

➤ **1)General and acute care**

The best-known type of hospital is the general hospital, also known as an **acute-care hospital**. These facilities handle many kinds of disease and injury, and normally have an emergency department (sometimes known as "accident & emergency") or trauma center to deal with immediate and urgent threats to health. Larger cities may have several hospitals of varying sizes and facilities. Some hospitals, especially in the United States and Canada, have their own ambulance service.

➤ **Acute care**

Acute care is a branch of secondary health care where a patient receives active but short-term treatment for a severe injury or episode of illness, an urgent medical condition, or during recovery from surgery. In medical terms, care for acute health conditions is the opposite from chronic care, or longer-term care.

➤ **Departments or wards**

Hospitals consist of departments, traditionally called wards, especially when they have beds for inpatients, when they are sometimes also called inpatient wards. Hospitals may have acute services such as an emergency department or specialist trauma center, burn unit, surgery, or urgent care. These may then be backed up by more specialist units such as the following:

- **Emergency department or specialist trauma center**
- **burn unit**
- **surgery**
- **Outpatient surgery**

➤ **Trauma center setup**

The basic trauma setup includes

- 4 soft restraints
- **EKG monitor with leads**
- **O2 sat probe**
- **automatic BP cuff**
- Mayo stand with IV catheters and crystalloid solution (Mayo stand #1).
- Foley catheter, NG tube and equipment for a femoral stab (Mayo stand #2).

➤ **Burn Unit**

- **Burn Treatment Equipment**
- **Bathtubs (TR 900)** Stainless steel baths safeguard against bacterial growth inside and outside the bath. They are easy to disinfect and resistant to staining from chemical additives.
- Mobile Patient Lifts (TR 9650)
- Hydraulic Shower Trolley (TR 2000)
- Battery Shower Trolley (TR 3000)

- Bariatric Shower Trolley (TR 4000/4200)
- Shower Panel (TR 2810) Showering and disinfection panel.

### ➤ **Medical-Surgical Equipment in the Acute Care Setting**

- Oxygen Therapy
  - **ventilators**
- Hemodynamic Monitoring
  - Minimally **invasive and invasive** hemodynamic monitoring
  - Noninvasively and continuously monitor blood pressure, cardiac output, stroke volume, and other critical hemodynamic parameters
- Intracranial Pressure Monitoring
  - ICP is the pressure in the skull.
  - The **intraventricular catheter** is the most accurate monitoring
- Multimodal Neuromonitoring
  - cEEG, continuous **EEG**.
  - CPP, cerebral perfusion pressure.
  - EEG, electroencephalography.
  - GCS, Glasgow coma scale
  - ICP, intracranial pressure.
  - **NIRS**, near-infrared spectroscopy
- Medical-Surgical Management Devices

### ➤ **Outpatient Surgery**

- Outpatient surgery is also referred to as ambulatory surgery or same-day surgery.
- Improved surgical instruments
- Less invasive surgical techniques
- The desire to reduce health care costs
- **Anesthesia machines** is continually display **vital signs** such as blood pressure, blood oxygen levels, heart function, and breathing patterns so that they can watch for any breathing problems.

### ➤ **2) District**

- A district hospital typically is the major health care facility in its region, with large numbers of beds for intensive care, critical care, and long-term care.
  - **intensive care**
  - **critical care**
  - **long-term care**

- **intensive care devices**

- **VENTILATOR**
- **SYRINGE DRIVER / SYRINGE PUMP**
- RESUSCITATOR BAG
- **SATURATION MONITOR (Pulse Oximeter)**
- CENTRAL VENOUS CATHETERS (CVC)
- NASOGASTRIC TUBES (NG TUBE)
- ENDOTRACHEAL TUBE (ETT OR BREATHING TUBE)
- **BLOOD PRESSURE CUFF**
- SEQUENTIAL COMPRESSION DEVICES
  - Sequential compression devices (SCD) are used in intensive care to reduce the risk of deep vein thrombosis (DVT) in the lower limbs of critically ill patients
- INDWELLING URINARY CATHETER (IDC)
- ICU BEDSIDE MONITORS

➤ **3) Specialized**

- **rehabilitation hospitals**

- also referred to as inpatient rehabilitation hospitals, are devoted to the rehabilitation of patients with various **neurological**, **Musculo-skeletal**, **orthopedic** and **occupational therapy**, and **physical therapy** and other medical conditions following **stabilization** of their acute medical issues.
- Devices
  - Electrical Muscle Stimulation
  - EEG

- **certain disease categories such as**

- cardiac
- oncology
- orthopedic problems

- **children's hospitals**

- Devices
  - Resuscitation cart containing readily accessible
  - Defibrillator designed for pediatric
  - Scales and stadiometer for infants and older children
  - Thermometers and blood pressure measuring device with a complete selection of cuffs appropriate for the full spectrum of pediatric patients
  - Cardiorespiratory monitors
  - Pulse oximeters
  - twenty-four-hour access to an electrocardiograph machine

- **long-term acute care facilities**

- hospitals for dealing with specific medical needs such as psychiatric problems

➤ **4) Teaching**

- A teaching hospital combines assistance to people with teaching to medical students and nurses and often is linked to a medical school

## PREVENTIVE MAINTENANCE PROCEDURE

DEFIBRILLATOR - Applies to battery- and line-powered defibrillators used with external and internal paddles and/or disposable defibrillation electrodes..

For details, refer to Health Devices Inspection and Preventive Maintenance (IPM) procedure and to the American National Standards Institute standards for defibrillators

Defibrillators

ECRI Procedure/Checklist 407-0595

Cardiac Defibrillator Devices

ANSI/AAMI DF2-1989

Equipment Needed: electrical safety analyzer, defibrillator analyzer, stopwatch or watch with second hand, storage oscilloscope

## 1. Qualitative Tests

- 1.1 Chassis - verify physical integrity, cleanliness
- 1.2 Mount/Fasteners - verify physical integrity of mounts (wall, equipment, cart, etc.)
- 1.4 AC Plug - verify integrity
- 1.5 Line Cord - verify proper insulation and integrity
- 1.6 Strain Reliefs - verify physical integrity at both ends of line cord
- 1.7 Circuit Breaker/Fuse - verify integrity of external circuit breaker and/or value of external fuse
- 1.9 Cables - inspect cables of internal/external paddles, disposable defibrillation electrodes, and synchronizer cables
- 1.10 Connectors examine all cable connectors
- 1.11 Paddles/Electrodes - verify physical integrity of paddles
- 1.13 Controls/Switches - verify proper operation; verify operation of redundant controls
- 1.17 Battery/Charger - verify operation & condition of battery/charger
- 1.18 Indicators/Displays - verify proper illumination and operation
- 1.21 Audible Signal - confirm appropriate volume and operation of volume controls
- 1.22 Labeling - verify presence and placement of all labels, placards, instruction cards, etc.
- 1.23 Accessories - verify availability of appropriate electrodes and electrodes
- 1.24 Internal Discharge Of Stored Energy - verify release of stored energy when power is turned off
- 1.25 Synchronizer - verify unit will not discharge when no ECG signal is present

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2. Quantitative Tests (line powered devices)
  - 2.1 Grounding Resistance [ $< 0.5$  ohm]
  - 2.2 Chassis Leakage [ $< 300$  microamps]
  - 2.3 Paddle Continuity [ $< 0.15$  ohm]
  - 2.4 Energy After 60 Seconds  
[ $> 85\%$  of energy delivered after immediate discharge]
  - 2.5 Internal Paddle Energy Limit
  - 2.10 Output Energy [ $\pm 15\%$  or 4J, whichever is greater]  
Test at 10J, 50J, 100J, 200J, 300J, 360J
  - 2.11 Charge Time [ $< 15$  Sec]  
Max Energy (10th Charge) [ $\pm 15\%$  or 4J, whichever is greater]
  - 2.12 Synchronizer Operation  
Verify that "R" wave of ECG trace is illuminated  
[discharge  $< 25$  mSec after detecting ECG]
3. Waveform Analysis - Display discharge curve through the simulator on a storage oscilloscope. Verify that the waveform is within specifications per ANSI/AAMI DF2-1989

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Defibrillator (ECRI)  
defib.doc

## PREVENTIVE MAINTENANCE PROCEDURE

MONITOR, ECG - HEWLETT PACKARD, MDE, Protocol, Tektronix, AND all other standalone units

For details, refer to Health Devices Inspection and Preventive Maintenance (IPM) procedure

ECG Monitors

Procedure/Checklist 409-0595

Equipment Needed: Electrical Safety Analyzer, Patient Simulator and associated cables

## 1. Qualitative Tests

- 1.1 Chassis - verify physical integrity, cleanliness
- 1.4 AC Plug - verify integrity
- 1.5 Line Cord - verify proper insulation and integrity
- 1.6 Strain Reliefs - verify physical integrity at both ends of line cord
- 1.9 Inspect patient cable and leads
- 1.10 Fittings/Connectors examine all cable connectors
- 1.13 Controls/Switches - verify proper operation
- 1.18 Indicators/Displays - verify proper illumination and operation
  - verify trace quality and linearity
  - verify QRS waveform on display
- 1.19 1mV Step Response - verify proper operation of TEST/CAL button
- 1.22 Labeling - verify presence and placement of all labels, placards, instruction cards, etc.

## 2. Quantitative Tests

- 2.1 Grounding Resistance [ $< 0.5 \text{ ohm}$ ]
- 2.2 Chassis Leakage [ $< 300 \text{ microamps}$ ]
  - Lead Leakage [ $< 10 \text{ microamps (G)}$ ,  $< 50 \text{ microamps (NG)}$ ]
  - Inter-lead Leakage [ $< 10 \text{ microamps (G)}$ ,  $< 50 \text{ microamps (NG)}$ ]
  - Input Isolation [ $< 50 \text{ microamps}$ ]
- 2.10 Rate Calibration
  - verify rate accuracy at 60 BPM and 120 BPM [ $\pm 5\%$  or 5 BPM, whichever is greater]
- 2.11 Rate Alarm
  - verify visual and audible alarms at 60 BPM 120 BPM [ $\pm 5\%$  or 5 BPM, whichever is greater]
- 2.12 Alarm Delay
  - verify high and low alarm delay [ $< 10 \text{ sec}$ ]
- 2.13 Asystole Alarm Delay
  - verify asystole alarm delay [ $< 5 \text{ sec}$ ]

\*\* Verify that ECG leadwires are of the shielded pin safety type \*\*

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## PREVENTIVE MAINTENANCE PROCEDURE

ELECTROSURGICAL UNIT - Applies to units that perform surgical functions by using high-frequency electrical currents that pass through the body.

For details, refer to Health Devices Inspection and Preventive Maintenance (IPM) procedure and to the appropriate manufacturers specifications.

Electrosurgical Units

ECRI Procedure/Checklist 411-0595

Equipment Needed: electrical safety analyzer; electrosurgical unit analyzer; oscilloscope; connectors, adapters, active electrode and/or return electrode, as required

## 1. Qualitative Tests

- 1.1 Chassis - verify physical integrity, cleanliness
- 1.2 Mount/Fasteners - verify physical integrity of mounts (wall, equipment, cart, etc.)
- 1.3 Casters/Brakes - if mounted on casters, verify physical integrity including brakes
- 1.4 AC Plug - verify integrity
- 1.5 Line Cord - verify proper insulation and integrity
- 1.6 Strain Reliefs - verify physical integrity at both ends of line cord
- 1.7 Circuit Breaker/Fuse - verify integrity of external circuit breaker and/or value of external fuse
- 1.9 Cables - inspect cables (footswitch, etc.) as appropriate
- 1.10 Connectors examine all cable connectors
- 1.11 Dispersive Electrodes - verify supply and connection
- 1.12 Filters - check condition of filters as appropriate
- 1.13 Controls/Switches - verify proper operation
- 1.18 Indicators/Displays - verify proper illumination and operation
- 1.20 Dispersive Cable Continuity Monitor - verify proper operation
- 1.21 Audible Signal - confirm appropriate volume and operation of volume controls
- 1.22 Labeling - verify presence and placement of all labels, placards, instruction cards, etc.
- 1.23 Accessories (footswitch) - verify physical integrity, connection, and proper operation
- 1.24 Special Protective Features - verify proper operation as indicated by the manufacturer

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## 2. Quantitative Tests

- 2.1 Grounding Resistance [< 0.5 ohm chassis, footswitch]  
[>20 Megaohm return electrode (except grounded output units)]
- 2.2 Chassis Leakage [< 300 microamps]  
Electrode Leakage [< 10 microamps (G)]
- 2.3 Output Isolation [Manufacturer's specifications or >80%]
- 2.10 Output Power - verify that delivered energy is within  
specified range. Select the low, middle and maximum power  
settings, using the following test loads on the ESU analyzer

TEST LOAD VALUES, IN OHMS			
Make	Monopolar	Bipolar	+/- Power Specs
Valleylab	300	100	20%

- 2.11 RF Leakage [<200 milliamps]

## 4. Waveform Analysis

Verify and document the output waveform characteristics (frequency, duty cycle, crest factor, etc.). View waveform on an oscilloscope connected to the appropriate jack on the ESU analyzer.

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Electrosurgical Unit (ECRI)  
esu.doc

## PREVENTIVE MAINTENANCE PROCEDURE

INFUSION DEVICES - Applies to most types of electromechanical devices that regulate the delivery of fluids to a patient, including general-purpose infusion pumps, multichannel pumps, microinfusion pumps, patient-controlled analgesic (PCA) pumps, syringe pumps, ambulatory pumps, enteral feeding pumps, and infusion controllers.

For details, refer to Health Devices Inspection and Preventive Maintenance (IPM) procedure and to the appropriate manufacturers specifications.

## Infusion Devices

ECRI Procedure/Checklist 416-0595

Equipment Needed: electrical safety analyzer; stopwatch; 25 ml graduated cylinder; pressure gauge; applicable I.V. bag and tubing

## 1. Qualitative Tests

- 1.1 Chassis - verify physical integrity, cleanliness
- 1.2 Mount - verify physical integrity of mounts
- 1.3 Casters/Brakes - if mounted on IV pole, verify physical integrity
- 1.4 AC Plug - verify integrity
- 1.5 Line Cord - verify proper insulation and integrity
- 1.6 Strain Reliefs - verify physical integrity at both ends of line cord
- 1.7 Circuit Breaker/Fuse - verify integrity of external circuit breaker and/or value of external fuse
- 1.9 Cables - inspect drop sensors and external air-in-line detectors as appropriate
- 1.10 Connectors examine all cable connectors (drop sensor, nurse call, etc.)
- 1.13 Controls/Switches - verify proper operation; inspect membrane switches
- 1.18 Indicators/Displays - verify proper illumination and operation
- 1.20 Alarms - verify proper operation; specifically verify (as appropriate) air-in-line, empty container, infusion complete, open door/misloaded set, nurse call
- 1.21 Audible Signal - confirm appropriate volume and operation of volume controls
- 1.22 Labeling - verify presence and placement of all labels, placards, instruction cards, etc.
- 1.23 Accessories - verify physical integrity, connection, and proper operation of drop sensors and external air-in-line detectors
- 1.24 Flow-Stop Mechanisms - verify operation and integrity
- 1.25 Lockout Interval (PCA Pumps Only) - verify operation

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## 2. Quantitative Tests

- 2.1 Grounding Resistance [ $< 0.5 \text{ ohm}$ ]
- 2.2 Chassis Leakage [ $< 300 \text{ microamps}$ ]
- 2.10 Flow Accuracy

FLOW RATE ACCURACY			
Set Rate	Duration	Desired Volume	Flow Error
60 ml/hr	5 min	5 ml	+/- 5%
120 ml/hr	5 min	10 ml	+/- 5%
240 ml/hr	5 min	20 ml	+/- 5%

- 2.11 Maximum Pressure/Occlusion Alarms  
(exclude infusion controllers) [manufacturers specs]

## 3. Service/Self Test Mode

Enter service/self test mode and verify proper operation.  
Restore settings as they were initially found.

IMED PC-1 - press and hold the "hidden" key during power up.  
Keep the "hidden" key pressed until "Maintenance"  
Appears on the display. Successive presses of the "hidden"  
key will select each test, while pressing the "START" key

will

begin the test.

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Infusion Device (ECRI)  
infusion.doc

## PREVENTIVE MAINTENANCE PROCEDURE

## MONITOR, Invasive Blood Pressure Module or Stand-Alone Unit

For details, refer to Health Devices Inspection and Preventive Maintenance (IPM) procedure

Blood Pressure Monitors, Invasive  
Procedure/Checklist 434-0595

Equipment Needed: Electrical Safety Analyzer, Patient Simulator and associated cables

## 1. Qualitative Tests

- 1.1 Chassis - verify physical integrity, cleanliness
- 1.4 AC Plug - verify integrity
- 1.5 Line Cord - verify proper insulation and integrity
- 1.6 Strain Reliefs - verify physical integrity at both ends of line cord
- 1.9 Cables - inspect patient cables
- 1.10 Fittings/Connectors - examine all cable connectors
- 1.11 Transducer - verify physical integrity of available transducers
- 1.13 Controls/Switches - verify proper operation
- 1.18 Indicators/Displays - verify proper illumination and operation
- 1.19 User Calibration - verify zero-adjustment and any other calibration controls
- 1.20 Alarms - verify audible and visual alarms
- 1.24 Pressure Modes - verify systolic, diastolic, and mean pressure

## 2. Quantitative Tests

- 2.1 Grounding Resistance [ $< 0.5$  ohm]
- 2.2 Chassis Leakage [ $< 300$  microamps]
- 2.10 Accuracy, High (Arterial) Pressure Range
  - verify systolic, diastolic, & mean modes at 100mmHg and 200mmHg (or maximum) [ $\pm 2\%$  or 1mmHg, whichever is greater]
- 2.11 Accuracy, Low Pressure (Venous/Pulmonary) Range
  - verify systolic, diastolic, & mean modes at 10mmHg and 20mmHg [ $\pm 1$ mmHg]
- 2.12 Alarm Accuracy
  - verify high and low alarm limits at 180mmHg and 100mmHg respectively [ $\pm 5\%$  of set value]

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press\_inv.doc

Monitor, Invasive Pressure (ECRI)

**1. Daily  
equipment  
rounds**

**1a. Inquire with  
staff if there are  
any problems  
with the  
machine**

**1b. Check  
power supply,  
cables, and  
surge protector**

**2. Six month  
maintenance:  
check...**

**2a. Air filter**

**2b. Oxygen  
sensor**

**2c. O-rings on  
tank**

**2d. Bellows**

**2e. Reservoir  
bag**

**2f. Internal  
battery**

**2g. Solenoid**

**2h. Pressure  
valve**

**2i. Pressure  
transducer**

**2j. Fenton  
balloon**

**2k. Breathing  
circuit**

**2l. Monitor**

**2m. Monitoring  
leads (BP cuff,  
pulse oximeter,  
ECG leads)**

**2n. Vaporizer**

**2o. Power  
supply, cables,  
and surge  
protector**

**3. Yearly  
maintenance**

**3a. Perform all  
items in Step 2.**

**3b. Replace  
oxygen sensor**

**3c. Replace all  
monitoring leads**

**3d. Replace  
filter (if needed)**

**3e. Change O-  
rings**

**4. Repairs**

**4a. Verbal  
communication  
from clinicians to  
Biomedical  
Engineering**

**4b. Onsite check  
(is the issue an  
equipment  
failure or use  
error?)**

**4c. If use error,  
coach staff in  
appropriate use.**

**4d. If equipment  
malfunctions,  
determine if  
repair can be  
completed on  
site or needs to  
be taken to the  
repair shop.**

**4e. Perform  
repair**

## PREVENTIVE MAINTENANCE PROCEDURE

### MONITOR, Non-Invasive Blood Pressure (NIBP)

For details, refer to Health Devices Inspection and Preventive Maintenance (IPM) procedure

Blood Pressure Monitors, Electronic, Indirect  
Procedure/Checklist 545-0595

Equipment Needed: Electrical Safety Analyzer, NIBP Analyzer

#### 1. Qualitative Tests

- 1.1 Chassis - verify physical integrity, cleanliness
- 1.4 AC Plug - verify integrity
- 1.5 Line Cord - verify proper insulation and integrity
- 1.6 Strain Reliefs - verify physical integrity at both ends of line cord
- 1.8 Tubes/Hoses/Bulb - check condition of all tubing, all hoses, the cuff, and the bulb (if present).
- 1.10 Fittings/Connectors - examine all fittings and connectors
- 1.13 Controls/Switches - verify proper operation
- 1.15 Pump - Check the physical condition and proper operation
- 1.17 Battery - verify physical integrity (if accessible) and operation, and alarms
- 1.18 Indicators/Displays - verify proper illumination and operation
- 1.19 User Calibration - verify operation of the calibration function
- 1.20 Alarms - verify visual and audible alarms
- 1.21 Audible Signals - confirm operation of any audible signals
- 1.22 Labeling - verify presence and placement of all labels, placards, instruction cards, etc.
- 1.23 Accessories - inspect cuff for leaks and proper closure
- 1.24 Deflation Switch - confirm operation of manual deflation
- 1.25 Operation on Volunteer - verify operation of device on yourself. Also perform item 2.4 at this time.

#### 2. Quantitative Tests

- 2.1 Grounding Resistance [ $< 0.5 \text{ ohm}$ ]
- 2.2 Chassis Leakage [ $< 300 \text{ microamps}$ ]
- 2.3 Air Leakage - Check for leakage of the cuff [ $< 15 \text{ mmHg/min}$ ]
- 2.4 Heart Rate - Verify heart rate on a volunteer or simulator [ $\pm 10\%$ ]
- 2.10 Pressure Accuracy - Verify pressure at 80, 120, & 200 mmHg [ $\pm 3 \text{ mmHg}$ ]

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nibp.doc  
Monitor, NIBP (ECRI)

## PREVENTIVE MAINTENANCE PROCEDURE

PULSE OXIMETER - Applies to all stand-alone pulse oximeters and to pulse oximeter modules built into patient monitoring systems, anesthesia machines, or ventilators.

For details, refer to Health Devices Inspection and Preventive Maintenance (IPM) procedure

Pulse Oximeters  
Procedure/Checklist 451-0595

Equipment Needed: Electrical Safety Analyzer, pulse oximetry simulator

## 1. Qualitative Tests

- 1.1 Chassis - verify physical integrity, cleanliness
- 1.2 Mount/Fasteners - verify physical integrity of mounts (wall, equipment, cart, etc.)
- 1.4 AC Plug - verify integrity
- 1.5 Line Cord - verify proper insulation and integrity
- 1.6 Strain Reliefs - verify physical integrity at both ends of line cord
- 1.7 Circuit Breaker/Fuse - verify integrity of external circuit breaker and/or value of external fuse
- 1.9 Cables - inspect patient cable and leads
- 1.10 Connectors examine all cable connectors
- 1.11 Probes - verify physical integrity of reusable probes
- 1.13 Controls/Switches - verify proper operation
- 1.17 Battery/Charger - verify operation & condition of battery/charger
- 1.18 Indicators/Displays - verify proper illumination and operation
  - verify SpO<sub>2</sub> value on yourself
  - verify pulse rate on yourself to manually palpated pulse [±10%]
  - verify SpO<sub>2</sub> and pulse rate values on appropriate simulator
- 1.20 Alarms - verify visual & audible alarms on yourself or SpO<sub>2</sub> simulator
  - SpO<sub>2</sub> [±1%]
  - pulse rate [±1 BPM]
  - verify alarm-silence to manufacturer specifications
- 1.21 Audible Signal - confirm appropriate volume and operation of volume controls
- 1.22 Labeling - verify presence and placement of all labels, placards, instruction cards, etc.

## 2. Quantitative Tests (line powered devices)

For double insulated devices, indicate "DI" in place of resistance and leakage current values

- 2.1 Grounding Resistance [ $< 0.5 \text{ ohm}$ ]
- 2.2 Chassis Leakage [ $< 300 \text{ microamps}$ ]