Radial Artery Access and Care

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MUNSON HEALTHCARE

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

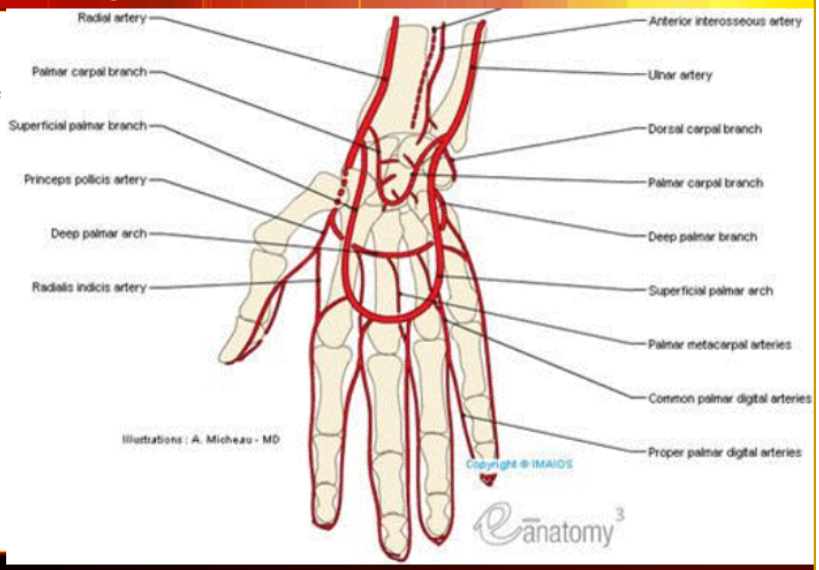
Review of Radial Anatomy

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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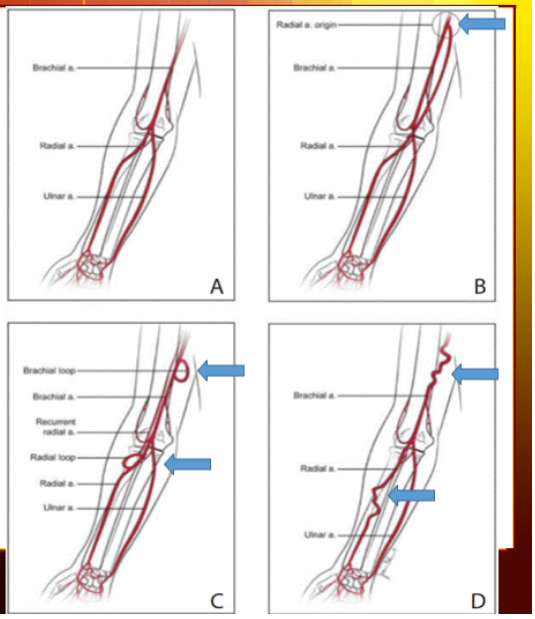
Anatomical Considerations

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.*



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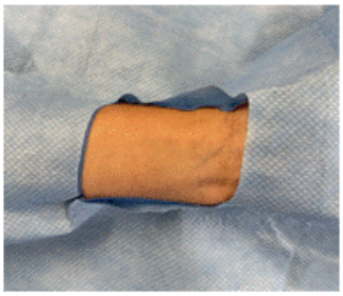
Pre-procedural Considerations

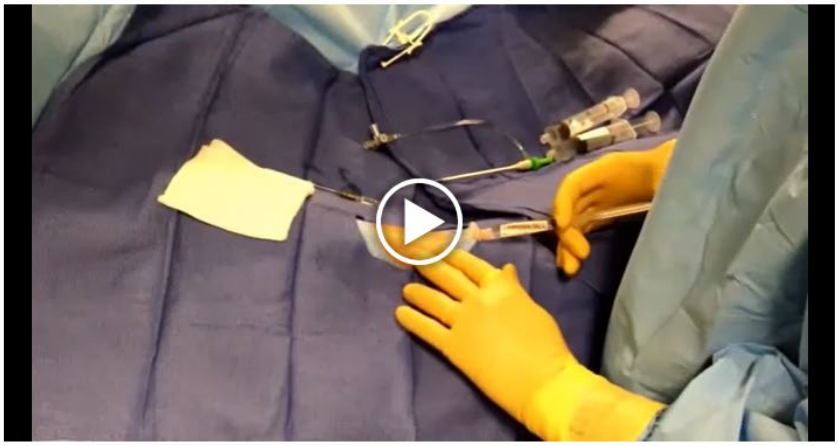
Pre-procedural care includes:

- 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.



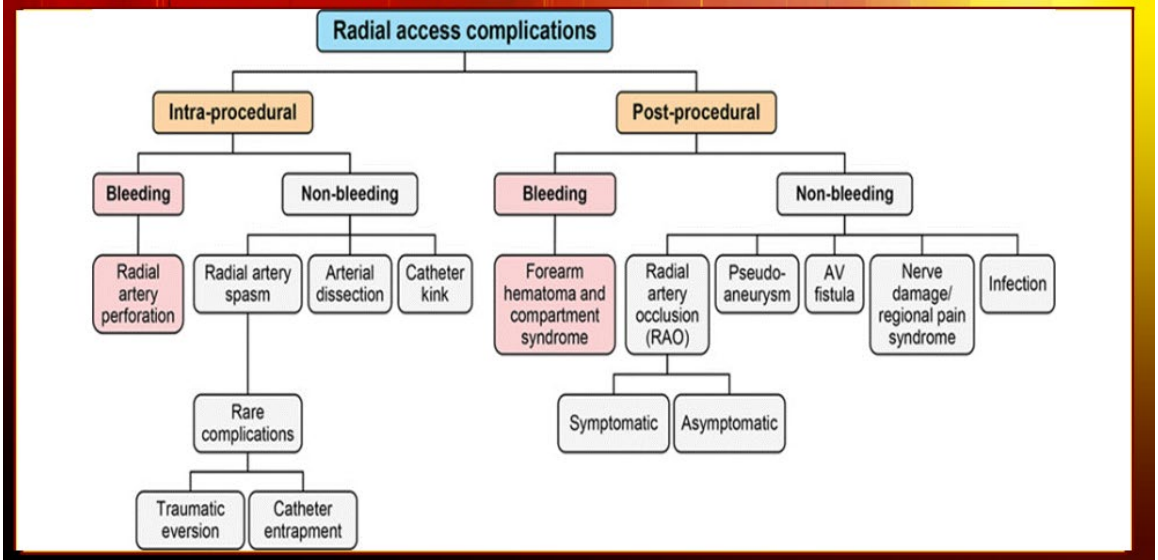
Radial Artery: Access Procedure

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:

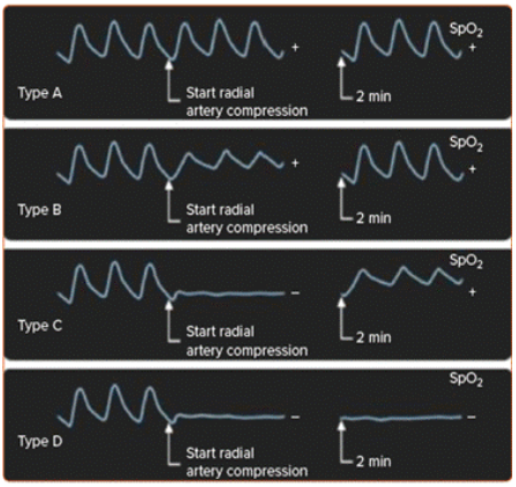
- Immediately after application of the compression device.
- On arrival to recovery room/inpatient unit.
- Whenever there is an increase in amount of air in the compression or adjustments to the compression band.
- After removal of the compression band.
- At the time of discharge.

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
D indicated no flow

Site Assessment Post-Procedure

Thoroughly assess the radial access site for:

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

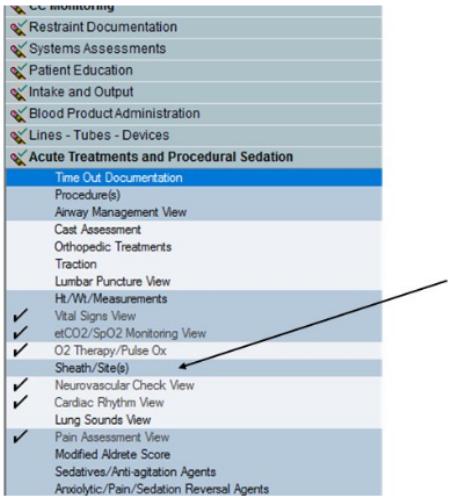
Perform neurovascular checks and document:

- 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.

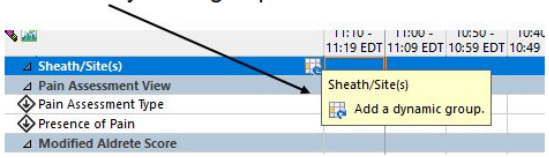
Sheath/Site Documentation



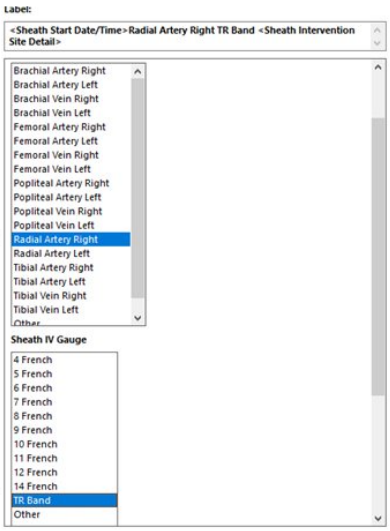
- Document sheath sites and neurovascular status in the Sheath/Site(s) section of the "Acute Treatments and Procedural Sedation" band in iView.

Sheath/Site Documentation (con't)

- Add a dynamic group for each site

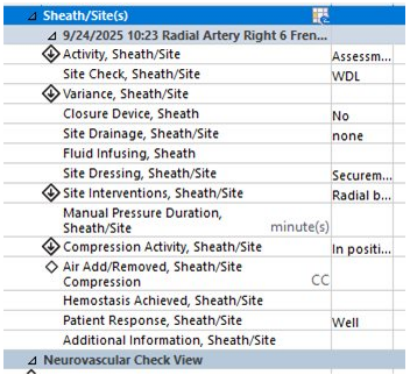


- Select the correct site and choose "TR band" for a radial site with a band in place



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.

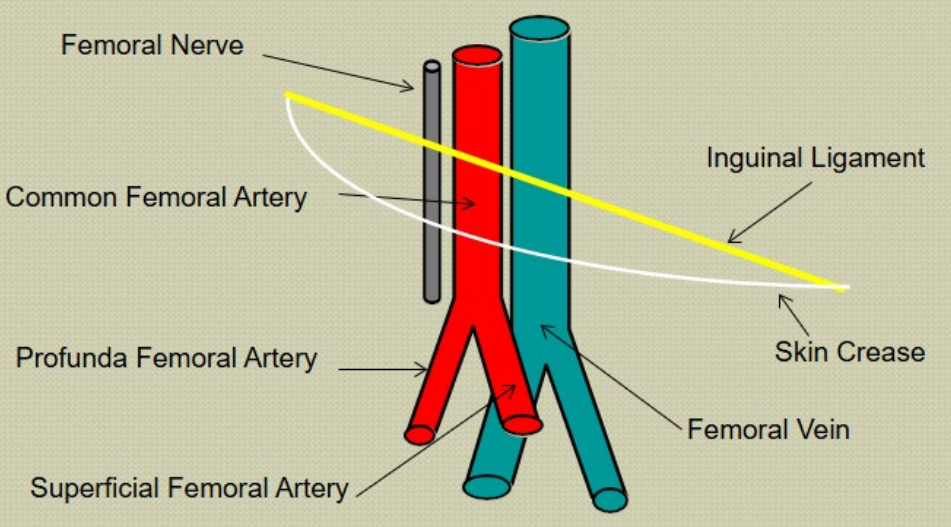
Objectives

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

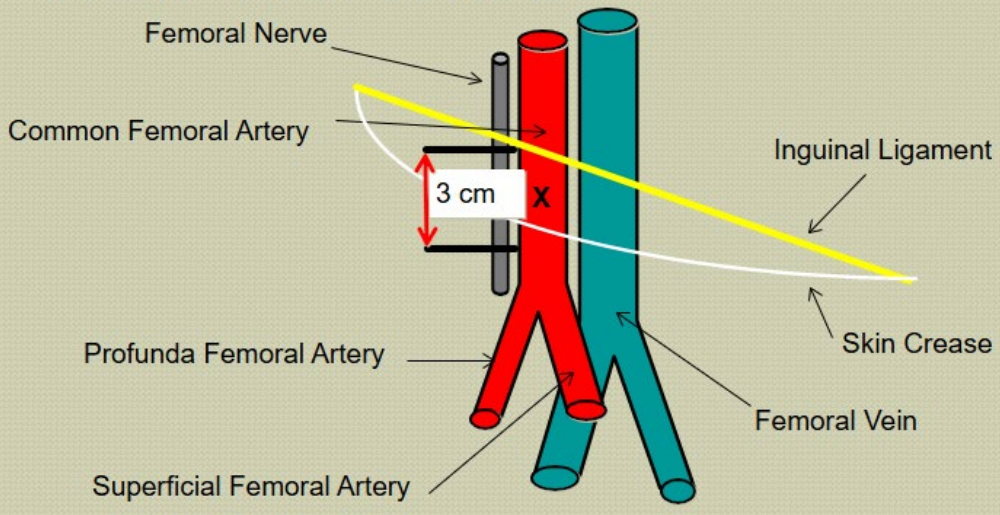
Identify the nerve, artery, vein, and ligament structures in the groin area.



Progress

Vascular Anatomy Relevant to the Sheath Insertion Site

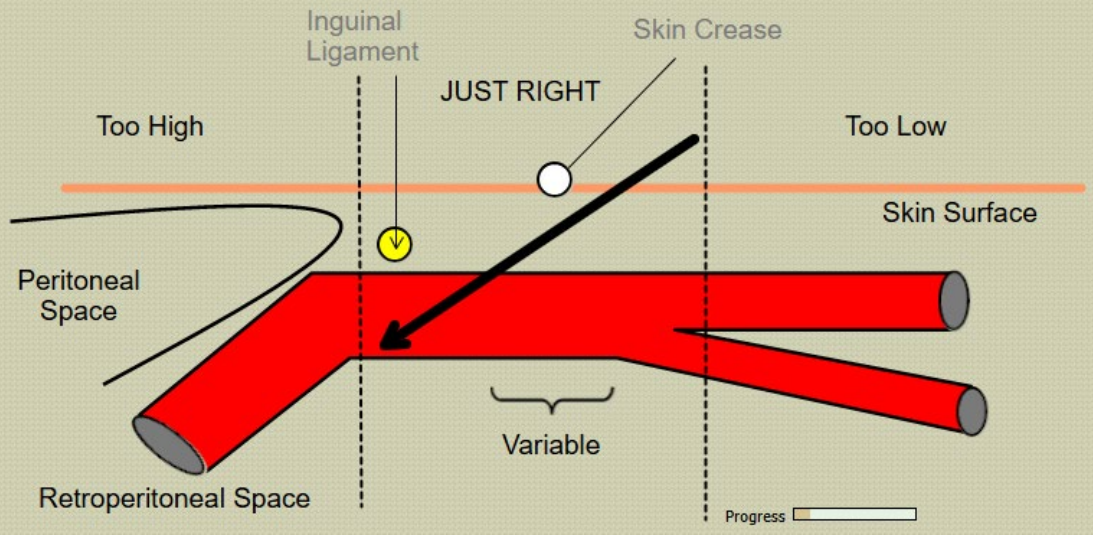
The arterial stick should be placed approximately 3 cm below the inguinal ligament and directly over the femoral artery pulse.



Progress

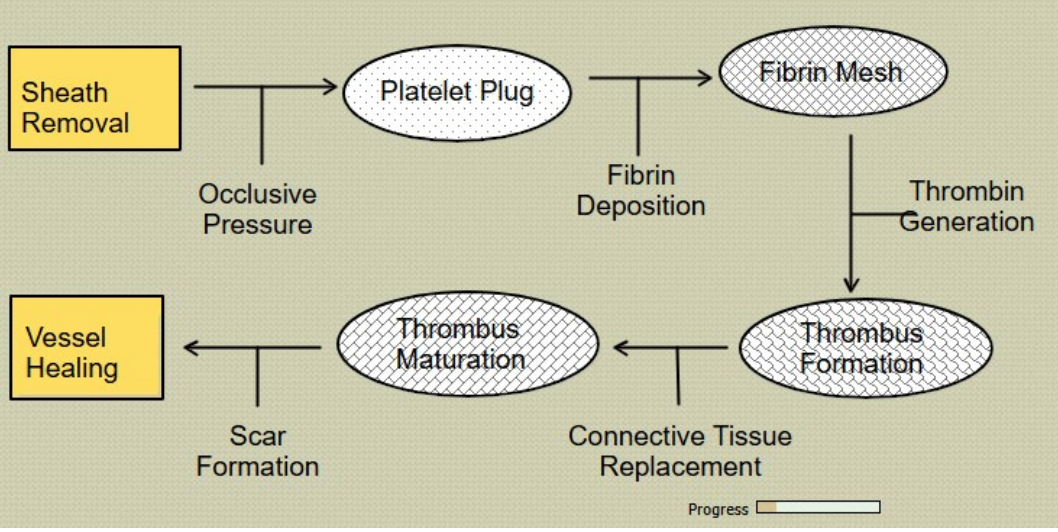
Arterial Puncture

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



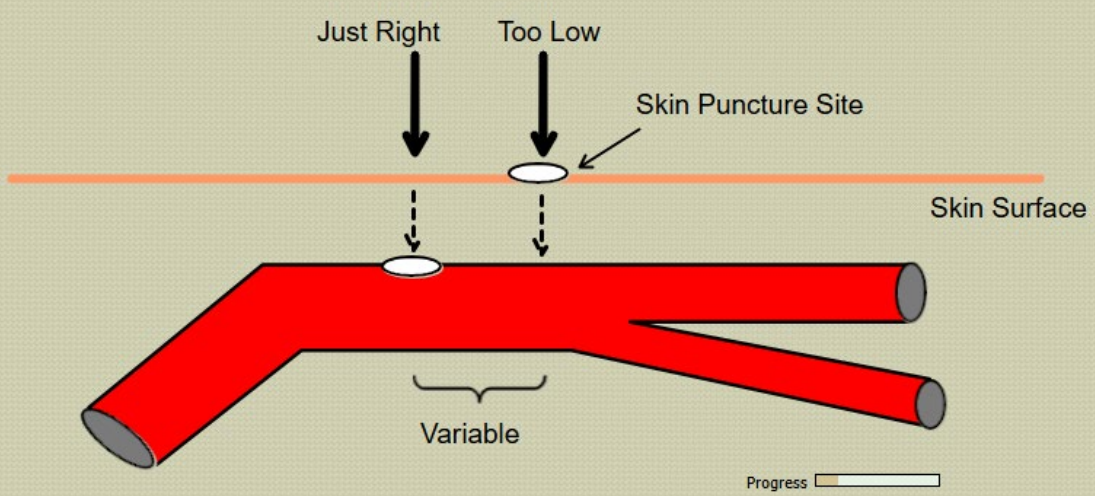
The Hemostasis Process

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



Hemostasis

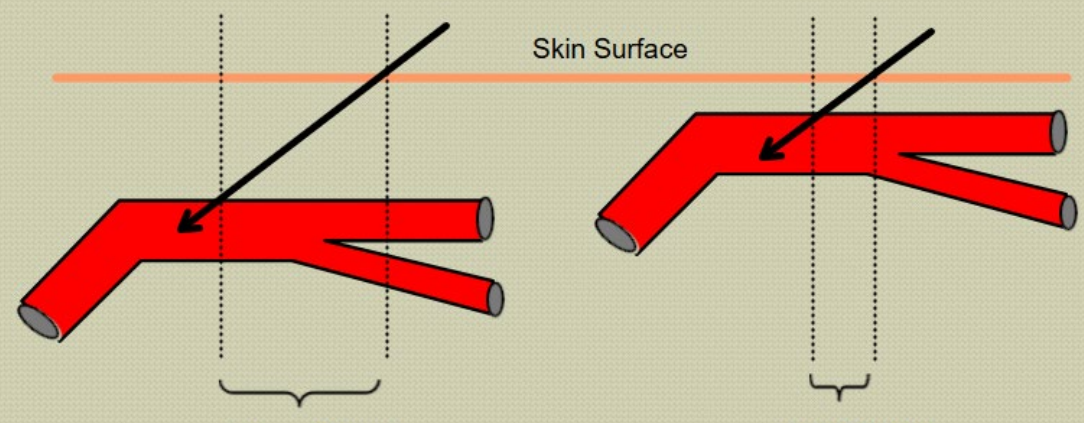
Manual pressure should be applied 2-3 cm above the skin puncture to achieve hemostasis.



Progress

Hemostasis *(cont.)*

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



Progress

Post Sheath Pull:
Potential Vascular Complications

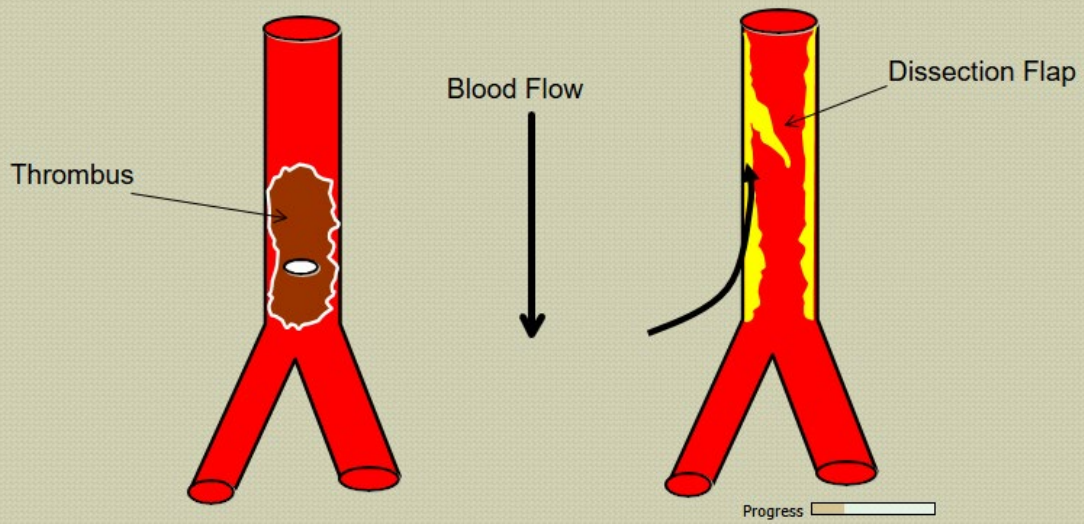
- Vessel thrombosis and dissection
- Bleeding
- Re-bleeding
- Femoral hematoma
- Retroperitoneal hemorrhage
- Pseudoaneurysm
- Arteriovenous fistula
- Atheroembolism

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

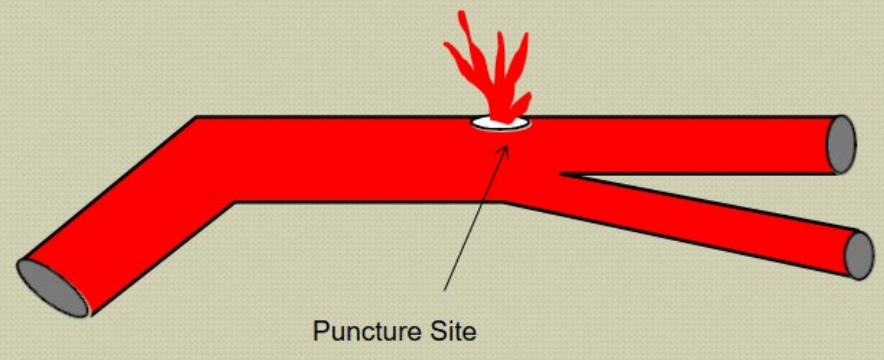
- Femoral artery thrombosis is rare and typically occurs in patients with small arterial lumens. Examples: peripheral vascular disease (PVD), diabetes mellitus (DM), and female gender.
- Dissection usually occurs in the setting of PVD or difficult arterial access.
- Patients commonly complain of leg 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.

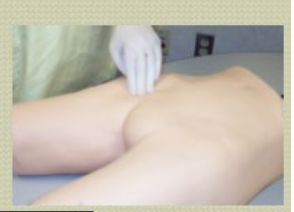
- It is possible for the Hematocrit to drop by $\geq$ 10% and the hemoglobin to drop by $\geq$ 3 g/dL.
- The patient may require a transfusion.



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.

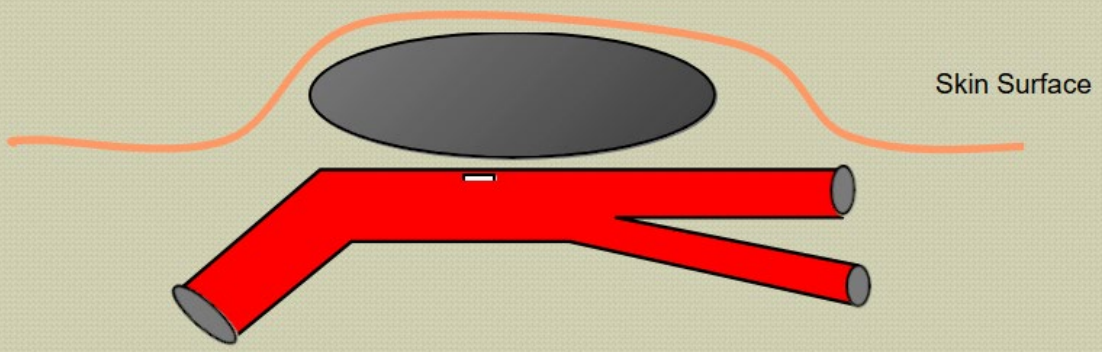


Progress

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.)*

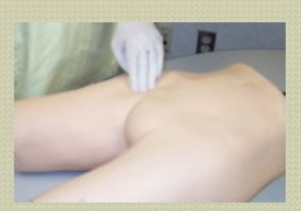
Key Points:

- 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

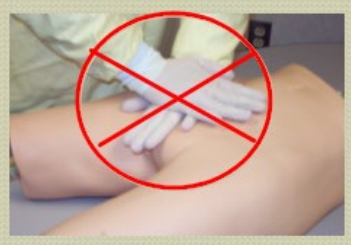
Nursing Considerations: Hematoma

- 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.

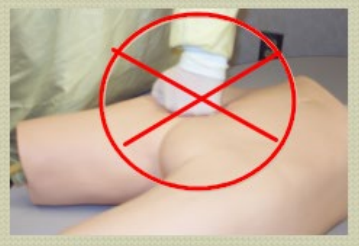


Progress

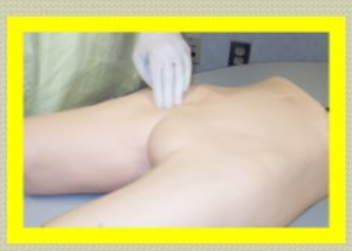
Nursing Considerations: Manual Compression Technique



Wrong Techniques



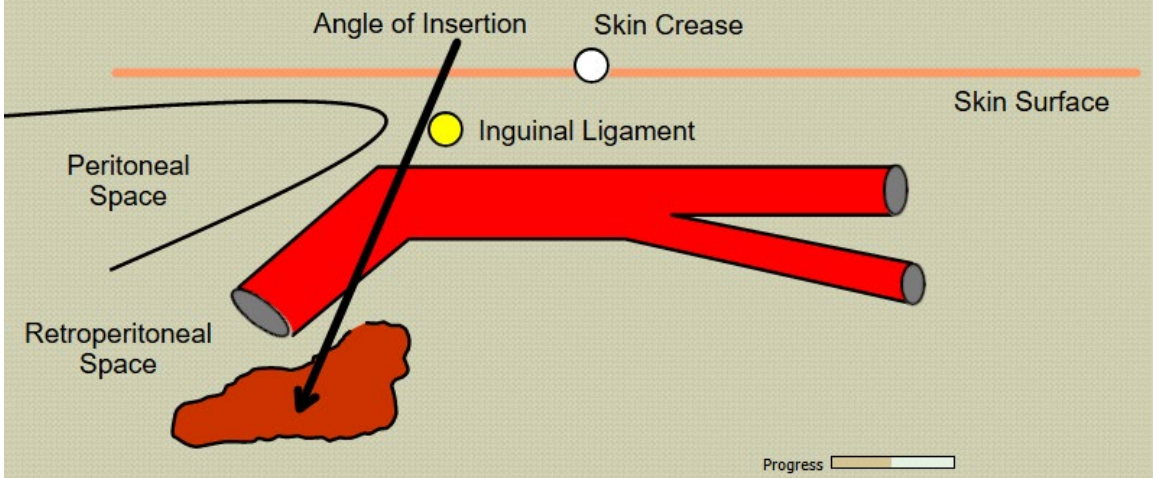
Correct Technique



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:

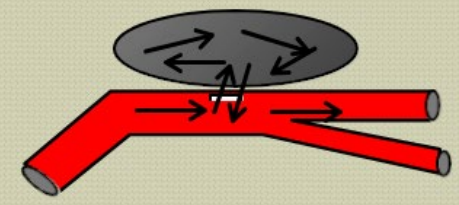
- This type of bleeding is not evident from the surface.
- Symptoms include hypotension, abdominal pain, and ipsilateral flank pain.
- Physical exam may reveal a palpable mass with discoloration over the flank or abdomen.
- Marked anemia can occur from blood loss.
- **This is a life-threatening situation!**
- 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:

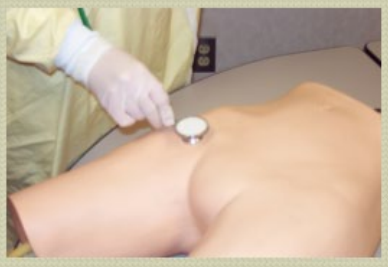
- Anticoagulation and platelet inhibitors.
- Obesity - causes difficulty in maintaining direct pressure.
- Advanced age - causes loss of tissue elasticity.
- Atherosclerotic occlusive disease.
- Increased sheath size - creates larger vascular interruption.
- Improper operator technique.
- Thrombolytic 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.)*

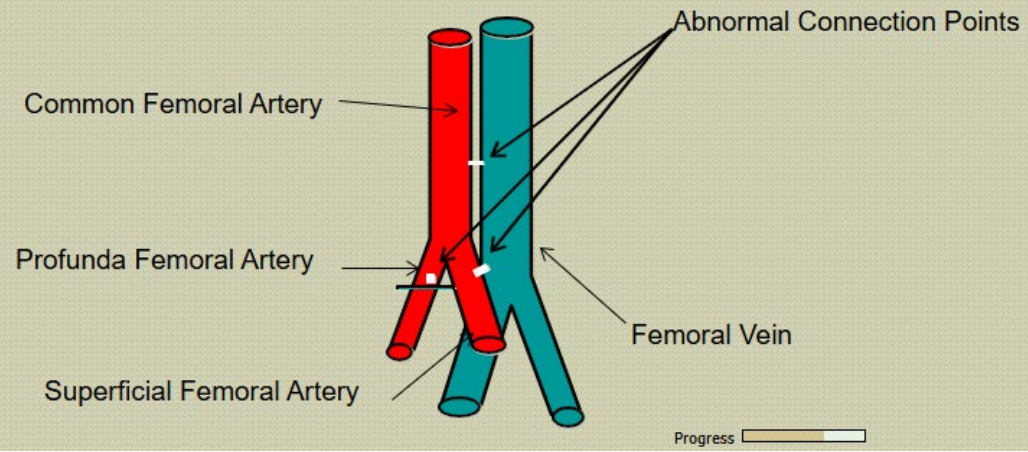
Key Points:

- 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.

Progress

Vascular Complications: Arteriovenous Fistula *(cont.)*

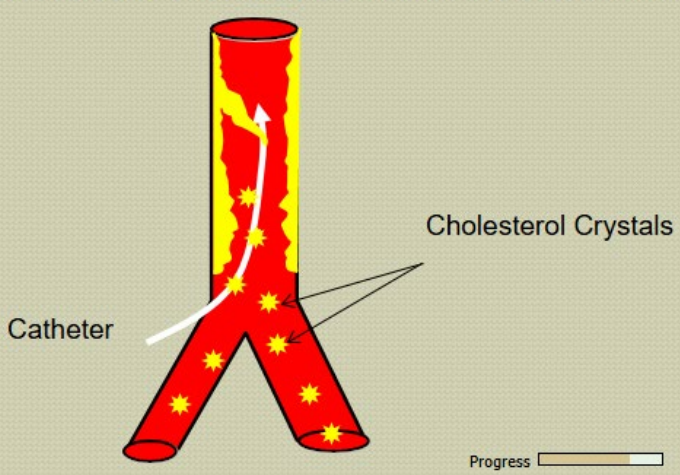
Key Points:

- 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.

Progress

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.

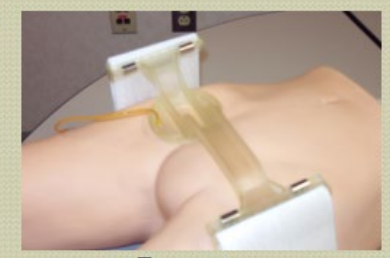
Progress

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

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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.

Munson Medical Center Procedures. (2024). Femoral compression device use. Lippincott Procedures.

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Munson Medical Center PolicyStat. (2023). Arterial/Venous Sheath Management.

Progress

MUNSON HEALTHCARE

Overview of Procedural Sedation

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Jeannette Reynolds, MSN, BBA, RN, CPAN

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.

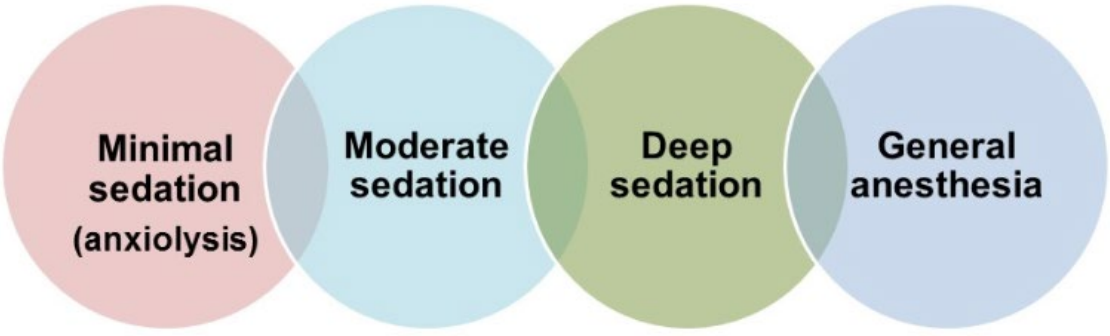
Exclusion List: Non-Procedural Sedation

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	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	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:

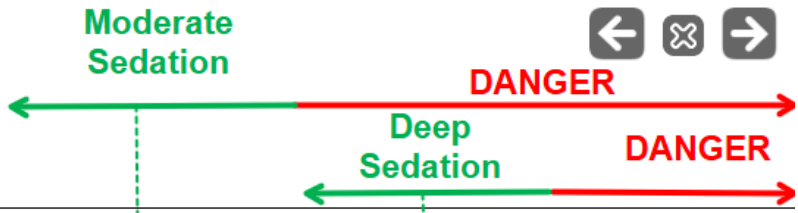
- Not easily aroused
- Partial or complete loss of protective reflexes
- Difficulty maintaining a patent airway independently
- Unable to respond to physical stimulation or verbal commands
- Severely slurred speech

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
- [x] Ability to respond normally to verbal commands
- [ ] Diminished respiratory rate or blood pressure
- [x] Ability to maintain a patent airway
- [x] 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:

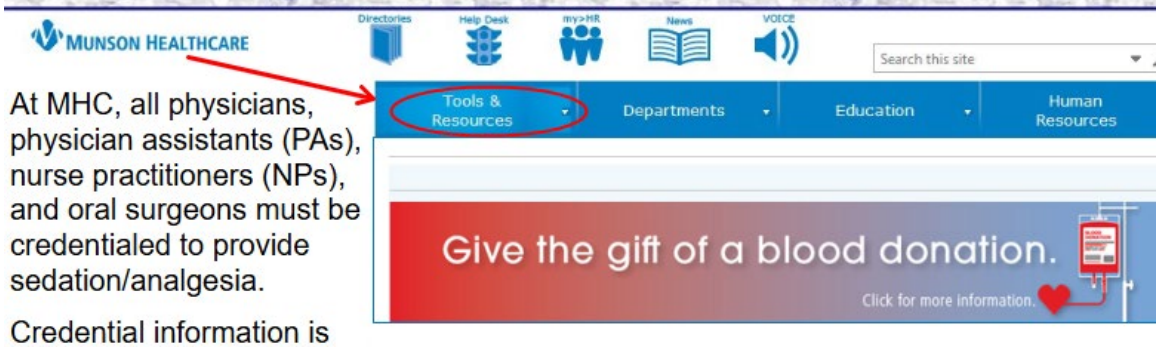
Upon hire:

- 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

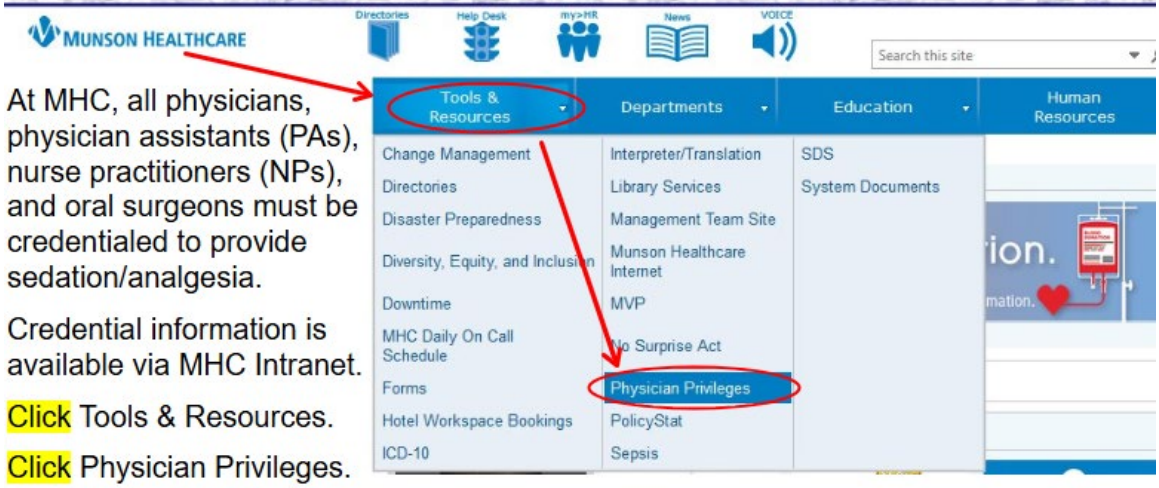


At MHC, all physicians, physician assistants (PAs), nurse practitioners (NPs), and oral surgeons must be credentialed to provide sedation/analgesia.

Credential information is available via MHC Intranet.

Click Tools & Resources.

Provider Credential Check



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Click Tools & Resources.

Click Physician Privileges.

Provider Credential Check

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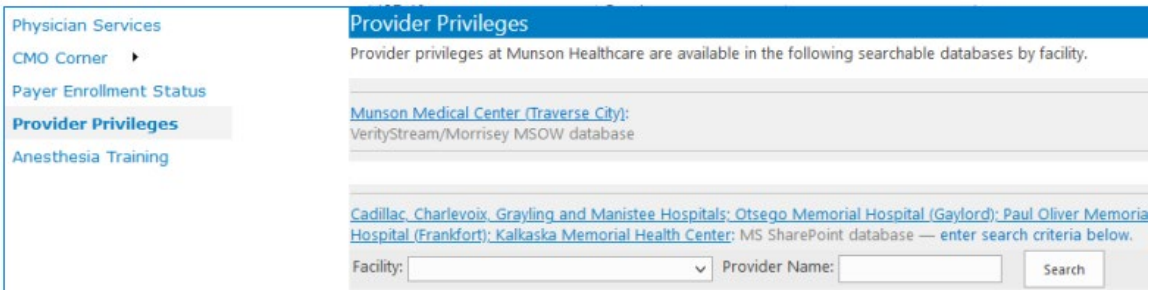


Knowledge Check

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.)*

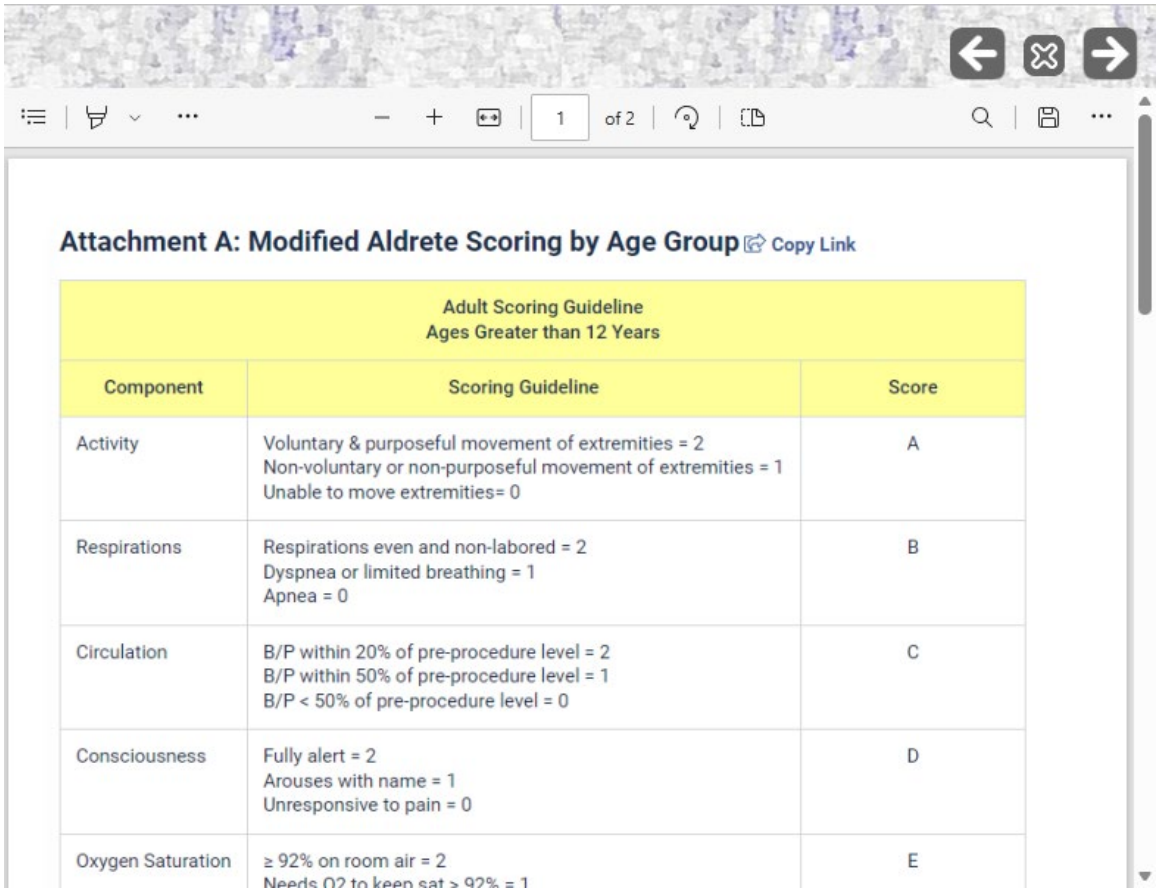
- Ensure a comprehensive assessment of the patient is completed.
- Perform a baseline pain assessment.
- Verify patent IV access.
- Pre-oxygenate the patient via nasal cannula at a flow rate of 2 L/m (unless medically contraindicated).
- Verify emergency equipment is available and in working condition.
- 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
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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:

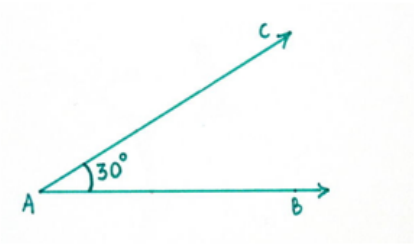
- IV fluid replacement
- Vasopressors
- Blood transfusion
- If you suspect the cause is over-sedation, administer reversal agents per protocol:
  - Flumazenil (Romazicon) for benzodiazepines.
  - Naloxone (Narcan) for opioids.

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.

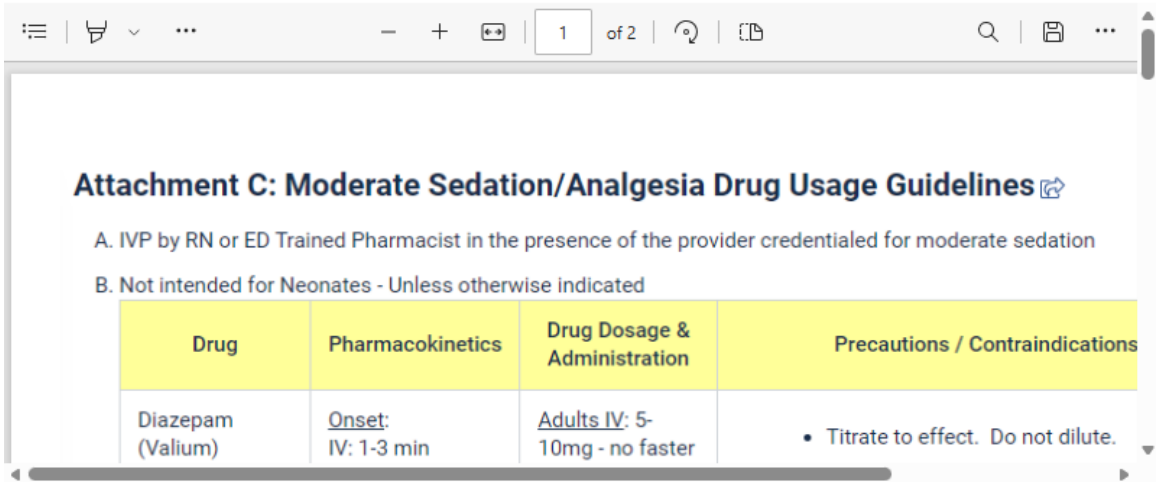
These guidelines are intended for initial doses and may be exceeded or decreased according to the patient's history, previous response to sedatives or other clinical circumstances.

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.



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

. 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

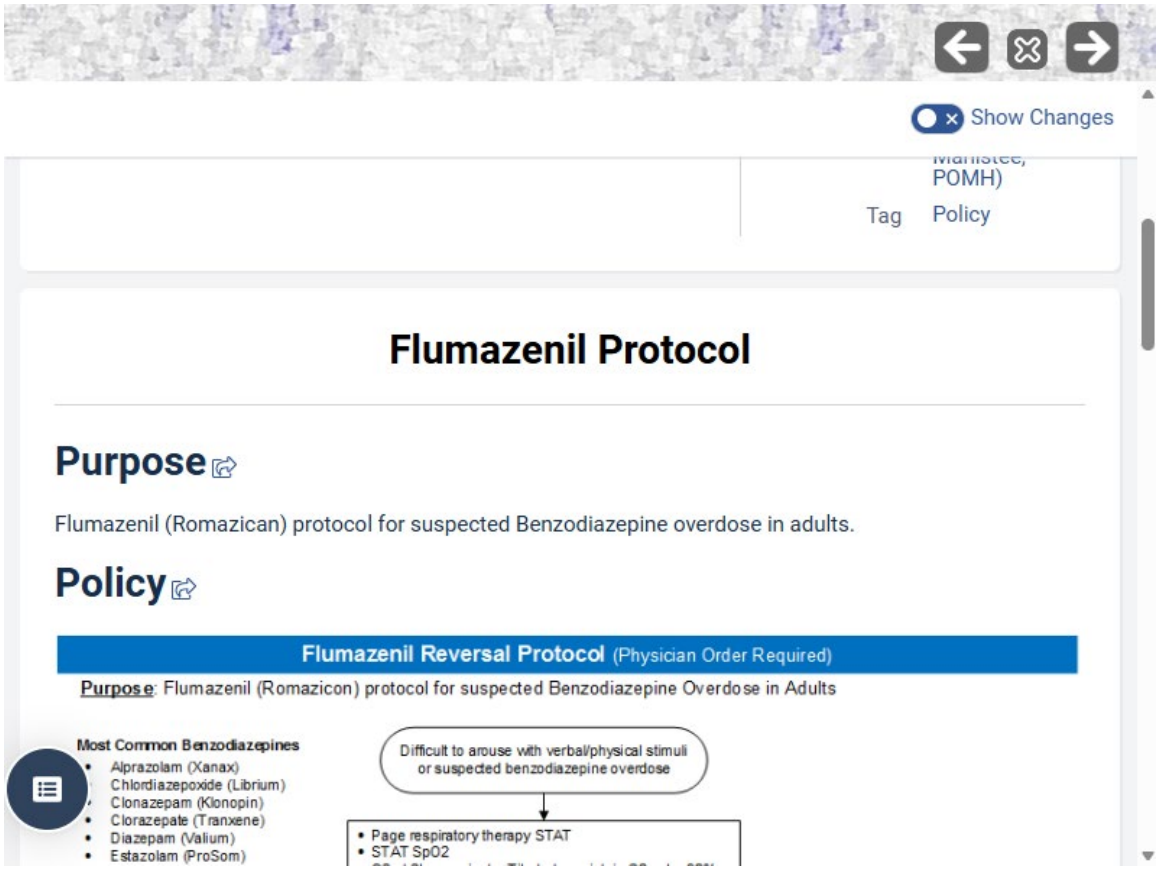
flumazenil (Romazicon) Protocol

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



- 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.

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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 

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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.

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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.

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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)[3]
- 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

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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

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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

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Radiation Safety for Patients
Fluoroscopy

Dennis Aurand, MS, DABR
Radiation Safety Officer
August 2023

MUNSON HEALTHCARE

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Goal and Objectives

Goal

This course will provide information about worker and patient radiation safety during fluoroscopy.

Objectives

1. Identify three ways to reduce personnel radiation dose.
2. Determine best patient/source/receptor relationship.
3. Select ways to reduce patient dose.
4. State warning levels for patient dose.

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Reasons

Patients undergoing diagnostic and interventional fluoroscopic and/or angiographic procedures can receive high skin doses.

The FDA has reported skin injury from such procedures.

The Joint Commission added fluoroscopy with cumulative dose greater than 1500 rads (15,000 mGy) to a single field as a reviewable sentinel event.

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Radiation Dose Effects

Effect	Single-dose threshold (mGy)	Onset time
Early transient erythema	2,000	Hours
Main erythema	6,000	~10 d
Temporary epilation	3,000	~3 wk
Permanent epilation	7,000	~3 wk
Dry desquamation	14,000	~4 wk
Secondary ulceration	24,000	>6 wk
Late erythema	15,000	~8-10 wk
Skin cancer	Unknown	>5 yr

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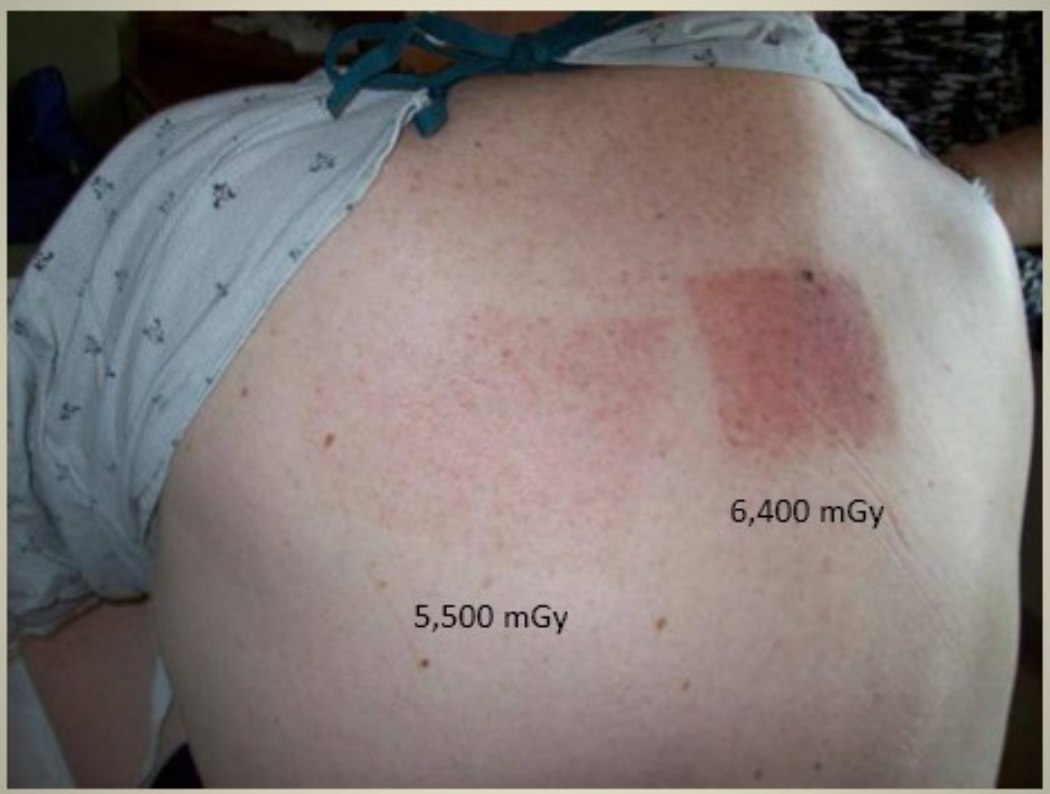
Radiation Dose Effects *(cont.)*



62 y.o. patient, 2 procedures 2 weeks apart

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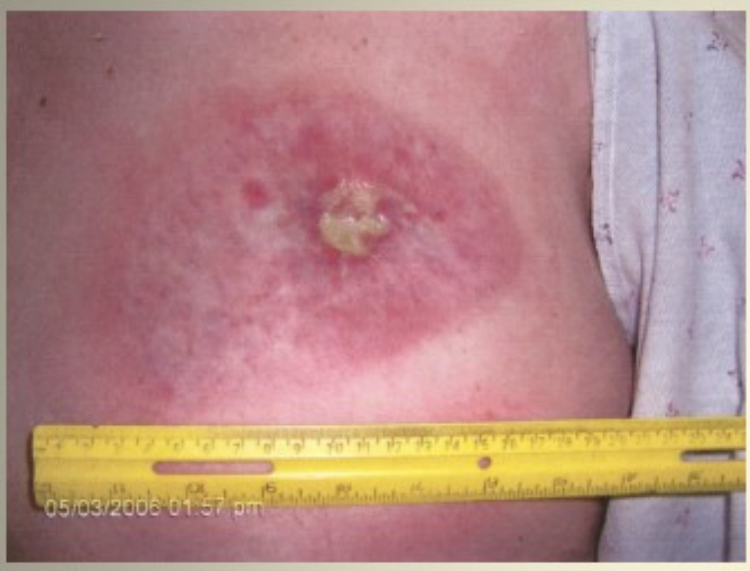
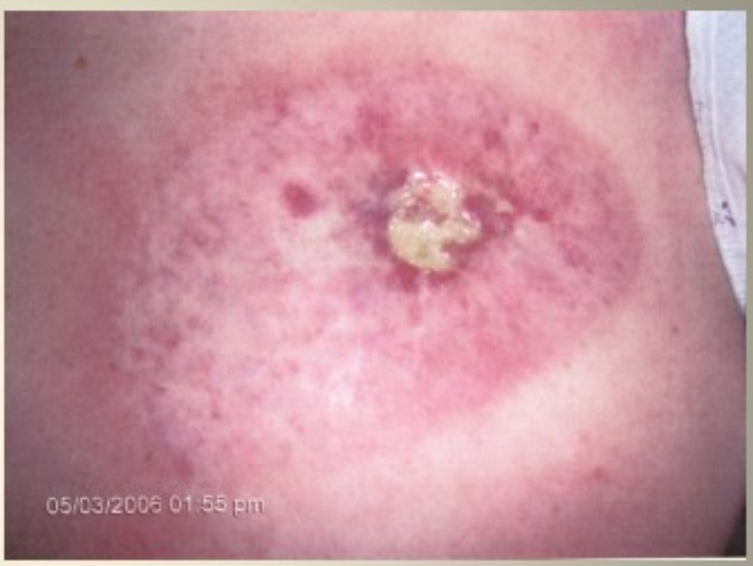
Radiation Dose Effects *(cont.)*





47 y.o. patient, lupus, estimated 6,100 mGy
(later estimated at 15,000-20,000 mGy)

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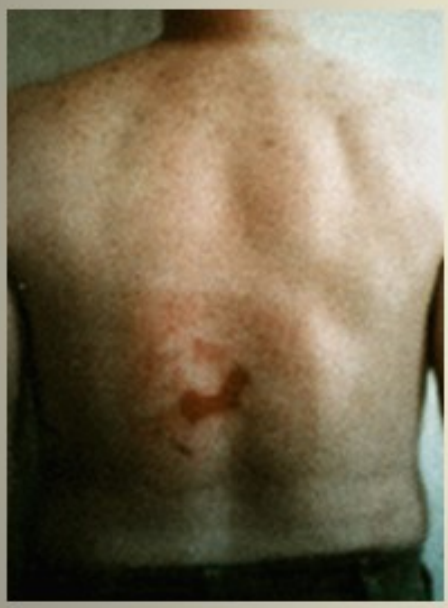
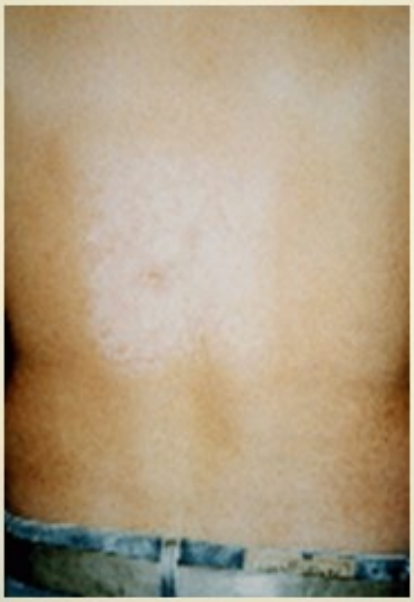
Radiation Dose Effects *(cont.)*

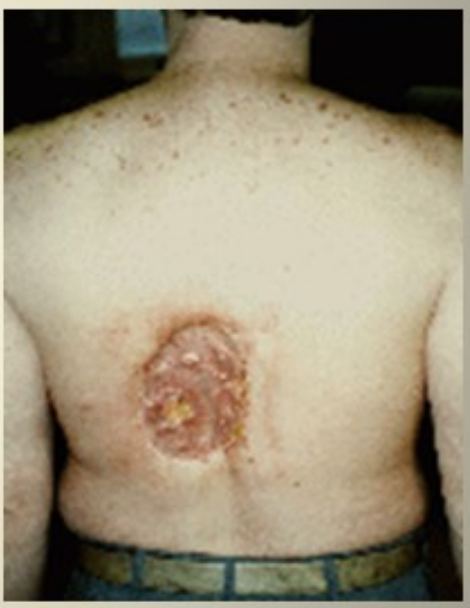
After multiple coronary angiography and angioplasty procedures
(120 minutes of fluoro and dose of 20,000 mGy)



> 6-8 weeks
redness, peeling



16-18 weeks
Small ulcerated area



18-21 month
Tissue necrosis

Shope T. Radiation-induced skin injuries from fluoroscopy. FDA/CDRH, 1995

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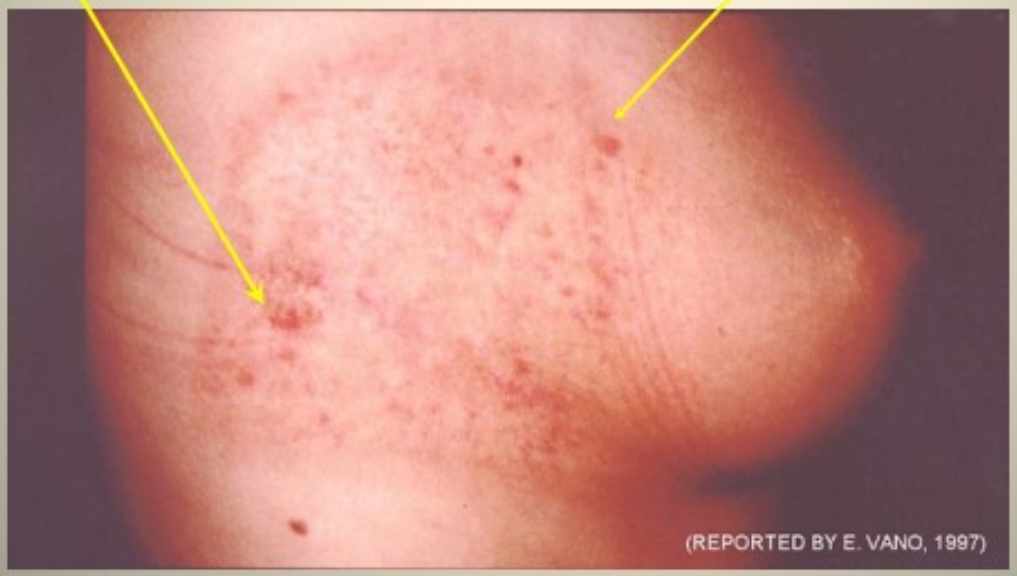
Radiation Dose Effects *(cont.)*

Chronic radiodermatitis in 17-year-old female patient after x2 radiofrequency ablation procedures

Atrophic indurated plaque

Hyper- and hypo-pigmentation, with telangiectasia



Reproduced with permission from Vañó, Br J, Radiol 1998; 71, 510 - 516.

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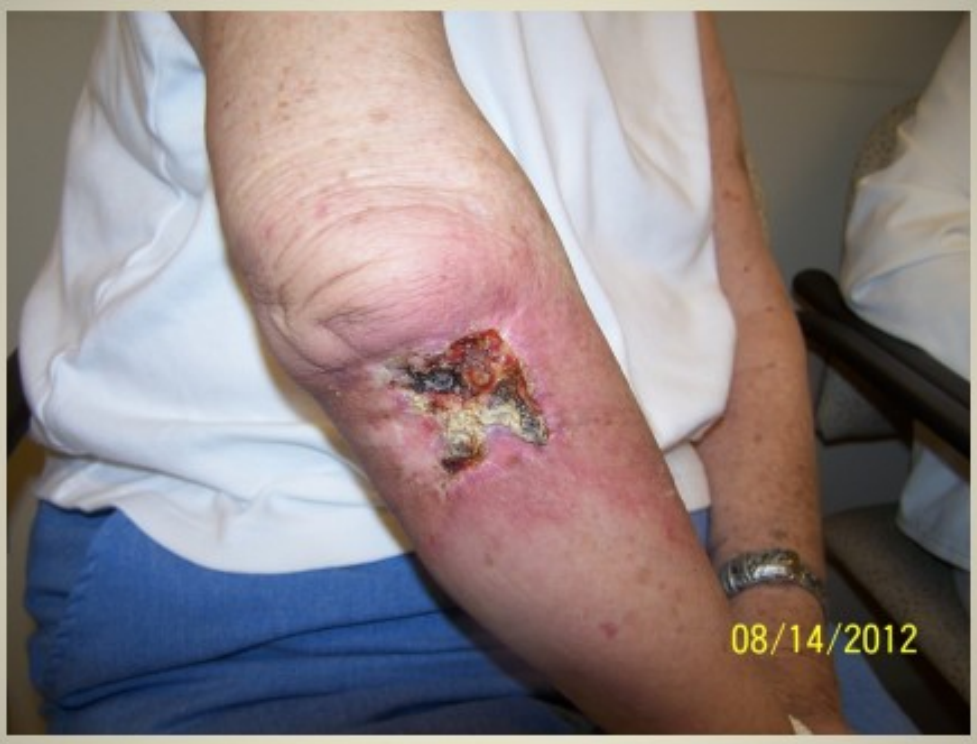
Radiation Dose Effects *(cont.)*



The patient's arm was in the beam near the x-ray tube.

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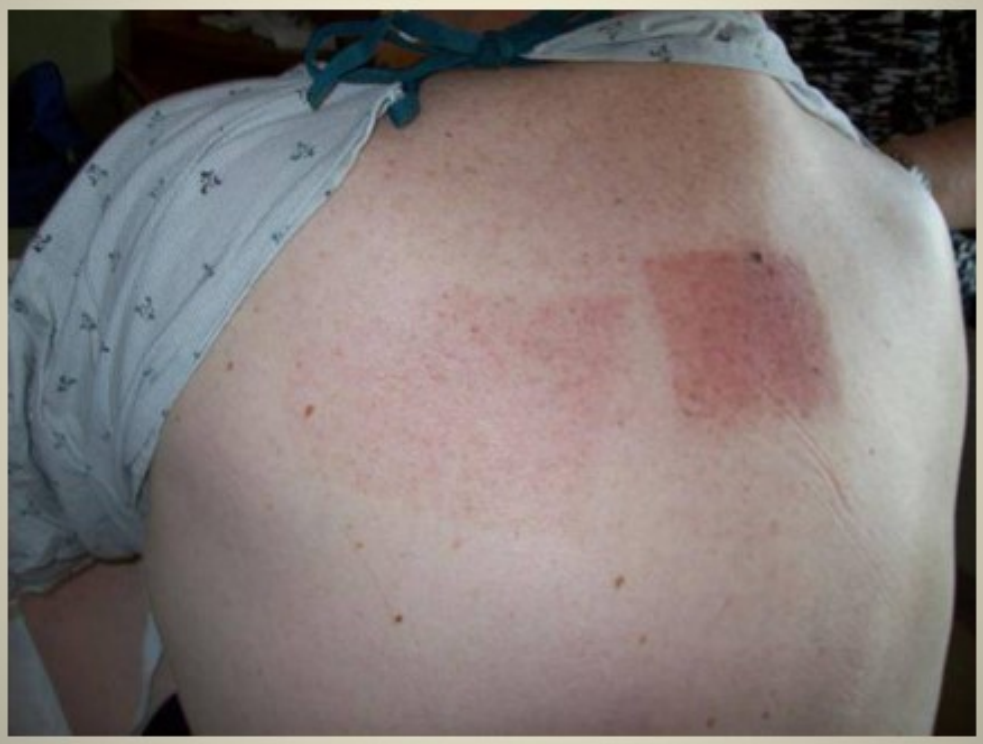
Erythema

Radiation-induced erythema is caused by cell death.



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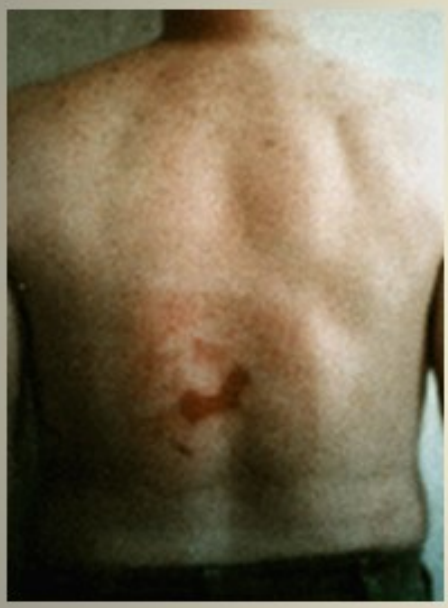
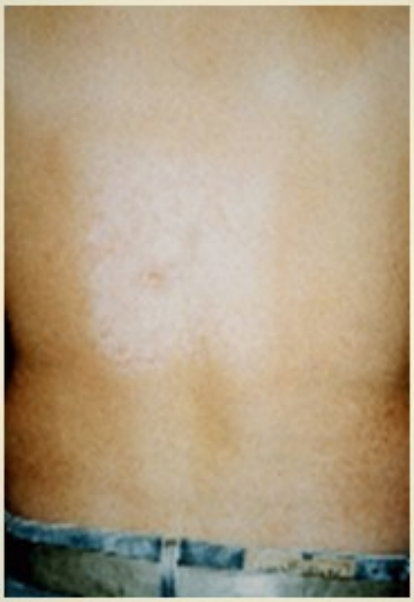
Injury

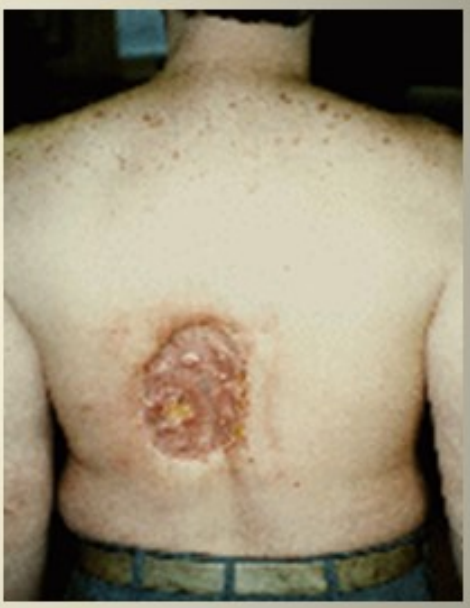
Radiation injury can be cyclic -- appears, fades, re-appears.



> 6-8 weeks
redness, peeling



16-18 weeks
Small ulcerated area



18-21 month
Tissue necrosis

Shope T. Radiation-induced skin injuries from fluoroscopy. FDA/CDRH, 1995

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Responsibility

The operator (the person activating the radiation) of the machine is responsible for:

- Patient dose
- Worker dose
- Operator dose
- Making certain each person in the room is prepared
  - Wearing dosimetry badges
  - Wearing radiation protection apparel

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Time as a Protection Method

X-ray beam-on time is directly proportional to dose.

- Short intermittent exposure vs. extended continuous exposure.
- Be aware of the 5-minute timer alarm.

Be efficient and reduce the fluoroscopy times.

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Distance as a Protection Method

Extremely effective ($1/d^2$) - By doubling the distance between yourself and the source of radiation, you decrease your dose by a factor of four.

Increase your distance from the patient and the x-ray machine when it is not necessary to stand immediately next to the patient.

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Shielding - Personal Radiation Protection Apparel

Personnel are required to wear approved apparel during x-ray exposures.

Shielding of 0.5 mm lead equivalent will reduce scatter radiation by ~90%.

There are MHC policies for proper use and care, labeling, and annual integrity testing.

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Trained Operators

Registered x-ray technologists control and operate the x-ray equipment in the OR.

Non-radiology physicians may be authorized to operate x-ray equipment, if they complete the required training and testing.

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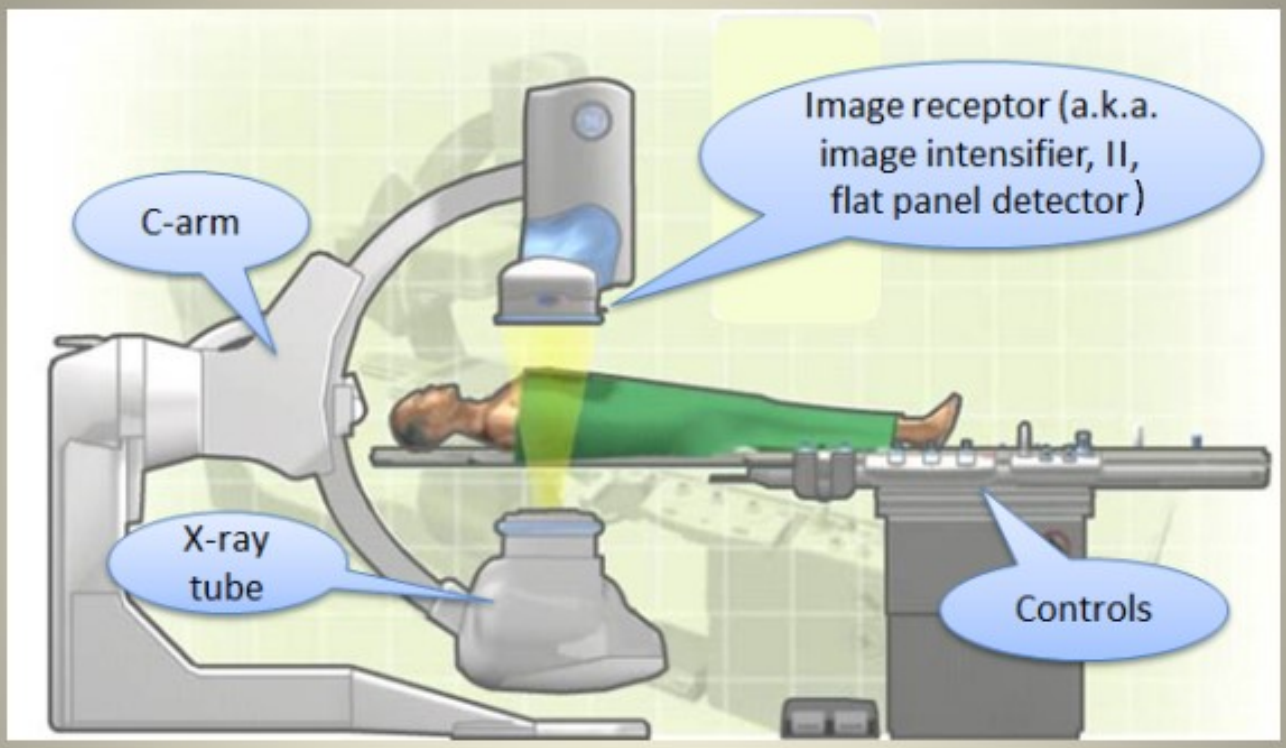
Positioning



To reduce dose:

- The patient should be placed as far from the x-ray tube as possible.
- The patient should be placed as close to the image receptor as possible.

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Pulse Rate

Patient dose is nearly proportional to pulse rate.

Suggested pulse rate and approximate dose rate:

Area	Pulse Rate	Dose Rate
Coronary Arteries	15 frames/second	3.0 R/min
Peripheral Vascular	7.5 frames/second	1.5 R/min
Non-vascular	4 frames/second	0.8 R/min

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Magnification

Patient dose increases rapidly with increased magnification (reduced image receptor size).

Receptor	Dose Rate	Increase
Normal	3 R/min	-
Mag 1	4 R/min	33%
Mag 2	6 R/min	50% (100% over Normal)

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Cine Acquisition

Patient dose is at least 6 times greater when using cine instead of fluoro.

Receptor	Dose Rate Fluoro	Dose Rate Cine
Normal	3 R/min	18 R/min
Mag 1	4 R/min	24 R/min
Mag 2	6 R/min	50 R/min

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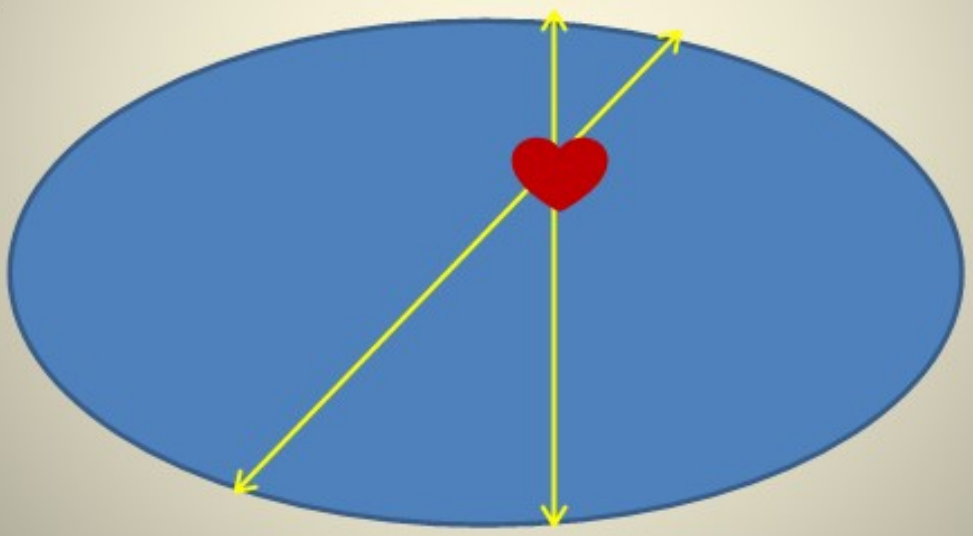
Beam Angulation

Skin dose will double with each 4 – 6 cm increase in path length through the patient.

Changing from vertical to 35 degrees will often increase the path length 4 - 6 cm.



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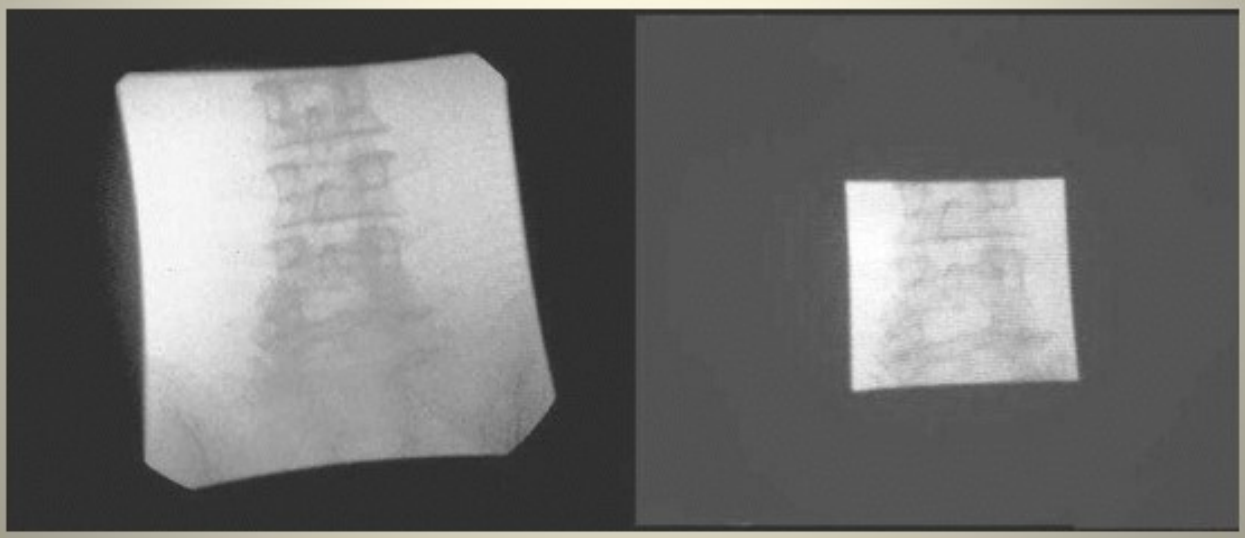
Collimation

Proper collimation:

- Reduces patient dose
- Improves image quality by reducing scattered radiation
- Reduces scatter to personnel
- Reduces overlap of fields when beam is reoriented



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Notifications

The dose (mGy) displayed on the monitor **($K_{a,r}$)** is not necessarily the patient skin dose. It is the dose to a reference point between the x-ray tube and the image receptor.

Technologist, nurse, or control room personnel will notify the operator when the dose displayed on the monitor **($K_{a,r}$)** reaches certain levels.

The notification levels are 3000 mGy, 4000 mGy, 5000 mGy, etc. (Think 3, 4, 5...)

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Notifications *(cont.)*

Notifications are for operator information and not intended to stop a procedure. The operator should take into consideration the benefit vs. risk of continuing.

When a procedure exceeds 5000 mGy, the diagnostic medical physicist will be notified. A peak skin dose calculation will be performed.

The operator will receive notification of peak skin doses that exceed 3000 mGy so patients may receive appropriate follow-up for skin injury.

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Patient Size

Large patients and steep beam angulation are the most common factors related to injuries.

Thick body masses exponentially decrease penetration and cause the skin to be positioned closer to the x-ray port.

Skin dose will double with each 4 – 6 cm increase in path length through the patient.

Large patients result in poorer image quality and require more time.

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Patient History

Review patient history for previous fluoroscopically-guided procedures and radiation therapy within 6 months:

- Consider changing the beam geometry.
- The operator may request peak skin doses from previous procedures.
- Discuss possibility of radiation-induced injury during patient consent.

Review patient history for skin sensitizing conditions:

- Connective tissue diseases (e.g., scleroderma, lupus erythematosus)
- Diabetes mellitus
- Hyperthyroidism
- Chemotherapy agents
- Homozygous form of ataxia telangiectasia

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Informed Consent

Radiation information for consent:

Make sure the following risk factors associated with the procedure have been shared with the patient. Risks associated with the procedure include:

- Infection
- Bleeding
- Radiation induced skin injury
- Temporary or permanent hair loss
- Damage to organs
- Heart or lung complications
- And even death

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Test Your Knowledge

Click **Yes** for the statements below that will reduce patient dose.
Click **No** for statements that will not change or increase patient dose.

Using a large distance between x-ray tube and patient.	Yes	No
Using a large distance between patient and image receptor.	Yes	No
Using a high pulse rate.	Yes	No
Avoiding steep beam angulation.	Yes	No
Using cine acquisition instead of fluoroscopy looping.	Yes	No
Using high image magnification (small receptor size).	Yes	No
Collimating to a small area of interest.	Yes	No

Please complete this exercise.

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References

Hirshfeld J, Ferrari V, Bengel F, et al. 2018 ACC/HRS/NASCI/SCAI/SCCT Expert Consensus Document on Optimal Use of Ionizing Radiation in Cardiovascular Imaging: Best Practices for Safety and Effectiveness. J Am Coll Cardiol. 2018 Jun, 71 (24) e283–e351 https://doi.org/10.1016/j.jacc.2018.02.016

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Vano, E., Loose, R., Frija, G. et al. Notifications and alerts in patient dose values for computed tomography and fluoroscopy-guided interventional procedures. Eur Radiol 32, 5525–5531 (2022). https://doi.org/10.1007/s00330-022-08675-w

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Fire Safety in Anesthetizing/ Procedural Areas

Jeannette Reynolds, MSN, BBA, RN, CPAN
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July 2024

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Goal and Objectives

Goal:

To educate anesthetizing/procedural area staff about the recommended actions for fire prevention and fire response.

Objectives:

After completing this activity, the participant will be able to:

1. Identify the three components of the fire triangle.
2. Identify steps for fire prevention interventions.
3. Describe the staff's role in fire safety.
4. Discuss the steps to extinguish a fire.

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Procedural Fire Facts

According to The Joint Commission (TJC)

- 90-100 surgical fires occur yearly.
- 70% involve use of an electrosurgical device (ESU), also known as a Bovie.
- 15% are related to use of a light source.
- Other contributing factors include:
  - Inadequate orientation, understanding and/or communication of fire risk in procedural areas
  - Insufficient time-out procedures
  - Overconfidence, distraction, or loss of situational awareness
  - Equipment malfunction

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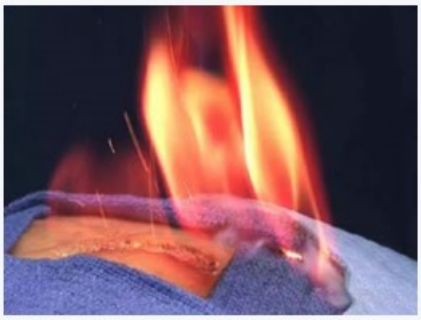
It Happens Here!

In the first quarter of 2022, an MHC OR had two fire/unintentional smoke events from equipment (laser and surgical drill). No patient or staff injury occurred.

Also in April 2022, a fire occurred when a patient applied petroleum jelly to their lips while on high-flow oxygen. The patient sustained first- and second-degree burns.



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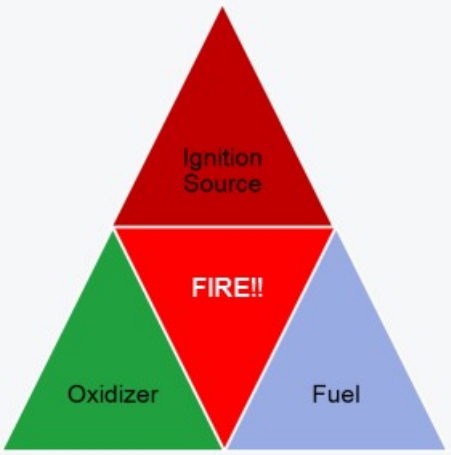
Fire Triangle

There are three elements necessary for a fire:

- Ignition source
- Fuel
- Oxidizer



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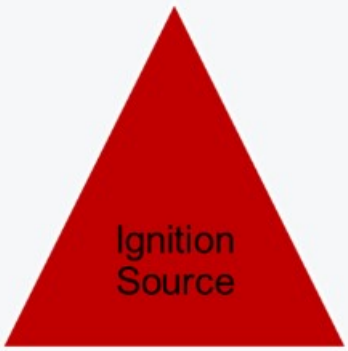
Common Ignition Sources

An ignition source is anything providing enough energy to start a fire:

- ESU/Bovie
- Argon beam coagulator
- Power tools (e.g., drills, burrs)
- Laser
- Fiber Optic light cords
- Defibrillator
- Electrical equipment



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Common Fuels

A fuel is anything that will burn:

- Alcohol-based skin antiseptic agents (preps)
- Drapes
- Gowns
- Endotracheal tubes
- Skin degreasers/tinctures/aerosols
- Body tissues and hair
- Intestinal gases
- Petroleum-based products

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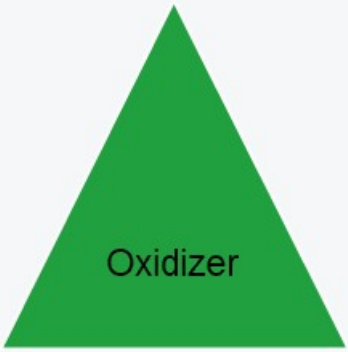
Common Oxidizers

An oxidizer is a gas which supports combustion:

- Oxygen
- Nitrous oxide



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Fire Risk Assessment

Fire risk assessment is a team effort.

As part of the preprocedural briefing process, the proecdural team should initiate a fire risk assessment to assess for the presence of the three elements of the fire triangle (AORN).

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Fire Risk Assessment *(cont.)*

Before each procedure, evaluate the following:

- Are there alcohol-based prep agents or other flammable solutions being used?
- Is the procedure being performed above the xiphoid process?
- Is there open oxygen or nitrous oxide being administered?
- Is an ESU, laser, fiber-optic light cord, defibrillator, drill, or saw being used?
- Are there other possible contributors?

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You must complete the activity.

Controlling Ignition Sources

Click each arrow:

Fiber-Optic Light Source:

- Place the light source in standby mode or turn it off when not in use.
- Inspect light cables before use. Remove from service if broken light bundles are visible.
- Place the scope and light source on a designated heat-resistant surface when not in use.

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Controlling Fuels

Surgical Skin Prep:

- Prevent pooling of skin prep solutions.
- Remove and discard prep-soaked materials, ensuring they are at least 3 feet from an ignition source.
- Skin prep dry time should follow manufacturer instructions for use to allow fumes to dissipate before draping.
- Allow chemicals to dry (e.g., alcohol, collodion, tinctures).
- Use water-soluble gel to cover facial hair.

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Controlling Oxidizers

Considerations for oxygen/flammable gas administration:

- Check the anesthesia circuits for possible leaks prior to the start of the procedure.
- Tent the surgical drapes to allow for free air flow.
- Keep the oxygen percentage as low as possible on non-intubated patients.
- Inform the surgeon when an open oxygen source is being used.
- Turn off oxygen or nitrous for 1 minute prior to use of an ignition source in head, neck, or upper chest procedures.

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Controlling Oxidizers *(cont.)*

Oropharynx Procedures

- Inflate the endotracheal tube cuff with tinted saline.
- Evacuate intended surgical smoke from small or enclosed spaces.
- Pack wet sponges around the back of the patient's throat.
- Document placement and removal of throat sponges.
- If oxygen is being used, suction the patient's oropharynx deeply before using the ignition source.

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See Unintended Smoke or Flames?

Pull the fire alarm!

All team members should be alerted to the presence of a fire or unintended smoke, no matter how small. Alerting other team members decreases the risk of injury to the patient and personnel.

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Fire Pull Station Locations and Responders

- It is the responsibility of each team member to be aware of the locations for fire pulls in his/her areas.
- When a fire pull is activated, the facility response team and the fire department will respond to the alarm.
- Assign a staff member to assist responders with donning disposable coveralls and lead them to the location of the fire.

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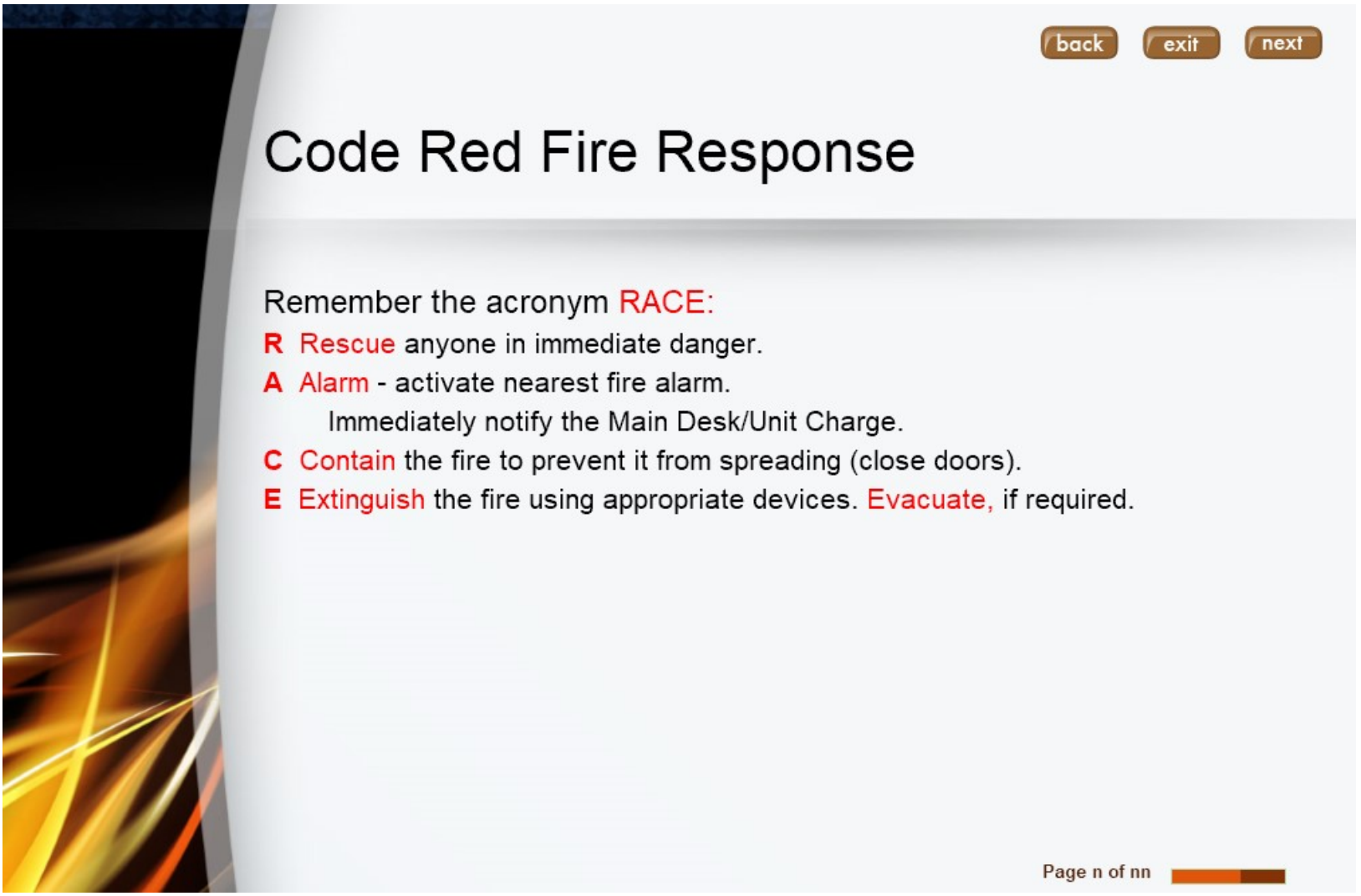
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Code Red Fire Response
Remember the acronym RACE:
R Rescue anyone in immediate danger.
A Alarm - activate nearest fire alarm.
Immediately notify the Main Desk/Unit Charge.
C Contain the fire to prevent it from spreading (close doors).
E Extinguish the fire using appropriate devices. Evacuate, if required.
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Medical Gas Shut-off

Be aware of the medical gas shut-off valve locations in your area. They are typically located outside the procedural suite and labeled.

In the event of a fire, the team should critically evaluate medical gas shut off for that specific area, then communicate medical gases have been emergently shut off in your location.

The decision to further shut off medical gases is made upon mutual consent among Nursing Administration, Respiratory Therapy, Facilities services, and anesthesia providers (if present).

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Extinguish a Fire Using Solution

- Douse the base of the fire with a nonflammable liquid (saline or water) if readily available.
- Impermeable drapes must be removed to effectively extinguish the fire.

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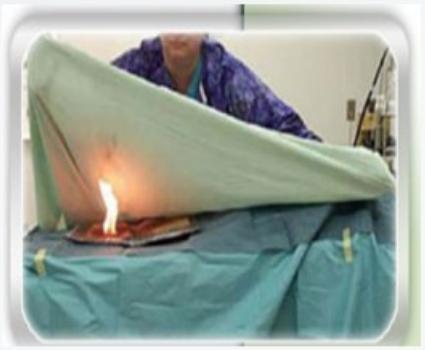
Extinguish a Fire by Smothering

- Keep your body away from fire.
- Hold towel between fire and patient's airway.
- Drop the end of towel closest to the head.
- Drop the other end of towel over the fire.
- Sweep hand over towel from head toward feet. DO NOT PAT the fire! This fans the flames and expands the fire.
- Lift the towel carefully to determine if flames are extinguished.
- Remove drapes or burned material from patient and inspect for injury.



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Extinguish a Fire Using a Fire Extinguisher

Remember the acronym PASS:

P Pull the pin.

A Aim nozzle at the base of the fire.

S Squeeze the handle to release the extinguishing agent.

S Sweep the stream over the base of the fire.

If possible, spray extinguisher away from the patient or other people.

http://www.dol.gov

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Fire Extinguisher Types

Most patient care areas have ABC multipurpose fire extinguishers available for use.

A. Fires involving wood, paper, cloth, and post plastics.
B. Fires involving flammable liquids or grease.
C. Fires involving energized electric equipment.

Some areas (OR, Sterile Processing, and MRI suites) may also have specialty extinguishers such as BC, CO_2, or water mist (non-magnetic) available for use.

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Airway Fire Management

Assist the anesthesia provider to:

1. Stop the medical gas flow.
2. Disconnect the breathing circuit.
3. Pour normal saline or water directly into the airway, if directed.
4. Remove the endotracheal tube, saving any burned segments.
5. Examine the airway.
6. Re-establish airway support.

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After a Fire is Extinguished

1. Inspect the area for a secondary fire on the underlying drapes or towels.
2. Assess the patient for injury.
3. Determine what needs to be done to complete the case (new room, tear down, supplies, instruments, etc.).
4. Complete an incident report using VOICE.
5. Notify nursing administration and the administrator on call.
6. Save all materials from the fire for inspection by facility specialists and the fire department.

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Fire Evacuation

Depending on the severity of the fire, evacuation may be limited to the immediate area followed by partial or total department evacuation.

Unless the patient and staff are in immediate danger, the decision to evacuate and the safest route to go occurs in conjunction with unit/facility leadership.

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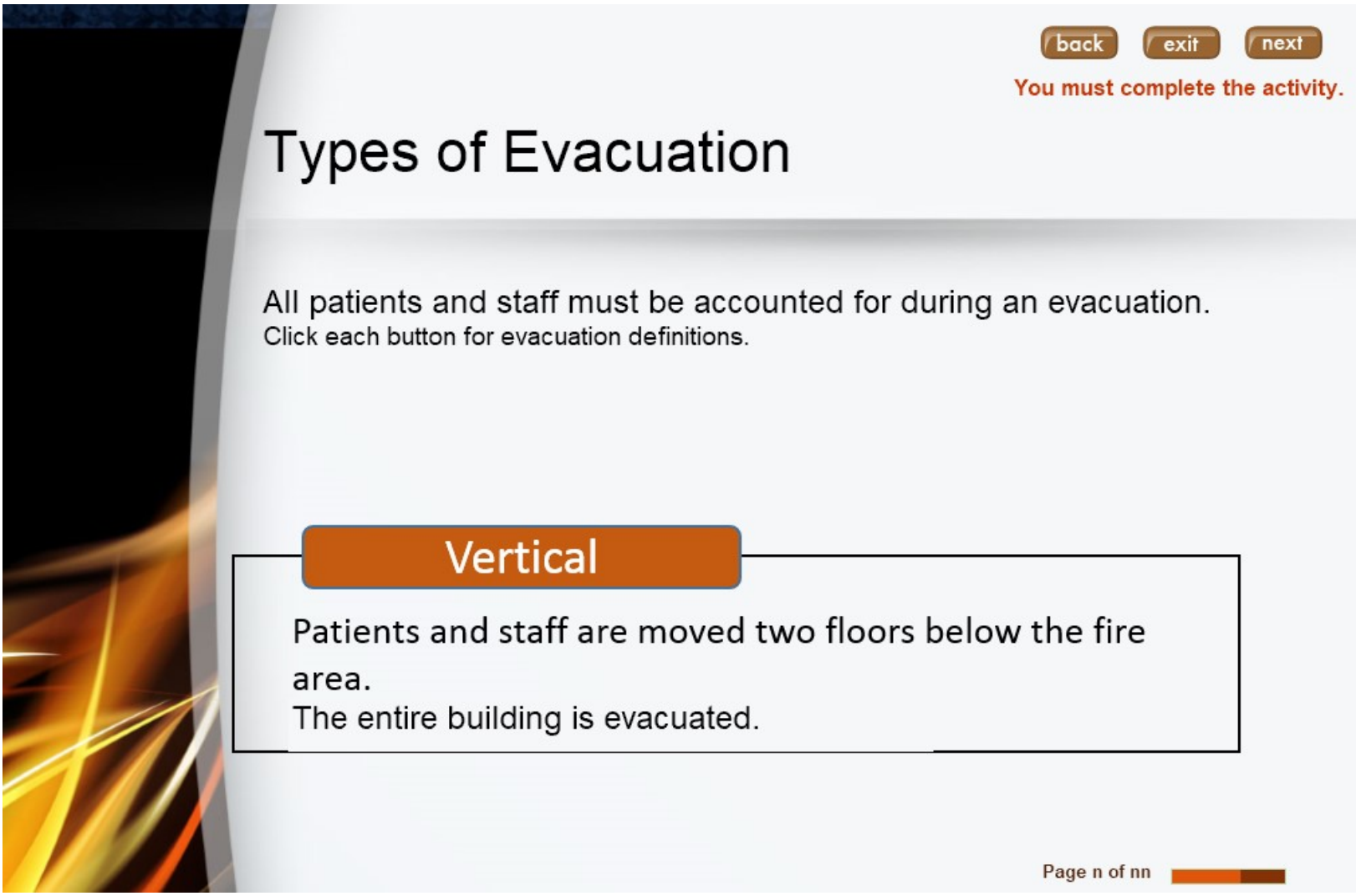
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next
You must complete the activity.
Types of Evacuation
All patients and staff must be accounted for during an evacuation.
Click each button for evacuation definitions.
Vertical
Patients and staff are moved two floors below the fire area.
The entire building is evacuated.
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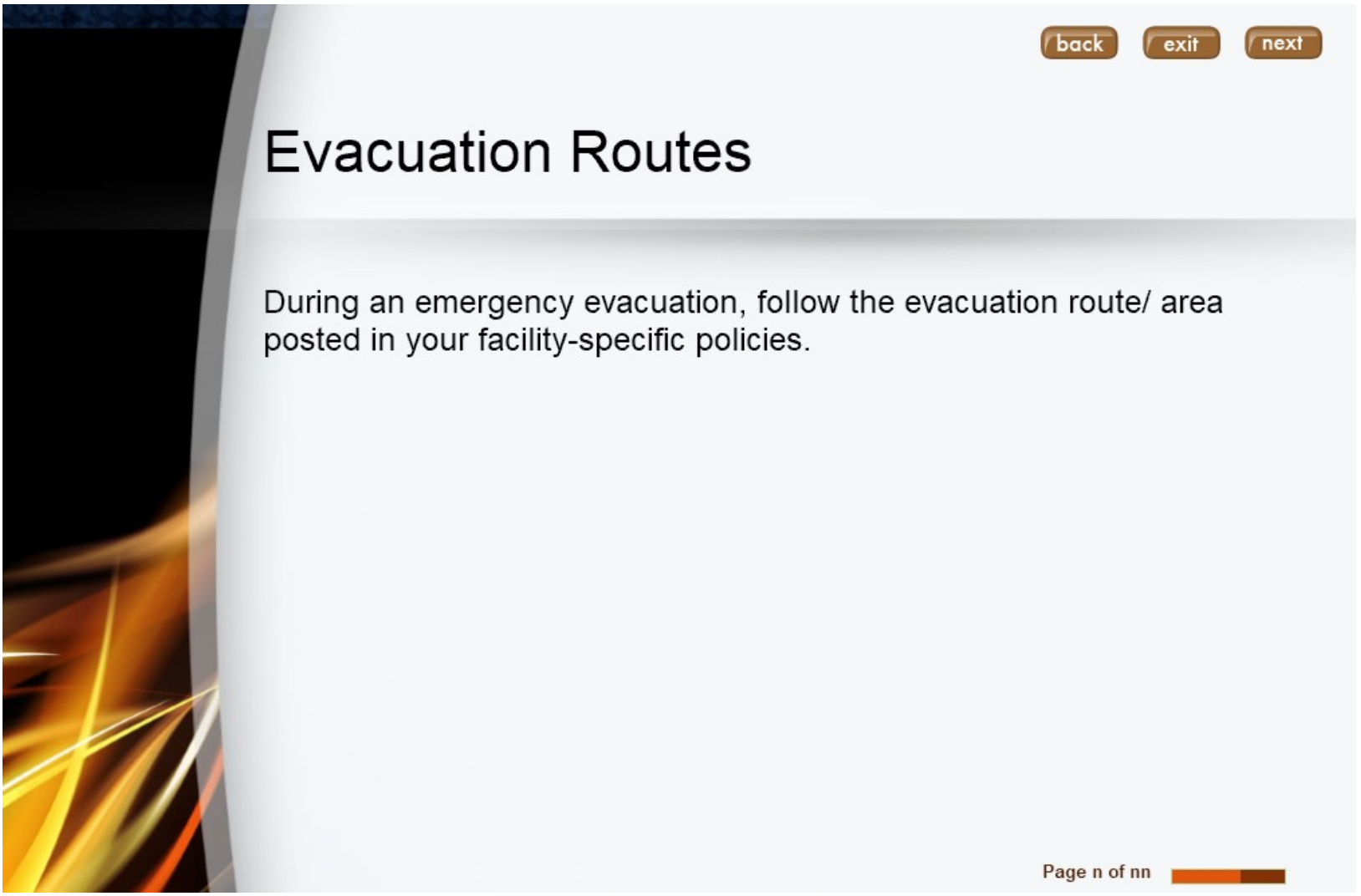
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Evacuation Routes
During an emergency evacuation, follow the evacuation route/ area posted in your facility-specific policies.
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Teamwork

Fire prevention and fire control takes a **critically-thinking team**.
Keep in mind the following:

- Location of the fire alarms, extinguishers, and gas shut-offs.
- Closest evacuation route.
- Cases that are at risk for fires.
- Steps to take to prevent fires.
- Steps to take when there is a fire.
- Who to contact STAT.

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References

Association of PeriOperative Registered Nurses Guidelines for Perioperative Practice. (2022). *Environment of Care* *http://online.statref.com/document/zCT1HcgrG7DjzPC-uTPnBj*

Association of PeriOperative Registered Nurses. (2022). *Fire safety toolkit.* *https://test.aorn.org/guidelines/clinical-resources/tool-kits/fire-safety-tool-kit*

MHC PolicyStat Evacuation Plan

MHC PolicyStat Munson Medical Center Fire Plan

MHC PolicyStat Operating Room Fire Plan

Pfander, Valerie (2017-2022). Fire Safety in the Operating Room. Munson Medical Center

AVOXimeter™ 1000E

Kayla Barber, CLPT, MMC Lab Section Head
March 2024

MUNSON HEALTHCARE

Goal and Objectives

Goal

This course, in conjunction with direct observation of the AVOXimeter 1000E procedure completion, will complete the annual competency requirement.

Objectives

1. List steps required in the completion of the AVOXimeter 1000E procedure.
2. State when to re-analyze the specimen to confirm results.
3. Obtain 80% or better on the AVOXimeter 1000E exam.

Overview

AVOXimeter 1000E is an instrument that uses multiple wavelengths to measure whole blood hemoglobin concentration, oxyhemoglobin fraction, and oxygen content.

- The AVOXimeter reports a value for the total hemoglobin concentration that is the sum of the concentrations of oxy-, deoxy-, met-, and carboxyhemoglobin:

$$[THb] = [HbO_2]+[HHb]+[MetHb]+[COHb]$$

- The AVOXimeter uses multiple wavelengths to obtain accurate measurements of $\%HbO_2$ even if bilirubin and four different hemoglobin species are present in the sample. Thus, the value reported on the display for $\%HbO_2$ is defined as:

$$[\%HbO_2] = \frac{\%HbO_2 \times 100}{[HbO_2] + [HHb] + [MetHb] + [COHb]}$$

Overview *(cont.)*

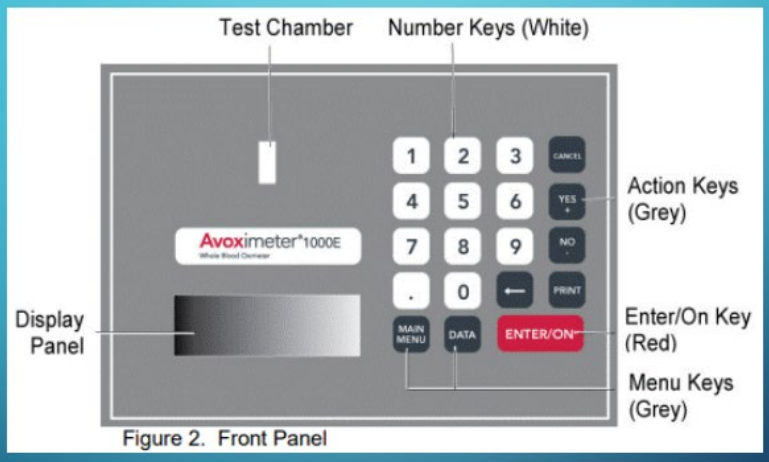


Figure 2. Front Panel

Clinical Significance

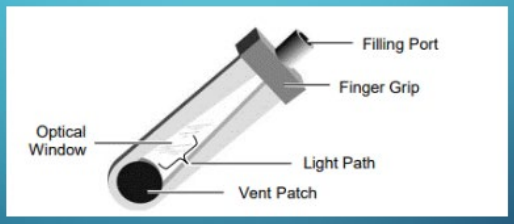
THb: Hemoglobin, the main component of the red blood cell, is a conjugated protein that serves to transport oxygen throughout the body. Adequate hemoglobin levels are needed for tissue oxygenation.

%HbO_2: Oxygen saturation is a measurement of the oxygen binding of hemoglobin. Measurement of oxygen saturation is helpful in predicting the amount of oxygen available for tissue use and is used to assess effectiveness of oxygen therapy.

Reagents and Materials

AVOXimeter 1000E cuvettes include the cuvette path length printed on the label. This cuvette path length must be updated on each analyzer before continuing testing.

- Storage - Room temperature in closed bag.
- Stability - As long as the desiccant indicator is blue.



Quality Control

Daily Quality Control (QC)

- Yellow and orange optical QC filters are run daily.
- Stored at room temperature in specific case for each AVOX.
- Each filter has the acceptable reference range attached to it and on the QC log.
- Both filters must be within acceptable range and be properly documented in the QC book before patient testing. If the QC is out of range, please take corrective action. Remove the analyzer from service and contact the POC coordinator.

Quality Control *(cont.)*

Weekly QC

- RNA Medical QC 253 full range co-oximeter control Level 1, Level 2, and Level 3 are run weekly.
- All three levels must be within acceptable range and properly documented in the QC book before continuing patient testing. If the QC is out of range, please take corrective action. Remove the analyzer from service and contact the POC coordinator.
  - Storage: Refrigerated 2-8°C
  - Stability: Until expiration date; do not use if solutions turn brown.

Patient Testing

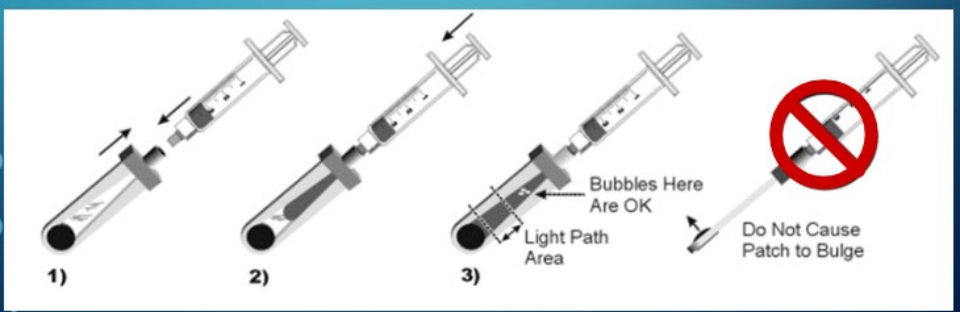
- Don the required PPE before performing testing.
- Verify the Cuvette path length is correct for the cuvettes in use. The path length for the cuvette lot is found on the label of the cuvette packaging. If it is different than the current path length in use, press the Main Menu key. Select Calibration, Cuvette Path length, and Enter Value. Enter the correct path length using the numeric keypad. Press OK to enter the path length into the analyzer's memory.
- Roll the syringe containing the blood sample between hands, periodically inverting the syringe to fully mix the sample. The sample must be mixed for a full ten (10) second interval just prior to injection into the cuvette.

  Note: Poorly mixed samples or those containing clots may cause inaccurate results.

Patient Testing *(cont.)*

- Expel a small amount of sample from the syringe. Insert the syringe tip into the cuvette syringe port and inject the blood sample into the cuvette, holding the cuvette down at a 45° angle. Inject blood into the cuvette until the sample reaches the black vent patch. Leave the syringe attached to the cuvette.

  Note: Over-injection of blood will cause the vent patch to bulge outward. If this happens, pull back slightly on the syringe plunger to flatten the patch.



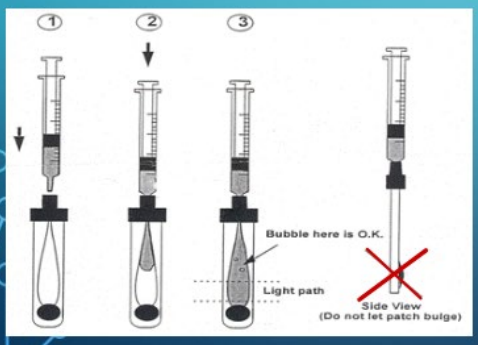
Patient Testing *(cont.)*

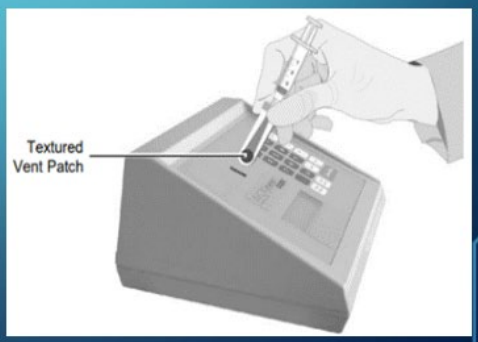
- Check that no air bubbles are present in the sample light path.

  Note: Air bubbles will yield erroneous results. If air bubbles are present in the light pathway, discard the cuvette.

- Holding the cuvette by the black cap, insert it into the slot of the instrument's front panel.
- Insert the cuvette within 30 seconds of filling.

  Note: A delay greater than 30 seconds may yield erroneous results.



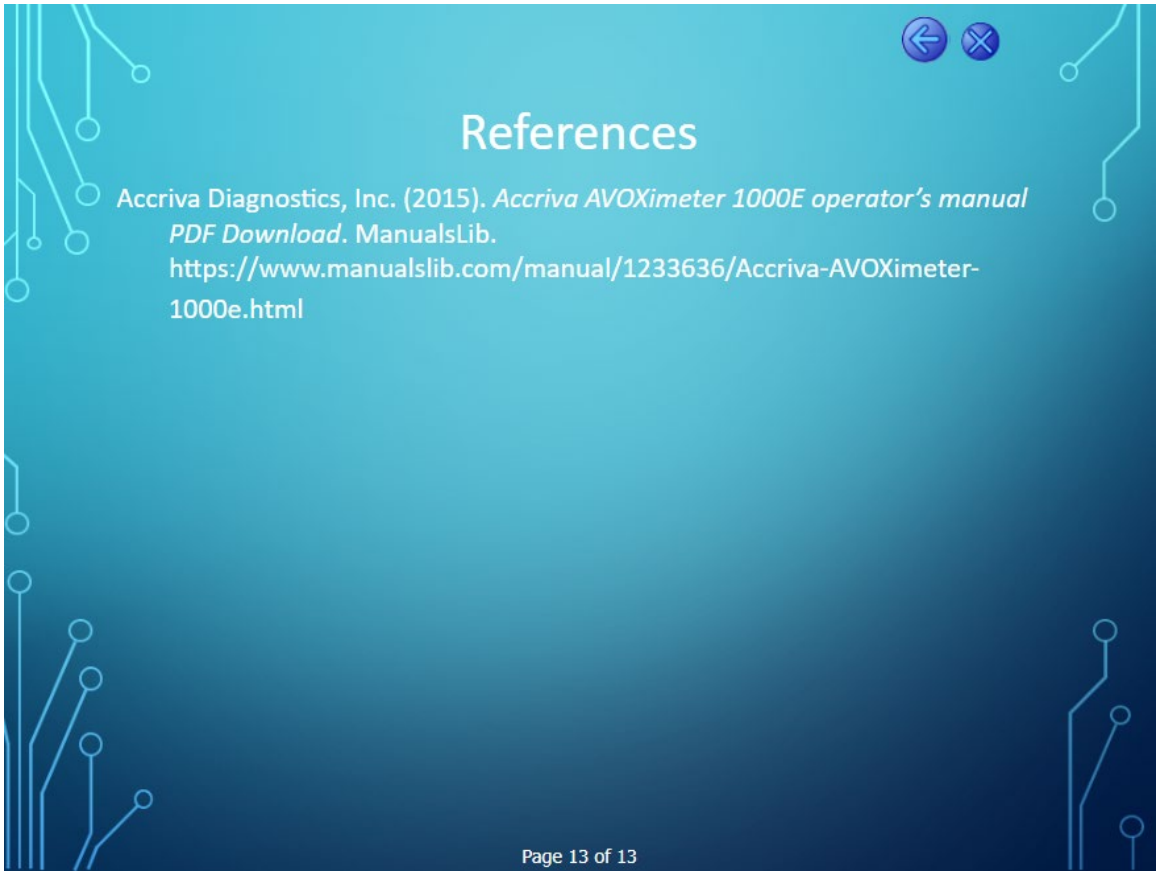


Patient Testing *(cont.)*

- Enter the User ID number, using the numeric keypad and press Enter/On.
- Enter the patient ID number, using the numeric keypad. Verify the number on the screen and press Enter/On to enter the number into the analyzer's memory.

  Note: A delay greater then 30 seconds may yield erroneous results.

- After the analysis, print the results. Retain the printout for 2 years.



Instructions

The Evaluator will complete the checklist validation. You are responsible for ensuring you work with your manager, preceptor, or educator to have this checklist completed. Check with your manager for additional information.

Evaluator Guidelines

N/A = Not Assessed. If you choose **Unmet** or **N/A**, please add a comment to indicate the reason for the selection. The employee and manager or evaluator will develop an action plan for meeting the competency. The action plan should include 1) steps in the action plan, and 2) date to be completed.

See PolicyStat for complete information on Competency Assessment. Viewing Competency Assessment and Verification :: PolicyStat

Verification Methods Key:

CS	Case Study	E	Exemplar	PR	(Qualified) Peer Review	SA	Self-Assessment
DR	Discussion/Reflection	ME/S	Mock Event/Survey	QI	Quality Improvement	TE	Test/Exam
EDW	Evidence of Daily Work	P	Presentation	RD/DO	Return Demo/Direct Observation		

1	Demonstrates process for total hemoglobin and oxygen saturation measurement according to AVOXimeter 1000E Competency criteria and manufacturer's instructions. DR; Discusses how to problem solve issues with Hemochron Signature Elite analyzer AND RD/DO: Perform blind duplicate QC sample OR RD/DO: Performs ACT measurement and documentation. Add Comment ▾	Met Unmet

HEMOCHRON Signature Elite

Kayla Barber, CLPT, MMC Lab Section Head
April 2024

MUNSON HEALTHCARE

Goal and Objectives

Goal

This course, in conjunction with direct observation of the Hemochron activated clotting time (ACT) procedure completion, will complete the annual competency requirement.

Objectives

1. List steps required in the completion of the Hemochron ACT procedure.
2. State procedure to follow if the instrument message says, 'ASSAY LOCKED'.
3. Obtain 80% or better on the Hemochron exam.

Clinical Significance

Anticoagulation is necessary during various medical and surgical procedures to counterbalance the natural thrombotic response of blood upon its exposure to a foreign surface, such as the bypass circuit or angioplasty guidewire.

Without optimal anticoagulant therapy, clot formation would occur within minutes. Close monitoring and control of anticoagulation is desirable to ensure clot-free blood flow, while minimizing bleeding complications following the procedure.

ACT testing is also useful for monitoring patients who are candidates for sheath removals following cardiac procedures.

Overview

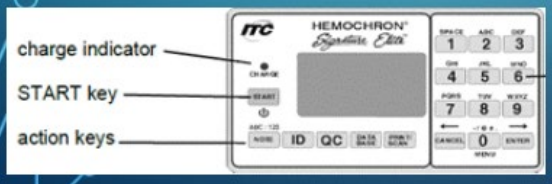
The Hemochron Signature Elite/Hemochron Jr. II Microcoagulation System utilizes a mechanical endpoint clotting mechanism in which testing occurs within the disposable ACT+ cuvette. Following whole blood sample introduction, the Hemochron Signature Elite/Hemochron Jr. II Microcoagulation System precisely measures 15 microliters of blood and automatically moves it into the test channel within the ACT+ cuvette.

The remainder of the blood sample, not needed for testing, is automatically drawn into the waste channel of the cuvette. Sample/reagent mixing and test initiation are performed automatically, requiring no operator interaction. After mixing with the reagent, the sample is then moved back and forth within the test channel and monitored for clot formation.

Clot Detection

The clot detection mechanism consists of two LED optical detectors aligned with the test channel of the cuvette. The speed at which the blood sample moves back and forth between the two detectors is measured. As clot formation begins, blood flow is impeded and the movement slows.

The Hemochron Signature Elite/Hemochron Jr. II Microcoagulation instrument recognizes that a clot endpoint has been achieved when the movement decreases below a predetermined rate. The instrument's digital timer displays the correlated celite-ACT value in seconds.



Reagents and Materials

Each single-use cuvette contains a label, a sample well, a test channel containing reagents, an enclosed waste reservoir, and one or more optical detection windows.

Hemochron Signature Elite/ Hemochron Jr. II ACT test cuvette →

Storage & Stability

- Cuvettes should be stored at 2-8°C and are stable until the expiration date on the cuvette box.
- Cuvettes must be brought to room temperature before use.
  - You must date the cuvettes when room temperature is attained.
- Cuvettes may be kept at room temperature for up to 12 weeks, if kept in the sealed pouch.

Electronic Quality Control (EQC)

- The EQC is programmed to automatically run and perform two levels of EQC verification every 8hrs when plugged in.
- If you need to, you can also manually program the EQC to run by pressing the QC button and then 1=Run EQC.
- If the EQC fails for any reason, the instrument must be taken out of service and your POC coordinator contacted.

directCHECK Whole Blood Quality Control

Liquid Quality Control (LQC)

LQC (normal level and abnormal level) is performed weekly and documented in the appropriate QC book.

QC control must be within the range established by the manufacturer for the two levels used. If the quality control is out of range and can not be corrected, you must take the instrument out of service and contact your POC coordinator.

If the screen states "Run LQX - Check QC Status" at any time, you must run the liquid QC before continuing with any patient testing.

Storage and Stability

- Controls are stable at 2-8°C until the expiration date on the box.
- Controls must be brought to room temperature before testing.
- Controls may be stored at room temperature for up to 4 weeks.

Patient Testing

- Insert cuvette into the cuvette opening of the instrument. The instrument will automatically identify the test cuvette and display the test type.
- During the pre-warm stage, observe the display for fault messages.
- When ready, the instrument will signal with an audible tone. The display will indicate the alternating messages "ADD SAMPLE" and "PRESS START".
  - The instrument will remain in the ready mode for 5 minutes before a "TIME OUT...FAULT" will occur, requiring a new cuvette to be placed in the instrument.

Patient Testing *(cont.)*

Obtain Sample

- If you are drawing from a line, make sure you flush until it is free from contamination before obtaining the patient test sample.
- Using a syringe, slowly draw the blood sample from a previously flushed line or via venipuncture.
- Immediately dispense blood into the sample well of the test cuvette.
  - This may be done with or without a needle.
  - Using a sufficient quantity of blood, directly fill the center sample well to the edge.
  - Should a large drop of blood extend above the center sample well, push it over into the outer sample well.

Patient Testing *(cont.)*

- Press the START key.
  - NOTE: The instrument displays a fault if an inadequate or excessive amount of sample has been provided.
- Test completion will indicate a fault condition.
  - NOTE: Two beeps indicate a fault condition.
- Upon clot detection, the ACT+ test result is automatically converted to a reference celite-ACT result. The correlated celite-ACT value will be displayed.
  - The test results will remain on the screen until the test cuvette is removed from the instrument and for 120 seconds following its removal.
  - NOTE: At any time during testing, if you receive any error codes that cannot be resolved, (e.g., "Assay Locked Out"), you must place a 'Do Not Use' sticker on the instrument, pull it out of service, and contact the POC coordinator at 56118 or 56405.

Reference

International Technidyne Corporation. (n.d.). Hemochron Signature Elite Manual. https://wexnermedical.osu.edu/-/media/files/wexnermedical/healthcare-professionals/clinical-labs/forms-policies-procedures/point-of-care/act/hemochron-signature-elite-user-manual.pdf?la=en&hash=6C636933E25222635380AA83D3033A2B1776A313

Instructions

The Evaluator will complete the checklist validation. You are responsible for ensuring you work with your manager, preceptor, or educator to have this checklist completed. Check with your manager for additional information.

Evaluator Guidelines

N/A = Not Assessed. If you choose **Unmet** or **N/A**, please add a comment to indicate the reason for the selection. The employee and manager or evaluator will develop an action plan for meeting the competency. The action plan should include 1) steps in the action plan, and 2) date to be completed.

See PolicyStat for complete information on Competency Assessment. Viewing Competency Assessment and Verification :: PolicyStat

Verification Methods Key:

CS	Case Study	E	Exemplar	PR	(Qualified) Peer Review	SA	Self-Assessment
DR	Discussion/Reflection	ME/S	Mock Event/Survey	QI	Quality Improvement	TE	Test/Exam
EDW	Evidence of Daily Work	P	Presentation	RD/DO	Return Demo/Direct Observation		

1 Demonstrates process for activated clotting time (ACT) measurement according to Hemochron Signature Elite Competency criteria and manufacturer's instructions.

DR: Discusses how to problem solve issues with Hemochron Signature Elite analyzer

AND

RD/DO: Perform blind duplicate QC sample

OR

RD/DO: Performs ACT measurement and documentation.

Add Comment ▾

Met | Unmet