Radial Artery Access and Care

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MUNSON HEALTHCARE

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Goal and Objectives

Goal

The goal for this course is to educate the nurse on radial access anatomy, care, and complications.

Objectives

1. Describe three benefits and limitations of radial artery access.
2. Differentiate three radial post-procedural complications and their treatments.
3. Explain radial artery patency in relation to radial artery occlusion.

Background, Benefits, and Limitations of Radial Access

- On August 14th, 1992, the first interventional coronary procedure was performed using the radial artery.
- **Radial artery access** is now the ***Gold Standard*** of practice in the Cath Lab and Interventional Radiology (IR).

Benefits	Limitations
Early ambulation	Prone to vasospasm
Fewer bleeding complications	Arterial vessel size limitations: Women have smaller vessels
Faster discharge rate	Difficult tortuosity
Collateral circulation prevents hand ischemia	Vessel accommodates up to 6fr sheath
Absence of major nerve structures minimizes neurological complications	Radial/brachial anatomical loops

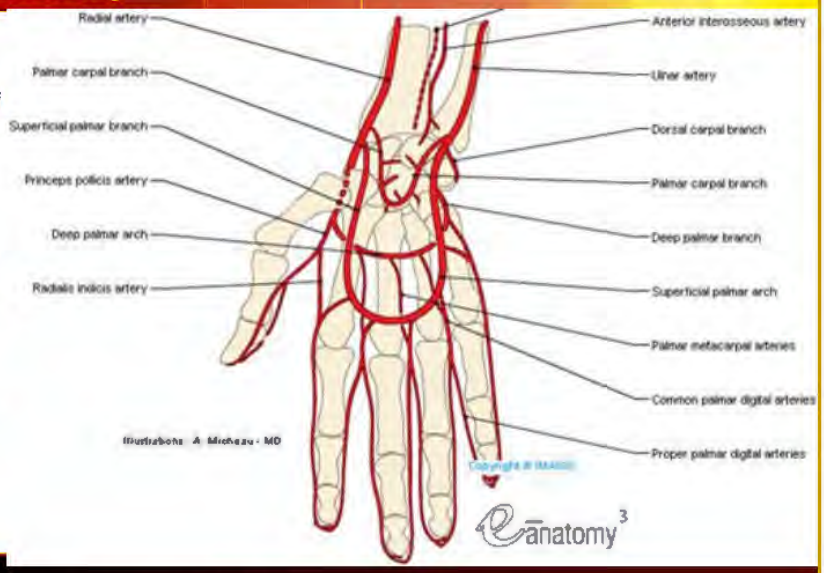
Review of Radial Anatomy

The radial artery arises together with the ulnar artery from the bifurcation of the brachial artery just below the bend of the elbow.

It passes along the lateral side of the forearm from the neck of the radius to the styloid process in the wrist and is smaller than the ulnar artery.

The average diameter of the radial artery is:

- ***2.8mm in females***
- ***3.1mm in males***



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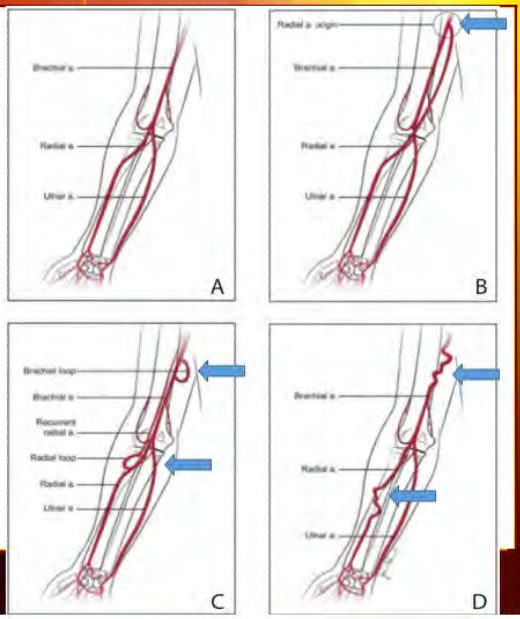
Anatomical Considerations

Common radial artery anatomic variants

- **Normal (A)**
- **Other variants:**
  - High take-off radial artery **(B)**.
  - Radial and/or brachial loop **(C)**.
  - Vessel tortuosity **(D)**.
- *Consider abnormal variants as possible limitations to radial access which may increase risk of complications.*



Krishna, H., & Shroff, A. (2018). Ten Common (and Uncommon) Reasons for Unsuccessful Transradial Procedures. [Figure 1]. *Endovascular Today*, *17*(11), 50. Retrieved from https://assets.bmctoday.net/evtoday/pdfs/et1118_SF2_Shroff.pdf

Pre-procedural Considerations

Pre-procedural care includes:

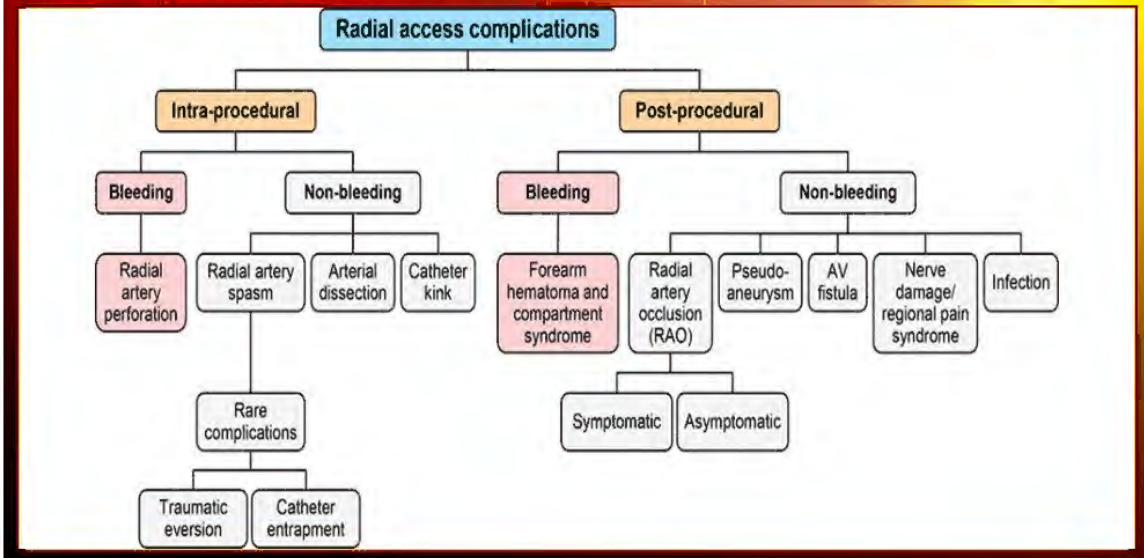
- Assessment ***and*** documentation of the radial pulse bilaterally.
- **Clip the wrist** from the base of the thumb, approximately **15cm** towards the antecubital area.
- **Clip the right groin** (may need to use femoral approach, if radial limitations occur).
- Avoid starting an IV within **9cm** of the wrist area.

Radial Artery: Access Procedure

Radial Access Sheath Insertion

(1½ mins.)

Radial Access Complications



Radial Access Care

The compression device is used to apply direct pressure to the radial artery.

Upon receiving patient, verify the radial band is in the correct position (~2mm above the puncture site).

- **Elevate** the arm on a pillow with the site facing up.
- **Place** the limb-alert wrist band on the affected hand and leave it on for **2 days** post-procedure.
- Place the **Plethysmography/SpO_2** monitor on the ***affected*** hand (index finger or thumb).
  - **Verify patent hemostasis** by occluding the ulnar artery and ensuring blood flow to the hand (plethysmography wave form on monitor).
- **Assess** for signs and symptoms of bleeding, hematoma, pseudo-aneurysm, compartment syndrome, and radial artery occlusion.
- **Control** hypertension.
  - Place the blood pressure (BP) cuff on the ***non-procedural*** arm.
- **Verify** the type of procedure: Diagnostic vs Intervention
  - **Diagnostic procedure:** Remove 1-2cc of air, 1-hour post-procedure.
  - **Intervention (PCI, FFR, IVUS, OCT):** Remove 1-2cc of air, 2-hours post-procedure.
- Do not leave the radial compression band on the patient for an extended period of time.

Post-Procedural Complications: Re-bleed

Re-bleeding at the Access Site and Hematoma

- Bleeding can occur from the radial access site or from a small peripheral side branch of the radial artery.
- Local bleeding or hematomas may occur as a result of improper hemostatic device application, device failure, or vessel perforation.

What to do?

- **Compression of the radial artery**, ***both*** *proximal and distal* to the puncture site must be performed to control both antegrade and retrograde flow from the palmar arch collateral.
- **This can be achieved by** repositioning the hemostatic band or applying manual pressure.
- **If unable to control bleeding** or a growing hematoma at the access site, **occlude the brachial artery**, either manually or with a blood pressure cuff.

Post-Procedural Complications: Hematoma

Forearm Hematoma

- Bleeding may also rarely occur from a site on the radial artery remote from the puncture site. It can **occur from a perforation of a small side branch of the radial artery by a guide wire.**
- **If not controlled urgently** and appropriately, forearm hematomas can lead to the development of **compartment syndrome**. The forearm is anatomically susceptible to an increase in pressure, in case of a blood leak, as it has very little room for expansion.

Forearm Hematoma

What to do?

- Apply pressure to **occlude** the brachial artery by using the BP cuff to compress the brachial artery.
  - **Inflate the BP cuff** to **20mmHg above the systolic pressure.**
  - **Release the BP cuff pressure for 10-15 seconds every 10 minutes** to allow blood flow to the arm.
- **Assess** for pain, paresthesia, pallor, and pulselessness of the hand.
- **Protamine** can be used for Heparin reversal.
- **Control hypertension**, attain pain management, and closely monitor the distal perfusion bed with plethysmography.
- Assess the hematoma every 15 mins. by **measuring it with a measuring tape. Mark the borders with a marker** to check if the hematoma is growing.
- ***Suspect compartment syndrome?*** Consult a vascular surgeon.

Compartment Syndrome

This is a **rare** complication of radial artery catheterization. ***If not identified and treated emergently, it can lead to profound disability or limb loss.***

Compartment syndrome is an EMERGENCY!

Greater than expected **pain** is the earliest and most reliable indicator.

- Escalating pain unrelieved by immobilization and requiring increasing analgesics should illicit high suspicion.

A **swollen and tense** compartment is a direct manifestation of increased pressure.

An **abnormal sensation**, feeling like "pins and needles" and tingling, can be in the arm and hand.

Late indicators

- **Decreased pulses.**
- **Absence of pain** - due to tissue ischemia and necrosis or nerve injury.

Post-Procedural Complications - Pseudoaneurysm

Pseudoaneurysm

- Rarely occurs at the radial artery access site.
- Should be suspected in the presence of ***pulsatile swelling at the access site.***
- **Often painless**; however, some patients can have associated discomfort.
- ***Risk factors:*** systemic anticoagulation, inadequate compression post-procedure, infection, and multiple arterial punctures.

Diagnosis is confirmed by ultrasound.

What to do?

- Apply pressure to the brachial artery ***and*** notify the provider.
- Management options ordered by provider: compression with a radial hemostasis device, thrombin injection, ultrasound-guided compression, or surgical repair.

Post-Procedural Complications - Radial Artery Occlusion

Radial Artery Occlusion (RAO)

- Occurs in 1-12% of cases.
- **Often asymptomatic** and goes unnoticed.
- Limits use of the radial artery for: future cardiac catheterizations, use as a conduit in patients undergoing coronary artery bypass graft surgery, or for creation of an arteriovenous fistula in patients with end-stage renal disease.
- Hand ischemia is rare, but may occur.

Factors Impacting the Risk of RAO

Pre-procedural risk factors
- Elevated creatinine
- Female
- Low body weight
- Diabetes

Intra-procedural risk factors
- Artery to sheath ratio >1
- Vasospasm
- Longer procedure time

Post–procedural risk factors
- Longer compression
- Too much compression limiting blood flow through radial artery

Radial Artery Occlusion Risk Reduction

Factors that decrease the risk of RAO:
- Smaller catheters
- Heparin use during procedure
- Timely sheath removal
- **Patent hemostasis!!!**
- Short duration of compressive device

What is Patent Hemostasis?

Patent hemostasis is the technique of maintaining radial artery flow through guided artery compression during hemostasis.

- After the procedure is completed, the compression band is applied and 15-20cc of air is injected to exhibit pressure on the radial artery puncture site by the Cath Lab.
- The radial sheath is removed and no exterior bleeding should be observed at the arteriotomy (puncture) site.
- This volume of air typically creates radial artery total or partial collapse. At this point, slow balloon deflation (1cc/second) is performed until a small jet of bleeding is observed at the skin puncture site. In order to stop it, a quick insertion of 2cc of air is performed.

Radial Artery Patency (Patent Hemostasis)

Using a pulse oximetry waveform, radial artery patency should be assessed:

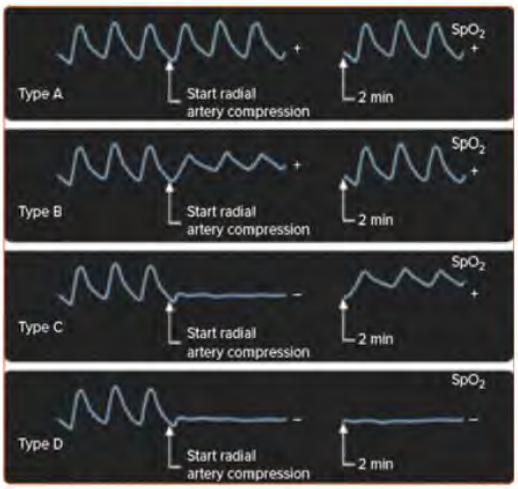
- Immediately after application of the compression device.
- On arrival to recovery room/inpatient unit.
- Whenever there is an increase in amount of air in the compression or adjustments to the compression band.
- After removal of the compression band.
- At the time of discharge.

How to Check Patent Hemostasis

- Patency of the radial artery is checked with a reversed Barbeau's test.
- Place the oximetry pulse detector on the patient's thumb or index finger on the affected hand. With the balloon inflated on the top of the radial artery, **simultaneous manual compression should be applied to collapse the ulnar artery.**
- If the inflated balloon has too much pressure, causing radial artery collapse, **the plethysmography pulse waveform will be flat**; in other words, there is no "flow" pulse/flow reaching the detector. In that case, an additional *1cc should be aspirated* from the balloon with the goal to reestablish flow through the radial artery.

What to Do for No-Flow on Pulse Oximetry

- If **no-flow** is identified, **remove 1-2cc of air** from the band until the flow is restored and patent hemostasis is achieved.
- **If bleeding occurs** and unable to maintain hemostatis, re-check **in** 15 minutes.
- **If *no-flow is* identified *after the band is removed*, immediately notify the provider.**
- **Document** patent hemostasis in IView.



A,B, and C show patent hemostasis

Site Assessment Post-Procedure

Thoroughly assess the radial access site for:

- Bleeding or oozing
- Hematoma formation
- Pain or tenderness
- Bruising/Discoloration

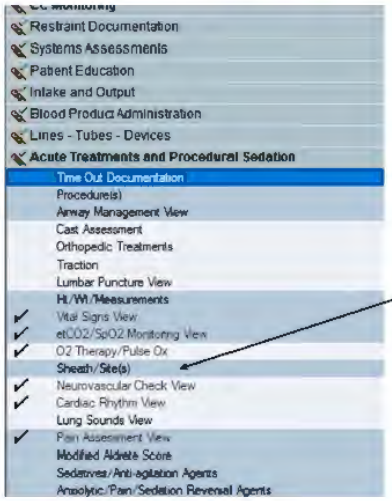
Perform neurovascular checks and document:

- Capillary refill
- Skin temperature and color: Compare with contralateral hand
- Radial and ulnar pulses: Presence, strength, and symmetry
- Sensation and motor function: Assess fingers for movement and any numbness/tingling
- Reversed Barbeau Test post-procedure to ensure collateral circulation

Post-Procedure Site Documentation

- Assess site immediately after arrival from the procedure.
- Verify the time and that the radial compression band was applied.
- Follow provider orders for frequency of site assessment.
- Assess site immediately before and immediately after any activity.
- Document the site assessment in PowerChart.

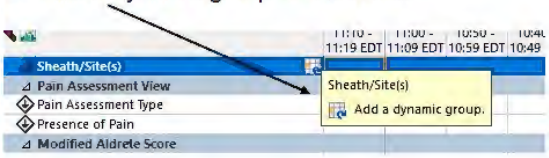
Sheath/Site Documentation



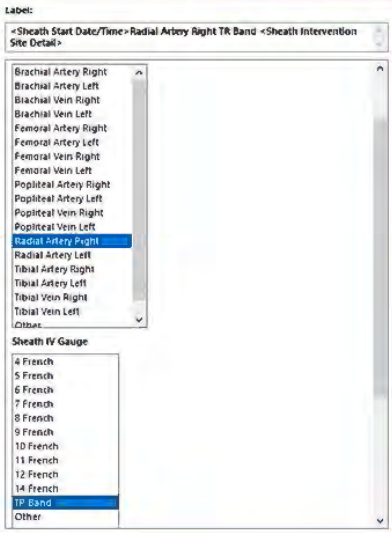
- Document sheath sites and neurovascular status in the Sheath/Site(s) section of the "Acute Treatments and Procedural Sedation" band in iView.

Sheath/Site Documentation (con't)

- Add a dynamic group for each site

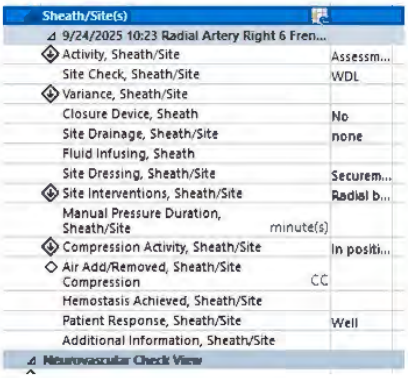


- Select the correct site and choose "TR band" for a radial site with a band in place



Sheath/Site Documentation (con't)

- Document the assessment including:
  - Site condition
  - Presence of a closure device
  - Compression activity/band
  - Drainage
  - Site interventions
- **NOTE:** A TR band is NOT a closure device.
- With each site assessment, document a neurovascular check of the affected limb.



Summary

- Radial approach is the gold standard of practice in the Cath Lab.
- It allows for early mobilization, increases patient satisfaction, and decreases bleeding complications.
- Nursing interventions include awareness and prevention of complications.
- A rare complication of radial access is compartment syndrome.
- With the increase in radial use, RAO is a potential concern with permanent consequences.
- Patent hemostasis is considered best practice to prevent RAO.

For any questions or concerns, please contact the Cath Lab Clinical Nurse Specialist.

Case Study #1

Patient: John D., 67-year-old male

Procedure: Coronary angiography via right radial artery

Post-procedure orders:

- Radial compression band applied
- Vital signs Q15 minutes X 1 hour, then Q30 minutes X 2 hours
- Assess neurovascular status and site per protocol

Situation:

One hour post-procedure, the nurse notes that the patient's right hand is cooler than the left, and capillary refill is sluggish. The radial pulse is weak but present. The compression band is still inflated at the same pressure as it was post-procedure.

Case Study #1 Questions

Question 1:

What is the nurse's priority action in response to the assessment findings?

- ○ Document findings and continue monitoring
- ○ Notify the provider immediately
- ◉ Deflate the radial band slightly and reassess perfusion
- ○ Apply a warm compress to the affected hand

Question 2:

Which of the following is a critical nursing intervention during the first hour after radial artery procedures?

- ○ Encourage full mobility to prevent stiffness
- ◉ Frequently assess for signs of bleeding and neurovascular compromise
- ○ Apply ice packs to prevent inflammation
- ○ Encourage the patient to flex the wrist to promote circulation

Case Study #2

Patient: Maria L., 58-year-old female

Procedure: Subclavian artery stent via left radial access

Post-procedure orders:

- Radial compression band to be weaned off over 2 hours
- Monitor access site for bleeding, swelling, and hematoma
- Patient instructed to report tingling or numbness

Situation:

90 minutes post-procedure, the nurse begins deflating the radial band as per protocol. As air is released, the patient reports feeling a "warm, wet sensation" at her wrist. On inspection, there is oozing at the site.

Case Study #2 Questions

Question 1:

What is the most appropriate immediate response by the nurse?

- ○ Continue deflating the band
- ◉ Re-inflate the band slightly and apply direct pressure
- ○ Remove the band and apply a gauze dressing
- ○ Notify the provider and document the finding

Question 2:

Which patient complaint would be most concerning during radial band monitoring?

- ◉ "My hand feels cold and numb"
- ○ "This band is tight, but not painful"
- ○ "I feel tired and want to sleep"
- ○ "I'm feeling a little thirsty"

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MUNSON HEALTHCARE

Femoral Post Sheath Removal Care

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December 2025

Goal and Objectives

Goal

To educate health care providers in the care of the patient femoral post sheath removal.

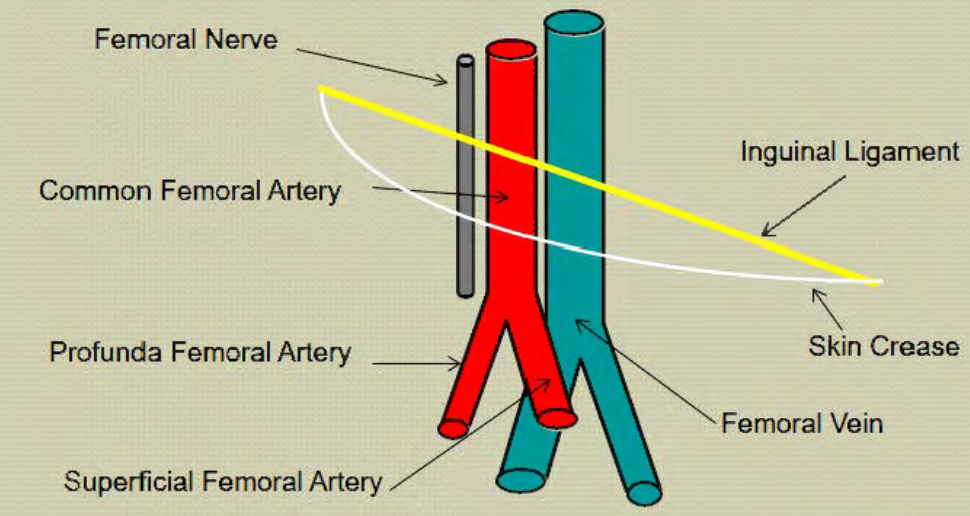
Objectives

1. Identify vascular anatomy.
2. State the process of hemostasis.
3. Define five complications that may occur femoral post sheath removal.
4. Identify potential complications associated with closure/compression devices.
5. State two nursing considerations for identified complications.

Progress

Vascular Anatomy

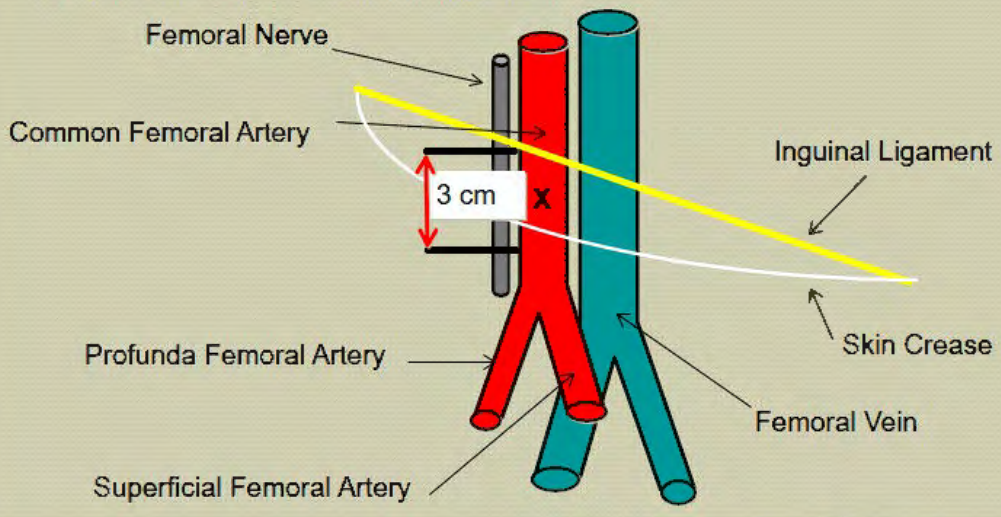
Identify the nerve, artery, vein, and ligament structures in the groin area.



Progress

Vascular Anatomy Relevant to the Sheath Insertion Site

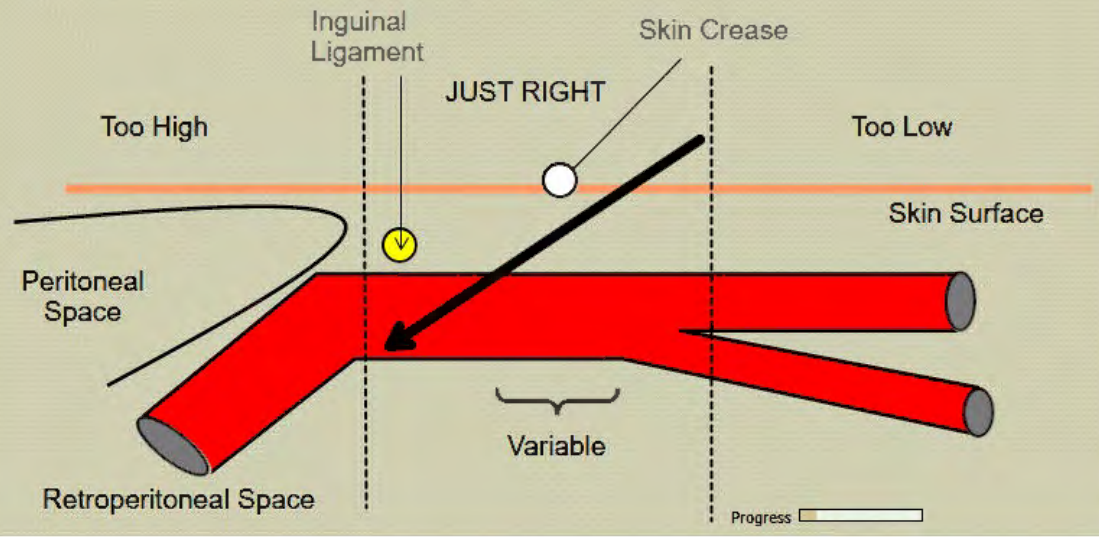
The arterial stick should be placed approximately 3 cm below the inguinal ligament and directly over the femoral artery pulse.



Progress

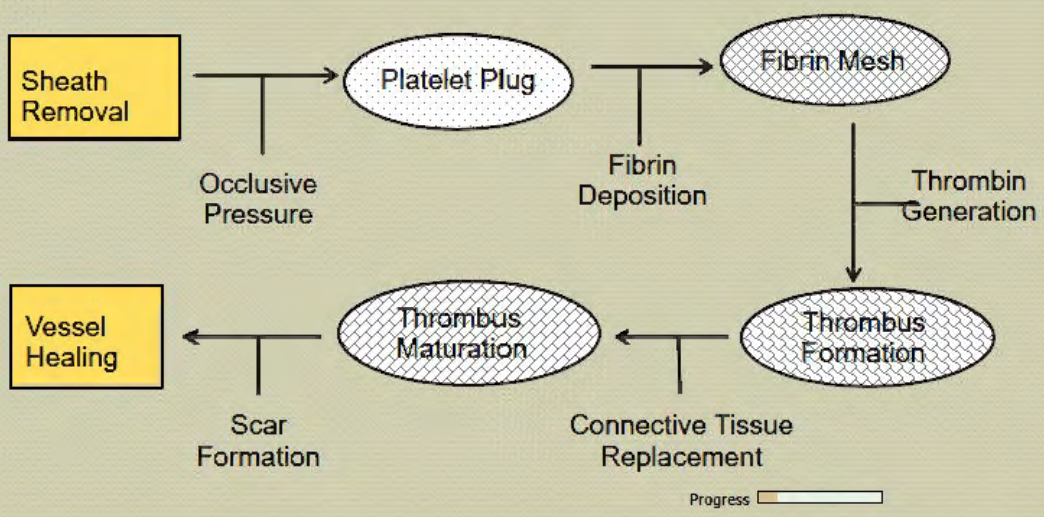
Arterial Puncture

If the arterial puncture is too high or too low, it may result in vascular complications. Review the correct position for puncture below.



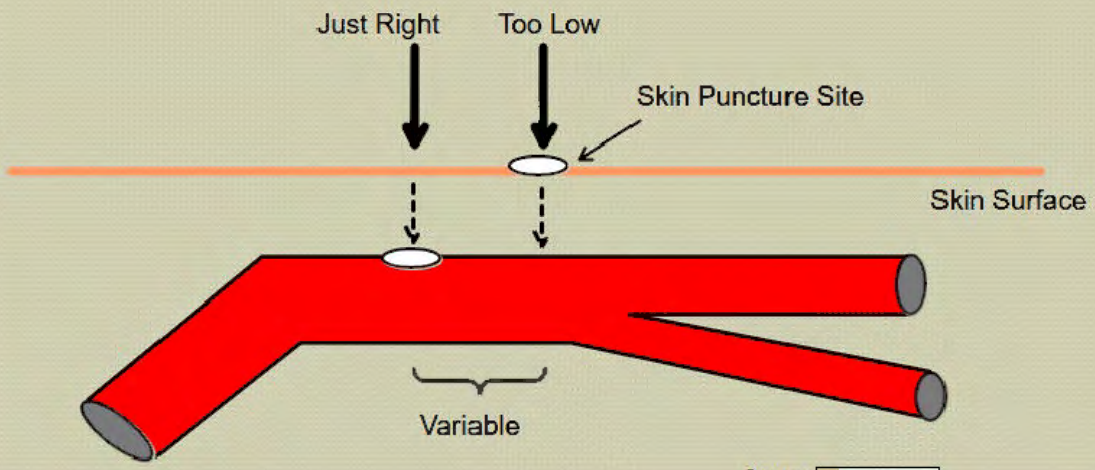
The Hemostasis Process

This is the normal hemostasis process. The process can be disrupted by certain drugs such as heparin and Integrilin.



Hemostasis

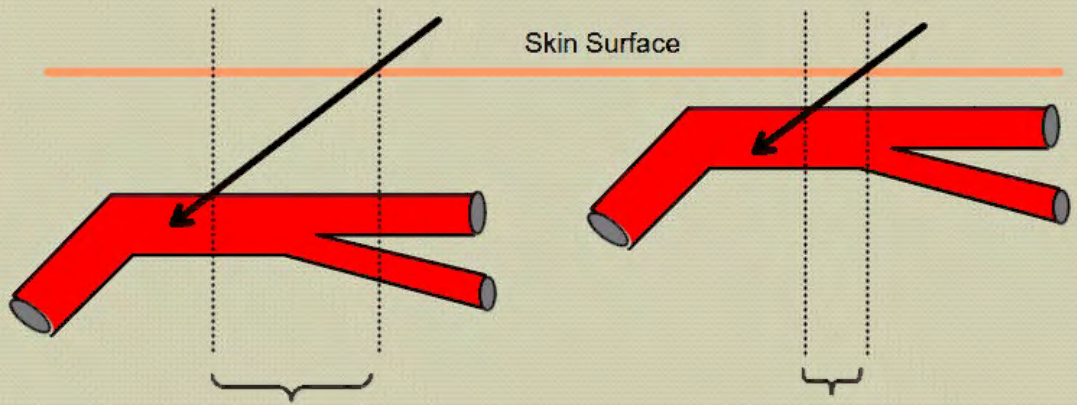
Manual pressure should be applied 2-3 cm above the skin puncture to achieve hemostasis.



Progress

Hemostasis *(cont.)*

Vascular anatomy may be displaced depending on the weight of the patient.



Progress

Post Sheath Pull:
Potential Vascular Complications

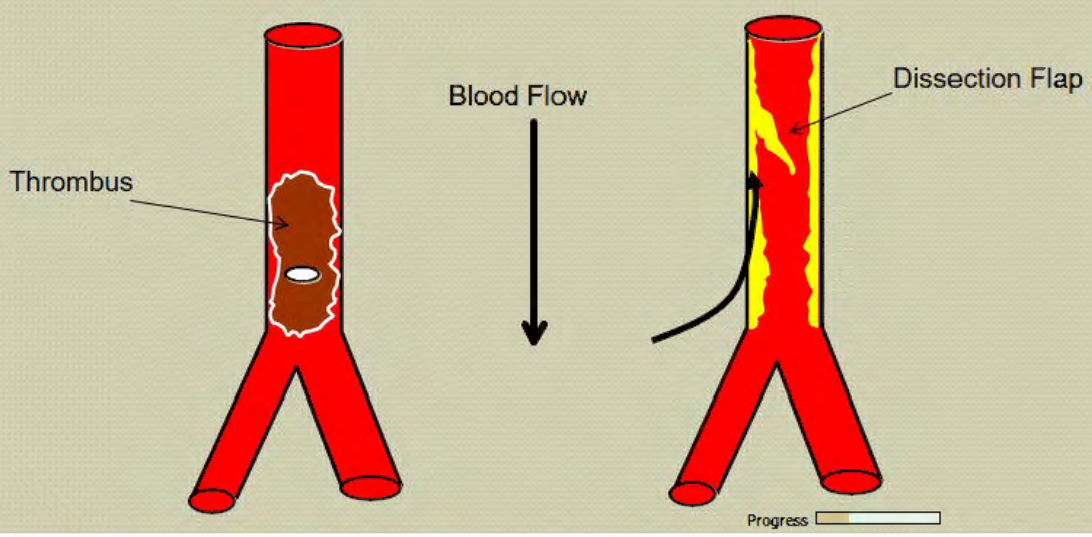
- Vessel thrombosis and dissection
- Bleeding
- Re-bleeding
- Femoral hematoma
- Retroperitoneal hemorrhage
- Pseudoaneurysm
- Arteriovenous fistula
- Atheroembolism

If any of the above complications occur, contact:
Cardiac Cath Lab - 231-935-9578
or the "neuro-on-call" if IR case

Progress

Vascular Complications:
Vessel Thrombosis and Dissection

Blood flow may be inhibited by a thrombus or dissection.



Progress

Vascular Complications: Vessel Thrombosis and Dissection *(cont.)*

Key Points

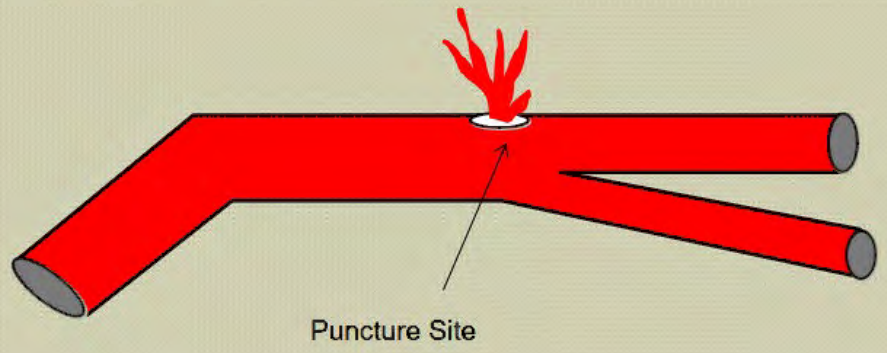
- Femoral artery thrombosis is rare and typically occurs in patients with small arterial lumens. Examples: peripheral vascular disease (PVD), diabetes mellitus (DM), and female gender.
- Dissection usually occurs in the setting of PVD or difficult arterial access.
- Patients commonly complain of leg pain or numbness.
- Physical exam reveals diminished or absent pulses.
- Rapid recognition is critical to avoid irreversible limb ischemia.
- Doppler ultrasound can be diagnostic.
- Urgent revascularization (surgical or percutaneous) is the treatment of choice.

Progress

Vascular Complications: Re-Bleeding

A re-bleed is uncontrolled bleeding from the puncture site.

- It is possible for the Hematocrit to drop by $\geq$ 10% and the hemoglobin to drop by $\geq$ 3 g/dL.
- The patient may require a transfusion.



Progress

Nursing Considerations: Re-Bleeding

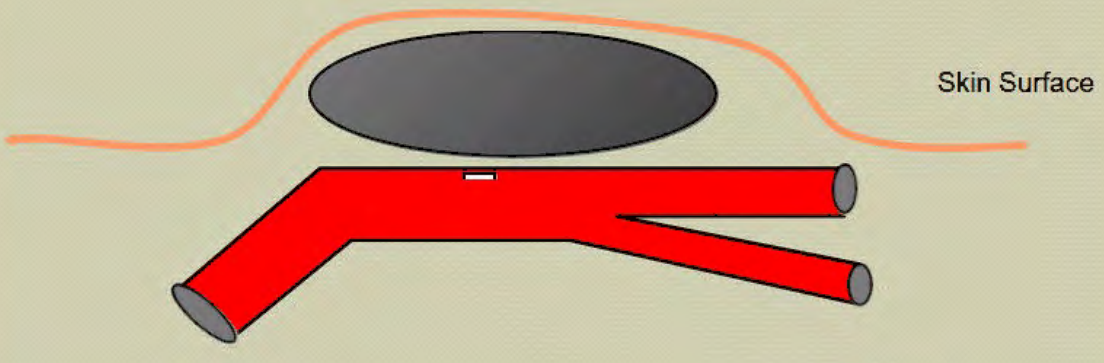
- Assess distal pulse prior to compression.
- Apply gloves and palpate artery just superior to puncture site.
- **Apply manual pressure above the site for a minimum of 20 minutes. No peeking!**
- Compression should be forceful enough to prevent bleeding, oozing, and hematoma formation.
- Delegate someone to call the cardiology provider.
- After bleeding stops, assess for hematoma.
- After hemostasis, restart bed rest and site checks per protocol.
- Document in a Focus Note in PowerChart.
- Assess distal pulses.
- Check Hgb/Hct, if indicated.

Progress

Vascular Complications: Hematoma

A hematoma is a collection of blood in the soft tissues of the upper thigh causing a tender mass of variable size.

- It is possible for the Hematocrit to drop by ≥ 10% and the hemoglobin to drop by ≥ 3 g/dL.
- The patient may require a transfusion.



Progress

Vascular Complications: Hematoma *(cont.)*

Risk Factors:

- Female gender
- Low platelet count
- Operator technique - inaccurate puncture of common femoral artery; number of arterial punctures
- Anticoagulation and/or platelet inhibitors
- Sheath size
- Delayed sheath pull
- Sheath pull technique
- Noncompliant patient or patient unable to comply with bed rest protocol

Progress

Vascular Complications: Hematoma *(cont.)*

Key Points:

- Hematomas can occur at any time before or after sheath removal.
- Measure (by palpation or imaging) and document the maximal dimension of the hematoma in centimeters.
- Immediate treatment includes correct manual compression. Do not "mash on" or massage the hematoma as this can cause damage to the vessel.
- Serial Hgb measurements and blood transfusions as needed. These are the treatments of choice.
- 1 - 2 weeks is required to reabsorb the hematoma and the patient should be warned about normal changes in the hematoma's appearance.
- Femoral nerve compression can occur from large hematomas.
- Surgical drainage is rarely needed.
- **Deaths do occur from hematomas - they must be respected.**

Progress

Nursing Considerations: Hematoma

- Assess distal pulse prior to compression.
- Apply gloves and palpate artery just superior to puncture site.
- **Apply manual pressure above the site for minimum of 20 minutes. No peeking!**
- Compression should be forceful enough to prevent increased hematoma formation, while maintaining distal pulses.
- Delegate someone to call the cardiology provider.
- Mark site: measure in centimeters.
- In PowerChart, document both a Focus Note and the hematoma size in Iview.
- Check Hgb/Hct, if indicated.

Progress

Nursing Considerations: Manual Compression Technique

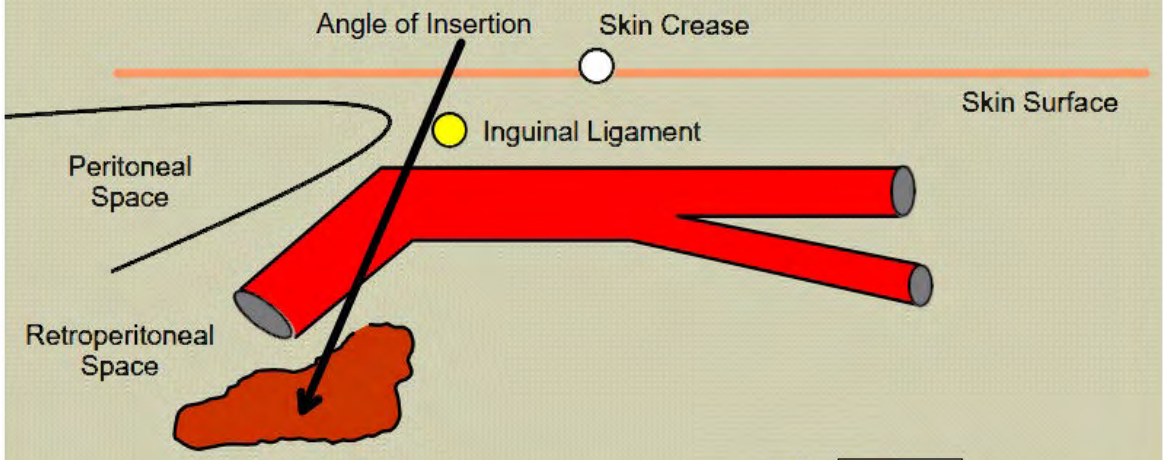
Wrong Techniques

Correct Technique

Progress

Vascular Complications: Retroperitoneal Hemorrhage

A retroperitoneal hemorrhage is a hematoma extending into the retroperitoneal space that usually occurs from arterial puncture above the inguinal ligament.



Progress

Vascular Complications: Retroperitoneal Hemorrhage *(cont.)*

Risk Factors:

- Female gender
- Low platelet count
- Improper operator technique: a "high" stick above the inguinal ligament or a puncture through the back wall of the artery
- Anticoagulation and platelet inhibitors
- Sheath size
- Delayed sheath removal

Progress

Vascular Complications: Retroperitoneal Hemorrhage *(cont.)*

Key Points:

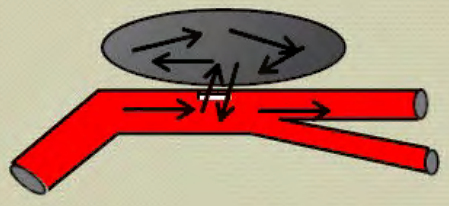
- This type of bleeding is not evident from the surface.
- Symptoms include hypotension, abdominal pain, and ipsilateral flank pain.
- Physical exam may reveal a palpable mass with discoloration over the flank or abdomen.
- Marked anemia can occur from blood loss.
- **This is a life-threatening situation!**
- CT scanning is the diagnostic test of choice.
- Treatment usually involves stopping anticoagulants, bed rest, and blood transfusion.

Progress

Vascular Complications: Pseudoaneurysm

A pseudoaneurysm is an interruption of the artery wall from the femoral artery puncture that does not thrombose when arterial sheaths are removed. This interruption in the arterial wall, caused by the original puncture, allows blood to jet back and forth from the bloodstream to the pouch. The aneurysm is termed "false." It does not involve any layers of the vessel wall as found with a true aneurysm.

"False" aneurysms can be masked by a hematoma and may rupture at any time. They continue to expand because they lack elastic fibers.



Progress

Vascular Complications: Pseudoaneurysm *(cont.)*

Risk Factors:

- Anticoagulation and platelet inhibitors.
- Obesity - causes difficulty in maintaining direct pressure.
- Advanced age - causes loss of tissue elasticity.
- Atherosclerotic occlusive disease.
- Increased sheath size - creates larger vascular interruption.
- Improper operator technique.
- Thrombolytic therapy - interrupts previously achieved hemostasis.
- Infection - impairs healing at the site of hemostasis.

Progress

Vascular Complications: Pseudoaneurysm *(cont.)*

Key Points:

- Physical exam reveals a pulsatile mass with a bruit auscultated superior to the puncture site. Bruits are heard when an artery is partially obstructed causing turbulent blood flow.
- Listen for bruits with the bell of the stethoscope held lightly against the skin.

Progress

Vascular Complications: Pseudoaneurysm *(cont.)*

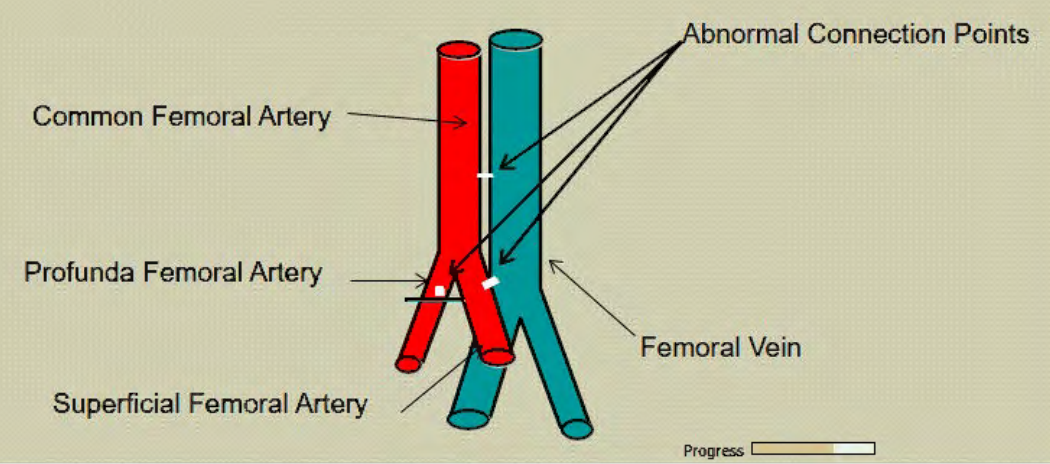
Key Points:

- Duplex ultrasound scanning allows a measure of size as well as distinction from intravenous fistula.
- There is a risk of enlargement and ultimate rupture if not detected and treated.
- Pseudoaneurysms smaller than 3 cm tend to close spontaneously or with compression.
- Those larger than 3 cm require alternative methods:
  - Ultrasound guided compression
  - Thrombin injection
  - Surgical repair

Progress

Vascular Complications: Arteriovenous Fistula

An arteriovenous fistula is an abnormal connection between an artery and a vein which forms when ongoing bleeding from the arterial puncture site decompresses into an adjacent venous structure.



Progress

Vascular Complications: Arteriovenous Fistula *(cont.)*

Risk Factors:

- Anticoagulation and platelet inhibitors.
- Female gender.
- Obesity - causes difficulty in maintaining direct pressure.
- Advanced age - causes loss of tissue elasticity.
- Atherosclerotic occlusive disease.
- Increased sheath size - creates larger vascular interruption.
- Improper operator technique.
- Poor sheath pull technique.
- Thrombolytic therapy - interrupts previously achieved hemostasis.
- Infection - impairs healing at the site of hemostasis.

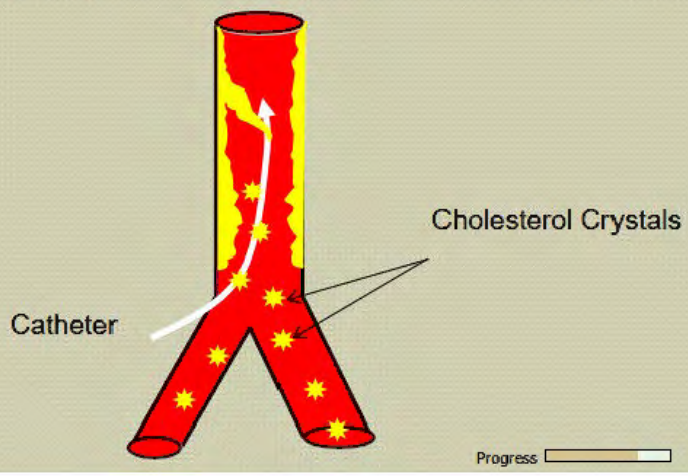
Vascular Complications: Arteriovenous Fistula *(cont.)*

Key Points:

- AV fistulas may not present for days.
- Physical exam reveals a to-and-fro murmur or continuous bruit.
- AV fistulas tend to enlarge with time.
- If they do not close spontaneously after 2 - 4 weeks, surgical repair is indicated.

Vascular Complications: Atheroembolism

- The release of cholesterol crystals and other microscopic debris from the aorta after catheter manipulation results in mechanical trauma to friable atheromatous plaques.
- Distal embolization may occur to the lower extremities and abdominal viscera.



Progress

Vascular Complications: Atheroembolism *(cont.)*

Key Points:

- Physical exam may reveal a cyanotic foot in the case of microemboli and signs of limb ischemia in the case of macroemboli.
- Renal failure can occur if the renal arterial bed is involved.
- Distal gangrene and death can occur, in extreme cases.
- The onset is often insidious and can take days to months to become evident.
- Management is variable depending on the severity.

Progress

Compression and Closure Devices

Compression of an artery and the use of closure devices must be deployed correctly and appropriately to decrease the risks of vascular complications. You may need to perform manual pressure or utilize a Femostop if the patient re-bleeds.

Compression options:
- Manual pressure
- Femostop

Closure devices:
- Angioseal
- Perclose
- Vascade

Femostop

Note: Femostops should not be used on patients with peripheral vascular disease.

Progress

Compression and Closure Devices *(cont.)*

Key Points:

- Multiple studies have shown that the lowest complication rates occur with correctly applied manual pressure.
- Incorrect application of compression devices is a common error in post sheath removal care.
- Bleeding, despite a compression device (Femostop), mandates removal of the device and manual control of the hemorrhage.
- Closure devices are not a substitute for close observation and have their own set of possible complications.
- If a closure device fails, manual control of the hemorrhage is needed.

Progress

Nursing Considerations: Femoral Post Sheath Removal

- Post procedure checks per protocol (every 15 min x 4, every 30 min x 4, every 1 hour until stable, then prn).
- Document post procedure checks in IView.
- Per Interventional Order Set:
  - Bed rest and activity guidelines
  - PRN medications for back pain or discomfort
  - IV fluid discontinuation or restart
  - Ambulate at least 1 hour prior to discharge
- Patient education on re-bleeding and groin care.
- When receiving the patient, always check the site together with the recovery nurse before he/she leaves the room.

Progress

Nursing Considerations: Hypotension

Systolic BP < 90 mmHg:

- Increase IV fluids: Give 250 ml 0.9 NS bolus and call cardiologist for further orders.
- Give 0.5 mg – 1 mg Atropine IVP if suspect cause is due to vasovagal stimulation.
- Call cardiology provider if hypotension does not resolve quickly.
- Assess for signs of retroperitoneal bleeding (i.e., flank pain, increased heart rate, decreased blood pressure).
- Assess for signs of a pseudoaneurysm (i.e., auscultated bruit).

Progress

Nursing Considerations: Bradycardia Due to Vasovagal Stimulation

- Give 0.5 mg – 1 mg Atropine IVP.
- Treat cause of vasovagal response (i.e., anti-emetics for nausea/vomiting).
- Increase IV fluids for associated hypotension.
- Call cardiology provider if bradycardia does not resolve quickly or if ACLS treatment is required.
- Assess hand/Femostop positioning and adjust.

Progress

Nursing Considerations: Loss of Pedal Pulses

- Assess affected limb for pain, coolness, or mottling.
- Attempt to find pulse with a Doppler.
- Adjust amount of pressure to obtain a balance between hemostasis and adequate pulses.
- Call cardiology provider.

Progress

Patient Education: Femoral Post Procedure Instructions

- Can elevate HOB 30 degrees 1 hour post procedure. May log roll patient to affected side in 1 hour.
- Vital signs/groin assessment checks - every 15 minutes x 4, then every 30 minutes x 4, then every 1 hour until stable, and prn.
- Notify RN of any pain, change in sensation, warmth, or bleeding at the groin site.
- Notify RN of any signs and symptoms of angina: chest discomfort; jaw, neck, arm, or shoulder pain; shortness of breath; sweating; nausea; dizziness or lightheadedness.

Progress

Patient Education: Femoral Post Procedure Instructions *(cont.)*

- The RN may administer an anti-emetic agent to prevent vomiting which causes unnecessary strain at the groin site.
- Refrain from activities that will cause strain to the groin site; for example, do not lift head, raise up on elbows, or bend knees when repositioning.

Progress

References

American College of Cardiology Foundation. (2008). CathPCI Registry, NCDR CathPCI Registry v. 4.3.1. Coder's Data Dictionary. pp. 76-78.

Munson Medical Center Procedures. (2024). Arterial and venous sheath removal. Lippincott Procedures.

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Preparing A Patient For Surgery

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October 2025

MUNSON HEALTHCARE

Goal and Objectives

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Goal:

This course provides information on the Preprocedure checklist and provides rationale on inpatient preparation for surgery or a procedure.

Objectives:

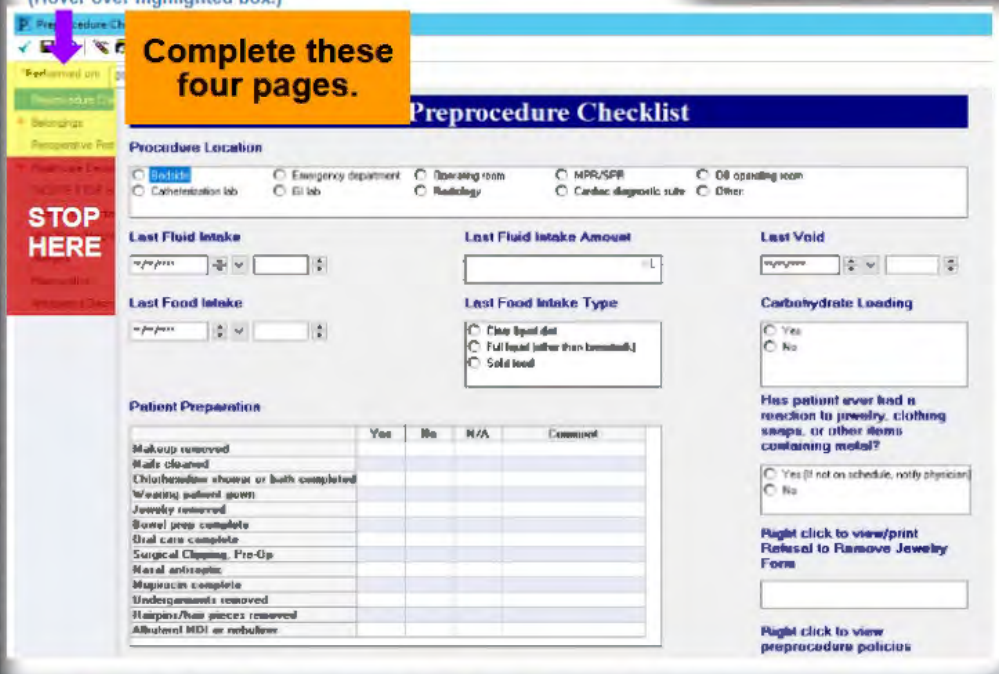
1. Accurately complete the Preprocedure checklist for a patient going to the Operating Room (OR), Medical Procedure Room (MPR), or Interventional Radiology (IR).
2. Correctly perform the pre-surgical hygiene elements when preparing a patient for surgery or a procedure.
3. Explain the importance of the Beta Blocker regimen during the peri-operative period.

Preprocedure Checklist

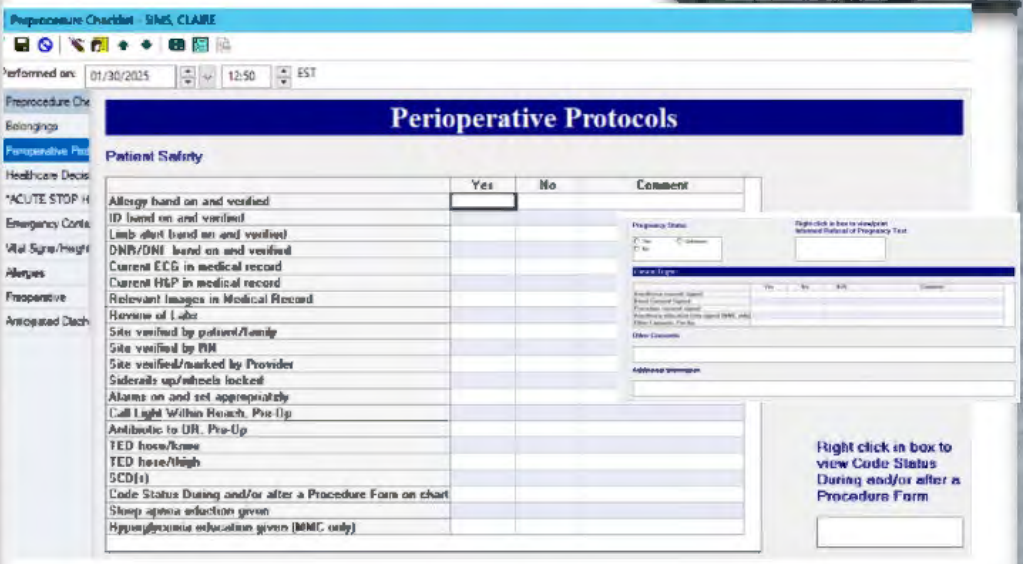
- Begin the Preprocedure checklist as soon as you know the patient is going to surgery - ideally the day before surgery.
- Must be completed for every patient going to the OR, MPR, or IR for surgery or procedure.
- With the patient's chart open, click AdHoc.
- Select preprocedure checklist.
- The acute care nurse will complete the first 4 pages of the powerform.

Preprocedure Checklist *(cont.)*

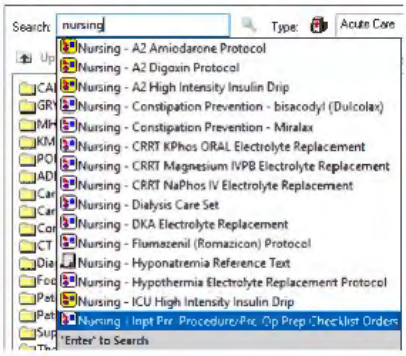
(Hover over highlighted box.)

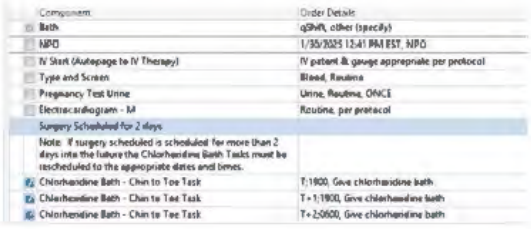


Preprocedure Checklist *(cont.)*



Nursing - Careset Orders

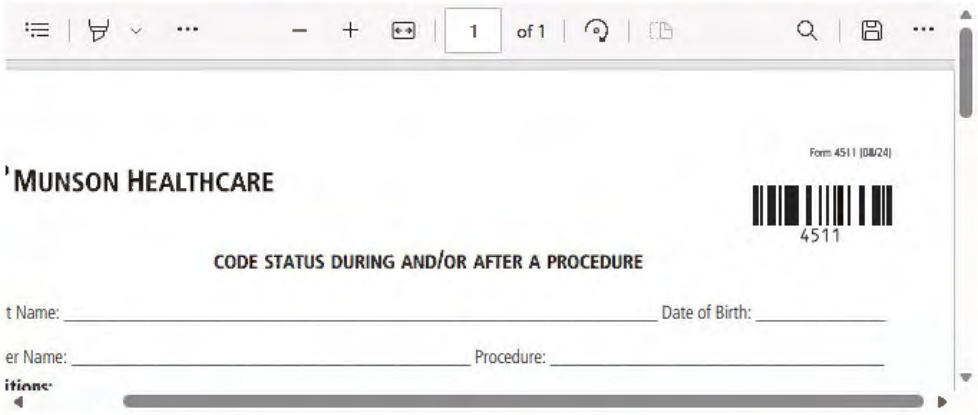




- Order your careset for Nursing - Inpt Preprocedure/Pre-Op Prep Checklist. Enter the careset as a 'Nurse per Protocol' (exception for patients scheduled in Maternity OR).
- Adjust the dates of CHG baths and nasal decolonization to correlate with day of surgery.
- Everything you do to help prepare the patient prior to their arrival in pre-op benefits the patient and prevents delays in surgery start times.

Treatment Decision Form

- Check code status in PowerChart.
- If the patient is anything except a full code, print a Treatment Decision Form (form #4511) and page the surgeon to complete it.
- Patients going to the operating room **do not** automatically become full codes. A Treatment Decision Form must be completed prior to surgery and will include a date/time to resume patient's preprocedure code status.



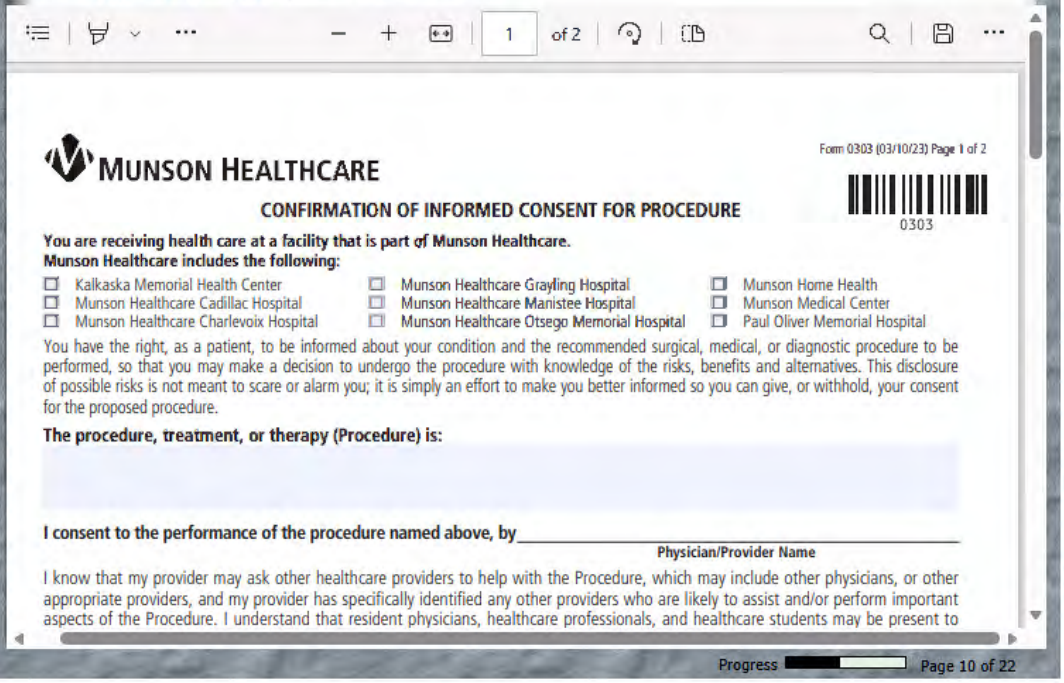
History and Physical (H&P)

- For all surgical or invasive procedures involving anesthesia or sedation, a valid H&P must be on the patient chart prior to start of the procedure. A valid H&P must have been completed within 30 days (not 31 or more days prior to admission or procedure).
- The surgeon must document in the patient's electronic record (H&P, consult, or progress note) the planned course of action and applicable side of the procedure, if warranted.
  - Writing an order is NOT acceptable as the surgical plan.
- In emergency cases, where completion of an H&P is not feasible, the surgeon should make a notation of relevant history and physical findings in the patients progress notes, if time allows.

Informed Consent

- Informed consent is a process of communication between a provider and patient to reach an agreement or permission to perform a procedure. The patient (or designee) signature on the form confirms that a provider has:
  - Reviewed the procedure.
  - Discussed the risks, benefits, or alternatives.
  - Answered all the patient or designee questions
- The informed consent process could occur on the inpatient floor or at the site of the procedure.
- The patient and the provider performing the procedure will both sign the form (#0303) "Confirmation of Informed Consent for Procedure" (often referred to as CIC) ideally at the time of the informed consent discussion. The form must be signed prior to performing an invasive procedure.
- The signature of the provider performing the procedure **is required** on the form confirming the informed consent process has been completed.
- Consents are valid for 90 days.

Confirmation of Informed Consent for Procedure



MUNSON HEALTHCARE

Form 0303 (03/10/23) Page 1 of 2

0303

CONFIRMATION OF INFORMED CONSENT FOR PROCEDURE

You are receiving health care at a facility that is part of Munson Healthcare.
Munson Healthcare includes the following:

- ☐ Kalkaska Memorial Health Center
- ☐ Munson Healthcare Cadillac Hospital
- ☐ Munson Healthcare Charlevoix Hospital
- ☐ Munson Healthcare Grayling Hospital
- ☐ Munson Healthcare Manistee Hospital
- ☐ Munson Healthcare Otsego Memorial Hospital
- ☐ Munson Home Health
- ☐ Munson Medical Center
- ☐ Paul Oliver Memorial Hospital

You have the right, as a patient, to be informed about your condition and the recommended surgical, medical, or diagnostic procedure to be performed, so that you may make a decision to undergo the procedure with knowledge of the risks, benefits and alternatives. This disclosure of possible risks is not meant to scare or alarm you; it is simply an effort to make you better informed so you can give, or withhold, your consent for the proposed procedure.

The procedure, treatment, or therapy (Procedure) is:

I consent to the performance of the procedure named above, by_____
Physician/Provider Name

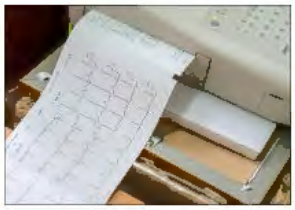
I know that my provider may ask other healthcare providers to help with the Procedure, which may include other physicians, or other appropriate providers, and my provider has specifically identified any other providers who are likely to assist and/or perform important aspects of the Procedure. I understand that resident physicians, healthcare professionals, and healthcare students may be present to

Informed Consent Process - Nurse's Responsibility

The nurse serves an important role in the process to optimize patient care and workflow.

- Review the provider's order and electronic record for the planned operative procedure.
- The RN may enter the procedure on the consent form using no abbreviations, or if available, use the procedure-specific consent form.
  - If needed, clarify any abbreviations, illegible or unusual order, and any discrepancies with the provider performing the procedure.
- Confirm the performing provider and patient have both signed, dated, and timed the CIC.
  - If the informed consent discussion occurred with the provider, but the provider did not have the patient sign the form at the time of the discussion, **nursing personnel may facilitate signature of the patient or the designee ONLY in situations where the patient or designee has no questions.**
  - Confirm the form is placed in the patient's chart and travels with the patient to the procedural area. If there is no provider or patient signature, inform the pre-procedure staff during hand-off communication.
  - The form may be sent to preop holding with only the patient's signature.

Checklist Components

Lab Tests

- Check all current lab values and report any abnormal findings to the surgeon.
- Obtain a urine pregnancy test (per Pre and Post Surgical/Procedural Adult Protocols) on all females between menarche and menopause. Women who have had tubal ligation still need a pregnancy test. Women who have had hysterectomies do not.
- Notify the pre-op RN of abnormal lab findings during handoff report.

Checklist Components




ECG Prior to Surgery?

When:

- There needs to be a normal ECG on the chart from the last year, **or** the last 6 months if the last ECG was abnormal and patient is stable.
- If using a paper ECG from another facility, it needs to be verified and signed.

Who:

- Any patient with a history of a previous MI, angina, arrhythmia, renal failure, medication-dependent diabetes, or CVA.
- Any patient 45 years or older with a history of hypertension or history of ≥ one pack per day smoker.
- All patients 45 years or older having major vascular, intra-abdominal, thoracic, neurological, or orthopedic surgery.

Checklist Components




IV Access

- Ensure a patent large bore IV. Refer to Pre and Post Surgical/Procedural Adult Protocols for catheter size required based on the type of surgery.
- If the patient has Heparin infusing, follow the physician orders regarding continuation/discontinuation.
- Discuss with the pre-op RN during handoff report if the patient's IV infusions should be discontinued prior to sending the patient to the peri-operative area.

Checklist Components




NPO

- NPO except clear liquids and medications after midnight.
- Stop clear liquids 4 hours before scheduled surgery time.
- If the surgeon's NPO orders conflict with the Pre-Procedure Nothing By Mouth Policy, page the anesthesiologist for clarification.
- Sips of water with meds are ok.

Pre-Surgical Hygiene

Prior to the pre-surgical bathing:

- **Remove all body jewelry** (including wedding bands).
- Remove hair clips, pins, rubber bands, etc.
- Remove body piercings.
- Remove makeup and nail polish.

Patient who did not remove ring prior to going into OR.

Pre-Surgical Hygiene *(cont.)*

The patient should have a total of three (3) chlorhexidine gluconate (CHG) baths **if required:**

- Two nights before surgery
- The night before surgery
- The morning of surgery

Example: If the patient's surgery is on Tuesday, bathe with CHG on Sunday night, Monday night, and Tuesday morning.

What if the patient is admitted the night before surgery?

You must ensure two (2) CHG baths are completed:

- The night the patient was admitted
- The morning of surgery

How to Give a CHG Bath

- Wash the entire body (from neck down) with CHG.
  - Cleanse groin area (avoid CHG on mucous membranes).
- Avoid scrubbing the skin too hard with CHG.
- Do **not** use regular soap after the CHG.
- Do **not** rinse the CHG off of the skin.
- Place the patient in a clean gown after the CHG bath (all clothing, including underwear, should be removed).
- Place clean linens on the bed after the CHG bath.

Pre-Surgical Hygiene *(cont.)*

Two nights before surgery:

- Give a soap and water bath ***prior*** to the first CHG prep bath.
- Shampoo hair with regular shampoo.
- Wash face with regular soap/cleanser.
- After the soap and water bath, give the first CHG bath, using either the wipes or the liquid.

The night before surgery:

- Wash face with regular soap or cleanser.
- Give the second CHG bath in the same manner as the previous night.
- Brush teeth and use mouth rinse.

Day of Surgery Preparation

- Use the Preprocedure checklist.
- Complete the 3rd CHG (last) bath. Place a clean hospital gown on the patient.
  - Clean under finger nails.
  - Confirm oral care is completed.
  - Encourage the patient to void prior to sending to pre-op.
    - Bathroom availability is limited in pre-op.
  - Remove the patient's underwear.
  - Inform the pre-op RN when medication patches are left on the patient.
- Complete nasal decolonization, if required.
- Document vital signs prior to transfer.
  - Report abnormal findings to the pre-op RN.
- Send the patient with dentures, glasses, and hearing aids.
- Call hand-off report to the pre-op RN.

Obstructive Sleep Apnea

- Communicate with the pre-op RN if your patient uses a CPAP or BiPAP and discuss if the device should be sent with the patient to the perioperative area.
- Ensure settings are documented, so that the machine can be used accurately postoperatively.

Antibiotics

- The surgeon or a covering physician shall write specific orders for all patients requiring prophylactic pre-operative antibiotics.
- Confirm an order for preoperative antibiotics is placed in PowerChart by the surgeon or covering provider.
  - Pre-op antibiotics should be administered by the pre-op nurse or anesthesia provider to ensure they are administered within one hour prior to the incision window.
- If the patient is on oral antibiotics, give prior to the patient going to pre-op.
- Ensure **scheduled antibiotics** are given as ordered.
- If a scheduled antibiotic is due during the perioperative period, please send it to OR with the patient.

Beta Blockers

Patients on a beta blocker at home should receive their beta blocker during the perioperative period (24 hours prior to surgery through discharge from PACU).

- Stress associated with surgery increases heart rate, myocardial contractility, and myocardial oxygen demand, putting the patient at risk for an acute myocardial infarction (AMI).
- Beta blockers offer cardioprotection for patients with a history of MI and hypertension. They diminish the effects of epinephrine and other stress hormones.
- An MI during surgery results in a nine-fold increase in unstable angina, MI, and cardiac death in the post-op period.
- If the patient's heart rate is greater than 50 and the systolic blood pressure is greater than 100, administer and document beta blocker in PowerChart.
- If held or stopped for a specific reason, it must be documented. This also applies to the perioperative period. Communicate this to the pre-op RN during handoff.
- NPO does **not** mean the patient should not receive their beta blocker. If in doubt, clarify with the surgeon and document who ordered the hold and why it is being held.

Miscellaneous Medications

Aspirin (ASA)

If the patient has a cardiac stent and takes a daily 81mg dose of ASA at home, they must have their ASA dose within 24 hours of surgery start time. There are rare instances where the bleeding risk outweighs the benefits and a surgeon may order the ASA be held.

- If the patient is having a neurosurgery procedure, confirm with surgeon prior to administering aspirin.

Anticoagulants/Anti-platelet medications

- Most anticoagulants will need to be held for invasive procedures/surgery.
- Verify the surgeon's order if anticoagulants are to be held or continued. If no order is present addressing the patient's anticoagulation status, page the performing provider.

Other medications

Medications such as anti-seizure, Parkinsons, anti-rejection, and chronic pain, should be continued, if ordered.

Please call pre-op holding and ask to speak with the charge nurse if you are unsure about giving a medication.

References

Munson Medical Center Policies and Procedures

- Surgical Antibiotic Prophylaxis
- Pre-Procedure Nothing by Mouth Policy
- Ensuring H&Ps are Present Before Surgery/Invasive Procedure
- Skin Preparation of the Surgical Patient
- Jewelry Removal Prior to Surgery
- Pre and Post Surgical/Procedural Adult Protocols
- Plan of Care – Nursing Process in the OR
- Inpatient Pre-Procedure/Pre-Op Checklist and Patient Preparation

Munson Healthcare Policies and Procedures

- Informed Consent - Diagnostic or Therapeutic Procedures and Treatments

MUNSON HEALTHCARE

Overview of Procedural Sedation

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October 2023

Goal and Objective

Goal

This course will ensure standardized practice for delivering sedation/analgesia during diagnostic and therapeutic procedures performed outside of the operating room, according to MHC policy. The ultimate outcome is to provide for the safety of our patients during sedation.

Objective

After completing this course, the participant will be able to identify the four levels of sedation.

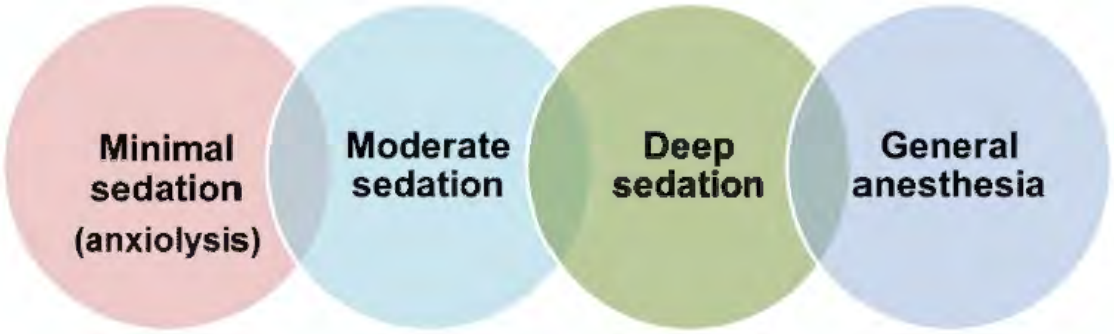
Exclusion List: Non-Procedural Sedation

The sedation policy and this education module **do not apply** when analgesics or sedative agents are given for the following:

- Pain management (analgesics given by **any** route).
- Minimal sedation (anxiolysis).
- Sedation during emergent medical care in an unstable patient.
- Sedation during ongoing ventilation therapy.
- Sedation for end of life/palliative care.
- Treatment of medical conditions such as delirium, alcohol withdrawal, traumatic brain injury, etc.

Four Levels of Sedation

In order to provide safe and effective care for patients receiving sedation, it is imperative that health care providers understand the four levels of sedation:



Minimal Sedation

This is a continuum. To understand, we will begin with minimal sedation, also known as anxiolysis.

Description	*Minimal Sedation*	*Moderate Sedation/Analgesia*	*Deep Sedation/Analgesia*	*General Anesthesia*
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous Ventilation	Unaffected	Adequate	Maybe inadequate	Frequently inadequate
Cardiovascular Function	Unaffected	Usually maintained	Usually maintained	May be impaired

Minimal Sedation (Anxiolysis)

Key Points – Minimal Sedation

- Anxiolysis is medication therapy given to reduce anxiety and to help patients relax, e.g., diazepam (Valium) PO or midazolam (Versed) IVP prior to a procedure.
- The patient continues to respond normally to verbal commands.
- This level of sedation has no effect on airway, breathing, or the cardiovascular system.
- Cognitive function and physical coordination may be impaired.

Moderate Sedation/Analgesia

Description	Minimol Sedotion	Moderate Sedation/Analgesia	Deep Sedation/Analgesia	General Anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response following repeated or painful stimulation	No response even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous Ventilation	Unaffected	Adequate	Maybe inadequate	Frequently inadequate
Cardiovascular Function	Unaffected	Usually maintained	Usually maintained	May be impaired

Moderate Sedation

During moderate sedation, the patient experiences a depressed level of consciousness during which they retain their ability to maintain a continuously patent airway. The patient will respond appropriately to physical stimulation and verbal commands, yet maintain partial amnesia.

The patient receives relief from anxiety and pain, allowing them to tolerate unpleasant procedures.

Moderate sedation/analgesia also expedites the course of procedures that are uncomfortable and require the patient to not move:

- Central line placements
- Scope procedures (endoscopy, bronchoscopy)
- Chest tube placement
- Painful wound debridements

Moderate Sedation *(cont.)*

Key Points – Moderate Sedation

- The patient is able to respond to verbal commands.
- No interventions are needed to protect the airway or maintain heart rate and blood pressure, but close monitoring is essential.
- Cardiac monitoring is required for a patient with cardiovascular disease or dysrhythmia.
- Consents need to be signed before sedation is administered.

Clinical Characteristics of Moderate Sedation

Clinical characteristics of moderate sedation include:

- Maintenance of protective reflexes, i.e., gag reflex, ability to swallow, and ability to breathe without assistance.
- Independent and continuous maintenance of a patent airway.
- Purposeful response to physical stimulation and/or verbal commands.
- Easily aroused, with the provider talking in a normal tone of voice.
- Minimally depressed level of consciousness.
- Slightly slurred speech.

Example:

In a normal tone of voice, the nurse asks the patient to take a deep breath and open their eyes. The patient should be able to follow this type of command at this level of sedation.

Clinical Characteristics of Moderate Sedation *(cont.)*

Key Points – Moderate Sedation

- Important: A reflex withdrawal from a painful stimulus is not considered a purposeful response and is a sign the patient is progressing to general anesthesia.
- All practitioners involved with moderate sedation must be prepared to "rescue" the patient from a deeper level of sedation than was intended.

Knowledge Check

During a procedure requiring moderate sedation, who is required to know how to rescue a patient from a deeper level of sedation than intended?
(Choose all that apply.)

- [x] The registered cardiovascular invasive specialists (RCIS) assisting with the procedure
- [x] The registered nurse (RN) assisting with the procedure
- [x] The provider performing the procedure

Deep Sedation/Analgesia

Description	Minimal Sedation	Moderate Sedation/Analgesia	Deep Sedation/Analgesia	General Anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous Ventilation	Unaffected	Adequate	Maybe inadequate	Frequently inadequate
Cardiovascular Function	Unaffected	Usually maintained	Usually maintained	May be impaired

Deep Sedation

Deep sedation is used for procedures such as cardioversions, closed reductions of joint dislocations, or fractures. Patients who are deeply sedated cannot be easily aroused, but they do respond purposefully to repeated or painful stimulation, such as a vigorous sternal rub.

Deep Sedation *(cont.)*

Key Point: A reflex withdrawal from a painful stimulus is **not** considered a purposeful response and is a sign the patient is progressing to general anesthesia.

The patient's respiratory status may be affected and spontaneous respirations may be inadequate.

- Assistance may be needed to maintain a patent airway.
- Ventilation assistance may be required.

Progression from Moderate to Deep Sedation

Clinical indications: Progression from moderate to deep sedation/anesthesia:

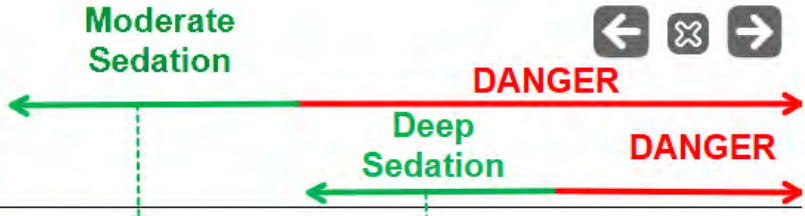
- Not easily aroused
- Partial or complete loss of protective reflexes
- Difficulty maintaining a patent airway independently
- Unable to respond to physical stimulation or verbal commands
- Severely slurred speech

Key Point:
ALL practitioners involved with deep sedation MUST be prepared to "rescue" the patient from deep sedation or general anesthesia.

Progression from Moderate to Deep Sedation *(cont.)*

Clinical indications: Identifying a patient is in deep sedation:

- Similar to general anesthesia, the patient may be unable to maintain a patent airway.
- Loss of protective reflexes (unable to swallow, no cough, no gag reflex).
- The patient purposefully responds to repeated painful stimulation, such as a vigorous sternal rub.



	Minimal Sedation Anxiolysis	*Moderate Sedation/ Analgesia ("Conscious Sedation")*	*Deep Sedation/ Analgesia*	*General Anesthesia*
Responsiveness	Normal response to verbal stimulation	Purposeful** response to verbal or tactile stimulation	Purposeful** response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous Ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular Function	Unaffected	Usually maintained	Usually maintained	May be impaired

Knowledge Check

Characteristics of anxiolysis include: (Choose all that apply.)

- ☐ Reflex withdrawal from a painful physical stimulus
- ☑ Ability to respond normally to verbal commands
- ☐ Diminished respiratory rate or blood pressure
- ☑ Ability to maintain a patent airway
- ☑ Administering midazolam (Versed) to a stressed patient prior to a procedure

Knowledge Check *(cont.)*

Drag the type of sedation to the light blue box beside its description.

Type of Sedation	Description
Deep Sedation	The patient is unresponsive to verbal commands, but does purposefully resond to a sternal rub. Assistance may be needed to maintain a patent airway and adequate ventilation.
Minimal Sedation (Anxiolysis)	The patient continues to respond normally to verbal commands. This level of sedation has no effect on airway, breathing, or the cardiovascular system.
Moderate Sedation	The patient is able to open their eyes and raise their hand when asked.

References

American Society of Anesthesiologists. *Position on monitored anesthesia care*. Last amended on October 23, 2019.

Munson Healthcare Policies and Procedures. (2022, December 16). *Sedation*. PolicyStat.

MUNSON HEALTHCARE

Procedural Sedation: Roles and Responsibilities

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October 2023

Goal and Objectives

Goal

This course will ensure standardized practice for delivering sedation/analgesia during diagnostic and therapeutic procedures performed outside of the operating room, according to MHC policy. The ultimate outcome is to provide for the safety of our patients during sedation.

Objectives

1. Identify who is qualified to order, administer, and monitor patients receiving moderate and deep sedation.
2. Describe the expected nursing care during procedural sedation.

Responsibilities

At MHC, Registered Nurses (RNs) and Registered Cardiovascular Invasive Specialists (RCIS) who will be monitoring sedated patients during procedures and administering moderate sedation are responsible for the following:

- Knowing the Sedation policy.
- Maintaining competence in sedation medication administration.
- Identifying when a patient has progressed to a deeper level of sedation than intended and intervening as needed.

NOTE: RNs and RCIS do not administer deep sedation for procedures.

Education Requirements

The education requirements for RNs and RCISs include:

Upon hire:

- Current BLS certification.
- Completion of the online HealthStream assignment.
- Completion of the airway station during RN orientation.
- Completion of the cardiac rhythm competency, the Basic ECG interpretation exam, or current ACLS certification.

Periodically thereafter:

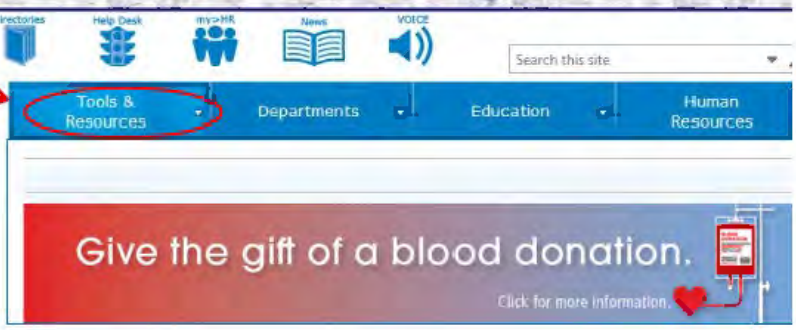
Completion of periodic sedation education and demonstration of competence.

Provider Credential Check

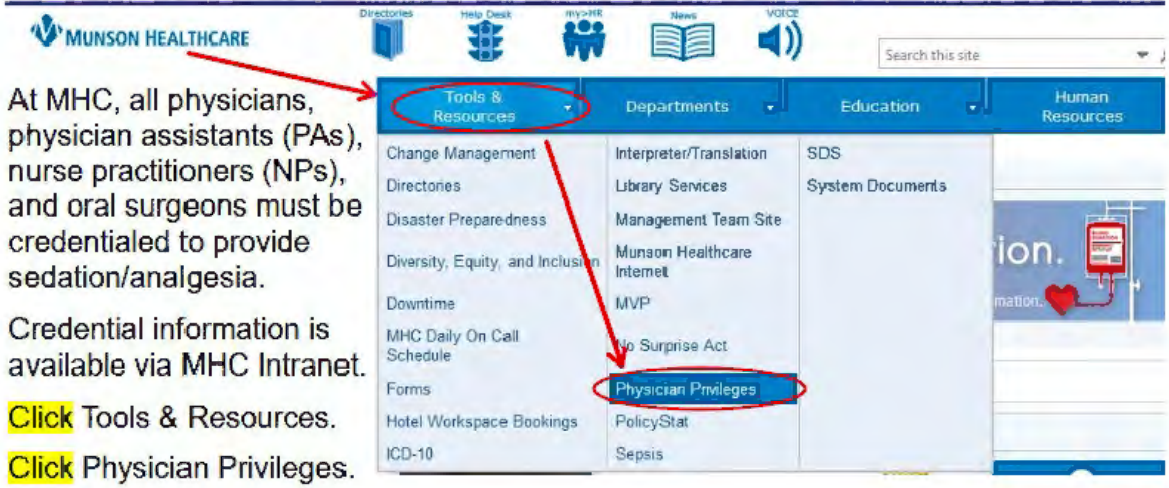
At MHC, all physicians, physician assistants (PAs), nurse practitioners (NPs), and oral surgeons must be credentialed to provide sedation/analgesia.

Credential information is available via MHC Intranet.

Click Tools & Resources.



Provider Credential Check



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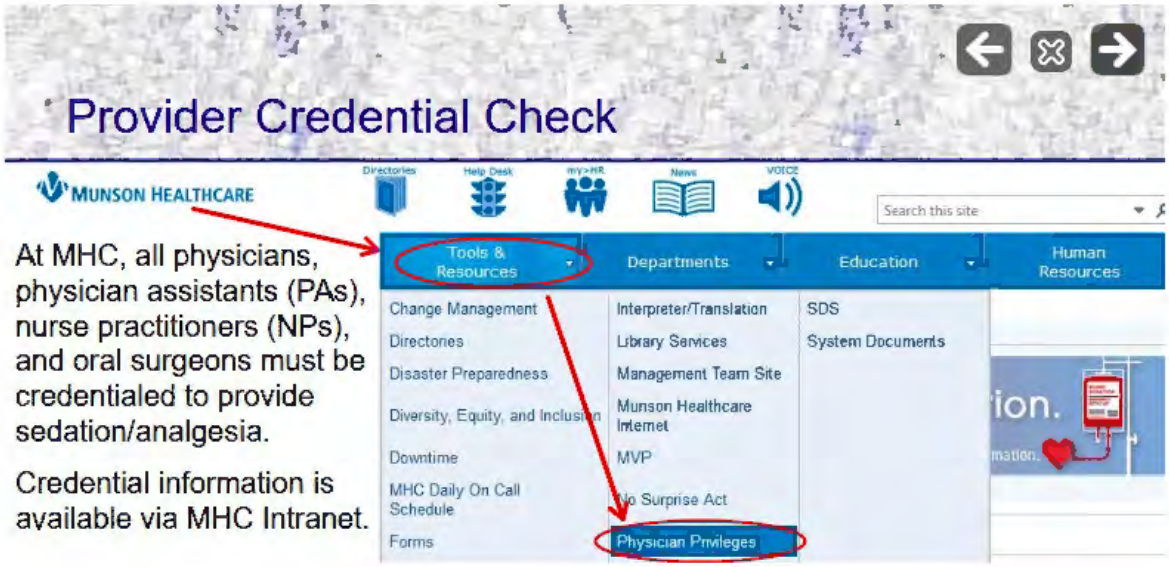
Credential information is available via MHC Intranet.

Click Tools & Resources.

Click Physician Privileges.

Provider Credential Check



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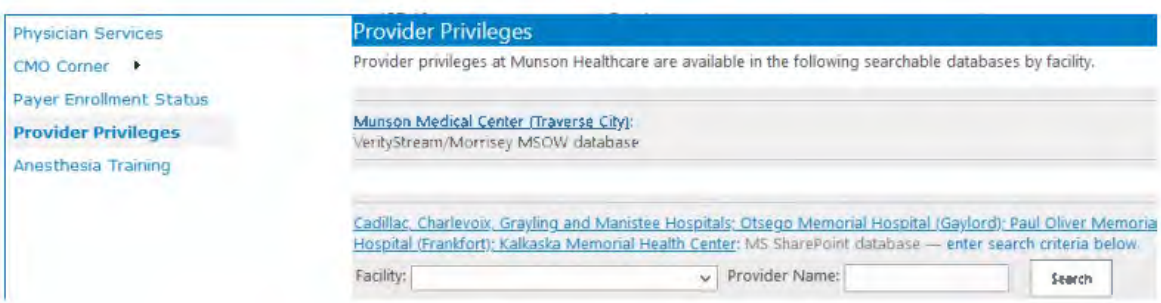
Credential information is available via MHC Intranet.



Knowledge Check

Who can administer moderate and deep sedation for procedural sedation (assuming they have the proper credentials and have completed the education)? (Choose all that apply.)

- [x] Oral Surgeon
- [ ] ICU RN who is ACLS-certified
- [x] Physician
- [x] Physician Assistant
- [x] Nurse Practitioner

Pre-procedure Responsibilities: Provider Assessment

The proceduralist/provider is required to complete a comprehensive assessment of the patient prior to performing the procedure. This includes:

- A determination of the patient's American Society of Anesthesiologists Classification (ASA Class).
  - This is used as a guideline for **NPO status**.
- An airway assessment.

Key Points:

- Anesthesiology can be consulted on any case, but consultation is **advisable** for patients with an ASA Class of IV or V.
  (See next page for description.)
- The pre-procedure assessment must be documented by the anesthesia provider.

Pre-procedure Responsibilities: ASA Classification

American Society of Anesthesiologists Classification ("ASA Class") [6]	
ASA I	A normal healthy patient
ASA II	A patient with mild systemic disease
ASA III	A patient with severe systemic disease that limits activity but is not incapacitating
ASA IV	A patient with severe systemic disease that is a constant threat to life
ASA V	A moribund patient who is not expected to survive without the operation or procedure
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes

= Anesthesia consultation advised.

Pre-procedure Responsibilities: RN/RCIS Role

The RN or RCIS assisting with a procedure requiring sedation must ensure the following documentation is complete:

- Patient/family education
- Patient monitoring during procedure
- Time-based documentation during procedure

Prior to the procedure, the RN/RCIS must ensure all necessary supplies and equipment are available.

Pre-procedure Responsibilities: Patient Preparation

Procedural sedation preparation is the same as any other procedure or surgery.

- Ensure all orders and diagnostic tests are complete, e.g., lab tests, x-rays, skin preps, etc.
- Verify the patient's NPO status. Follow orders based on ASA class.
- Educate the patient and family regarding the procedure scheduled and expectations of sedation; CONSENT SIGNED prior to any administration of sedation.

Pre-procedure Responsibilities: Patient Preparation *(cont.)*

Validate all required components are complete:

1. Valid H&P is less than 30-days old with reassessment of the patient documented within 24-hours of admission prior to the procedure.
2. Validation of the correct surgical/invasive procedure
3. Evaluation immediately prior to the procedure
4. Medications
5. Allergies and previous drug reactions
6. Patient's age
7. Patient's weight
8. Pre-procedure laboratory and other diagnostic testing
9. Consent

Pre-procedure Responsibilities: Patient Preparation *(cont.)*

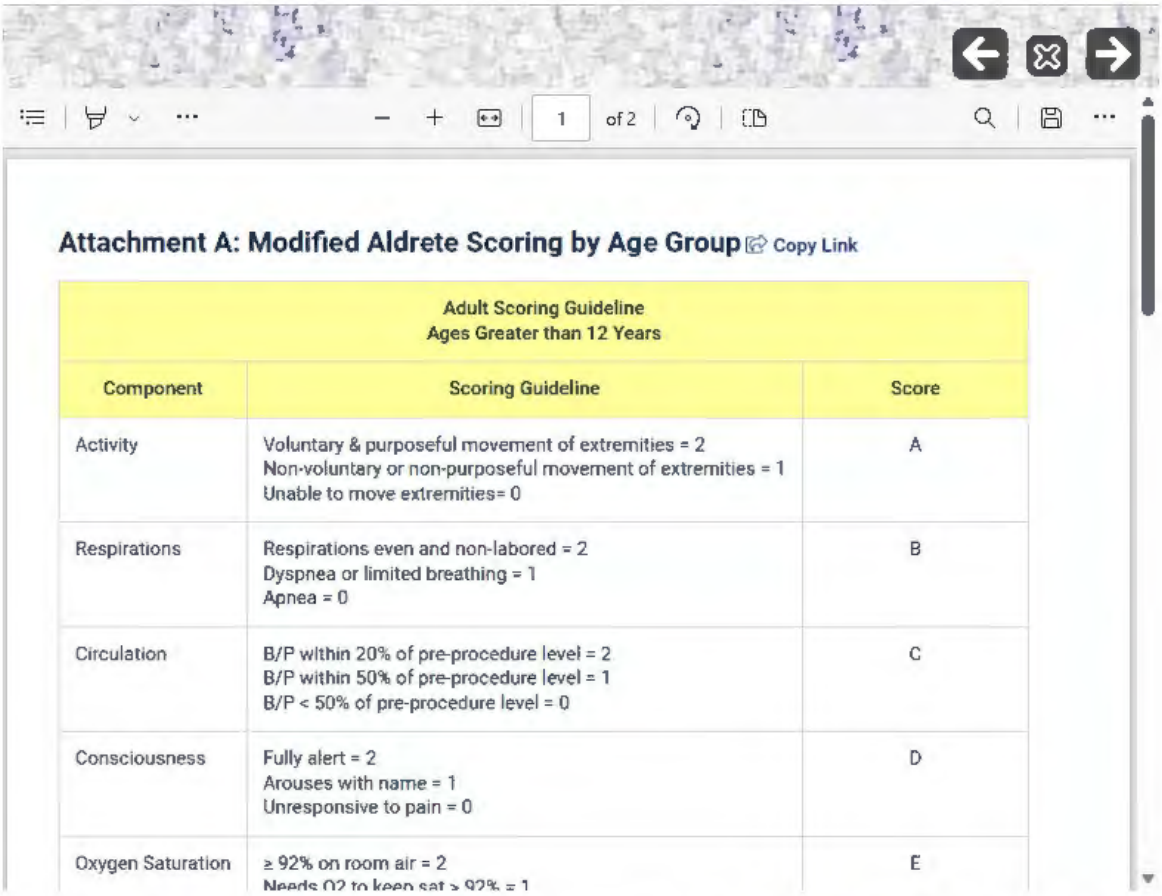
- Ensure a comprehensive assessment of the patient is completed.
- Perform a baseline pain assessment.
- Verify patent IV access.
- Pre-oxygenate the patient via nasal cannula at a flow rate of 2 L/m (unless medically contraindicated).
- Verify emergency equipment is available and in working condition.
- Identify the patient, using two identifiers. Validate the correct patient, procedure, and site.
- Perform a time-out prior to beginning the procedure.

Pre-procedure Responsibilities: The Modified Aldrete Score (or validated tool)

Modified Aldrete Scoring is a measurement tool rating post-procedure recovery of consciousness, activity, respirations, and blood pressure.

- A pre-procedural Aldrete score is necessary to establish an accurate baseline of the patient's status.
- Pre-existing conditions should be considered when evaluating the patient's score.
- A post-procedural score should equal the pre-procedural baseline score prior to discharge from the recovery area.

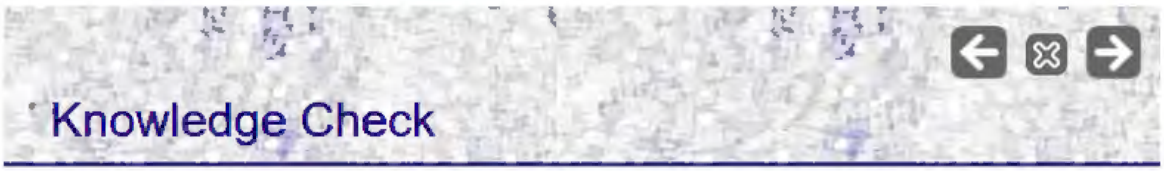
PRINT the Modified Aldrete Scoring document for use with answers on the quiz.



Attachment A: Modified Aldrete Scoring by Age Group

Copy Link

Adult Scoring Guideline Ages Greater than 12 Years		
Component	**Scoring Guideline**	**Score**
Activity	Voluntary & purposeful movement of extremities = 2 Non-voluntary or non-purposeful movement of extremities = 1 Unable to move extremities= 0	A
Respirations	Respirations even and non-labored = 2 Dyspnea or limited breathing = 1 Apnea = 0	B
Circulation	B/P within 20% of pre-procedure level = 2 B/P within 50% of pre-procedure level = 1 B/P < 50% of pre-procedure level = 0	C
Consciousness	Fully alert = 2 Arouses with name = 1 Unresponsive to pain = 0	D
Oxygen Saturation	≥ 92% on room air = 2 Needs O2 to keep sat > 92% = 1	E



Knowledge Check

The Modified Aldrete Scoring Guideline used to compare the patient's pre- and post-sedation status includes: (Choose all that apply.)

- [x] Activity
- [x] Respirations
- [ ] Pulse
- [ ] Cardiac rhythm
- [x] Blood pressure

Pre-procedure Responsibilities: Baseline Assessment

Immediately prior to medication administration, assess the following baseline parameters:

- Blood pressure
- Heart rate
- Respiratory rate
- Oxygen saturation
  - Maintain adult $SpO_2 \geq 92\%$ and pediatric $SpO_2 \geq 95\%$.
- End-tidal CO_2 level
  - Maintain CO_2 at 35 – 45 mmHg.
  - The CO_2 level will increase if the patient's ventilatory status is compromised.
- Level of consciousness
- Cardiac rhythm
  - Continuous ECG monitoring is required for **all** patients with a cardiac history or expected dysrhythmias, and for **all** deep sedation cases.
- Modified Aldrete score

Knowledge Check

Pre-oxygenation at 2 L/m via nasal cannula is required for all procedural sedation cases, unless medically contraindicated.

- (●) True
- ( ) False

Pre-procedure Responsibilities: Time-Out

Key Point: A "time-out" is **mandatory** prior to the start of the procedure.

During the time-out, the entire procedural team must pause, including the patient when possible, and verify the:

- Correct patient, using two patient identifiers
- Correct procedure
- Correct site (if applicable), including laterality

There must be **100% agreement** of the team **prior to starting** the procedure.

The time-out **must be documented** in the patient's medical record.

Intra-procedure Responsibilities: Monitoring

At a minimum, the following parameters should be monitored and documented **after every medication administration** and **every 5-10 minutes** during the procedure, following each additional dose of medication and more frequently as the patient's clinical needs dictate.

- Blood pressure
- Heart rate
- Respiratory rate
- Oxygen saturation
  - Maintain adult $SpO_2 \geq 92\%$
  - Maintain pediatric $SpO_2 \geq 95\%$.
- Identification and management of adverse events
- Level of consciousness
- Medication: dose, route, time
- Modified Aldrete score
- Pain level
- $EtCO_2$ level

Intra- & Post-procedure Assessment Considerations

Monitor the following to determine the patient's tolerance to the procedure:

- Significant variances in blood pressure, heart rate, respiratory rate and effort, SpO_2, and end-tidal CO_2.
- The patient's response **or** lack of response to verbal and physical stimuli.
- Facial grimacing and physical posturing, tensing, or flaccidity.

When observing the above, ask yourself:

- "Is the patient sedated enough?"
- "Is the patient experiencing pain?"
- "Is the patient over-sedated or at risk of being over-sedated?"

Post-procedure Monitoring

Post-procedure, the following page lists parameters which should be monitored continuously and documented **every 15 minutes**, depending on the patient's condition and the procedure performed.

Documentation will continue through the post-procedure period until the patient reaches 8 or greater on the Modified Aldrete score.

Post-procedure Responsibilities: Monitoring

At a minimum, the following parameters should be monitored and documented **after every medication administration** and **every 5-10 minutes** during the procedure, following each additional dose of medication and more frequently as the patient's clinical needs dictate.

- Blood pressure
- Heart rate
- Respiratory rate
- Oxygen saturation
  - Maintain adult $SpO_2 \geq 92\%$
  - Maintain pediatric $SpO_2 \geq 95\%$.
- Identification and management of adverse events
- Level of consciousness
- Medication: dose, route, time
- Modified Aldrete score
- Pain level
- $EtCO_2$ level

Post-procedure Responsibilities: Monitoring *(cont.)*

- Blood pressure
- Heart rate
- Respiratory rate
- Oxygen saturation
  - Maintain adult $SpO_2 \geq 92\%$
  - Maintain pediatric $SpO_2 \geq 95\%$.
- Identification and management of adverse events.
- Level of consciousness
- Medication: dose, route, time
- Modified Aldrete score
- Pain level
- Nausea
- End-tidal CO_2 level
  - Maintain CO_2 at 35 – 45 mmHg.
  - The CO_2 level will increase if the patient's ventilatory status is compromised.
- Cardiac rhythm
  - Continuous ECG monitoring is required for **all** patients with a cardiac history or expected dysrhythmias and for **all** deep sedation cases.

Post-procedure Assessment Considerations

- Patients may continue to be at significant risk for persistent/residual sedation effects or for developing complications after the procedure is completed.
- The reassessment and documentation of vital signs will revert to unit-specific standards of practice once the post-procedure monitoring criteria have been met.
- The patient's pain level may become more acute as the level of sedation decreases and will need to be treated accordingly.

Post-procedure and Over-Sedation

Over-sedated patients will require an extended recovery period.

Key Points:

- Monitor Patient - If the patient received a reversal agent due to over-sedation, they must be monitored for a minimum of two hours after the last dose of the reversal agent.
- Submit a VOICE File:
  - When a reversal agent is used to rescue a patient.
  - If there are any complications or adverse outcomes.

Discharge from Procedural Units

Patients are either discharged to their inpatient unit or discharged to home from the procedural unit.

Patients may be discharged when **at least** 30 minutes have elapsed since the last dose of sedation/analgesia was given.

Key Points:

If a reversal agent was administered, the patient must be monitored for at least 2 hours after the last dose of reversal agent was given.

Monitoring can continue on an inpatient unit.

Discharge Criteria

Prior to discharge, the following criteria must be met:

- Vital signs must be stable.
- Modified Aldrete score must be ≥ 8.
- None, or mild nausea with no active emesis.
- Patient is arousable with protective reflexes intact.
- Pain-free, mild discomfort, or controlled with analgesics.
- Mobility must be back to pre-procedure baseline.

Interpreting the Modified Aldrete Score

A patient requires either **a score ≥ 8** or **a proceduralist/provider's order** to be transferred or discharged from the procedural unit. Other department/ procedural-specific discharge criteria may also need to be applied.

Key Point:

A score < 8 indicates the patient should be closely monitored with interventions applied as indicated.

Discharging Inpatients vs. Outpatients

Inpatients:

- A full hand-off report must be given to the next provider of care.

Outpatients:

- Written discharge instructions must be reviewed with the patient and responsible party.
- Discharge instructions include the hospital- and department-specific instructions and the 24-hour minimum restrictions mandated for patients who have received pain or sedative agents, including an emergency phone number.

Key Point:

A responsible individual **must** be available to transport the patient home.

Knowledge Check

You are caring for a patient immediately post-bronchoscopy. She is very groggy, but arouses when you call her name. She can move her extremities when asked, but she keeps falling back to sleep. Her respirations are non-labored, but her respiratory rate is 9-10. Her blood pressure is 108/68 (baseline was 124/78). She needs O_2 at 2 L/m via nasal cannula to keep her oxygen saturation at 93%.

What is her Modified Aldrete Score?

- ○ 4
- ○ 5
- ○ 6
- ◉ 7
- ○ 8

Knowledge Check *(cont.)*

Continuing with the same patient in the previous question, what does her score need to be for her to be discharged from the procedural area?

- ○ Greater than or equal to 4
- ○ Greater than or equal to 6
- ◉ Greater than or equal to 8
- ○ Greater than or equal to 10

Reference

Munson Healthcare Policies and Procedures. (2022, December 16). *Sedation*. PolicyStat.

Symptom Management for Procedural Sedation

Amy Krug, BSN, RN, CGRN
Lisa Lord, MSN, RN, CNOR
Jeannette Reynolds, MSN, BBA, RN, CPAN

October 2023

Goal and Objectives

Goal

This course will increase the participant's knowledge of managing potential symptoms associated with patients receiving procedural sedation.

Objectives

1. Identify when a patient has progressed to a deeper level of sedation.
2. Identify nursing interventions appropriate to the patient's rescue needs.

Common Side Effects of Sedation

The most common side effects of sedation administration are:

- Respiratory depression
- Hypotension
- Nausea and vomiting
- Paradoxical response

The most common adverse effect of opioids, especially when combined with sedatives, is respiratory depression.

If left untreated, respiratory depression can progress to apnea, followed by cardiac arrest.

$EtCO_2$ and pulse oximetry may show early signs of respiratory distress.

Treatment of Respiratory Depression

- **Stop all administration of opioids and sedatives!**
  - The duration of these medications depends on the drug, dose, route of administration, and the patient's condition.
- Maintain an open airway:
  1. Reposition the head/neck using the chin-lift or jaw-thrust.
  2. Provide oxygen therapy. Be prepared to use an ambu bag if necessary.
  3. Insert a nasal or oropharyngeal airway as necessary.
- If airway management is not effective, administer the appropriate reversal agent:
  - Flumazenil (Romazicon) for benzodiazepines.
  - Naloxone (Narcan) for opioids.
- Call MRT as appropriate.

If the patient does not respond to airway management maneuvers and the reversal agent, call a Code Blue (5-5555)!

Knowledge Check

The most common side effect of sedation administration is:

- (●) Respiratory Depression
- ( ) Paradoxical Response
- ( ) Nausea and Vomiting
- ( ) Hypotension

Knowledge Check *(cont.)*

If respiratory depression occurs while I am assisting with a procedure that requires sedation, I should do all of the following: (Choose all that apply.)

- [ ] Reposition the head/neck by tucking the chin to the chest.
- [x] Provide oxygen therapy, assisting with ventilation, if necessary.
- [x] Insert an oropharyngeal airway, if needed.
- [x] Administer the appropriate reversal agent.

Hypotension

Hypotension is most likely caused by vasodilation, blood loss during the procedure, or a pre-existing condition, but could also be caused by sedation. The cause of the hypotension determines the treatment.

Possible treatments:

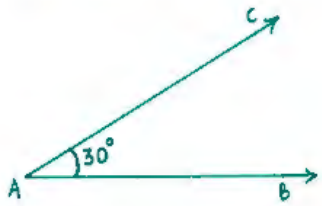
- IV fluid replacement
- Vasopressors
- Blood transfusion
- If you suspect the cause is over-sedation, administer reversal agents per protocol:
  - Flumazenil (Romazicon) for benzodiazepines.
  - Naloxone (Narcan) for opioids.

Nausea and Vomiting

Aspiration is a major concern with the patient receiving sedation.

Treatment for nausea and vomiting:

- Position the patient to prevent aspiration. The preferred position is Semi-Fowlers with the head of the bed at 30 degrees and the patient on his/her side.
- Suction as necessary to maintain a patent airway.
- Administer an antiemetic.
- Patient to remain NPO until awake and alert.



Paradoxical Responses

The desired effect of moderate sedation or analgesia is a relaxed and cooperative patient. The patient is sedated but can be aroused and is able to follow simple commands.

If a patient has a sensitivity to a specific drug, a paradoxical response can occur. Consider a paradoxical response if the patient becomes any of these:

- Agitated
- Uncooperative
- Combative
- Disoriented

Paradoxical Responses *(cont.)*

A thorough patient assessment is imperative to determine the actual cause of the patient's symptoms.

Paradoxical responses are seen more often in patients with a history of alcohol or IV drug abuse (most frequent).

Other causes to consider include:

- Hypoventilation due to hypoxia.
- Inadequate dosing of pain medication during a painful procedure.

Over-sedation

Symptoms:

- Decreased respiratory function (hypoventilation, decreased respiratory rate, or apnea)
- Decreased cardiovascular function (hypotension or dysrhythmias)
- Confusion
- Decreased level of consciousness that can progress to coma
- Depressed/absent cough and gag reflex
- Decreased response to physical/verbal stimuli

Treatment of Over Sedation

Treatment:

- Ensure an open airway.
- Encourage or stimulate the patient to breathe.
- Administer supplemental oxygen to increase or maintain oxygen saturation greater than or equal to 92%.
- Ventilate with ambu bag if spontaneous ventilation is inadequate.
- Administer reversal agents per protocol:
  - flumazenil (Romazicon) for benzodiazepines.
  - naloxone (Narcan) for opioids or narcotics.
- If hypotensive, infuse IV fluids or consider vasopressors.
- Reposition patient to semi-fowlers.
- Consider MRT or RT evaluation, if approriate.
- If patient uses home CPAP/BiPAP, also use it post-procedure.

If the patient does not respond to airway management maneuvers and the reversal agent, call a Code Blue (5-5555)!

Knowledge Check

Symptoms of over-sedation include: (Choose all that apply.)

- [x] Decreased response to stimuli
- [x] Decreased respiratory rate
- [ ] Agitation
- [x] Hypotension

Knowledge Check *(cont.)*

If a patient is in respiratory arrest and does not respond to airway management and reversal agents, I should:

- (●) Call a Code Blue.
- ( ) Call and MRT.
- ( ) Call the provider.

Reporting Requirements

Whenever it is necessary to administer a reversal agent, a VOICE file must be completed. Access the form from the MHC Intranet.

Other complications related to sedation to be reported include:

- Incidents in which the patient slips into a level of sedation that is greater than intended, e.g., moderate to deep sedation.
- Profound hypotension (50% decrease from pre-procedure mean blood pressure)
- Cardiac arrest
- Defibrillation
- Respiratory arrest
- Seizures
- Aspiration
- Medication errors
- Vomiting

Knowledge Check

I must fill out a VOICE file for the following situations: (Choose all that apply.)

- [x] If a patient slips into a deeper level of sedation than intended.
- [x] Profound hypotension
- [x] Medication errors
- [x] If a reversal agent is required to control an adverse reaction, such as respiratory depression.

References

Munson Healthcare Policies and Procedures. (2022, December 16). *Sedation*. PolicyStat.

Munson Healthcare Policies and Procedures. (2021, April 20). *Flumazenil Protocol*. PolicyStat.

Munson Healthcare Policies and Procedures. (2022, February 21). *Standing Order/Protocol for Adult Naloxone (Narcan)*. PolicyStat

Procedural Sedation Medication Guidelines

Lauren Wolf, PharmD, BCPS, BCCCP

December 2025

Goal and Objectives

Goal

This course will increase the participant's knowledge of administering medications for procedural sedation.

Objectives

1. Identify staff who can administer sedation.
2. Select the appropriate medication and dose for reversing over sedation.

Introduction

Dosage guidelines for procedural sedation and reversal agents are approved by the Pharmacy and Therapeutics (P & T) Committee at Munson Medical Center.

These guidelines are intended for initial doses and may be exceeded or decreased according to the patient's history, previous response to sedatives or other clinical circumstances.

Prior to administration, the P & T Committee must review and approve the use of all medications not listed in the approved guidelines.

Guidelines Location

Nurses and Registered Cardiovascular Invasive Specialists (RCIS) should be familiar with medication guidelines before administering sedation. The medication guidelines are attached to the Sedation policy.

Moderate & Deep Sedation/Analgesia Drug Usage Guidelines are listed below. **Print** the document to use as a reference for upcoming questions.

Attachment C: Moderate Sedation/Analgesia Drug Usage Guidelines

A. IVP by RN or ED Trained Pharmacist in the presence of the provider credentialed for moderate sedation

B. Not intended for Neonates - Unless otherwise indicated

Drug	Pharmacokinetics	Drug Dosage & Administration	Precautions / Contraindications
Diazepam (Valium)	Onset: IV: 1-3 min	Adults IV: 5-10mg - no faster	• Titrate to effect. Do not dilute.

Facility-specific IV Push and Infusion Guidelines

Munson Healthcare has an IV Push/Infusion Chart to assist staff with decisions regarding the administration of medications. This chart can be found on the Intranet on the Pharmacy Department site.

The chart contains various topics, including:

- Medications administered by IV push or by infusion.
- Approved medications per department.
- Medications a nurse can give during a Code Blue.
- Medications requiring a physician be present during administration.

NOTE: See the IV Push Chart on the next slide.

MMC IV Push Chart

MUNSON HEALTHCARE
IV MEDICATION ADMINISTRATION GUIDELINES

Definitions

Level 1	Units with general nursing and monitoring capabilities (ex. med-surg).
Level 2	Intermediate and telemetry units. RNs working on these units have more advanced training and advanced monitc telemetry) are present. Level 2 may be further divided into level 2a (telemetry units) or level 2b (step-down units)
Level 3	Critical and emergency care units (including operating rooms). Licensed clinicians working on these units are trai emergencies and manage critically ill patients. Advance monitoring and treatment resources are readily available.
OB	Birthing units and units dedicated to the care of antepartum and postpartum patients. OB units follow level 1 crite noted.
PEDS	Any unit caring for patients 18 years of age or less. Peds may be further subdivided as **level 1, level 2, and level** criteria above.

Exclusions

- Chemotherapy/antineoplastic agents
- Biologics and immune therapies typically restricted to outpatient administration (ex. Infliximab, vedolizumab)
- Basic IV hydration fluids (ex. 0.9% normal Normosol, lactated ringers)
- Non-intravenous parenterally administere

Who Can Administer Sedation?

Medications for **moderate** sedation may be given by a registered nurse (RN) or registered cardiovascular invasive specialist (RCIS) in the presence of the physician, physician assistant (PA), nurse practitioner (NP), or oral surgeon credentialed in moderate sedation and in advanced airway management.

Who Can Administer Sedation? *(cont.)*

Medications for **deep** sedation, can **ONLY** be administered by a provider credentialed in deep sedation.

- **Exception: Propofol** - a critical care RN may give propofol (Diprivan) IVP for an emergent intubation while a physician is present and performing the intubation.
  - Critical care is defined by the IV Push/Infusion Chart to include these units:
    - ✓ ICU
    - ✓ ED
    - ✓ PACU
    - ✓ OR
    - ✓ A2 (critical)
    - ✓ A3 (critical)
    - ✓ IR

Knowledge Check

A patient is scheduled for a wound debridement at the bedside. The physician orders hydromorphone (Dilaudid) 0.1-0.5mg IV titrated over 1 minute for moderate sedation.

This is an approved dose according to the MMC Moderate Sedation Guidelines.

- (●) True
- ( ) False

Knowledge Check *(cont.)*

A patient is scheduled for a synchronized cardioversion. The physician orders propofol (Diprivan) at 1mg/kg per minute over 60 seconds.

How long do the effects of propofol (Diprivan) last?

- ( ) 1-2 minutes
- (●) 3-10 minutes
- ( ) 12-20 minutes
- ( ) 25-30 minutes

Knowledge Check *(cont.)*

A registered nurse from the ICU can give propofol (Diprivan) IV push with a physician order, if the physician is present in the room, but is not intubating the patient.

- ○ True
- ◉ False

Reversal Agents

- Reversal agents may be indicated when:
  - ➢ The level of sedation is deeper than desired.
  - ➢ The patient's responsiveness or cardio-respiratory status is compromised.
  - ➢ An idiosyncratic reaction occurs.
- If a reversal agent is administered for the undesired effects, a **VOICE** file is required.
- A patient should be monitored for a minimum of two hours after giving a reversal agent.

Commonly Used Opioids

If a patient becomes difficult to arouse with verbal or physical stimuli related to sedation from an opioid, follow the Standing Order/Protocol for Adult Naloxone (Narcan) Protocol. The naloxone (Narcan) protocol can be located:

- Policy website on the Intranet
- Pharmacy website on the Intranet
- Side of the crash cart

Examples of commonly used opioids include:

Codeine	Morphine
Demerol (meperidine)	Norco (hydrocodone + acetaminophen)
Dilaudid (hydromorphone)	Oxycontin (oxycodone)
Dolophine (methadone)	Percocet (oxycodone + acetaminophen)
Duragesic (fentanyl patch)	Sublimaze (fentanyl injection)

naloxone (Narcan) Protocol

The naloxone protocol allows the registered nurse or RCIS to:

- Titrate oxygen to maintain an oxygen saturation of at least 92%.
- Perform further interventions, including the administration of naloxone depending on the patient's mental status and O_2 saturation.
- For patients with oxygen saturations ≥ to 80%, dilute the naloxone 0.4 mg in 9 ml of normal saline and administer in small, 1mL doses following the protocol. This allows for better titration of the dosing [so the patient doesn't over respond to the naloxone and end up in severe pain].
- Give naloxone 0.4 mg **undiluted** for an O_2 saturation below 80% or respiratory arrest.

NOTE: Click the button.

Review the naloxone (Narcan) Protocol

Show Changes

Tag Policy

Standing Order/Protocol for Adult Naloxone (Narcan)

Purpose

To provide a policy for Adult Naloxone (Narcan) standing orders/protocols.

Policy

A. The Protocol for Adult Naloxone (Narcan) shown below, is approved as a standing order and may be initiated by a Registered Nurse (RN) or Licensed Practical Nurse (LPN) without a provider order for any patient if:

1. Patient is difficult to arouse with verbal/physical stimuli **~AND~**
2. Patient is on, or recently was on, opioids or suspected that the patient has consumed opioids

B. This protocol is not applicable for end of life/palliative or comfort care/hospice patients. Call provider to clarify if any questions.

C. If criteria above are met then the initiating [illegible] would enter by Physician Order Entry (POE) using

naloxone (Narcan) Points to Remember

- The onset of action for naloxone is within 2 minutes.
- The half-life of naloxone is 30-90 minutes.
- Many opioids have a longer half-life than naloxone, so it is important to monitor your patients closely. A repeat dose of naloxone may be required.

Knowledge Check

A 52-year-old female was admitted post-intervention to her right coronary artery. She received an initial dose of morphine sulfate 2 mg IV push prior to her sheath pull. She continued to complain of discomfort @ 8/10. An additional morphine sulfate 4 mg IV push was administered for discomfort. Respirations are now 5/minute; oxygen saturation is 82%. The patient is not arousable to verbal stimuli, but is arousable to a sternal rub.

Which dose of reversal agent should be initiated?

- (●) naloxone 0.4 mg diluted in 9 mL of normal saline, and give 1 mL IV push
- ( ) naloxone 0.4 mg diluted in 9 mL of nomal saline, and give IV push
- ( ) naloxone 0.4 mg IV push (undiluted)
- ( ) naloxone 0.4 mg diluted in 9 mL of normal saline, and give 2 mL IV push

Treating Over Sedation from a Benzodiazepine

If a patient becomes difficult to arouse with verbal or physical stimuli related to sedation from a benzodiazepine, follow the flumazenil (Romazicon) protocol.

The flumazenil protocol can be located:

- Policy website on Intranet
- Pharmacy website on Intranet
- Side of the crash cart

Commonly Used Benzodiazepines

The most commonly used benzodiazepines are:

alprazolam (Xanax) ★	flurazepam (Dalmane)
chlordiazepoxide (Librium)	**lorazepam (Ativan)** ★
clonazepam (Klonopin)	**midazolam (Versed)** ★
clorazepate (Tranxene)	oxazepam (Serax)
diazepam (Valium) ★	**temazepam (Restoril)** ★
estazolam (Prosom)	triazolam (Halcion)

★ = MMC formulary benzodiazepines

flumazenil (Romazicon) Protocol

The flumazenil Protocol allows the registered nurse or RCIS to:

- Titrate oxygen to maintain an oxygen saturation of at least 92%.
- Perform interventions, including administering flumazenil if the patient is unarousable AND:
  - Oxygen saturation is less than 89% **OR**
  - Respiratory rate is less than 6.
- Initial dose: flumazenil 0.2 mg IV push over 30 seconds

NOTE: Click the button to review the flumazenil protocol; check for repeat dosing and the complete intervention sequence.

Review the flumazenil (Romazicon) Protocol

Show Changes

POMH)

Tag Policy

Flumazenil Protocol

Purpose

Flumazenil (Romazican) protocol for suspected Benzodiazepine overdose in adults.

Policy

Flumazenil Reversal Protocol (Physician Order Required)

Purpose: Flumazenil (Romazicon) protocol for suspected Benzodiazepine Overdose in Adults

Most Common Benzodiazepines

- Alprazolam (Xanax)
- Chlordiazepoxide (Librium)
- Clonazepam (Klonopin)
- Clorazepate (Tranxene)
- Diazepam (Valium)
- Estazolam (ProSom)

Difficult to arouse with verbal/physical stimuli or suspected benzodiazepine overdose

- Page respiratory therapy STAT
- STAT SpO2

flumazenil (Romazicon) Points to Remember

- The onset of action is 1-2 minutes.
- Duration:
  - ➢ Re-sedation occurs after approximately 1 hour (range: 19-50 minutes).
- Many benzodiazepines have a longer half-life than flumazenil, so it is important to monitor your patients closely. A repeat dose may be required.
- Avoid use of flumazenil in patients with chronic benzodiazepine use. Its use may precipitate seizures.

Knowledge Check

You are assigned to an 88-year-old man who arose from a sitting position and had a syncopal episode. He was placed on the stroke unit for telemetry monitoring. At the start of your evening shift, he becomes very agitated. An order is obtained to give him lorazepam (Ativan). He finally falls asleep after 0300. At the end of the shift (0700), you find him difficult to arouse to both verbal and physical stimuli. His respirations are 5/minute and his oxygen saturation is 86%.

Which reversal dosing agent is appropriate for this patient?

- ○ Undiluted naloxone (Narcan) 0.4 mg IV push STAT
- ○ Diluted naloxone (Narcan) 0.4 mg in 9 mL normal saline
- ◉ flumazenil (Romazicon) 0.2 mg IV push over 30 seconds
- ○ flumazenil (Romazicon) 0.4 mg IV push over 30 seconds

Selecting naloxone (Narcan) vs. flumazenil (Romazicon)

When a patient has received/taken both a benzodiazepine and an opioid, and a reversal agent is needed, **give the naloxone first**.

Reasons:

- Opioids are more likely to cause respiratory depression and other adverse effects, such as hypotension.
- flumazenil can cause seizures in patients with a history of long-term use of benzodiazepines.

Knowledge Check

A 21-year-old female patient has returned following endoscopy in the Medical Procedure Room. She received Demerol 75 mg and Versed 7.5 mg during the procedure.

She has a history of taking Xanax 0.25 mg three times per day for anxiety and Vicodin PRN for pain. She was discharged to B2 following an uneventful recovery with an Aldrete score of 8. Respirations are now 5/minute with an oxygen saturation of 85%. The patient is not arousable to verbal stimuli, but does arouse to a sternal rub.

Which reversal agent protocol should be used first?

- ◉ naloxone (Narcan) Protocol
- ○ flumazenil (Romazicon) Protocol

Knowledge Check *(cont.)*

A 21-year-old female patient has returned following endoscopy in the Medical Procedure Room. She received Demerol 75 mg and Versed 7.5 mg during the procedure.

She has a history of taking Xanax 0.25 mg three times per day for anxiety and Vicodin PRN for pain. She was discharged to B2 following an uneventful recovery with an Aldrete score of 8. Respirations are now 5 minute with an oxygen saturation of 85%. The patient is not arousable to verbal stimuli, but does arouse to a sternal rub.

Which dose of Narcan (naloxone) should be administered?

- ○ naloxone 0.4 mg IV push (undiluted)
- ○ naloxone 0.4 mg diluted in 9 mL of nomal saline, and give IV push
- ○ naloxone 0.4 mg diluted in 9 mL of normal saline, and give 2 mL IV push
- ◉ naloxone 0.4 mg diluted in 9 mL of normal saline, and give 1 mL IV push

Treating Patients Who Revert to a Deeper Level of Sedation

- Remember, the effects of opioids and benzodiazepines last longer than the effects of the reversal agents.
- Continue to monitor the patient for signs of progression to a deeper level of sedation for a minimum of 2 hours.
- Repeated dosing of the reversal agents may be needed.
- Create and submit a **VOICE** file.

Dissociative Sedation

Dissociative sedation is a trance state where the patient remains awake, but is unaware of pain and will have no memory of the event.

- In comparison to deep sedation, which causes the patient to:
  - Be unarousable, except with repeated or painful stimuli
  - Experience respiratory depression

Ketamine for Dissociative Sedation

Ketamine will be administered by providers credentialed for deep sedation.

1. A pharmacist, nurse, or non-credentialed provider may administer medications for dissociative sedation in the Emergency Department, as long as a provider credentialed for deep sedation, an RN, and a respiratory therapist are ***ALL*** present.
2. Respiratory adverse events, such as apnea or laryngospasm (although uncommon), may still occur, and providers must always be prepared to rescue the patient from a deep sedation state anytime ketamine is administered.
3. Ketamine (IM/IV) is used for dossociative sedation in both children and adults (including the mentally disabled) for medical procedures such as, but not limited to: fracture reduction, laceration repair, abscess drainage, foreign body removal.
4. If Ketamine is administered IM, IV access should be immediately available.

References

Lexicomp. (2023, November 29). *Flumazenil*. Retrieved December 5, 2023.

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Munson Healthcare Policies and Procedures. (2022, February 21). *Standing Order/Protocol for Adult naloxone (Narcan)*. PolicyStat.

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MUNSON HEALTHCARE

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Magnetic Resonance Imaging (MRI) Safety

Heather Davis, RT(R), Radiology
Amy Anderson, RT(R), MR, Radiology

April 2025

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Goal and Objectives

Goal

This course will enable the learner to provide a safe environment for patients and staff who are in the presence of the MRI scanner.

Objectives

1. Describe basic knowledge of magnetic fields and their influence on objects near them.
2. Describe the importance of safety when working around the MRI scanner.
3. Identify precautions that should be taken to avoid accidents when working near the MRI scanner.
4. Identify precautions that should be taken when patients have implantable devices or metallic foreign bodies.

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The MRI Magnet

Magnetic resonance imaging (MRI) is a noninvasive, painless medical test that helps physicians diagnose and treat medical conditions by providing views of the inside of the human body.

The MRI uses a powerful magnetic field, radio waves, and a computer to produce detailed three-dimensional pictures of internal body structures.

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The MRI Magnet *(cont.)*

Most people have had some experience with natural magnets and their attractive forces, such as, attaching papers to a refrigerator door.

The MRI scanner is a large magnet (10,000 lbs.) with a tremendously strong magnetic pull. The magnet in the MRI scanner creates a force field which can affect objects that are close to it. As you approach the MRI scanner, the attractive force field increases rapidly.

The strong magnetic field can have adverse effects on patients and staff who are within the scanner's magnetic force field.

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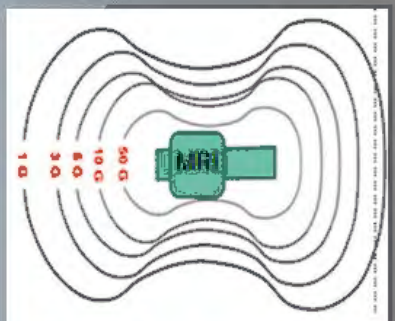
Magnetic Field Hazards

All MRI magnets have a magnetic field that extends into the exam room.

The various distances from the magnet consist of ***GAUSS Lines***, *which measure the attractive force of the magnet at a certain distance.*

As Gauss Line distances decrease, the magnetic field strength increases, until the field is so strong, it can cause any ferromagnetic object* to have a missile effect.



Distance closer, strength higher

*An object attracted by a magnet and can become magnetized.

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Magnetic Field Hazards *(cont.)*

Ferromagnetic metal alloys usually contain iron, nickel, or cobalt. These elements are found in most metal objects.

Examples of ferromagnetic objects:

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Magnetic Field Hazards *(cont.)*

The Missile Effect

This refers to the capability of the MRI magnetic field to attract a ferromagnetic object into the scanner with considerable force.

It can cause:

- Delayed patient care
- Possible injury to patient or staff
- Possible damage to the MRI scanner
- Approximate cost due to each "missile effect" incident: **$250,000**

It takes **96 hours** to:

- Turn the magnet off
- Remove the object
- Power back up

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The MRI Magnet is Always On!

The MRI Magnet is Always On!

The MRI Magnet is Always On!

Back Exit

Test Your Knowledge

Which of the following items should you remove from your pockets prior to entering the strong magnetic field of an MRI system?

- ○ Scissors
- ○ Safety pin
- ○ House key
- ◉ All of the above

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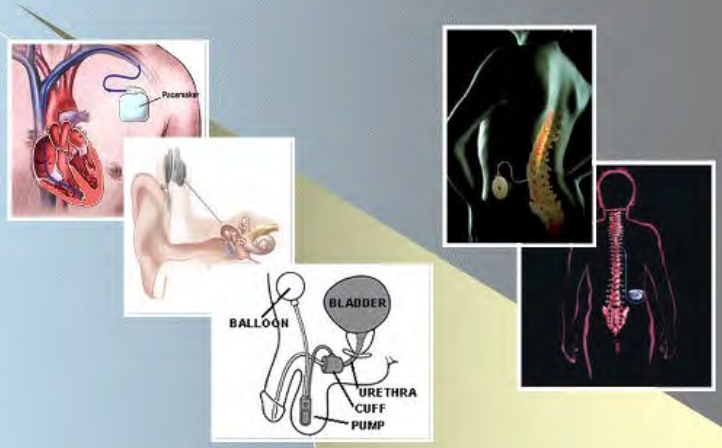
Magnetic Field Hazards *(cont.)*

MRI staff should ensure that implants are **"MR Conditional"** and should instruct patients to immediately report any burning sensations experienced during the scan.

Displacement and Heating of Surgical Implants:

- Cardiac pacemakers
- Neurostimulators
- Pain control pumps
- Penile implants
- Cochlear implants



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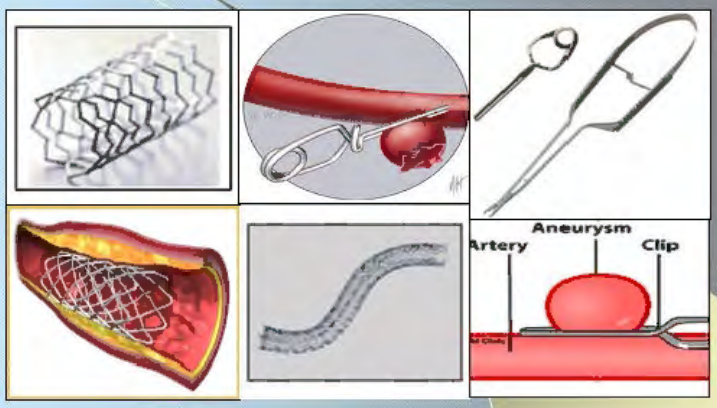
Magnetic Field Hazards *(cont.)*

Displacement (movement) of these implants may cause a life-threatening situation!

Stents and Aneurysm Clips:



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Magnetic Field Hazards *(cont.)*

Electromagnetic Interference with Electronic Devices

Mechanically- or electrically-activated implants may stop or malfunction in the presence of the MRI magnetic field.

Patients with pacemakers have died during or shortly after MRI exams due to disruption of pacemaker function by the MRI system.

Hospital staff with pacemakers or other implanted electronic devices could also be affected, if they come within the strong magnetic field of the MRI.

Back Exit Next

Magnetic Field Hazards *(cont.)*

All patients with body piercing jewelry must be screened for jewelry removal before they have an MRI scan!

Risks for these patients include:

- Discomfort or painful sensations due to possible displacement of the jewelry.
- Patient burns due to heat generated from the interaction between the jewelry and the electromagnetic fields.

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Magnetic Field Hazards *(cont.)*

All patients with transdermal patches must be screened for patch removal before they have an MRI scan.

Transdermal Patches:

Some patients are now wearing trans-dermal patches for medication delivery.

Many of these patches contain aluminum foil or other metallic components which can cause excessive heating, leading to burns in patients undergoing a MRI scan.

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Magnetic Field Hazards *(cont.)*

All patients with tattoos must be screened before they have an MRI scan.

Tattoos:

Many patients scheduled for an MRI scan will present with tattoos.

These tattoos will be either cosmetic or decorative and can be located anywhere on the body.

Some of these tattoos will contain ferromagnetic material, which can cause heating, swelling, or burning at the tattoo site.

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The MRI Magnet is Always On!

The MRI Magnet is Always On!

The MRI Magnet is Always On!

Magnetic Field Hazards *(cont.)*

Pregnancy **All pregnant patients must be screened before they have an MRI scan.**

MR imaging is recognized as a beneficial diagnostic tool to assess a wide range of diseases and conditions that affect pregnant women and their fetuses.

MR imaging in pregnant women should only be performed in cases where the referring physician and radiologist agree that the findings of the MRI has the potential to change or alter the care of the mother or fetus and that the benefit outweighs the risk.

The Policies, Guidelines, and Recommendations for MRI Imaging, Safety, and Patient Management issued by the Safety Committee of the Society for MRI imaging states:

"MRI may be used for pregnant women if other non-ionizing diagnostic imaging is inadequate, or if the MRI provides important information that would otherwise require exposure to ionizing radiation (CT, fluoroscopy, etc.)."

Summary of MRI Hazards

Hazard	Possible Danger
Body-piercing jewelry	Displacement; Heat
Transdermal skin patches	Burning
Tattoos	Burning
Aneurism clips	Displacement
Stents	Displacement
Cochlear implants	Displacement
Penile implants	Displacement
Pacemakers	Malfunction or Stop

Back Next

MRI Patient Safety Labels

Click each label to learn more:

MRI Safe Equipment Label
No Restrictions

MRI Conditional Equipment Label
Equipment needs to be tested prior to use

MRI Unsafe Equipment Label
Equipment is strongly ferromagnetic and must not be used in the scan room

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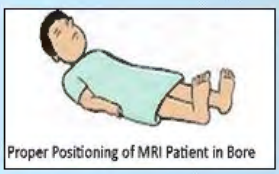
Thermal Injury Protection

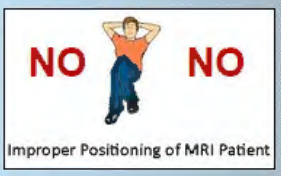
Electrical currents can be induced while in the magnet bore and cause thermal injury.

More tips:

- Cold compresses can be used over heavy tattoos to reduce tissue heating.
- Surface coils should be checked before scanning.
- Unused electrically-conductive materials outside the patient should be removed.

Arms and legs should not cross or touch each other.


Proper Positioning of MRI Patient in Bore



Improper Positioning of MRI Patient

The patient's body should not touch the inner bore of the magnet.

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Emergency Shutdown (Quenching)

A loss in superconductivity can result in massive heat gain in the magnet, producing cryogen boil-off and release. This is called "quenching."

- The resulting damage caused by quenching is costly and time-consuming.
- Emergency quenching should be avoided.
- If extended power loss is expected, the magnetic field can be ramped down to prevent quenching. Backup or temporary power should be available at all times.

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Patient Hearing Protection

- MRI systems can produce a very noisy environment for the patient.
- All patients should be offered hearing protection, especially when using systems which have sound pressures above 99 dB.

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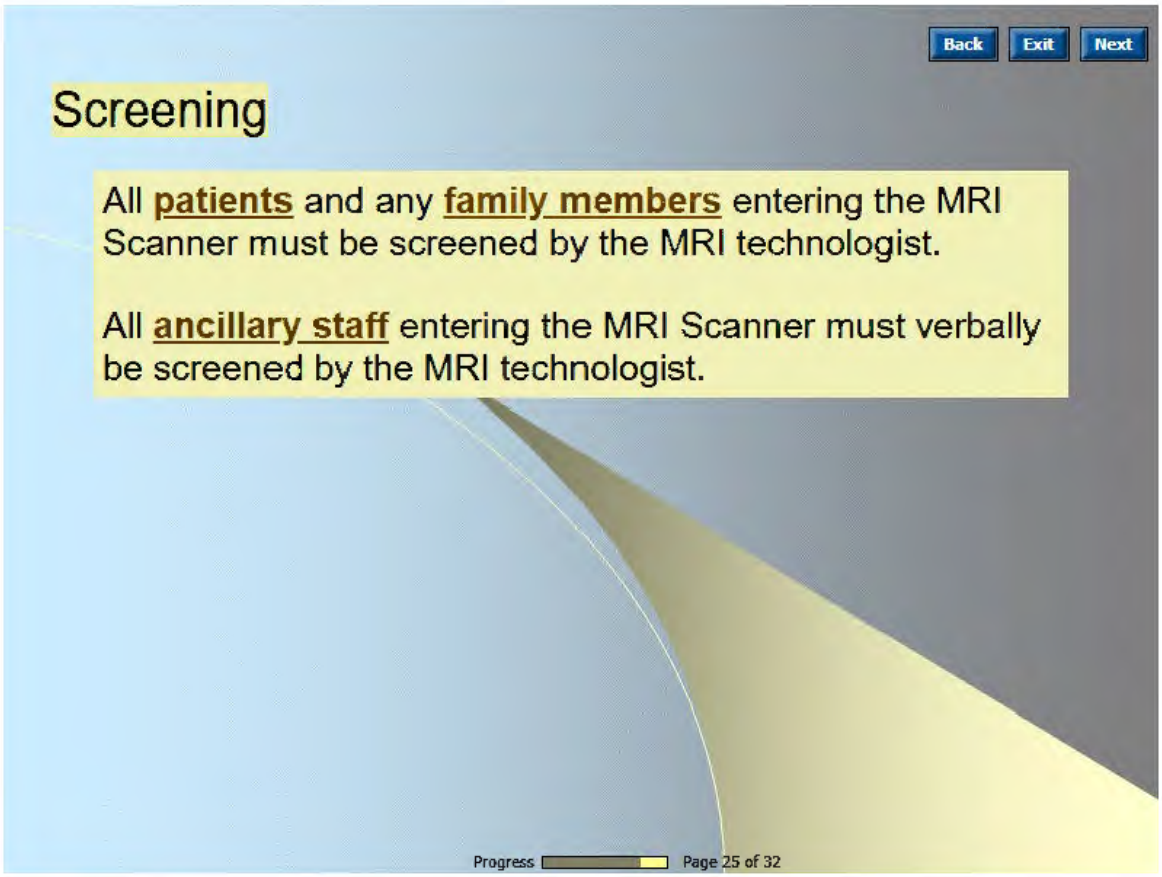
Patients with Claustrophobia - Anxiety - Emotional Distress

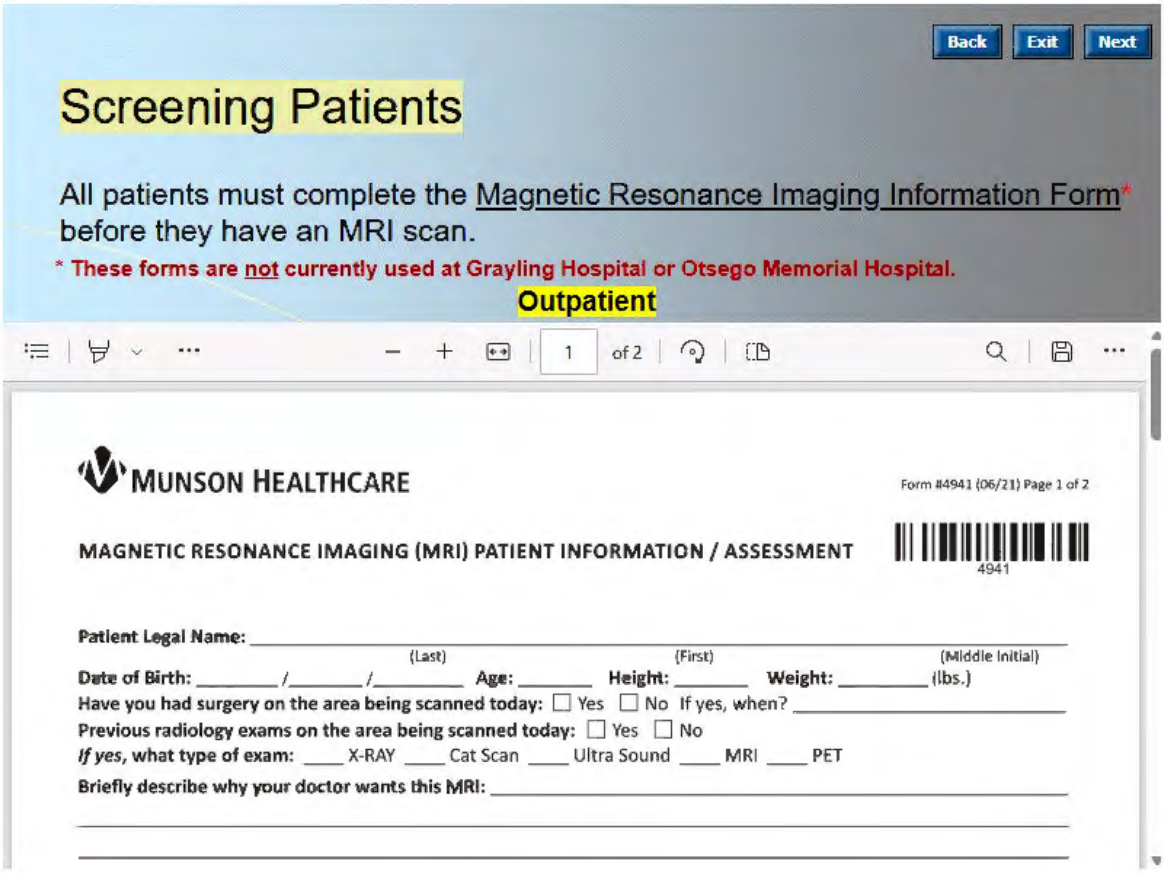
- Many patients experience anxiety prior to and during MRI exams. Some may not be able to complete the exam due to claustrophobia.
- It can be helpful to use audio and visual distractions.

Back Exit Next

Patients Requiring Immediate Medical Attention

- When a patient needs immediate medical care in the scan room, all responders must have sufficient training in MRI safety.
- This applies to medical/technical staff, as well as police, fire, and security personnel.
- If resuscitation is needed, the patient should be moved from the scanner to a safe area.
- Emergency and disaster plans should be in place and conducted periodically.





MUNSON HEALTHCARE

Form #4941 (06/21) Page 1 of 2

MAGNETIC RESONANCE IMAGING (MRI) PATIENT INFORMATION / ASSESSMENT

4941

Patient Legal Name: _____
(Last) (First) (Middle Initial)

Date of Birth: ____/____/____ **Age:** _____ **Height:** _____ **Weight:** _____ (lbs.)

Have you had surgery on the area being scanned today: ☐ Yes ☐ No If yes, when? _____

Previous radiology exams on the area being scanned today: ☐ Yes ☐ No

***If yes*, what type of exam:** ____ X-RAY ____ Cat Scan ____ Ultra Sound ____ MRI ____ PET

Briefly describe why your doctor wants this MRI: _____

_____

_____

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Screening Patients *(cont.)*

All patients must complete the Magnetic Resonance Imaging Information Form* before they have an MRI scan.

* These forms are not currently used at Otsego Memorial Hospital.

Inpatient

1 of 3

MUNSON HEALTHCARE

Form #12254 (06/20)

RN RADIOLOGY MRI CHECKLIST

RN TO COMPLETE WITH PATIENT PRIOR TO MRI

☐ Is the MRI questionnaire filled out and signed by the patient?

☐ Does the patient have any implants?
- o If yes, is the make and model identified?
- o Do you need assistance identifying?

☐ If the patient is in the ER:

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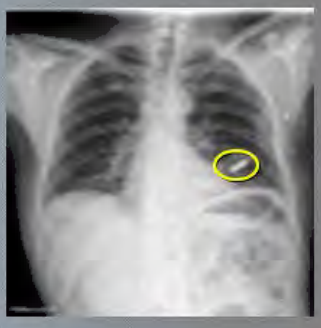
Screening Patients *(cont.)*

Patients with Metallic Foreign Bodies

- All patients with a history of injury by a metallic foreign body must be screened and evaluated before being placed in the magnetic field of an MRI scanner.
- Examples of metallic foreign bodies:
  - ✓ BBs
  - ✓ Bullets
  - ✓ Pellets
  - ✓ Shrapnel
  - ✓ Buckshot
  - ✓ Eye or body metal fragments



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Screening Patients *(cont.)*

Patients with Implants

- Information that must be supplied by the patient, a family member, or by hospital staff for a patient with an implant includes:
  - ✓ Make and model of implant
  - ✓ Manufacturer of implant
  - ✓ Date of implant insertion
- Medical Alert Cards: Most people who get an implant receive a medical alert card stating whether or not the implant is MRI compatible. These cards should be checked by the MRI technologist.

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The MRI Magnet is Always On!

The MRI Magnet is Always On!

The MRI Magnet is Always On!

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Safety Considerations

Zones of Exclusion

Joint Commission standards require Radiology to have four zones of exclusion when performing MRI exams.

Click the buttons to discover the zones.

Reception Desk	Patient Dressing Room	MRI Control Room	MRI Magnet Room
Zone 1: General Public	**Zone 2:** Unscreened MRI patients	**Zone 3:** Screened MRI patients and MRI personnel	**Zone 4:** Screened MRI patients under constant direct supervision or trained MR personnel

Back Exit

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Further Questions? Call Heather Davis, Radiology, ext. 57244

MUNSON HEALTHCARE

Malignant Hyperthermia

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Goals and Objectives

Goals

To assist staff in recognizing signs and symptoms of malignant hyperthermia (MH) to be able to implement treatment options.

To increase awareness of the Malignant Hyperthermia Association of United States (MHAUS).

Objectives

1. List the signs of malignant hyperthermia (MH).
2. State which patients are more conducive to the development of this crisis.
3. Demonstrate knowledge and understanding of administering dantrolene sodium (Ryanodex).
4. Describe management of an MH crisis to include cooling measures, electrolyte imbalances, and dysrhythmias.

Course contains videos - use  or 

What is Malignant Hyperthermia?

MH is a genetically inherited disorder of skeletal muscle that predisposes susceptible individuals to a life-threatening adverse reaction upon exposure to some anesthetic agents.

It leads to a hypermetabolic crisis manifesting as metabolic and respiratory acidosis, tachycardia, cardiac arrhythmias, skeletal muscle rigidity, and heat production.

Although the occurrence of an MH crisis is rare, incidence varies per geographic location which includes Michigan.

Malignant Hyperthermia

While most cases of MH occur during general anesthesia, the one-hour period immediately following surgery (including the recovery room) is also a critical time.

In addition, MH can occur if trigger anesthetics and/or succinylcholine are used in any location, such as EDs, dental surgeries, surgeon's offices, or ICUs.

Malignant Hyperthermia *(cont.)*

Triggers for MH include:

- Inhaled general anesthetics (e.g. desflurane, enflurane, halothane, isoflurane, sevoflurane)
- Succinylcholine
- Exertional heat or exercise (rare)

MH Susceptible Patients

Currently, no simple diagnostic test is available for screening the general public.

Patients with a history of MH, family history, or even possible history are treated as though they are MH susceptible.

Screening:

- Scheduled cases will be screened prior to surgery.
- Emergent cases will be screened prior to induction when patient condition or family presence allows.
- Screening should include family or personal history of MH and/or complications from anesthesia.

Pre-Procedure Prep

During the preprocedural screening, if a patient has been identified as MH susceptible, the following preparation is needed:

- Anesthesia/providers create a detailed plan considering alternative anesthetic agents.
- When possible, schedule the patient as a first case.
- Notify all post-procedure destinations.
- Place the MH cart outside of the procedure room.

Clinical Features

The sequence and timing of clinical manifestations may vary from patient to patient.

- Unexplained tachycardia or arrhythmias (usually ventricular tachycardia and premature ventricular contractions) - **Early Sign**
- Unexplained increase in end-tital carbon dioxide ($EtCO_2$) - **Early Sign**
- Tachypnea or breathing over the ventilator - **Early Sign**
- Sinus tachycardia - **Early Sign**
- Masseter muscle or generalized muscle rigidity - **Early Sign**
- Hyperkalemia - mixed metabolic/respiratory acidosis - **Early Sign**
- Rapidly rising body temperature (hyperthermia) - **Late Sign**
- Myoglobinuria - **Late Sign**
- Rhabdomyolysis - **Late Sign**
- Disseminated intravascular coagulation (DIC) - **Late Sign**

Pediatric patients

- Sinus tachycardia, hypercarbia, rapid temperature increase, and skin mottling; may not see muscle rigidity in pediatrics

Response to an MH Crisis

Please complete the activity before moving on.

If a MH crisis is suspected, immediately take the following steps:
(Click each arrow to view the information.)

- Call/page anesthesia provider STAT if not present.
- Discontinue volatile agents (inhaled general anesthetics and/or Succinylcholine).
- Obtain the MH Cart/Bag and dantrolene (Ryanodex or Dantrium).
- Obtain MH Crisis Checklist from MH Cart/Bag and follow the guidelines on the checklist.
  1. Master copies of hospital specific MH crisis checklists are attached to the MHC PolicyStat - Malignant Hyperthermia Guidelines.
- Contact the Malignant Hyperthermia Association of the United States (MHAUS) for additional support.
- Contact Pharmacy & Phlebotomy to assist, as needed.

MH Initial Treatment

- Hyperventilate with 100% oxygen at flows of 10ml/min.
  - If available, insert activated charcoal filters into the anesthesia breathing circuit.
- Administer initial dose of dantrolene (Ryanodex or Dantrium) 2.5 mg/kg IVP
- Establish large bore IV access (avoid hands), infuse Dextrose 5% (D5W) or 0.9% sodium chloride.
  - Avoid Lactated Ringer's and Normasol, which contain calcium.
- Continue patient monitoring of ECG, pulse oximetry, capnometry, and core body temperature.

MH Crisis Medications

- Dantrolene sodium IV (Ryanodex, Dantrium)
- Preservative-free sterile water for injection (in vials)
- 8.4% sodium bicarbonate
- 10% calcium chloride
- 50% dextrose
- 2% lidocaine (amiodarone is also acceptable)
- Regular insulin, 100 unit/mL (refrigerated)
- Normal saline solution (at least 3,000 mL, refrigerated)
- D5W

Dantrolene Sodium

Dantrolene sodium is available as a solution (Dantrium), or as a suspension (Ryanodex) once reconstituted, for treatment of MH.

Product Comparison

	Dantrium	Ryanodex
Vial strength	Each vial 20 mg	Each vial 250 mg
Reconstitution per vial	60 ml of sterile water preservative free yields 0.33 mg/ml	5 ml of sterile water preservative free yields 50 mg/ml
Time to reconstitute	15-20 minutes for 13 vials	<1 minute for 1 vial
# Vials/per dose	13-18 vials	1-2 vials
Color	**Shaken until solution is clear**	**Uniform orange color**
Dose	**2.5 mg/kg**	**2.5 mg/kg**

You must watch the video to advance.

Dantrolene Sodium (Ryanodex)

Mixing and Administration Instructions:

- Each vial is to be reconstituted with 5 mL of sterile water (NO preservative/NO bacteriostatic agent).
- Mix thoroughly.
- Draw up patient-specific, weight-based dose (2.5 mg/kg).
- Administer IVP into a large bore IV (avoid hand) of 0.9% normal saline or D5W solution; flush line after dose is given.
- Has potential for tissue necrosis with extravasation.

Ryanodex Video

Click here to watch a 4½ minute video on how to mix and administer Ryanodex.

Dantrolene Sodium (Ryanodex) *(cont.)*

Dosing chart is on the MH cart, and also comes with the vial of Ryanodex.

Maximum cumulative dose is 10 mg/kg

DOSAGE SCHEDULE TO TREAT MH

- Based on recommended loading dose of 2.5 mg per kg[1]
- Chart calculated using 250 mg vials of RYANODEX® (dantrolene sodium) for injectable suspension reconstituted with 5 mL of sterile water for injection USP (without a bacteriostatic agent)[2]
- In case of emergency, contact the 24-hour MHAUS Hotline at 800.644.9737

RYANODEX® DOSAGE CHART[3]

Patient's weight in kg	Patient's weight in pounds	Number of 250 mg vials to open	mg dosage needed	mL of reconstituted RYANODEX® to administer
5	11	1	12.5 mg	0.25 mL
10	22	1	25.0 mg	0.50 mL
15	33	1	37.5 mg	0.75 mL
20	44	1	50.0 mg	1.00 mL
25	55	1	62.5 mg	1.25 mL
30	66	1	75.0 mg	1.50 mL
35	77	1	87.5 mg	1.75 mL
40	88	1	100.0 mg	2.00 mL
45	99	1	112.5 mg	2.25 mL
50	110	1	125.0 mg	2.50 mL
55	121	1	137.5 mg	2.75 mL
60	132	1	150.0 mg	3.00 mL
65	143	1	162.5 mg	3.25 mL
70	154	1	175.0 mg	3.50 mL
75	165	1	187.5 mg	3.75 mL
80	176	1	200.0 mg	4.00 mL
85	187	1	212.5 mg	4.25 mL
90	198	1	225.0 mg	4.50 mL
95	209	1	237.5 mg	4.75 mL
100	220	1	250.0 mg	5.00 mL
105	231	2	262.5 mg	5.25 mL
110	242	2	275.0 mg	5.50 mL
115	253	2	287.5 mg	5.75 mL
120	264	2	300.0 mg	6.00 mL
125	275	2	312.5 mg	6.25 mL
130	286	2	325.0 mg	6.50 mL
135	297	2	337.5 mg	6.75 mL
140	308	2	350.0 mg	7.00 mL
145	319	2	362.5 mg	7.25 mL
150	330	2	375.0 mg	7.50 mL

Labeled dose range of 1 to 10 mg/kg with a maximum cumulative dose of 10 mg/kg. If the physiologic and metabolic abnormalities of MH continue, administer additional doses.[1]

Dantrolene Sodium (Ryanodex) Locations

Cadillac
MH Cart

Charlevoix
- MH Cart
- Pharmacy

Grayling
MH Cart

Manistee
MH Cart

Otsego Memorial Hospital
- Anesthesia Pyxis
- ICU Pyxis

Paul Oliver Memorial Hospital
MH Cart

MMC
- 2 vials: OR 2nd floor in the MH Cart
- 2 vials: OB (Recovery Room) Pyxis
- 2 vials: Basement Pharmacy

MH Crisis Checklist

Please refer to your facility-specific MH Crisis Checklist and policy for Malignant Hyperthermia treatment and management.

Web Window

https://mobile.mhc.net/Malignant Hyperthermia Crisis Checklist 2022.pdf

Recommended MH Supplies

Important - Know the location of your hospital's MH supplies.

- Charcoal filters
- Variety of syringes, including (3) 5mL syringes and (3) 60 mL syringes
- IV catheter supplies (large bore)
- Central venous access catheter kits (appropriate sizes for patient population)
- Transducer kits for arterial and central venous catheters
- Arterial blood gas (ABG) kits and syringes (3 mL) for blood gas analysis or point of care monitors
- Pressure bag
- Core temperature probes
- Bucket for ice and cold packs
- Large Steri-Drape™ to cover surgical wound
- Urinary catheter kit
- Urine collection container for myoglobin level
- Small and large plastic bags
- Test strips for urine hemoglobin
- Variety of blood collection tubes

Additional Equipment

- Capnography
- Cooling blanket
- Emergency equipment:
  - Crash cart
  - Defibrillator
  - Intubation supplies
  - Mechanical ventilator
  - Handheld resuscitation bag with mask

MH Supportive Therapy

- Cool patient, as needed, based on body temperature using ice packs to neck, axilla or groin, cooling blankets, chilled intravenous solution, or lavage.
- Obtain lab work, including blood gas.
- Re-dose dantrolene based on patient response.
- Treat respiratory and metabolic acidosis, hyperkalemia, and dysrhythmias, as needed (avoid calcium channel blockers).
- Monitor renal function and treat myoglobinuria, if needed.
- Provider should consider insertion of an arterial line, central venous catheter, and/or a pulmonary artery catheter.

Transferring a MH Suspected or Confirmed Patient

- The anesthesia provider will determine the location to best manage patient care during the acute phase (e.g., inpatient facility Post Anesthesia Care Unit (PACU) or critical care unit).
- Notify house supervisor/admitting for bed placement needs, as applicable.
- The anesthesia provider will arrange the transfer and accompany the patient, as needed.

Post-MH Crisis

- Observe the patient for at least 24 hours on a critical care unit.
- Monitor ABGs, electrolytes, calcium, clotting studies, myoglobin, urine output and color, and other studies as ordered.
- Key indicators of stability include:
  - $EtCO_2$ is declining or normal
  - Heart rate is stable
  - Hyperthermia is resolving
  - Generalized muscle rigidity has resolved
  - Restock MH cart or bag
- Ensure additional vials of dantrolene (Ryanodex or Dantrium) are readily available.

Post-MH Crisis Complications

- Dantrolene sodium (Ryanodex) is associated with flushing, drowsiness, voice disorders, dysphagia, and nausea.
  - Symptoms may persist up to 48 hours post-dose.
- Rhabdomyolysis
  - Urine becomes cola-colored (dark red or brown).
  - Patient may c/o muscle pain.
  - **Immediately** notify attending provider and anesthesia provider.
- Paralysis, blindness, renal failure, reoccurrence of syndrome, muscle weakness, multi-organ failure, and/or death
  - Patients should not ambulate without assistance until normal strength and balance has returned.
- Obstetrical cases
  - Dantrolene sodium (Ryanodex) readily crosses placenta - may lead to side effects in unborn child.
  - Notify the obstetrician and pediatrician of dantrolene sodium (Ryanodex) administration.

Documentation and Reporting

A. Notify the unit manager and director of the event.
B. Document event on unit-based patient care records (EMR).
C. Complete a facility occurrence report (e.g., VOICE) under "adverse medication event".
D. Anesthesia Services should review each case and consider contributing information to the MHAUS.

MH Guidelines

Web Window

https://munsonhealthcare-all.policystat.com/policy/14063752/latest

Malignant Hyperthermia Association of the United States (MHAUS)

Mission: To promote optimum care and scientific understanding of MH and related disorders.

The MHAUS Association provides:

- Resources for healthcare professionals
  - Education and research
- Patient/family teaching re: MH precautions, susceptibility, and testing centers

Visit **http://www.mhaus.org** for healthcare provider and public education materials.

For support during an MH crisis,

call the 24-hour **MH Hotline**

1-800-644-9737

References

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MUNSON MEDICAL CENTER
MUNSON HEALTHCARE

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Owner	Brendan Franklin: Dir Nursing Critical Care & Stroke
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Applicability	MMC
Tags	Policy

Critical Care Standards

Purpose

To provide a standard for nursing care in the critical care patient population and enhance coordination of care among the healthcare team.

Scope

Critically ill patients receiving care in A2, A3, and the Intensive Care Unit (ICU).

Policy

A. All Registered Nurses (RN) are prepared to:
   1. Utilize corresponding policies and procedures to implement nursing process for patient care.
   2. Respond to urgent and emergent situations.
   3. Perform specialized nursing procedures specific to critically ill patient needs.
   4. Administer care and specialized interventions in the critically ill patient population.
   5. Document care and specialized interventions.

B. Nursing care of critically ill patients in critical care units includes:
   1. Systems Assessments:
      a. Perform and document head-to-toe assessment every 4 hours, unless the patient's condition or physician order indicates alternative frequency.
      b. Including the following:

i. Recent and relevant events and patient outcomes.

ii. Device use, care and management and patient tolerance.

iii. Wound/skin care and management.

iv. Pain assessment and documentation unless patient condition requires a greater frequency. Pain reassessment will occur after treatment (per the Pain Management policy).

v. All individualized care needs for the critically ill patient.

2. Lines/Tubes/Devices
    a. Assessment is completed and documented every four hours including type, station, and status.

3. Vital signs:
    a. Blood pressure, heart rate, respiratory rate, and pulse oximetry with oxygen delivery method are monitored and recorded hourly, unless otherwise ordered or the patient's condition indicates alternative frequency.
    b. When titrating medications, vital signs are documented according to medication order titration guidelines.
    c. Temperatures are recorded at a minimum of every 4 hours unless otherwise ordered or the patient's condition indicates alternative frequency. Temperatures are recorded hourly when warming or cooling measures are used.
        i. All patients with abnormal temperatures are assessed for potential complications related to hypothermia or hyperthermia.
        ii. RN may initiate warm blankets, commercial warming devices, and/or fluid warmer on any patient with a rectal or core temperature of less than 35.6°C. Provider must be notified.
        iii. RN may initiate cooling blankets on any patient with a rectal or core temperature of greater than 38°C if antipyretics and other means of external cooling have been ineffective. Provider must be notified.
        iv. The fluid warmer may be used for any patient with a rectal or core temperature of less than 35.6°C.

4. Hemodynamic monitoring:
    a. Electrocardiogram (ECG) monitoring is established upon arrival and maintained throughout hospitalization.
    b. Invasive line pressures are documented every hour unless otherwise ordered or the patient's condition indicates alternative frequency. This includes but is not limited to: arterial blood pressure (ABP), central venous pressure (CVP), pulmonary artery pressure (PAP), pulmonary capillary wedge pressure (PCWP), Intracranial pressure (ICP), cerebral perfusion pressure (CPP).

c. Arterial lines and pulmonary artery catheters must always be transduced. Exception: during magnetic resonance imaging (MRI) testing.

d. Transport monitoring: Minimum transport monitoring of critical care patients will include continuous ECG, blood pressure, and oxygen saturation monitoring. Arterial lines and pulmonary artery catheters must always be transduced, even during transport. Additional monitoring may be held or continued during transport.

5. Respiratory:
    a. Airway or endotracheal tube (ETT) station is documented every four hours.
    b. ETT is repositioned every four hours and prn in collaboration with Respiratory Therapy (RT).
    c. An RN may extubate a patient upon a physician's order or per protocol, with RT at the bedside.
6. Fluid volume status and intake & output (I&O):
    a. Patients require strict hourly I&O with daily weights unless otherwise ordered or the patient's condition indicates alternative frequency.
7. Nutrition:
    a. The goal is to start nutrition within 24 hours of admission, based on patient condition. Diet/nutrition is monitored daily, including type of nutrition, source and patient tolerance. RN may initiate dietary consult as needed.

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Approval Signatures

Step Description	Approver	Date
System Policy Oversight Committee	Terri Fries: Document Mgmt Spec	11/7/2025
CNO	Tamara Putney: VP and CNO Patient Care Services	11/7/2025
Mgr Nursing Services	Amber Bowers: Mgr Nursing Services	11/5/2025
Document Owner	Brendan Franklin: Dir Nursing Critical Care & Stroke	11/5/2025

Applicability

Munson Medical Center

Standards

No standards are associated with this document

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MUNSON MEDICAL CENTER
MUNSON HEALTHCARE

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Cardiac Telemetry Monitoring

Purpose

To enhance patient safety and clinical consistency by outlining continuous cardiac monitoring guidelines, arrhythmia detections and overall alarm management.

Definitions

1. **Cardiac Monitoring/Telemetry Monitoring:** Continuous cardiac rhythm display at the bedside and/or transmitted to a central monitoring console that can provide alarms or print/save rhythm strips.
2. **Telemetry Technician:** Licensed or unlicensed staff member with training and competency in electrocardiogram (ECG) rhythm interpretation.
3. **Telemetry Observer:** An individual assigned to listen for and/or observe specific visual cues with the intention of escalating information to a resource trained to assess and/or intervene in a specific situation.

Policy

A. An order is needed to initiate and discontinue cardiac monitoring. Orders should specify any parameters and any circumstances in which the patient can be temporarily or permanently removed from monitoring.

B. When initiating cardiac monitoring, the following identifiers are used:
    1. 10-digit account number
    2. Last Name, First Name (NOTE: This will automatically pull through ADT feed if 10-digit account number is entered correctly)

C. The Registered Nurse (RN) is responsible to:

1. Initiate and maintain continuous monitoring and to perform initial review and adjustment of settings and alarm parameters.
2. Regularly review and interpret cardiac rhythm and document findings in the chart.
3. Assess need for continued cardiac monitoring daily, using provider orders or protocol, where applicable.
4. Report clinically relevant abnormalities identified on review or by alarm/event review to the provider. Abnormalities include but are not limited to:
    a. Any new dysrhythmia (i.e., tachy or brady arrhythmia exceeding alarm)
    b. Heart block
    c. New atrial fibrillation or flutter or inadequate rate control of these rhythms
    d. Ventricular tachycardia/fibrillation
    e. Supra-ventricular tachycardia
    f. Any symptomatic patient with a dysrhythmia
    g. Any dysrhythmia requiring immediate treatment
5. Initiate code response or other facility specific rapid response protocols or appropriate emergency interventions
6. The RN may delegate tasks to appropriately trained support personnel. These may include, but are not limited to: equipment preparation, skin preparation, electrode application/reapplication, application of monitoring equipment.

D. Where present, telemetry technicians may review and adjust specific settings and alarm parameters and may interpret cardiac rhythms, complete specific documentation, and shall report abnormalities to the RN.

1. The technician will monitor each telemetry unit for ventricular tachycardia, ventricular fibrillation, asystole, tachycardia and bradycardia, low battery and lack of rhythm. The telemetry technician will contact the nurse with findings.
2. A telemetry log may be kept on each unit with pertinent info such as the patient's name, dominant rhythm, assigned nurse and the direct phone number(s) for the assigned care team.

E. A telemetry technician and/or any RN not directly responsible for the patient's care who observes events or responds to alarms at the bedside or central monitoring station will notify the primary nurse of any changes in the patient's condition, monitor settings, or alarm parameters.

F. Where present, telemetry observers are identified 24 hours a day. The telemetry observer may perform other clerical duties that do not remove them from direct view or audio of the monitor. The observer will arrange for another trained observer or nurse to fill the role temporarily if needed for breaks or to perform other job duties away from the area.

G. Any support personnel should consult with/notify the appropriate individual (eg., telemetry observer or technician, RN, etc.) prior to removing a patient from monitoring for showering,

procedures/testing or discharge.

Electrode and Lead Placement, Battery Replacement

A. Electrodes are applied according to Lippincott Procedures - Cardiac monitoring (lww.com) instructions found online. Electrodes shall be changed daily and as needed (PRN) or in accordance with manufacturer recommendations.

B. Lead placement should be confirmed at the beginning of each shift, along with verification the monitor / transmitter is functioning properly and that suitable battery life remains.

C. Battery change should occur minimally when "low battery" signal appears, or with approximately 25% battery life remaining.

Lead Selection

A. Lead II is generally selected as the standard monitoring lead.

B. For a standard 5 lead system, V1 is commonly selected as the second lead. An alternate lead may be selected based on which provides a clearer trace, more prominent or upright waves, or by which a particular area of the heart can be better monitored.

Cleaning

A. Upon discontinuation of telemetry monitoring, the telemetry unit and electrodes are cleaned per manufacturer instructions.

Cardiac Rhythm Waveforms and Documentation

A. A rhythm strip will be measured, interpreted, and documented per the following guidelines:

1. Rhythm interpretation is ongoing and documented as part of the nursing assessment
2. Inpatient care (critical, intermediate, or telemetry care departments) at admission, each shift with initial RN assessment, and with any significant change in rhythm or significant symptoms
3. Emergency Department (ED) at admission and with any life-threatening rhythms or significant changes in patient condition
4. Rhythm waveform documentation should include the name of identified rhythm, heart rate, PR/QRS/QT intervals where applicable, and the name of the RN or Telemetry Technician performing the documentation.

Monitoring Guidelines

A. HR alarms will be set appropriately to the patient's baseline HR, rhythm, clinical condition or treatment plan by an RN or Telemetry Technician.

B. If a monitored patient has a pacemaker, the pacemaker detection function of the cardiac monitor must be turned ON

Refer to Munson Healthcare (MHC) entity specific intravenous (IV) Medication Guidelines and/or consult with pharmacy for information related to risk of prolonged QT interval and for IV medication administration and required monitoring.

C. QT interval monitoring functions of the cardiac monitors may be utilized by the RN/Tele Tech as an adjunct to patient / rhythm assessment. A patient with a baseline prolonged QT or on a medication that has the potential of prolonging the QT interval may have orders for more frequent QT measurements.

D. ST segment monitoring and ST mapping functions of the cardiac monitors may be utilized by the RN/Tele Tech as an adjunct to patient assessment. (Note: some clinical conditions make it difficult to achieve accurate ST monitoring i.e., atrial fib or flutter with an irregular baseline, ventricular pacing, left bundle branch block. Consider turning ST monitoring off in these conditions).

E. Silencing Alarms:

    1. A trained telemetry observer or technician or a registered nurse may silence clearly erratic/false alarms such as those caused by motion or artifact while requesting evaluation by clinical personnel.
    2. A lethal rhythm alarm may be silenced by a Telemetry Technician or RN after the RN evaluates the rhythm and/or patient condition.

Alarm Settings and Clinical Management

A. The Clinical Engineering department has oversight for the testing and maintenance of clinical devices to ensure accurate settings, proper operation, and detectability of alarms.

B. Monitor settings are configured according to manufacturer recommendations to enhance patient safety. A copy of all configuration settings is maintained by the Clinical Engineering department. These settings may only be changed with approval of the Cardiac Monitoring Steering Committee or the Cardiac Monitoring Alarm Committee, with the endorsement of the Clinical Leadership Council.

C. Arrhythmia monitoring will be on and audible for all monitored patients, with the exception of patients who are receiving end of life care, where death is anticipated and an order for comfort care is present.

D. Alarm volume should be set audibly so that nursing staff is able to hear and respond appropriately to non-critical and critical alarms. It is the responsibility of the bedside nurses, the unit coordinator, and other clinical staff to maintain the appropriate alarm volume which decreases noise pollution for patients and visitors, while ensuring prompt staff notification of alarm situations.

E. Select alarm parameters are unlocked and able to be adjusted on an individual basis by the RN, Telemetry Technician, or other licensed clinician within their scope of service.

F. All monitor alarm settings should be adjusted to reflect patient or condition specific values and should be reviewed and adjusted (if indicated) at admission, each shift, and as needed by the RN and/or Telemetry Technician.

    1. The nursing staff member will determine the appropriate response to the alarm; however, the nurse is responsible to confirm findings, verify patterns, and evaluate

interpretations through patient assessment. The response to an alarm may include but is not limited to silencing the alarm, recording the strip, and/or initiating emergency interventions.

2. In the event of a Code Blue or Cardioversion, an event strip will be documented containing the initiation of the event and documentation of changes in rhythm continuing through termination of efforts. As an alternative, a strip from the defibrillator may be used to record the events of the Code Blue.

G. Patient care staff are familiar with alarm settings, policies and procedures.

Transfer/Discharge Procedure

A. At the time of transfer/discharge, the patient MUST be discharged from the bedside and/or central monitoring console, and when applicable, have their encounter be dissociated from the electronic health record (EHR).

B. Refer to manufacturer instructions for use for specific steps to transfer or discharge patient.

Transport Monitoring

A. An RN (or in some cases, a paramedic) shall accompany the patient for transport if the patient is in critical condition, hemodynamically unstable and/or on continuous vasoactive infusions.

B. Other monitored patients transported by unlicensed staff will be monitored remotely by the telemetry technician, telemetry observer, or RN. A portable phone will be assigned and in the possession of the staff member closest to/responsible for the patient at all times. Monitoring staff will use this phone to communicate emergency conditions and request immediate assistance for the patient.

Reference

1. Wiegand, D. L. (Ed.). (2017). AACN Procedure Manual for High Acuity, Progressive, and Critical Care (7th ed., pp. 467-476). St. Louis, MO: Elsevier.

Keywords

Cardiac, Telemetry, Monitoring, Tele Tech

Approval Signatures

Step Description	Approver	Date
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Document Owner	Jennifer Standfest: CNO [AM]	6/2/2025

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Cadillac Hospital, Charlevoix Hospital, Grayling Hospital, Munson Medical Center, Otsego Memorial Hospital

Standards

No standards are associated with this document

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MUNSON MEDICAL CENTER
MUNSON HEALTHCARE

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Stroke Care

Purpose

To provide a process for stroke care.

Background

The vision of the stroke care program is to reduce the incidence of stroke in Northern Michigan through public education and to optimize quality outcomes through collaboration and innovation.

The mission of the stroke program at Munson Medical Center (MMC) is to deliver the best evidence-based care to the patient with a stroke according to the guidelines established by the American Stroke Association.

Scope

The scope of the services is for patients who are 18 years of age and older presenting to the Emergency Department (ED) with acute stroke-like symptoms within 24 hours of last known well. Patients with acute stroke symptoms who arrive within 4.5 hours of last known well are considered for thrombolytic. Patients presenting with acute stroke symptoms with a last known well of 24 hours or less may be considered for neurointervention.

Policy

Stroke Team

A. **Core stroke team members**: The role and responsibilities of these members are to oversee the stroke program, this includes program compliance with evidence-based practice guidelines for

stroke and close monitoring of stroke metrics for process improvement opportunities with reporting to the Stroke Interdisciplinary Team.

1. ED Medical Director
2. Medical Director of the Stroke Program
3. Director of the Endovascular Stroke Program
4. Neurocritical Care Lead Provider
5. Stroke Program Lead Advanced Practice Provider
6. Nursing Director Critical Care and Stroke
7. Stroke Program Manager
8. Stroke Program Clinical Coordinator

B. **Acute Stroke Team members**: If a patient has an apparent stroke and symptom onset is less than 24 hours, the triage or ED charge nurse will notify the stroke team members by the use of the Stroke Protocol Burst Page.

1. ED physicians
2. ED charge registered nurse (RN)
3. ED staff nurses

C. **Ad hoc stroke team member**:

1. Stroke Neurology
2. Neuro-interventionalist on call.
3. Neurosurgery Advanced Practice Provider (APP) working with the Neuro-interventionalist

Procedure

Triage ED Nurse

A. The triage nurse will identify patients with focal neurological complaints with an onset of less than twenty-four CT hours and complete a focused neurological examination.

1. Subjective focal neurological complaints include:
    a. Aphasia
    b. Ataxia
    c. Cranial nerve palsy
    d. Dysarthria
    e. Diplopia
    f. Hemiparesis
    g. Sensory loss
    h. Visual field deficits

2. Alternatively, the ED charge nurse may be alerted by Emergency Medical Services (EMS) about an incoming patient with focal neurological complaints.

Initial Management

A. The patient is quickly assessed by a provider.

B. Routine orders may be initiated by nursing staff:

1. Complete vital signs, Pulse Oximetry
2. Peripheral intravenous (IV), oxygen, cardiac monitor
3. Bedside glucose
4. Labs: complete blood count (CBC) with diff, prothrombin time (PT)/partial thromboplastin time (PTT), basic metabolic, international normalized ratio (INR), Troponins, Magnesium Level, Phosphorus, Hepatic function, fibrinogen level, Urinalysis, Pregnancy test (serum) if female is of childbearing age
5. Electrocardiogram (EKG)

C. Patients should remain on strict no orals (NPO) while in the ED unless they successfully pass the bedside swallowing screen completed by the nursing staff. The nursing staff will document the results of the screening. This should be done for all stroke and suspect stroke patients.

D. If indicated, nasogastric (NG) tubes, urinary (Foley) catheters, and arterial lines should be placed before thrombolytic administration.

E. Evaluation will be performed by an ED provider including history, physical, and neurological exam. The National Institute of Health Stroke Scale (NIHSS) will be completed. Evaluation will be facilitated by using the "Stroke Protocol Resource Packet" located in designated areas. The stroke packet consists of an Inclusion/Exclusion Thrombolytic Checklist, Stroke Candidate Process Flow, NIHSS Documentation, Swallow Screen, Stroke Alert Nurse Checklist, Talking Points for Stroke/Thrombolytic for Acute Stroke Patient Fact Sheet, stroke neuro checklist and vital sign documentation flow sheet.

F. Blood pressure (BP) management before thrombolytic;

1. If a potential candidate for thrombolytic has a systolic BP greater than 180 or a diastolic BP greater than 105 for more than two or more readings 5-10 minutes apart, the medical management will be found in the ED Stroke PowerPlan or the Stroke MRT PowerPlan.
2. If one of these does not bring the systolic BP less than or equal to 185, and the diastolic BP less than or equal to 110, the patient will no longer be considered a thrombolytic candidate.
3. Post Thrombolytic BP management may include Vasopressors (see attached guideline) when ordered. BP parameters post thrombolytic less than 180mmHg systolic for the first 24 hours after administration of thrombolytic.

G. For ischemic stroke patients who will not receive thrombolytic:

1. BP treatment should be withheld unless systolic BP is greater than 220 mmHg or

diastolic BP is greater than 120 mmHg, as long as there are no concomitant medical conditions requiring treatment (e.g. aortic dissection)

2. BP management may include vasopressors when ordered. (See attached guideline.)

Imaging

A. A non-contrast head Computed Tomography (CT) scan should be performed within 20 minutes of arrival at the ED. As soon as the patient is identified as a potential thrombolytic and or thrombectomy candidate the physician or nursing staff will notify the charge nurse. The clerk will convey this information to the CT radiology department for CT scanning by the Burst Page and/or ED PowerPlan.

B. The head CT should be read by a qualified radiologist within 35 minutes of the patient's arrival.

C. CT angiogram imaging will be performed on patients presenting with acute stroke symptoms with a last known well of less than 24 hours.

D. CT Perfusion imaging will be completed on those patients presenting with acute stroke symptoms with a last known well of less than 24 hours.

Endovascular Intervention

A. If the patient has a last known well time of less than 24 hours and Computed Tomography Angiography (CTA)/Computed Tomography Perfusion (CTP) suspicious for large vessel occlusion (LVO) consultation with the Neuro-interventionalist takes place.

B. A decision is made by the neuro-interventionalist for potential endovascular intervention candidacy. The ED provider and/or the Neurosurgical APP relay pertinent information to the neuro-interventionalist.

C. Once a decision is made for intervention an Interventional Radiology (IR) Stroke page is called notifying the IR team of a patient in the ED or nursing unit.

D. Written consent is obtained. The consent contains the risks and benefits of intervention.

E. Hand-off is completed between IR and ED.

F. Post procedure the patient is admitted to the Intensive Care Unit (ICU).

G. Monitoring post procedure:

1. Vital signs will be obtained and recorded every 15 minutes for 2 hours, then every 30 minutes for 6 hours, then every hour for 16 hours.
2. Swallow screen: This will be performed before any oral intake.
3. Neurological checks: These will be performed and documented by nursing staff using the Stroke Protocol Packet (6910). Neurological checks will be completed with the same frequency as vital signs as indicated above.
4. The patient will be observed for signs of intracerebral hemorrhage (ICH), including neurological worsening, decreasing mental status, acute hypertension, nausea, vomiting, diaphoresis, or new headache.
5. The patient will require an ICU bed.

Determining Candidacy for Thrombolytic

A. The emergency physician will review all labs and EKG and repeat a brief neurological assessment. Findings are reviewed with the patient and family members.

B. The Inclusion/Exclusion Checklist is completed by the physician for eligible candidates.

C. ***Obtaining consent***

1. The potential benefits and risks of thrombolytic therapy will be discussed with the patient and family members. The risk of ICH and other bleeding will be specifically discussed. Documentation of the discussion and the final decision of the patient/ family are adequate and written consent is not necessary.

D. ***Administration of Thrombolytic***

1. In appropriate patients, the goal is tenecteplase administration within 45 minutes of arrival. The thrombolytic will be obtained and mixed by the pharmacist according to the manufacturer's instructions. Actual weight will be obtained when possible.
    a. A peripheral IV should be placed before tenecteplase administration; preferably an 18 gauge in the antecubital.
    b. Type and screen should be sent to all patients receiving thrombolytic.
    c. Patient should be on bed rest except for assisted use of the bedside commode 24 hours after infusion.
    d. No IM injections for 24 hours after administration
    e. If a subcutaneous injection is prescribed (e.g. insulin), pressure should be held at the site for 10 minutes.
    f. Medications: Withhold any anticoagulant or drugs that have a predominant effect on platelets.
2. Following thrombolytic administration, no nasogastric tube, foley catheter, or invasive lines/procedures for 24 hours unless clinically indicated.

E. ***Monitoring during and after thrombolytic administration***

1. **Vital signs**
    a. BP will be obtained and recorded every 15 minutes for 2 hours, then every 30 minutes for 6 hours, then every hour for 16 hours.
    b. The physician will be notified immediately if systolic BP is greater than 180 or less than 120, diastolic BP is greater than 100 or less than 60, HR is greater than 120 or less than 50, or respiratory rate is greater than 24.
2. **Swallow screen**: This will be performed before any oral intake.
3. **Neurological checks**: These will be performed and documented by nursing staff using the thrombolytic flow sheet. Neurological checks will be done with the same frequency as vital signs as indicated above.
4. The patient will also be observed for **signs of ICH**, including neurologic worsening, decreasing mental status, acute hypertension, nausea, vomiting, diaphoresis, or new

headache.

5. The patient will be observed for other **signs of bleeding and adverse drug reactions**: gingival oozing, ecchymosis, petechiae, bleeding at IV or arterial puncture sites, abdominal/flank pain, hemoptysis, hematemesis, shortness of breath (SOB)/rales/ rhonchi, arrhythmias, or anaphylaxis (angioedema).
6. The patient will require an ICU bed.
7. The thrombolytic flow sheet will be handed off to the receiving unit.

F. ***BP management after thrombolytic administration***

1. BP **should** be maintained at systolic BP less than 180mmHg, diastolic BP less than 105mmHg
    a. **If systolic BP greater than 180 or diastolic BP greater than 105 mmHg follow the medical management in the ED Stroke PowerPlan or Stroke MRT PowerPlan.**
    b. **If diastolic BP is greater than 140 for two or more readings 5 -10 minutes apart follow the medical management in the ED Stroke PowerPlan or Stroke MRT PowerPlan.**

G. ***Management of bleeding complications***

1. For active bleeding from arterial or venous puncture sites, apply direct mechanical pressure.
2. For any suspected severe or life-threatening hemorrhage, immediately notify the provider.
3. **For suspected ICH (decreasing level of consciousness (LOC), neurological worsening, acute hypertension, nausea, vomiting, or new headache):**
    a. Obtain immediate CT head
    b. Redraw STAT labs: type and cross (if not already drawn), PT, PTT, platelet count, and fibrinogen.
    c. Arrange for cryoprecipitate from the blood bank.
4. **If ICH present:**
    a. Consider giving cryoprecipitate.
    b. Consult Neurosurgery
    c. Consider Hematology consult
    d. Consider serial head CT to assess progress
5. For severe non-neurological hemorrhage, obtain appropriate imaging, correct thrombolytic state, and obtain appropriate medical or surgical consult.

H. ***Disposition***

1. Patients who have received thrombolytic will be admitted to an ICU bed.
2. Hemodynamically unstable patients will be admitted to an ICU bed.

3. All other acute stroke patients, other than those patients who are admitted with palliative care, will be admitted to a monitored bed preferably on A7.

I. ***Monitoring of Thrombolytic Data***

1. Meetings to review thrombolytic cases are scheduled.
2. Team members include Stroke Neurology, ED Physician Champion, Stroke Program Manager, Stroke Coordinator, ED Manager, ED Educator, EMS, and others as appropriate.
3. The team reviews and discusses cases with designated follow-up to practitioners who were involved in the care.

Hemorrhagic Stroke

A. If non-traumatic hemorrhagic stroke is suspected, initial management is similar to acute ischemic stroke: IV access, oxygen, cardiac monitor, and labs (CBC, PT/PTT), with Type & Screen sent on all anticoagulated patients. Physician assessment and CT head should be performed with the same urgency (i.e. within 20 min arrival) as non-hemorrhagic stroke.

B. Patients on anticoagulation or anti-platelet agents, see the Emergent Reversal of Anticoagulated Patients Protocol.

C. ***BP control***

1. Patients presenting with a systolic BP of 150 to 220 mmHG, acute lowering of systolic BP to 140 mmHG is safe. Goal blood pressure recommendations per Stroke Neurology, Neurocritical Care and or Neurosurgery service.

D. ***Swallow Screen***

1. Patients should remain on strict NPO while in the ED unless they successfully pass the bedside swallowing screen which is completed by the nursing staff. The nursing staff will document the results of the screening. This should be done for all stroke and suspect stroke patients.

E. ***Neurosurgery consultation***

1. Any surgical management, intracranial pressure monitoring, and further medication management will be based on neurosurgery recommendations.

F. ***Neurocritical Care consultation***

1. Provide recommendations for care and treatment as needed.

G. ***Monitoring***

1. Assess for electrolyte abnormalities, seizures, vasospasms, and signs of neurological change.
2. Consider repeat CT scans to monitor ongoing bleeding and other complications.

H. ***Disposition***

1. Patients with hemorrhagic stroke will be admitted to the ICU or A7 Stroke Unit unless palliative care/end-of-life is requested by the family or patient advocate.

2. For patients with a new hemorrhagic stroke that is felt to be of aneurysmal origin (i.e. subarachnoid hemorrhage [SAH]) the Neuro-interventionalist on call will be consulted.

Document ID: 070.G027

Attachments

Inpatient ICH Process.docx

Vasopressor in AIS protocol Final.docx

Approval Signatures

Step Description	Approver	Date
System Policy Oversight Committee	Terri Fries: Document Mgmt Spec	11/12/2025
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Applicability

Munson Medical Center

Standards

No standards are associated with this document

Status Active PolicyStat ID 15373418

MUNSON MEDICAL CENTER
MUNSON HEALTHCARE

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Applicability	MMC
Tags	Procedure

Thrombolysis for Acute Ischemic Stroke

Purpose

To provide a process for Thrombolysis (Tenecteplase or Alteplase) for Acute Ischemic Stroke (AIS). Tenecteplase is the preferred thrombolytic for AIS for Munson Healthcare (MHC) facilities. However, since Munson Medical Center (MMC) is a Joint Commission (JC) recognized Comprehensive Stroke Center; it is a requirement to be able to offer Alteplase to patients who refuse Tenecteplase due to its current off label use. Genentech, the manufacture of both thrombolytics, has recently filed for Food and Drug Administration (FDA) approval of Tenecteplase for AIS and tentatively expects approval by end of 2024.

Procedure

All pharmacists are responsible for understanding the steps needed to administer Tenecteplase OR Alteplase at the bedside.

A. **Emergency Department (ED) Procedure**

1. The ED pharmacist is alerted by an overhead burst page. If the ED pharmacist is not available, the Pharmacy will send a pharmacist to ED to assist.
2. The ED pharmacist will be present during the initial patient assessment, follow the patient to the Computed Tomography (CT) scan if clinically indicated and work closely with the ED physician to begin mixing the Tenecteplase or Alteplase if the patient meets criteria and is consenting to treatment.
3. ED patients will receive Alteplase administration in the ED.

B. **Inpatient Pharmacy Department Procedure**

1. Pharmacy staff will be notified of a Stroke Medical Response Team (MRT) via the

hospital paging system.

2. The Intensive Care Unit (ICU) Pharmacist will respond to all Stroke MRTs Monday – Friday
3. When a pharmacist is unable to immediately respond to the bedside the pharmacist will communicate with the charge registered nurse (RN) to obtain pertinent patient information [name, weight, medical record number (MRN)] and remain in contact with the team until Alteplase eligibility is determined.
4. Inpatients must be transferred to the ICU after Tenecteplase or Alteplase administration. The pharmacist will communicate with the ICU charge nurse to determine the patient's location for Tenecteplase or Alteplase preparation and administration.

C. **Decision to Administer**

1. The pharmacist will be directed by the medical team provider(s) during the initial response whether or not the patient meets criteria for Tenecteplase or Alteplase administration. A STAT CT of the head will be performed to rule out a hemorrhagic stroke, the pharmacist may follow the patient to CT if clinically indicated. If the patient meets criteria for Tenecteplase or Alteplase and the patient is consenting to treatment the pharmacist will prepare Tenecteplase or Alteplase for administration at the bedside as directed by the provider.
2. Obtain the Tenecteplase or Alteplase kit from the pharmacist code blue bag.

D. **Dosing**

1. Tenecteplase
    a. 0.25mg/kg (ABW) IVPush over 5 second. Max dose of 25mg
2. Alteplase
    a. Both bolus and infusion are based on patient weight; it will be very important for the pharmacist to verify the patient's **actual** body weight during the stroke MRT for accurate dosing.
        i. The total dose equals 0.9mg/kg (maximum dose = 90mg)
        ii. 10% of the total administered as an intravenous (IV) Push bolus over one minute
        iii. 90% administered as a continuous infusion over 60 minutes (i.e. 0.09mg/kg IV push followed by 0.81mg/kg continuous infusion over 60 minutes)

E. **Reconstitution**

1. Tenecteplase
    a. Remove the shield assembly from the supplied B-D® 10 mL syringe with TwinPak™ Dual Cannula Device. **NOTE: Do not discard the shield assembly.**
    b. Aseptically withdraw 10 mL of Sterile Water for Injection, USP, from the

supplied diluent vial using the red hub cannula syringe filling device. Only use the supplied Sterile Water for Injection, USP for reconstitution.

c. Aseptically reconstitute the vial with 10 mL Sterile Water for Injection, USP by directing the stream into the lyophilized powder to obtain a final concentration of 5 mg/mL. Slight foaming upon reconstitution is not unusual; any large bubbles will dissipate if the product is allowed to stand undisturbed for several minutes.

d. GENTLY SWIRL until contents are completely dissolved. DO NOT SHAKE. Solution should be colorless or pale yellow and transparent. Once the appropriate dose of Tenecteplase is drawn into the syringe, stand the shield vertically on a flat surface (with green side down) and recap the red tab cannula.

e. Because Tenecteplase contains no antibacterial preservatives, reconstitute immediately before use. If not used immediately, refrigerate solution at 2-8°C (35-46°F) and use within 8 hours. DO NOT FREEZE. Final concentration of Tenecteplase is 5 mg/mL.

2. Alteplase

a. Using aseptic technique, remove the flip-caps from the Alteplase and Sterile Water for Injection, USP (SWFI) vials and swab with alcohol.

b. Open the package containing the transfer device by peeling the paper label off, remove the protective cap from one end of the device and insert into the upright vial of SWFI, DO NOT INVERT, but remove the protective cap from the other end of the device.

c. Position the Alteplase vial upside-down over the exposed piercing pin so that the center of the stopper is directly over the piercing pin and push the vial of Alteplase onto the piercing pin.

d. Invert the two vials so that the Alteplase is on the bottom (upright) and allow the SWFI to flow into the Alteplase bottle until empty (this will take about two minutes). Remove the transfer device from the Alteplase and empty SWFI vial and GENTLY SWIRL the Alteplase (DO NOT SHAKE) until dissolved.

e. Genetech Video for Dosing and Reconstitution of Alteplase www.activase.com/ais/dosing-and-administration/reconstituting.html (Video is located on the right-hand side of the website)

f. **Alteplase Waste**

i. Draw the waste from the vial first and place in purple waste bin. This reduces the risk of over administration.

g. **Alteplase Bolus Dose**

i. Draw the amount of the bolus dose (obtained from the chart) into a syringe WITHOUT FILTERING and attach the appropriate label or utilize the blank label in the kit. Bolus dose must be given immediately before the infusion, therefore prepare both at

the same time.

F. **NOTE: Tenecteplase and Alteplase CANNOT BE TUBED**

G. **Prior to Administration**

1. Prior to administration of Tenecteplase or Alteplase a 'timeout' will occur and the decision to administer a thrombolytic will be confirmed with the ordering provider.
2. Once the decision to give Alteplase has been verified the trained pharmacist, nurse or ED provider will begin administering the medication.

H. **Administration**

1. Tenecteplase
    a. Determine the correct dose of Tenecteplase based on patient weight. Tenecteplase is for IV administration only.
    b. WITHDRAW the appropriate volume of solution based on patient weight. **The recommended total dose should not exceed 25 mg.** Discard solution remaining in the vial.
    c. Tenecteplase is incompatible with dextrose containing solutions. When used together, precipitation may occur.
    d. FLUSH a dextrose-containing line with a saline-containing solution prior to and following administration (precipitation may occur when Tenecteplase is administered in an IV line containing dextrose). ADMINISTER as an IV BOLUS over 5 seconds.
2. Alteplase
    a. Prime the Primary Plum set 103 inch tubing (Order no 14687-28), "blue to shoe" and "one drip flip" (see intranet site for educational video and one page tip document). **Remember to open the vent for glass bottles AFTER filling the drip chamber.**
    b. If you haven't withdrawn the bolus dose and waste from the vial (see F and G above), the following steps are for withdrawing from the tubing:
        i. "Scrub the hub" CLAVE secondary port (near the pumping chamber) using alcohol swab, attach 10 or 20 mL syringe, and withdraw the calculated bolus dose. (Ensure there is no air in the syringe when attaching to the port). Label and hand to person administering bolus dose.
        ii. "Scrub the hub" CLAVE secondary port using alcohol swab, then attach appropriate size syringe and withdraw the calculated waste. Discard in purple pharmaceutical waste container.
    c. Insert tubing into the Plum 360 pump, selected Critical Care/Tele CCA, select Line A, and select "alteplase-Stroke". Program the calculated infusion dose to infuse over 1 hour.
    d. After close to an hour when the alteplase container and drip chamber are empty and air is just getting to the pumping chamber, attach an empty 10

mL syringe to the Clave Y-site (after disinfecting). Remove spike from alteplase container and spike a normal saline bag. Close the vent. Squeeze drip chamber to fill to the fill line.

e. Use the back-prime feature to back air into the syringe until the air is cleared, being careful not to collect alteplase in the syringe.

f. Program the Plum 360 pump Line A for "maintenance IV fluid" at the same rate the alteplase was running, with a volume to be infused (VTBI) of 20 mL. This will assure the patient receives the ENTIRE dose.

I. **Post Administration**

1. Pharmacist to enter focus note to document when thrombolytic was available for administration and when physician gave verbal order to give Tenecteplase or Alteplase (if known).
2. Pharmacist to double check medication administration record (MAR) to confirm charting of Tenecteplase or Alteplase administration. If needed, pharmacist will enter the Tenecteplase or Alteplase orders chart as given after administration.
3. Complete the "Tenecteplase or Alteplase replacement and usage form" attached to the box and return to the pharmacy buyer.

J. **Unused Doses**

1. If Tenecteplase or Alteplase is mixed and not administered for any reason send to the Pharmacy Buyer for reimbursement and crediting (syringe, IVPB and/or vial along with all tubing and boxes, completed "Tenecteplase or Alteplase replacement and usage form").

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Approval Signatures

Step Description	Approver	Date
System Policy Oversight Committee	Terri Fries: Document Mgmt Spec	3/6/2024
MMC P&T Committee	Philip Dimondo: Clinical Pharmacist	3/5/2024
Document Owner	Heather Tolfree: Mgr Pharmacy - CPS	3/5/2024

Applicability

Munson Medical Center

Standards

No standards are associated with this document

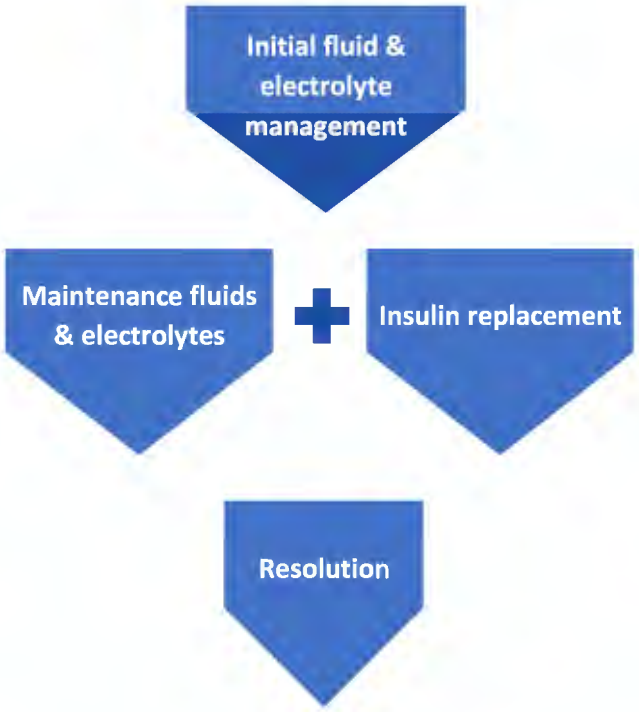
Reference Text:

Diabetic Ketoacidosis (DKA); Adult

This power plan is intended for use in individuals 22 years of age and up. It may also be used in individuals 18-21 years of age if care will not be primarily directed by a pediatric hospitalist (i.e. community hospital admissions, ICU-level care).

Last updated: 4/3/2024

I. DKA TREATMENT SUMMARY – QUICK REFERENCE



Initial Management
- Fluid resuscitation
- Electrolyte replacement

Acidosis Treatment
- **Two-bag method**
- Continuous insulin infusion

Transition to Subcutaneous Insulin
- **Requires 2-hr overlap with IV insulin**
- Upon DKA resolution
- Resumption of diet

Quick Reference for Nursing

Regular insulin (IV)

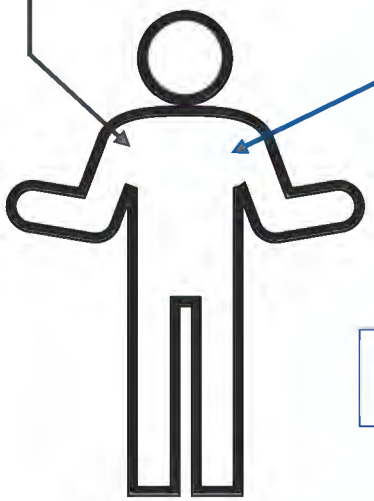
Q1H BG

0.9% NaCl or 0.45% NaCl ± 20 mEq/L KCL

D10 + 0.45% ± 20 mEq/L KCL

Clinical Scenario		Action Required
-	**...Default rate (no bolus, no titration)**	**Infuse at 0.1 unit/kg/hr**
IF	...BG 71-99 mg/dL	-PAUSE INSULIN- *Check BG Q15min until >100. To resume insulin, ensure Bag 2 is running at full rate*
IF	...BG ≤ 70 mg/dL or symptomatic HYPOglycemia	-PAUSE INSULIN- *Follow hypoglycemia protocol. To resume insulin, ensure Bag 2 is running at full rate*
IF	...Patient has persistent or recurrent HYPOglycemia	-CALL PROVIDER- *May consider decreasing insulin rate to 0.05 unit/kg/hr*
IF	...BG does NOT decrease by ≥100 mg/dL within the first two hours	-CALL PROVIDER- *May consider increasing insulin rate to 0.15 unit/kg/hr*
IF	...Potassium < 3.3 mmol/L	-PAUSE INSULIN & CALL PROVIDER- *Replace potassium per DKA electrolyte replacement protocol*

Blood glucose (mg/dL)	DKA Bag 1 rate (mL/hr)	DKA Bag 2 w/Dextrose rate (mL/hr)	TOTAL rate (mL/hr)
STANDARD			
BG >250	250	0 (zero)	250
BG 150-250	125	125	250
BG < 150	0 (zero)	250	250
FLUID RESTRICTED			
BG >250	125	0 (zero)	125
BG 150-250	75	125	200
BG < 150	0 (zero)	250	250



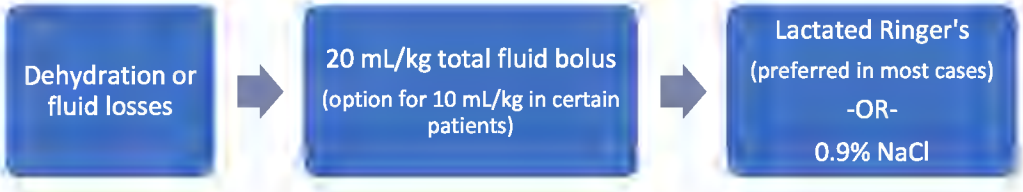
Potassium Level (mmol/L)	Parenteral (as potassium chloride IVPB)
< 3.3	Total dose: 80 mEq over minimum of 4 hours, *AND* 1. PAUSE insulin 2. Call provider to discuss before resuming
3.3 - 3.5	Total dose: 60 mEq over minimum of 3 hours
3.6 - 3.9	Total dose: 40 mEq over minimum of 2 hours
4 - 5.2	Total dose: 20 mEq over minimum of 1 hour
> 5.5	Call provider

Q4H BMP+ Mg + Phos

PLUS magnesium + phos replacement

II. DKA TREATMENT DETAILS

A. INITIAL FLUID MANAGEMENT:



B. INITIAL ELECTROLYTE REPLACEMENT:

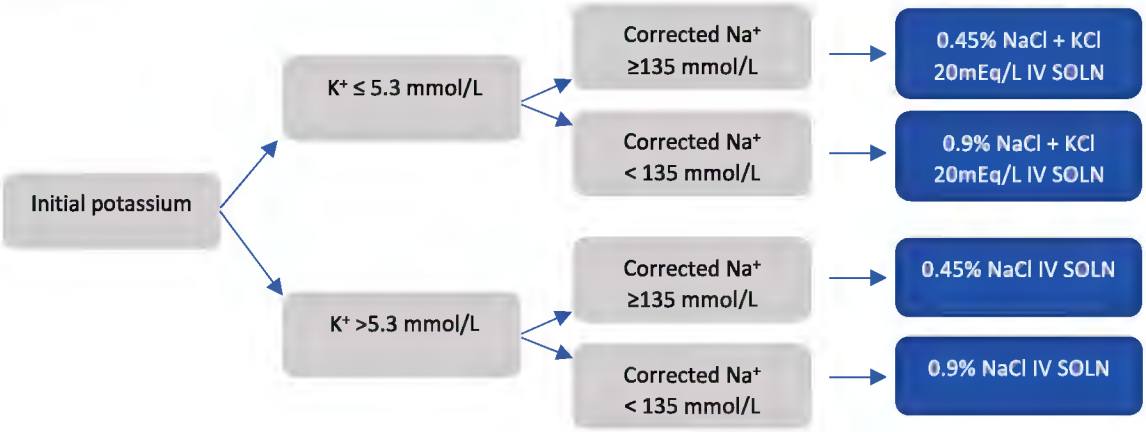
C. IV INSULIN INFUSION

Clinical Scenario		Action Required
-	**...Default rate (no bolus, no titration)**	**Infuse at 0.1 unit/kg/hr**
IF	...BG 71-99 mg/dL	-PAUSE INSULIN- *Check BG Q15min until >100.* ***To resume insulin, ensure Bag 2 is running at full rate***
IF	...BG ≤ 70 mg/dL or symptomatic HYPOglycemia	-PAUSE INSULIN- *Follow hypoglycemia protocol.* ***To resume insulin, ensure Bag 2 is running at full rate***
IF	...Patient has persistent or recurrent HYPOglycemia	-CALL PROVIDER- *May consider decreasing insulin rate to 0.05 unit/kg/hr*
IF	...BG does NOT decrease by 100 mg/dL within the first two hours	-CALL PROVIDER- *May consider increasing insulin rate to 0.15 unit/kg/hr*
IF	...Potassium < 3.3 mmol/L	-PAUSE INSULIN & CALL PROVIDER- *Replace potassium per DKA electrolyte replacement protocol*

D. TWO-BAG MAINTENANCE FLUIDS:

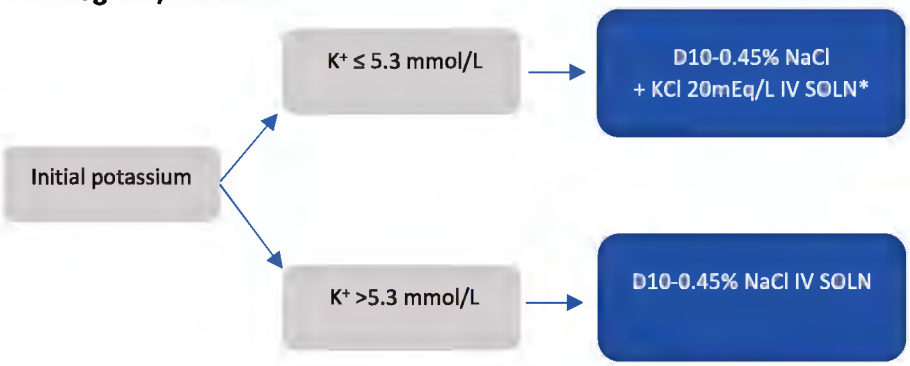
DKA Bag 1 and DKA Bag 2 w/Dextrose are connected to two different IV pumps and connected to each other via Y-site to be administered through one IV line.
Provider to order bag 1 and bag 2 at same time as insulin drip, according to initial electrolytes:

DKA Bag 1



Corrected serum sodium = Na + 0.016(blood glucose – 100)*

DKA Bag 2 w/ Dextrose



***Solution requires compounding by pharmacy. If pharmacy unavailable to compound, may utilize D10/0.45 NaCl with electrolyte replacement per protocol.**

Bag 1 & 2 titration

1. Standard rate

Blood glucose (mg/dL)	DKA Bag 1 rate (mL/hr)	DKA Bag 2 w/Dextrose rate (mL/hr)	TOTAL rate (mL/hr)	Functional Dextrose
BG >250	250	0	250	0%
BG 150-250	125	125	250	5%
BG < 150	0	250	250	10%

2. Fluid restriction

Blood glucose (mg/dL)	DKA Bag 1 rate (mL/hr)	DKA Bag 2 w/Dextrose rate (mL/hr)	TOTAL rate (mL/hr)	Functional Dextrose
BG >250	125	0	125	0%
BG 150-250	75	125	200	6.25%
BG < 150	0	250	250	10%

E. ONGOING ELECTROLYTE REPLACEMENT (SEE **APPENDIX 1**)

1. Nurse to order and replace per *DKA Electrolyte Replacement Protocol using the Nursing – DKA Electrolyte Replacement care set*. **If patient not eligible for replacement protocol, provider to order all electrolyte replacement.**

F. TRANSITION TO SUBCUTANEOUS INSULIN

1. Patients will be transitioned from IV insulin to long-acting subcutaneous (basal) insulin when ALL of the following criteria are met:
    a. pH > 7.3
    b. Anion gap < 12
    c. Serum bicarbonate > 15
    d. Blood glucose < 200
    e. Beta-hydroxybutyrate < 5 or trending down
    f. Patient is tolerating PO and ready to resume full diet
2. Nurse to call provider when criteria are met to help facilitate transition to next step in DKA management.
3. **Continue insulin infusion and IV fluids for TWO hours after administration of subcutaneous long-acting (basal) insulin.**

III. DKA TREATMENT RATIONALE

A. Definitions

1. Diabetic ketoacidosis (DKA): An acute metabolic complication of diabetes. DKA is characterized by metabolic acidosis and ketone body derangements (e.g., ketosis) resulting from a profound or absolute lack of insulin in the body. Though hyperglycemia is usually associated with DKA, a minority of patients with DKA will have euglycemia (normal blood glucose).
2. Two-bag system: An approach to DKA management that uses two maintenance fluid solutions (one WITH and one withOUT dextrose), allowing insulin to run at a set rate. In clinical trials, the two-bag system has led to faster DKA resolution, less hypoglycemia, and faster anion gap closure compared to conventional (i.e., methods with insulin titration) approaches.

Table 1. Common diagnostic criteria for DKA. Adapted from *Diabetes Care*. 2009;32(7):1335-1343.

	DKA		
	Mild	***Moderate***	***Severe***
Glucose (mg/dL)*	>250	>250	>250
Arterial pH	7.3 to 7.25	7.24 to 7	<7
Serum bicarbonate (mEq/L)	18 to 15	15 to 10	<10
Urine ketones	Positive	Positive	Positive
beta hydroxybutyrate (mmol/L)	3 to 4	4 to 8	>8
Anion gap	>10	>12	>12
Mental Status	Alert	Alert/drowsy	Stupor/coma

*Blood glucose may be normal in patients with *euglycemic DKA.*

B. Initial fluid & electrolyte management

1. Fluid resuscitation: Patients with DKA frequently present with significant dehydration from GI losses and decreased oral intake. Many of these patients will require IV fluids prior to insulin initiation.
    a. Aggressive fluid resuscitation with 0.9% NaCl may cause renal tubular acidosis. In prospective clinical trials, this has been shown to cause or worsen acidemia and hyperkalemia, leading to increased incidence of AKI and need for renal replacement therapy.[1-4]
    b. The use of a balanced crystalloid such as Lactated Ringer's (LR) solution may be preferred for DKA management. *Prospective clinical data show that use of balanced crystalloids lead to faster time to DKA resolution and faster time to IV insulin discontinuation compared to 0.9% NaCl.*[5,6]
    c. Despite theoretical concerns, LR is NOT contraindicated in hyperkalemia, acute renal failure, or lactic acidosis, and is indeed preferred over 0.9% NaCl in these settings.
    d. Relevant contraindications to LR may include elevated intracranial pressure, metformin-associated lactic acidosis, overt liver failure, and severe hypercalcemia.
2. Electrolyte replacement: Correction of electrolyte derangements, especially hypokalemia, is recommended prior to the initiation of insulin. Since insulin therapy will decrease potassium further, the cutoffs for potassium replacement are *higher* in DKA compared to other diseases. *Serum potassium levels < 3.3 mmol/L should be repleted before insulin is started.* See **Appendix 1** for more information.

C. IV insulin infusion

1. IV insulin is required to correct the underlying pH abnormalities in DKA. Insulin secondarily lowers blood glucose when elevated.
2. As opposed to a one-bag system, *the two-bag system for DKA treatment does NOT require insulin titration.* Boluses of IV insulin are NOT recommended with the two-bag system.

D. Two-bag maintenance fluids

1. Treatment of DKA with the two-bag system has been tested in prospective, randomized clinical trials in adults.[7,8] Pertinent findings include:
    a. Faster normalization of blood pH
    b. Faster closure of the anion gap
    c. Fewer instances of significant hypoglycemia
    d. Less IV insulin administered in total
    e. No increase in length of hospital stay
2. Standard nomenclature will be adopted throughout MHC for the naming of Bag 1 and Bag 2 on labels and smart pump infusion devices:
    a. Bag 1: "DKA Bag 1"
    b. Bag 2: "DKA Bag 2 w/Dextrose"
3. ***DKA Bag 1 and DKA Bag 2 w/Dextrose are connected to two different IV pumps & connected to each other via Y-site, to be administered through one IV line.***
4. There are four (4) options for DKA Bag 1. The choice between these four options is dependent on:
    a. Initial serum potassium, **and**
    b. Corrected serum sodium
5. There are two (2) options for DKA Bag 2 w/Dextrose. The choice between the two may be dependent on either initial or subsequent serum potassium levels.
6. Maintenance fluid titration:
    a. Standard: the total, combined rate of DKA Bag 1 and DKA Bag 2 w/Dextrose is always equal to **250mL/hr.** The specific rates of Bag 1 or Bag 2 will be titrated by nursing per hourly glucose measurement.
    b. Fluid restriction: the total, combined rate of DKA Bag 1 and DKA Bag 2 w/Dextrose is NOT constant. The specific rates of Bag 1 or Bag 2 will vary between 125 and 250 mL/hr and will be titrated by nursing per hourly glucose measurement.

E. Ongoing electrolyte replacement

1. Prompt recognition and treatment of evolving hypokalemia and other electrolyte derangements is crucial in DKA management, as patients frequently present with electrolyte depletion and insulin therapy may have dramatic effects on serum electrolyte balance.
2. Electrolytes will be supplemented throughout the treatment window by the nursing-driven by the DKA Electrolyte Replacement Protocol and monitored with Q4H BMP laboratory measurement.
3. See **Appendix 1** for the *DKA Electrolyte Replacement Protocol*

F. Transition to subcutaneous insulin

1. Biochemical markers: DKA resolution is marked by normalization of blood pH, anion gap, and blood glucose.
2. Symptoms: Nausea, vomiting, and pertinent GI symptoms from presentation are resolved. Patients are able to tolerate meals.

3. Transition to SQ insulin: To prevent relapse, insulin therapy **MUST** continue after the acute treatment phase. **Continue insulin infusion and IV fluids for TWO hours after administration of subcutaneous long-acting (basal) insulin.**

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APPENDIX 1: DKA ELECTROLYTE REPLACEMENT PROTOCOL

Purpose

To provide a plan for replacing potassium, magnesium, and phosphorus during the acute management of diabetic ketoacidosis in adults.

Criteria for use*

1. Patients must be monitored by continuous telemetry
2. To be used exclusively within the Adult DKA PowerPlan subsequent to a provider order
3. To be discontinued at the time of IV insulin discontinuation
4. Serum creatinine is ≤ 2.5 mg/dL and patient not on renal replacement therapy

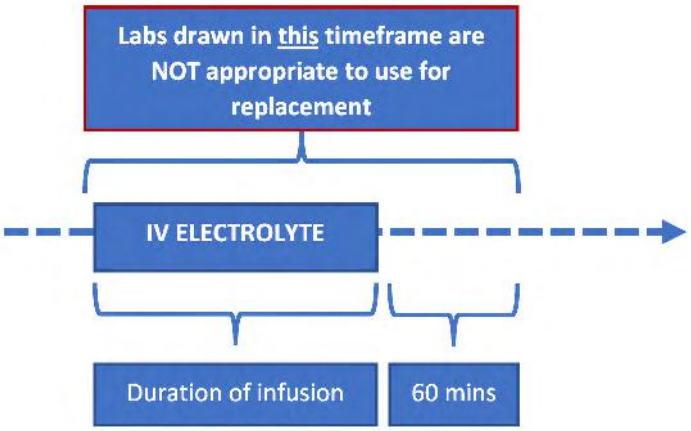
**If patient not eligible for replacement protocol, provider to order all electrolyte replacement.*

Process and Product Selection

1. Nurse to order electrolyte replacement in PowerChart based on potassium, magnesium, or phosphate protocol below.
    a. PowerChart search term: "Nursing - DKA Electrolyte Replacement"
    b. Ordering provider: "Nurse, per protocol"
2. Nurse to discontinue electrolyte replacement protocol when IV insulin is discontinued
3. Parenteral product selection will be guided by site formulary, availability, and MHC system electrolyte policies:
    a. MHC High-Alert Medications Policy
    b. Parenteral Potassium Supplementation Policy- Adult
4. Enteral administration is preferred where indicated

Monitoring

1. Scheduled BMP will be ordered for all patients every 4 hours
2. Nursing to order additional serum potassium levels as directed in *Potassium Replacement Protocol*
3. Replace electrolytes based only on appropriate serum measurements. To be an appropriate measurement, the lab draw must meet the following criteria:
    a. Lab NOT drawn during IV replacement of the electrolyte (electrolytes contained in maintenance IV fluids do not count)
    b. Lab drawn at least 60 minutes after administration of the electrolyte replacement, including oral (PO) replacement



Potassium Replacement Protocol

Replacement rate: 10 mEq/hr. If patient is monitored via continuous telemetry AND has a condition that requires more rapid supplementation, the administration rate shall not exceed 20 mEq/hr.

Potassium Level (mmol/L)	Enteral	Parenteral (as potassium chloride IVPB)	When to recheck level
< 3.3	Use IVPB replacement	Total dose: 80 mEq over minimum of 4 hours, *AND* 1. PAUSE insulin 2. Call provider to discuss before resuming	At next appropriate time until K >3.3 mmol/L *(see graphic above)*
3.3 – 3.5	Use IVPB replacement	Total dose: 60 mEq over minimum of 3 hours	At next appropriate time after replacement has finished *(see graphic above)*
3.6 – 3.9	40 mEq PO/NG x 1 dose Do not give both PO and IV replacement	Total dose: 40 mEq over minimum of 2 hours Do not give both PO and IV replacement	At next appropriate time after replacement has finished *(see graphic above)*
4 – 5.2	20 mEq PO/NG x 1 dose Do not give both PO and IV replacement	Total dose: 20 mEq over minimum of 1 hour Do not give both PO and IV replacement	At next appropriate time after replacement has finished *(see graphic above)*
> 5.5	Call provider		

Magnesium Replacement Protocol

Replacement rate: 1 gram/hour

Magnesium Level (mg/dL)	Parenteral (as magnesium sulfate IVPB)	When to recheck level
≤ 1.5	Total dose: 4 grams over minimum of 4 hours	At next appropriate time after replacement has finished *(see graphic above)*
1.6-1.9	Total dose: 2 grams over minimum of 2 hours	At next appropriate time after replacement has finished *(see graphic above)*

Phosphate Replacement Protocol

Replacement rate: 15 mmol over 1 hour

Phosphorus Level (mg/dL)	Enteral	Parenteral (as sodium phosphate IVPB)*	When to recheck level
< 1.5	K-Phos Neutral 2 tabs q2hr x3	15 mmol x3 doses	At next appropriate time after replacement has finished
1.5 – 1.9	K-Phos Neutral 2 tabs q2hr x2	15 mmol x2 doses	At next appropriate time after replacement has finished

*Solution requires compounding by pharmacy.

Owner: Pharmacy
Reviewed: 4/2024
Reference attached to: DKA IV Glucose Management order

Status Active PolicyStat ID 13648797

MUNSON MEDICAL CENTER
MUNSON HEALTHCARE

Origination	1/18/2011	Owner	Kerry Kole: Medical Director
Last Approved	5/15/2023	Area/ Department	Trauma Services
Effective	5/15/2023	Applicability	MMC
Last Revised	5/15/2023	Tags	Procedure
Next Review	5/14/2026		

Massive Transfusion Protocol

Purpose

To provide a process in the case of a massive transfusion.

Policy

Indications

A. Massive blood loss and profound hemorrhagic/hypovolemic shock.

B. Triggers:

1. Greater than 6 units packed red blood cells (PRBC) transfused within 2 hours.
2. Hemodynamically unstable patient with identified or suspected coagulopathy of trauma or disseminated intravascular coagulopathy (DIC)
3. Any time at the discretion of the trauma surgeon / intensivist.
4. Assessment of blood consumption (ABC) score of greater than or equal to 3 (total possible score 4)
    a. Penetrating mechanism (no= 0; yes= 1)
    b. Emergency department (ED) systolic blood pressure less than 90 mmHg (no= 0; yes= 1)
    c. ED heart rate greater than 120 bpm (no= 0; yes= 1)
    d. Positive Ultrasound FAST Exam (no= 0; yes= 1)
5. Trauma patient who requires more than 1 liter crystalloid to maintain systolic blood pressure greater than 90mmHg.

Responsible Parties

A. Team leaders: depending on area in hospital
    1. Trauma surgeon (trauma bay, operating room (OR), intensive care unit (ICU))
    2. Intensivist (in ICU when trauma surgeon unavailable).
    3. ED physician (in ED when trauma surgeon unavailable)
    4. Anesthesiologist (in OR or Post Anesthesia Care Unit (PACU))
    5. Trauma advanced practice provider (APP)
    6. Obstetrician (OB)
    7. Sound hospitalist

B. Clinical pathologist

C. Lab blood bank / laboratory personnel

D. Pharmacy

E. Nursing supervisor / charge nurse

F. Clinical team:
    1. Trauma physician assistant (PA)/nurse practitioner (NP)
    2. ED registered nurse (RN)/paramedic
    3. ICU RN
    4. OR RN
    5. ED Technician / ICU technician / OR technician

G. Vascular Access

Procedure

A. Initiation of the massive transfusion protocol (MTP):
    1. Trauma surgeon, intensivist, ED physician, trauma APP, anesthesiologist, Sound hospitalist, or OB initiate MTP.
        a. Staff member call switchboard to page out MTP overhead and to all responsible parties.
        b. Staff member enter order for Massive Transfusion in Cerner
            i. Initiate *Lab - every 30 minutes* immediately
        c. Blood bank and lab supervisor notified (by switchboard) of MTP initiation.
        d. Nursing/house supervisor to come to area if needed.
        e. Blood bank will notify clinical pathologist of MTP initiation
        f. Maintain communication with blood bank during the initiation and maintenance of MTP.

g. Consider the use of tranexamic acid (TXA) on patients greater than 18yrs old, initial 1g dose over 10 minutes and then a second 1g dose over the next 8 hours. **MUST BE USED WITHIN 3 HOURS OF INITIAL INJURY, IDEALLY less than 1 HOUR

h. Communicate with pharmacy the need for anticoagulation reversal agents.

2. Clinical pathologist or designee:
    a. Supervises procurement of lab tests.
    b. Tracks the use and available supply of blood and blood products.
    c. Advises the clinical team on the use of blood, blood products, and procoagulants
    d. Use of products based on lab results and available reserves.
3. Lab: confirm patient identification (ID) and medical record number (MR#) (actual or John Doe)
    a. Initial testing
        i. Type and cross (GTAB)
        ii. STAT coagulation profile: Prothrombin time (PT), partial thromboplastin time (PTT), fibrinogen, hemoglobin (HGB), platelet count
        iii. Basic metabolic panel (BMP), arterial blood gas (ABG), and lactate.
    b. Massive transfusion serial lab process.
        i. Repeat labs every 30 minutes until discontinued by clinical team.
        ii. Include complete blood count (CBC), PT/PTT, fibrinogen, lactate, BMP, and ionized calcium.
4. Blood bank:
    a. Prepares and releases
        i. First of five uncrossmatched PRBCs – O-negative or O-positive as indicated
        ii. 5 more units uncrossmatched, O-negative or O-positive PRBC as indicated (unless type specific available).
        iii. 5 single units of plasma
        iv. 5 units platelets
    b. Delivers the first trauma pack to the location of the MTP
    c. Prepares fresh frozen plasma (FFP) to stay 5 single units ahead.
    d. Prepares platelets to stay 5 units ahead.
    e. Ships components at temperatures appropriate for the product being

delivered. This should prevent inappropriate temperature storage of a blood product, such as refrigeration of platelets.

f. Prepares trauma packs (see attached schedule). Trauma packs should be ready to be delivered every 20 minutes.

g. Updates to appropriate type-specific or crossmatched components once available.

h. Tracks results of labs as they become available.

i. Communicates with clinical pathologist and designated clinical team leader (usually the trauma surgeon, anesthesiologist, or intensivist depending on clinical area).

j. Access and maintenance of services:

i. Notifies blood center and requests urgent delivery as needed.

ii. Communicates status of reserves to clinical pathologist.

5. ED RN/paramedic and ICU RN respond to all MTPs

a. Maternity Unit: ED Brings Belmont and Maternity provides the MTP Cart

b. ED MTP: ICU brings the Belmont only (not the MTP cart)

c. All Other Units: ICU Brings MTP Cart and Belmont. ED also brings Belmont for backup.

6. Vascular Access ensure patient has large bore IV (unless physician inserting Cordis)

B. Maintenance of MTP:

1. Charge nurse/Patient Care Coordinator:

a. Checks for accuracy of specimens and verification of patient identity.

b. Expedites transfer of patient within the institution.

c. Expedites transfer of lab specimens in timely fashion.

d. Communicates with and assists clinical team to maintain accuracy and timeliness.

2. Clinical team:

a. Draws, labels and maintains serial labs every 30 minutes during MTP or until discontinued by team leader (see heading III, below).

b. Transfuses shipped trauma packs at regular intervals as needed

c. Documents Input/Output (I/O) and medication administration record (MAR) during MTP.

d. Accompany the patient to the OR or ICU.

e. Remain with the patient until the MTP is terminated.

3. Team leader:

a. Ensures timeliness of serial blood draws.

b. Ensures timeliness of transfusions.

c. Supervises clinical team during the maintenance of MTP.

d. Designates alternate team leader when appropriate (e.g.: trauma surgeon designates anesthesiologist when operating).

e. Communicates with clinical pathologist regarding trend of lab results and transfusion needs.

i. Laboratory goals:

1. HGB 8-10 g/dL during the resuscitation and in the first 24 hours post stabilization. After 24 hour period of stabilization the HGB may be reduced to 7 g/dL if not actively bleeding.

2. Platelet count greater than 100,000 during resuscitation and in the first 24 hours post stabilization. After the 24 hour period of stabilization the goal is a platelet count greater than 50,000.

3. Coagulation testing goals: INR less than 2.0 and PTT less than 55 seconds. INR of 1.8 may be needed in TBI patients.

4. Fibrinogen greater than 150 mg/dL.

f. Terminates MTP (See heading III)

4. Clinical pathologist or designee:

a. Monitors coagulation and lab results

b. Advises team leader and clinical team of need for other blood components or specific alterations in transfusion needs (e.g. cryoprecipitate)

c. Notifies team leader of critical shortages in blood supply.

C. Termination of MTP:

1. Determined by team leader when either of the following are achieved

a. Achievement of endpoints of resuscitation ("stabilization").

i. Normalization of vital signs, including temperature.

ii. Normalization or improvement of coagulation parameters.

iii. Termination of bleeding/exsanguination.

b. Failure or Futility.

2. Call 55555 for switchboard to announce termination of MTP overhead.

3. Maintenance of hematologic function:

a. Serial hematologic assessments (CBC, PT/INR, PTT) every 6 hours for 24 hours, then twice daily (BID) or as needed.

b. Do not transfuse if there is no evidence of bleeding

c. Transfuse FFP if there is evidence of oozing until INR less than 2.0.

d. Transfuse platelets if platelets less than 50 k/dL.

e. Transfuse red blood cells (RBC) to maintain HGB 8-10 g/dL in first 24 hours post stabilization; transfuse for HGB less than 7 g/dL after 24 hours (restrictive transfusion trigger) unless evidence of new bleeding.

f. Transfuse cryoprecipitate if fibrinogen less than 150 g/dL.

D. Review of case and debriefing:

1. What went well.
2. What did not.
3. Product wasted.

E. *If rotational thromboelastometry (ROTEM) is available, the following cut-points for transfusion triggers may also be used:

1. Plasma for CT exTEM greater than 100 seconds and/or CT inTEM greater than 230 seconds.
2. Cryoprecipitate (fibrinogen concentrate) and/or plasma for MCF fibTEM less than 8 mm.
3. Platelets for MCF exTEMless than 45 mm and MCF fibTEM greater than 10 mm.
4. Anti-fibrinolytics for ML exTEM greater than 15 percent.

Document ID: 038.P003

Attachments

- ED Step-by-step instructions for using the Massive Transfusion Protocol Edits.doc
- Expected Response to Product
- MTP schedule.docx
- Step by step instructions for MTP in ICU 2019.pdf

Approval Signatures

Step Description	Approver	Date
System Policy Oversight Committee	Terri Fries: Document Mgmt Spec	5/15/2023

Mgr Trauma Program	Sarah Helveston: Mgr Trauma Program	5/15/2023
Document Owner	Kerry Kole: Medical Director	5/13/2023

Applicability

Munson Medical Center

Standards

No standards are associated with this document

Status Active PolicyStat ID 13403601

Origination	12/11/2015	Owner	Danielle Graber: Mgr Laboratory Services - Phlebotomy
Last Approved	1/24/2024		
Effective	1/24/2024	Area/ Department	Laboratory
Last Revised	1/24/2024	Applicability	Munson Healthcare Systemwide
Next Review	1/23/2026	Tags	Policy

LAB GEN: Patient Identification for Laboratory Specimen Collection

Purpose

To provide accurate identification of patients, eliminating related medical errors and patient harm. Identification (ID) of the patient is an on-going process that begins when the patient enters the hospital and continues throughout the patient's stay. To maintain and facilitate patient care and safety and to ensure accurate and reproducible laboratory results, the labeling of laboratory samples will be consistently completed at the point of care.

Definition

1. **Point of Care:** within close proximity of the draw site; meaning at the patient's bedside or similar area (i.e. next to the drawing chair).

Policy

A. Patients are identified by two (2) identifiers at the point of care. All samples are adequately and permanently labeled immediately upon collection at the point of care.

Identification Guidelines

A. Two aspects of patient ID must be verified prior to specimen collection:

   1. **Inpatients (includes Emergency Room (ER) patients)**

a. Scan the patient's ID band located on the patients' wrist or ankle with the PDA system. Ask the patient to state their legal name (First & Last) and date of birth (DOB). Compare their response to the information on the PDA system & patient ID band.

b. If the PDA system is unavailable compare Sunquest label or chart sticker to the patient ID band located on the patients' wrist or ankle. Ask the patient to state their legal name (First & Last) and DOB. Compare their response to the information on the Sunquest label or chart sticker & patient ID band.

c. Note: For patients who are unable to verbalize two aspects of ID, verify ID with a caregiver or family member whenever practical.

2. **Outpatients**

   a. Ask patient to state the following information:

      i. Name: (First and Last legal)??

      ii. DOB

   b. Verify this information with that on all paperwork provided including the lab requisition(s).

Labeling Guidelines

A. Immediately upon collection all samples must be permanently labeled with two patient-specific identifiers:

   1. Affix a sunquest label, chart sticker, or hand write full legal name and second unique ID number (medical record #). If the medical record # is unknown or is not available, acceptable 2nd identifiers are the patient's DOB, account number, office chart number, social security number.

   2. Affix labels vertically down blood tubes and horizontally across other collection containers.

B. If second label is required, the first permanent label may be covered but not removed. Double check full name and date of birth when applying second label.

C. Samples must be labeled in the patient's presence. Do not move samples or allow patient to leave the area before labeling the samples.

Pretransfusion Specimen Labeling Guidelines

A. Immediately upon collection pretransfusion blood specimens are labeled at the time of specimen collection in the presence of the patient with:

   1. Patient's first and last name

   2. Unique identification number (medical record #)

   3. Date and time of collection

   4. Initials of individual collecting the specimen if not Sunquest label

B. Sunquest Label, Chart Label, or hand labeled with black or blue ink is acceptable for labeling pretransfusion specimens.

C. Pretransfusion blood specimen collectors are recorded in the laboratory information system. All phlebotomists have a Tech ID code unique to employee. For non-laboratory staff collections, initials of collector are recorded in the laboratory information system as a comment.

Additional Information on Specimen Container(s) when Applicable

A. Specimen Source (such as cultures)

B. Collection Duration (12 or 24 hours for timed urine specimens)

C. Collection Time for Serial Draws (30 minutes, 1 hour, 2 hours, 3 hour)

D. Tube Number in Order of Draw (#1, #2, #3 for spinal fluid tubes)

E. Preservative Added (acetic acid preservative added to a 24-hour urine container)

Glass Slides

A. Glass slides must be labeled with the patient name. A second identifier is preferred, but the name only is acceptable.

Approval Signatures

Step Description	Approver	Date
System Policy Oversight Committee	Terri Fries: Document Mgmt Spec	1/24/2024
Lab Medical Director	William Kanner	1/24/2024
Document Owner	Danielle Graber: Mgr Laboratory Services	10/20/2023

Applicability

Cadillac Hospital, Charlevoix Hospital, Grayling Hospital, Kalkaska Memorial Health Center, MHC Corporate (Home Health, Dialysis, NMSA, etc.), Manistee Hospital, Munson Medical Center, Otsego Memorial Hospital, Paul Oliver Memorial Hospital

Standards

No standards are associated with this document

Peripheral nerve stimulation

MUNSON

Peripheral nerve stimulation

Revised: February 24, 2025

Introduction

Peripheral nerve stimulation assesses nerve impulse transmission at the neuromuscular junction of certain skeletal muscles to monitor the depth of neuromuscular blockade in patients who are receiving neuromuscular blocking drugs.[1] Neuromuscular blocking drugs produce paralysis to help synchronize breathing and mechanical ventilation in patients with severe lung injury; treat severe muscle spasms in patients with seizures, tetanus, or a drug overdose; and manage increased intracranial pressure in patients with head injuries.[1][2]

A peripheral nerve stimulator (PNS) helps evaluate the level of neuromuscular blockade and determine the lowest therapeutic dose of the neuromuscular blocking drug necessary to produce paralysis.[3] A PNS works by stimulating a peripheral nerve with a series of brief electrical pulses to produce a muscle response or twitch.

The train-of-four (TOF) method is the most common PNS method for monitoring neuromuscular blockade.[2] In this method, a PNS delivers a series of four electrical impulses to a particular peripheral nerve, and the practitioner then evaluates the muscle's response to the nerve stimulation. The most common and recommended location for the test is the ulnar nerve site, but you can also use the facial or posterior tibial nerves.[1] Four muscle twitches occur in response to the PNS indicates that less than 75% of the receptors are blocked. Three twitches occur when about 75% of the receptors are blocked. One or two twitches correspond to about 80% to 90% neuromuscular blockade.[1][4] Titration of the neuromuscular blocking drug ensures that each series of four electrical impulses produces one or two muscle twitches. The absence of twitches, which may indicate that 100% of the receptors are blocked, exceeds the desired level of neuromuscular blockade.[1]

Equipment

- Alcohol pads
- Facility-approved disinfectant
- Gloves
- PNS
- Pulse oximeter and probe
- Electrode gel patches
- Two leadwires
- Vital signs monitoring equipment
- Optional: arterial blood gas analysis supplies, battery, clippers, other personal protective equipment

Preparation of Equipment

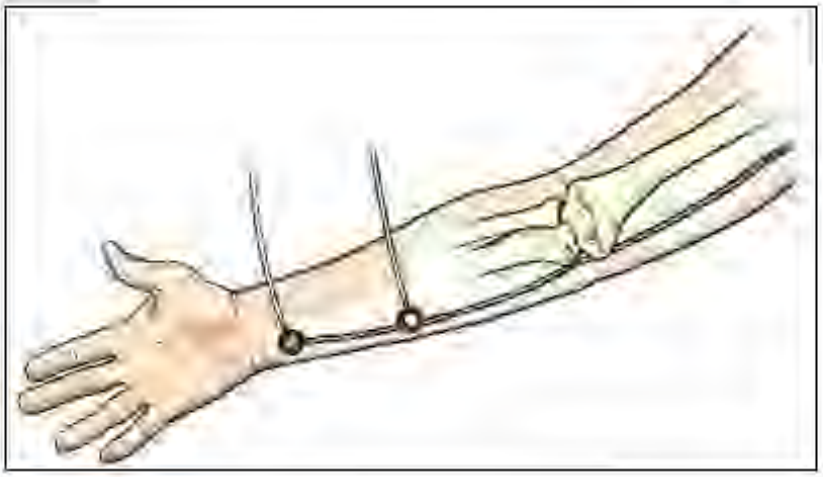
Inspect all equipment and supplies. If a product is expired, is defective, or has compromised integrity, remove it from patient use, label it as expired or defective, and report the expiration or defect as directed by your facility.

Implementation

- Verify the practitioner's order.
- Gather and prepare the necessary equipment and supplies.
- Perform hand hygiene.[5][6][7][8][9][10]
- Confirm the patient's identity using at least two patient identifiers.[11]
- Provide privacy.[12][13][14][15]
- Explain the procedure to the patient and family (if appropriate) according to their individual communication and learning needs *to increase their understanding, allay their fears, and enhance cooperation.*[16]
- Raise the bed to waist level before performing care *to prevent caregiver back strain.*[17]
- Perform hand hygiene.[5][6][7][8][9][10]
- Select a site for electrode placement that is accessible and without edema, wounds, catheters, or dressings *to ensure optimum placement for conducting stimulating current.* The preferred monitoring site is the ulnar nerve, but if this site isn't accessible, you may use another site.[18]
- If the patient has excessive hair at an electrode placement site, remove the hair with clippers *to improve electrode contact with the skin.*[1]
- Assess the patient's oxygen saturation level using pulse oximetry, vital signs, and neurovascular status *to obtain baseline data for later comparison.*

Performing ulnar nerve stimulation

- Use an alcohol pad to clean the electrode placement sites on the patient's arm and then allow the sites to dry *to improve electrode contact with the skin.*
- Place the patient's arm in a relaxed position with the palm up *so that the ulnar nerve is easily accessible.*
- Place one electrode over the ulnar nerve at the crease of the wrist and the other electrode 0.4" to 0.8" (1 to 2 cm) away, parallel to the carpi ulnaris tendon (as shown below), *to ensure ulnar nerve stimulation.*



- Attach the leadwires to the PNS.
- Connect the black lead (negative) to the electrode nearest the wrist and the red lead (positive) to the electrode on the forearm.
- Turn on the PNS and choose a low amplitude (commonly 10 to 20 mA). *Higher current can overstimulate the nerve and result in rhythmic nerve firing.*[1]
- Press the TOF button to initiate the four impulses. Note thumb adductions or twitches that the stimulation produces and count them while lightly feeling for twitches. Don't count finger movement caused by muscle stimulation.
- Turn off the PNS.
- Perform hand hygiene.[5][6][7][8][9][10]

Performing facial nerve stimulation

- Use an alcohol pad to clean the electrode placement sites on the patient's face and then allow the sites to dry *to improve electrode contact with the skin.*
- Place one electrode near the outer canthus of the eye and the other electrode 0.8" (2 cm) below so that it's level with the tragus of the ear (as shown below) *to ensure facial nerve stimulation.*

- Attach the leadwires to the PNS.
- Connect the black lead (negative) to the electrode nearest the tragus and the red lead (positive) to the electrode near the outer canthus of the eye.
- Turn on the PNS and choose a low amplitude (commonly 10 to 20 mA). *Higher current can overstimulate the nerve and result in rhythmic nerve firing.*[1]

- Press the TOF button to initiate the four impulses. Note eyebrow twitches that the stimulation produces and count them while lightly feeling for twitches.
- Turn off the PNS.
- Perform hand hygiene.[5][6][7][8][9][10]

Performing posterior tibial nerve stimulation

- Use an alcohol pad to clean the electrode placement sites on the patient's foot and then allow the sites to dry *to improve electrode contact with the skin.*
- Place one electrode 0.8" (2 cm) behind the medial malleolus and the other electrode 0.8" (2 cm) above the first electrode (as shown below) *to ensure posterior tibial nerve stimulation.*

- Attach the leadwires to the PNS.
- Connect the black lead (negative) to the electrode behind the medial malleolus and the red lead (positive) to the electrode above the first.
- Turn on the PNS and choose a low amplitude (commonly 10 to 20 mA). *Higher current can overstimulate the nerve and result in rhythmic nerve firing.*[1]
- Press the TOF button to initiate the four impulses. Note plantar flexion of the great toe and count the number of twitches that the stimulation produces.
- Turn off the PNS.
- Perform hand hygiene.[5][6][7][8][9][10]

Establishing supramaximal stimulation

- To determine the baseline amplitude setting for a patient who hasn't received neuromuscular blockade, set the amplitude to 5 mA and press the TOF button to initiate the stimulus.[1]
- Note the number of twitches produced.
- Increase the amplitude by 5 mA at a time until TOF stimulation produces four muscle twitches. *This step establishes the amount of current to use for peripheral nerve stimulation and enhances the reliability of testing.*[1]

- Once TOF stimulation produces four muscle twitches, increase the amplitude by 5 mA *to confirm this response level.*
    - If there is no increase in the intensity of the twitches, then the supramaximal stimulation is the level at which four vigorous twitches were observed.
    - If there is an increase in the intensity of the twitches, continue to increase by 5 mA until no increase in the intensity of the twitches is seen. Once there is no increase in intensity of the the twitches, then then supramaximal stimulation is the level at which four vigorous twitches were observed.[1]

Establishing TOF after neuromuscular blockade

- Determine the TOF 10 to 15 minutes after a bolus dose or any change in neuromuscular blocker administration *to assess the level of neuromuscular blockade.*[1]
- If no twitches occur, troubleshoot the equipment (replace the battery, check lead connections, or replace electrodes, as necessary).[1] Next, increase the stimulating current and then retest another nerve. If no response occurs, check the neuromuscular blocker infusion rate, concentration, and dose and then hold the bolus dose or reduce the infusion rate, as ordered. Retest the TOF in 10 to 15 minutes.[1]
- If one or two twitches occur, continue the current rate of the infusion.
- If three or four twitches occur, increase the rate of the neuromuscular blockade, as ordered, and then retest using TOF in 10 to 15 minutes.

Performing ongoing care

- Assess the oxygen saturation level (using pulse oximetry or arterial blood gas analysis), vital signs, and neurologic status before any increase in the level of neuromuscular blockade.[1]
- Change electrodes daily or more frequently if they become loose or if the gel dries out *to ensure optimum conduction.*[1]
- Assess the skin under the electrodes for signs of irritation and breakdown, which could impede conduction.
- Reevaluate the level of neuromuscular blockade every 4 to 8 hours during therapy with neuromuscular blocking drugs after the patient is stable and reaches an adequate level of neuromuscular blockade, as ordered or as directed by your facility.[1]
- Return the bed to the lowest position *to prevent falls and maintain the patient's safety.*[19]
- Discard used supplies in appropriate receptacles.[20]
- Perform hand hygiene.[5][6][7][8][9][10]
- Put on gloves and, as needed, other personal protective equipment.[20]
- Clean and disinfect reusable equipment according to the manufacturer's instructions *to prevent the spread of infection.*[21][22]
- Remove and discard your gloves and, if worn, other personal protective equipment.[20]
- Perform hand hygiene.[5][6][7][8][9][10]
- Document the procedure.[23][24][25][26]

Special Considerations

- *Because neuromuscular blocking drugs don't produce amnesia, sedation, or analgesia,* administration of sedative and analgesic drugs should always precede administration of a neuromuscular blocking drug.[1][2][3]
- Assess the patient's baseline electrolyte, blood urea nitrogen, and creatinine levels, *because imbalances may potentiate the effects of neuromuscular blocking drugs.*[1]

- Be aware that, *to avoid complications of neuromuscular blockade,* the patient will require frequent routine oral care and suctioning, deep vein thrombosis prophylaxis (as ordered), GI prophylaxis (as ordered), eye lubrication (as ordered), and footdrop prevention measures.[2]
- Be aware that PNS devices are unreliable for discerning the degree of neuromuscular recovery required for spontaneous ventilation and tracheal extubation. More precise medical devices, such as neuromuscular monitors that provide objective responses to nerve stimulation, are necessary *to assess readiness for tracheal extubation. Such monitors use different methods to measure the evoked muscle responses to electrical nerve stimulation.*[3]
- If the patient has hemiplegia, hemiparesis, or peripheral neuropathy (due to diabetes or another condition), keep in mind that the motor response to peripheral nerve stimulation may not be as pronounced, which can lead to the incorrect belief that a higher dose of neuromuscular blocking drugs is necessary. With a patient who has hemiplegia or hemiparesis, place the electrodes on the unaffected limb (if possible).
- Carefully check the electrode placement site, *because incorrect placement can lead to muscle, rather than nerve, stimulation.*[1]
- If no twitches are elicited at a level that previously elicited a response, troubleshoot the PNS before decreasing the level of neuromuscular blockade. Check the polarity of the leads, battery charge, electrode contact with the skin, condition of electrode gel pads, and leadwire connections.[1]
- Neuromuscular blockade should be discontinued as early as possible *to avoid drug metabolite accumulation and prolonged recovery.*[2]

Complications

Complications associated with peripheral nerve stimulation may include:

- cardiac arrhythmias (if PNS leadwires come in contact with an external pacing catheter or leadwire)[1]
- mild discomfort or tingling during TOF testing[1]
- pressure injury[1]
- protracted paralysis and muscle weakness (caused by excessive neuromuscular blockade)[3][18]
- skin irritation.[1]

Documentation

Documentation associated with peripheral nerve stimulation includes:

- date and time of assessment
- initial TOF assessment
  - site used
  - amplitude used
  - dose of neuromuscular blocking drug administered
- each subsequent TOF assessment as a ratio of twitches per four stimulations (for example, 0/4, 1/4, 2/4, 3/4, 4/4)
- current used
- bolus doses or changes in the infusion rate of the neuromuscular blocking drug
- assessment findings
  - respiratory
  - cardiovascular
  - neurologic
  - neurovascular
- adverse effects
  - name of the practitioner notified
  - date and time of practitioner notification
  - prescribed interventions
  - response to those interventions

- teaching provided to the patient and family (if applicable)
  - understanding of that teaching
  - follow-up teaching needed.

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(Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions)

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Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions

The following leveling system is adapted from *Evidence-Based practice in nursing & healthcare: A guide to best practice,* Fifth edition, by Bernadette Mazurek Melnyk and Ellen Fineout-Overholt (2023).

Level I	Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs)
Level II	Evidence from well-designed single RCTs (experimental)
Level III	Evidence from well-designed nonrandomized controlled trials (quasi-experimental), systematic reviews of a complete body of evidence, and intervention studies using mixed methods
Level IV	Evidence from well-designed case-control and cohort studies (observational)
Level V	Evidence from systematic reviews of qualitative and descriptive studies

Level VI	Evidence from single descriptive and qualitative studies, evidence-based practice implementation, and quality improvement projects
Level VII	Evidence from expert opinion, expert committee reports, and literature reviews

Data from Gyatt, G., & Rennie D. (2002). Users' guides to the medical literature. American Medical Association; Harris, R. P., et al. (2001). Current methods of the U.S. Preventative Services Task Force: A review of the process. American Journal of Preventative Medicine, 20, 21-35.

Philips Monitoring System (MUNSON)

Philips Monitoring System (MUNSON)

Introduction

Central Monitoring System

The Philips Patient Information Center is a regulated medical IT system that:

- Provides continuous monitoring of patient vital signs from admission to discharge.
- Consolidates and communicates vital signs data from monitors and third-party devices to caregivers and to the Electronic Medical Record (EMR) for a complete patient record.

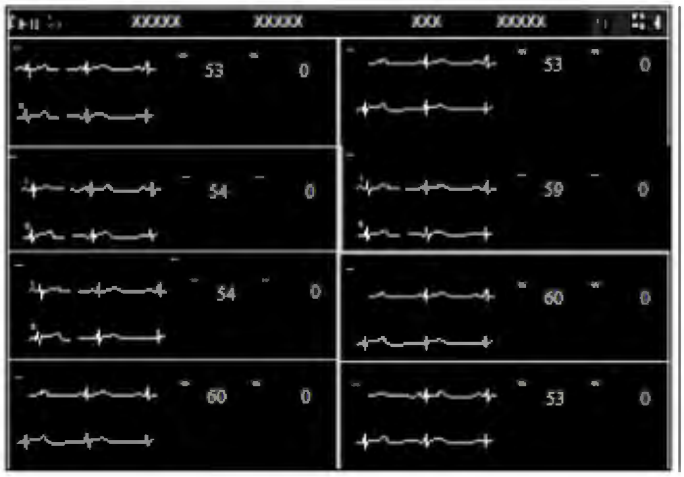
- Supports industry standard interfaces to integrate into existing hospital IT infrastructure and EMR systems while meeting requirements for manageability, serviceability, and security.
- Meets the needs of caregivers on the go by means of remote access to patient vital signs for information anywhere.

Through a combination of advanced alarm management, mobility, and clinical decision support, Philips Patient Monitoring Systems enable reduction of non-actionable alarms, improve workflow efficiency, and facilitate early intervention of patient deterioration to improve patient care and outcomes.

The Information Center software runs on a PC workstation with one or two displays for viewing patient data and accessing clinical applications. A mouse and keyboard are provided for entering and changing patient data and other information. If you position the cursor on a labeled application button and click, the application is immediately displayed on the screen. Note that an on-screen keyboard is not available.

With a touchscreen, you can access patient data by either using the mouse or by touching the item on the screen with your finger or a stylus. The mouse is best for making precise selections and measurements, such as using calipers. The touchscreen is best for actions such as acknowledging alarms, accessing application windows, or recording strips. When using a touchscreen, keep the area free of items that can inadvertently touch the screen. If the touchscreen becomes unavailable for any reason, you can access patient data by using the mouse and keyboard.

The Main Screen displays real-time waves, numerics, and alarms from multiple patients. It can be configured to show up to 64 waves, and contains the following elements:



1 Caption Bar

 Select the Patient Window button to open the Patient window to Display a real-time view of the current patient's data. You also can choose to do an ECG analysis to view all available ECG leads. The Patient Window provides a real-time view of the patient's waves and numerics. You can view patient data and perform all tasks in the Patient Window. In addition to the waves and numerics, the Patient Window contains the following items:

- The Bed Label Pane - Displays the bed label and ID for the currently selected patient. Select the down arrow to select another patient to view.
- The Print Icon to start a printout of the Patient summary report.
- The Help Icon.
- Alarm message areas – All active alarms and technical alarms display on the top right of the patient window. Status messages are color-coded to indicate the message severity. Orange background indicates high severity. Black background indicates low severity. Select the status message to open System Help in the application window. The Help contains a list of status messages with the possible causes and recommended actions for each message.
- Patient Name - Displays the patient's name. Depending on the length of the complete string and the amount of available space, a minimum number of characters is shown, ending with an ellipsis (...). Three question marks (???) precede the patient's name when there is a problem identifying the patient. For example: Patient data between the Information Center and the bedside does not match. All required information was not entered when the patient was admitted.

Buttons in the sector become visible when you move the cursor into the sector or, if using a touch screen display, when you first touch the sector with a stylus or the tip of your finger. When you place the cursor inside a patient sector, the sector is outlined in an orange border. You can minimize the buttons by moving the cursor into the sector and holding down the **Ctrl** key. While the cursor is inside the sector, the buttons remain minimized until you press the **Ctrl** key again. If you move the cursor out of the active sector and move it back in, the buttons become visible.

 Select the Manage Patient Icon, which will allow you to:

- Admit, discharge, and transfer patients.
- Enter or update patient demographic information.
- Manage the equipment associated with the patient.
- Temporarily place the bed in standby.
- Enter a temporary transport location, and/or select the patient's equipment to place in standby.
- Export ECG waveform data to a Philips Holter system for analysis.

To Admit a Patient: Use one of the following methods:

- Manually enter new patient information in the fields in the **Patient Demographics** section by typing a 1-30 character first and last name in the appropriate fields. You can use the TAB key to move from field to field. You can also admit a new patient by entering the MRN.
- Use the **Find Patient...** option to find a patient who is being monitored in another Information center or who has been recently discharged.

You can then choose the patient's gender from a drop-down list. It will default to Male while performing a 12-lead if not assigned. It will default to Female while measuring STE if not assigned. Specify the patients birth date by entering it on the calendar. This will update the age field. Enter the patient's height in the appropriate field. This can be in inches or centimeters according to your policy. Enter the Patient's weight using pounds or kilograms according to your policy. Select "Apply" after verifying all information is correct.

Read all confirmation messages and check patient alarms, settings, and paced status when automatic admission, discharge, or transfer is complete.

Viewing and Adjusting Waves:

When the ECG measurement is on, the first wave displayed is the primary ECG wave. The primary wave is always used for ECG analysis. A rhythm status message displays in the upper right corner of the wave, and an arrhythmia status message displays above and in the center of the wave.

Pleth waves on an Efficia monitor are labeled as SpO2.

Wave Adjustments

You can adjust waves in the patient sector or Patient Window layout by selecting a wave then selecting one or more options described below.

- Change Wave – Select a wave from the list. You cannot select the primary ECG wave.
- ECG Analysis – Available if you select an ECG wave. Select to access the ECG Analysis application.
- Primary Lead – Available if you select the primary ECG wave. Select the primary led from the list.
- Size up or Size down - Select to increase or decrease the size (gain) of the wave (if available).
- Set up ECG – Available if you select an ECG wave. Select to access the **Measurements** application ECG page, where you can change heart rate limits and asystole thresholds.

Manually Transferring a Patient to a New Bed: Transfer data for a patient by performing the following steps:

- Use one of the following methods to open the **Manage Patient** In the sector for the bed that you want to transfer, select the name field or select the **Manage Patient** shortcut button. In the application window task bar, select the **Manage Patient** button.
- Select the **..** button. The **Transfer Patient** dialog box displays a list of available beds in the institutions and units.
- To transfer this patient to another bed within this unit, select the bed from the list of beds in your unit. To transfer this patient to a bed in another unit, first select the unit name, then select a bed from the list.
- Specify whether to clear the sector (remove the bed from the sector) upon transfer by selecting or clearing the **Clear Sector** check box. The system can be configured so that the check box is selected by default. Depending on your unit practices, you may want to clear the check box so the sector is not cleared and the equipment remains assigned to the sector.
- Select "OK".
- Confirm the transfer by selecting the orange "TRANSFER" button.

To Discharge a Patient: Use one of the following methods to discharge a patient.

- Manually discharge a patient in the **Manage Patient** application.
- Discharge a patient directly from the hospital information system or bed management system.

Considerations

Before discharging a patient, note the following:

- Discharging the patient at the Information Center also discharges the patient from the bedside monitor. All monitor and MMS settings (including arrhythmia settings) reset to their defaults.
- When you discharge a patient, the Information Center saves the patient data for all admitted patients. The system stores seven days of data and purges the stored data seven days after discharge.

You can search discharged patient data without readmitting for up to seven days.

- If you readmit a patient, the discharge data is overwritten by new monitoring data as it occurs, and you will only see the full disclosure amount of data.
- Monitoring devices may be set up with predefined configurations called *profiles*. When you discharge a patient, the profile reverts to the default profile configured for the device. Refer to your monitoring device documentation for details. When

you discharge an admitted patient at the Patient Monitor, the Information Center discharges the patient and saves the data.

- *Important* — For MRx monitors, turning off the bedside monitor for more than 10 seconds discharges the patient at the MRx monitor and resets defaults, but it does not discharge the patient from the Information Center; the patient is still admitted at the Information Center. It is important to discharge the patient before turning the monitor off to avoid data being associated with the wrong patient.
- Patients that are discharged while the Information Center is in Local/Disconnected mode will be synchronized upon connection to the primary server.

Warning

Read all confirmation messages and check patient alarms, settings, and paced status when automatic admission, discharge, or transfer is complete.

Measuring ECG:

The electrocardiogram (ECG) measures the electrical activity of the heart and displays it on the

Information Center as a waveform and a numeric. In order to compare measured ECG signals, the electrodes are placed in standardized positions, forming "leads". To obtain ECG signals optimized for use in diagnosis and patient management in different care environments, different lead placements can be used.

Selecting the Primary and Secondary ECG Leads

The telemetry device or patient monitor uses the primary and secondary lead selected at the

Information Center to compute HR and to analyze and detect cardiac arrhythmias.

You should choose a primary and (if using multi-lead monitoring) secondary lead that have the

following characteristics:

- the QRS complex should be either completely above or below the baseline and it should not be biphasic
- the QRS complex should be tall and narrow
- the T-wave should be less than 1/3 the R-wave height
- the P-wave should be less than 1/5 the R-wave height

Documenting Patient Events

Documentation of patient events and procedures is a necessary element of patient care. You can print reports from the PIC iX to paper, electronically via PDF, or both.

Create a Saved Strip

You can create a saved strip with the PIC iX electronic caliper (eCaliper) measurements and comments in any strip tile in Alarm Review, General Review, or specialty review applications.

Note —You must have Full Permission Access to annotate and save a strip to the database.

- Select the strip that you want to annotate.
- Select the Annotate icon. The Saved strip dialog box opens. You can move the dialog box as needed.
- Select a label from the drop-down list to add labels. This field can be customized as needed in Alarm Review.
- Enter text in the second field, up to 30 characters. This value displays in the Comment field for the strip.
- Add eCaliper measurements. Consider changing the wave speed to 50 mm/sec. (Select the speed on the bottom right of the strip, then select a speed from the list.) Click and drag in the strip to and from the desired location in the wave. The measurement is displayed between the vertical lines. In the dialog box, click the measurement label to add the measured value. *Note* — Double-click the measurement to see the caliper bars at any time.
- Select another strip and repeat these steps as needed.
- When you are done, select Save. The measurements are saved to the strip.

Reviewing ECG Waves

Depending on the number of ECG leads and licensing, 3 to 12 waves are available for review. These waves can be reviewed with the other data tiles, such as with events and alarms.

Alarms:

Quickly Viewing Target Events - When reviewing patient data, it is often helpful to quickly view specific types of alarms or events.

Fast Alarm Review - Select either the Acknowledge key, or the alarm banner in the sector to see alarming waves prior to being available in other applications. Alarm strips can be printed, annotated, or discarded. If you are using secondary notifications, such as with Philips CareEvent, you can manually page an alarm from this application.

Note — The Silence key is called the Acknowledge key.

Alarm Review

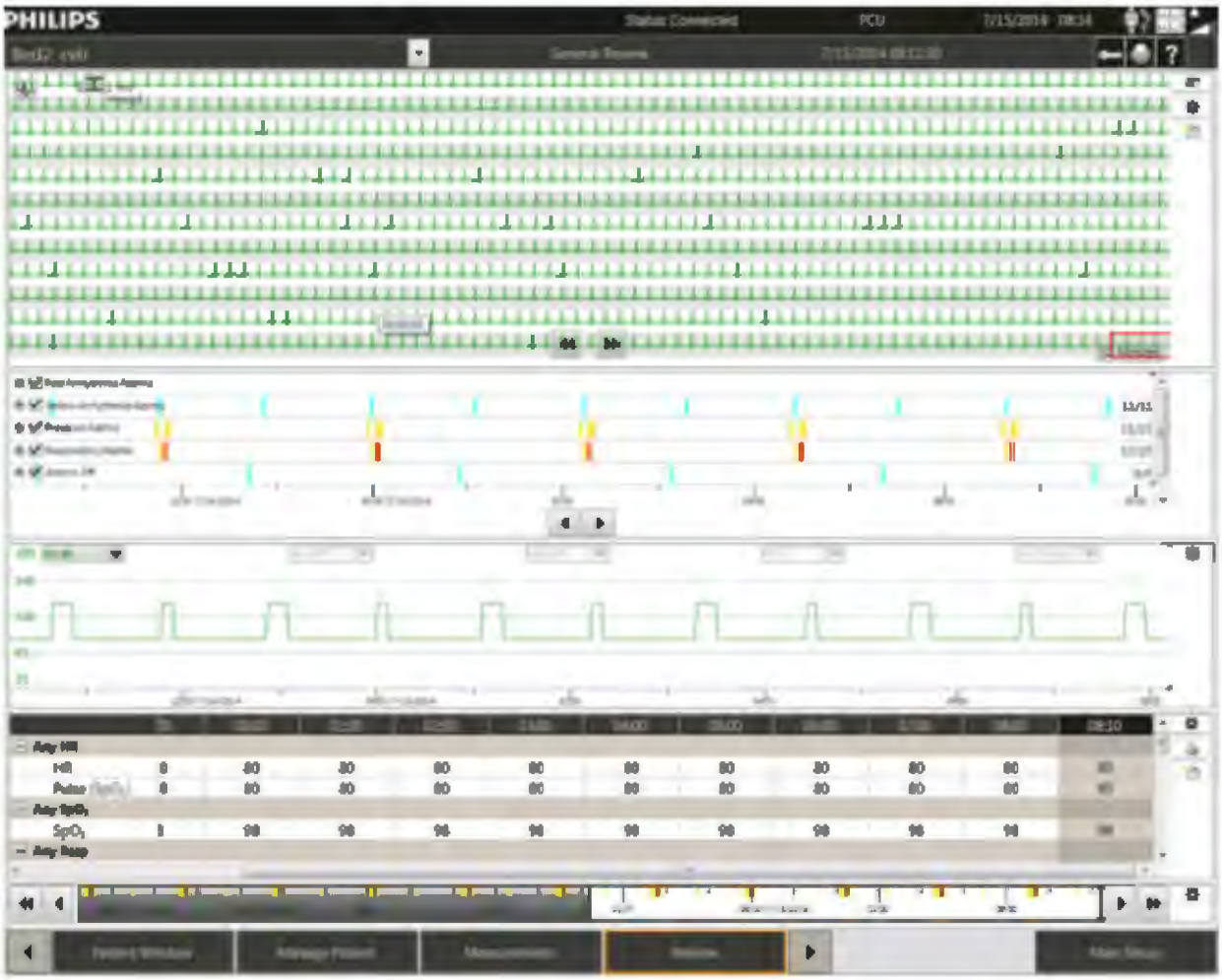
Alarm Review always opens with the most recent alarm strip. To review alarms, open Alarm Review from the Review sector button, if configured, or you can open Alarm Review from the main Setup menu or from the Review application menu in any open application. Use the toggle icon to switch between the three different tiles. The tile you prefer can be set up as a default on each host.

- **Tabular** tile – shows a detailed strip with multiple waves and a tabular list of alarms. Use the up and down arrow keys to quickly view alarm strips. This is the factory default tile.
- **Compressed** tile – shows 30 seconds of compressed waves for all strips.
- **Strip Window** tile – a combination of Compressed and Strip tiles.

Reviewing Alarms and Events in Other Applications

Within the factory default review applications (as well as custom applications that were created for your unit), there is a data type called the Event tile. You can use the Event tile to review alarms with other associated data, such as compressed wave storage or graphical trends. Arrhythmia events are also shown, even when a specific alarm is off, such as for yellow level ventricular alarms. The length of the colored box indicates the duration of the event.

- Open the review application. If opened from Alarm Review, the time focus is the selected alarm. If opened from another application, it opens at the current time minus the one minute for storage.
- The Event tile is highlighted below. Note the displayed number of events shown on the right. Alarms are shown with the corresponding color, and arrhythmia events are shown in cyan.



- Clear the check box next to the events you do not want to see. If licensed, specific events can be customized for each review application.
- Move the cursor over any alarm or event to see text that contains the details.
- Select the event to examine its associated waves, trends, and numerics.
- Use the arrow keys in the middle of the tile to quickly navigate to next or previous events.

 Alarms off. Displays next to the numeric when alarms are turned off for the numeric.

 Pause Alarms (Red and/or yellow). **PRESS THIS BUTTON AGAIN TO RESUME ALARMS!**

 Acknowledge/Review Button. Turns off the alarm sound and the sector background changes from blue to black.

 Volume icon. Select to adjust the alarm volume.

Physiological alarms are red and yellow alarms. A red alarm indicates a high priority patient alarm such as a potentially life-threatening situation (for example, asystole). A yellow alarm indicates a lower priority physiological alarm (for example, a respiration alarm limit violation). Additionally, there are short yellow alarms, most of which are specific to arrhythmia-related patient conditions (for example, ventricular bigeminy). Alarm message areas. All active alarms and technical alarms/INOPs display on the top right of the patient sector. A RED warning alerts you to a potential serious outcome, adverse event or safety hazard. Failure to observe a warning may result in death or serious injury to the user or patient. A YELLOW caution alerts you to where special care is necessary for the safe and effective use of the

product. Failure to observe a caution may result in minor or moderate personal injury or damage to the product or other property, and possibly in a remote risk of more serious injury. Technical alarms, or INOPs indicate that the monitoring device cannot measure or detect alarm conditions reliably. If a technical alarm interrupts monitoring and alarm detection (for example, LEADS OFF), the numeric is replaced by a question mark in the sector and Patient Window, and an audible indicator sounds. Technical alarms without this audible indicator indicate that there may be a problem with the reliability of the data, but that monitoring is not interrupted. Most technical alarms are light blue, however there are a small number of technical alarms that are always yellow or red to indicate a severity corresponding to red and yellow alarms.

There can be only one alarm sound annunciating at the Information Center at one time.

- If there is an unacknowledged red level alarm in the presence of any other level alarm, the sound for the red alarm annunciates.
- If there is no unacknowledged red level alarm condition and there is an unacknowledged long yellow alarm in the presence of any other yellow technical alarm (acknowledged or unacknowledged) the sound for the long yellow alarm annunciates.
- If there is no unacknowledged red level alarm or long yellow level alarm condition and there is an arrhythmia or nurse call event, the short yellow (*) alarm sound annunciates.
- If there are no unacknowledged red or long/short yellow alarm conditions and there is any bed with an unacknowledged technical alarm condition, the sound for the technical alarm annunciates.
- If multiple sectors are in alarm, once the highest level alarm is acknowledged in a sector the next highest alarm annunciates.
- An alarm tone indicates the alarm type. There is no sound for soft INOPs/technical alarms.

Other Buttons and Icons:

 **Battery Icon.** If there is at least one battery-operated device assigned to this patient, the battery icon indicates the device with the least amount of battery strength. Move your cursor over the icon to view a list of equipment for this patient sorted from the lowest to highest battery charge. The battery icon has five levels: approximately 100% to 80%, 80% to 60%, 60% to 40%,40% to 20%, or -Replace Battery strength. The number of segments indicates the approximate power level.

 **Help Icon.** Select to view the online Help application. The Help application is always available and provides context-specific information on using the Information Center applications.

 **Manage Patient Icon.** Available in sectors not currently monitoring a patient. Select the icon to access the **Manage Patient** application where you can assign a monitoring device.

The Measurements Button: Provides access to the **Measurements** application, which allows you to:

- Change alarm limits for a patient.
- Turn specific alarms on or off for a patient.
- Adjust measurement settings within a profile.
- Set up telemetry devices.
- Designate which alarms will generate a recording or report or initiate a page.
- View or print an Alarm Summary.
- Configure criteria to trigger alarm advisor notifications.
- View active notifications.

Your choices in the application depend on how your unit is set up and the equipment assigned to the patient.

Paced Mode Icon. Indicates the patient's current paced status.

-  On – The icon is white when **Paced Mode** is turned on.
-  Off – The icon is green with an X over it when **Paced Mode** is turned off.
-  Unconfirmed – A red question mark displays over the icon when the patient's paced mode is unknown or in conflict.

The pacer spike color is always white unless the ECG wave is white. If the ECG wave is white, then the pacer spike color is green. Pacer spikes may be configured to display with fixed amplitude for increased visibility.

Important — If **Paced Mode** is set to **Unconfirmed,** the ST/AR algorithm acts as though **Paced mode** is turned on. Select the icon to display a menu where you can turn **Paced Mode** on or off.

Warning - If the patient has a pacemaker, **Paced Mode** must be turned on, enabling the ST/AR algorithm to detect and reject pace pulses (spikes) from the HR count. Otherwise, pace pulses could be detected as beats and the monitor may not alarm for an asystole condition. If the patient does not have a pacemaker, turn **Paced Mode** off to allow the ST/AR algorithm to work most effectively.

 **Print/record Icon.** Depending on your system setup, select this icon to do the following:

- **Record All** — make a delayed recording for all sectors that currently have patient data.
- **Print All** — print a strip for all patients in the unit.
- **Save Strips** — create saved strips for all patients in the unit.

If you select this icon, a message asks you to confirm that you want to proceed with the action. Select **Yes** to confirm. Your system may be set up to just record, record and save a strip, or to just save a delayed strip.

Resuscitation Status Icons:

 Do Not Resuscitate. Resuscitation icon. Indicates the patient's current resuscitation status.

 Modified. The icon is solid white when the patient's resuscitation status is set to **DNR** (Do Not Resuscitate). The icon is a white outline when the patient's status is set to **Modified**. The icon does not display if the patient's resuscitation status is set to **Full**. Select the icon to access the **Manage Patient** application where you can change the resuscitation status.

Prior Data:

Patient data can be stored up to 7 days for each patient of Retrospective Review at Central Station. Data stored upon discharge, or from another unit with a transfer, will be shown separately from current data.

« SCROLL »

- A Prior Data icon shows in the review applications. Selecting it opens a menu of prior encounters.

Once you are into this window –

- **The Information Bar at the top turns teal green (states 'Prior Data')**
- **The only smart key on the bottom task bar will be 'Review'**
- **Main Screen button becomes 'Current Unit'**
- **To close the application, use the red X in the upper right or choose the Current Unit button**

« SCROLL »

References:

- **MX Series QR Codes**
- **Central Monitoring Station PICIX**
  - **IFU_-_PIC_IX_Rel_C.03_-_English.pdf- Central station user manual**
  - **PIICIX Rev C.03 Patient Data Review**
- **MX40 Telemetry box**
  - **the MX40 IFU manual link**
  - **the MX40 quick card reference**
- **MX400 Large Mounted Monitor**
  - **IFU MX400-800_IVPM_NOx)Mar2019.pdf User manual**
- **Invasive pressure Guide**
  - **Invasive Pressure PDF**
- **Capnography**
  - **Capnography Application Guide**

Notes

MX Series QR Codes

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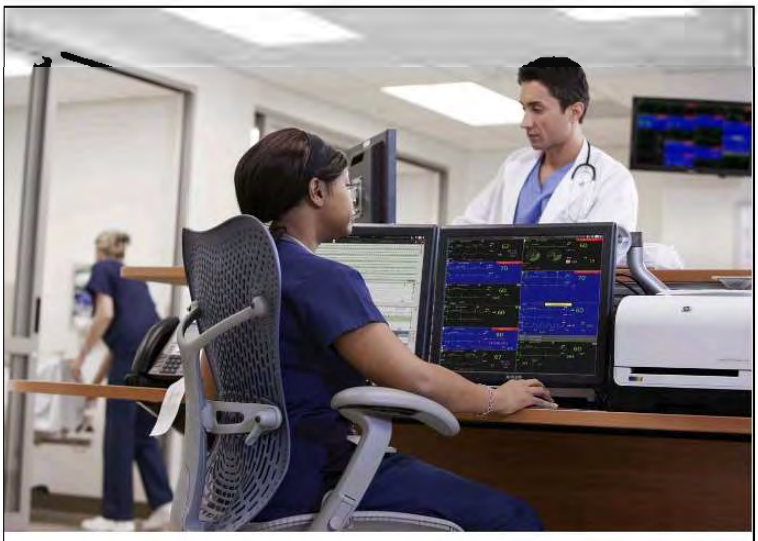
Philips Monitoring System Manual



Patient Information Center iX

Instructions for Use

Release C.03

PHILIPS

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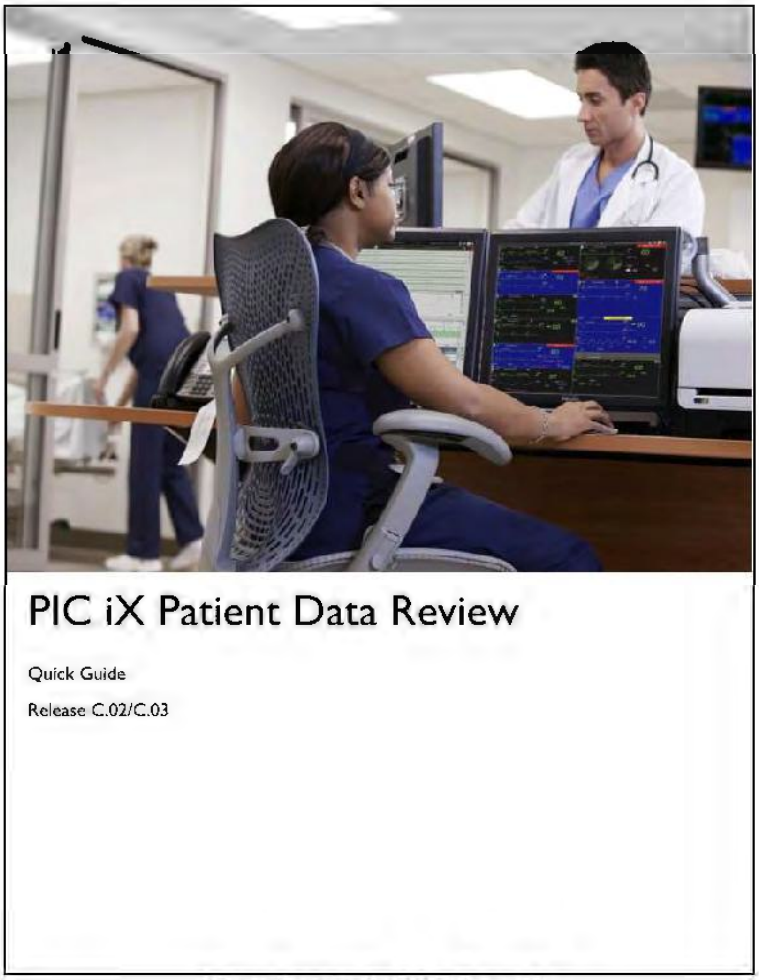

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Car Seat Quick Guide

Car Seat Assessment Record (CAR)
Quick Guide

1. Place baby in car seat.
2. Change Screen to **CAR SEAT TEST**.

3. Touch SmartKey **START CAR**.
4. Select amount of time for Test Duration *(based on hospital protocol)*.

5. Touch **CONFIRM** key

*****CAR is now in progress*****
Monitoring is continued during CAR.

6. If at any time during CAR you need to exit or stop – press the SmartKey **STOP CAR** and **CONFIRM**

   At any time you can also switch back to your default monitoring screen by touching **Change Screen**, then touch the back arrow at the top of that menu. *CAR will continue to run in the back ground.*

7. When CAR is complete, the countdown timer (to the far right in the CAR Screen) will turn **RED**

View image in PDF format.

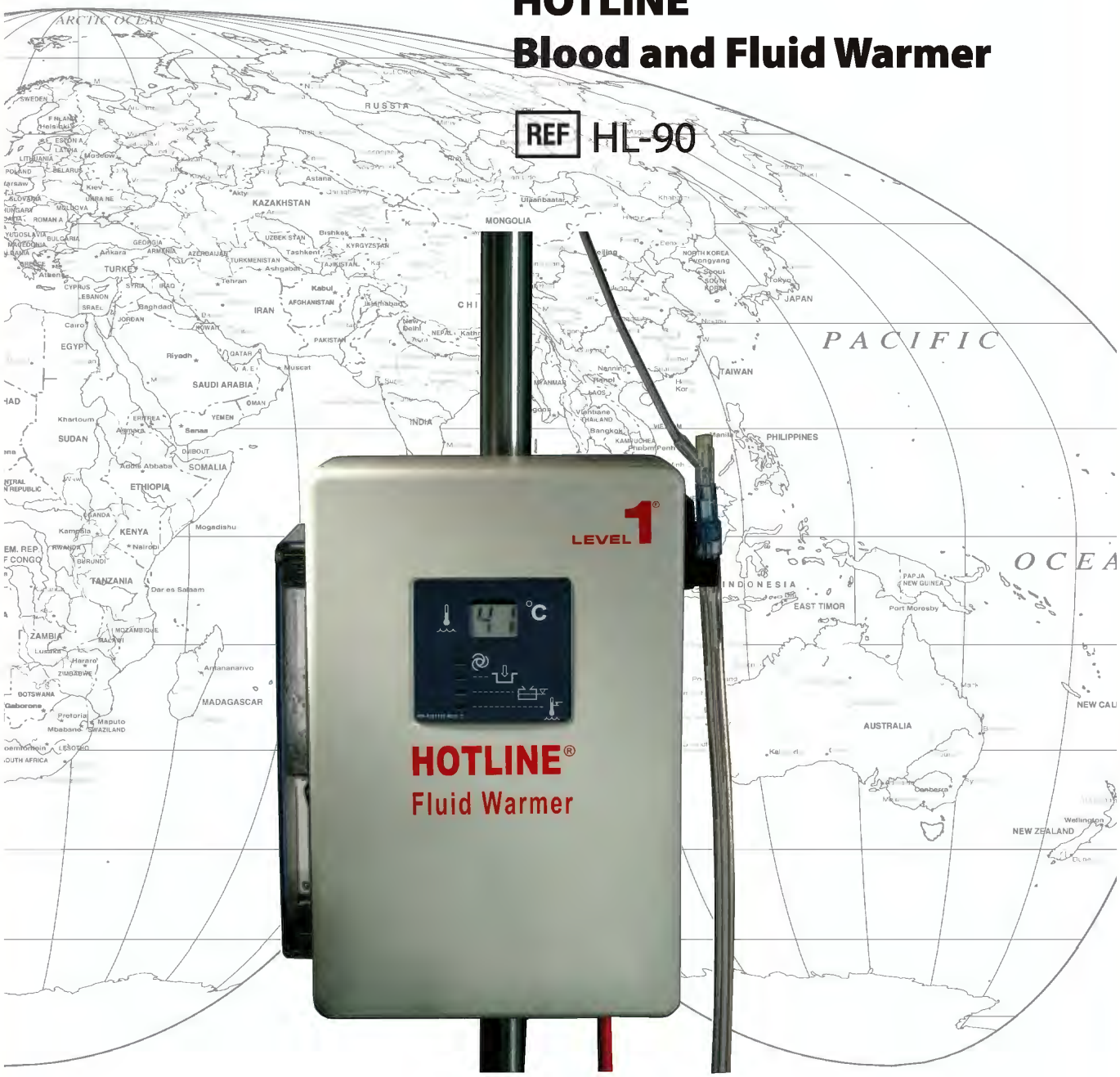
LEVEL 1®

OPERATOR'S MANUAL

en

HOTLINE®
Blood and Fluid Warmer

REF HL-90



smiths medical

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LEVEL 1®

HOTLINE®
Blood and Fluid Warmer

REF HL-90`

OPERATOR'S MANUAL

PN 10011022-003

smiths medical

HOTLINE® Blood and Fluid Warmer

Part Number: 10011022-003

This revision supercedes all previous revisions.

Every effort has been made to ensure that the information in this manual is accurate and details provided are correct at the time of printing. The company, however, reserves the right to improve the equipment shown. Mention of third-party products is for informational purposes only and constitutes neither an endorsement nor a recommendation. Smiths Medical ASD, Inc. ("Smiths Medical") assumes no responsibility with regard to the performance or use of these products.

For further information, please call your local Smiths Medical distributor or Smiths Medical direct at 1 800 258 5361 or +1 614 210 7300.

Contents

SECTION 1

About this Manual

This operator's manual describes the assembly, use, and maintenance of the HOTLINE® Blood and Fluid Warmer. This manual is intended for use by individuals trained in the healthcare and biomedical professions.

WARNING: These instructions contain important information for safe use of the product. Read the entire contents of this operator's manual, including Warnings and Cautions, before using this product. Failure to properly follow warnings, cautions, and instructions could result in death or serious injury to the patient.

Indications for Use

The HOTLINE® Blood and Fluid Warmer is designed for use with the HOTLINE® Fluid Warming Set to warm blood and intravenous (I.V.) fluids and deliver them to the patient's intravenous access site at normothermic temperatures under gravity flow conditions. The HOTLINE® Warmer is intended for use by trained medical personnel to provide routine flow of warmed I.V. fluid.

Conventions Used in this Manual

- The HOTLINE® Blood and Fluid Warmer will be referred to as the HOTLINE® Warmer.
- The L Series Fluid Warming Sets (L-70, L-70NI, L-80) will be referred to as the HOTLINE® Fluid Warming Set or Disposable Set.

Convention	Description
CONTRAINDICATION	A Contraindication statement alerts the operator to conditions when the device should not be used.
CAUTION	A Caution statement alerts the operator to conditions that may cause malfunction, failure, or damage to the device.
WARNING	A Warning statement alerts the operator to conditions that may cause death or serious injury to the patient or operator.

SECTION 2

Description

The HOTLINE® Warmer delivers blood and intravenous fluid at normothermic temperatures by surrounding the sterile intravenous line with a layer of warmed recirculating solution. An onboard recirculating solution supply is heated to 41.5°C ± 0.5 and circulated through the outer lumen of the HOTLINE® Fluid Warming Set, which surrounds the intravenous line.

The HOTLINE® Warmer employs a safe, recirculating solution heating system, inherently free of "hot spots," to actively warm the patient line. Electronic circuitry continuously monitors the recirculating solution temperature. The primary temperature control circuit limits the recirculating solution to 42°C maximum. In the unlikely event of a malfunction of this circuit, a second "watchdog" circuit will visually and audibly alarm and stop the recirculating solution pump if the temperature reaches 43.1°C. Fluid in the HOTLINE® Fluid Warming Set is never exposed to any damaging or dangerous temperatures while the HOTLINE® Warmer is operating.

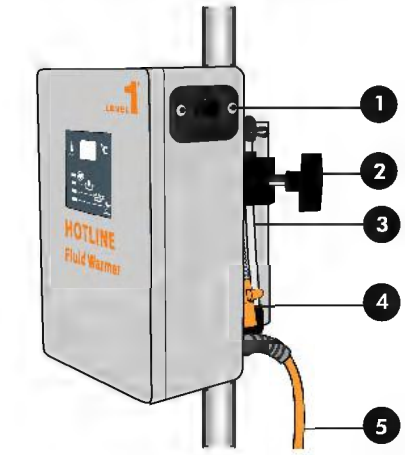
The recirculating solution temperature and visual alarms are indicated on the Display Panel on the front of the HOTLINE® Warmer. A green Operating light illuminates on this panel when the HOTLINE® Warmer is set up and operating correctly.

Components

The HOTLINE® components are called-out in the following series of figures.

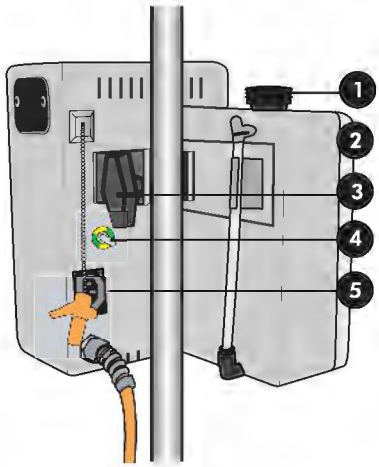
Front View

1. Socket for HOTLINE® Fluid Warming Set with the reflux plug in place
2. Display Panel



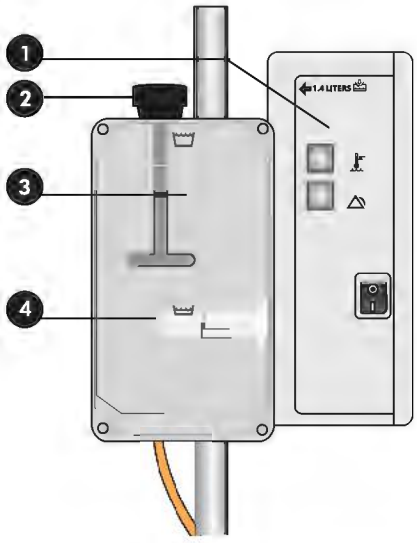
Right Side View

1. Socket with the reflux plug removed
2. Clamp for I.V. pole
3. Drain tube in tube holder
4. Reflux plug
5. Power cord



Rear View

1. Fill-port plug
2. Drain tube in tube holder
3. Clamp for I.V. pole
4. Protective earth terminal
5. Auxiliary electrical outlet (uncovered)



Left Side View

1. Power and Alarm Test Panel
2. Fill-port plug
3. Reservoir, contains recirculating solution
4. Float switch (inside reservoir)

HOTLINE® Fluid Warming Set

HOTLINE® Fluid Warming Sets (L-70, L-70NI, L-80) are individually packed, single-use disposables with a Sterile Fluid Path. The priming volume is 20 ml for the L-70 and L-70NI, and 21 ml for the L-80. The HOTLINE® Fluid Warming Set has a Twin-Tube Connector that plugs into the socket on the right side of the HOTLINE® Warmer. This is the only connection necessary to provide the warming function. The HOTLINE® Fluid Warming Set is easily unplugged from the HOTLINE® Warmer and discarded.

SECTION 3

Important Safety Information

This section covers information for prescribers and guidelines for safe use of the HOTLINE® Warmer.

CONTRAINDICATION

Not for use in warming platelets, cryo-precipitates, or granulocyte suspensions.

WARNINGS

Death or serious injury may occur to the patient or operator if these warnings are not followed.

- **These instructions contain important information for safe use of the product. Read the entire contents of this operator's manual, including Warnings and Cautions, before using this product. Failure to properly follow warnings, cautions, and instructions could result in death or serious injury to the patient.**
- **The HOTLINE® Fluid Warming Set, L-10, PC-8, and YC-8 are single-use devices and are not intended for re-sterilization.**
- **Do not use HOTLINE® Fluid Warming Set, L-10, PC-8, and YC-8 if the caps are not securely in place, else the I.V. flow path may not be sterile.**
- **The HOTLINE® Warmer is for use only with Smiths Medical supplied or approved parts, accessories, and Disposable Sets. The device may not function as intended with the use of unapproved parts, accessories, or Disposable Sets.**
- **Blood and blood products could contain pathogenic organisms. Failure to follow institutional policy and procedures for biomedical-hazardous materials could lead to exposure to harmful pathogens.**
- **Set-up, priming, and use require aseptic technique as per applicable institutional policies and procedures.**

WARNINGS *[continued]*

- **Prime the recirculating solution path before connecting to the intravenous extension set. This is to confirm that there is not a breach between the recirculating solution path and intravenouspath. If fluid exits the patient end of the HOTLINE® Fluid Warming Set before connecting to the intravenous administration set, remove and replace HOTLINE® Fluid Warming Set.**

- **Remove all air from the HOTLINE® Fluid Warming Set, L-10, PC-8, and YC-8 before connecting to the patient. Failure to do so may result in introduction of air to the patient.**

- **To reduce the risk of outgassed microbubbles entering patient vasculature, an L-10 Gas Vent may be used with the HOTLINE® Fluid Warming Set.**

- **Not for use with pressure devices generating over 300 mmHg. Pressure greater than 300 mmHg may compromise the integrity of the HOTLINE® Fluid Warming Set.**

- **To prevent a breach between the recirculating solution path and intravenous path, do not use needles greater than 38 mm (1.5") in length when accessing the injection port. If there is a breach between the recirculating solution path and intravenous path, patient illness may occur because of the HOTLINE® Warmer's recirculating solution entering the patient's bloodstream.**

- **Do not stick the HOTLINE® Fluid Warming Set with needles, as this will breach the I.V. path and compromise the integrity of the patient intravenous line. If a Disposable Set with a breached recirculating solution path/intravenous path is used, then patient illness may occur because of the HOTLINE® Warmer's recirculating solution entering the patient's bloodstream.**

- **Activation of the Over Temperature warning signal indicates that warming has stopped and immediate operator intervention is required to clear the over temperature condition or to remove the device from service.**

- **If any visual indicator does not illuminate or the audible signal does not sound, do not use the HOTLINE® Warmer. Remove the device from service immediately.**

- **Do not operate the HOTLINE® Warmer in the presence of a flammable anesthetic mixture with air, oxygen, or nitrous oxide. The risk of explosion exists if the HOTLINE® Warmer is operated in a potentially explosive environment.**

WARNINGS *[continued]*

- **Do not use the HOTLINE® Warmer in high-energy fields such as: MRI, X-RAY, portable and mobile RF communications equipment, and other such devices. The HOTLINE® Warmer may act as a projectile in a strong magnetic field, cause image artifacts, or not function as intended.**
- **Exposed conductor on MAINS power cord can cause an electrocution hazard. Remove device from service if the MAINS power cord has exposed wires.**
- **Grounding reliability can only be achieved when the MAINS power cord is connected to a properly grounded receptacle. Risk of electrical shock exists if the equipment is not connected to a properly grounded receptacle.**
- **Do not mount the HOTLINE® Warmer more than 107 cm (42") above the floor. For convenience, 107 cm (42") is indicated on the HOTLINE® Warmer power cord by a black mark. Mounting the HOTLINE® Warmer above 107 cm (42") may result in instability of the pole and tipping.**
- **Ensure that the HOTLINE® Warmer clamp is screwed tightly onto the I.V. pole. Failure to securely mount the HOTLINE® Warmer onto the I.V. pole may cause the HOTLINE® Warmer to slide down the I.V. pole.**
- **Do not use the HOTLINE® Warmer if equipment or Disposable Set malfunction is evident.**
- **No operator-serviceable parts. All service must be performed bySmiths Medical or competent personnel.**
- **No modification of this equipment is allowed.**
- **The HOTLINE® Warmer should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, you should verify normal operation of the HOTLINE® Warmer in the configuration in which it is to be used.**
- **Common portable and mobile consumer electronic devices may cause interference with the HOTLINE® Warmer. Observe the HOTLINE® Warmer to verify normal operation.**
- **Facility wiring must comply with all applicable electrical codes. Do not bypass power cord connections. Do not remove a prong from the power cord.**

CAUTIONS

Malfunction, failure, or damage to the device may occur if these cautions are not followed.

- **Federal (U.S.A.) law restricts this device to sale by or on the order of a physician.**
- **Do not autoclave or immerse any part of the HOTLINE® Warmer in liquids, which may cause damage and improper functioning.**
- **Never use organic solvents (e.g., acetone), strong acids, or bases to clean any portion of the HOTLINE® Warmer.**
- **Do not place the HOTLINE® Warmer directly under a faucet or use a faucet sprayer to rinse. Never spray cleaning or other fluids into openings on the HOTLINE® Warmer or into the external connectors.**
- **This device is cooled by convection. Be sure the air vents on the bottom and the back of the device are kept clear.**
- **Do not fill the HOTLINE® Warmer reservoir with a HOTLINE® Fluid Warming Set in place. Failure to remove the HOTLINE® Fluid Warming Set before the fill procedure may result in an air lock in the HOTLINE® Warmer.**
- **Medical devices require specific material characteristics to perform as intended. These characteristics have been verified for single use only. Any attempt to re-process the device for subsequent re-use may adversely affect the integrity of the device or lead to deterioration in performance.**

Additional WARNINGS and CAUTIONS for Accessories

WARNINGS for the L-10 Gas Vent and L-80 Fluid Warming Set

- Do not tape over vents, else air will not be vented.
- Not for use with volumetric infusion pumps, hand pumps, or syringes. These may compromise the integrity of the L-10 Gas Vent or HOTLINE® Fluid Warming Set.
- When the L-10 Gas Vent is in use, it should be placed at or below the heart level. Do not raise the gas vent above the patient's heart level. If the gas vent is raised above heart level, air may be entrained into the infusion line, possibly causing air embolism, resulting in serious injury or death.

CAUTIONS for the L-10 Gas Vent and L-80 Fluid Warming Set

- This product contains natural rubber latex, which may cause allergic reactions.

SECTION 4

Assembly Instructions

Read through the instructions completely prior to setting up the HOTLINE® Warmer.

Step 1 - Unpack the HOTLINE® Warmer

1. Open the shipping carton and remove the HOTLINE® Warmer.
2. Check the contents of the package to verify the following components are present:
   - HOTLINE® Warmer
   - Operator's Manual
   - HOTLINE® Inspection/Test Form
3. Examine the HOTLINE® Warmer for damage. If any components appear damaged, do not use the HOTLINE® Warmer. Contact Smiths Medical for a replacement.

Note: *After unpacking the HOTLINE® Warmer, recycle packaging material according to hospital policy for recyclable materials.*

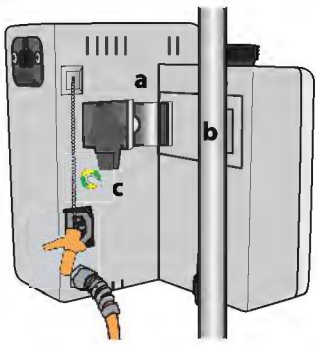
Step 2 - Clamp the HOTLINE® Warmer to the I.V. Pole

WARNINGS

- **Ensure that the HOTLINE® Warmer pole clamp is screwed tightly onto the I.V. pole. Failure to securely mount the HOTLINE® Warmer onto the I.V. pole may cause the HOTLINE® Warmer to slide down the pole and may injure the patient or operator.**
- **Do not mount the HOTLINE® Warmer more than 107 cm (42") above the floor. For convenience, 107 cm (42") is indicated on the HOTLINE® Warmer line cord by a black mark. Mounting the HOTLINE® Warmer above 107 cm (42") may result in instability of the pole and tipping that may injure the patient or operator.**

CAUTION

This device is cooled by convection. Be sure the air vents on the bottom and the back of the device are kept clear.



1 Slide the clamp **(a)** on the HOTLINE® Warmer over the I.V. pole **(b)** and tighten the clamp screw **(c)** firmly.

2 Check the tightness of the HOTLINE® Warmer to ensure it is securely clamped to the pole.

Step 3 - Disinfect the Reservoir

1 Prepare a 0.3% hydrogen peroxide solution by mixing 140 ml of 3% hydrogen peroxide solution and 1,260 ml of distilled water.

2 Remove the reflux plug from the socket if required, and then remove the fill-port plug **(d)** and fill the reservoir with 1.4 liters of 0.3% hydrogen peroxide solution.

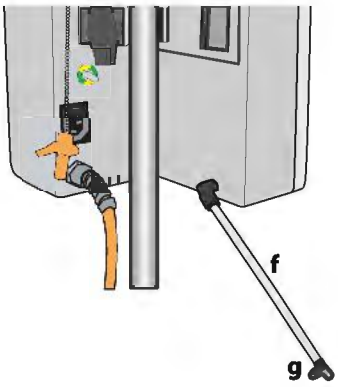
3 Replace the fill-port plug **(d)**.

4 Insert a HOTLINE® Fluid Warming Set **(e)** (L-70, L-70 NI, L-80) into the socket.

5 Plug the HOTLINE® Warmer into properly grounded power outlet.

6 Turn the HOTLINE® Warmer ON and let the solution circulate for a 30-minute disinfection period.

7 Turn the HOTLINE® Warmer OFF.



8 Invert the drain tube **(f)** and place a container under the end of the tube. Remove the end cap **(g)** and drain the recirculating solution into the container.

9 When all the recirculating solution has drained from the reservoir, replace the end cap and insert the drain tube back in the holder.

10 Remove the HOTLINE® Fluid Warming Set and discard according to established hospital procedures.

Step 4 - Fill the Reservoir With Recirculating Solution

WARNING

Do not fill the HOTLINE® Warmer reservoir with a HOTLINE® Fluid Warming Set in place. Failure to remove the HOTLINE® Fluid Warming Set before the fill procedure may result in an air lock in the HOTLINE® Warmer.

Recirculating Solution Protocols

Use one of the following solutions for the reservoir.

Recirculating Solution	Preparation	Maintenance
0.3% Hydrogen Peroxide Solution	Mix 140 ml of 3% hydrogen peroxide with 1,260 ml of distilled water.	Replace solution and disinfect reservoir every 12 months.
Distilled Water	Use distilled water.	Replace solution and disinfect reservoir every 30 days.
35% Isopropyl Alcohol Solution	Mix 700 ml of 70% isopropyl alcohol with 700 ml of distilled water.	Replace solution and disinfect reservoir every 30 days.

Note: *Use distilled water only, not tap water. Failure to do so may cause build-up of mineral deposits in the recirculating solution path, which may impair heater performance.*

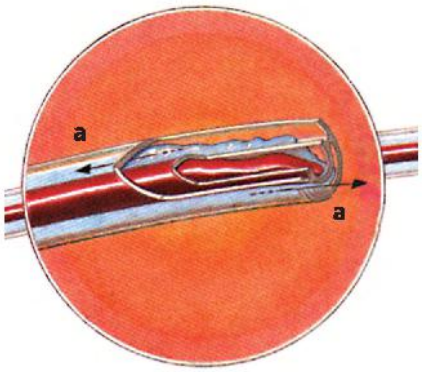
1. Prepare the recirculating solution.
2. Remove the fill-port plug **(a)**.
3. Fill the reservoir with 1.4 liters of recirculating solution.
4. Replace the fill-port plug.

Step 5 - Perform the Electrical Safety Tests

Perform all applicable electrical safety tests as required per institutional procedure. Refer to Section 9, *"Testing"*, for more information about electrical safety testing.

SECTION 5

Principle of Operation



HOTLINE® Warmer delivers blood and intravenous fluid at normothermic temperatures under routine, gravity flow rates. Conventional fluid warming systems suffer from cool-down between the warmer and the patient connection. HOTLINE® Warmer overcomes this problem by providing active warming of the patient line all the way to the patient connection.

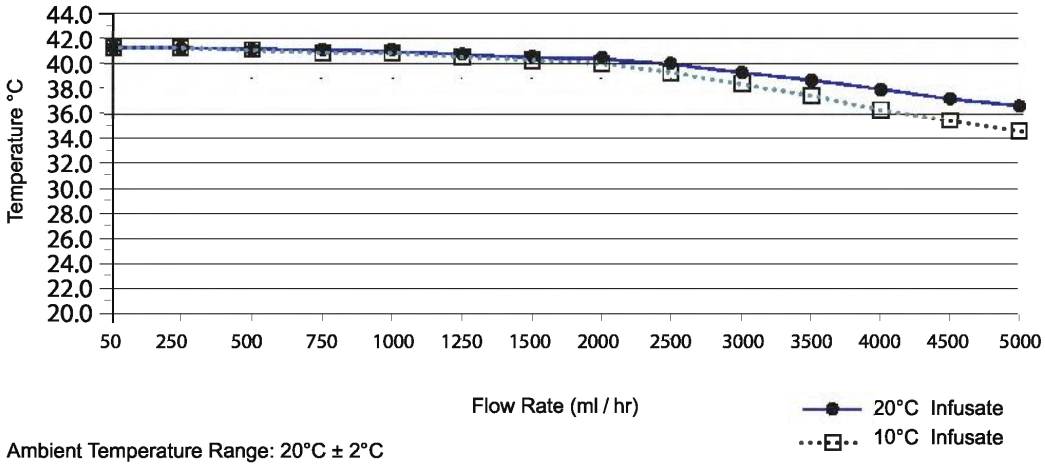
Active warming is achieved by surrounding the sterile intravenous line with a layer of precisely controlled warm recirculating solution **(a)**, thereby protecting the patient line against exposure to cold and eliminating patient line cool-down.

The unique design of the HOTLINE® Fluid Warming Set allows blood and intravenous fluid to be delivered to the patient at normothermic temperature at gravity flow rates to 50-5,000 ml/hr.

Infusate Delivery Temperatures

The following table shows the typical infusate delivery temperatures at the patient end of an L-70 HOTLINE® Fluid Warming Set.

Note: *The setpoint temperature of the recirculating solution is 41.9°C.*



Ambient Temperature Range: 20°C ± 2°C

SECTION 6

Operation

This section describes the controls and displays that monitor and control the HOTLINE® Warmer, and the modes of operation.

Controls and Displays

- Display Panel
- Power and Alarm Test Buttons
- Reservoir Level Display

Display Panel

The Display Panel is located on the front of the HOTLINE® Warmer and provides continuous information about the operation of the HOTLINE® Warmer. A liquid crystal display (LCD) indicates recirculating solution temperature. Just below the LCD, four light-emitting diodes (LEDs) indicate operation modes for the HOTLINE® Warmer.

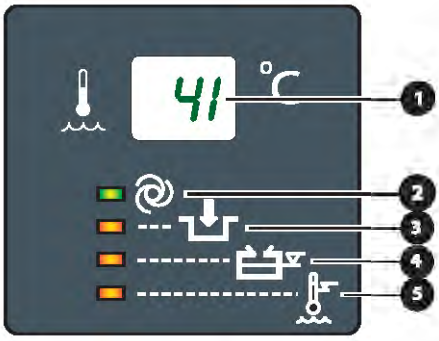
1 **Recirculating Solution Temperature** - The temperature is displayed in degrees Celsius.

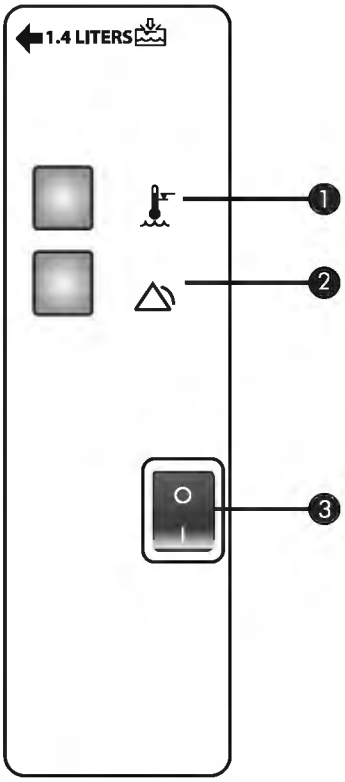
2 **ON/Operation** - The green LED illuminates when the power is turned on and the HOTLINE® Fluid Warming set is properly installed.

3 **Check Disposables** - The red LED illuminates and an audible attention signal beeps when the HOTLINE® Fluid Warming Set is not properly installed.

4 **Add Recirculating Solution** - The red LED illuminates and an audible attention signal beeps when the level in the reservoir is low and additional recirculating solution must be added.

5 **Over Temperature** - The red LED illuminates and an audible warning signal beeps when the recirculating solution is over the acceptable temperature for safe use.





Power and Alarm Test Panel

The Power and Alarm Test Panel is located on the left side of the HOTLINE® Warmer next to the reservoir. This panel contains two pressure-sensitive buttons that are activated when pressed, and the ON/OFF switch.

1 **Over Temperature Alarm Test Button -** The Over Temperature Alarm Test is used to confirm the proper operation of the Over Temperature circuitry.

2 **Alarm Test Button -** The Alarm Signal Test is used to confirm proper operation of the visual and audible alarms.

3 **Power ON/OFF Switch -** The black switch toggles to turn power ON and OFF.

Reservoir Level Display

The reservoir for the recirculating solution is located on the left side of the HOTLINE® Warmer, next to the Power and Alarm Test Panel. The level of the recirculating solution is visible in the reservoir. Two symbols indicate the maximum **(a)** and minimum **(b)** solution level requirements.

Modes of Operation

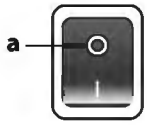
The HOTLINE® Warmer operation is defined in the following modes:

- OFF Mode
- ON/Operating Mode
- Check Disposables Mode
- Add Recirculating Solution Mode
- Over Temperature Alarm Mode

The description of each mode includes a definition of the mode, activation and/or monitoring of the mode, mode characteristics, and method to clear the mode state.

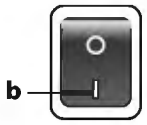
OFF Mode

The power switch is in the OFF position **(a)** and the HOTLINE® Warmer is turned off.



ON/Operating Mode

The power switch is in the ON position **(b)** and the HOTLINE® Fluid Warming Set has been properly installed.



Mode characteristics

- The green Operating LED **(c)** illuminates.
- The reservoir temperature display will begin to increase.
- The recirculating solution path in the HOTLINE® Fluid Warming Set will automatically prime.

Check Disposables Mode

The Check Disposables mode indicates a missing or improperly installed HOTLINE® Fluid Warming Set.

Mode characteristics

- The green Operating LED on the Display Panel turns off.
- The red Check Disposables LED **(d)** on the Display Panel illuminates.
- The audible alarm sounds (54-59 dB) and repeats approximately every two seconds.
- The recirculating solution stops circulating.

To clear this mode, check that the Twin-Tube Connector on the HOTLINE® Fluid Warming Set is firmly inserted in the socket.

Add Recirculating Solution Mode

The Add Recirculating Solution mode indicates that the solution level in the reservoir is below its minimum level.

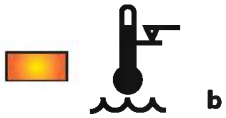
Mode characteristics

- The green Operating LED on the Display Panel turns off.
- The red Add Solution LED **(a)** on the Display Panel illuminates.
- The audible alarm sounds (54-59 dB) and repeats approximately every two seconds.
- The recirculating solution stops circulating.

To clear this mode, add recirculating solution to the reservoir.

Over Temperature Alarm Mode

The Over Temperature Alarm mode indicates that the temperature of the recirculating solution is at or above 43.1°C.



Mode characteristics

- The green Operating LED on the Display Panel turns off.
- The red Over Temperature LED **(b)** on the Display Panel illuminates.
- The audible alarm sounds (54-59 dB) and repeats approximately every two seconds.
- The recirculating solution stops circulating.

For instructions to clear this mode, see Section 8, *"Troubleshooting"*.

SECTION 7

Operating Instructions

The Operating Instructions are grouped into five segments. Read through each segment BEFORE performing a procedure.

WARNINGS

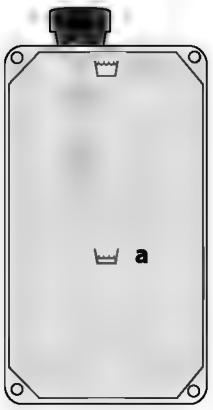
- **Set-up, priming, and use require aseptic technique as per applicable institutional policies and procedures. Death or serious injury may occur to the patient or operator if this warning is not followed.**
- **Grounding reliability can only be achieved when MAINS power cords are connected to a properly grounded receptacle. Risk of electrical shock exists if the equipment is not connected to a properly grounded receptacle.**
- **Do not fill the HOTLINE® reservoir with a HOTLINE® Fluid Warming Set in place. Failure to remove the HOTLINE® Fluid Warming Set before the fill procedure may result in an air lock in the HOTLINE® Warmer.**

Step 1 - Set Up the HOTLINE® Warmer

1 Check that the level is above the minimum level mark **(a)** on the reservoir. Add recirculating solution to the reservoir through the fill-port if required.

2 Check the condition of the HOTLINE® Warmer with a visual inspection before using. Remove from service any HOTLINE® Warmer that shows physical damage.

3 Plug the HOTLINE® Warmer into properly grounded power outlet.



Step 2 - Set Up the HOTLINE® Fluid Warming Set

WARNINGS

- **The HOTLINE® Fluid Warming Set is a single-use device and is not intended for re-sterilization. Death or serious injury may occur to the patient or operator if this warning is not followed.**
- **Do not use HOTLINE® Fluid Warming Set, L-10, PC-8, and YC-8 if the caps are not securely in place, else flow path may not be sterile and may cause death or serious injury.**
- **Prime the recirculating solution path before connecting to the intravenous extension set. This is to confirm that there is not a breach between the recirculating solution path and intravenous path. If fluid exits the patient end of the HOTLINE® Fluid Warming Set before connecting to the intravenous extension set, remove and replace HOTLINE® Fluid Warming Set. Death or serious injury may occur to the patient or operator if this warning is not followed.**

To set up the HOTLINE® Fluid Warming Set, you will need the following:

- HOTLINE® Warmer
- Intravenous administration set
- Intravenous fluid or blood
- Extension Set, 20 cm (8") or less in length (optional)

1. Remove the reflux plug (if present) from the socket on the right side of the HOTLINE® Warmer.
2. Plug the Twin-Tube Connector on the HOTLINE® Fluid Warming Set **(a)** into the socket.
3. Turn ON the power switch.
   - The green Operating LED on the Display Panel illuminates.
   - The recirculating solution temperature display will begin to increase.
   - The recirculating solution path in the HOTLINE® Fluid Warming Set will automatically prime.
4. Remove the end cap and inspect the patient end of the HOTLINE® Fluid Warming Set for leaks to confirm the integrity of the intravenous pathway.

Step 3 - Connect the Intravenous Administration Set

WARNINGS

- **Remove all air from the HOTLINE® Fluid Warming Set, L-10, PC-8, and YC-8 before connecting to the patient. Failure to do so may result in introduction of air to the patient, which may contribute to serious patient injury or death.**

- **To prevent a breach between the recirculating solution path and intravenous path, do not use needles greater than 38 mm (1.5") in length when accessing the injection port. If there is a breach between the recirculating solution path and intravenous path, patient illness may occur because of the HOTLINE® Warmer's recirculating solution entering the patient's bloodstream.**

- **Do not stick the HOTLINE® Fluid Warming Set with needles, as this will breach the I.V. path and compromise the integrity of the patient intravenous line. If a Disposable Set with a breached recirculating solution path/intravenous path is used, then patient illness may occur because of the HOTLINE® Warmer's recirculating solution entering the patient's blood stream.**

1. Connect the I.V. fluid and the intravenous administration set to the HOTLINE® Fluid Warming Set.
2. Fully prime the intravenous administration set, the HOTLINE® Fluid Warming Set, and patient extension set (if used).
3. Connect the distal end of the HOTLINE® Fluid Warming Set to the patient's intravenous access site without entrapping air.

Step 4 - Using the HOTLINE® Warmer

WARNINGS

- **Activation of the Over Temperature warning signal indicates that warming has stopped and immediate operator intervention is required to clear the over temperature condition or to remove the device from service. Death or serious injury may occur to the patient or operator if this warning is not followed.**

- **If any visual indicator does not illuminate or the audible signal does not sound, do not use the HOTLINE® Warmer. Remove the device from service immediately. Death or serious injury may occur to the patient or operator if this warning is not followed.**

WARNINGS ***[continued]***

- **Not for use with pressure devices generating over 300 mmHg. Pressure greater than 300 mmHg may compromise the integrity of the HOTLINE® Fluid Warming Set.**

1 Wait until the recirculating solution temperature display reaches 41°C, which indicates the HOTLINE® Warmer is ready for use.

2 Adjust the rate of I.V. flow using the clamp on the intravenous administration set.

Note: *Do not kink the Disposable Set. Do not restrict the circulation of the solution through the tubing.*

Step 5 - After Use

WARNING

Blood and blood products could contain pathogenic organisms. Failure to follow institutional policy and procedures for biomedical-hazardous materials could lead to exposure to harmful pathogens.

1 Turn OFF the power switch.

2 Remove the HOTLINE® Fluid Warming Set, and insert the reflux plug **(a)** into the socket.

3 After use, handle and dispose of the HOTLINE® Fluid Warming Set in a safe manner according to local guidelines for disposal of contaminated medical waste.

4 Wipe down the external surfaces of the HOTLINE® Warmer with mild liquid detergent soap and warm tap water mixture and a soft cloth or sponge. See Section 10, *"Maintenance"*, for more details about cleaning and external disinfection.

Storage

Store the HOTLINE® Warmer in a cool, dry place. Do not expose to extreme temperatures. See Section 13, *"Specifications and Accessories"*, for more details.

SECTION 8

Troubleshooting

Only competent personnel should perform any routine maintenance and repairs to the HOTLINE® Warmer.

Problem	Check the following
No power	1 Confirm that the HOTLINE® Warmer is plugged in properly. 2 Confirm that the power switch is in the ON position. **Note:** *If the HOTLINE® Warmer is plugged in and the power switch is turned ON, the green or red LED will illuminate.*
Check Disposables alarm	Confirm that the HOTLINE® Fluid Warming Set is properly installed. 1 Push the Twin-Tube Connector firmly into the socket on the right side of the HOTLINE® Warmer. **Note:** *Turn OFF the power switch before replacing the HOTLINE® Fluid Warming Set.* 2 If the alarm is not cleared, replace the HOTLINE® Fluid Warming Set. Turn ON the power switch and verify that the alarm has cleared. 3 If the alarm is not cleared, remove the HOTLINE® Warmer from service.
Add Recirculating Solution alarm	Check the level in the reservoir • Turn OFF the power switch, remove the HOTLINE® Fluid Warming Set if installed, and add recirculating solution to the maximum level.
Over Temperature alarm	1 Check the HOTLINE® Fluid Warming Set for kinks or other restrictions. 2 Check for air lock: a Turn the power switch OFF, remove the HOTLINE® Fluid Warming Set, and gently shake HOTLINE® Warmer to dislodge air. b Plug in the HOTLINE® Fluid Warming Set and turn power switch ON. c If the alarm is not cleared, remove the HOTLINE® Warmer from service and return it for repair or replacement.
Hot cabinet	Check for blocked air vents on the bottom or the back of the HOTLINE® Warmer. **Note:** *Room temperature above 42°C may cause the HOTLINE® Warmer to shut down and the Over Temperature alarm to activate. In this situation, turn the power switch OFF and allow the HOTLINE® Warmer to cool down before returning it to service.*

Problem	Check the following
Difficult to install the HOTLINE® Fluid Warming Set	Lubricate O-rings in the socket. Refer to Section 10, *"Maintenance"*, for the procedure.
Recirculating solution leaks at the socket where the HOTLINE® Fluid Warming Set plugs into the HOTLINE® Warmer	Replace O-rings. Use the O-ring Replacement Kit: P/N 80-04-001. Refer to Section 10, *"Maintenance"*, for the procedure.
Electrical interference - receiving or transmitting	1 Move the HOTLINE® Warmer away from the device in question. 2 Plug the HOTLINE® Warmer into a separate electrical circuit. • If the problem continues, notify Smiths Medical or your local Smiths Medical distributor.

SECTION 9

Testing

The HOTLINE® Warmer should be tested by hospital biomedical personnel prior to placing it in service. All testing and maintenance should be performed by competent personnel. If competent personnel are not available, contact Smiths Medical or your local Smiths Medical distributor.

If the HOTLINE® Warmer and any installed accessories do not pass any of the listed tests, discontinue use of the HOTLINE® Warmer and remove from service. Contact Smiths Medical or your local Smiths Medical distributor.

WARNING

If any visual indicator does not illuminate or the audible signal does not sound, do not use the Fluid Warmer. Remove the device from service immediately. Death or serious injury may occur to the patient or operator if this warning is not followed.

Note: *Alarm testing requires a HOTLINE® Fluid Warming Set to be installed and that the HOTLINE® Warmer be turned ON and in the Operating mode.*

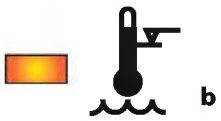
Alarm Signal Test

The Alarm Signal Test is used to confirm proper operation of the visual and audible alarm indicators.

1 Press and hold the Alarm Test button **(a)**.

2 Observe the following:

- The green Operating LED turns off.
- Three red LEDs (Check Disposables, Add Solution, and Over Temperature) illuminate.
- The audible alarm sounds (54-59dB) and repeats approximately every two seconds.



Over Temperature Alarm Test

The HOTLINE® Warmer should be running at an operating temperature of approximately 41°C to 42°C.

1. Press and hold the Over Temperature Alarm Test button **(a)**.
2. Observe the following:
   - The recirculating solution Over Temperature Alarm activates at 43°C.
   - The green Operating LED turns off.
   - The red Over Temperature LED **(b)** illuminates.
   - The audible alarm sounds (54-59 dB) and repeats approximately every two seconds.
3. Stop pressing the Over Temperature Alarm Test button to stop the test.

Add Recirculating Solution Test

The HOTLINE® Warmer is equipped with a float switch, which senses the recirculating solution level in the reservoir. When the recirculating solution is too low, the Add Recirculating Solution Alarm will activate.

1. Remove the fill-port plug **(c)** on the reservoir.
2. Gently depress the float switch **(d)**. (This action will simulate the low solution condition.)

   Note: *Use a non-metal tool to depress the float switch because the float switch contains a magnet.*
3. Observe the following:
   - The green Operating LED turns off.
   - The red Add Recirculating Solution LED **(e)** illuminates.
   - The audible alarm sounds (54-59 dB) and repeats approximately every two seconds.

Check Disposables Test

An interlock switch/sensor, located in the socket on the right side of the HOTLINE® Warmer, senses a properly installed HOTLINE® Fluid Warming Set. When the switch does not sense a HOTLINE® Fluid Warming Set, the Check Disposables alarm activates.

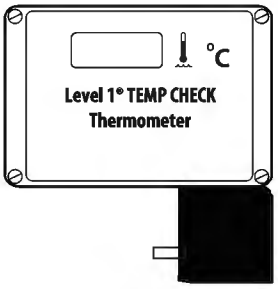
1 Slowly remove the HOTLINE® Fluid Warming Set **(a)** from the HOTLINE® Warmer socket.

2 Observe the following actions:

- The green Operating LED turns off.
- The red Check Disposables LED **(b)** illuminates.
- The audible alarm sounds (54-59dB) and repeats approximately every two seconds.

Note: *In any alarm condition, the pump should not be running. A small amount of solution dripping from the disconnection is normal and should stop in a few seconds.*

Temperature Verification of the Recirculating Solution



Use the Level 1® TEMP CHECK Thermometer (HLTA-40) to verify the displayed recirculating solution temperature. Other methods of temperature verification may be inaccurate.

TEMP CHECK provides an accurate reading of the highest temperature of the recirculating solution. Because the temperature of the reservoir is typically 0.5°C to 2.0°C lower than the temperature from the heater, and the temperature of the recirculating solution begins to drop due to the effect of ambient temperature on the HOTLINE® Fluid Warming Set, the highest temperature of the solution is just after it leaves the heater. During the temperature verification test, the TEMP CHECK is positioned on the right side of the HOTLINE® Warmer attached to the socket and senses the solution just after it leaves the heater and before it enters the HOTLINE® Fluid Warming Set.

Refer to the TEMP CHECK HLTA-40 Thermometer Operator's Manual for complete Temperature Verification and Calibration Instructions.

To verify the recirculating solution temperature, you will need the following:

- TEMP CHECK (HLTA-40)
- HOTLINE® Warmer
- HOTLINE® Fluid Warming Set

To Verify the Recirculating Solution Temperature:

1. Plug the HOTLINE® Warmer into a power outlet.
2. Place the TEMP CHECK on the top right corner of the HOTLINE® Warmer and plug it into the socket on the right side of the HOTLINE® Warmer.
3. Plug the Twin-Tube Connector on the HOTLINE® Fluid Warming Set into the socket on the right side of the TEMP CHECK.
4. Remove the black label from the auxiliary outlet on the back of the HOTLINE® and plug in the TEMP CHECK power cord.

   Note: *The auxiliary outlet is for use only with Smiths Medical accessories.*
5. Turn ON the HOTLINE® Warmer. Allow 15 minutes for the temperature to stabilize.
6. If the TEMP CHECK display indicates a temperature between 41°C and 42°C, and the HOTLINE® Warmer display equals the TEMP CHECK display, recirculating solution verification is complete. Refer to the TEMP CHECK Manual for OVERTEMP ALARM verification.
7. If the TEMP CHECK display does not indicate a temperature between 41°C and 42°C, refer to the TEMP CHECK Manual for calibration instructions.

Periodic Electrical Testing

Electrical Safety Tests must be performed by competent personnel authorized by the institution to perform such testing. The Safety Tests must be performed and documented at least once per year, or according to institutional policy. These tests include but are not limited to:

- Leakage current
- Ground bond test

Note: *All equipment connecting to the device must conform to IEC or ISO standards for requirements for medical electrical systems (e.g., IEC 60601-1 or clause 16 of IEC 60601-1 3Ed.). Any persons connecting additional equipment to the device, is responsible that the device system created as a result complies with the standard requirements for medical electrical systems.*

Leakage Current

Leakage current must be tested according to methods and pass/fail criteria described in IEC 60601-1. Leakage current must be performed with the heater circuit in the full ON condition. To achieve this condition, perform the test when the reservoir is at room temperature. When the HOTLINE® Warmer is first turned on and the temperature is rapidly rising, but still below 41°C, the heater circuit is in a full ON condition.

Note: *The HOTLINE® Warmer is equipped with sensing interlocks. A HOTLINE® Fluid Warming Set is required to correctly operate the HOTLINE® Warmer and perform leakage current testing. Do not defeat the sensing interlocks or try to operate the HOTLINE® without a HOTLINE® Fluid Warming Set in place.*

Ground Bond Test

Ground bond test must be tested according to methods and pass/fail criteria described in IEC 60601-1.

SECTION 10

Maintenance

Only competent personnel should perform any routine maintenance and repairs to the HOTLINE® Warmer. Maintenance is scheduled with each use, every 30 days, and every 12 months. The tasks are described below.

Maintenance Performed with Every Use

CAUTION

Do not autoclave or immerse any part of the HOTLINE® Warmer in liquids, which may cause damage and improper functioning.

Clean and inspect the HOTLINE® Warmer.

Clean the Exterior

Clean the entire HOTLINE® Warmer after every use.

CAUTIONS

- **Never use organic solvents (e.g., acetone), strong acids, or bases to clean any portion of the HOTLINE® Warmer**
- **Do not place the HOTLINE® Warmer directly under a faucet or use a faucet sprayer to rinse. Never spray cleaning or other fluids into openings on the HOTLINE® Warmer or into the external connectors.**

1. To isolate equipment from MAINS, unplug the HOTLINE® Warmer before servicing.
2. Visually inspect the HOTLINE® Warmer to ensure there is no visible damage or deterioration of the enclosure such as cracks, or deterioration of the labels and power cord. Do not clean if there is a defect. Contact Smiths Medical or your local Smiths Medical distributor.
3. Immerse a soft cloth or sponge as an applicator into the cleaning solution consisting of mild liquid detergent soap and warm tap water mixture. Squeeze out excess solution so that the applicator is not dripping. Wipe or scrub the entire surface of the enclosure and control panels. Use a soft brush to clean the power cord if necessary.

4 Rinse a separate soft cloth or sponge in room temperature running potable water. Squeeze out excess water so that the applicator is not dripping. Wipe all of the aforementioned surfaces. Repeat rinsing the cloth or sponge several times with fresh running water during this process to insure all visible residue is removed.

5 Dry the item with a hand towel or soft cloth.

6 Visually inspect the HOTLINE® Warmer and its components to insure that they have been thoroughly cleaned. Repeat cleaning procedure if necessary.

7 After thoroughly cleaning the HOTLINE® Warmer, perform disinfection if required.

8 If it is hospital policy to perform disinfection as part of reprocessing, then follow your institution's guidelines for disinfecting of the surfaces of non-critical medical devices. The list below includes low-level disinfectants that are commonly used in the medical community and high-level disinfectants that are claimed by the manufacturer. The effectiveness of these listed disinfectants should be validated using the hospital procedures.

   The following disinfectant agents can be used without causing damage to the enclosure:

   Low Level Disinfectants:

   - fantastik® All Purpose Cleaner

   High Level Disinfectants:

   - 1.56% Phenol (e.g., Sporicidin®)
   - 3.4% Glutaraldehyde (e.g., CIDEX® Plus)
   - 10% Bleach solution
   - 1% Ammonia solution
   - Surface disinfectants compatible with plastic materials.

9 Rinsing of the disinfectant residue should be done using a soft cloth or sponge as the applicator.

General Inspection

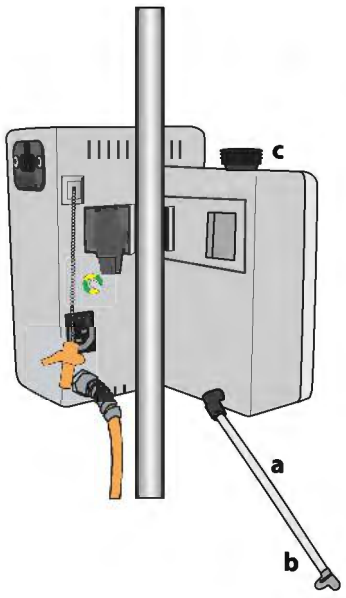
- Check the condition of the HOTLINE® Warmer with a visual inspection before using. Remove from service any HOTLINE® Warmer that shows physical damage.
- If the HOTLINE® Fluid Warming Set does not install easily, lubricate the O-Rings as directed in the following section.

Disinfect the Reservoir and Change the Recirculating Solution

Disinfect the reservoir and change the recirculating solution every 30 days or every 12 months based on the recirculating solution used for the HOTLINE® Warmer. Refer to the following table for the maintenance schedule.

Recirculating Solution	Preparation	Maintenance
0.3% Hydrogen Peroxide Solution	Mix 140 ml of 3% hydrogen peroxide with 1,260 ml of distilled water.	Replace solution and disinfect reservoir every 12 months.
Distilled Water	Use distilled water.	Replace solution and disinfect reservoir every 30 days.
35% Isopropyl Alcohol Solution	Mix 700 ml of 70% isopropyl alcohol with 700 ml of distilled water.	Replace solution and disinfect reservoir every 30 days.

Note: *Use distilled water only, not tap water. Failure to do so may cause build-up of mineral deposits in the recirculating solution path, which may impair heater performance.*



Disinfect the Reservoir

1. To isolate equipment from MAINS, unplug the HOTLINE® Warmer before servicing.
2. Remove the drain tube from the holder on the rear of the HOTLINE® Warmer.
3. Invert the drain tube **(a)** and place a container under the end of the tube. Remove the end cap **(b)** and drain the recirculating solution into the container.
4. When all the recirculating solution has drained from the reservoir, replace the end cap and insert the drain tube back in the holder.
5. Prepare a 0.3% hydrogen peroxide solution by mixing 140 ml of

3% hydrogen peroxide solution and 1,260 ml of distilled water.

6 Remove the fill-port plug **(c)**, fill the reservoir with the hydrogen peroxide solution, and replace the fill-port plug.

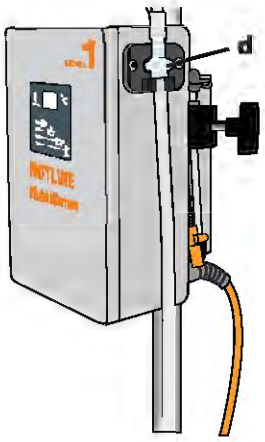
7 Remove the reflux plug from the socket if required, and insert a HOTLINE® Fluid Warming Set **(d)** (L-70, L-70NI, L-80) into the socket.

8 Turn the HOTLINE® Warmer ON, and let the recirculating solution circulate for a 30-minute disinfection period.

9 Turn the HOTLINE® Warmer OFF and to isolate equipment from MAINS, unplug the power cord.

10 Empty the reservoir.

11 Remove the HOTLINE® Fluid Warming Set and discard according to established hospital procedures.



These suggested instructions are designed to be used in conjunction with established hospital procedures.

Add Recirculating Solution

CAUTION

Do not fill the HOTLINE® Warmer reservoir with a HOTLINE® Fluid Warming Set or a TEMP CHECK in place. Failure to remove the HOTLINE® Fluid Warming Set before the fill procedure may result in an air lock in the HOTLINE® Warmer.

1 Prepare the recirculating solution.

2 Remove the fill-port plug.

3 Fill the reservoir with 1.4 liters of recirculating solution.

4 Replace the fill-port plug.

Maintenance Performed Every 30 Days

Disinfect the Reservoir and Change Recirculating Solution for Distilled Water and 35% Isopropyl Alcohol Solution

Refer to *Disinfect the Reservoir and Change the Recirculating Solution* procedure in this section.

Lubricate O-Ring Seals

1 Place a small amount of silicone lubricant on a cotton swab.

2 Apply silicone lubricant along the O-Rings inside the socket **(a)** located on the right side of the HOTLINE® Warmer.

Silicone lubricant is available from Smiths Medical, (Silicone lubricant P/N 80-04-002).

Maintenance Performed Every 12 Months

Disinfect the Reservoir and Change Recirculating Solution for 0.3% Hydrogen Peroxide Solution

Refer to *Disinfect the Reservoir and Change the Recirculating Solution* procedure in this section.

Replace O-Rings (O-Ring Kit: P/N 80-04-001)

1. To isolate equipment from MAINS, unplug the HOTLINE® Warmer before servicing.
2. Remove the socket head screws **(b)** with a 0.31 cm (1/8") hex wrench.
3. Remove the face plate, being careful not to damage the micro-switch lever.
4. Remove the old O-rings and clean the sockets with a cotton swab.
5. Apply silicone lubricant to two new O-rings and install into the sockets.
6. Reassemble in reverse order, being careful not to damage the micro-switch lever.
7. Insert HOTLINE® Fluid Warming Set and power on HOTLINE® Warmer to verify that there are no leaks around the face plate.

Testing HOTLINE® Warmer Operation

Perform all the tests described in the testing section of this manual. See Section 9, *"Testing"*. The Scheduled Maintenance Checklist below also lists the tests.

Maintenance Log

All maintenance and testing should be done by competent personnel. Regularly scheduled maintenance ensures proper functioning of the equipment. Refer to the table below for required tasks and frequency of routine maintenance.

Maintenance Checklist

Task	Every Use	Every 30 Days	Every 12 Months
Clean the Exterior	☐		
General Inspection	☐		
Disinfect the Reservoir and Change Distilled Water or Isopropyl Alcohol solution		☐	
Lubricate the O-Rings		☐	☐
Disinfect the Reservoir and Change the Hydrogen Peroxide Solution			☐
Replace the O-Rings			☐
Alarm Signal Test			☐
Add Recirculating Solution Test			☐
Check Disposables Test			☐
Over Temperature Alarm Test			☐
Verify Temperature Calibration			☐
Electrical Safety Tests			☐

SECTION 11

Limited Warranty

Smiths Medical ASD, Inc. (the "Manufacturer") warrants to the Original Purchaser that the HOTLINE® Blood and Fluid Warmer (the "HOTLINE® Warmer"), not including accessories, shall be free from defects in materials and workmanship under normal use, if used in accordance with this Operator's Manual, for a period of one year from the actual date of sale to the Original Purchaser. THERE ARE NO OTHER WARRANTIES.

This warranty does not cover normal wear and tear and maintenance items, and excludes any accessory items or equipment used with the HOTLINE® Warmer.

Subject to the conditions of and upon compliance with this Limited Warranty, the Manufacturer will repair or replace at its option without charge (except for a minimal charge for postage and handling) any HOTLINE® Warmer (not including accessories) which is defective if a claim is made during such one-year period.

The following conditions, procedures, and limitations apply to the Manufacturer's obligation under this warranty:

A. Parties Covered by this Warranty: This warranty extends only to the Original Purchaser of the HOTLINE® Warmer. This warranty does not extend to subsequent purchasers. The Original Purchaser may be medical personnel, a hospital, or institution which purchases HOTLINE® Warmers for treatment of patients. The Original Purchaser should retain the invoice or sales receipt as proof as to the actual date of purchase.

B. Warranty Performance Procedure: Notice of the claimed defect must be made in writing or by telephone to the Manufacturer as follows: Customer Service Department, Smiths Medical ASD, Inc., 6000 Nathan Lane North, Minneapolis, MN 55442, (800) 258-5361. Notice to the Manufacturer must include date of purchase, model and serial number, and a description of the claimed defect in sufficient detail to allow the Manufacturer to determine and facilitate any repairs which may be necessary. AUTHORIZATION MUST BE OBTAINED PRIOR TO RETURNING THE HOTLINE® WARMER. If authorized, the HOTLINE® Warmer must be properly and carefully packaged and returned to the Manufacturer, postage prepaid. Any loss or damage during shipment is at the risk of the sender.

C. Conditions of Warranty: The warranty is void if the HOTLINE® Warmer has been 1) repaired by someone other than the Manufacturer or its authorized agent; 2) altered so that its stability or reliability is affected; 3) misused; or 4) damaged by negligence or accident. Misuse includes, but is not limited to, use not in compliance with the Operator's Manual or use with non-approved accessories. Removal or damage to the HOTLINE® Warmer's serial number will invalidate this warranty.

D. Limitations and Exclusions: Repair or replacement of the HOTLINE® Warmer or any component part thereof is the EXCLUSIVE remedy offered by the Manufacturer. The following exclusions and limitations shall apply:

1. No agent, representative, or employee of the Manufacturer has authority to bind the Manufacturer to any representation or warranty, expressed or implied.
2. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS OR USE OF THE HOTLINE® WARMER FOR ANY PARTICULAR PURPOSE.
3. The HOTLINE® Warmer can only be used under the supervision of medical personnel whose skill and judgment determine the suitability of the HOTLINE® Warmer for any particular medical treatment.
4. All recommendations, information, and descriptive literature supplied by the Manufacturer or its agents are believed to be accurate and reliable, but do not constitute warranties.

The Manufacturer disclaims responsibility for the suitability of the HOTLINE® Warmer for any particular medical treatment or for any medical complications resulting from the use of the HOTLINE® Warmer. The Manufacturer shall not be responsible for any incidental damages or consequential damages to property, loss of profits, or loss of use caused by any defect or malfunction of the HOTLINE® Warmer.

This warranty gives the Original Purchaser specific legal rights, and the Original Purchaser may have other legal rights which may vary from state to state.

SECTION 12

Service

WARNING

No operator-serviceable parts. All service must be performed by Smiths Medical or competent personnel. Death or serious injury may occur if this warning is not followed.

All service must be performed by Smiths Medical or competent personnel. Service by any other person or organization voids the warranty and transfers liability for malfunctions of the device to the servicing organization.

Non-Warranty Work

Devices received that are no longer under warranty can be returned for repair at a cost. The device will be promptly inspected and a verbal estimate of the repair cost will be provided. A purchase order will be required from the original purchaser consistent with the verbal estimate. A written estimate will be provided upon request.

Before returning the HOTLINE® Warmer for service, contact Smiths Medical for Returned Goods Authorization. Be sure that ALL recirculating solution is drained from the device before packing the HOTLINE® Warmer for shipment.

Note: *The HOTLINE® Warmer must be cleaned and disinfected for repair shipment or it will be immediately returned as received.*

Additional Documentation

Upon request Smiths Medical will provide the following documentation:

- Circuit diagrams
- Components parts list(s)
- Description of function
- Service and calibration instructions

Disposal Information

Observe national and local codes or requirements for disposal of contaminated materials and for recycling of solid waste materials that may impact the environment.

Service Contacts

Contact your Smiths Medical Technical Service Department or Smiths Medical distributor at:

USA/Canada

Smiths Medical ASD, Inc.
6000 Nathan Lane North
Minneapolis, MN 55442 USA
Tel: 1 800 258 5361 (US/CA)
Tel: + 1 614 210 7300

European Representative

Smiths Medical Czech Republic a. s.
Olomoucká 306, Hranice 1 - Město,
753 01 Hranice, Czech Republic
Tel: +44 (0)1233 722100

www.smiths-medical.com

SECTION 13

Specifications and Accessories

System Specifications

Standard Compliance	Guidelines		
Product Safety	IEC 60601-1		
EMC	EN 60601-1-2, FCC 47 CFR Part 15, Class A		
Enclosure Protection	IEC 60529 IP Code: IPX1		
Fluid Warmers	ASTM F2172-02		
Physical	**Dimensions**		
Height, Overall	24.1 cm	(9.5 inches)	
Width, Overall	21.0 cm	(8.3 inches)	
Depth, Overall	17.8 cm	(7.0 inches)	
Weight, Dry	3.5 Kg	(7.6 lbs)	
Weight, Wet (with recirculating solution)	5.0 Kg	(11.0 lbs)	
Weight, Shipping	3.6 Kg	(7.95 lbs)	
Recirculating Solution Capacity	1.4 L	(0.37 gallons)	
Maximum Height on I.V. Pole	107 cm	(42 inches)	
Environmental	**Temperature**	**Humidity [%]**	**Atmospheric Pressure**
Operation	10°C to 45°C	10 to 95	70kPa to 106kPa
Transportation	-18°C to 60°C	5 to 90	70kPa to 106kPa
Storage	-18°C to 60°C	5 to 90	70kPa to 106kPa
Thermal	**Temperature**		
Temperature Set Point	41.9°C ± 0.1°C		
Over Temperature Set Point	43.1°C		
Electrical	**Type**		
MAINS Power Input:			
100V	100VAC, 50/60 Hz, 3.8 Amps		
115V	115VAC, 50/60 Hz, 3.0 Amps		
230V	230VAC, 50/60 Hz, 1.5 Amps		

Electrical	**Type**
MAINS Auxiliary Supply Power Output:	
100V	100VAC, 50/60 Hz, 1.0 Amps
115V	115VAC, 50/60 Hz, 1.0 Amps
230V	230VAC, 50/60 Hz, 0.6 Amps
Protection Against Electrical Shock	Class 1 Equipment, Type BF Applied Part (Disposable set)
Mode of Operation	Continuous
Type of Current	Alternating
Ingress Protection Rating	IPX1
Performance	
Recirculating Solution Temperature	Recirculating solution temperature reaches 37°C from ambient in about 4 minutes
Normothermic Flow Rates	At gravity flow rates to 5,000 ml per hour

Electromagnetic Compliance

HOTLINE® Warmer is certified to be in compliance with the European Communities Council Directive relating to Electromagnetic Compatibility (EMC): (89/336/EEC). Test methods and acceptance criteria as specified in EN 60601-1-2 demonstrate conformance.

Guidance and Manufacturer's Declaration – Electromagnetic Emissions		
Emissions test	Compliance	Electromagnetic environment - guidance
RF emissions CISPR 11	Group 1	The HOTLINE® Warmer uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	Note: The EMISSIONS characteristics of this equipment make it suitable for use in industrial areas and hospitals (CISPR 11 class A). If it is used in a residential environment (for which CISPR 11 class B is normally required) this equipment might not offer adequate protection to radio-frequency communication services. The operator might need to take mitigation measures, such as relocating or re-orienting the equipment.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	
Note: Compliance using 100-240V 50/60Hz with AC power cord of 3.8 m (12.5 ft.).		

WARNINGS:

- **The HOTLINE® Warmer should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, you should verify normal operation of the HOTLINE® Warmer in the configuration in which it is to be used.**
- **Common portable and mobile consumer electronic devices may cause interference with the HOTLINE® Warmer. Observe the HOTLINE® Warmer to verify normal operation.**
- **Facility wiring must comply with all applicable electrical codes. Do not bypass power cord connections. Do not remove a prong from the power cord.**

Guidance and Manufacturer's Declaration – Electromagnetic Immunity			
Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Electrostatic discharge (ESD) IEC 61000-4-2	± 8 kV contact ± 15 kV air	± 8 kV contact ± 15 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/ output lines	± 2 kV for power supply lines No input/output lines tested	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 0.5 kV, ±1 kV for line to line ± 0.5 kV, ±1 kV, ±2 kV for line to ground	± 1 kV line to line ± 2 kV line to ground	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	100% drop, 0.5 periods, 0^0, 45^0, 90^0, 135^0, 180^0, 225^0, 270^0, 315^0 100% dip, 250/300 period 30% dip, 25/30 periods	100% drop, 0.5 periods, 0^0, 45^0, 90^0, 135^0, 180^0, 225^0, 270^0, 315^0 100% dip, 250/300 period 30% dip, 25/30 periods	Mains power quality should be that of a typical commercial or hospital environment. If the operator of the device requires continued operation during power mains interruptions, it is recommended that the device be powered from an uninterruptible power supply or a battery.
Power frequency (60 Hz) magnetic field IEC 61000-4-8	30 A/m	30 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

Guidance and Manufacturer's Declaration – Radiofrequency Electromagnetic Immunity

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms 150 kHz to 80 MHz	Portable and mobile RF communications equipment should be used no closer to any part of the system, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. **Recommended separation distance:** $d = [1.2]\sqrt{P}$
	6 Vrms ISM bands 150 kHz to 80 MHz	6 Vrms 150 kHz to 80 MHz	$d = [0.58]\sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.7 GHz	10 V/m 80 MHz to 2.7 GHz	$d = [0.35]\sqrt{P}$ 80 MHz to 800 MHz $d = [0.7]\sqrt{P}$ 800 MHz to 2.5 GHz
Radiated RF Proximity Fields	Per 60601-1-2:2014 section 8.10 Table 9.	Per 60601-1-2:2014 section 8.10 Table 9.	$d = [6/E]\sqrt{P}$ *E is the immunity test level in V/m. Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strength from fixed RF transmitters, as determined by an electromagnetic site survey,[a] should be less than the compliance level in each frequency range.[b] Interference may occur in the vicinity of equipment marked with the following symbol:

Note 1: At 80 MHz and 800 MHz, the higher frequency range applies.

Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflected from structures, objects and people.

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the system is used exceeds the applicable RF compliance level above, the system should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the system.

[b] Over the frequency range 150 KHz to 80 MHz, field strengths should be less than 3 V/m.

Electromagnetic Environmental Recommendations

Recommended separation distances between portable and mobile RF communications equipment and the HOTLINE® Warmer

The HOTLINE® Warmer is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the operator of the HOTLINE® Warmer can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the HOTLINE® Warmer as recommended below, according to the maximum output power of the communications equipment.

Rated Maximum output power or transmitter W	**Separation distance according to frequency of transmitter m**		
	150 kHz to 80 MHz $d=[3.5/V1]\sqrt{P}$	80 MHz to 800 MHz $d=[3.5/E1]\sqrt{P}$	800 MHz to 2.5 GHz $d=[7/E1]\sqrt{P}$
0.01	0.12	0.12	0.23
0.10	0.37	0.37	0.74
1	1.16	1.16	2.33
10	3.69	3.69	7.38
100	11.66	11.66	23.33

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in metres (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

Note 1 *At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.*

Note 2 *The ISM (industrial, scientific, and medical) bands between 150 kHz and 80 MHz are 6.765 MHz to 6.795 MHz; 13.553 MHz to 13.567 MHz; 26.957 MHz to 27.283 MHz; and 40.66 MHz to 40.70 MHz.*

Note 3 *An additional factor of 10/3 is used in calculating the recommended separation distance for transmitters in the ISM frequency bands between 150 kHz and 80 MHz and in the frequency range 80 MHz to 2.5 GHz to decrease the likelihood that mobile/portable communications equipment could cause interference if it is inadvertently brought into patient areas.*

Note 4 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.

Accessories

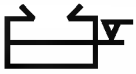
REF	Product Description
L-70	HOTLINE® Fluid Warming Set with Injection Port
L-70NI	HOTLINE® Fluid Warming Set without Injection Port
L-80	HOTLINE® Warming Set with L-10 Gas Vent
L-10	Gas Vent
PC-8	T-Connector, 20.3 cm (8") Patient Lead with Injection Port
YC-8	Y-Connector, 20.3 cm (8") Patient Lead with Injection Port

SECTION 14

Symbols

	**Caution**
	Follow Instructions for Use
	Do not re-use
	Catalog Number
	Serial Number
	Batch Code
	Part Number
	Date of Manufacture
	Use by
	Manufacturer
	Authorized Representative in the European Community
	Contains or Presence of Natural Rubber Latex
	Not made with natural rubber latex
	Contains or Presence of Phthalate: bis(2-ethylhexyl) phthalate (DEHP)
	Sterile Fluid Path, Ethylene oxide gas sterilized
	Type BF Applied Part (Disposable Sets)
	Alternating Current
	Protective earth; protective ground
	Equipotentiality
	Temperature Limitation

	Humidity Limitiation
	Atmospheric pressure limitation
	Quantity
	Do not use if package is damaged
	Keep dry
	Keep away from sunlight
	Collect separately
Rx ONLY	**Caution:** Federal (U.S.A.) law restricts this device to sale by or on the order of a physician
	Electrical Shock Hazard
IPX1	Protected Against Dripping Water
CLASS 1	Device is a class type 1 equipment
	Protective earth terminal, for maintenance only
	Recyclable Product
	Alarm Test
	Power switch in the ON position
	Power switch in the OFF position.
	Reservoir Temperature Display
	Automatic Operation
	Recirculating Solution Temperature

	Over Temperature Test (Recirculating Solution Over Temperature)
	Add Recirculating Solution
	Check Disposables, Check Tubing
	Maximum Reservoir Level
	Minimum Reservoir Level
	Device has been tested by TÜV SÜD America, a nationally recognized technical laboratory, to meet all requirements for safety.
	Device has been tested by National Technical Systems, a nationally recognised technical lab, to meet U.S. requirements for safety.
	Warning: Do not stick HOTLINE® tubing wiht needles. Patient injury or death result.

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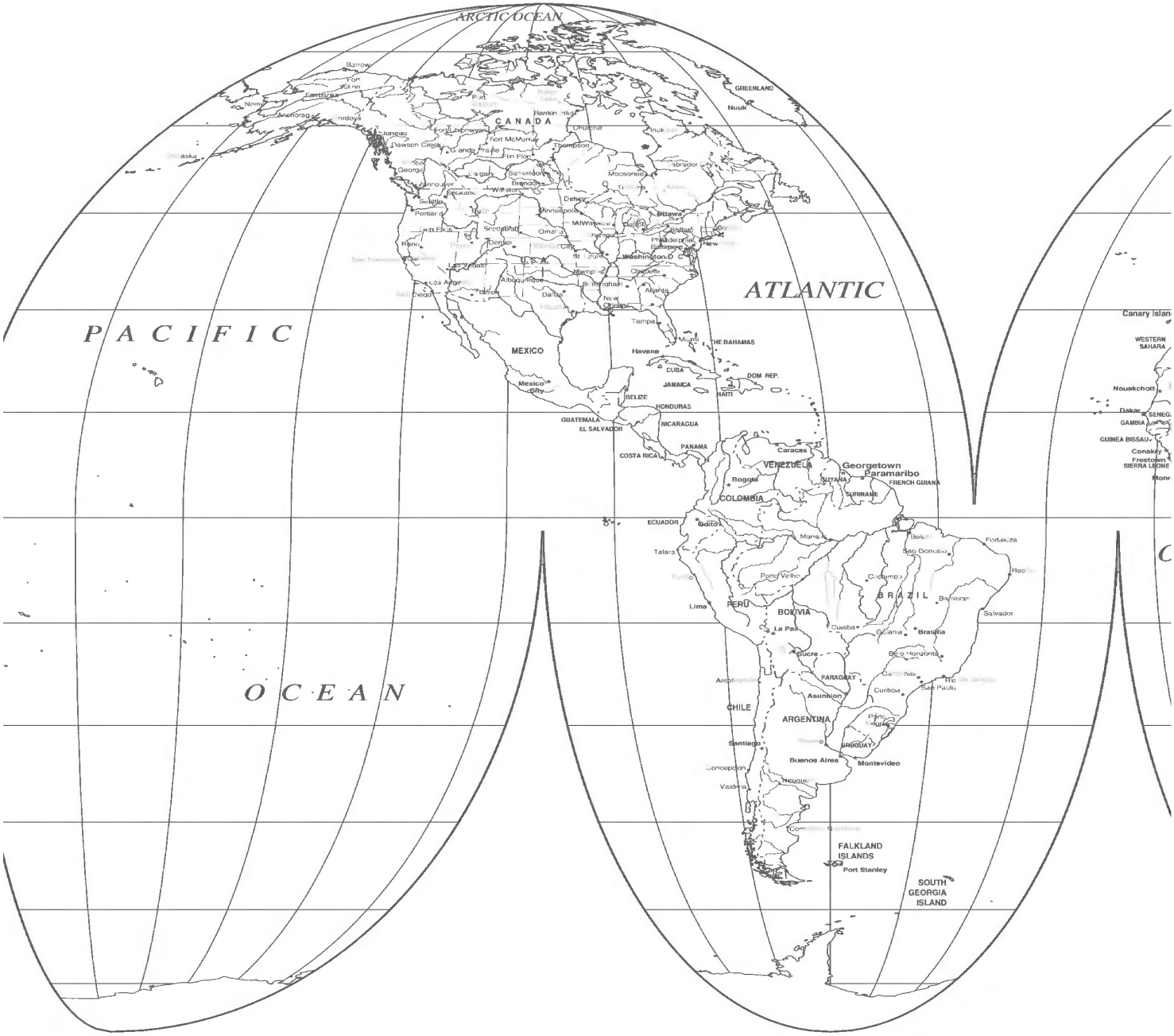
LEVEL 1®



Manufacturer:
Smiths Medical ASD, Inc.
6000 Nathan Lane North
Minneapolis, MN 55442 USA
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753 01 Hranice, Czech Republic
Tel: +44 (0)1233 722100

Rx CE
ONLY 2797

smiths medical

MUNSON

Procedure: Massive infusion device use

Checklist: Massive infusion using a Belmont infuser device

Evaluator's Name: _____ **Examinee's Name:** _____

Evaluator's ID: _____ **Examinee's ID:** _____

Evaluator's Dept: _____ **Examinee's Dept:** _____

Date: _____ **Meets criteria/Does not meet criteria:** _____

Select Evaluation Method:

☐ Clinical Observation ☐ Documentation Review

☐ Demonstration ☐ Verbalization

Massive infusion using a Belmont infuser device

Objective: To administer a massive IV fluid or blood infusion using a Belmont infuser device according to the standard of care.

Checklist Step	Comments
Y- Meets; N- Does not meet; I- Not Applicable	
__ Verify the practitioner's order. __ Review the practitioner's order to make sure that the prescribed infusion solution, rate, and administration route are appropriate for the patient's age, condition, and access device and that the infusion or medication is compatible with other solutions or medications. Make sure the order includes any test results that require monitoring. Address concerns about the order with the practitioner, the pharmacist, your supervisor, the risk management department, or as directed by your facility. __ Verify the patient's baseline hematocrit, electrolyte and hemoglobin levels, and results of coagulation and other studies, as ordered. __ Review the patient's medical record for history of allergies, as indicated. __ Gather and prepare the necessary equipment and supplies. __ Perform hand hygiene. __ Confirm the patient's identity using at least two patient identifiers.	

__ Provide privacy.

__ Explain the procedure to the patient and family (if appropriate) according to the patient's and family's individual communication and learning needs.

__ Raise the bed to waist level before providing care.

__ Perform a baseline physical assessment. Assess for conditions that can increase the risk of adverse effects of therapy.

__ Insert an indwelling urinary catheter, as ordered, if the patient doesn't already have one.

__ Perform hand hygiene.

__ Put on gloves and, as needed, other personal protective equipment.

__ Make sure that the patient has two patent large-bore IV catheters. If not, insert two IV catheters. If you can't establish venous access, initiate intraosseous access if indicated.

__ Assist the practitioner as needed with insertion of a central venous or pulmonary artery catheter.

__ Assist the practitioner as needed with insertion of an arterial catheter.

__ If you're infusing blood products, perform a pretransfusion blood verification with another qualified health care provider.

__ Remove the administration set from its packaging and inspect it.

__ Install the appropriate administration set into the infusion device according to the manufacturer's instructions.

__ Confirm that the heat exchanger is properly secured.

__ As necessary for infusion of larger volumes of fluid, replace the reservoir chamber with the larger-capacity reservoir. Using sterile technique, remove the reservoir chamber from the administration set by disconnecting the luer connectors.

__ Attach the reservoir holder onto the IV pole and place the larger reservoir into the holder.

__ Attach the three fluid supply tails onto the top of the larger reservoir you plan to use.

__ Connect the larger reservoir to the administration set. Adjust the reservoir holder so that the connection leads underneath the reservoir aren't stretched or kinked.

__ Hang the fluid bag on the IV pole.

__ Close the bag clamps, remove the bag spike cap, vigorously scrub the port with an antiseptic pad, and allow it to dry. Then spike the fluid bag.

__ Repeat the process with additional fluid lines you'll use.

__ Open the bag clamps.

__ Prime the main system by pressing the PRIME button to recirculate 100 mL of fluid at 500 mL/minute.

__ Prime the remainder of the administration tubing: Open the IV fluid bag roller clamp and remove the male luer cap at the distal end of the tubing. Press the PT. LINE PRIME button once to prime at 50 mL/minute and press and hold the button to prime at 200 mL/minute. Press the STOP button after inspecting the tubing for air bubbles. Press the PT. LINE PRIME button again.

__ Perform a vigorous mechanical scrub of the needleless connector on the vascular access device for at least 5 seconds using an antiseptic pad. Allow it to dry completely.

__ While maintaining the sterility of the syringe tip, attach a prefilled syringe containing preservative-free normal saline solution to the needleless connector. Unclamp the catheter and slowly aspirate for a blood return (if not contraindicated) that's the color and consistency of whole blood. If you don't obtain a blood return, take steps to locate an external cause of obstruction.

__ If you obtain a blood return, inject preservative-free normal saline solution slowly into the catheter.

Don't forcibly flush the device; further evaluate the device if you meet resistance.

__ Clamp the catheter and remove and discard the syringe in a puncture-resistant sharps disposal container.

__ Carefully remove the needleless connector from the vascular access device. Perform a vigorous mechanical scrub of the catheter hub for at least 5 seconds using an antiseptic pad. Allow it to dry completely.

__ Trace the IV tubing from the patient to its point of origin.

__ Connect the distal end of the tubing to the patient's vascular access catheter. Route the tubing in a standardized direction if the patient has other tubing and catheters that have different purposes. Label the tubing at both the distal and proximal ends if multiple IV lines will be used.

__ Unclamp the catheter, press INFUSE, and adjust the flow rate, as necessary.

__ Monitor the patient's vital signs every 5 to 15 minutes, as indicated. As the patient's condition stabilizes, monitor vital signs less frequently.

__ Monitor core temperature every 15 to 30 minutes and maintain a core temperature of no lower than 96.8° F (36° C).

__ Assess the patient's hemodynamic parameters every 15 to 30 minutes and urine output every 30 to 60 minutes, as ordered.

__ Inspect the IV sites every 15 minutes.

__ If the patient is receiving blood products, monitor closely for signs of a transfusion reaction.

__ Obtain an arterial blood gas sample, as ordered.

__ When the infusion is complete, change the IV fluid or blood bag.

__ Discard the empty infusion bag in a proper receptacle or, if required by your facility, return it to the blood bank.

__ Obtain blood samples, as ordered, to check hemoglobin level, hematocrit, lactic acid level, and electrolyte levels and for coagulation studies and thromboelastography.

__ Notify the practitioner of critical test results within your facility's established time frame.

__ Return the bed to the lowest position.

__ Discard used supplies in appropriate receptacles.

__ Provide warming measures, such as blankets.

__ Remove and discard your gloves and, if worn, other personal protective equipment.

__ Perform hand hygiene.

__ Clean and disinfect your stethoscope with a disinfectant pad.

__ Perform hand hygiene.

__ Document the procedure.

Bilevel positive airway pressure (BiPAP) use

Bilevel positive airway pressure (BiPAP) use
Revised: December 15, 2025

Introduction

Bilevel positive airway pressure (BiPAP) is a noninvasive positive-pressure ventilation (NPPV) mode that delivers inspiratory and expiratory positive airway pressures as the patient breathes. NPPV helps improve oxygenation or ventilation or prevent airway obstruction during sleep. NPPV is useful for patients who shouldn't undergo intubation or invasive ventilation.[1]

During BiPAP, you can independently adjust the duration of inspiratory and expiratory positive airway pressure to set the inspiratory-to-expiratory ratio according to the patient's condition.[2] When you apply inspiratory and expiratory positive airway pressures according to the patient's respiratory cycle, BiPAP improves ventilation, oxygenation, and alveolar recruitment. BiPAP devices typically have a default respiratory rate setting for cases in which the patient's own breathing is insufficient.[3] The noninvasive ventilator device should be able to deliver a mandatory respiratory rate of up to 30 breaths/minute, an inspiratory positive airway pressure of up to 30 cm H_2O, an expiratory positive airway pressure of up to 15 cm H_2O, and an inspiratory flow rate of up to 180 L/minute at 20 cm H_2O.[2]

BiPAP requires the use of an appropriate patient interface. Available interfaces include a nasal mask, an oronasal mask, and nasal pillows. Nasal masks and pillows primarily help treat patients with sleep disorders; oronasal masks are common for treating patients with respiratory failure. The oronasal mask permits mouth breathing and delivers greater ventilation pressures with less leakage. It also requires less patient cooperation.[4]

Research has found that BiPAP positively benefits patients with acute exacerbation of chronic obstructive pulmonary disease, acute cardiogenic pulmonary edema, and acute respiratory failure due to obesity hypoventilation syndrome or neuromuscular disease.[1,3] Other indications for BiPAP include ventilatory support after mechanical ventilation discontinuation, postoperative acute respiratory failure, asthma, pneumonia, thoracic trauma, obstructive sleep apnea when the patient has an intact respiratory drive, and palliative care.[1] It's contraindicated in agitated or uncooperative patients, those with severely impaired consciousness or impaired cough or swallowing, in the absence of upper airway reflexes, and in cases of untreated pneumothorax, respiratory or cardiac arrest, cardiac instability, status epilepticus, uncontrolled vomiting, upper GI bleeding, recent surgery (gastric, laryngeal, or esophageal), facial or airway trauma, total airway obstruction, or poor secretion clearance.[1,2,5]

• ***Clinical alert:*** When caring for a patient with known or suspected coronavirus disease 2019 (COVID-19), see the latest recommendations from the Centers for Disease Control and Prevention at https://www.cdc.gov/covid/hcp/infection-control/•

Equipment

- Air source that can supply 50 psi (unless the ventilator has an internal compressor)
- BiPAP circuit tubing, connectors, and adapters
- BiPAP ventilator
- Disinfectant pad
- Facility-approved disinfectant

- Gloves
- Handheld resuscitation bag and mask
- Headgear
- Intubation equipment[1]
- Oral care supplies
- Oxygen source
- Oxygen tubing
- Properly sized patient interface (nasal mask, oronasal mask, or nasal pillows)
- Pulse oximeter and probe
- Stethoscope
- Suction equipment
- Vital signs monitoring equipment
- Optional: arterial blood gas (ABG) kit, equipment for an alternative method of communication, heated humidifier, hydrocolloid patch, liquid skin barrier, other personal protective equipment, respirator (disposable N95 or higher-level disposable respirator)

Preparation of Equipment

Inspect all equipment and supplies. If a product is expired, is defective, or has compromised integrity, remove it from patient use, label it as expired or defective, and report the expiration or defect as directed by your facility.

In most facilities, a respiratory therapist assumes the responsibility for setting up and administering BiPAP. If a respiratory therapist isn't available and you must set up a BiPAP device, follow the manufacturer's instructions. Assemble the circuit, attach the circuit to the BiPAP ventilator, and set up the BiPAP device according to the manufacturer's instructions for use. Make sure that the exhalation valve is positioned properly. Provide active humidification through a heated humidifier, if necessary, *to improve patient comfort.*[6] If supplemental oxygen is necessary, connect the oxygen tubing to the oxygen source and the BiPAP device. Plug the device into an electrical outlet with a backup power source. Turn on the device and allow it to perform a self-test before beginning therapy. Make sure that intubation equipment is available and that a handheld resuscitation bag with a mask and suction equipment are set up, functioning properly, and readily available. Then select the appropriate patient interface. (See *Selecting a patient interface for BiPAP.*)

EQUIPMENT

SELECTING A PATIENT INTERFACE FOR BiPAP

You can use a nasal mask, an oronasal mask, or nasal pillows to deliver bilevel positive airway pressure (BiPAP). Each type of interface has advantages and disadvantages, and each one works best for different types of patients. Use this guide to help you select the interface that's most appropriate for the patient's condition.

Nasal mask

Indications

- Patients who can cooperate
- Patients with less severe illness

Advantages

- Less likely to cause claustrophobia
- Allows for speaking, drinking, coughing, and clearing secretions
- Associated with decreased emesis aspiration risk
- Generally better tolerated

Disadvantages

- Increases the risk of air leaks from the mouth
- Has limited effectiveness in patients with nasal deformities or blocked nasal passages

Oronasal mask

Indications

- Patients who are less able to cooperate
- Patients with more severe illness
- Patients who breathe through the mouth or pursed lips
- Patients without teeth

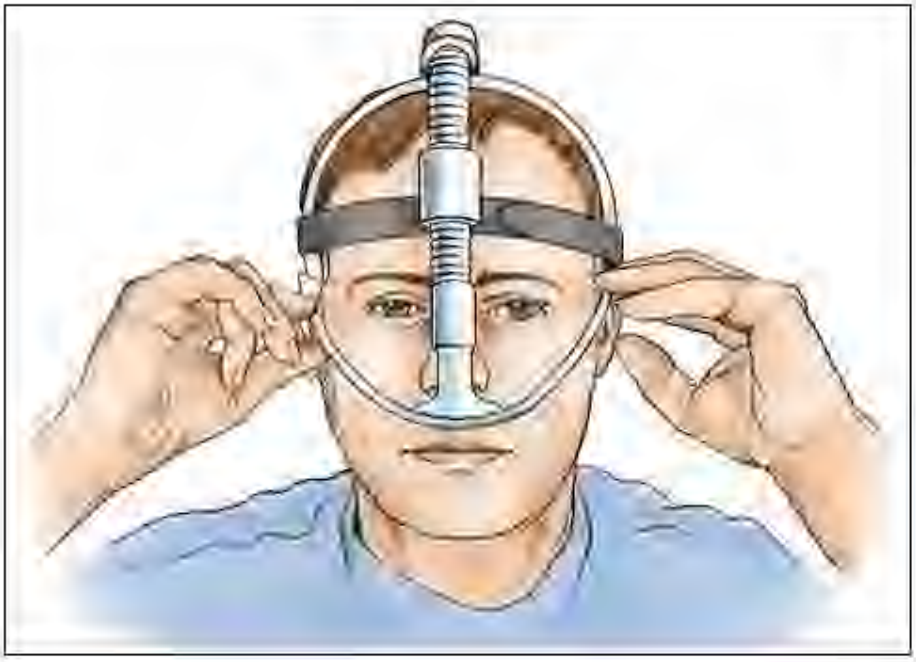
Advantages

- Generally provides more effective ventilation

Disadvantages

- More likely to cause claustrophobia
- Interferes with speaking and coughing
- Increases the risk of emesis aspiration

Nasal pillows



Indications

- Patients who can cooperate
- Patients with less severe illness

Advantages

- Less likely to cause claustrophobia
- Allows for speaking, drinking, coughing, and clearing secretions
- Usually better tolerated

Disadvantages

- Increases the risk of air leaks from the mouth
- Has limited effectiveness in patients with nasal deformities or blocked nasal passages

Implementation

- Verify the practitioner's order.
- Review the patient's medical record for history, indication for BiPAP use, and any contraindications to BiPAP use.
- Gather and prepare the necessary equipment and supplies.
- Perform hand hygiene.[7][8][9][10][11][12]
- Confirm the patient's identity using at least two patient identifiers.
- Provide privacy.[13][14][15][16]
- Explain the procedure to the patient and family (if appropriate) according to their individual communication and learning needs *to increase their understanding, allay their fears, and enhance cooperation.*[17]
- Raise the bed to waist level before providing care *to prevent caregiver back strain.*[18]
- Perform hand hygiene.[7][8][9][10][11][12]
- Put on gloves and, as needed, other personal protective equipment *to comply with standard precautions.*[19][20][21]

◆ ***Clinical alert:*** If a patient is on airborne precautions, wear a fit-tested N95 or higher-level disposable respirator when caring for the patient; put on the respirator before entering the room and remove it after exiting the room. If you anticipate spraying of respiratory fluids, wear gloves, a gown, and a mask with a face shield or a mask and goggles.[19] ◆

- Obtain the patient's vital signs *to serve as baselines for comparison.*
- If not already in use, attach a pulse oximeter to the patient *to ensure adequate oxygenation.* Make sure that alarm limits are set appropriately for the patient's current condition and that alarms are turned on, functioning properly, and audible to staff.[22][23][24][25]
- Obtain the patient's oxygen saturation level using pulse oximetry, and assess the patient's respiratory status *to serve as baselines for comparison.*
- Adjust the inspiratory positive airway pressure, expiratory positive airway pressure, breaths/minute (if applicable), inspiratory time, and fraction of inspired oxygen, as ordered. The initial setting for inspiratory positive airway pressure is usually 10 cm H_2O; for expiratory positive airway pressure, 5 cm H_2O.[5] Titrate pressures, as ordered, and according to the patient's condition.[1][5]
- Adjust the sensitivity as low as possible without causing autocycling.
- Confirm the settings by comparing them with the practitioner's order. Confirm that the BiPAP device is functioning properly.
- Apply the patient interface to the patient's face, secure it with the headgear, and tighten the straps *to begin therapy.* Avoid tightening the straps more than necessary *to prevent pressure-related skin breakdown.*[2]
- Set the alarm limits on the BiPAP device and make sure that alarms are turned on, functioning properly, and audible to staff.[22][23][24]
- Monitor the patient's vital signs, oxygen saturation level, and respiratory status, observing for chest expansion and auscultating for bilateral breath sounds, *to evaluate tolerance of therapy.*
- Obtain an arterial blood sample for ABG analysis if ordered *to evaluate the effectiveness of therapy.* (See the "Arterial puncture for blood gas analysis" and "Arterial pressure closed monitoring system blood sampling" procedures.)[1][2][5] Notify the practitioner of critical test results within your facility's established time frame *to ensure that the patient receives prompt treatment.*[26]
- Maintain the head of the patient's bed at 30 to 45 degrees unless contraindicated *to promote air exchange and to reduce the risk of health care–associated pneumonia.* If the patient can't bend at the hip, use the reverse Trendelenburg position.[27]
- Regularly assess the patient's skin for signs of skin breakdown under the patient interface; if redness persists after removing the interface, apply a liquid skin barrier or hydrocolloid patch *to protect the patient's skin.*[2][28]
- Assist the patient with oral care, including brushing the teeth, tongue, and gums at least twice per day using a soft toothbrush *to remove dental plaque from all tooth surfaces and to prevent oral colonization, which increases the risk of health care–associated pneumonia.* Moisturize the patient's oral mucosa and lips every 2 to 4 hours *to reduce inflammation and improve oral health.*[29] (See the "Oral care" procedure.)
- Return the bed to the lowest position *to prevent falls and maintain the patient's safety.*[30]
- Remove and discard your gloves and, if worn, other personal protective equipment.[21]
- Perform hand hygiene.[7][8][9][10][11][12]
- Place the call light within the patient's reach, and establish an alternative method of communication such as a communication board if necessary.[1][31]
- Clean and disinfect your stethoscope with a disinfectant pad.[32][33]
- Perform hand hygiene.[7][8][9][10][11][12]
- Put on gloves and, as needed, other personal protective equipment *to comply with standard precautions.*[19][20][21]
- Clean and disinfect other reusable equipment according to the manufacturer's instructions *to prevent the spread of infection.*[32][33]

- Remove and discard your gloves and, if worn, other personal protective equipment.[21]
- Perform hand hygiene.[7][8][9][10][11][12]
- Document the procedure.[34][35][36][37]

Special Considerations

- The Joint Commission issued a sentinel event alert concerning medical device alarm safety *because alarm-related events have been associated with permanent loss of function and death*. Among the major contributing factors were improper alarm settings, alarm settings turned off inappropriately, and alarm signals that were inaudible to staff. Make sure alarm limits are set appropriately and that alarms are turned on, functioning properly, and audible to staff. Follow facility guidelines for preventing alarm fatigue.[22]
- If you're using heated humidification, frequently check the ventilator circuit for condensation, *which can cause resistance to airflow.* As needed, drain the condensate into a collection trap. Keep the circuit closed during condensate drainage *to prevent bacterial contamination.* Don't drain the condensate into the humidifier, *because the condensate may be contaminated with the patient's secretions.* Also avoid accidental drainage of condensation into the patient's airway when moving the tubing or the patient.[6][38]
- Change the circuit tubing and equipment when it's visibly soiled or malfunctioning and at an interval determined by your facility *to reduce the risk of bacterial contamination.*[38]
- Don't open the BiPAP circuit unless absolutely necessary *to reduce the risk of health care–associated pneumonia.*[38]
- Routinely check the BiPAP ventilator settings and alarm activation after removal and reapplication of BiPAP *to ensure patient safety.*[1]
- Monitor the in-line temperature (if available) when humidification is added *to reduce the risk of thermal inhalation injury.* The typical temperature range should be 95° to 98° F (35° to 37° C).[1]
- If the patient is receiving enteral feedings, avoid gastric distention *to reduce the risk of aspiration.*[39]
- Teach the patient and family about measures to prevent health care–associated pneumonia, such as performing hand hygiene and maintaining the head of the bed at 30 to 45 degrees. Encourage the family to remind staff members when these measures aren't followed.[27][39]

Patient Teaching

If the patient will receive BiPAP therapy at home, teach the patient and family (if appropriate) how to set up, use, maintain, and clean the device. Stress the importance of cleaning all equipment daily *to avoid contamination and reduce the risk of infection.* Allow the opportunity for a return demonstration to ensure competency. Provide written instructions for reference at home. Explain the importance of follow-up appointments to make sure that the equipment is functioning properly and to address any problems or concerns that the patient may be having with the system.

Complications

Complications associated with BiPAP use may include:

- skin breakdown (caused by the patient interface)
- aspiration of gastric contents
- eye irritation
- sinus pain
- sinus congestion
- thick secretions
- dry mucous membranes
- ear pain
- gastric distention
- barotrauma
- hypotension.[2][5]

Documentation

Documentation associated with BiPAP use includes:

- date and time of BiPAP initiation
- type of BiPAP ventilator used and its settings
- assessment findings before and after initiation of BiPAP
    - vital signs
    - oxygen saturation levels
    - respiratory status
    - chest expansion
    - bilateral breath sounds
- skin assessment under the interface
- type of oral care provided
- complications
    - name of the practitioner notified
    - date and time the practitioner was notified
    - prescribed interventions
    - response to those interventions
- pertinent laboratory data (including ABG analysis results)
- teaching provided to the patient and family (if applicable)
    - understanding of that teaching
    - follow-up teaching needed.

Related Procedures

- Bilevel positive airway pressure (BiPAP) use, home care

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(Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions)

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Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions

The following leveling system is adapted from *Evidence-Based practice in nursing & healthcare: A guide to best practice,* Fifth edition, by Bernadette Mazurek Melnyk and Ellen Fineout-Overholt (2023).

Level I	Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs)
Level II	Evidence from well-designed single RCTs (experimental)
Level III	Evidence from well-designed nonrandomized controlled trials (quasi-experimental), systematic reviews of a complete body of evidence, and intervention studies using mixed methods
Level IV	Evidence from well-designed case-control and cohort studies (observational)
Level V	Evidence from systematic reviews of qualitative and descriptive studies
Level VI	Evidence from single descriptive and qualitative studies, evidence-based practice implementation, and quality improvement projects
Level VII	Evidence from expert opinion, expert committee reports, and literature reviews

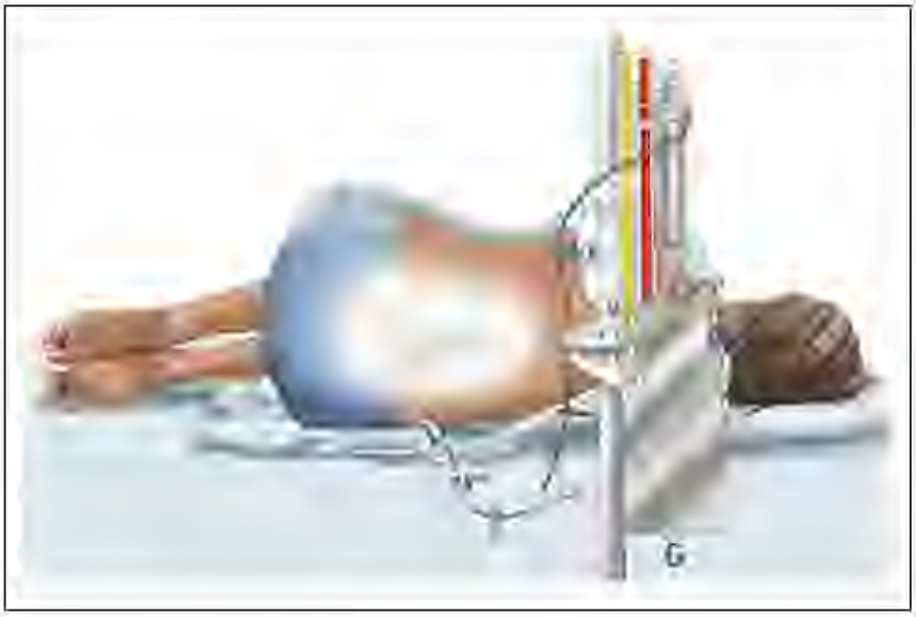
Data from Gyatt, G., & Rennie D. (2002). Users' guides to the medical literature. American Medical Association; Harris, R. P., et al. (2001). Current methods of the U.S. Preventative Services Task Force: A review of the process. American Journal of Preventative Medicine, 20, 21-35.

Lumbar drain management after thoracoabdominal aortic aneurysm repair

Lumbar drain management after thoracoabdominal aortic aneurysm repair
Reviewed: December 15, 2025

Introduction

A lumbar drainage device (shown below) is a closed sterile system that enables the drainage of cerebrospinal fluid (CSF) from the subarachnoid space, which is located between the arachnoid and pia mater. A practitioner inserts the device through a special spinal needle, known as a *Tuohy needle*, into the lumbar subarachnoid space at the L2 to L3 level or below. When inserted for patients undergoing thoracoabdominal aortic aneurysm repair, the device helps prevent paralysis by maintaining spinal perfusion pressure through CSF drainage when the aorta is cross-clamped for the operative procedure. Lumbar drainage may continue after surgery to prevent postoperative spinal cord ischemia.[1] When lumbar drainage continues postoperatively after thoracoabdominal aortic aneurysm repair, the practitioner may order a specific pressure parameter for when drainage should occur, typically around 10 mm Hg.[2] [3] Alternatively, the practitioner may elect to limit lumbar drainage by keeping the drain closed unless a neurologic deficit occurs.[4]



Relative contraindications to lumbar drainage include coagulopathy, active bleeding, brain abscess, and a history of lumbar spine surgery or lumbar vertebral fracture. Absolute contraindications to lumbar drainage include increased intracranial pressure, unequal pressures between the supratentorial and infratentorial compartments as evidenced by computed tomography findings, infected skin over the intended drain insertion site, spinal epidural abscess, intracranial mass, obstructive noncommunicating hydrocephalus, and spinal arteriovenous malformation.

Special considerations when caring for a patient with a lumbar drain device include minimizing device handling. When device handling is necessary, the health care provider must perform hand hygiene, put on gloves, and maintain the sterility of the drainage system.

Equipment

- Closed (nonvented) cap or luer-lock adapter
- Gloves
- IV pole
- Lumbar drainage system and tubing
- Pole clamp or cord attachment
- Vital signs monitoring equipment
- Optional: 30-mL syringe containing sterile preservative-free normal saline solution, bedside monitor, drainage bag, graduated burette, labels, leveling device (carpenter's level or laser), other personal protective equipment, pressure cable, sterile occlusive dressing, stopcock, transducer system

Preparation of Equipment

Inspect all equipment and supplies. If a product is expired, is defective, or has compromised integrity, remove it from patient use, label it as expired or defective, and report the expiration or defect as directed by your facility.

Implementation

- Receive handoff communication from the person who was responsible for the patient's care. Ask questions, as necessary, *to avoid miscommunications that may cause patient care errors during transitions of care.* As part of the handoff process, trace each tubing and catheter from the patient to its point of origin; a standardized line reconciliation process should be used.[5]
- Verify the practitioner's order.
- Review the patient's medical record for a history of allergies to tape, antiseptic solutions, or latex.
- Gather and prepare the necessary equipment and supplies.
- Perform hand hygiene.[6][7][8][9][10][11]
- Confirm the patient's identity using at least two patient identifiers.[12]
- Provide privacy.[13][14][15][16]
- Explain the procedure to the patient and family (if appropriate) according to their individual communication and learning needs *to increase their understanding, allay their fears, and enhance cooperation.*[17]
- Perform hand hygiene.[6][7][8][9][10][11]
- Put on gloves and, as needed, other personal protective equipment *to comply with standard precautions.*[18][19][20]
- Make sure that the lumbar drainage system is clamped before changing the patient's position *so that CSF overdrainage doesn't occur.*[21]
- Assist the patient to a side-lying position *to expose the lumbar drain exit site.*
- Assess the condition of the dressing and lumbar drainage system exit site. Make sure that the sterile occlusive dressing is intact and that the drainage system is free from kinks. Change the dressing immediately using sterile technique if it becomes wet or soiled or is no longer intact.[21][22]
- After assessing the dressing and lumbar drainage system exit site, reposition the patient as ordered.
- Make sure that the lumbar drainage system is secured to an IV pole at the patient's bedside using the cord attachment or a pole clamp and cord attachment. Make sure that the drainage system is positioned so that minor patient position changes won't put pressure on the tubing or let the drainage unit fall, causing CSF overdrainage.
- Trace the lumbar drainage system tubing from the patient to its point of origin *to make sure that it's attached to the proper port.*[23][24] Make sure that all ports on the drainage system have a closed cap or luer-lock adapter *to prevent leakage and reduce the risk of infection.*

- Set the zero reference level by raising or lowering the system so that the zero reference mark on the lumbar drainage system is set to the appropriate anatomic landmark, as ordered.[21] Examples of anatomic landmarks include the external auditory meatus, shoulder height, and the level of the catheter insertion.[21] If you're using a laser level to level the device, make sure that the laser light doesn't shine in the patient's eyes or the eyes of anyone else in the room.
- Unclamp the lumbar drainage system.
- If the practitioner orders a pressure parameter for CSF drainage, set the pressure level on the graduated burette of the lumbar drainage system as ordered *so that CSF will drain into the graduated burette when the pressure in the lumbar space is higher than the prescribed pressure level.*
- If the practitioner prescribes intraspinal pressure monitoring, assemble a fluid-filled transducer system with a stopcock and closed cap as follows:[21]
    - Using sterile technique, prime the transducer system with preservative-free normal saline solution. Don't attach a pressurized bag of IV fluid to the transducer system.[21]
    - Maintaining the sterility of the system, attach the fluid-filled transducer system to the lumbar drainage system.[21] Trace the tubing from the patient to the point of origin *to make sure that you're connecting the tubing to the proper port.*[23][24] Make sure that all connections are secure *to prevent dangerous disconnections.*[23] Route the tubing in a standardized direction if the patient has other tubing and catheters having different purposes. Label the tubing at both the distal (near the patient connection) and proximal (near the source container) ends *to reduce the risk of misconnection if multiple tubes will be used.*[24]
    - Connect the transducer system to the pressure cable and bedside monitor.
    - Level and zero the transducer to the prescribed anatomic reference point.[21]
    - Make sure that alarm limits are set appropriately for the patient's current condition and that alarms are turned on, functioning properly, and audible to staff.[25][26][27]
- Assess the patient's vital signs and neurologic status hourly *to promptly identify changes in condition.* Notify the practitioner immediately of changes in the patient's neurologic status, such as decreased level of consciousness, focal deficit, pupillary or vision changes, headache, photophobia, nuchal rigidity, and irritability. Any change in level of consciousness, new headache, confusion, or irritability could indicate CSF overdrainage and require immediate notification of the practitioner and clamping of the drainage system. Neurologic checks should also include checking the lower extremities for sensory and motor function.[3]
- Assess the patient hourly for signs of infection or CSF leakage from the insertion site.
    - Monitor the CSF amount, clarity, and color hourly or as ordered.[21] Also monitor the level and security of the lumbar drainage system. Change the drainage system bag when it becomes three-quarters full. (See *Changing the drainage bag.*)[28]

EQUIPMENT

CHANGING THE DRAINAGE BAG

Follow these steps to change a drainage bag when it becomes three-quarters full:

- Perform hand hygiene.[6][7][8][9][10][11]
- Put on sterile gloves.[18][19][20]
- Turn the stopcock on the drainage system to stop CSF flow from the patient.
- Disconnect the drainage bag from the system using strict sterile technique.
- Place a closed cap over the exposed port on the three-quarters-full bag.
- Connect the replacement drainage bag to the lumbar drainage device system using strict sterile technique.
- Make sure that the connections are tight and that the stopcocks and clamps are in the correct position to enable drainage (if ordered).

- Discard the old drainage bag in an appropriate receptacle as directed by your facility.[20]
- Remove and discard your gloves.[20]
- Perform hand hygiene.[6][7][8][9][10][11]
- Document the procedure.[29][30][31]

- When the drain is open to drainage, instruct the patient to avoid coughing, sneezing, and straining, when possible, *to prevent overdrainage caused by increased thoracic pressure.*
- Assist the patient with turning from side to side at least every 2 hours *to prevent skin breakdown.* If the drain is positional, monitor which positions cause variances in the drainage rate from the lumbar drainage device. Plan patient care and positioning as indicated. Instruct the patient and family members about restrictions in patient positioning. Advise them to call the nurse for assistance with position changes.
- Discard used supplies in appropriate receptacles.[20]
- Remove and discard your gloves and, if worn, other personal protective equipment.[20]
- Perform hand hygiene.[6][7][8][9][10][11]
- Document the procedure.[29][30][31][32]

Special Considerations

- The Joint Commission issued a sentinel event alert concerning medical device alarm safety *because alarm-related events have been associated with permanent loss of function or death.* Among the major contributing factors were improper alarm settings, alarms settings turned off inappropriately, and alarm signals that were inaudible to staff. Make sure that alarm limits are set appropriately and that alarms are turned on, functioning properly, and audible to staff. Follow facility guidelines for preventing alarm fatigue.[27]
- Note that data are insufficient to recommend a specific dressing and dressing change frequency for lumbar drainage devices. Therefore, the recommendations of the Centers for Disease Control and Prevention in the "Guidelines for the Prevention of Intravascular Catheter-Related Infections" are widely accepted for maintenance of lumbar drainage devices.[22]
- Be sure to keep the head of the bed in the prescribed position *to prevent CSF overdrainage or underdrainage.*[21]
- For a patient with a cognitive impairment and for the safety of all patients, use the lockout control on the bed to prevent the patient from changing the bed height or head-of-the-bed elevation. An observer may also be necessary in the patient's room *to prevent complications from lumbar drainage for a patient with cognitive impairment.*
- The Joint Commission issued a sentinel event alert related to managing risk during transition to new International Organization for Standardization tubing standards that were designed to prevent dangerous tubing misconnections, which can lead to serious patient injury and death. During the transition, make sure to trace the tubing and catheter from the patient to the point of origin before connecting or reconnecting any device or infusion, at any care transition (such as a new setting or service), and as part of the handoff process; route tubes and catheters having different purposes in different standardized directions; when there are different access sites or several bags hanging, label the tubing at both the distal and proximal ends; use tubing and equipment only as intended; and store medications for different delivery routes in separate locations.[24]
- The Joint Commission issued a sentinel event alert concerning inadequate handoff communication *because of the potential for patient harm that can result when a receiver receives inaccurate, incomplete, untimely, misinterpreted, or otherwise inadequate information.* To improve handoff communication, standardize the critical information communicated by the sender. At a minimum, include the sender contact information, illness assessment, patient summary (including events leading up to the illness or admission, hospital course, ongoing assessment, and plan of care), to-do action list, contingency plans, allergy list, code status, medication list, and dated laboratory test results and vital signs. Provide face-to-face communication whenever possible in an interruption-free location. Use facility-approved, standardized tools and methods (for example, forms, templates,

checklists, protocols, and mnemonics). Provide ample time and opportunity for questions. Include the multidisciplinary team members and the patient and family, when appropriate.

Patient Teaching

Teach the patient and family (if applicable) about the reason for the drain and the importance of restricting the patient's activity level. Instruct the patient to avoid straining, coughing, and sneezing.

Complications

Complications associated with lumbar drain management after thoracoabdominal aortic aneurysm repair may include:

- infection[21]
- excessive drainage at the puncture site[21]
- change in neurologic status[21]
  - decreased level of consciousness
  - pupillary changes
  - motor or sensory impairment
- bladder or bowel dysfunction[21]
- overdrainage[21]
- headache[21]
- meningeal irritation
- nerve root irritation
- tension pneumocranium
- central herniation
- subdural hemorrhage
- spinal hematoma[21]
- intracranial venous thrombosis
- retained catheter.

Documentation

Documentation associated with lumbar drain management after thoracoabdominal aortic aneurysm repair includes:

- vital signs
- neurologic assessment findings
- abnormal findings
  - name of practitioner notified
  - date and time of notification
  - prescribed interventions
  - response to those interventions
- color, clarity, and amount of CSF drainage every hour for a patient on an intensive care unit and every 2 hours for a patient on a regular patient unit
- condition of the dressing
- teaching provided to the patient and family (if applicable)
  - understanding of that teaching
  - follow-up teaching needed.

Related Procedures

- External ventriculostomy device management, pediatric

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(Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions)

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Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions

The following leveling system is adapted from *Evidence-Based practice in nursing & healthcare: A guide to best practice,* Fifth edition, by Bernadette Mazurek Melnyk and Ellen Fineout-Overholt (2023).

Level I	Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs)
Level II	Evidence from well-designed single RCTs (experimental)
Level III	Evidence from well-designed nonrandomized controlled trials (quasi-experimental), systematic reviews of a complete body of evidence, and intervention studies using mixed methods
Level IV	Evidence from well-designed case-control and cohort studies (observational)
Level V	Evidence from systematic reviews of qualitative and descriptive studies

Level VI	Evidence from single descriptive and qualitative studies, evidence-based practice implementation, and quality improvement projects
Level VII	Evidence from expert opinion, expert committee reports, and literature reviews

Data from Gyatt, G., & Rennie D. (2002). Users' guides to the medical literature. American Medical Association; Harris, R. P., et al. (2001). Current methods of the U.S. Preventative Services Task Force: A review of the process. American Journal of Preventative Medicine, 20, 21-35.

External ventricular drain insertion, assisting

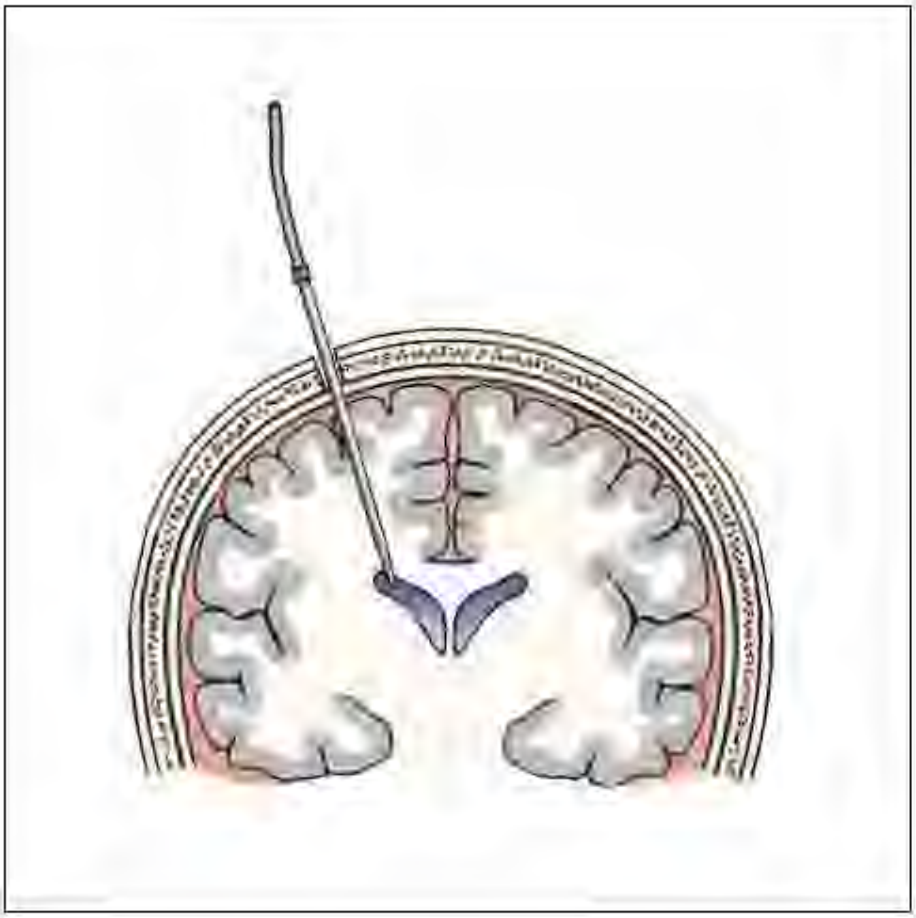
External ventricular drain insertion, assisting
Reviewed: December 15, 2025

Introduction

Cerebrospinal fluid (CSF) drainage reduces intracranial pressure (ICP) to a desired level and then maintains it at that level. Withdrawal of fluid can occur from the lateral ventricle or the lumbar subarachnoid space, depending on the indication and the desired outcome, via a catheter or an external ventricular drain (EVD) attached to a sterile closed-drainage collection system. Ventricular drainage helps reduce increased ICP. In addition, ICP monitoring is possible by connecting an external transducer to the external ventricular drainage system.[1][2]

Indications for EVD insertion include obstructive hydrocephalus, subarachnoid hemorrhage resulting in acute hydrocephalus due to obstruction of arachnoid villi, Hunt and Hess grade 3 or higher subarachnoid hemorrhage, cerebral edema, surgical mass lesions, infections (such as meningitis), Chiari malformations, shunt failure caused by mechanical disruption or infection, and brain relaxation in an operating room (OR).[2]

To insert a ventricular drain, a practitioner inserts a ventricular catheter through a burr hole in the patient's skull (as shown below) using sterile technique. The practitioner usually performs this procedure in an OR with the patient receiving general anesthesia, but the procedure may also be performed in an emergency department or intensive care unit.



Strict sterile technique is necessary throughout equipment setup and catheter insertion as well as during ventricular drain care, because the catheter's location in the brain poses an increased risk of infection.[1] [2] Use of prophylactic antibiotics remains controversial because of the risk of the development of resistant microorganisms.[2]

Equipment

- 3-mL syringe
- 18G spinal needle
- 25G ¾" (1.9-cm) needle
- Antiseptic solution or sterile preparation kit
- Caps
- Cardiac monitor with leads and electrodes
- Emergency equipment (code cart with emergency medications, handheld resuscitation bag and mask, defibrillator, intubation equipment)
- EVD set (includes drainage tubing, drip chamber, and drainage bag)
- Facility-approved pain assessment tool
- Facility-approved sedation scale
- Gloves
- Gowns
- ICP monitoring equipment with flushless transducer setup
- Intracranial access kit
- IV pole
- Labels
- Level or laser leveling device
- Light source
- Local anesthetic (usually 1% lidocaine)

- Masks and goggles or masks with face shields
- Neurologic assessment equipment (penlight or another light source, reflex hammer, pupil size chart)
- Overbed table
- Pressure cables and module
- Pulse oximeter and probe
- Scalpel
- Sign with prescribed device height and head-of-bed elevation level
- Sterile drapes
- Sterile gloves
- Sterile gown
- Sterile nonvented dead-end caps
- Sterile occlusive dressing
- Sterile preservative-free normal saline solution in a 30-mL or 40-mL syringe
- Suture material
- Suture scissors
- Tape
- Ventricular catheter
- Vital signs monitoring equipment
- Optional: arterial catheter insertion equipment, clippers, connector to secure the catheter, facility-approved disinfectant, IV catheter insertion supplies, prescribed analgesic, prescribed sedative, sterile towel

Some equipment may be available in a prepackaged EVD tray.

Preparation of Equipment

Inspect all equipment and supplies. If a product is expired, is defective, or has compromised integrity, remove it from patient use, label it as expired or defective, and report the expiration or defect as directed by your facility. Make sure that emergency equipment is readily available and functioning properly.

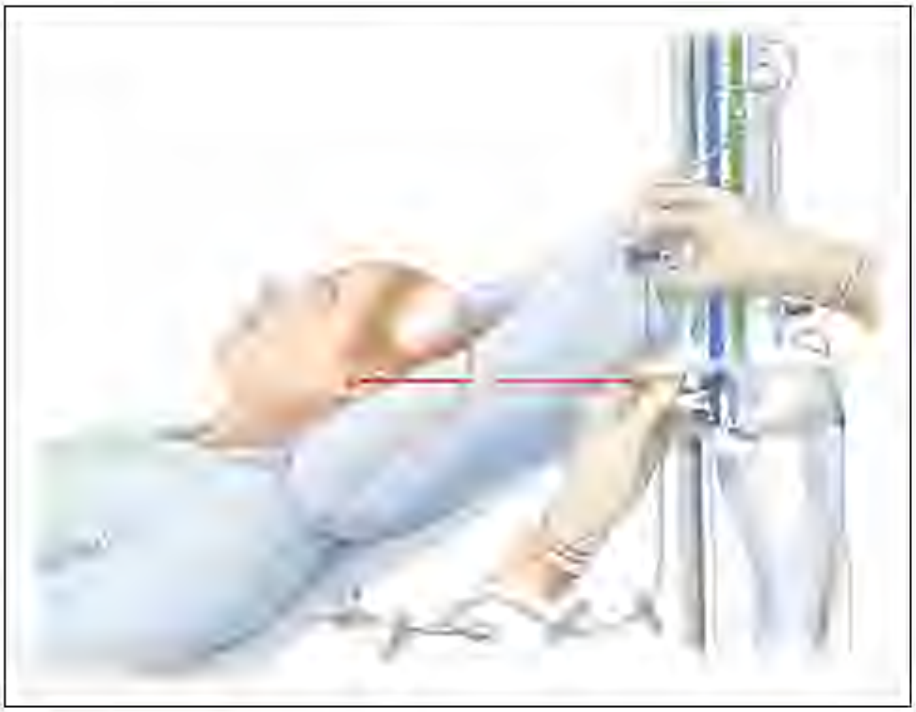
If the practitioner elects to perform the procedure in an OR, prepare the equipment in that location using sterile technique. If the practitioner chooses to perform the procedure at the bedside, disinfect a work surface using a facility-approved disinfectant, as necessary, *to prepare for setting up a sterile field*.[3][4]

Implementation

- Verify the practitioner's order.
- If required by your facility, confirm that informed consent has been obtained and that the signed consent form is in the patient's medical record.[5][6][7][8]
- Conduct a preprocedure verification *to make sure that all relevant documentation, related information, and equipment are available and correctly identified to the patient's identifiers*.[9][10]
- Verify that the laboratory and imaging studies have been completed, as ordered, and that the results are in the patient's medical record. Note that International Normalized Ratio should range from 1.2 to 1.6 in a patient with a traumatic brain injury who requires emergency ventriculostomy *to reduce the risk of hemorrhage*.[11][12] Notify the practitioner of any unexpected results.
- Review the patient's medical record for a history of an allergy or hypersensitivity to latex, antiseptic solution, the local anesthetic, and other medications.
- Gather and prepare the necessary equipment and supplies.
- Perform hand hygiene.[13][14][15][16][17][18]
- Confirm the patient's identity using at least two patient identifiers.[19]
- Provide privacy.[20][21][22][23]
- Reinforce the practitioner's explanation of the procedure to the patient and family (if appropriate) according to their individual communication and learning needs *to increase their understanding, allay their fears, and enhance cooperation*. Answer any questions.[5][6][7][8]

- Explain to the patient and family (if appropriate) that the patient must restrict activity while the drain is in place.[2] The patient may not sit up, stand, or walk when the drain is open and must receive assistance with movement. Explain that a nurse must turn off the system when the patient is repositioning or transferring.[1] Instruct the patient to avoid straining, coughing, and sneezing.
- Make sure that the procedure room door remains closed and limit traffic in the room *to reduce the risk of contamination.*
- Raise the bed to waist level before providing care *to prevent caregiver back strain.*[24]
- Perform hand hygiene.[13][14][15][16][17][18]
- Attach the patient to a cardiac monitor and pulse oximeter *to monitor heart rate and rhythm and oxygen saturation level during the procedure.* Make sure that the alarm limits are set appropriately for the patient's current condition and that the alarms are turned on, functioning properly, and audible to staff.[25][26][27][28]
- Obtain the patient's vital signs and oxygen saturation level, and perform a baseline neurologic assessment *to detect alterations or signs of deterioration during and after the procedure.*[1]
- Make sure that the practitioner marks the catheter insertion site using the process determined by your facility. Involve the patient or family in the process, if possible, *to avoid wrong-site insertion.*[10][29]
- Assess the patency of IV access or initiate IV access, as necessary and ordered.[1] (See the "IV catheter insertion" procedure.)
- Assess the patient's sedation and pain management needs in collaboration with the practitioner.[1][30] Administer a sedative or an analgesic, as needed and prescribed, following safe medication administration practices *to ensure the patient's comfort during the procedure.*[1][31][32][33][34]
- Position the patient supine with the head of the bed elevated 30 degrees. If necessary, obtain assistance to immobilize the patient's head *to prevent movement during catheter insertion.*[1]
- Illuminate the catheter insertion area with a light source.
- Braid or clip the patient's hair, if necessary, *to expose the insertion site.* If you clip the hair, use tape or another similarly sticky product *to remove residual hair clippings.*
- Put on a cap and a mask and goggles or a mask with a face shield.[1][2] Make sure that everyone in the room is wearing a cap and a mask and goggles or a mask with a face shield.
- Perform hand hygiene.[13][14][15][16][17][18]
- Put on a gown and gloves.[35][36][37]
- Establish a sterile field on an overbed table using a sterile towel or the wrapping from the EVD tray, and then unwrap the EVD tray or open all supplies using sterile technique.
- Label all medications, medication containers, and other solutions on and off the sterile field.[38][39]
- Using sterile technique, prepare the ICP monitoring equipment with flushless transducer setup by priming the pressure tubing and EVD system with sterile, preservative-free normal saline solution in a 30-mL or 40-mL syringe and turning the stopcocks, as necessary, *to prime the system.* Replace the vented caps with nonvented caps. Then remove the syringe and replace it with a sterile nonvented dead-end cap.[1] (See the "Intracranial pressure catheter insertion, monitoring, and care" procedure.)
- If you're assisting with sterile supplies, follow these steps:
  - Remove and discard your gloves.[37]
  - Perform hand hygiene.[13][14][15][16][17][18]
  - Put on sterile gloves.[35][36][37]
- Assist, as necessary, as the practitioner cleans the insertion site with antiseptic solution and allows it to dry, drapes the site with a sterile drape, and administers a local anesthetic into the scalp using a 3-mL syringe and a 25G ¾" (1.9-cm) needle.[2]
- Conduct a time-out immediately before the start of the procedure *to perform a final assessment, ensuring that the correct patient, site, positioning, and procedure are identified and, as applicable, that all relevant information and necessary equipment are available.*[1][10][40]

- During drain insertion, continuously monitor the patient's heart rate and rhythm, respiratory rate, oxygen saturation level, and blood pressure. Guidelines recommend using an arterial catheter for blood pressure monitoring *to ensure vigilant monitoring of mean arterial pressure to avoid decreased cerebral perfusion pressure.*
- Assess the patient's neurologic status every 15 minutes during drain insertion. *Serial assessments are necessary to immediately identify and treat neurologic changes.*
- Using sterile technique, assist the practitioner, as necessary, throughout the insertion procedure.
- To insert the drain, the practitioner makes an incision in the scalp and subcutaneous tissue, drills a burr hole through the cranium, and rinses the area with sterile, preservative-free normal saline solution. Next, the practitioner uses an 18G spinal needle to puncture the dura. Then the practitioner inserts the catheter through the burr hole to the desired depth, secures it using a tunneling method through a separate incision, and sutures it. After completing EVD insertion, the practitioner covers the insertion site with a sterile occlusive dressing and secures the catheter *to prevent accidental removal.*
- After the practitioner inserts the catheter, connect the prepared ICP monitoring system and the prepared EVD system to the distal tip of the catheter.[1] Attach the pressure cables and the module following the manufacturer's instructions for use. Trace each tubing from the patient to its point of origin *to make sure that it's connected to the correct catheter.*[41] [42] Label each tubing at both the distal (near the patient) and proximal (near the drainage bag) ends *to distinguish the tubing and reduce the risk of misconnections.* Secure connection points with tape or a connector *to prevent accidental disconnections.*[42]
- Return the bed to the lowest position *to prevent falls and maintain the patient's safety.*[43]
- Place the EVD system, including the drip chamber and collection bag, on an IV pole. Set the drip chamber manometer at the pressure level ordered by the practitioner.[1] Using the level or laser leveling device, level the ICP transducer at the foramen of Monro (as shown below). Anatomically, the external reference point to approximate the foramen of Monro is the level of the external auditory meatus (tragus of the ear) or the outer canthus of the eye. *Maintaining the proper position of the ICP transducer ensures accurate waveform and pressure data.* Use the same landmark every time you check the zero-reference level.[1] [2]



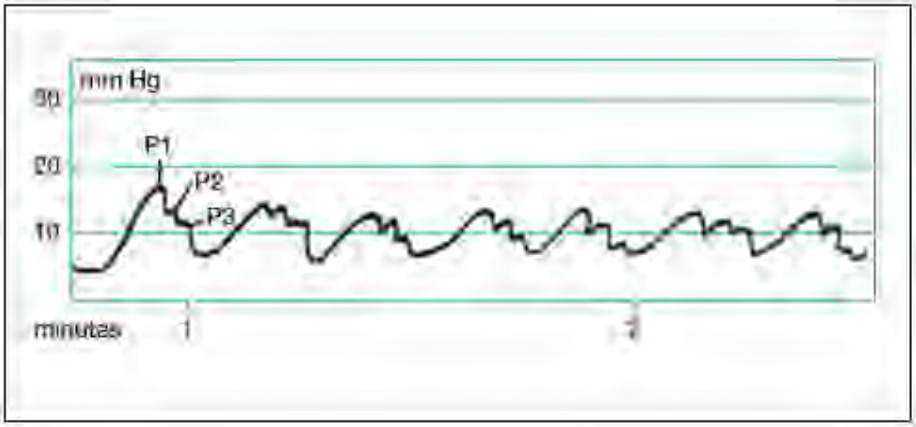
- Ensure that the monitoring system is free from air, *which could alter the pressure reading.*
- Calibrate the pressure monitor, following the manufacturer's instructions.
- After EVD insertion, monitor the patient's vital signs, oxygen saturation level, neurologic status, and ICP waveform at least every hour, according to the patient's condition or as directed by your facility. (See *Interpreting intracranial pressure waveforms*.)
- Ensure that the drainage system is appropriately clamped or open, depending on the patient's situation and the practitioner's order.
- Assess and record the volume, clarity, and color of CSF drainage hourly or as ordered.[1]
- Check the patient's position to ensure that the transducer is at the ordered reference level. If the patient is very active and moving around in the bed, frequently assess that the drainage system is leveled appropriately *to prevent overdrainage or underdrainage*.[1]
- Check drain patency, as necessary, by briefly lowering the entire system to assess the drip rate into the graduated burette.
- Notify the practitioner immediately if drainage ceases and you find no external cause (such as kinking or disconnection).[2]
- Place a sign at the head of the patient's bed, clearly identifying the prescribed device height and head-of-bed elevation level, as directed by your facility.
- Instruct the patient and family (if appropriate) not to change patient positioning without the assistance of a nurse.[1]
- Discard used supplies in appropriate receptacles.[37]
- Remove and discard your gloves and other personal protective equipment.[37]
- Perform hand hygiene.[13][14][15][16][17][18]
- Reassess and respond to the patient's pain by evaluating the response to treatment and progress toward pain management goals. Assess for adverse reactions and risk factors for adverse events that may result from treatment.[30]
- Perform hand hygiene.[13][14][15][16][17][18]
- Document the procedure.[44][45][46][47]

INTERPRETING INTRACRANIAL PRESSURE WAVEFORMS

Becoming familiar with intracranial pressure (ICP) waveforms can help you quickly identify and respond to changes that may indicate decreased intracranial compliance.

Normal waveform

A normal ICP waveform typically has three peaks: P1, P2, and P3. P1, the pressure wave, originates from choroid plexus pulsations. P2, the tidal wave, is more variable in shape and amplitude and ends on the dicrotic notch. P3, the dicrotic wave, falls after the dicrotic notch and commonly tapers downward.[1] Closure of the aortic valve causes P3. Some individuals have additional peaks, but these peaks aren't as clinically significant as the three main peaks. The waveform below occurs continuously and indicates an ICP in the normal range (0 to 15 mm Hg).

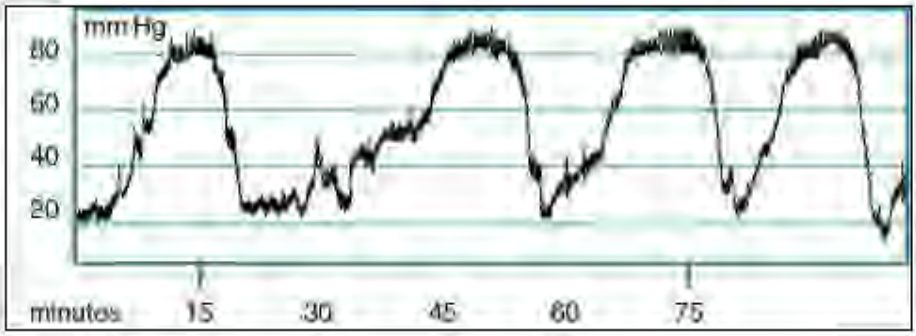


Abnormal waveforms

The P2 portion of the waveform most directly reflects the state of the brain's compliance. Abnormal ICP waveform trends include A, B, and C waves.

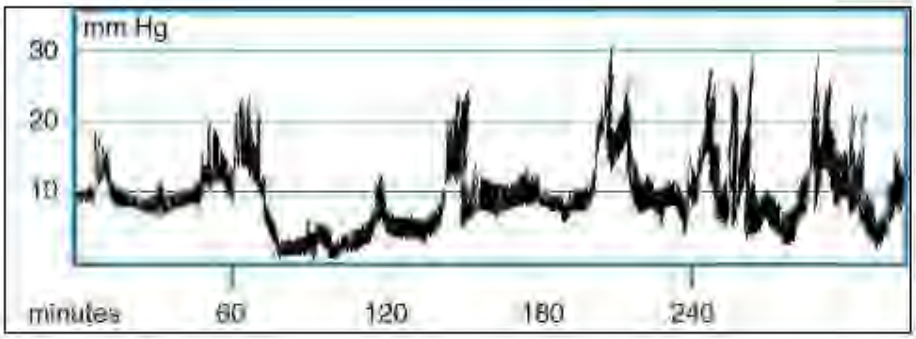
A waves

As mean ICP rises, P2 progressively elevates, causing the pulse wave to appear more rounded. The most clinically significant ICP waveforms are A waves (shown below), which may reach elevations of 50 to 100 mm Hg, persist for 5 to 20 minutes, and then drop sharply, signaling exhaustion of the brain's compliance mechanisms.[1] A waves may come and go, spiking from temporary rises in thoracic pressure or from any condition that increases ICP beyond the brain's compliance limits. Certain activities, such as sustained coughing and straining during defecation, can cause temporary elevations in thoracic pressure. *Because A waves are an ominous sign,* they require emergency treatment.[1]



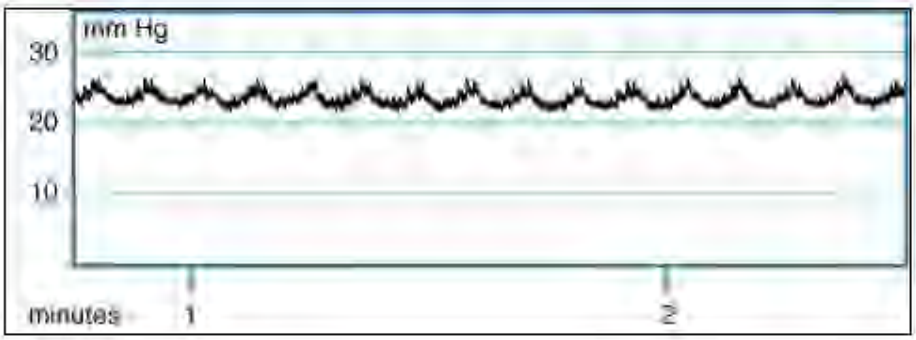
B waves

B waves (shown below), which appear sharp and rhythmic with a sawtooth pattern, occur every 1 to 2 minutes and may reach elevations of 50 mm Hg.[1] The clinical significance of B waves isn't clear, but the waves correlate with respiratory changes and may occur more commonly with decreasing compensation. *Because B waves sometimes precede A waves,* notify the practitioner if B waves occur frequently.



C waves

C waves (shown below) are rapid and rhythmic but not sharp and are associated with an ICP as high as 20 mm Hg. Clinically insignificant, they may fluctuate with respirations or systemic blood pressure changes.[1]



Waveforms showing equipment problem

A damped waveform, such as the one below, typically signals a problem with the transducer or monitor or results from kinks, air bubbles, blood clots, or debris in the catheter or drainage system. Check for catheter obstruction, and determine whether the transducer needs releveling and rezeroing. If the patient has a low ICP reading, this waveform may be normal.

Special Considerations

- Vigilant assessment of CSF drainage volume throughout each hour is essential *to prevent overdrainage and underdrainage.*[1] Overdrainage can occur if the drip chamber is placed too far below the catheter insertion site. Underdrainage may reflect kinked tubing, catheter displacement, or a drip chamber placed higher than the catheter insertion site.
- Maintain the collection system in the upright position. If you need to lay down the system, drain the CSF into the lower collection bag *to reduce the incidence of infection and backflow.*[1]
- Raising or lowering the head of the bed can affect the CSF flow rate. When changing the patient's position, level the transducer to the tragus of the ear or the outer canthus of the eye.[1][2]
- Patients may experience a chronic headache during continuous CSF drainage. Reassure the patient that this symptom isn't unusual; however, monitor for headache and administer analgesics, as appropriate, following safe medication administration practices.[31][32][33][34]
- Assess for signs of increased ICP, which include headache, a decrease in level of consciousness, nausea, vomiting, and lethargy or agitation.[2]
- Guidelines discourage taking the patient off the patient floor to perform tests and procedures *to prevent catheter dislodgement.* Check your facility's requirements for scheduling such tests and procedures at the patient's bedside.
- Don't change the drainage tubing routinely; let it remain for the duration *to maintain sterility and reduce the risk of infection.*[2] Only change the drainage bag, as directed by your facility.[1] When changing the drainage bag, wear sterile gloves and a mask to reduce the risk of infection.
- Change the EVD insertion site dressing daily, as ordered or as directed by your facility. Use sterile technique *to maintain sterility and observe the insertion site.*[1]
- The Joint Commission issued a sentinel event alert concerning medical device alarm safety *because alarm-related events have been associated with permanent loss of function or death.* Among the major contributing factors were improper alarm settings, alarm settings turned off inappropriately, and alarm signals that were inaudible to staff. Make sure that alarm limits are set appropriately and that the alarms are turned on, functioning properly, and audible to staff. Follow facility guidelines for preventing alarm fatigue.[28]
- The Joint Commission issued a sentinel event alert related to managing risk during transition to new International Organization for Standardization tubing standards that were designed to prevent dangerous tubing misconnections, *which can lead to serious patient injury and death.* During the transition, make sure to trace each tubing and catheter from the patient to its point of origin before connecting or reconnecting any device or infusion, at any care transition (such as a new setting or service), and as part of the handoff process; route tubes and catheters having different purposes in different standardized directions; when the patient has different access sites or several bags hanging, label tubing at both the distal and proximal ends; use tubing and equipment only as intended; and store medications for different delivery routes in separate locations.[42]

Complications

Complications associated with EVD insertion may include:[1][2]

- aneurysmal rebleeding and hemispheric shifts from reduction in ICP
- CSF overdrainage, indicated by these signs and symptoms:
  - facial numbness
  - facial weakness
  - hearing changes
  - horizontal diplopia
  - mental status decline
  - postural headache that's relieved in the supine position
  - small pupil size
  - vertigo
- infection
- intracranial hemorrhage or misplacement.

◆ ***Clinical alert:*** If drainage accumulates too rapidly, clamp the system, immediately notify the practitioner, and perform a complete neurologic assessment. This complication constitutes a potential

neurosurgical emergency.◆

Documentation

Documentation associated with EVD insertion includes:

- preprocedure verification process
- that a time-out was performed immediately before the procedure
- date and time the practitioner inserted the drain
- position of the patient
- position of the transducer at the ordered reference level
- tolerance of the insertion process
  - neurologic assessment findings
  - vital signs
  - oxygen saturation level
  - medication administration
  - ICP (place an ICP pressure tracing in the patient's medical record)
- complications
  - interventions performed
  - response to those interventions
- hourly CSF output and neurologic and hemodynamic status
- teaching provided to the patient and family (if applicable)
  - understanding of that teaching
  - follow-up teaching needed.

Related Procedures

- Cerebrospinal fluid drainage management
- External ventricular drain insertion, assisting, pediatric
- External ventriculostomy device management, pediatric

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(Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions)

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Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions

The following leveling system is adapted from *Evidence-Based practice in nursing & healthcare: A guide to best practice,* Fifth edition, by Bernadette Mazurek Melnyk and Ellen Fineout-Overholt (2023).

Level I	Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs)
Level II	Evidence from well-designed single RCTs (experimental)
Level III	Evidence from well-designed nonrandomized controlled trials (quasi-experimental), systematic reviews of a complete body of evidence, and intervention studies using mixed methods

Level IV	Evidence from well-designed case-control and cohort studies (observational)
Level V	Evidence from systematic reviews of qualitative and descriptive studies
Level VI	Evidence from single descriptive and qualitative studies, evidence-based practice implementation, and quality improvement projects
Level VII	Evidence from expert opinion, expert committee reports, and literature reviews

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