

Initial Fluoroscopy Education for Providers

1. Initial Fluoroscopy Education for Providers

1.1 Title



Notes:

1.2 Nebraska Medicine Information



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Last Updated: June 2022

For questions or more information contact: Thomas Lane, Medical Physicist (tlane@nebraskamed.com) or the Office of Health Professions Education (ophe@nebraskamed.com)

The Joint Commission requires each facility to have their own Annual Mandatory Review. So if you have privileges at Children's Hospital and Medical Center and Nebraska Medicine, you must take this education at both locations.

1.3 Tips for this Module...

Tips for this Module...



There is NO audio for this module



Check out the handy Glossary in the upper left menu of the module



Some pages offer more information about a topic by clicking a button on the slide

Notes:

1.4 Objectives

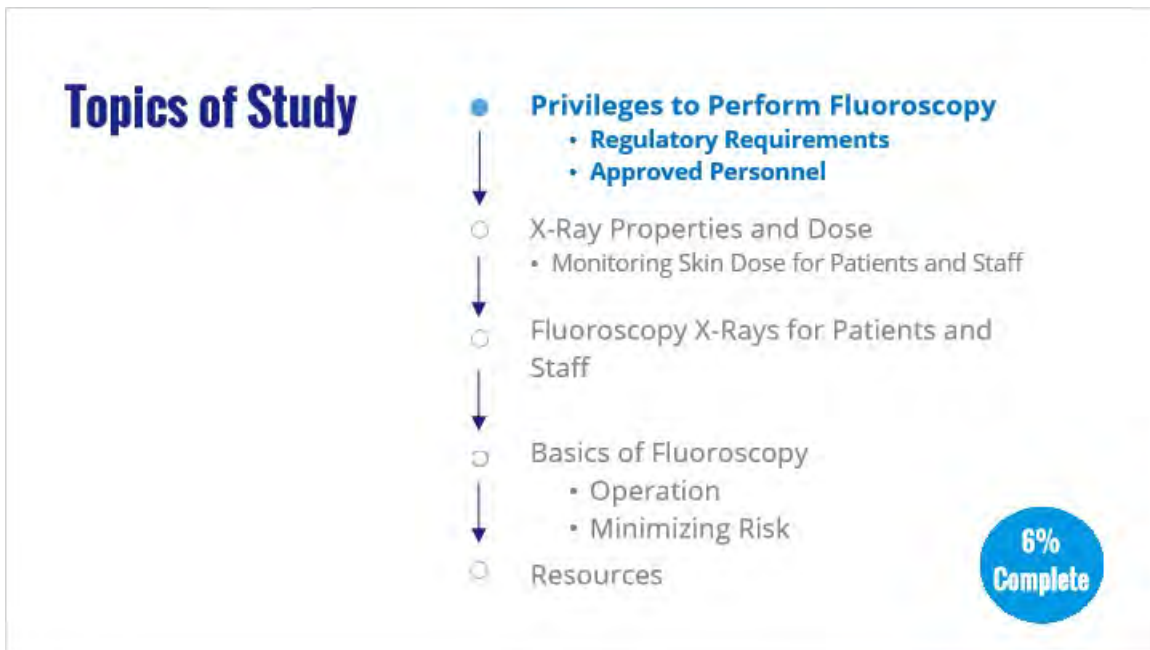


Objectives

- Medical providers who use fluoroscopy will complete Initial Fluoroscopy Education and complete annual training thereafter, in accordance with The Joint Commission and the Nebraska Department of Health and Human Services
- Consider the biological effects of fluoroscopic x-rays to patients and staff
- Describe various factors that affect the radiation dose rate to the patient
- Describe techniques that can be used to minimize radiation dose to patient and staff

Notes:

1.5 Topics: Privileges to Perform Fluoroscopy





1.6 Worker's Right

**Why Should Practitioners
Use Fluoroscopy
Safely and Responsibly?**

Notes:

1.7 Regulations and Accreditation Guidelines for Fluoroscopy

Regulations and Accreditation Guidelines for Fluoroscopy

	Accreditation Joint Commission	The Joint Commission requires that physicians who administer fluoroscopic x-rays to patients or human subjects receive annual radiation safety training, including Image Gently® and Image Wisely® .
	Regulatory State of Nebraska	The regulations regarding the use of radiation are provided in Title 180 Nebraska Administrative Code (180 NAC), "Control of Radiation". These regulations may be reviewed at the Radiation Safety Office or online. Regulations require that physicians who administer fluoroscopic x-rays are required to be monitored for radiation exposure and require radiation safety training.

Notes:

1.8 Why is this important?


Why is this important?

- It's the right thing to do.
- Number of Fluoro injuries/adverse effects in physician, staff and patients is on the rise.
- Provide safety techniques to minimize exposure to patients and workers
- Improves care quality to patients

Notes:

1.9 Who Can Administer

Who Can Administer Fluoroscopy?




Physicians	Residents/ Fellows	Physician Assistants
Physicians who have been granted privilege to use fluoroscopy by Medical Credentialing and by completing this course.	Residents/fellows are permitted to use fluoroscopy without the attending present if the following criteria is met: <ul style="list-style-type: none">✓ Resident/fellow has completed fluoroscopy training;✓ The attending physician has fluoroscopy privileges and;✓ If ACGME requirements are met	Physician Assistants who have been credentialed by Medical Credentialing may perform fluoroscopy if covered by their practice agreement.

1.10 Who Can Assist

Who Can Assist with Fluoroscopy?


CardioVascular Interventional Technologist (CVIT) and Radiology Technologists (RT's)

Only licensed Radiology Technologists (RT's) or board certified CardioVascular Interventional Technologists (CVIT's) are allowed to assist with positioning and operating of fluoroscopic equipment. These technologists may activate the fluoroscopic x-rays (i.e. push on the pedal) at the request of a credentialed physician who is physically present in the suite or control area.



WHY use Assistance?

RT's and CVIT's are not only trained to safely assist in operating the fluoroscopic equipment, they have training in how to comply with documentation requirements in the EMR, billing, etc.



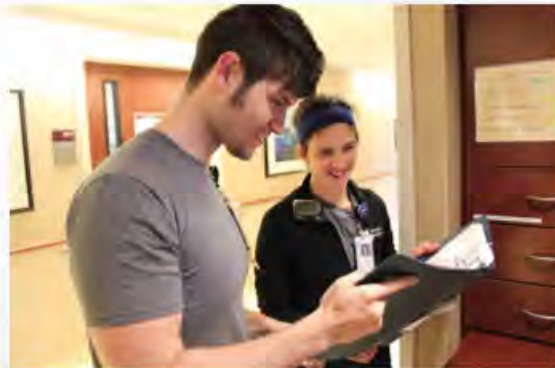
1.11 Who Can NOT Administer

Who Can **NOT Administer** Fluoroscopy?

Nurses or Nurse Practitioners (APRN's)

NOT PERMITTED:

Other personnel, including nurses and Nurse Practitioners (APRN), are NOT permitted to activate fluoroscopy. They are prohibited from assisting with fluoroscopy in any way (i.e., may not touch the equipment).



1.12 Who can administer fluoroscopic exams?

(Multiple Choice, 10 points, 3 attempts permitted)

Let's Review!

Who can administer fluoroscopic exams?

- ☐ Nurse Practitioners (APRN) and nurses
- ☒ Physicians who have been granted privileges, residents and fellows who have been fluor trained and supervised by privileged physicians, credentialed physician assistants
- ☐ All of the Above



Correct	Choice
	Nurse Practitioners (APRN) and nurses
X	Physicians who have been granted privileges, residents and fellows who have been fluor trained and supervised by privileged physicians, credentialed physician assistants
	All of the Above

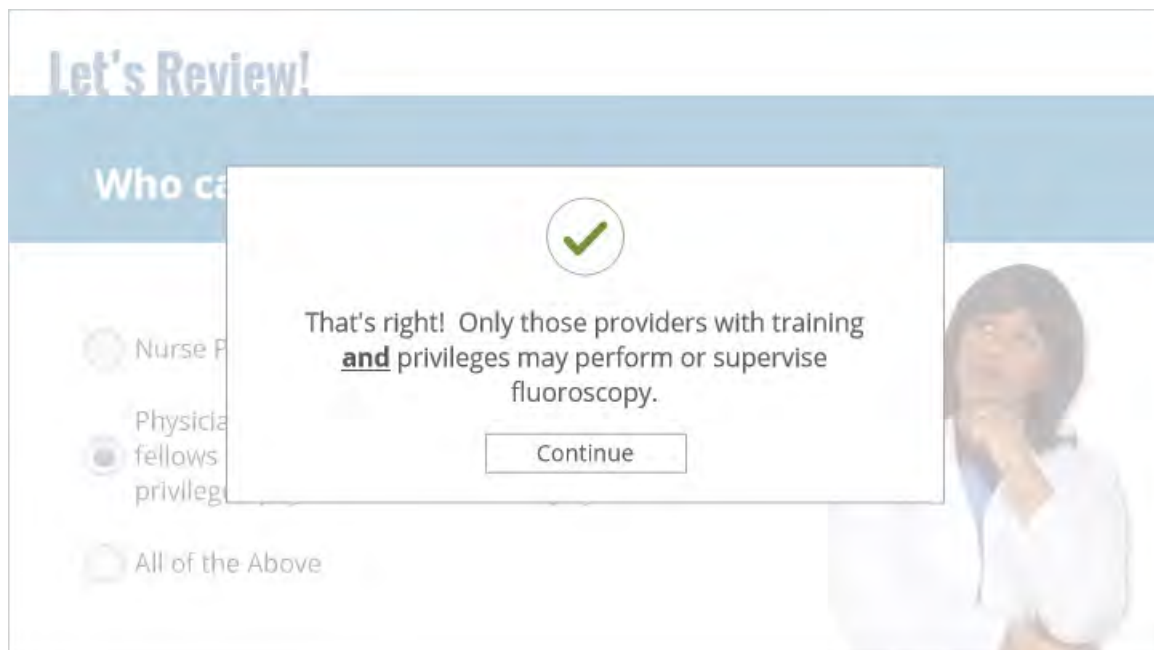
Feedback when correct:

That's right! Only those providers with training and privileges may perform or supervise fluoroscopy.

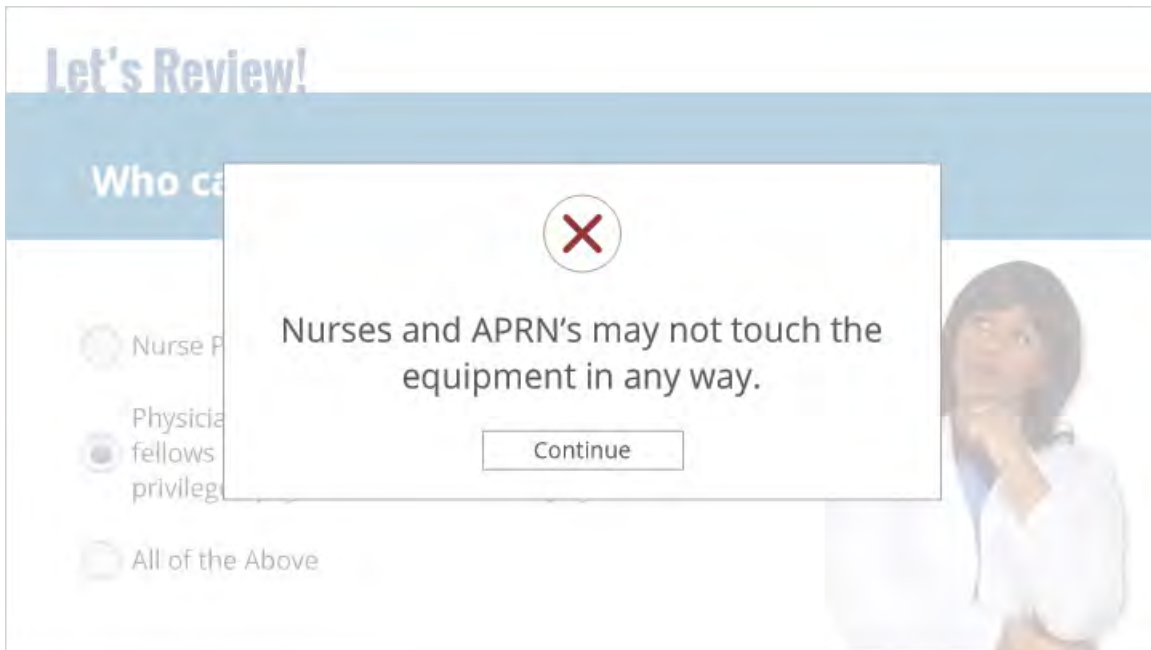
Feedback when incorrect:

Nurses and APRN's may not touch the equipment in any way.

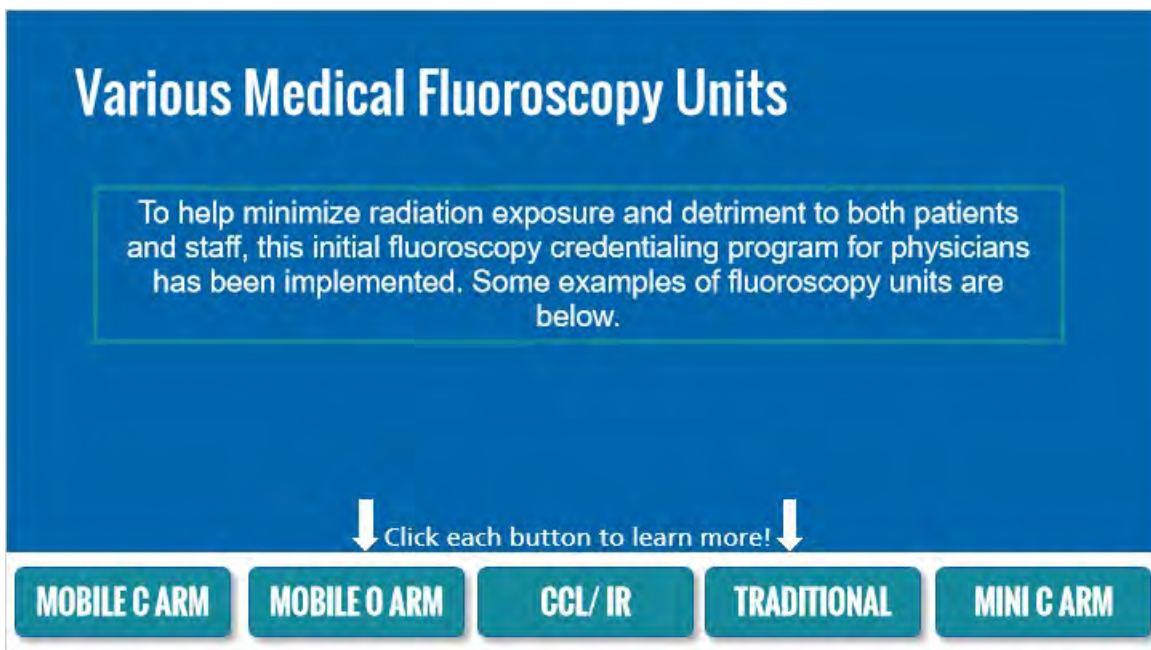
Correct (Slide Layer)



Incorrect (Slide Layer)



1.13 Examples of Fluoroscopy Units



Mobile C (Slide Layer)

Various Medical Fluoroscopy Units

Mobile C Arm Fluoroscopy Unit:
A lower power fluoroscopy unit primarily used for OR procedures.



MOBILE C ARM **MOBILE O ARM** **CCL/ IR** **TRADITIONAL** **MINI C ARM**

Mobile O (Slide Layer)

Various Medical Fluoroscopy Units

Mobile O Arm Fluoroscopy Unit:
Primarily used for spine, orthopaedics, and neurological OR procedures (2D and 3D capabilities).




MOBILE C ARM **MOBILE O ARM** **CCL/ IR** **TRADITIONAL** **MINI C ARM**

CCL (Slide Layer)

Various Medical Fluoroscopy Units

Cardiac Cath Lab/Interventional Fluoroscopy Unit:
These are the highest power fluoro units capable of the best quality angiographic images.



MOBILE C ARM MOBILE O ARM CCL/ IR TRADITIONAL MINI C ARM

Traditional (Slide Layer)

Various Medical Fluoroscopy Units

Traditional Fluoroscopy Unit:
Typically used for conventional gastrointestinal studies.




MOBILE C ARM MOBILE O ARM CCL/ IR TRADITIONAL MINI C ARM

Mini C (Slide Layer)

Various Medical Fluoroscopy Units

Mini C Arm Fluoroscopy Unit:
Primarily used for extremity imaging.



MOBILE C ARM

MOBILE O ARM

CCL/ IR

TRADITIONAL

MINI C ARM

1.14 Does a physician need fluoroscopic privileges to use the mini-C arm, a unit used for extremities only?

(Multiple Choice, 10 points, 3 attempts permitted)

Let's Review!

Does a physician need fluoroscopic privileges to use the mini-C arm, a unit used for extremities only?

☒ Yes

☐ No



Correct	Choice
X	Yes
	No

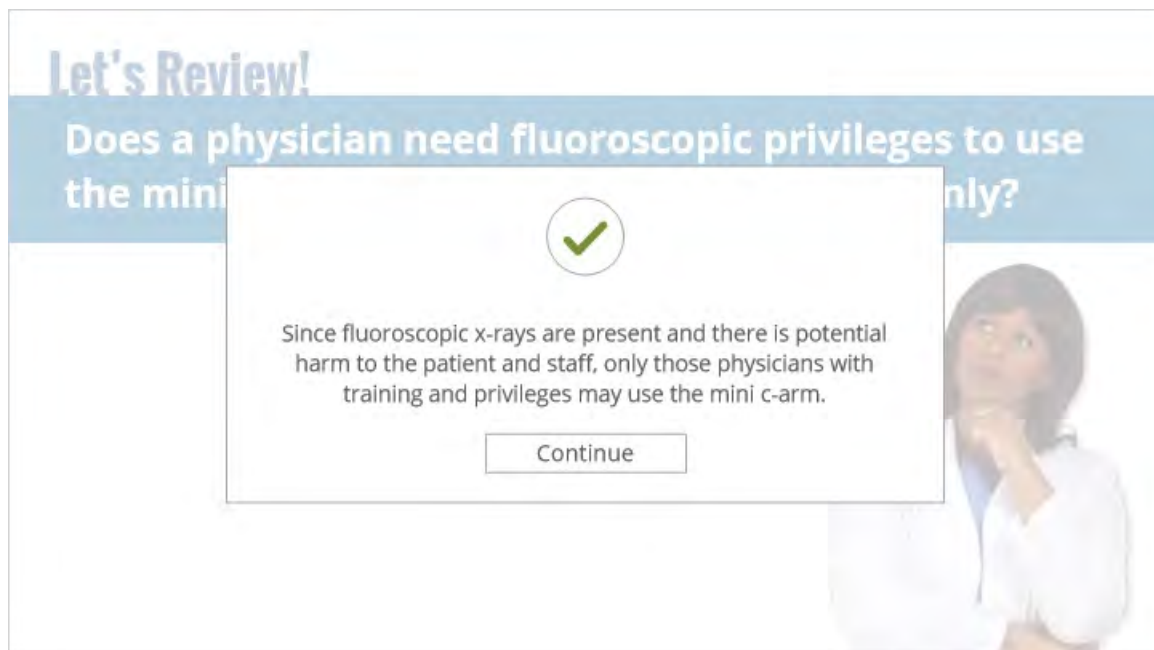
Feedback when correct:

Since fluoroscopic x-rays are present and there is potential harm to the patient and staff, only those physicians with training and privileges may use the mini c-arm.

Feedback when incorrect:

Since fluoroscopic x-rays are present and there is potential harm to the patient and staff, only those physicians with training and privileges may use the mini c-arm.


Correct (Slide Layer)



Incorrect (Slide Layer)


Let's Review!

Does a physician need fluoroscopic privileges to use the mini c-arm?



Since fluoroscopic x-rays are present and there is potential harm to the patient and staff, only those physicians with training and privileges may use the mini c-arm.

[Continue](#)



1.15 Topics: X-Ray Properties and Dose

Topics of Study

- Privileges to Perform Fluoroscopy
 - Regulatory Requirements
 - Approved Personnel
- ▼
- **X-Ray Properties and Dose**
 - **Monitoring Skin Dose for Patients and Staff**
- ▼
- Biological Effects of Fluoroscopy X-Ray for Patients and Staff
- ▼
- Basics of Fluoroscopy
 - Operation
 - Minimizing Risk
- ▼
- Resources

22% Complete

1.16 Fluoroscopic X-Ray Properties

Fluoroscopic X-Ray Properties

As the x-rays pass through the patient, there are 3 possible events that can occur:

Complete Penetration

Total Absorption

Scatter Interaction

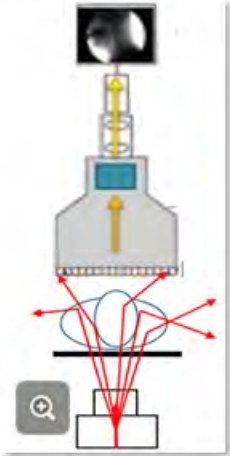
Click each  to learn more! 

Notes:

Scatter Interaction (Slide Layer)

Fluoroscopic X-Ray Properties

As the x-rays pass through the patient, there are 3 possible events that can occur:




Complete Penetration

Total Absorption

Scatter Interaction

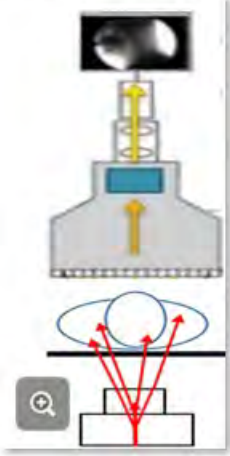
Some of the x-rays interact with the body (imparting some of their energy) and are scattered in a different direction. This "Patient Scatter" distorts the image and is the biggest contributor to staff dose.

Click each **BUTTON** to learn more! 

Total Absorption (Slide Layer)

Fluoroscopic X-Ray Properties

As the x-rays pass through the patient, there are 3 possible events that can occur:




Complete Penetration

Total Absorption

Scatter Interaction

Some of the x-rays will interact and give up all their energy causing patient dose. Denser material (e.g., bone) will absorb x-rays much more than soft tissue.

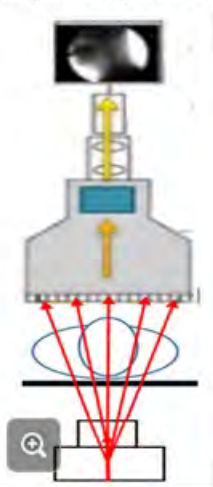
Click each **BUTTON** to learn more! 

Complete Penetration (Slide Layer)


Fluoroscopic X-Ray Properties

As the x-rays pass through the patient, there are 3 possible events that can occur:

- Complete Penetration
- Total Absorption
- Scatter Interaction

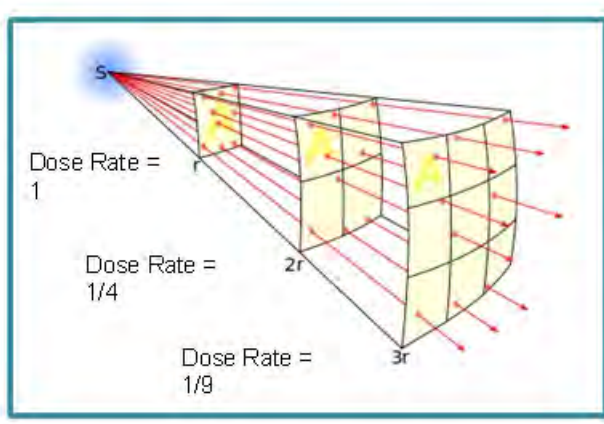


Some x-rays will pass entirely through the body without interacting and generate the image. For a normal sized adult, only around 1% of the x-rays make it through.

Click each **BUTTON** to learn more! 

1.17 Fluoroscopic X-Ray Properties

Fluoroscopic X-Ray Properties



Dose Rate = 1

Dose Rate = $\frac{1}{4}$

Dose Rate = $\frac{1}{9}$

Another property of x-rays is that it follows the inverse square law. This means the intensity and dose rate of the x-rays drops off significantly as the distances increases from the x-ray tube.

Notes:

1.18 Units of Measure

Radiation Doses in X-Ray

Units of Measure



milligray (mGy):
measurement of
Patient Skin Dose



millirem (mrem):
measurement of
radiation dose to
staff

Notes:

1.19 Radiation Dose to the Patient and Staff

Radiation Dose to the Patient and Staff

The entrance dose rate to the patient varies from 20 to 50 mGy/minute. The actual dose rate depends on factors such as:

- The patient's size
- Distance of the image receptor and x-ray tube from the patient
- If cine or digital acquisition is used

Fluoroscopy Dose Rates

The diagram illustrates radiation dose rates in a fluoroscopy suite. An X-ray tube is positioned on the left, emitting radiation towards a patient on a table. A red arrow points from the tube to the patient, labeled '40 mGy/min Entering Patient'. Another red arrow points from the patient, labeled '0.4 mGy/min Exiting Patient'. A dashed red line indicates a distance of '1 meter' from the patient to a staff member wearing an orange lead apron. The dose rate at this distance is '0.04 mGy/min (4 mrem/min)'. Below the apron, the dose rate is noted as 'Under Apron 0.0004 mGy/min (0.04 mrem/min)'.

1.20 CINE/Digital Acquisition

Radiation Doses in X-Ray

CINE/ Digital Acquisition

FLUORO

CINE
(Dose 8x Higher)

- Involves Complex neuro and cardiac interventional procedures
- Image Types
CINE, digital Angiograph (DA), digital subtraction angiography (DSA)
- Patient Skin Dose Rates
Normal Fluoroscopy: 40 mGy/minute
Digital Recording (CINE): 200 mGy/minute
- High Quality Images
Dose rates from digital recording can be up to 60 times greater than regular fluoroscopy

Notes:

1.21 What is the typical dose rate we assume to patient skin during normal fluoroscopy?

(Multiple Choice, 10 points, 3 attempts permitted)


Let's Review!

What is the typical dose rate we assume to patient skin during normal fluoroscopy?

☐ 15 mGy/min

☒ 40 mGy/min

☐ 200 mGy/min



Correct	Choice
	15 mGy/min
X	40 mGy/min
	200 mGy/min

Feedback when correct:

The entrance dose rate to the patient varies from 20 to 50 mGy/minute, but 40 mGy/min is assumed.

Feedback when incorrect:

The entrance dose rate to the patient varies from 20 to 50 mGy/minute, but 40 mGy/min is assumed.

Correct (Slide Layer)

Let's Review!

What is the typical dose rate we assume to patient skin dur




The entrance dose rate to the patient varies from 20 to 50 mGy/minute, but 40 mGy/min is assumed.

Continue

Incorrect (Slide Layer)


Let's Review!

What is the typical dose rate we assume to patient skin during




The entrance dose rate to the patient varies from 20 to 50 mGy/minute, but 40 mGy/min is assumed.

Continue



1.22 Monitoring Patient Skin Dose



Monitoring Patient Skin Dose

Estimation of Cumulative Dose
Most modern fluoroscopy units provide an estimation of the cumulative skin dose to the patient and is displayed as mGy on the monitor

----- Exposure Dose -----

X-ray Time (min)	4.5
mGy	1270
cGy cm2	8447

Activation and Dose Rate
On many units when the x-rays are activated the dose rate (displayed in mGy/min) will be displayed instead of the cumulative dose

Notes:

1.23 Interventional Reference Point



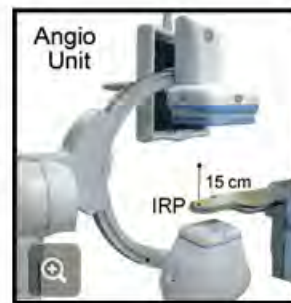
Monitoring Patient Skin Dose

Interventional Reference Point (IRP)

The displayed skin dose estimate is often referred to as the Interventional Reference Point (IRP)



The fluoro unit calculates the radiation dose at a fixed point which may not be where the x-rays actually enter the patient. In addition, the IRP does not take into account the movement of the tube, so it can significantly overestimate the peak skin dose if the tube is moved around.



Notes:

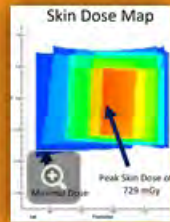
1.24 Interventional Reference Point



Monitoring Patient Skin Dose

Interventional Reference Point (IRP): Only an Estimate

NOTE: Skin dose and dose rate shown on the fluoroscopy machine are only estimates. The unit does not account for the machine movement and also has to make an assumption where the x-rays enter the body.



In this example, the total dose displayed on the monitor was 1677 mGy. However, the peak skin dose was actually 729 mGy.



As you can see from this picture, this location may or may not be correct.

Notes:

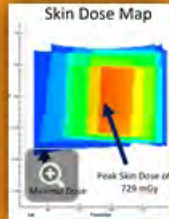
Exposure Dose (Slide Layer)



Monitoring Patient Skin Dose

Interventional Reference Point (IRP): Only an Estimate

NOTE: Skin dose and dose rate shown on the fluoroscopy machine are only estimates. The unit does not account for the machine movement and also has to make an assumption where the x-rays enter the body.



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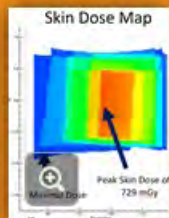
IRP (Slide Layer)



Monitoring Patient Skin Dose

Interventional Reference Point (IRP): Only an Estimate

NOTE: Skin dose and dose rate shown on the fluoroscopy machine are only estimates. The unit does not account for the machine movement and also has to make an assumption where the x-rays enter the body.




In this example, the total dose displayed on the monitor was 1677 mGy. However, the peak skin dose was actually 729 mGy.



As you can see from this picture, this location may or may not be correct.

1.25 IRP: Action Levels



Monitoring Patient Skin Dose

Interventional Reference Point (IRP): Action Levels

2000 mGy	<ul style="list-style-type: none">• Notify physician that 2000 mGy has been reached• Physician should evaluate the pacing of the exam and subsequent use of fluoroscopy and cine exposure
4000 mGy	<ul style="list-style-type: none">• Notify physician that 4000 mGy has been reached• Patients with skin doses > 4000 mGy are to be given a "Patient Information, Radiation Exposure" sheet• Physician evaluates pacing and continued use of fluoroscopy
6000 mGy	<ul style="list-style-type: none">• Notify physician that 6000 mGy has been reached (threshold of erythema)• "Time Out" should be called to determine potential skin effects and assess ways to minimize further radiation exposure to the patient.
8000 mGy	<ul style="list-style-type: none">• Notify physician that 8000 mGy has been reached and then at every 2000 mGy interval increase• Notify Diagnostic Medical Physicist after procedure for detailed dose assessment. Physicist evaluates the patient's skin dose with current regulations and guidelines. If critical thresholds are reached, the physicist will notify the hospital and medical directors.
12000 mGy	<ul style="list-style-type: none">• At this dose, desquamation and ulceration may occur weeks to months later

Notes:

1.26 The Interventional Reference Point (IRP) takes into account the movement of the x-ray tube.

(Multiple Choice, 10 points, 3 attempts permitted)

Let's Review!

The Interventional Reference Point (IRP) takes into account the movement of the x-ray tube.

- ☐ True
- ☒ False



Correct	Choice
	True
X	False

Feedback when correct:

Skin dose and dose rate shown on the fluoroscopy machine are only estimates. The unit does not account for the machine movement and also has to make an assumption where the x-rays enter the body.


Feedback when incorrect:

Skin dose and dose rate shown on the fluoroscopy machine are only estimates. The unit does not account for the machine movement and also has to make an assumption where the x-rays enter the body.

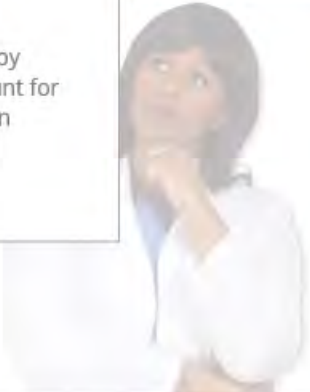
Correct (Slide Layer)

Let's Review!

The Interventional Reference Point (IRP) takes into account




Skin dose and dose rate shown on the fluoroscopy machine are only estimates. The unit does not account for the machine movement and also has to make an assumption where the x-rays enter the body.



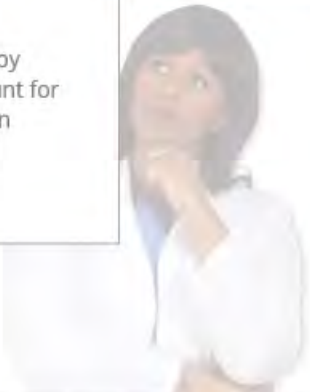
Incorrect (Slide Layer)

Let's Review!

The Interventional Reference Point (IRP) takes into account



Skin dose and dose rate shown on the fluoroscopy machine are only estimates. The unit does not account for the machine movement and also has to make an assumption where the x-rays enter the body.



1.27 Monitoring Staff Radiation Dose



Monitoring Staff Radiation Dose

Landauer OSL radiation **badge** is **required** to be worn by physicians who administer fluoroscopic x-rays, to monitor staff radiation exposure.

Filters on the badge monitor allow it to measure the radiation dose to the whole body, lens of the eye, and skin



Badge is worn on outside of collar area of the lead apron



Notes:

1.28 Monitoring Staff Radiation Dose: Minimize Risk



Monitoring Staff Radiation Dose

Minimize Risk

TIME


DISTANCE

SHIELDING

Click each **BUTTON** to learn more! 

Notes:

Time (Slide Layer)




Monitoring Staff Radiation Dose

Minimize Risk


TIME

DISTANCE


SHIELDING



Minimize your time being close to the patient

Click each **BUTTON** to learn more! 

Shielding (Slide Layer)




Monitoring Staff Radiation Dose

Minimize Risk

TIME

DISTANCE

SHIELDING




Examples of X-Ray shield apparel and shields.


Shielding reduces scatter radiation by over 90%.

Regulations **REQUIRE** you wear a lead apron when administering fluoroscopy.

Joint Commission requires that all lead aprons be checked annually for damage. If you have your own personal lead apron you are responsible that this inspection has been performed. Contact an imaging department supervisor to perform this inspection if required.

Click each **BUTTON** to learn more! 

Distance (Slide Layer)



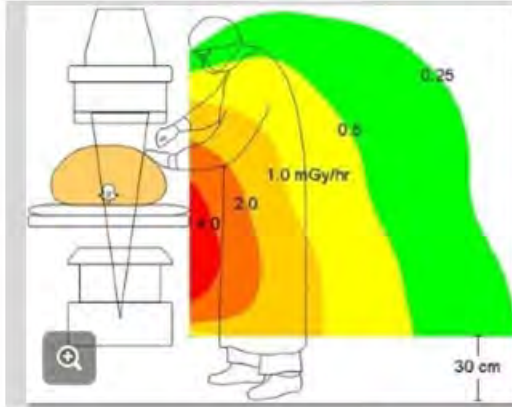
Monitoring Staff Radiation Dose

Minimize Risk


TIME

DISTANCE


SHIELDING



Increasing distance from the patient can significantly lower the dose rate.

Click each **BUTTON** to learn more! 

1.29 Pregnant Staff



Monitoring Staff Radiation Dose

Pregnant Staff


Pregnant workers may voluntarily enroll in the fetal monitoring program by declaring pregnancy in writing to the Radiation Safety Officer.

Fetal badges are exchanged monthly.

Two badges will be worn:


Wear **regular badge** **OUTSIDE** of lead apron

Wear **fetal badge** **UNDER** the apron



Notes:

1.30 Dose Limits to Radiation Workers

 Dose Limits to Radiation Workers		
Dose	Regulatory Limit (Nuclear Regulatory Commission)	Comments
EDE2	5000 mrem/yr	Essentially the "Whole Body" dose (DDE) modified by the shielding provided by the lead apron. The risk of 5000 mrem is comparable to risk working in "safe industry" (government office worker).
LDE	15,000 mrem/yr	This is the Lens of the Eye Dose. Studies indicate the threshold for opacities in the eye may be much lower than thought and this dose limit is likely to be reduced down to 5000 mrem/yr.
SDE	50,000 mrem/yr	SDE is a measure of dose to your skin and hands. This dose limit was set well below the threshold for where erythema occurs (acute exposure of 2 Gy or approximately 200,000 mrem).
Fetal	500 mrem/gestation	The fetus is believed to be more radiosensitive so this dose limit was set at 10% of the adult whole body limit.

Notes:

1.31 What is the EDE2 regulatory limit for occupational workers in fluoro?

(Multiple Choice, 10 points, 3 attempts permitted)

Let's Review!

What is the EDE2 regulatory limit for occupational workers in fluoro?

- ☐ 10000 mGy
- ☐ 7000 mGy
- ☒ 5000 mGy



Correct	Choice
	10000 mGy
	7000 mGy
X	5000 mGy

Feedback when correct:

Essentially the “Whole Body” dose (DDE) modified by the shielding provided by the lead apron. The risk of 5000 mrem is comparable to risk working in “safe industry” (government office worker).

Feedback when incorrect:

Essentially the “Whole Body” dose (DDE) modified by the shielding provided by the lead apron. The risk of 5000 mrem is comparable to risk working in “safe industry” (government office worker).

Correct (Slide Layer)

Let's Review!

What is the EDE2 regulatory limit for occupational workers



Essentially the "Whole Body" dose (DDE) modified by the shielding provided by the lead apron. The risk of 5000 mrem is comparable to risk working in "safe industry" (government office worker).



Incorrect (Slide Layer)

Let's Review!

What is the EDE2 regulatory limit for occupational workers



Essentially the "Whole Body" dose (DDE) modified by the shielding provided by the lead apron. The risk of 5000 mrem is comparable to risk working in "safe industry" (government office worker).



1.32 Topics: Biological Effect for Patients and Staff

Topics of Study


- Privileges to Perform Fluoroscopy
 - Regulatory Requirements
 - Approved Personnel
- X-Ray Properties and Dose
 - Monitoring Skin Dose for Patients and Staff
- Biological Effects of Fluoroscopy X-Ray for Patients and Staff**
- Basics of Fluoroscopy
 - Operation
 - Minimizing Risk
- Resources

50% Complete

1.33 Patient Health Concerns

Biological Effects of Fluoroscopy X-Rays

Health Concerns




Patient:

Skin is the major concern. A **threshold dose of 3000 mGy** is typically needed before you see any effects such as temporary reddening.

Notes:

1.34 Patient Skin Effects from Fluoroscopy



Patient Skin Effects from Fluoroscopy

Typical skin dose rates range
from 40 mGy/min (fluoroscopy) to 200 mGy/min (CINE, DSA)


< 3000 mGy

3000- 6000 mGy

6000 mGy


8000 mGy

12,000 mGy

Click each **BUTTON** to learn more! 

Notes:

<2000 (Slide Layer)





Patient Skin Effects from Fluoroscopy

Typical skin dose rates range from 40 mGy/min (fluoroscopy) to 200 mGy/min (CINE, DSA)


- < 3000 mGy
- 3000- 6000 mGy
- 6000 mGy
- 8000 mGy
- 12,000 mGy

No skin effects are observed



Click each [BUTTON](#) to learn more! 

2000-6000 (Slide Layer)





Patient Skin Effects from Fluoroscopy

Typical skin dose rates range from 40 mGy/min (fluoroscopy) to 200 mGy/min (CINE, DSA)


- < 3000 mGy
- 3000- 6000 mGy
- 6000 mGy
- 8000 mGy
- 12,000 mGy

Transient erythema (skin reddening) is observed, usually a few hours to a few days after the procedure, with reddening eventually disappearing.



Click each [BUTTON](#) to learn more! 

6000 (Slide Layer)




Patient Skin Effects from Fluoroscopy

Typical skin dose rates range from 40 mGy/min (fluoroscopy) to 200 mGy/min (CINE, DSA)


- < 3000 mGy
- 3000- 6000 mGy
- 6000 mGy
- 8000 mGy
- 12,000 mGy

Main erythema can occur. This is when the transient erythema disappears and then reappears about 10 to 14 days later (this is a good indicator that the patient received a significant skin dose). This skin damage can be apparent for years after exposure.



Click each **BUTTON** to learn more! ?

8000 (Slide Layer)



Patient Skin Effects from Fluoroscopy


Typical skin dose rates range from 40 mGy/min (fluoroscopy) to 200 mGy/min (CINE, DSA)

- < 3000 mGy
- 3000- 6000 mGy
- 6000 mGy
- 8000 mGy
- 12,000 mGy

Notify Mark Theis, Radiation Safety Officer

Click each **BUTTON** to learn more! ?

12,000 (Slide Layer)



Patient Skin Effects from Fluoroscopy

Typical skin dose rates range from 40 mGy/min (fluoroscopy) to 200 mGy/min (CINE, DSA)

< 3000 mGy


3000- 6000 mGy


6000 mGy

8000 mGy


12,000 mGy

At this dose, desquamation, ulceration and/or necrosis can develop (will not become apparent until several weeks or months after exposure).
Mark Theis, Radiation Safety needs to be notified if this dose is reached.



Click each [BUTTON](#) to learn more! 

1.35 Detrimental Skin Effects from Fluoroscopy



Detrimental Skin Effects from Fluoroscopy

Effect	Single Dose Threshold	Onset	Time to Reach Threshold-Fluoro (40 mGy/min)	Time to Reach Threshold- Digital (200 mGy/min)
Early Transient Erythema	3000 mGy	2-24 Hours	75 minutes	15 minutes
Main Erythema	6000 mGy	10 days	150 minutes	30 minutes
Dry Desquamation	14,000 mGy	4 weeks	350 minutes	70 minutes
Moist Desquamation	18,000 mGy	4 weeks	450 minutes	90 minutes
Secondary Ulceration	24,000 mGy	>6 weeks	600 minutes	120 minutes
Dermal Necrosis (late phase)	>12,000 mGy?	>1 year	300 minutes	60 minutes


Notes:

1.36 Case Studies





Case Studies

Case 1
Angioplasty




Case 2
Ablation



Click each case to learn more! 

Notes:

1.37 Detrimental Skin Effects Summary



Detrimental Skin Effects from Fluoroscopy

Summary

- Threshold for Skin Injury starts around 3000 mGy (temporary reddening)
- 3000 mGy corresponds to 75 minutes of fluoroscopy or 15 minutes of digital recording (cine)
- X-rays do NOT cause any sensation in patients
- Skin damage develops slowly; visual evidence of erythema typically does not occur until days after irradiation
- As the skin dose exceeds the threshold dose, the more severe the skin injury and the longer it takes to manifest
- Prior to performing any procedure that may involve the extensive use of fluoroscopy, the patient's history (over the last 6 months) should be reviewed and skin area examined to determine any potential for skin injury

Notes:

1.38 For most patients, what is the dose threshold to the patient's skin at which reddening/damage occurs?

(Multiple Choice, 10 points, 3 attempts permitted)

Let's Review!

For most patients, what is the dose threshold to the patient's skin at which reddening/damage occurs?

- ☐ 1000 mGy
- ☐ 6000 mGy
- ☒ 3000 mGy



Correct	Choice
	1000 mGy
	6000 mGy
X	3000 mGy

Feedback when correct:

3000 mGy corresponds to 75 minutes of fluoroscopy or 15 minutes of digital recording (cine) and patients do not feel any sensation initially.

Feedback when incorrect:

3000 mGy corresponds to 75 minutes of fluoroscopy or 15 minutes of digital recording (cine) and patients do not feel any sensation initially.

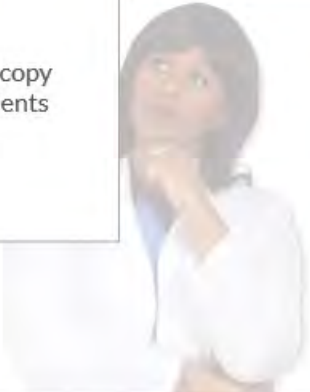
Correct (Slide Layer)

Let's Review!

For most patients, what is the dose threshold to the patient's skin?

3000 mGy corresponds to 75 minutes of fluoroscopy or 15 minutes of digital recording (cine) and patients do not feel any sensation initially.

Continue



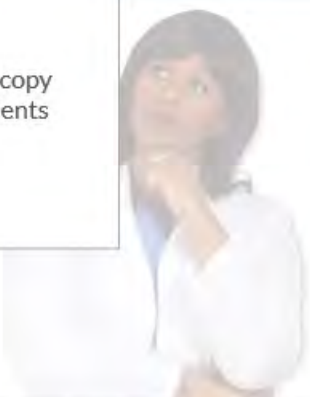
Incorrect (Slide Layer)

Let's Review!

For most patients, what is the dose threshold to the patient's skin?

3000 mGy corresponds to 75 minutes of fluoroscopy or 15 minutes of digital recording (cine) and patients do not feel any sensation initially.

Continue




1.39 If the patient skin dose threshold (3000 mGy) is reached, transient erythema can be seen:

(Multiple Choice, 10 points, 3 attempts permitted)

Let's Review!

If the patient skin dose threshold (3000 mGy) is reached, transient erythema can be seen:

- ☐ immediately following the procedure
- ☒ approximately 2-24 hours following the procedure
- ☐ at least one month following the procedure



Correct	Choice
	immediately following the procedure
X	approximately 2-24 hours following the procedure
	at least one month following the procedure

Feedback when correct:

Transient Erythema (skin reddening) occurs initially between 3000 and 6000 mGy and appears few hours to a few days after the procedure, with reddening eventually disappearing.

Feedback when incorrect:

Transient Erythema (skin reddening) occurs initially between 3000 and 6000 mGy and appears few hours to a few days after the procedure, with reddening eventually disappearing.

Correct (Slide Layer)

Let's Review!

If the patient skin dose threshold (3000 mGy) is reached

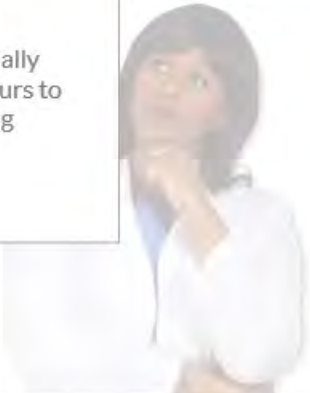
☐ Immediately

☒ Approximately 24 hours

☐ At least 48 hours

Transient Erythema (skin reddening) occurs initially between 3000 and 6000 mGy and appears few hours to a few days after the procedure, with reddening eventually disappearing.

Continue



Incorrect (Slide Layer)

Let's Review!

If the patient skin dose threshold (3000 mGy) is reached

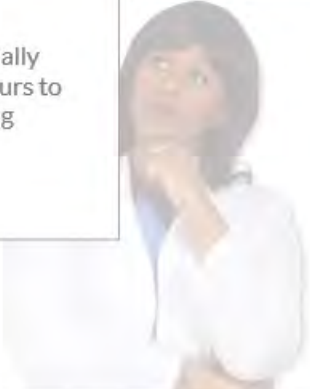
☐ Immediately

☒ Approximately 24 hours

☐ At least 48 hours

Transient Erythema (skin reddening) occurs initially between 3000 and 6000 mGy and appears few hours to a few days after the procedure, with reddening eventually disappearing.

Continue



1.40 At what dose threshold should the Diagnostic Medical Physicist be notified?

(Multiple Choice, 10 points, 3 attempts permitted)


Let's Review!

At what dose threshold should the Diagnostic Medical Physicist be notified?

☐ 6000 mGy

☒ 8000 mGy

☐ 3000 mGy



Correct	Choice
	6000 mGy
X	8000 mGy
	3000 mGy

Feedback when correct:

If the patient dose reaches 8000 mGy, the Radiation Safety Officer is required to be notified.

Feedback when incorrect:

If the patient dose reaches 8000 mGy, the Radiation Safety Officer is required to be notified.


Correct (Slide Layer)

Let's Review!

At what dose threshold should the Diagnostic Medical



If the patient dose reaches 8000 mGy, the Radiation Safety Officer is required to be notified.



Incorrect (Slide Layer)

Let's Review!

At what dose threshold should the Diagnostic Medical



If the patient dose reaches 8000 mGy, the Radiation Safety Officer is required to be notified.



1.41 Staff Health Concerns

Biological Effects of Fluoroscopy X-Rays

Health Concerns

Risk of Cancer for Low Radiation Exposure

The concern for low radiation exposure is thought to be a slight increase in cancer incidence years later. Statistically, the increase can't be seen at low doses like the staff receives so it is extrapolated from individuals who received very large radiation doses (e.g., Japanese atomic bomb survivors from WWII). Click "Next" to see an illustration of this risk.




Staff:

The major concern for lower radiation doses is the potential increase in cancer years later.

Notes:

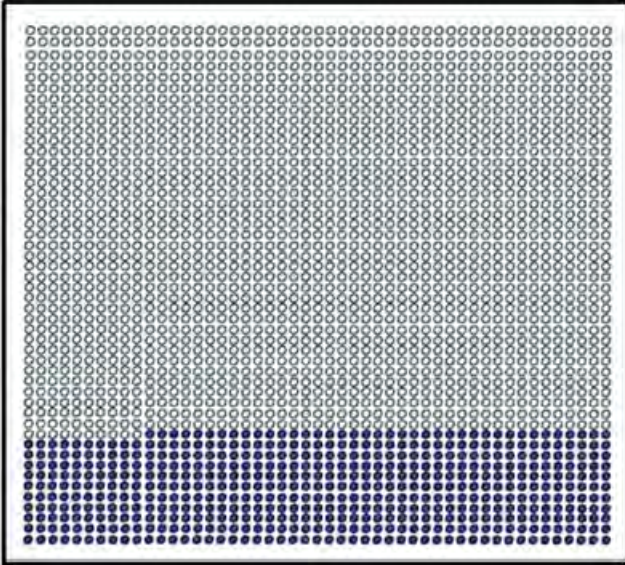
1.42 Risk of Cancer



Risk of Cancer


The chance of eventually developing a fatal cancer from radiation is 0.00004% per millirem. The figure (right) illustrates this situation. The **gray circles represent 2,500 workers** each receiving 1000 mrem (the amount a worker could receive annually where fluoroscopy is used).

Over the course of a lifetime, more than **500 individuals** will contract a fatal cancer from other causes not associated with exposure to ionizing radiation (the **colored purple circles** at the bottom of the figure).



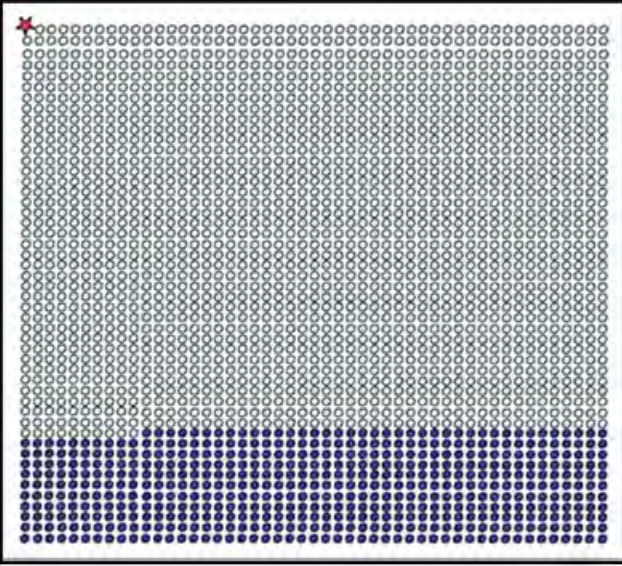
Notes:

1.43 Risk of Cancer



Risk of Cancer

If each worker is exposed to 1000 mrem of ionizing radiation, **one individual (the red star) may eventually develop a fatal cancer as a result.** It is impossible to predict which individual of the 2,500 will be affected.



Notes:

1.44 Topics: Basics of Fluoroscopy

Topics of Study

- Privileges to Perform Fluoroscopy
 - Regulatory Requirements
 - Approved Personnel
- X-Ray Properties and Dose
 - Monitoring Skin Dose for Patients and Staff
- Biological Effects of Fluoroscopy X-Ray for Patients and Staff
- Basics of Fluoroscopy**
 - Operation**
 - Minimizing Risk**
- Resources

66% Complete

1.45 Basic X-Ray Production

Basic X-Ray Production

Click each numbered tab to learn more!

12

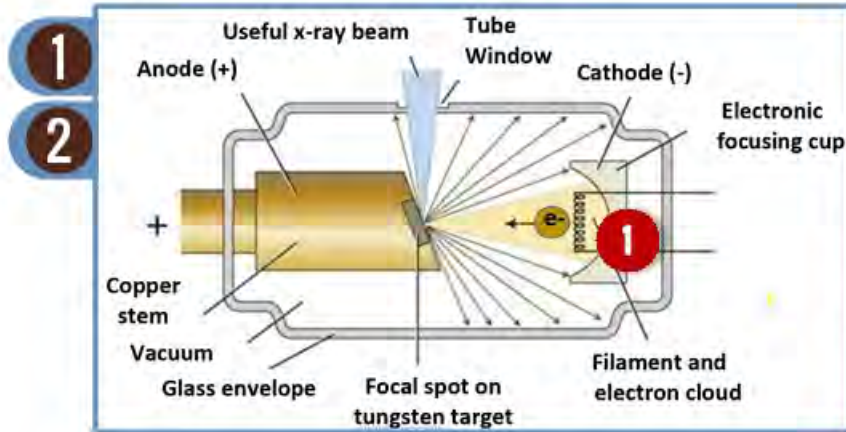
The diagram illustrates the components and operation of an X-ray tube. A copper stem is connected to the anode (+) and the cathode (-). The tube is filled with a vacuum and enclosed in a glass envelope. The cathode is a filament and electron cloud, and the anode is a tungsten target. An electronic focusing cup is around the cathode. X-rays are produced at the focal spot on the tungsten target and exit through the tube window as a useful x-ray beam.

Notes:

Tab 01 (Slide Layer)

Basic X-Ray Production

Click each numbered tab to learn more!

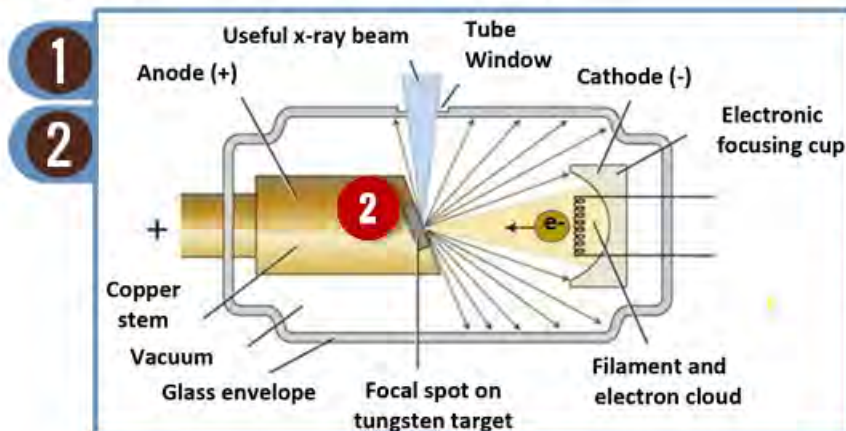


1
A filament is heated up and electrons are "boiled" off. The flow of electrons is expressed in millamperes (mA) and is the tube current. If you double the mA (tube current) you will double the number of x-rays.

Tab 02 (Slide Layer)

Basic X-Ray Production

Click each numbered tab to learn more!



2
Voltage, measured in kilovolts (kVp), is applied across the tube to accelerate the electrons towards the anode and tungsten target. The higher the voltage the higher the average energy, and penetrability, of the x-rays.

1.46 To increase the penetrability of x-rays, the _____ should be _____.

(Multiple Choice, 10 points, 3 attempts permitted)


Let's Review!

To increase the penetrability of x-rays, the _____ should be _____.

☐ mA, increased

☒ kVp of the tube, increased

☐ magnification, decreased



Correct	Choice
	mA, increased
X	kVp of the tube, increased
	magnification, decreased

Feedback when correct:

mA only affects the number of x-rays, not the penetrability of the x-rays" and "decreasing magnification will not increase the penetrability of the x-rays.


Feedback when incorrect:

mA only affects the number of x-rays, not the penetrability of the x-rays" and "decreasing magnification will not increase the penetrability of the x-rays.


Correct (Slide Layer)

Let's Review!

To increase the penetrability of x-rays, the _____ should be _____




mA only affects the number of x-rays, not the penetrability of the x-rays" and "decreasing magnification will not increase the penetrability of the x-rays.




Incorrect (Slide Layer)

Let's Review!

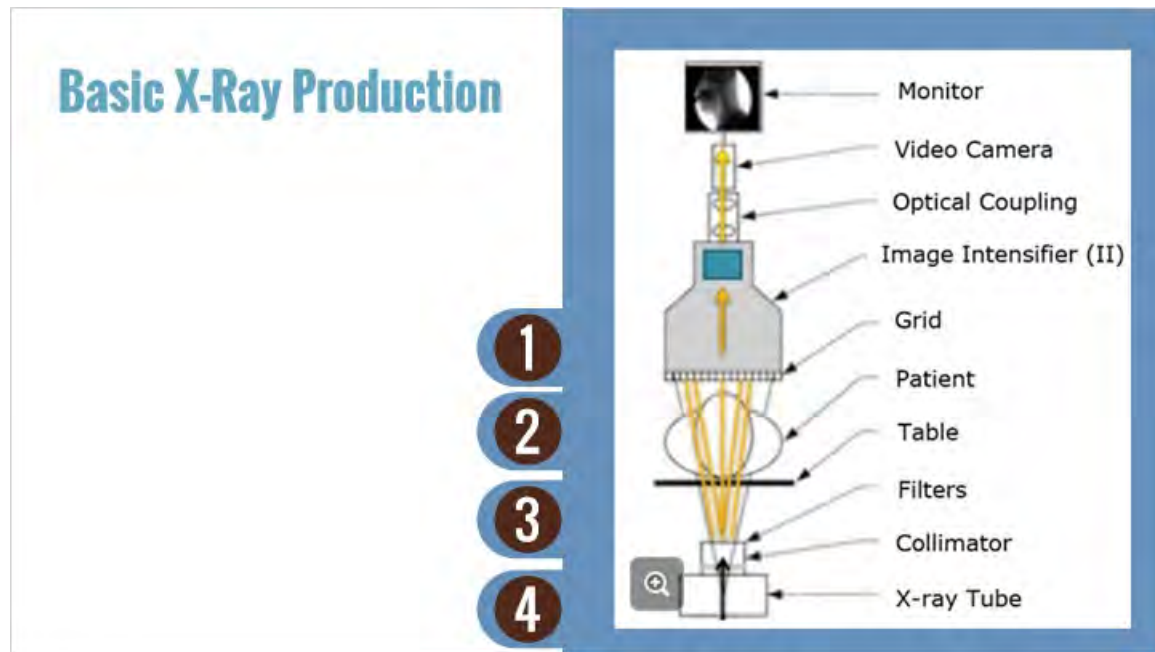
To increase the penetrability of x-rays, the _____ should be _____



mA only affects the number of x-rays, not the penetrability of the x-rays" and "decreasing magnification will not increase the penetrability of the x-rays.



1.47 Basic X-Ray Production



Notes:

Tab 01 (Slide Layer)

Basic X-Ray Production

1

A filter (copper or aluminum) stops low energy x-rays which have no chance of making it through the patient's body & contribute nothing to the diagnostic image. The physician has the ability to select the amount of filtration.

1 2 3 4

Monitor
Video Camera
Optical Coupling
Image Intensifier (II)
Grid
Patient
Table
Filters
Collimator
X-ray Tube

Tab 02 (Slide Layer)

Basic X-Ray Production

2

A collimator (metal blades) is located just outside the x-ray tube and is used to reduce or enlarge the area of the patient that is being exposed. The physician has the ability to set the amount of collimation.

1 2 3 4

Monitor
Video Camera
Optical Coupling
Image Intensifier (II)
Grid
Patient
Table
Filters
Collimator
X-ray Tube

Tab 03 (Slide Layer)

Basic X-Ray Production

3

A grid is used to prevent x-rays that were scattered in the patient's body from reaching the image receptor to improve image contrast. The grid is removable and often not required for pediatric patients or small adults.

Tab 04 (Slide Layer)

Basic X-Ray Production


4

The x-rays finally reach an image receptor (either an image intensifier (II) or flat panel detector) where the image is constructed and sent to a monitor

Some newer units use Flat Panel detectors to capture and convert the x-rays into the image

1.48 Automatic Exposure Control

Automatic Exposure Control (AEC)



Many image quality operations are automatically controlled in real-time by the fluoroscopy system. While the operations are passive to the operator, they markedly affect radiation dose.

The AEC controls the x-ray technique (kVp and mA). Using feedback, the technique is adjusted to ensure that a sufficient number of x-rays reach the image receptor. The adjustment of the kVp and mA affects the radiation dose rate to the patient.

Remember!
In general, the higher the image quality the higher the dose rate to the patient.

Be aware of sampling area often visualised by dotted line

Notes:

1.49 Typically, what is the relationship between image quality and patient dose rate?


(Multiple Choice, 10 points, 3 attempts permitted)

Let's Review!

Typically, what is the relationship between image quality and patient dose rate?

☒ The higher the image quality, the higher the patient dose rate.

☐ The higher the image quality, the lower the patient dose rate.



Correct	Choice	Feedback
X	The higher the image quality, the higher the patient dose rate.	In general, you should go with the lowest image quality that you can adequately perform the exam with.
	The higher the image quality, the lower the patient dose rate.	High image quality is achieved by increasing the patient dose rate. Care should be taken to balance the highest image quality with patient safety.

The higher the image quality, the higher the patient dose rate. (Slide Layer)

Let's Review!


Typically, what is the relationship between image quality and patient dose rate?

☒ The higher the image quality, the higher the patient dose rate.

☐ The higher the patient dose rate, the higher the image quality.

In general, you should go with the lowest image quality that you can adequately perform the exam with.

Continue



The higher the image quality, the lower the patient dose rate. (Slide Layer)

Let's Review!


Typically, what is the relationship between image quality and patient dose rate?

☒ The higher the image quality, the lower the patient dose rate.

☐ The higher the patient dose rate, the higher the image quality.

High image quality is achieved by increasing the patient dose rate. Care should be taken to balance the highest image quality with patient safety.

Continue



1.50 Operator Settings

Operator Settings

The control panel is used to control settings such as magnification, collimation, high dose rate setting, and image programs.

The x-rays can be generated at the control panel but typically the physician uses the foot pedals to turn on the x-rays.

Be aware of foot pedal control combinations

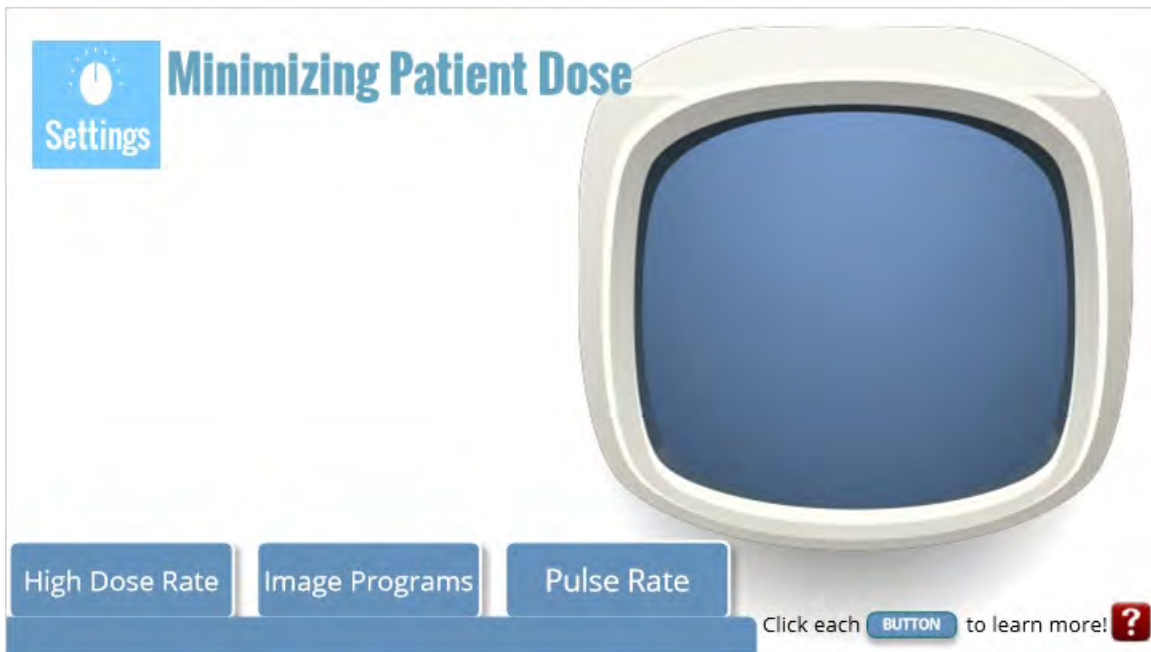
1.51 Minimizing Risk

Minimizing Risks from Fluoroscopic X-Rays

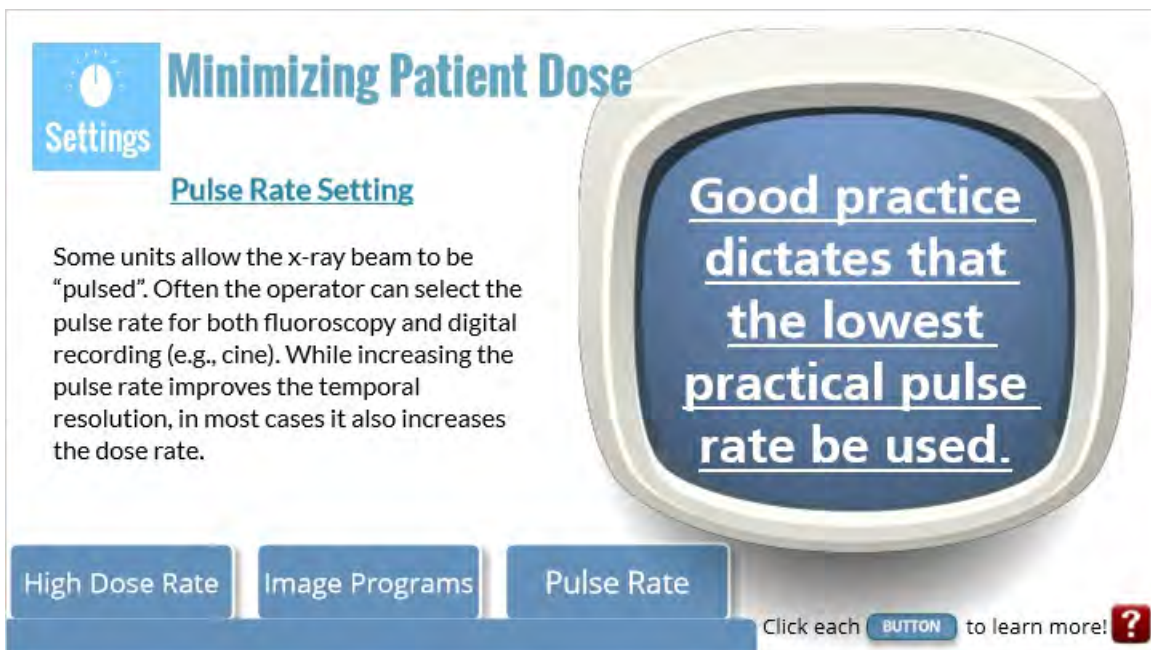
For fluoroscopy and digital recording (e.g., cine) the following are principle factors that control radiation dose rate and total dose rate to the patient and personnel:

 Settings	 Collimation	 Magnification
 Patient Size	 Tube & Receptor Proximity	 Beam Time


1.52 Minimizing Patient Dose: Settings



Pulse Rate (Slide Layer)



high Dose Rate (Slide Layer)



Minimizing Patient Dose

High Dose Rate Setting

Some machines have a high level option (or high-dose rate) which allows dose rates well above the standard regulatory levels. For this mode a special means of activation is required and a special audible signal is used to indicate its engagement.

Because of the high dose rates to the patient, the high dose rate setting should only be used briefly to perceive detail that cannot be otherwise discerned.

High Dose Rate

Image Programs

Pulse Rate



Click each **BUTTON** to learn more! 


Image program 1 (Slide Layer)



Minimizing Patient Dose

Image Programs

Some of fluoroscopy units have programmed settings for various imaging tasks. For example, if imaging iodinated contrast you need to maintain kVp at a fixed level. Some units have programs that allow the operator to control this.



In this example, select "Liver Embolize" first.

High Dose Rate

Image Programs

Pulse Rate



Click each **BUTTON** to learn more! 

Image program 2 (Slide Layer)





Minimizing Patient Dose

Image Programs


The exam "FL Angio" is then selected which has a low default setting of 3 frames/second. The Body 4 CARE selection uses various algorithms to manipulate the kVp and mA to minimize radiation dose to the patient.

High Dose Rate Image Programs Pulse Rate

Click each **BUTTON** to learn more! 



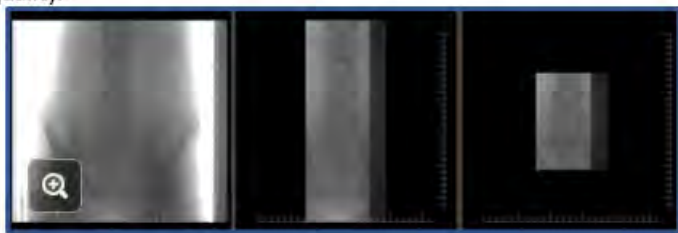
1.53 Minimizing Patient Dose: Settings



Minimizing Patient Dose

Always collimate down to the area of interest

Collimators are devices that limit the size of the x-ray field. While collimation doesn't reduce the dose rate to the patient, reducing the size of the x-ray field reduces the volume of tissue exposed, reduces patient scatter, and improves image quality.



HOT TIP

To reduce exposure the "Last Image Hold" should be used when adjusting collimator settings. Good collimation reduces the amount of patient tissue exposed, the amount scatter radiation, and improves image quality.

Pulse Rate (Slide Layer)



Minimizing Patient Dose

Pulse Rate Setting

Always collimate down to the area of interest


Collimators are devices that limit the size of the x-ray field. Some units allow the x-ray beam to be pulsed. Often the pulse exposure, reduces the volume of tissue exposed, reduces patient scatter, and improves image quality.

Collimators are devices that limit the size of the x-ray field. While collimation doesn't reduce the dose rate to the patient, reducing the size of the x-ray field reduces the volume of tissue exposed, reduces patient scatter, and improves image quality.

Good practice dictates the lowest practical pulse rate.




collimate to area of interest (Slide Layer)



Minimizing Patient Dose

Always collimate down to the area of interest


Collimators are devices that limit the size of the x-ray field. While collimation doesn't reduce the dose rate to the patient, reducing the size of the x-ray field reduces the volume of tissue exposed, reduces patient scatter, and improves image quality.



HOT TIP

To reduce exposure the "Last Image Hold" should be used when adjusting collimator settings. Good collimation reduces the amount of patient tissue exposed, the amount scatter radiation, and improves image quality.

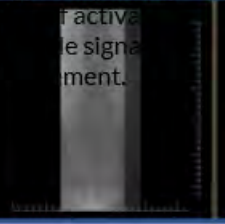
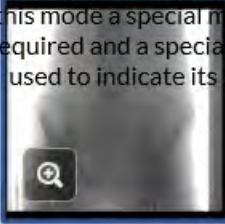
high Dose Rate (Slide Layer)



Minimizing Patient Dose

High Dose Rate Setting


Always collimate down to the area of interest. Collimators are devices that limit the size of the x-ray field. Some units have a high level option (or reduced the volume of tissue exposed) to reduce patient dose. For this mode a special signal is required and a special signal is used to indicate its activation.



Because of the high dose rates to the patient, the high dose rate setting should only be used briefly to perceive detail that cannot be otherwise discerned.

...ter
...ion, and
improves image
quality.

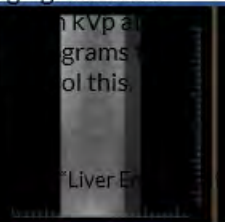
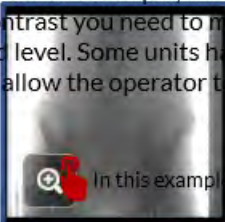
Image program 1 (Slide Layer)




Minimizing Patient Dose

Image Programs

Always collimate down to the area of interest. Collimators are devices that limit the size of the x-ray field. Some units have a high level option (or reduced the volume of tissue exposed) to reduce patient dose. For example, if imaging iodinated contrast you need to maintain a fixed level. Some units have programs that allow the operator to control this.






Exam Set Selection			
Neuro VD11E	ERCP	RFP Pad	3D Body
Neuro CLEAR VD11E	PICC	Cerebral US	3D Body Open
END OF CHANGE	Misc. Iodine Bone	Service&Regulat	3D Card
	Veri. Dyna & Scan	3D Head	3D Surgery

Pulse Rate

...ter
...ion, and
improves image
quality.

Image program 2 (Slide Layer)

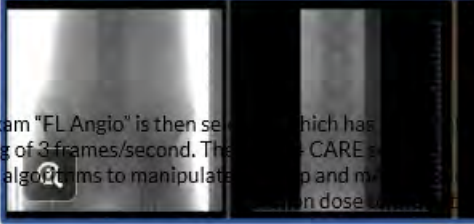


Minimizing Patient Dose


Image Programs

Always collimate down to the area of interest

Collimators are devices that limit the size of the x-ray field. Collimating doesn't reduce the dose rate to the patient, reducing the volume of tissue exposed, reduces patient dose and improves image quality.



The exam "FL Angio" is then selected, which has a default setting of 3 frames/second. The system uses CARE (Control of Air Kerma) and various algorithms to manipulate exposure and maintain image quality while minimizing dose.

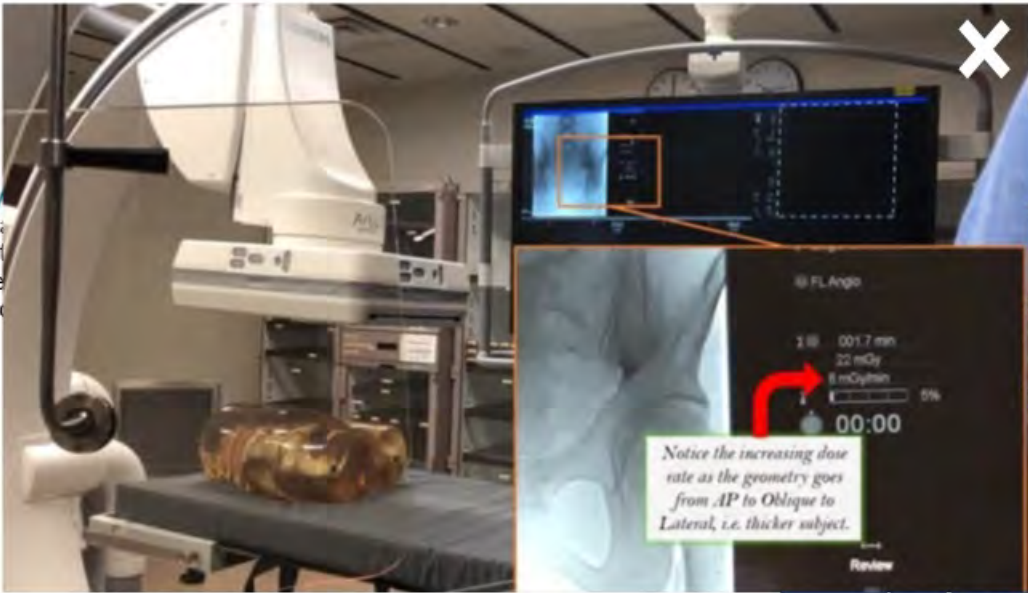


Pulse Rate

Pulse Rate - magnified (Slide Layer)

Always Collimate down to the area of interest


Collimators are devices that limit the size of the x-ray field. Collimating doesn't reduce the dose rate to the patient, reducing the volume of tissue exposed, reduces patient dose and improves image quality.



Notice the increasing dose rate as the geometry goes from AP to Oblique to Lateral, i.e. thicker subject.

00:00 / 00:09

1.54 Minimizing Patient Dose: Magnification




Minimizing Patient Dose

Magnification enlarges the anatomy being viewed and increases the radiation dose to the patient.

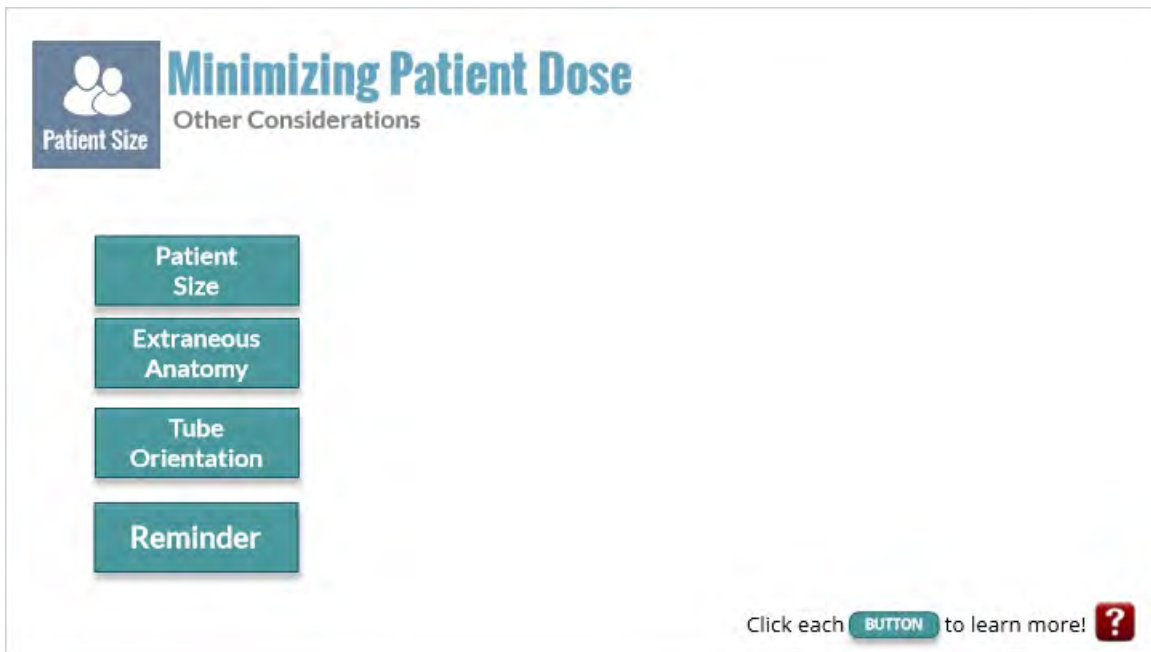
Multiple electronic magnification modes may be available.

Magnification controls on the operator panel allow the user to restrict the field of view and magnifies it on the monitor. For systems with image intensifiers increasing the magnification can significantly increase the entrance dose rate to the patient.



Notes:

1.55 Minimizing Patient Dose: Patient Size



The interface is titled "Minimizing Patient Dose" in large blue text, with "Other Considerations" in smaller text below it. On the left, there is a vertical stack of four teal buttons: "Patient Size", "Extraneous Anatomy", "Tube Orientation", and "Reminder". The "Patient Size" button is highlighted with a white border. In the top left corner, there is a blue square icon with two white figures and the text "Patient Size". In the bottom right corner, there is a prompt "Click each" followed by a teal button labeled "BUTTON", then "to learn more!" and a red square icon with a white question mark.

Minimizing Patient Dose
Other Considerations

Patient Size

Extraneous Anatomy


Tube Orientation

Reminder

Click each **BUTTON** to learn more! ?

Notes:

Patient Size (Slide Layer)



Patient Size

Minimizing Patient Dose

Other Considerations


Patient Size

Extraneous Anatomy

Tube Orientation

Reminder

- Dose rates to a large patient can exceed that of a thin patient by a factor of 10 or more.
- Physicians occasionally resort to high dose rate modes to improve image quality for large patients. Be aware that this mode can result in extremely rapid dose buildup.

Click each **BUTTON** to learn more! 

Extraneous Anatomy (Slide Layer)



Patient Size

Minimizing Patient Dose

Other Considerations

Patient Size

Extraneous Anatomy

Tube Orientation


Reminder



Make sure that extraneous anatomy (especially arms) are kept out of the beam

Click each **BUTTON** to learn more! 

Tube Orientations (Slide Layer)



Patient Size

Minimizing Patient Dose

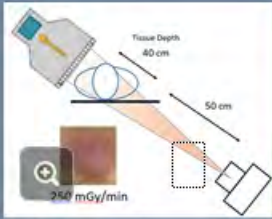
Other Considerations

Patient Size

Extraneous Anatomy

Tube Orientation

Reminder

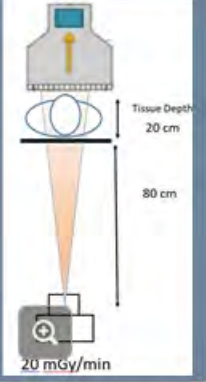


40 cm

50 cm

250 mGy/min


When x-ray beam is oriented at an angle, the amount of tissue that the must be penetrated also increases. Be cognizant that entrance dose rate rapidly increases with steeper beam angles.




20 cm

80 cm

20 mGy/min

Click each **BUTTON** to learn more! 

Reminder (Slide Layer)



Patient Size

Minimizing Patient Dose

Other Considerations


Patient Size

Extraneous Anatomy


Tube Orientation

Reminder

- Direct irradiation of the female breast should be avoided if possible to minimize the risk of breast cancer.
- Using a PA instead of AP projection through the thorax can reduce the absorbed dose to the breast by more than a factor of 30

Click each **BUTTON** to learn more! 

1.56 Minimizing Patient Dose: Tube & Receptor Proximity




Tube & Receptor Proximity

Minimizing Patient Dose

X-ray intensity and dose rate drops off significantly as the distance from the x-ray tube increases (conversely, it goes up significantly to closer you get to the x-ray tube).

To minimize the dose:

- Keep image receptor as close as possible to the patient
- Keep the x-ray tube as far away as practical



OPTIMAL **TABLE TOO LOW** **TABLE TOO LOW**
Detector Too High


30 cm 30 cm 60 cm

40 cm 50 cm 60 cm

1.0 Dose Units 1.4 Dose Units 1.6 Dose Units

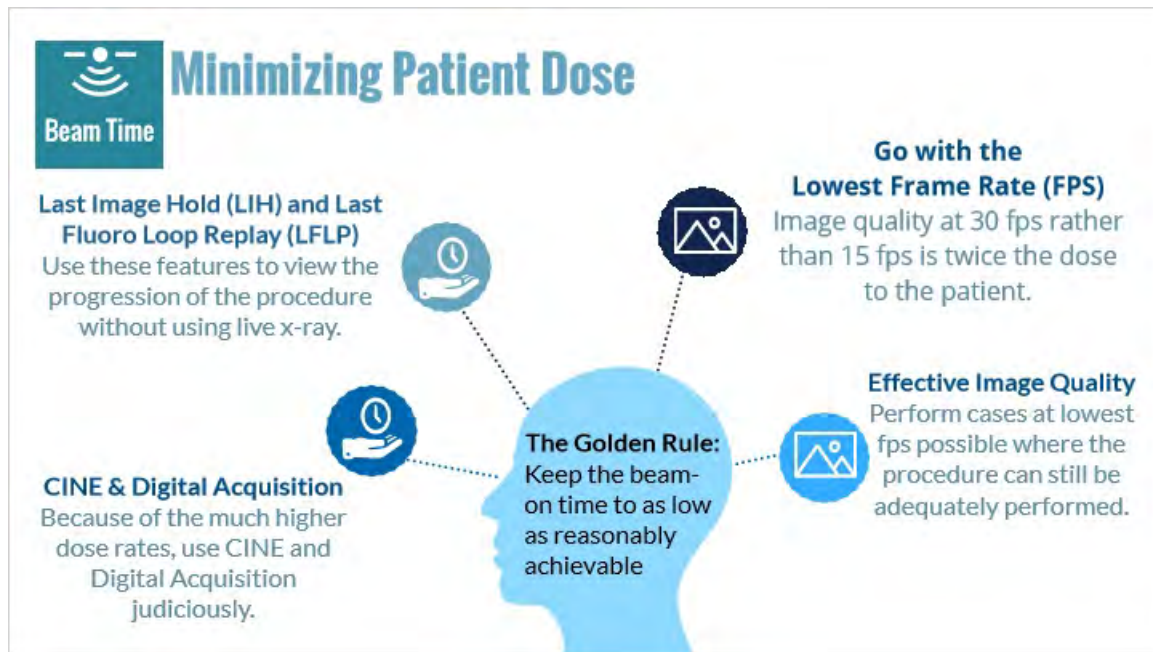
Temporary W/Lensaid Min 2/1/20mm 4200mm Density Time/Distance

See it in Action!



Notes:

1.57 Minimizing Patient Dose:Beam Time



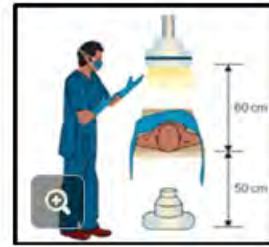
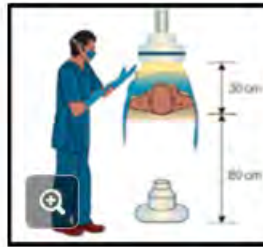
1.58 Which diagram depicts the optimal distance the patient should be from the x-ray tube and image receptor in order to give a lower dose rate to the patient, but still acquire adequate images:

(Drag and Drop, 10 points, 4 attempts permitted)

Let's Review!

Which diagram depicts the optimal distance the patient should be from the x-ray tube and image receptor in order to give a lower dose rate to the patient, but still acquire adequate images:

Drag and Drop
the Optimal
image
here then click
"Submit" for
feedback



Drag Item	Drop Target
Picture 2	Label 01
Picture 3	
Picture 1	

Drag and drop properties
Return item to start point if dropped outside the correct drop target
Snap dropped items to drop target (Stack random)
Delay item drop states until interaction is submitted

Feedback when correct:

The optimal distance the patient should be from the x-ray tube is 30 cm, and 80 cm from the image receptor.

Feedback when incorrect:

You did not select the correct response.

Notes:

Correct (Slide Layer)

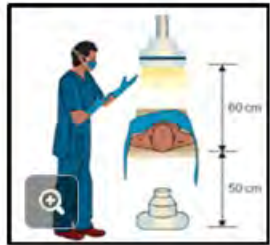
Let's Review!

Which diagram depicts the optimal distance the patient should be from the x-ray tube and image receptor in order to give a lower dose rate to the patient, but still acquire adequate images:

Drag and Drop the Optimal image here then click "Submit" for feedback

The optimal distance the patient should be from the x-ray tube is 30 cm, and 80 cm from the image receptor.

Continue



Incorrect (Slide Layer)

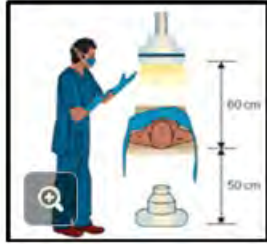
Let's Review!

Which diagram depicts the optimal distance the patient should be from the x-ray tube and image receptor in order to give a lower dose rate to the patient, but still acquire adequate images:

Drag and Drop the Optimal image here then click "Submit" for feedback

Incorrect
You did not select the correct response.

Continue



Try Again (Slide Layer)

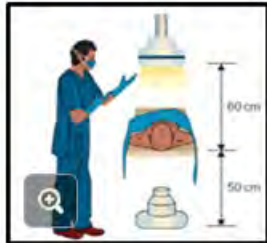
Let's Review!

Which diagram depicts the optimal distance the patient should be from the x-ray tube and image receptor in order to give a lower dose rate to the patient, but still acquire adequate images:

Drag and Drop the Optimal image here then click "Submit" for feedback

Incorrect
That is incorrect. Please try again.

Try Again



1.59 Minimizing Patient Dose: Pregnant Patients



Special Populations

Pregnant Patient Considerations

The possibility of pregnancy in any woman of childbearing age should be considered a potential contraindication to fluoroscopic study of the abdomen or pelvis unless the situation is a life-threatening emergency.



Irradiation of the abdomen or pelvis of a potentially pregnant woman should be performed only after careful examination of the benefits and risks.



For all procedures involving extensive fluoroscopy of the pelvis, a pregnancy test is advisable unless there is no reproductive potential.



The use of a lead apron on a pregnant patient is contraindicated.

Notes:

1.60 Special Populations: Pediatrics



Special Populations

Pediatric Considerations

NOTE: Radiation safety in fluoroscopic imaging is of special concern for pediatric patients

- Children are more radiosensitive than adults for about 30% of cancers. The younger the child the more sensitive his or her body is.
- Children have a longer expected lifetime for the effects from radiation exposure to potentially develop into cancer.
- Children receive a larger radiation dose than is necessary when the fluoroscope uses x-ray equipment settings designed exclusively for adults.



Notes:

1.61 Special Populations: Pediatrics



Special Populations: Pediatrics


Potential Harm



The number of x-rays used to image a large adult may be **1000 times** the number of x-rays needed for a small child.


Notes:

1.62 Special Populations: Pediatrics



Special Populations: Pediatrics

Anatomical Programming



- Select choice for **ANATOMICAL PROGRAMMING** for task and patient type (child vs. adult).
- Consult the Medical Physicist to determine what this actually means.
- **Note:** Do **NOT** base size of a child's age...the width of a large 3 year old's abdomen can be the same as that of a small teenager's.

Notes:

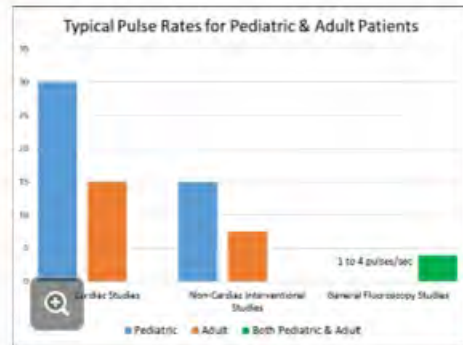
1.63 Special Populations: Pediatrics



Special Populations: Pediatrics

Anatomical Programming and Pulse Rate

Selecting the correct anatomical programming (child versus adult) also selects the correct **PULSE RATE**.



EXAMPLE: Pediatric cardiac studies require frame rates of 30 pulses/second versus 15 pulses/second that is typically used for adult cardiac cases.

Notes:

1.64 Special Populations: Pediatrics

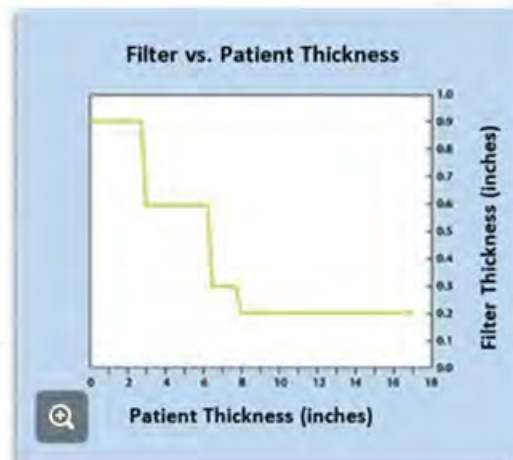
Importance of Filters



Special Populations: Pediatrics


Importance of Filters

- For pediatrics and very small adult patients, a low energy x-ray copper filter is needed to ensure safety.
- Low energy x-ray copper filter results in equal or slightly better image quality at a reduced patient dose.
- As patient size increases a thinner filter, which attenuates fewer x-rays, must be used to ensure that adequate number of x-rays reach the image receptor.



Notes:

1.65 Special Populations: Pediatrics



Special Populations: Pediatrics

Use of Grid Technique

While appropriate for adult patients, **the grid is NOT APPROPRIATE FOR PEDIATRICS.**

The radiation dose rate without a grid is approximately 60% of the radiation dose rate with a grid for thicknesses less than 10 cm.

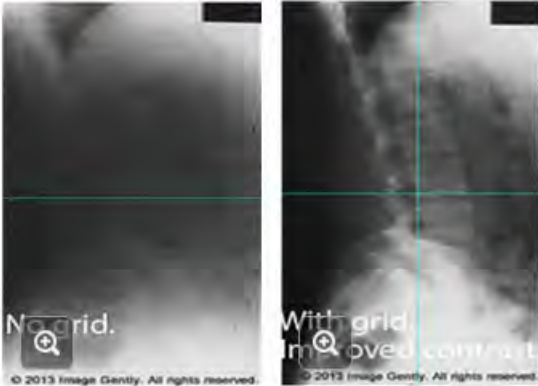


Image of the lateral lumbar spine of an adult with and without a grid. For adults, the grid is necessary to obtain an acceptable image quality.

Notes:

1.66 For the pediatric patient, is the grid needed?

(Multiple Choice, 10 points, 3 attempts permitted)

Let's Review!

For the pediatric patient, is the grid needed?

☐ Yes

☒ No




Correct	Choice	Feedback
	Yes	The radiation dose rate without a grid is approximately 60% of the radiation dose rate with a grid for thicknesses less than 10 cm.
X	No	The radiation dose rate without a grid is approximately 60% of the radiation dose rate with a grid for thicknesses less than 10 cm.

Notes:

Correct (Slide Layer)

Let's Review!


For the medium patient, is the grid used?



Feedback Title

The radiation dose rate without a grid is approximately 60% of the radiation dose rate with a grid for thicknesses less than 10 cm.


Continue



Incorrect (Slide Layer)

Let's Review!

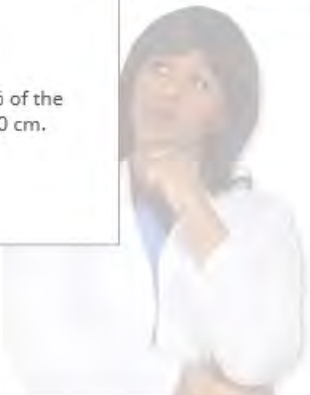
For the medium patient, is the grid used?



Feedback Title

The radiation dose rate without a grid is approximately 60% of the radiation dose rate with a grid for thicknesses less than 10 cm.

Continue



1.67 As a Radiation Worker, Pledge your Responsibility...

(Multiple Response, 10 points, unlimited attempts permitted)

As a Radiation Worker, Pledge your Responsibility...

Read and click each item below to continue.

- ☒ I will be responsible for correctly wearing a radiation badge at all times when working with or near a source of occupational radiation exposure.
- ☒ I understand supervisors and managers have been instructed to enforce rules and consequences for noncompliance
- ☒ I will follow any applicable rules and procedures for protection and safety specified by the hospital
- ☒ I will cooperate with the radiation safety officer with respect to wearing dosimeter badges and notify them if my badge is lost/damaged in any way
- ☒ I will abstain from any willful action that could put myself or others in situations that contravene the requirements of the standard
- ☒ I will accept information, instruction, and training concerning radiation protection and safety

Correct	Choice
X	I will be responsible for correctly wearing a radiation badge at all times when working with or near a source of occupational radiation exposure.
X	I understand supervisors and managers have been instructed to enforce rules and consequences for noncompliance
X	I will follow any applicable rules and procedures for protection and safety specified by the hospital
X	I will cooperate with the radiation safety officer with respect to wearing dosimeter badges and notify them if my badge is lost/damaged in any way
X	I will abstain from any willful action that could put myself or others in situations that contravene the requirements of the standard
X	I will accept information, instruction, and training concerning radiation protection

and safety

Feedback when correct:

Thank You for taking the pledge!

Feedback when incorrect:

You must select all responsibilities in the pledge.

Notes:

Correct (Slide Layer)

As a Radiation Worker, Pledge your Responsibility...
Read and click each item below to continue.


☒ I will be responsible for my actions when working with or near a source of radiation.

☒ I understand the consequences for noncompliance with the hospital's policies.

☒ I will follow the hospital's policies and procedures.

☒ I will cooperate with my supervisor and notify them if my actions may contravene the requirements of the standard.

☒ I will accept information, instruction, and training concerning radiation protection and safety.


Correct

Thank You for taking the pledge!

Continue

Incorrect (Slide Layer)

As a Radiation Worker, Pledge your Responsibility...
Read and click each item below to continue.

☒ I will be responsible for my actions when working with or near a source of ionizing radiation.


☒ I understand the consequences for noncompliance by the hospital.

☒ I will follow the hospital's policies, procedures, and notify the appropriate personnel if I observe a violation.

☒ I will cooperate with the hospital's radiation safety program and notify the appropriate personnel if I observe a violation.

☒ I will abstain from using alcohol or drugs that could contravene the requirements of the standard.

☒ I will accept information, instruction, and training concerning radiation protection and safety.


Incorrect
You must select all responsibilities in the pledge.
Continue

Try Again (Slide Layer)

As a Radiation Worker, Pledge your Responsibility...
Read and click each item below to continue.

☒ I will be responsible for my actions when working with or near a source of ionizing radiation.

☒ I understand the consequences for noncompliance by the hospital.

☒ I will follow the hospital's policies, procedures, and notify the appropriate personnel if I observe a violation.

☒ I will cooperate with the hospital's radiation safety program and notify the appropriate personnel if I observe a violation.

☒ I will abstain from using alcohol or drugs that could contravene the requirements of the standard.

☒ I will accept information, instruction, and training concerning radiation protection and safety.


Incorrect
You must select all responsibilities in the pledge.
Try Again

1.68 Resource: ACR Image Gently Pause and Pulse Checklist

Resources

ACR Image Gently Pause and Pulse Checklist

Below are a few highlights from the ACR Image Gently Alliance [Pause and Pulse Checklist](#) for physicians to enhance radiation protection in **PEDIATRIC** fluoroscopy.

- Ask patient or family about previous radiation. Answer questions about radiation safety ([brochure available on Image Gently website](#)).
- Use non-radiation modality, such as ultrasound, when possible.
- Consider position and aperture of the collimators before and during the procedure, as conditions and fields of view change.
- Enlist help of Child Life Specialist, Patient Education Specialist, parent/guardian, or appropriate music to minimize patient motion. A DVD could be viewed in procedures involving wait time (e.g., waiting for bladder to fill during VCUG).
- When patient position needs to be changed, plan ahead and communicate with personnel to minimize need for additional fluoroscopy or repeat exposure.
- After procedure: record and review fluoroscopic procedures used and fluoroscopy time.
- Only perform fluoroscopy in compliance with hospital policy.

1.69 Resource: Radiation Safety Office

Radiation Safety Contacts

Mark Theis
Radiation Safety Officer

 402-559-3013 (office)
402-250-6402 (cell)

 mtheis@unmc.edu

Prestan Kiichler, BS, CNMT, NMTCB(RS), R.T., (R) (N) (CT)
Children's Hospital & Medical Center
Radiation Safety Liaison

 402-955-5617

 pkiihler@childrensomaha.org

Notes:

1.70 Exit



Notes:

2. Lightboxes

2.1 Angioplasty

Case 1: Angioplasty

Radiation induced injury in a patient who had three angioplasty procedures. Erythema appeared promptly after the third angioplasty and was evident after several months. The area appears to be healing but there is notable lack of skin tone due to the destruction of melanocytes. Deep necrosis later developed as a result of radiation damage to the vascular system of the dermis.

Several months after exposure



Healing 5 months post exposure



Wound 22 months after exposure



Notes:

2.2 Ablation

Case 2: Ablation

Radiation injury to the (R) arm just above elbow of a patient who underwent radiofrequency cardiac catheter ablation for arrhythmia. The right humerus of the patient is visible in the cine image in Figure 1. The arm was in the direct beam very near port of the x-ray tube. The dose rates exceeded 500 mGy/minute. The total fluoroscopy time was about 20 minutes with the dose to the arm probably exceeding 25,000 mGy.

EP catheter ablation,
CINE with humerus
in FOV



Ulcer, 5 months after
procedure



Humerus visible 6/5
months after
procedure



Surgical flap 10
months after
procedure



Notes:

Date 01 (Slide Layer)

Case 2: Ablation

Radiation injury to the (R) arm just above elbow of a patient who underwent radiofrequency cardiac catheter ablation for arrhythmia. The right humerus of the patient is visible in the cine image in Figure 1. The arm was in the direct beam very near port of the x-ray tube. The dose rates exceeded 500 mGy/minute. The total fluoroscopy time was about 20 minutes with the dose to the arm probably exceeding 25,000 mGy.

EP catheter ablation,
CINE with humerus



Title 01

Display your
text for the first
time period
here.

Ulcer, 5 months after
procedure



Humerus visible 6/5
months after
procedure



Surgical flap 10
months after
procedure



Date 02 (Slide Layer)

Case 2: Ablation

Radiation injury to the (R) arm just above elbow of a patient who underwent radiofrequency cardiac catheter ablation for arrhythmia. The right humerus of the patient is visible in the cine image in Figure 1. The arm was in the direct beam very near port of the x-ray tube. The dose rates exceeded 500 mGy/minute. The total fluoroscopy time was about 20 minutes with the dose to the arm probably exceeding 25,000 mGy.

EP catheter ablation,
CINE with humerus
in FOV



Ulcer, 5 months after



Title 02

Display your
text for the
second time
period here.

Humerus visible 6/5
months after
procedure



Surgical flap 10
months after
procedure



Date 03 (Slide Layer)

Case 2: Ablation

Radiation injury to the (R) arm just above elbow of a patient who underwent radiofrequency cardiac catheter ablation for arrhythmia. The right humerus of the patient is visible in the cine image in Figure 1. The arm was in the direct beam very near port of the x-ray tube. The dose rates exceeded 500 mGy/minute. The total fluoroscopy time was about 20 minutes with the dose to the arm probably exceeding 25,000 mGy.

EP catheter ablation, CINE with humerus in FOV



Ulcer, 5 months after procedure



Humerus visible 6/5 months after



Title 03

Display your text for the third time period here.

Surgical flap 10 months after procedure



Date 04 (Slide Layer)

Case 2: Ablation

Radiation injury to the (R) arm just above elbow of a patient who underwent radiofrequency cardiac catheter ablation for arrhythmia. The right humerus of the patient is visible in the cine image in Figure 1. The arm was in the direct beam very near port of the x-ray tube. The dose rates exceeded 500 mGy/minute. The total fluoroscopy time was about 20 minutes with the dose to the arm probably exceeding 25,000 mGy.

EP catheter ablation, CINE with humerus in FOV



Ulcer, 5 months after procedure



Humerus visible 6/5 months after procedure



Surgical flap 10 months after



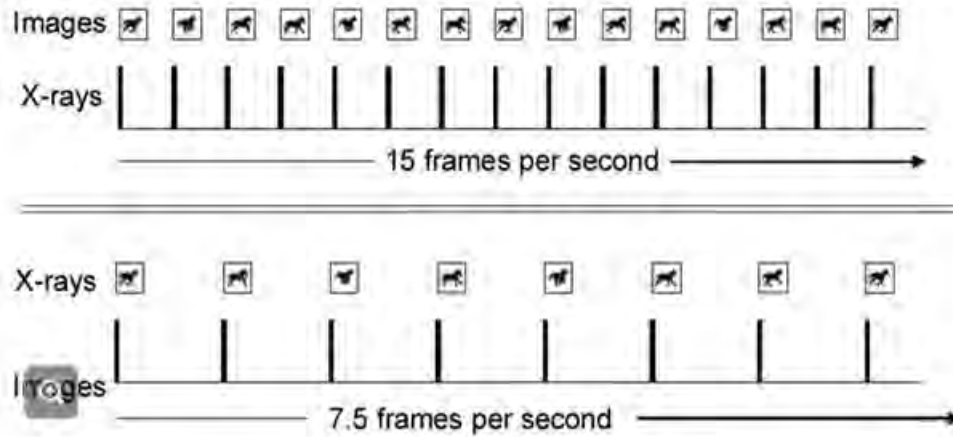
Title 04

Display your text for the fourth time period here.

2.3 Pulse Rate

Pulse Rate

The downside of decreasing pulse rate is that motion becomes more "choppy". Below is the effect of reducing the pulse rate from 15 to 7.5 frames per second. Patient dose is reduced by around a half. Tradeoff is a more choppy motion.

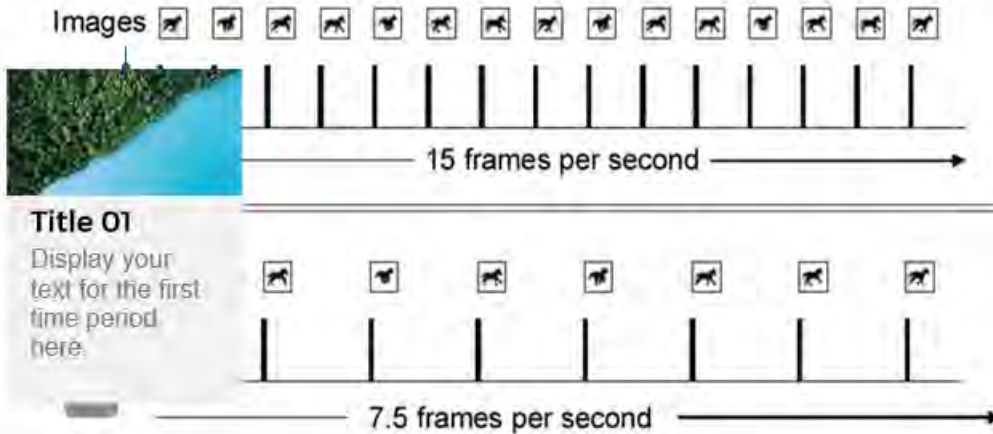


Notes:

Date 01 (Slide Layer)

Pulse Rate

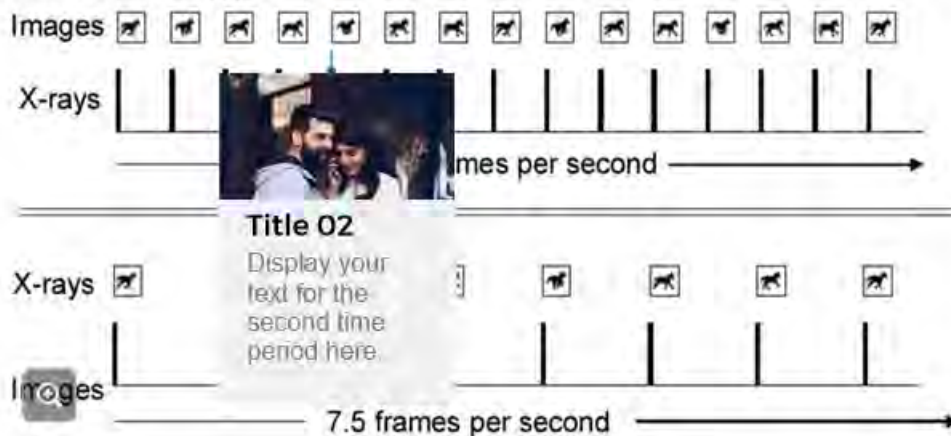
The downside of decreasing pulse rate is that motion becomes more "choppy". Below is the effect of reducing the pulse rate from 15 to 7.5 frames per second. Patient dose is reduced by around a half. Tradeoff is a more choppy motion.



Date 02 (Slide Layer)

Pulse Rate

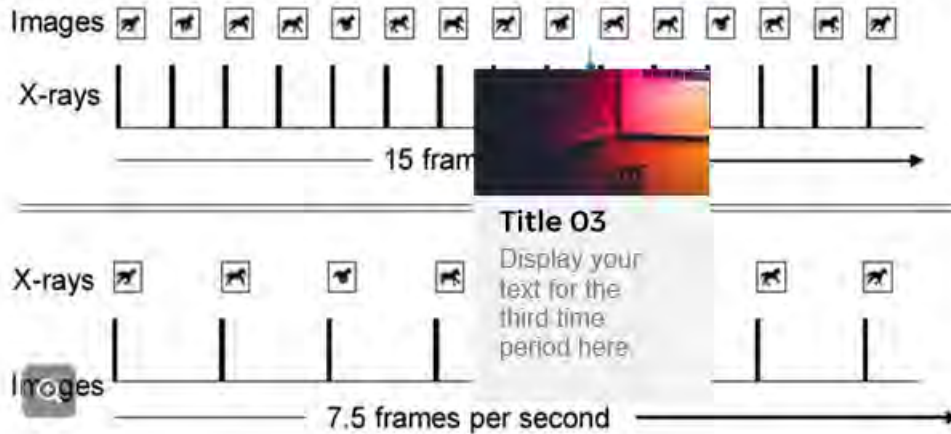
The downside of decreasing pulse rate is that motion becomes more "choppy". Below is the effect of reducing the pulse rate from 15 to 7.5 frames per second. Patient dose is reduced by around a half. Tradeoff is a more choppy motion.



Date 03 (Slide Layer)

Pulse Rate

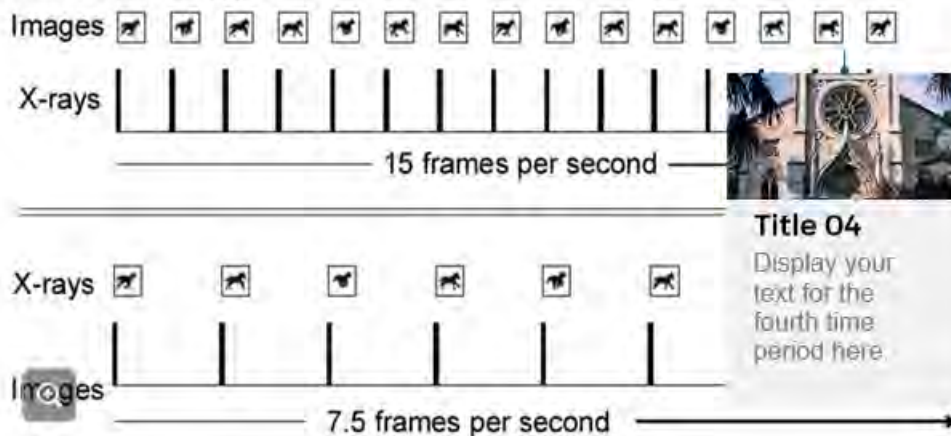
The downside of decreasing pulse rate is that motion becomes more "choppy". Below is the effect of reducing the pulse rate from 15 to 7.5 frames per second. Patient dose is reduced by around a half. Tradeoff is a more choppy motion.



Date 04 (Slide Layer)

Pulse Rate

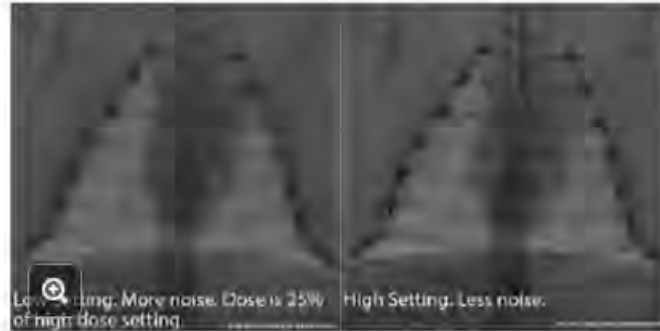
The downside of decreasing pulse rate is that motion becomes more "choppy". Below is the effect of reducing the pulse rate from 15 to 7.5 frames per second. Patient dose is reduced by around a half. Tradeoff is a more choppy motion.



2.4 Dose Rate

Dose Rate

For the a high level option (or high-dose rate) which allow dose rates well beyond the standard regulatory levels, a special means of activation is required and a special audible signal is used to indicate its engagement. Because of the high dose rates to the patient, the high dose rate setting **should only be used briefly to perceive detail that cannot be otherwise discern.**



Notes:

Date 01 (Slide Layer)

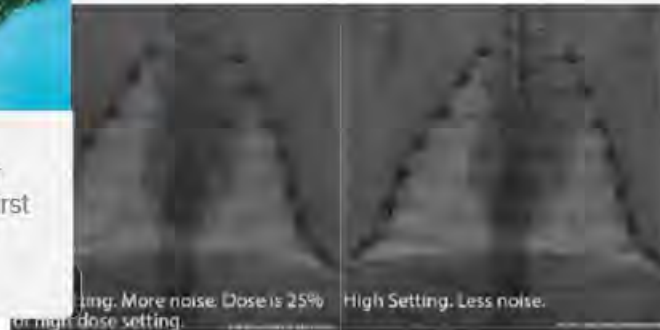
Dose Rate

For the a high level option (or high-dose rate) which allow dose rates well beyond the standard regulatory levels, a special means of activation is required and a special audible signal is used to indicate its engagement. Because of the high dose rates to the patient, the high dose rate setting **should only be used briefly to perceive detail that cannot be otherwise discern.**



Title 01

Display your text for the first time period here.



Date 02 (Slide Layer)

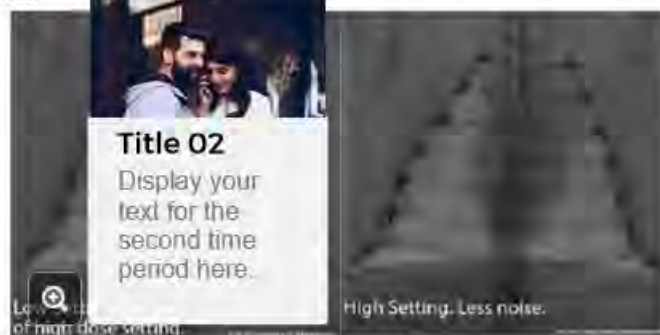
Dose Rate

For the a high level option (or high-dose rate) which allow dose rates well beyond the standard regulatory levels, a special means of activation is required and a special audible signal is used to indicate its engagement. Because of the high dose rates to the patient, the high dose rate setting **should only be used briefly to perceive detail that cannot be otherwise discern.**



Title 02

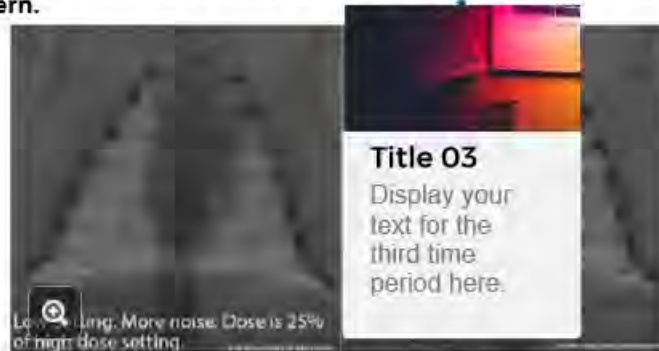
Display your text for the second time period here.



Date 03 (Slide Layer)

Dose Rate

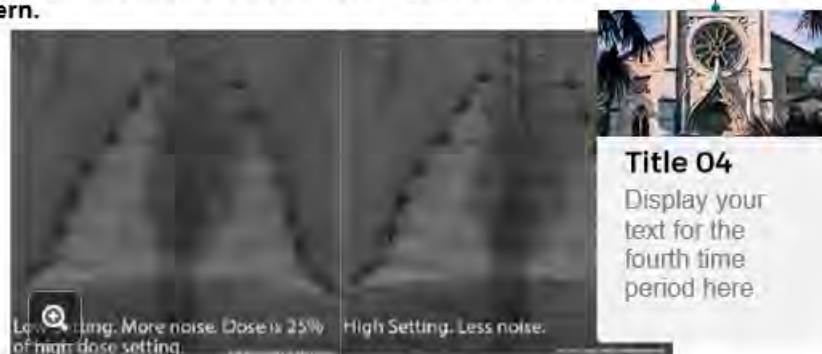
For the a high level option (or high-dose rate) which allow dose rates well beyond the standard regulatory levels, a special means of activation is required and a special audible signal is used to indicate its engagement. Because of the high dose rates to the patient, the high dose rate setting **should only be used briefly to perceive detail that cannot be otherwise discern.**



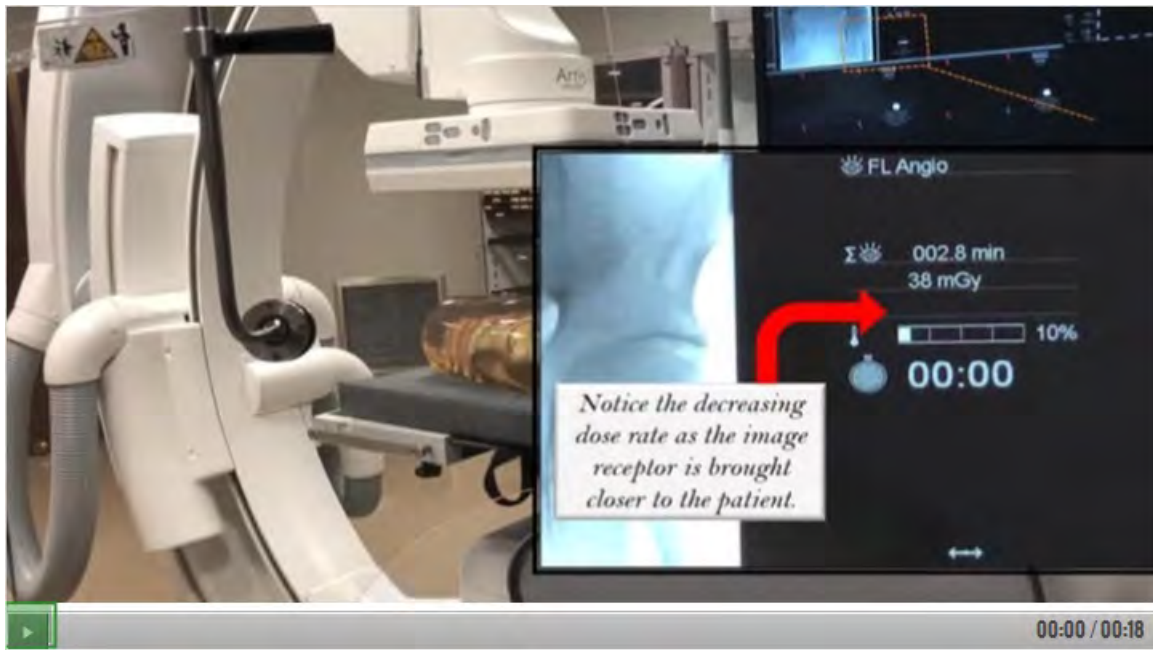
Date 04 (Slide Layer)

Dose Rate

For the a high level option (or high-dose rate) which allow dose rates well beyond the standard regulatory levels, a special means of activation is required and a special audible signal is used to indicate its engagement. Because of the high dose rates to the patient, the high dose rate setting **should only be used briefly to perceive detail that cannot be otherwise discern.**



2.5 Monitoring Staff Radiation Dose: Minimize Risk



Notes:

Time (Slide Layer)

The video frame shows a medical simulation environment. A slide layer is overlaid on the screen, featuring a cartoon character in a blue uniform and cap, holding a device. The slide contains the following text and graphics:

- Two analog clocks. The left clock is labeled "5 min = 15 mrem". The right clock is labeled "10 min = 30 mrem".
- A central graphic showing a patient lying on a table, with a dose rate of "3 mrem/min" indicated.
- Text below the graphic: "closer to the patient."
- Text at the bottom of the slide: "Minimize your time being close to the patient"

The video player interface at the bottom shows a progress bar and a timestamp of "00:00 / 00:18".

Distance (Slide Layer)

The video frame shows a medical simulation environment. A slide layer is overlaid on the screen, featuring a cartoon character in a blue uniform and cap, holding a device. The slide contains the following text and graphics:

- A graphic showing a patient lying on a table, with a dose rate of "3 mrem/min" indicated.
- Text below the graphic: "closer to the patient."
- Text at the bottom of the slide: "Minimize your time being close to the patient"

The video player interface at the bottom shows a progress bar and a timestamp of "00:00 / 00:18".

Shielding (Slide Layer)



Examples of X-Ray shield apparel and shields.
All the shields will reduce patient scatter by more than 90%. You are
REQUIRED by regulation to wear an apron when administering fluoroscopy.