructions for Use available in case you need to demonstrate any related procedures.**

Additional points/notes:

Alarms

Mention the following invasive pressure alarm characteristics and details in the following table, as appropriate.

- Invasive pressure alarms are all categorized as "non-latching" alarms, being automatically removed when their alarm condition no longer exists.
- If alarms are enabled, alarm limits appear next to the pressure value.

The following table details red/yellow physiological alarms.

Alarm Message	Type of Alarm	Indicator	Condition
[ABP, ART, Ao, PAP, P1, P2] Disconnect	Red	Red alarm message; alarm tone	The mean pressure has fallen below 10 mmHg (1.3 kPa) and the pressure is non-pulsatile.
[Pressure label]s High	Yellow	Yellow alarm message; alarm tone	The systolic pressure value exceeds the high alarm limit.
[Pressure label]d High	Yellow	Yellow alarm message; alarm tone	The diastolic pressure value exceeds the high alarm limit.
[Pressure label]m High	Yellow	Yellow alarm message; alarm tone	The mean pressure value exceeds the high alarm limit.
[Pressure label]s Low	Yellow	Yellow alarm message; alarm tone	The systolic pressure value has fallen below the low alarm limit.
[Pressure label]d Low	Yellow	Yellow alarm message; alarm tone	The diastolic pressure value has fallen below the low alarm limit.
[Pressure label]m Low	Yellow	Yellow alarm message; alarm tone	The mean pressure value has fallen below the low alarm limit.

- Each pressure label has its own unique set of default alarm limits as set in Configuration mode.
- If the alarm is from a pulsatile source, the source is displayed above the alarm limits. If alarms are off, the Alarms Off symbol replaces the limits.
- If a wave becomes non-pulsatile, the measurement becomes mean only and is compared to the current source (which may be systolic or diastolic) and alarm limits.

Note the following: Make sure you enable/disable and set alarm limits for the correct label. These settings apply to that particular label only. Changing the label might change the alarm limits.

Enabling/Disabling Alarms

Demonstrate how to enable/disable alarms.

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select the pressure label (**channel: label**) you wish to modify alarm status on and press Menu Select.
4. Select **Alarms On** (or **Alarms Off**) and press Menu Select.

Viewing/Changing/Setting Source for Alarms

Demonstrate how to view or change alarm settings for a given pressure label.

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select the pressure label (**channel: label**) you wish to view/modify alarms on and press Menu Select.
4. Select pressure label **Limits** and press Menu Select.
5. If the pressure label is pulsatile, select the desired source of the alarm (Systolic, Diastolic or Mean) and press Menu Select.
6. Using the Navigation buttons, increase or decrease the high limit and press Menu Select.
7. Set the new low limit and press Menu Select.

CPP Alarms

Mention the following unique CPP and ICP alarm characteristics.

- Only one of the two parameters can have alarms enabled at one time. If CPP alarms are turned on, then ICP alarms are turned off. ICP alarms default to 'On'; CPP to 'Off'.
- The parameter with alarms off is displayed at the bottom of the ICP/CPP parameter area with the Alarms Off symbol.
- Both alarms can be turned off at the same time.

Practice Exercise 2

Have students change invasive pressure alarm limits, and enable/disable and respond to related alarms. Pose the following questions:

1. What happens when you change a limit? Disable an alarm? Respond to an alarm?

Additional points/notes:

Wedge

Briefly mention the pulmonary artery wedge procedure, as appropriate.

- Perform a pulmonary artery wedge procedure, according to your hospital protocol.
- The wedge numeric will not be stored in the Vital Signs Trending.

Note the following:

- For Pulmonary Artery Wedge Pressure (PAWP) readings, due to a measurement delay, do not use Microstream (sidestream) CO_2 as a direct reference for determining the end expiratory point in the pressure curve.
- If the pulmonary artery flotation catheter drifts into the wedge position without inflation of the balloon, the pulmonary artery pressure waveform will assume a wedged appearance. To correct the situation, take appropriate action in accordance with standard procedures.

Additional points/notes:

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Pulse

Discuss MRx's ability to provide pulse readings in relation to the Invasive Pressures option. To discuss how pulse works with SpO_2 only, refer to the Pulse Oximetry lesson. If the MRx you are instructing on has SpO_2 and Invasive Pressures options, discuss the following Pulse Sources topic.

Pulse Sources

- When both SpO_2 and Invasive Pressures options are present on the MRx, pulse is derived from an SpO_2 pleth wave or one of the two invasive pressure waves in Monitor, Pacing and Manual Defib modes. The pulse reading is displayed in the color of its source (e.g. if your pleth wave is cyan and pulse is being derived from the pleth wave, then the pulse reading will appear in cyan.)
- Pulse is on (and displayed) if one of these possible sources is activated. SpO_2 is the factory default but can be modified in Configuration Mode.
- If the default pulse source is not active during an event but a secondary source is, the pulse value will display but will be invalid and display a -?- where the value should be. A *Pulse Check Source* INOP will also appear on the screen. To obtain a pulse rate, you must modify the pulse source to an active source for this incident.

- If the pulse source you are using to obtain a pulse rate is disconnected during active measuring and a secondary pulse source is available, the pulse rate does not automatically switch to the secondary source. The pulse value (and the value of your source measurement) remains on screen but becomes invalid and displays a -?- where the value should be. An INOP message also appears on screen. To reactivate a pulse reading, reconnect the original pulse source or change the pulse source to the secondary option.

Changing Pulse Source

Demonstrate how to change pulse source for the current incident.

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select **Pulse** and press Menu Select.
4. Select **Pulse Source** and press Menu Select. Pick a source with an arterial or pulmonary waveform.
5. Using the Navigation buttons, highlight the pulse source desired and press Menu Select.

Setting Pulse Alarms

Mention the following pulse alarm characteristics.

- When on, pulse alarms annunciate if measurements fall outside of the limits for high or low pulse.
- Alarms are turned off unless you turn them on during use. Once turned on, alarms remain on until they are turned back off.
- If pulse alarms are enabled, alarm limits appear next to the pulse value. If alarms are off, the Alarms Off symbol replaces the limits.

Enabling/Disabling the Pulse Alarm

Demonstrate how to enable/disable the pulse alarm.

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select **Pulse** and press Menu Select.
4. Select **Alarms On/Off** and press Menu Select.

Changing Pulse Alarm Limits

Demonstrate how to change pulse alarm limits.

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select **Pulse** and press Menu Select.
4. Select **Pulse Limits** and press Menu Select.
5. Using the Navigation buttons, select the new high limit value and press Menu Select.
6. Select the new low limit and press Menu Select.

Changing Default Pulse Source and Alarm Limits

Mention that you can change the default pulse source in the pulse section of Configuration Mode and default pulse alarm limits in the ECG section of Configuration Mode (the latter because pulse and heart rate share the same default alarm limits).

Practice Exercise 3

Have students change pulse alarm limits, and enable/disable and respond to related alarms. Pose the following questions:

1. What happens when you change a limit? Disable an alarm? Respond to an alarm?

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold. Consider having students correct FALSE statements to ensure comprehension.)

1. You must flush the tubing system to remove air bubbles to prevent potential incorrect readings. (**T**)
2. Which of the following statement(s) are TRUE regarding pressure selection and related wave scale adjustment?
   a. When selecting a label, you need to specify its color, alarm source and limits, and scale. (F - The MRx uses that label's stored (configured) information.)
   b. Controls for scale and alarm settings automatically appear after selecting a new label. (**T**)
   c. You can not select the same label for both pressure channels. (**T**)
   d. The available pressure wave scale spans from 300 to -20 in mmHg and from 38 to -2.5 in kPa. (**T**)
3. Which of the following statement(s) are TRUE regarding zeroing a pressure?
   a. You must zero a pressure every time you reconnect the transducer cable to the MRx. (**T**)
   b. Before zeroing a pressure, you must vent pressure transducers to atmospheric pressure and close the stopcock to the patient. (**T**)
   c. Invasive pressure alarms are active while the transducer is zeroing. (F - Invasive pressure alarms are temporarily turned off while the transducer is zeroing.)
   d. The message **Unable to zero** message displays if the zeroing process fails. (**T**)
4. Which of the following statement(s) are TRUE regarding pressure alarms?
   a. All invasive pressure alarms cease when their alarm condition no longer exists. (**T**)
   b. The **PAPd High** message means the pulmonary artery diastolic pressure has exceeded the high alarm limit. (**T**)
   c. If the pressure label is non-pulsatile, you select either Systolic, Diastolic or Mean as the desired alarm source. (F - The measurement is Mean only if the pressure label is non-pulsatile.).
   d. When CPP and ICP are displayed together, only one of them can have related alarms enabled. (**T**)
5. If SpO2, as the default pulse source, is not active but the ABP source is, the pulse value displays but it is invalid. (**T**)

12

Temperature Monitoring

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to monitor temperature using the HeartStart MRx.

Objectives

Upon completion of this lesson, students should be able to:

1. Select a temperature to monitor.
2. Set temperature alarms and related limits.

Time

5 minutes

Accessories Recommended

- Simulator (e.g., Dale14 multiparameter simulator- p/n# 2249138 from Dale Technology)
- Temperature cable (connecting the simulator to the MRx)
- Skin surface temperature probe (connecting directly to the MRx) (Example: 21078A) as an alternative to the simulator and related temperature cable

Lesson Presentation

Overview

Introduce the Temperature option associated with the MRx.

- The MRx offers one channel of real-time continuous temperature monitoring while in Monitor, Pacer or Manual Defib Modes.
- It can monitor nasopharyngeal, esophageal, rectal, skin, arterial, venous, core and urinary bladder (vesic) temperatures.
- It can display temperature in either Fahrenheit or Celsius. The default is Celsius, which can only be changed through Configuration Mode.

Selecting a Temperature Label

Discuss the following temperature label characteristics and then demonstrate label selection.

- The MRx monitors the temperature of the area where the sensor is located.
- Assign the proper temperature label to the measurement to assure specific temperature settings are matched with the temperature reading,
- When modifying a temperature label, all settings (including alarm limits) associated with that label become active.
- Below are the available labels. Temp is the default label.

Label	Type	Label	Type
Tesoph	esophageal temperature	Tnaso	nasopharyngeal temperature
Trect	rectal temperature	Tvesic	urinary bladder
Tskin	skin temperature	Tart	arterial temperature
Temp	non-specific temp label	Tven	venous temperature
Tcore	core temperature		

To select a temperature label:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select the temperature label option currently assigned to your measurement and press Menu Select.
4. Select **Label** and press Menu Select.
5. Select the appropriate label from the list provided and press Menu Select.

Suggestion: **Have students complete the above steps during or after your demonstration.**

Monitoring Temperature

Demonstrate how to monitor temperature.

1. Connect the temperature cable to the MRx.
2. Select the correct temperature label for your measurement.
3. Check that the current device settings (including alarm settings) are appropriate for the patient.
4. Apply the temperature probe to the patient.

***Suggestion*: Have students complete the above steps during or after your demonstration.**

Note the following: The temperature function performs a self-test when initially turned on and also performs hourly system tests when active.

Additional points/notes:

Alarms

Setting Temperature Alarms

Mention the following temperature alarm characteristics and details in the following table, as appropriate.

- Temperature alarms are all categorized as "non-latching" alarms, meaning they are automatically removed when their alarm condition no longer exists.
- They annunciate if measurements fall outside the configured limits for high and low temperatures.

The table below details temperature physiological alarms.

Alarm Message	Type of Alarm	Indicator	Condition
[Temperature label] High	Yellow	Yellow alarm message; alarm tone	The temperature value exceeds the high alarm limit.
[Temperature label] Low	Yellow	Yellow alarm message; alarm tone	The temperature value has fallen below the low alarm limit.

- Alarms are on unless turned off during use. Once turned off, alarms remain off until they are turned back on.
- If temperature alarms are enabled, alarm limits appear next to the temperature value. If alarms are off the Alarms Off symbol replaces the limits.

Changing Temperature Alarm Limits

Demonstrate how to change the temperature alarm limits for the current incident.

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press Menu Select.
3. Select the temperature label option currently assigned to your measurement and press Menu Select.
4. Select **Temperature Limits** and press Menu Select.
5. Using the Navigation buttons, change the high limit and press Menu Select.
6. Using the Navigation buttons, change the low limit and press Menu Select.

Note the following: Make sure you enable/disable and set alarm limits for the correct label. These settings are stored for that particular label only. Changing the label may change the alarm limits.

Disabling/Enabling Temperature Alarms

Demonstrate how to disable/enable temperature alarms.

1. Press the Menu Select button.
2. Using the Navigation buttons, select the **Measurements/Alarms** menu and press Menu Select.
3. Select the temperature label option currently assigned to your measurement and press Menu Select.
4. Select **Alarms Off/Alarms On** and press Menu Select.

Disabling the Temperature Function

Demonstrate how to disable the Temperature function.

- Disconnect the temperature cable from the MRx Temperature port. The message *Temp* (or the label currently activated) *Unplugged. Turn Off Temp* (or the label currently activated)*?* appears. Select *Yes* and press the Menu Select button.
- Should the temperature cable get disconnected accidentally or if the probe and cable separate, and you want to continue monitoring temperature, select *No* and press Menu Select. Reconnect the temperature cable to restart the temperature monitoring function.

Practice Exercise 1

Have students change temperature alarm limits, and disable/enable and respond to related alarms. Pose the following questions:

1. What happens when you change a limit? Disable an alarm? Respond to an alarm?

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold. Consider having students correct FALSE statements to ensure comprehension.)

1. True or false? When you change a temperature label, you need to activate its related alarm limits. (F - All settings (including alarm limits) associated with a label become active as soon as you change the label.)
2. Which of the following statement(s) are TRUE regarding temperature alarms?
   a. All temperature alarms cease when their alarm condition no longer exists. (**T**)
   b. The **Tesoph Low** message means the esophageal temperature has fallen below the low alarm limit. (**T**)
   c. Temperature alarms default to off. (F - Temperature alarms default to on.)
   d. Changing the label may change the alarm limits. (**T**)

13

12-Lead ECG Monitoring

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to use the diagnostic 12-Lead ECG function of the HeartStart MRx.

Objectives

Upon completion of this lesson, students should be able to:

1. Identify pertinent information in the 12-Lead preview screen.
2. Perform 12-Lead ECG acquisition.
3. Identify important characteristics of the 12-Lead Report.

Time

10-20 minutes

Accessories Recommended

- Simulator
- 10-Lead monitoring electrodes cable

Clinical Resources

- 12-Lead Algorithm Data Sheet (5990-0724EN)
- *Philips 12-Lead Algorithm Physician's Guide*, available from IntelliVue Information Center - User Materials under Patient Monitoring at http://www3.medical.philips.com/en-us/doc_downloads/docdownload.asp

Lesson Presentation

Overview

Introduce the 12-Lead ECG function.

- It previews, acquires, prints, copies, and stores 12-Lead ECGs.
- It provides computerized ECG analysis* and a report, using the Philips 12-Lead Algorithm.The algorithm is age/gender specific and very dependent on the patient's paced status. Adult criteria apply if the patient age is 16 years old or older. Pediatric criteria apply if the patient age is less than 16.

* Analysis focuses on amplitudes, durations, and morphologies of the ECG waveforms and the associated rhythm.

Preview Screen

Attach a 10-Lead set to the MRx and a simulator, set the simulator to a normal sinus rhythm (NSR), turn the device to the Monitor position, press the `[12-Lead]` soft key, and discuss the following Preview Screen characteristics.

- The screen provides real-time 12-Lead ECG data (patient ID, age, and sex, and approximately 2.5 seconds of each acquired lead).
- The screen verifies signal quality before acquiring the ECG.
- Waveforms are presented at a rate of 25mm/sec. and at the configured wave size.
- A dashed line indicates a lead cannot be derived.
- *(Lead-Wire) Lead Off* message indicates an electrode is not making adequate contact with the patient.
- Parameter measurements, alarms, and inop messages remain active and are reported in Parameter Blocks 1 and 2 and the general status area.
- A filter soft key is available to switch between ECG bandwidth filters.

***Suggestion*: Ask students to point out characteristics instead of YOU stating them. Ask students if they think it matters if age and sex are left to the default values or if accurate patient information is entered.**

Additional points/notes:

Preparation

Discuss the following points on 12-Lead monitoring preparation and demonstrate the related steps, as appropriate.

- Proper patient preparation and electrode placement are the most important elements in producing a high quality 12-Lead ECG.
- The patient should be supine and relaxed when an ECG is acquired.

To prepare for ECG acquisition:

1. Connect the 10-Lead cable to the HeartStart MRx. **DEMONSTRATE**
2. Prepare the patient's skin at appropriate electrode sites.
   - If necessary, clip hair at the electrode sites (or shave sites if needed).
   - Wash sites thoroughly (with soap and water, if possible).
   - Dry the electrode sites briskly to increase capillary blood flow in the tissues and to remove oil and skin cells.
3. Attach the snaps to the electrodes.
4. Apply the electrodes to the patient. (**Note: Attach electrodes to the simulator.**)
5. Turn the Therapy Knob to **Monitor**.
6. Enter the patient's ID, name, age, and sex through the **Patient ID** menu, using the Menu Select and Navigation buttons.
7. Confirm the patient's pacing status is correct.

Suggestion: **Have students attach a 10-Lead set to the MRx and a simulator, set the simulator to NSR, and complete the appropriate preparation steps.**

Additional points/notes:

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Acquiring the 12-Lead ECG

Demonstrate how to acquire a 12-Lead ECG.

1. Press the **[12-Lead]** soft key.
2. Check the signal quality on each lead and, if necessary, make adjustments.
3. Press the **[Start Acquire]** soft key. The message *Acquiring 12-Lead* is then displayed while the MRx acquires ten seconds of ECG data.
4. If the patient age and sex were not previously entered, you are prompted to enter the information using the Navigation and Menu Select buttons.
5. Keep the patient still while the message *Acquiring 12-Lead* is displayed.
6. Once ECG acquisition is complete, ECG analysis begins automatically and is accompanied by the message *Analyzing 12-Lead*. The patient does not need to be still during this time.
7. Following analysis, the 12-Lead Report is displayed, printed, and stored internally.
8. Press **[New 12-Lead]** to acquire another 12-Lead ECG.
9. Press **[Exit 12-Lead]** to exit the 12-Lead function.

Note the following:

- Failure to enter correct patient age, sex, and pacing status can result in an erroneous diagnosis. Changing patient type to Adult or Pedi is not sufficient.
- The Lead Select button is disabled when the 12-Lead function is active.

Suggestion: **Ask students to point out characteristics instead of YOU stating them.**

Practice Exercise 1

Have students complete a 12-Lead acquisition. Ask them to point out what display changes they see when completing each step.

Additional points/notes:

12-Lead Report

Discuss the characteristics of the 12-Lead Report View and printout.

- The 12-Lead Report View lets you monitor a patient and see report data simultaneously.
- The report replaces Wave Sectors 3 and 4 and includes the following information, if configured:
  - Measurements - standard interval and duration measurements (in milliseconds), limb lead axis measurements (in degrees) and heart rate (in beats per minute).
  - Interpretive statements - describe patient's cardiac rhythm and waveform morphology, and communicate signal quality problems encountered during ECG acquisition.
  - ECG severity - Associated with each interpretive statement; categories of severity are "No Severity", "Normal ECG", "Otherwise Normal ECG", "Borderline ECG", "Abnormal ECG", and "Defective ECG".
- Stored and printed reports can be configured to include measurements and interpretive analysis statements, along with the 12 leads (waveforms).
- One or two copies of the report are printed at the completion of acquisition and/or analysis, as configured; use the **`[Print]`** soft key to print another copy.
- The printed report includes on-screen data and up to three rhythm strips, with the configured leads.
- If an alarm condition occurs during printing, an alarm strip is not printed; however, the corresponding ECG waveform is stored and available in the Event Summary.
- Do not pull on the paper while a report is printing; waveform distortion may occur, leading to potential misdiagnosis.

Accessing Stored Reports

Demonstrate how to access stored reports (to print additional copies or delete them from internal storage). You can also copy a report to a data card.

The list of stored reports for the current patient event may be accessed while a report is displayed or from either the 12-Lead Acquire Screen or the 12-Lead Preview Screen. To do this:

1. While in 12-Lead, press the Menu Select button.
2. Use the Navigation buttons to select **Reports**.
3. Reports for the current patient event are listed by date, time and sequence number.
4. Use the Navigation buttons to select a report and press Menu Select.
5. Select **Print**, **Copy**, or **Delete** and press Menu Select.
6. Press **Exit** to close the menu.

Suggestion: **Have students try printing an additional copy of a report.**

Adjusting Wave Size

Demonstrate how to adjust the ECG wave size to improve signal viewability if necessary.

1. While in 12-Lead, press the Menu Select button.
2. Using the Navigation buttons, select *ECG Size* and press Menu Select.
3. Using the Navigation buttons, select the desired size value and press Menu Select.

Note the following:

- The lead size is retained when you exit and then return to 12-Lead functionality, without turning off power for more than 10 seconds.
- Selecting an ECG wave size of either *10mm/mV ½ V* or *20 mm/mV ½ V* displays V/C leads at half of the selection (i.e., 5 mm/mV and 10 mm/mV respectively).

Suggestion: **Have students try adjusting a few wave sizes to see related changes.**

12-Lead Filters

Discuss the characteristics of 12-Lead filters.

- ECG bandwidth filters of 0.15 - 40 Hz, 0.05 - 40 Hz, or 0.05 - 150 Hz can be configured to apply to 12-lead ECG waveforms shown on the display.
- The 12-Lead Report can be configured to apply either the same filter choice used for the display, or a 0.05 - 150 Hz filter. The filter setting is applied to both printed and stored 12-Lead Reports.

Note the following: Although the 0.05 -150 Hz, or "Diagnostic", bandwidth filter may be selected for the display filter, LCD display limitations prevent the ECG from appearing in true diagnostic quality.

- A filter soft key is available to switch between filter settings during use. When changing the filter during use, the filter setting is applied to both the display and the 12-Lead Report. The display and 12-Lead Report filter settings are returned to their configured settings whenever the [**New 12-Lead**] soft key is pressed or when the Therapy Knob is moved from the **Monitor** position.

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold. Consider having students correct FALSE statements to ensure comprehension.)

1. Which of the following statements is FALSE? The 12-Lead Preview screen displays:
   a. Patient ID, age, and sex.
   b. Waveforms are presented at a rate of 15mm/sec. for approximately 2.5 seconds. (F - 25mm/sec. rate)
   c. A flat straight line which indicates a lead can't be derived. (F - dashed line)
   d. SpO_2, CO_2, and NBP measurements display in Parameter Blocks 1 and 2 if configured.
2. True or false? Once ECG acquisition is complete, you press the Start Analysis soft key to start ECG analysis. (**F - Once acquisition is complete, ECG analysis begins automatically.**)
3. The MRx acquires how many seconds of ECG data?
   a. 5
   b. 10
   c. 12
   d. 15
4. Which of the following statement(s) are TRUE regarding the 12-Lead Report?
   a. It displays standard interval and duration measurements and waveform morphology.
   b. It can be configured to include ALL 12 leads and related measurements.
   c. Its printout can includes on-screen data and up to two rhythm strips. (F - It can include up to three rhythm strips.)
   d. An alarm strip is printed when an alarm condition occurs during printing. (F - An alarm strip is not printed, thought the ECG waveform in question is available in the Event Summary.)

14

12-Lead ECG via Bluetooth Transmission

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to transmit 12-Lead Reports from the HeartStart MRx using wireless Bluetooth® technology.

Objectives

Upon completion of this lesson, students should be able to:

1. Identify characteristics of the 12-Lead report transmission process.
2. Set up for Bluetooth transmission.
3. Transmit a displayed or stored 12-Lead Report to a configured site or fax number.

Time

10-20 minutes

Accessories Required

- Bluetooth-enabled wireless device (e.g., cell phone or modem) with Dialup Networking (DUN) profile
- Printer, a fax machine, a server running Philips 12-Lead Transfer Station software, or Philips TraceMaster ECG Management System
- Web server running Philips 12-Lead Transfer Station software

Technical Resources

- *12-Lead Transmission Implementation Guide* (M3536-90900) for detailed information on transmission device and HeartStart MRx setup, configuration, and troubleshooting
- *12-Lead Transfer Station Instructions for Use* (M3536-91900) for detailed information on the 12-Lead Transfer Station
- *MRx Instructions for Use (M3535-91900)*

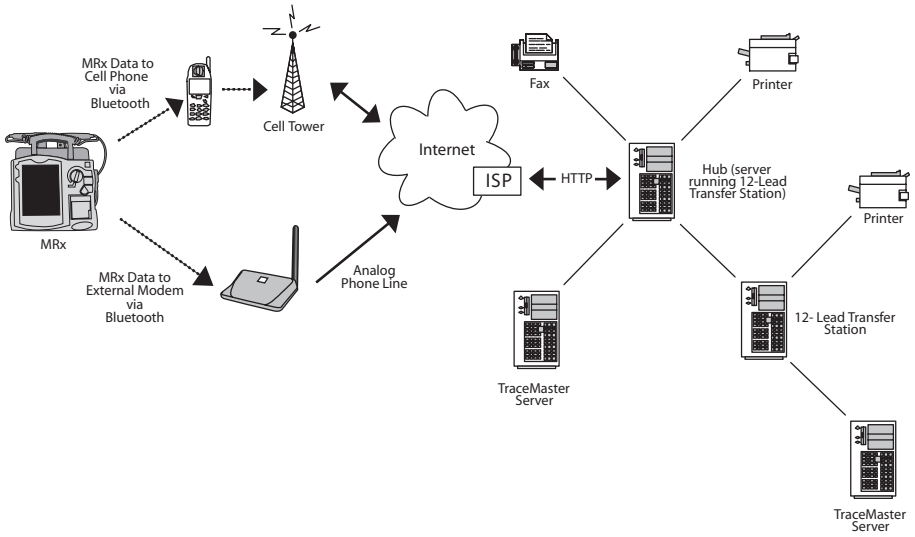
Note: The HeartStart MRx contains an Ezurio PC Card with Bluetooth® wireless technology. The Bluetooth wordmark and logos are owned by the Bluetooth SIG, Inc. and any use of such marks by Ezurio is under license. Other trademarks and trade names are those of their respective owners.

Lesson Presentation

Overview

Introduce the 12-Lead ECG transmission option, using the figure below to explain the data transmission flow.

- You can transmit 12-Lead Reports from the MRx to a hub (a web server running Philips' 12-Lead Transfer Station software) to a printer, a fax machine, another server running 12-Lead Transfer Station software, or Philips' TraceMaster ECG Management System.
- Reports are transmitted using configured Bluetooth wireless devices (e.g., cell phones and handheld devices). Using RS 232 Transmission, they are transmitted via a cell phone with internet capability connected to the MRx's RS 232 Serial Port.
- The 12-Lead Transfer Station then forwards the report to the selected destination site.



- You can view waveforms in Monitor Mode for monitored parameters (e.g., ECG, SpO_2 and CO_2) during report transmission; however, the waveform appearing in Wave Sector 4 is partially obscured when the transmission status bar is displayed.
- Related alarms, measurements and inop messages remain active and appear in Parameter Blocks 1 and 2 and the general status area.
- The MRx is a Bluetooth Class I device that can communicate with another Bluetooth device within a maximum distance of 100 meters (300 feet). In contrast, most cell phones are Class II devices, which can only communicate within 10 meters. Keep in mind that the maximum communication distance between two Bluetooth devices is dependent upon the device with the lowest class.
- **Emphasize this point:** Many institutions prohibit the use of cell phones on their premises. Please abide by local rules and regulations.

Additional points/notes:

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Setting Up for Bluetooth Transmission

Discuss and demonstrate how to set up a wireless device that sends a 12-Lead Report to the hub. It is recommended that you have at least one wireless device set up and tested with the MRx prior to teaching this lesson. Use an accessible fax machine or printer as the end-destination device to print out the 12-Lead Report to illustrate successful transmission.

Adding a Bluetooth Device

- Configure up to 20 Bluetooth devices for use. Adding a twenty-first device replaces the device used least recently.
- Bluetooth devices may not be added or modified during 12-Lead transmission. Conversely, 12-Lead transmission is not allowed during Bluetooth device pairing.

To add a Bluetooth device to the list of transmission devices:

1. Access 12-Lead Mode and press the Menu Select button.
2. From the 12-Lead Main Menu, select **Bluetooth Devices** and press Menu Select.
3. Select **Add Device** and press Menu Select. The message *Searching for Bluetooth Devices* displays.
4. From the Add Device menu, select the desired Bluetooth device and press Menu Select.

The selected Bluetooth device must now go through the "pairing" process described below.

All Bluetooth devices within the specified range are discovered (detected) by the HeartStart MRx and displayed on the Add Device menu, even if you have already paired with the device.

Pairing a Bluetooth Device and Selecting a Profile

Once a Bluetooth device is selected from the Add Device menu, perform a passkey procedure to communicate or "pair" the wireless device with the HeartStart MRx. (The passkey is like a PIN number or password you create for a personal account.) Some Bluetooth devices only allow pairing for approximately 30 seconds, so be ready to enter the passkey.

5. Use the Navigation buttons to enter the passkey on the MRx and select **Done**.
   The Bluetooth device prompts you for a passkey.
6. Enter the same passkey on your Bluetooth device. See the documentation that came with your Bluetooth device for instructions.
7. Select the designated profile from the Phone/Modem Profiles menu.

The profile contains specific information about the cellular service provider (i.e., phone company) that enables the Bluetooth device to communicate with the 12-Lead Transfer Station. Your administrator sets up (configures) the profiles prior to your Bluetooth transmission set up and can tell you which one to choose.

Once the Bluetooth device is paired with the MRx and the profile selected, the MRx performs a transmission test. After successfully connecting to the device and network, the message ***Transmission Test Passed*** displays. Press Menu Select to acknowledge the message. If the transmission test fails, the message ***Transmission Test Failed*** displays, along with additional information about where the failure occurred. See the Troubleshooting section in the *12-Lead Transmission Implementation Guide* for support on failures.

Changing a Bluetooth Profile

Once you have added and paired a Bluetooth device, you can change its profile.

1. Press Menu Select.
2. From the 12-Lead Main Menu, select **Bluetooth Devices** and press Menu Select. A list of configured Bluetooth devices displays.
3. Use the Navigation buttons to select a device and press Menu Select.
4. Select **Change Profile** and press Menu Select. A menu of configured profiles for that device displays, with the current associated profile highlighted.
5. Select the profile you want to associate with the device.

The MRx tests the profile to determine if the Bluetooth device can communicate with the 12-Lead Transfer Station. Progress messages are displayed during the test. If the test is successful, the message ***Transmission Test Passed*** displays. Press Menu Select to acknowledge the message. If the transmission test fails, the message ***Transmission Test Failed*** displays, along with additional information about where the failure occurred. See the Troubleshooting section in the *12-Lead Transmission Implementation Guide* for support on failures.

Additional Bluetooth Device Information

Mention the following points regarding Bluetooth devices, as appropriate.

- Many Bluetooth devices are not discoverable by default. Check the device's documentation to see if you need to enable discovery.
- As a general security practice, don't leave the Bluetooth device in discovery mode.
- Some devices require that you turn on the Bluetooth functionality.
- Some devices may prompt you to authenticate each time. Check the device's documentation to see if you can configure it to always communicate with the MRx.
- Give your Bluetooth device an easily recognizable name as this is the name that appears on the MRx menus. Limit the name to up to 15 characters.

Practice Exercise 1

Have students complete a Bluetooth transmission set-up. After completing a successful setup, try failing the transmission test (e.g., add a cell phone that not Bluetooth-enabled or fail the pairing process by letting it time out) and pose a few related questions:

1. For example, what does it mean if you can't find a Bluetooth device when trying to add it to the transmission device list? (Answer: It may not be turned on, there may be too many Bluetooth-enabled devices (more than 10) in the area, or it may not be discoverable. For the latter condition, you'll have to enable it following the device's documentation. Keep in mind that during discovery, the MRx will pick up to 10 Bluetooth devices within the maximum communication distance based on a device's class. If the device is not found, search again and complete the procedure for adding a Bluetooth device.)
2. What other resources would you use to troubleshoot a problem? (Answer: *12-Lead Transmission Implementation Guide* and/or IT administrator)

Additional points/notes:

Transmitting to a Configured Site using Bluetooth

Demonstrate how to transmit a displayed 12-Lead Report to a previously configured destination. Acquire a 12-Lead ECG, display the 12-Lead Report View, and complete the following procedure.

1. Press Menu Select.
2. Using the Navigation buttons if necessary, select **Send** from the 12-Lead Main Menu and press Menu Select.
3. Select the destination site from the configured list.
4. Press Menu Select to complete the selection.
5. Select the transmission device from the configured list.
6. Press Menu Select to complete the selection.

If the profile associated with the Bluetooth device is configured as a landline, use the numeric menu to edit the configured dial prefix, if necessary. To confirm the prefix, select **Done** from the menu and press Menu Select.

Transmitting to a Fax Number

Demonstrate how to transmit a displayed 12-Lead Report to a manually entered fax number. Acquire a 12-Lead ECG, display the 12-Lead Report View, and complete the following procedure.

1. Press Menu Select.
2. Using the Navigation buttons if necessary, select **Send** from the 12-Lead Main Menu and press Menu Select.
3. Select **Fax Number** from the Send To menu.
4. Enter the fax number from the numeric list using the Navigation buttons. Include any extra digits necessary (e.g., 9 for an outside line or 1 plus the area code for long distance).
5. Select **Done** and press Menu Select.

Transmitting Stored 12-Lead Reports

Demonstrate how to transmit a 12-Lead Report (for the current patient) stored in internal memory.

1. From the 12-Lead Preview or Report View, press Menu Select.
2. Use the Navigation buttons to select **Reports** from the 12-Lead Main Menu.
3. Use the Navigation buttons to scroll through the list of stored reports and highlight the desired report. Reports are identified by date/time stamp and sequence number.
4. Press Menu Select to complete your selection.
5. Select **Send** from the 12-Lead Report Menu and press Menu Select.
6. Select the destination site or to manually enter a fax number.
7. Press Menu Select to complete the selection. For manual fax number entry, enter the fax number from the numeric list, select **Done** and press Menu Select.

Subsequent 12-Lead Reports can be placed in queue for transmittal while transmission is in progress or the originally selected 12-Lead Report can be chosen for transmission to multiple sites.

Transmission Status

- During 12-Lead Report transmittal, a status bar displays to show the progress of the connection and report transmission. Once the connection is made, the status bar contains the date and time stamp of the 12-Lead Report being sent.
- The status bar continues to display in any clinical mode of operation.
- 12-Lead Reports successfully transmitted to the destination site are logged to the Event Summary and appear using the format "12-Lead (hh:mm:ss) Transmitted to *site name*".

Practice Exercise 2

Have students complete transmission to a configured site, fax number, and/or for a stored report, as appropriate. Ask them to point out what display changes they see when completing each transmission procedure and differences between each procedure.

Cancelling Transmission

Demonstrate how to cancel a transmission once a connection has been initiated.

1. From the 12-Lead Preview or Report View, press Menu Select.
2. Select **Cancel Transmission** from the 12-Lead Main Menu and press Menu Select.

The transmission of any pending 12-Lead Reports is also canceled.

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold.)

1. Philips' 12-Lead Transfer Station software is required to complete 12-Lead Report transmission. (**T**)
2. Which of the following statements is TRUE? To establish communication between a Bluetooth device and the MRx, a pass key is needed for:
   a. only the Bluetooth device.
   b. only the MRx
   c. both the Bluetooth device and MRx.
3. Which of the following statements is FALSE regarding 12-Lead Report transmission?
   a. To complete transmission to a configured site, you need to select a transmission device from a list of paired devices.
   b. If you are transmitting to a fax number, you may need to include a "9" for an outside line or "1" before the area code.
   c. You must wait for one transmission to complete before initiating another one. (F - You can put additional reports in queue for transmittal while transmission is in progress.)
   d. You can use MRx's Monitor Mode while transmission is in progress.

15

Vital Signs Trending

Lesson Introduction

Introduce the lesson, including the learning objective and estimated time to complete.

This lesson describes the HeartStart MRx Vital Signs Trending and related report data.

Objectives

Upon completion of this lesson, students should be able to:

1. Identify data and functionality of the Vital Signs Trending Report.

Time

5-10 minutes

Accessories Recommended

- Simulator
- Option monitoring cables to produce trending data (e.g., for invasive pressures, $EtCO_2$, SpO_2, etc.)

NOTE: It is recommended that you have the monitor on for at least 10-15 minutes to create enough trending data for instructional purposes.

Lesson Presentation

Overview

Introduce the MRx's Vital Signs Trending.

- The MRx lets you view and print numeric vital sign trending for the current incident in Monitor Mode.
- Trending data are automatically acquired if parameters are on.
- Trending data are presented at the selected interval. The newest data appear in the far right column when trending is initially displayed. The oldest measurements are deleted as needed to store the newest measurements.

Reviewing Trending Data

Demonstrate how to review trending data and discuss Vital Signs Trending Report data and related functionality. Set the trend interval to 1 minute to display a more populated report.

Suggestion: **Have students complete the steps below and follow your discussion while viewing the Trending Report.**

1. Turn the Therapy Knob to **Monitor**.
2. Press the Menu Select button.
3. Using the Navigation buttons, select **Trends** and press Menu Select.

- The Vital Signs Trending Report displays, covering the bottom two wave sectors and the existing soft key functions. The report includes:
  - **Report date**, which is determined by the earliest time displayed in the table.
  - **Parameter** vital signs monitored by the MRx during the displayed time period.
  - **Time intervals** for vital signs.
  - **Trending data**, without related units of measure.
- The latest (most recent) trending data appears in the far right column when the Trending Report first displays.
- The display automatically updates as new vital sign data become available as long as the latest data are displayed on screen. If you scroll left to view older data, the screen will not update to new data when available. The latest data will be displayed when scrolling back to the most recent data.
- Parameters are listed in the following order, beginning at the top of the table: HR, P1, P2, ABP, Ao, ART, PAP, RAP, CVP, LAP, ICP, CPP, NBP, $EtCO_2$, AwRR, SpO_2, Pulse, Temp.
- If a parameter has not been measured during the display period, it is not listed in the display.
- If a parameter has invalid information, it is indicated by -?-. Questionable data is indicated by a question mark just before the numeric value, while unavailable data is indicated by an empty space.
- Aperiodic measurements (e.g., NBP) are displayed with a measurement timestamp below the readings. A ^ after the timestamp indicates multiple measurements taken during the interval. The most recent measurement within the interval displays.
- If an inactive parameter becomes active when viewing the Trending Report, the added parameter automatically appears in the report when the interval is updated and the latest data is available.

Trending Report Intervals

- Trending data can be shown at selected intervals for up to 12 hours* of monitoring. You can adjust the display's time interval for the current incident to 1, 5, 10, 15, 30 or 60 minutes. The default is 5 minutes.

  *The internal Event Summary stores up to 12 hours of 2 continuous ECG waves, 1 CO_2 and 2 invasive pressure waves, events and trending per patient incident.

- When the time interval is one minute, data from continuous measurements represents the average reading for that one-minute period. For all other time intervals, the measurement shown is the one-minute average from the most recent minute in the time interval.

To adjust the interval:

1. With Vital Signs Trending active on your display, press the Menu Select button.
2. Using the Navigation buttons, select **Trend Interval** and press Menu Select.
3. Using the Navigation buttons, select the trend interval you want and press Menu Select.

Scrolling in the Trending Report

- Use the **[<<]** or **[>>]** softkeys to scroll left and right (backward and forward) in the report. The softkey is inactive if there is no more data to be viewed in a particular direction.
- If there are more vital signs than can be shown on the screen, use the Navigation buttons to scroll up and down with the vertical scroll bar on the display. Make sure there is not a menu active at the same time.

Printing the Trending Report

Print the Trending Report two ways:

1. Press the soft key under the **Print Trends** label. A report for the displayed period and interval is printed.
2. Press the Summary button, select **Trends**, and then **Trends Interval**. A report for the entire incident period is printed.

If your MRx has a 50mm printer, the report will have 11 lines of text. If you have a 75mm printer, the report contains 16 lines.

Exiting the Trending Report

To exit the Trending Report and return to a waveform display, simply press the **[Close Trends]** soft key. You will be returned to Monitor Mode.

Practice Exercise 1

Have students change report time intervals, scroll through data, and print out sample reports. Pose the following questions:

1. Does the layout of a report change in any way when you increase or decrease the time interval?
2. Does the information on a printout differ from what you see on the display?

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold. Consider having students correct FALSE statements to ensure comprehension.)

1. Which of the following statement(s) are TRUE regarding data displayed on the Trending Report?
   a. If you scroll left to view older data, the screen will not update to new data when available. (**T**)
   b. Questionable data is indicated by **-?-**. (F - Questionable data is indicated by a question mark just before the numeric value.)
   c. Unavailable data is indicated by an empty space. (**T**)
   d. A ^ after the timestamp indicates multiple measurements taken during the interval. (**T**)
2. For the one-minute time interval, data from continuous measurements is the average reading for that one-minute period. (**T**)

16

Data Management

Lesson Introduction

Introduce the lesson, including the learning objectives and estimated time to complete.

This lesson describes the data management features of the HeartStart MRx.

Objectives

Upon completion of this lesson, students should be able to:

1. Identify MRx data management features.
2. Mark patient events.
3. Identify characteristics associated with printing Event Summaries.

Time

5-10 minutes

Accessories Recommended

- External data card

Lesson Presentation

Overview

Provide a summary of MRx's data management features. MRx:

- Marks events in the Event Summary (for a patient incident).
- Displays information about internal memory or the removable data card.
- Creates Event Summaries that:
  - Have a unique event identification number and date/time stamp.
  - Contain measurements stored for viewing, reporting and printing in the Vital Signs Trending Report.
  - Include trending and associated 12-Lead Reports,
  - Are automatically stored in internal memory; the oldest summary is deleted if space is needed for new summary.
  - May be copied to a data card using the **Data Management** menu.
  - May be printed out on an Event Summary Report.
- New Event Summaries are initiated each time one of the following activities occurs:
  - The arrival of a valid ECG signal.
  - The arrival of valid SpO_2 data.
  - The arrival of valid CO_2 data.
  - An NBP measurement is requested.
  - The arrival of valid invasive pressure data.
  - The arrival of valid temperature data.
  - The Charge button is pressed.
  - The Mark Event button is pressed.
  - A 12-Lead Report is successfully transmitted from the MRx.
- The amount of patient data collected, including two ECG waveforms, two invasive pressure waveforms and one CO_2 waveform, and other clinical events, is determined by the amount of internal memory available. The number of incidents stored in memory at any given time is determined by the length of each incident and the amount of data collected. There is a 12-hour data limit per incident with a maximum capacity of 55 patient incidents, regardless of card capacity or size of incidents.
- Disables monitoring and defibrillation functions while in the Data Management function.

Additional points/notes:

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Marking Events

Discuss the characteristics associated with marking events.

- Use the Mark Event button to annotate the Event Summary and the ECG strip (at the point in time the button is pressed).
- The Mark Event button prints a 6-second ECG strip (if so configured); the strip is printed real time or prepended with the previous 10 seconds of data leading up to the marked event. (See details below regarding printing events.)
- Once pressed, the Mark Event label (on the display) changes to Select Event and the Mark Events menu displays. Use the Navigation buttons to select the desired event and press Menu Select. The ECG strip is annotated with the mark event symbol and the selected annotation.

Suggestion: **Have students mark and print an event during or after your discussion.**

Printing Events

As appropriate, review the following list of events and related strip lengths that are printed automatically or with a 10-second delay.

Event	Real-Time Strip Length	Delayed Strip Length
HeartStart MRx charges to deliver a shock.	Continuous	10 seconds just prior to charging, plus continuous printing through the charge duration
Shock delivered	12 seconds	10 seconds just prior to shock, plus 12 seconds after shock
Shock failed	12 seconds	10 seconds just prior to the message *No Shock Delivered*, plus 12 seconds after the message
Alarm condition	15 seconds (10 seconds of pre-alarm data and 5 seconds of post alarm data when specified alarm type occurs.)	Same as real-time strip.
Mark Event button pressed	6 seconds from the start of the annotation text or from the time the Events menu is removed from the display.	10 seconds prior to the Mark Event plus 6 seconds from the start of the annotation text or from the time the Events menu is removed from the display.

Printing the Event Summary

Point out the steps and characteristics associated with printing Event Summaries.

- You can print the current Event Summary at any time during an event by pressing the Summary button and selecting **Event Summary** from the Print menu.
- If an event is not in progress, pressing the Summary button and selecting **Event Summary** prints most recent Event Summary.
- If an alarm condition occurs while an Event Summary is printing, an alarm strip is not printed, however, the corresponding ECG waveform is stored and available in the Event Summary.
- Previous Event Summaries stored in internal memory may be individually selected and printed using the **Data Management** menu.
- To print an Event Summary stored on the removable data card, the information must be downloaded to the HeartStart Event Review Pro data management system. Refer to the *HeartStart Event Review Pro Instructions for Use* for download instructions.

Note the following: To print individual 12-Lead ECG Reports for the current or most recent patient event, use the 12-Lead Report View menu. 12-Lead Reports stored in internal memory may be printed as part of the Event Summary using the **Data Management** menu if the Event Summary format is configured to 'Long'.

Suggestion: **Have students print an Event Summary during or after your discussion.**

Printing the Vital Signs Trending Report

Describe the options and related steps to print the Vital Signs Trending Report. (This topic is also covers in the Vital Signs Trending lesson.)

- To print the current Vital Signs Trending Report at any time during an event, press the Summary button, select **Trends** and then **Trends Interval** from the menu. Alternatively, press the soft key under the **`[Print Trends]`** label.
- If an event is not in progress, press the Summary button, select **Trends** ,and then a **Trends Interval** to print the most recent Vital Signs Trending Report.
- To select and print a Vital Signs Trending Report after an event:

1. Turn the Therapy Knob to either **Monitor**, **Pacer**, or **Manual Defib**.
2. Press the Menu Select button.
3. Using the Navigation buttons, select the **Other** menu and press Menu Select.
4. Select **Data Management** and press Menu Select.
5. Press Menu Select to acknowledge the message *Leaving Normal Operational Mode*.
6. Use the soft keys labeled **`[Prev Item]`** and **`[Next Item]`** to select the Vital Signs Trending Report you want to print.
7. Press Menu Select to display the Data Management menu.
8. Select **Print** and press Menu Select.
9. Using the Navigation buttons, select **Trends** from the menu and press Menu Select. The Vital Signs Trending Report is printed using the configured format.

Suggestion: **Have students print a Trending Report during or after your discussion.**

Additional points/notes:

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Using Data Management - Internal Memory

Demonstrate how to copy Event Summaries and 12-Lead ECG Reports stored in internal memory to a data card.

1. Insert a data card into MRx.
2. Turn the Therapy Knob to **Monitor**.
3. Press the Menu Select button.
4. Using the Navigation buttons, select **Other** and press Menu Select.
5. Select **Data Management** and press Menu Select.
6. Press Menu Select to acknowledge the message *Leaving Normal Operational Mode*.
7. Use the **[Prev Item]** and **[Next Item]** soft keys to select an Event Summary.
8. Press Menu Select to display the **Data Management** menu.
9. Select **Copy** and press Menu Select. The message *Copying Patient Data* is displayed while the Event Summary and any 12-Lead Reports are copied to the data card.

Suggestion: **Have students complete the copy procedure during or after your demonstration. Remind students not to remove the external data card from the MRx during the procedure.**

Using Data Management - Data Card

Demonstrate how to display a list of Event Summary and 12-Lead ECG Report identifiers located on the data card.

1. Turn the Therapy Knob to **Monitor**.
2. Press the Menu Select button.
3. Using the Navigation buttons, select the **Other** menu and press Menu Select.
4. Select **Data Management** and press Menu Select.
5. Press Menu Select to acknowledge the message *Leaving Normal Operational Mode*.
6. Press Menu Select to display the **Data Management** menu.
7. Select **View Data Card** and press Menu Select.

[Prev Page] and **[Next Page]** soft keys appear to navigate to additional display pages. Use the **Erase Card** menu entry to delete the data card contents.

Suggestion: **Have students complete the view procedure during or after your demonstration.**

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold. Consider having students correct FALSE statements to ensure comprehension.)

1. Which of the following statement(s) are TRUE related to MRx's data management?

   a. Data management includes Event Summaries that have a unique event identification number and are automatically stored in internal memory.

   b. New Event Summaries are initiated by valid SpO_2, CO_2, or invasive pressure data.

   c. The amount of patient data collected is determined by the amount of data card space available. (F - The amount of patient data collected is determined by the amount of internal memory available.)

   d. When using the Data Management function, monitoring and defibrillation modes are disabled.

2. True or false? The Mark Event button can be configured to print a 6-second ECG strip real time or prepended with the previous 10 seconds of data leading up to the marked event. (**T**)

3. True or false? For a 'Shock delivered' or 'Shock failed' event, the MRx will print a 12-second string, if so configured. (**T**)

17

Maintenance

Lesson Introduction

Introduce the lesson, including the learning objectives, estimated time to complete, and applicable resources.

This lesson describes how to care for the HeartStart MRx, including a brief look at battery maintenance and cleaning.

Objectives

Upon completion of this lesson, students should be able to:

1. Identify the meaning of each Ready For Use status.
2. Identify the appropriate steps to complete a shift check.
3. Perform the necessary steps to complete an operational check on the MRx.
4. Identify the appropriate steps related to battery maintenance.
5. Identify the appropriate steps to clean the MRx and its associated accessories.

Time

10-20 minutes

Accessories Recommended

- Simulator (or test load)
- Hands-free cable (or Pads/CPR cable, when appropriate)
- Multifunction electrode pads or external paddles
- 3-, 5-, or 10-Lead monitoring electrodes cable

Maintenance Resources

- *M3538A Lithium Ion Battery Characteristics and Care* Application Note
- MRx Shift Checklist

Lesson Presentation

Overview

Describe the critical aspects associated with maintaining the MRx.

- Providing power so automated tests can be run
- Observing the Ready For Use (RFU) indicator.
- Performing a shift check, weekly shock test, and an operational check.
- Caring for batteries.
- Cleaning the device and accessories.
- Ordering replacement supplies and accessories.

Note the following:

- The operational check discussed in this lesson is for a MRx with software version B.05 or greater. For devices containing versions prior to B.05, please refer to the *MRx Instructions for Use* for operational check instructions.
- For information on cleaning the MRx and accessories, device disposal, and a listing of replacement supplies and accessories, check out the Maintenance chapter of the *HeartStart MRx Instructions For Use*. Also, MRx service (including calibration of optional EtCO2 and NBP modules) should only be performed by qualified service personnel, in accordance with the *HeartStart MRx Service Manual*.

Additional points/notes:

Automated Tests

If appropriate to your audience, describe the three automated tests MRx runs to assess operational performance and alert users if a problem exists. Point out that they occur at regularly scheduled intervals while the device is off.

Test Name	Description	Frequency
Hourly	Tests batteries, internal power supplies, and internal memory	Hourly
Daily	Tests batteries, internal power supplies, internal memory, internal clock battery, defibrillation, pacing, ECG, SpO_2, $EtCO_2$, NBP, Invasive Pressure, Temperature, Bluetooth, and printer. The defibrillation test includes low energy internal discharges. If a 3-, 5-, or 10-Lead ECG cable is attached, the cable is tested as well.	Daily, between 11 pm and 1 am
Weekly	Performs the Daily test described above, plus delivers a high energy internal discharge to further exercise the defibrillation circuitry	Weekly, between 11PM Sunday and 1 AM Monday

- Test results are reported through:
  - the Automated Test Summary report.
  - the RFU indicator.
  - inop statements (when MRx is turned on).
- Automated tests do not test therapy cables, paddles, buttons, audio, or the display. An ECG cable is tested, if connected at the time of the test.

Discuss the possible automated test summary results, visual indications, what they mean, and what action to take based on the result. Note the following: The following test results refer to an MRx with software release B.05 or greater. For the results associated with devices containing releases prior to B.05, please refer to the *MRx Instructions for Use*.

Result	RFU Indicator	Definition	Required Action
Pass	Hourglass	All tests passed	None
Fail/DX	Solid red X, chirp	A problem has been detected that may prevent the delivery of a shock, pacing, or ECG acquisition.	Turn the Therapy Knob to **Monitor**. An inop indicating a problem has occurred is displayed. Refer to the *MRx Instructions For Use* (Troubleshooting chapter) for the action to take. If the condition persists, take the device out of use and call for service.

Result	RFU Indicator	Definition	Required Action
Fail/BF	Blinking red X	The total battery capacity (combination of both batteries) is less than 20%.	Charge the battery as soon as possible and/or replace the battery with a charged battery. Charging may be done in the HeartStart MRx or by connecting to AC/DC power or in a Philips-approved battery support system.
Fail/D	Hourglass	A problem has been detected with a component that does not affect therapy delivery.	Turn the Therapy Knob to **Monitor**. An inop indicating the failed component is displayed. Refer to the *MRx Instructions For Use* (Troubleshooting chapter) for the action to take. If the condition persists, take the device out of use and call for service.

Ready For Use Indicator

Cover what action to take based on automated test results that are communicated through the RFU status, as described below.

RFU Status	Meaning	Required Action
Blinking black hourglass	Shock, pacing, and ECG functions are ready for use and sufficient battery power is available.	None
Blinking red “X” with or without a periodic chirp	Low battery or no battery. The device has limited runtime. Chirping indicates the battery is not being charged. No chirping indicates the battery is being charged.	Charge the battery as soon as possible and/or replace with a charged one. Charge in the MRx using AC/DC power or in a Philips-approved battery support system.
Solid red “X” and a periodic chirp	A failure has been detected that may prevent delivery of a shock, pacing, or ECG acquisition.	Turn the Therapy Knob to **Monitor**. A message indicates a critical device error and an inop message describes the failure. Refer to the *MRx Instructions For Use* (Troubleshooting chapter) for the action to take. If needed, run an Operational Check for further information. If the condition persists, take the device out of use and call for service.
Solid red “X” without a periodic chirp	No power or device failure (cannot turn on)	Insert a charged battery or connect to AC/DC power. If the condition persists, take the device out of use and call for service.

Additional points/notes:

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Shift Check

Introduce the shift check.

- The American Heart Association (AHA) recommends completion of a checklist (shift check) at the beginning of each change in personnel to ensure that defibrillators are ready when needed. Philips supports the AHA checklist recommendations and has shipped a Shift Checklist document with the MRx.
- Checklist activities include:
  - Defibrillator Inspection - Ensure the MRx is clean, clear of objects, and has no visible signs of damage. Check RFU Indicator status.
  - Cables/Connectors/Paddles/Pads/Monitoring Electrodes - Check for cracks, broken wires, or other visible signs of damage, as well as secure connections. Check expiration date and quantity of pads and monitoring electrodes.
  - Batteries - Keep a charged battery in the MRx and another on hand or charging. Check for visible signs of damage.
  - AC/DC Power - Check the AC/DC power source; verify that the external power indicator on the front panel is lit.
  - Printer Paper - Check for sufficient paper and proper printing.
  - Data Card - If applicable, insert a data card with sufficient space available.
  - SpO_2 Sensor - Inspect the sensor and cable for visible signs of damage.
  - NBP Cuffs and Tubing - Inspect the pressure cuffs and tubing for visible signs of damage.
  - CO_2 FilterLine - Confirm that at least one un-opened, sterile package is available.
  - Invasive Pressure Transducer - Inspect the transducer for visible signs of damage.
  - Temperature Sensor - Inspect the sensor for visible signs of damage.
  - Compression Sensor - Inspect the Compression Sensor and cable for visible signs of damage. If damaged, remove from use.
  - Compression Sensor Adhesive Pads - Make sure there is a Compression Sensor Adhesive Pad applied to the Compression Sensor and there is an adequate supply available.

***Suggestion*: Ask students complete a shift check using a Shift Checklist versus you telling them what they should do.**

Additional points/notes:

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Weekly Shock Test

In addition to the shift check, verify the ability to deliver defibrillation therapy once a week by performing either a weekly shock test or an Operational Check (Op Check). Demonstrate how to perform a weekly shock test on the MRx.

1. If using:
   – External paddles, make sure the paddles are secure in their pockets and that the Patient Contact Indicator (PCI) LEDs located on the sternum paddle are not lit. If the LEDs light, adjust the paddles in their pockets. If the LEDs continue to light, clean both the adult and pediatric paddle electrode surfaces.
   – Multifunction electrode pads, attach a test load to the end of the patient Therapy cable.

Note the following: See the *Sterilizable Defibrillator Paddles Instructions for Use* for instructions to test reusable sterilizable paddles (internal or external) prior to each use.

2. Turn the Therapy knob to 150J.
3. Press the Charge button.

If it is necessary to disarm the defibrillator, press the **`[Disarm]`** soft key.

4. The strip prints if configured to do so. If the strip does not print immediately, press the Print button.
5. If using:
   – External paddles, simultaneously press the shock buttons located on the paddles to deliver a shock into the paddle tray.
   – Pads, press the Shock button on the MRx to deliver a shock into the test load.
6. Confirm on the strip print that the energy delivered to the test load is 150J ± 23J (127J to 173J). If not, take the device out of use and call for service.

Operational Check

Discuss Op Check characteristics.

- The Op Check should be performed at regular intervals to supplement Automated Tests.
- The Op Check checks for electrical shorts on therapy and ECG cables, and verifies paddles, audio, the Charge and Shock buttons, Therapy Knob, and Compression Sensor, along with replicating the Weekly test.
- The Op Check notifies you if the battery, NBP module, or CO2 module needs calibration.
- The Op Check should be run with a battery installed to reflect optimal operating conditions for defibrillation.
- The user should test each type of patient therapy cable used (multifunction electrode pads or paddles).
- If the MRx is equipped with multifunction defib pads only and does not have a paddle tray, you cannot test paddles during an Op Check. To test the paddles, you ***must*** have a test load. Run the Weekly Shock Test, delivering the shock into the test load. Ensure paddles (if tested) are secure in their pockets prior to performing the check.
- If your MRx has software version B.05 or greater and the Pacing option, test external paddles using the Weekly Shock test. You must run Operational Check with a pads cable in order to pass the Pacer test.
- If the device has the Q-CPR option, you should run the Operational Check with the Pads/CPR cable and the Compression Sensor, keeping the Compression Sensor still during the test.

Performing the Operational Check

Note the following:

- Be sure the MRx is not connected to the patient when performing an Operational Check.
- The following Op Check procedure refers to an MRx with software version B.05 or greater. For the Op Check procedure associated with devices containing versions prior to B.05, please refer to the *MRx Instructions for Use*.

Demonstrate how to perform the Op Check.

1. Insert a charged battery (with a capacity of 20% or greater).
2. Turn the Therapy Knob to **Monitor**.
3. Press the Menu Select button.
4. Using the Navigation buttons, select **Other** and press Menu Select.
5. Select **Operational Check** and press Menu Select.
6. Select **Run Op Check** and press Menu Select.
7. The message window *Leaving Normal Operating Mode* indicates exiting clinical functionality and entering device test mode. Press Menu Select to acknowledge the message.
8. Carefully read the setup instructions on the screen.
   – Attach a pads or paddles therapy cable and test load (or Pads/CPR cable, Compression Sensor, and test load). If the MRx has Pacing, you must run the Operational Check with a Pads cable.
   – Attach an ECG cable.

– Turn the Therapy Knob to 150J.

If you choose to proceed without correctly setting up the device, the Operational Check may fail.

9. Read and respond to applicable test prompts. Once you have answered the last prompt (Audio test), you can leave the MRx unattended and the Op Check will complete. As each test is run, the message *In Progress* appears, followed by *Pass* or *Fail*.

At completion of the Op Check, the message *Operational Check Passed* is displayed if all tests have passed. If any test fails, the message *Operational Check Failed* is displayed along with one (or more) of the following messages, depending upon the severity of the failed functionality:

– Service device.
– Replace battery.
– Replace Compression Sensor.
– Replace Pads cable.
– Replace Paddles cable.
– Replace Therapy cable.
– Replace ECG cable.

You must fix the problem and successfully run Op Check to clear the failure.

- A report prints out automatically, listing test results and items the user should check manually. The user can press the [**Print**] soft key to print an additional copy of the report.
- If you cancel the Op Check before it completes, there is no record of it in the Operational Check Summary.
- Upon completing the Op Check and returning to a clinical mode (Monitor, Pacer, Manual Defib or AED), all settings are reset to the device's configured values.

***Suggestion*: Have students complete the Op Check steps with you or after you have demonstrated the procedure. Advise students to safely discharge paddles if they are being tested.**

Consider discussing the Op Check details outlined on the next few pages, depending on your audience's interests and needs. Point out that Op Check test results and the actions to take are described in the Maintenance chapter of the *MRx Instructions For Use*. Mention a few of the typical results that may be encountered if students ask (e.g., indication that batteries need charging or calibration, there has been a module failure, or NBP or CO2 needs calibration). Encourage students not to take MRx out of service on its first failure. They should run Op Check again and troubleshoot as much as possible, referencing the Troubleshooting chapter of the *MRx Instructions For Use* as needed.

Additional points/notes:

Operational Check Tests

Discuss the Op Check tests in the order they are performed, corresponding prompts, and actions to take (if any).

Test	Description	Prompts	Action
General System	Tests internal clock battery, power supply, and internal memory card.	None	None
Therapy Knob	Tests if the Therapy Knob is set to 150J.	None	None
Charge Button	Tests the Charge button.	Depending on the cable connected, as follows: • If the Pads cable is attached, you are prompted to *Verify Test Load is Attached and Press the Charge Button*. • If external paddles are attached, you are prompted to *Verify Paddles are in Holders and Press the Charge Button*. • If no cable is attached, the test is marked Not Tested. If the MRx does not detect a press of the Charge button within 10 seconds, the message *If the Charge button does not work, select Charge from the menu below* is displayed.	Respond to the prompt, as follows: • Check the test load is attached and press the Charge button. • Make sure the paddles are seated in their pockets and press the Charge button. If the Charge button is not working, press **Charge** from the No Button Response menu. The Charge button test is marked Fail and the Op Check fails.
Shock Button	Tests the Shock button.	• Once charged, the Shock button lights and you are prompted to *Press Shock* or *Press Shock buttons on paddles*. • If the MRx does not detect a press of the Shock button within 10 seconds, the message *If the Shock button does not work, select Shock from the menu below* is displayed. Note: The device automatically disarms after the time specified in the configuration is reached. • The message *Defib Disarmed* is displayed.	• Press the Shock button. • If the Shock button is not working, press **Shock** from the No Button Response menu. The Shock button test is marked Fail. • Select **Shock** from the menu to continue the Operational Check or press **Exit Op Check.** The Shock button test is marked Fail.

Operational Check Tests (Continued)

Discuss the Op Check tests in the order they are performed, corresponding prompts, and actions to take (if any).

Test	Description	Prompts	Action
Audio	If a shock was delivered during the Shock test, the voice prompt, *Shock Delivered* is annunciated. If no shock was delivered during the Shock test, the voice prompt *No Shock Delivered* is annunciated.	*Did you hear No Shock Delivered?*	Use the navigation buttons to respond **Yes** or **No**. Then press the Menu Select button.
Defib	Tests defibrillation circuitry and delivers a shock through: • pads into a test load and/or • external paddles into the MRx Note: The Defib test has two components: a high energy internal discharge and a low energy (5J) external discharge. The results of the device's ability to charge and shock are reported in the Defib test.	None	None
Pacer	Tests pacing functionality and delivers a paced pulse into a 50 ohm test load.	None	None
Compression Sensor	Checks the basic communication circuity of the sensor.	None	None
Leads ECG	Tests leads ECG acquisition and the ECG cable.	None if the test passes. If the test fails, the following prompt is displayed at the end of all remaining tests: *Leads ECG Test failed with cable. Disconnect ECG cable to rerun test without cable.*	If the ECG test fails with the cable and passes without the cable, the ECG cable is bad. Replace the ECG cable and rerun Operational Check. If the ECG test fails with and without the cable, refer to the *MRx Instructions For Use* (Troubleshooting chapter) for the action to take.

Operational Check Tests (Continued)

Discuss the Op Check tests in the order they are performed, corresponding prompts, and actions to take (if any).

Test	Description	Prompts	Action
Pads/Paddles ECG	Checks ECG acquisition through pad/paddles.	None, if test passes. If test fails the following prompt is displayed at the end of all remaining tests: *Pads/Paddles ECG Test failed with cable. Disconnect therapy cable to rerun test without cable.*	If the Pads/Paddles test fails with the cable and passes without the cable, the cable is bad. Replace the Therapy cable and rerun Operational Check. If the Pads/Paddles test fails with and without the cable, refer to the *MRx Instructions For Use* (Troubleshooting chapter) for the action to take.
Battery A Battery B	Checks the capacity and calibration status of the batteries in Compartments A and B.	None	None
SpO_2	Checks the internal SpO_2 PCA. The SpO_2 cable is not tested.	None	None
NBP	Checks to see if the NBP module is functioning; determines if it is due for calibration.	None	None
CO_2	Checks to see if the CO_2 module is functioning; determines if it is due for calibration.	None	None
Invasive Pressures	Checks to see if the invasive pressure hardware is working properly.	None.	None.
Temperature	Checks to see if the temperature hardware is working properly.	None.	None.
Bluetooth	Checks for the presence of the Bluetooth card and database integrity.	None	None
Printer	Runs a printer self test.	None	None

Operational Check Summary

Demonstrate how to view the Operational Check Summary (which lists the results from the last 60 Op Checks):

1. Turn the Therapy Knob to **Monitor**.
2. Press the Menu Select button.
3. Using the Navigation buttons, select **Other** and press Menu Select.
4. Select **Operational Check** and press Menu Select.

5. Using the Navigation buttons, select **Op Check Summary** and press Menu Select.
6. Press Menu Select to acknowledge the message *Leaving Normal Operational Mode*.
   The Operational Check Summary screen is displayed.
7. Press the **[Print]** soft key to print the report.

***Suggestion*: Have students complete the steps to access the Op Check Summary with you or after you have demonstrated the procedure. Discuss the Op Check Summary Results and actions to take (see below).**

Result	RFU Indicator	Definition	Required Action
Pass	Hourglass	All tests passed	None
Fail/DX	Solid red X, chirp	A problem has been detected that may prevent the delivery of a shock, pacing, or ECG acquisition.	Turn the Therapy Knob to **Monitor**. An inop indicating the problem is displayed. See *MRx Instructions For Use* (Troubleshooting chapter) for the action to take.
Fail/CX	Solid red X, chirp	A problem has been detected with a cable.	Turn the Therapy Knob to **Monitor**. An inop indicating the failed cable is displayed. Replace the failed cable.
Fail/BF	N/A[1]	A battery failure was detected.	Replace the battery.
Fail/D	Hourglass	A problem has been detected with a component that does not affect therapy delivery.	Turn the Therapy Knob to Monitor. An inop indicating the failed component is displayed. *MRx Instructions For Use* (Troubleshooting chapter) for the action to take.
Fail/S	Hourglass	Compression Sensor failure	Check the Compression Sensor and cable connections. If necessary, replace the Compression Sensor.

1.The Automated Tests continually check for a low battery condition and set the RFU Indicator appropriately.

Additional points/notes:

Battery Maintenance

Discuss battery maintenance, related activities, and characteristics.

- Proper maintenance:
  - ensures the battery's charge state is accurately reported.
  - ensures there is sufficient charge and capacity to operate the MRx.
  - ensures battery life is optimized.
  - begins upon receipt of a new battery and continues throughout the battery life.

Detailed information on battery care is available in the *M3538A Lithium Ion Battery Characteristics and Care* application note provided with each MRx.

Here are the battery maintenance activities and when they should be performed:

Activity:	**When to Perform:**
Perform a visual inspection.	As part of the Operational Check.
Charge the battery.	Upon receipt, after use, or if the message *Batteries Low* is displayed.
Perform a calibration.	When the Operational Check test results state *Calibration Recommended*, or every 6 months, whichever comes first.
Store batteries in a state of charge in the range of 20% - 40%	When not in use for an extended period of time.
Discard the battery.	When there are visual signs of damage or calibration reports less than 80% capacity.

- Life is approx. 2 years when properly cared for and depending on the frequency and duration of use.
- Charging a fully (or nearly fully) discharged battery as soon as possible optimizes performance.
- Charging should be done in either the HeartStart MRx (with AC or DC power) or in the Philips-approved Battery Support System at temperatures between 0°C (32°F) and 45°C (113°F).
- Charge status is indicated by the fuel gauge on the battery top (each LED represents approx. 20% charge capacity) and the battery power indicators displayed in the General Status area.

Suggestion: **Discuss how and when batteries will be charged in students' organizations to ensure charged batteries are available when needed. Ask who will calibrate the batteries. Recommend students check the Maintenance chapter of *MRx Instructions For Use* for information about battery calibration, storage, and disposal. Also, stress caution when handling, using, and testing the batteries to prevent physical injury.**

Additional points/notes:

Cleaning Instructions

Discuss the following recommendations for cleaning the HeartStart MRx and its associated accessories, as appropriate.

- The HeartStart MRx, along with its accessories and supplies, may not be autoclaved, steam cleaned, ultrasonically cleaned, or immersed unless otherwise indicated in the Instructions for Use that accompany the accessories and supplies.
- Do not use abrasive cleaners or strong solvents such as acetone or acetone-based cleaners.
- Do not mix disinfecting solutions (such as bleach and ammonia) as hazardous gases may result.
- Do not clean electrical contacts or connectors with bleach.
- Disinfect the device as determined by your organization's policy to avoid long-term damage to the device.

Monitor/Defibrillator

- Use these cleaning products on the exterior surfaces of the MRx, as well as the batteries and data card:
  - Isopropyl alcohol (70% solution in water).
  - Mild soap and water.
  - Sodium hypochlorite (chlorine bleach) (3% solution in water).
  - Quaternary ammonium compounds (21% quaternary ammonium content, such as Steris Coverage Plus NPD®; .5 ounces/gallon - one part Coverage Plus NPD® to 255 parts water).
- Remove all adherent soil (tissue, fluids, etc.) and wipe the MRx thoroughly with a cloth dampened with water before applying the cleaning solution.
- When cleaning, do not immerse the MRx in fluid. Wring any excess moisture from the cloth before cleaning. Avoid pouring fluids on the device, and do not allow fluids to penetrate the exterior surfaces of the device.
- Use a soft cloth on the display to prevent scratching.

Printer Printhead

If the printout has light or varying print density, clean the printhead to remove any buildup of paper residue.

To clean the printhead:

1. Push the printer door latch to open the door.
2. Remove the roll of paper.
3. Clean the printhead surface (above the brush) with a cotton swab dipped in isopropyl alcohol.
4. Replace the roll of paper.

Paddles and Therapy Cable

- External non-sterilizable paddles and Therapy cables (including Pads/CPR cable) may be cleaned with a soft cloth moistened with:
  - Mild soap and water.
  - Gluteraldehyde solution (such as Cidex Plus®) (2% solution in water).
  - Sodium hypochlorite (chlorine bleach) (3% solution in water).
  - Quaternary ammonium compounds (21% quaternary ammonium content, such as Steris Coverage Plus NPD®; .5 ounces/gallon - one part Coverage Plus NPD® to 255 parts water).
  - Isopropyl alcohol (70% solution in water).
- The paddles and Therapy cables may not be ultrasonically cleaned or immersed, autoclaved, or ETO sterilized.
- See the *Sterilizable Defibrillator Paddles Instructions for Use* for cleaning and sterilizing internal and external sterilizable paddles.
- Philips' disposable sterile internal defibrillation paddles, multifunction electrode pads, and monitoring electrodes are single use items and do not require cleaning.

ECG Cable

For M3525A, M3526A, M3527A, M3528A, M3529A and 989803147691 ECG cables:

- Wipe clean with any of the following:
  - Isopropyl alcohol (70% solution in water).
  - Mild soap and water.
  - Gluteraldehyde solution (3.4% gluteraldehyde content such as CidexPlus®).
  - Quaternary ammonium compounds (21% quaternary ammonium content such as Steris Coverage Plus NPD®). Dilution: .5 oz. per gallon water - one part Coverage Plus NPD® to 255 parts water.
  - Chlorine bleach (6% sodium hypochlorite), 3% solution in water. This solution may discolor the cable.

For any other approved ECG cable:

- Clean according to the manufacturer's instructions.
- Do not ultrasonically clean, immerse, autoclave, or steam sterilize the ECG cable. Do not clean the ECG cable with alcohol or clean electrical contacts and connectors with chlorine bleach.

NBP Cuff

- Disinfect the cuff by immersion in a decontamination solution of 70-85% isopropyl alcohol, but remove the rubber bag if you use this method.
- Machine- or hand-wash the cuff as recommended by the manufacturer; the latter method will prolong the service life of the cuff. Before washing, remove the latex rubber bag and, for machine-washing, close the Velcro fastening. Allow the cuff to dry thoroughly after washing, then reinsert the rubber bag.
- Do not dry clean the cuff.

SpO_2 Sensor and Cable

Clean the SpO_2 sensor and cable by following the instructions provided with the accessory.

Invasive Pressure Cable

To clean the invasive pressure cable, follow the instructions provided with the accessory.

Temperature Probe and Cable

To clean the temperature probe and cable, follow the instructions provided with the accessory.

Compression Sensor

- Clean with a soft cloth moistened with:
  - mild soap and water.
  - Gluteraldehyde solution (3.4% gluteraldehyde content, such as Johnson & Johnson Cidex Plus™).
  - Sodium hypochlorite (chlorine bleach) (3% solution in water).
  - Quaternary ammonium compounds (21% quaternary ammonium content, such as Steris Coverage Plus NPD™) (one part Coverage Plus NPD to 255 parts water).
  - Isopropyl alcohol (70% solution in water).
- Do not immerse the Compression Sensor.

Carrying Case

Clean the carrying case by hand with mild soap and water. Use fabric stain removers to remove stubborn stains. Air dry the carrying case. Do not wash or dry by machine.

Additional points/notes:

Review

Have students answer the following questions individually or as a group. (Correct answers are in bold. Consider having students correct FALSE statements to ensure comprehension.)

1. Which RFU status indicates the MRx is unable to acquire an ECG?
   a. Blinking red X with a chirp
   b. Blinking red X without a chirp
   c. Solid red X with a chirp
   d. Solid red X without a chirp
2. Which of the following statement(s) are TRUE related to the Operational Check?
   a. It is automatic. You can start it, leave, and come back later when it's done. (F - This test requires user interaction for some of the tests.)
   b. The Battery Compartment B test checks for BOTH capacity and calibration of battery B. (**T**)
   c. An ECG cable must be connected to the MRx to complete the Leads ECG test. (F - A user can check the ECG without a cable.)
   d. A pads cable must be connected to complete the Pads ECG test. (**T**)
3. Which of the following statement(s) are TRUE related to battery maintenance?
   a. Batteries should be inspected as part of the Operational Check. (**T**)
   b. Discard the battery when calibration reports less than 80% capacity. (**T**)
   c. Batteries charge automatically if they are in an MRx connected to AC or DC power. (**T**)
   d. Frequency and duration of use have a direct correlation on battery life. (**T**)
4. Which of the following statement(s) are TRUE related to MRx and accessory cleaning?
   a. You can clean the exterior of the MRx and the batteries with chlorine bleach. (**T**)
   b. You can clean the printer printhead surface with isopropyl alcohol. (**T**)
   c. You can ETO sterilize the external paddles. (F - You should not ETO sterilize paddles.)
   d. You can clean the carrying case by hand or machine with mild soap and water. (F - You should not machine wash the carrying case.)

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