Introduction

The goals of this training are to develop a better appreciation of equipment controls, scatter radiation in the interventional suite, the radiation output capabilities of the angiography unit, and the effect of various parameters on patient and staff dose.

Section 1 – Principles of fluoroscopic systems

Identify the following:

		Function of this control
Spacer device		
Image receptor		
X-ray tube and housing		
Integrated dose display		
Power on		
Emergency stop		
Integrated radiation shielding		
Collision sensors		

Section 2 – Operation of fluoroscopic systems for interventional purposes

Perform each of the following actions:

- Raise the patient table ☐
- Lower the image receptor ☐
- Collimate the X-ray field ☐
- Change the fluoroscopic pulse rate ☐
- Change the acquisition frame rate ☐
- Store a fluoroscopy loop ☐
- Store a LIH image ☐
- Change the magnification mode ☐

Section 3 – Fluoroscopic exposure outputs and high level control options

Rank the following modes of operation in order of lowest (1) to highest (3) potential radiation output.

High level fluoroscopy (boost mode) _____
Acquisition/digital subtraction angiography (DSA) _____
Normal fluoroscopy _____

Perform each of the following actions:

Activate normal fluoroscopy ☐
Activate high level fluoroscopy (boost mode) ☐
Activate acquisition/DSA ☐

Section 4 – Dose management techniques

Considering the setup after patient transfer, what are some basic actions that should be taken before staring the fluoroscopic procedure? Record the reference air kerma rate ($K_{a,r}$) and the patient entrance air kerma rate (EAKR) in the spaces provided.

	$K_{a,r}$	EAKR
Baseline:		
Order	$K_{a,r}$	EAKR
Raise patient table to a comfortable working height		
Lower image receptor as much as practical		
Take one small step down the table or back from the table		
Collimate to the area of interest		

What impact will the following actions have on the patient EAKR? Will the patient EAKR decrease, increase, or remain the same? Record the $K_{a,r}$ and the EAKR in the spaces provided.

	$K_{a,r}$	EAKR
Baseline:	_____	_____
Action	$K_{a,r}$	EAKR
Increase magnification		
Reduce the fluoroscopic pulse rate		
Increase in patient thickness		

Collimate to the area of interest			
Use acquisition/DSA instead of fluoroscopy			
Rotate the C-arm to a 30° oblique projection			

What are some other techniques that can be used to reduce the patient dose rate?

_____

Section 5 – Basics of radiation protection

Perform each of the following actions:

Activate Radiation Release Inhibit ☐

Activate Positioning without Radiation ☐

What impact will the following actions have on your (the operator's) dose rate? Will your dose rate decrease, increase, or remain the same? Record the operator dose rate in the spaces provided.

	Operator dose rate (mSv/hr)
Baseline:	
Action	Impact / Operator dose rate (mSv/hr)
Collimate to the area of interest	
Reduce the fluoroscopic pulse rate	
Raise the patient table	
Lower the image receptor	
Take one small step down or away from the table	

Where should your personal dosimeter be worn?

_____

Section 6 – Ambient radiation levels and auxiliary shielding

On what side of the patient is the operator dose rate lowest when using lateral (cross-table) fluoroscopy? Test your prediction by making measurements.

_____

How does the ambient radiation level compare at different positions around the fluoroscopy lab?

Position	Relative ambient radiation level	Measured dose rate (mSv/hr)
Operator		
First assistant		
Nurse		
Anesthesiologist		
Outside room door (open)		
Outside room door (closed)		
Control console		

How is the ambient radiation level affected by the use of table drapes?

Position	Predicted % of initial intensity	Measured dose rate (mSv/hr)
Operator		
First assistant		
Nurse		
Anesthesiologist		

How is the ambient radiation level affected by the use of a suspended shield?

Position	Predicted % of initial intensity	Measured dose rate (mSv/hr)
Operator		
First assistant		
Nurse		
Anesthesiologist		

How is the ambient radiation level affected by the use of a sterile protective drape?

Position	Predicted % of initial intensity	Measured dose rate (mSv/hr)
Operator		
First assistant		
Nurse		
Anesthesiologist		

Considering the operator, measure the occupational dose rate with no auxiliary protection and the impact of adding each of the following auxiliary protective devices in sequence.

Protective device(s)	Measured dose rate (mSv/hr)
None	
Table drapes	
Table drapes + suspended shield	
Table drapes + suspended shield + sterile protective drape	

Section 7 – Personal protective equipment

What types of personal protective equipment are available?

_____

What is the impact of a protective garment on occupational dose rate?

_____

What are some considerations for the selection of personal protective equipment?

_____

What characteristics of a protective garment influence its protective value?

_____

What characteristics of protective eyewear influence its protective value?

_____

What is the approximate reduction in occupational dose rate offered by a 0.50 mm protective garment? A 0.35 mm protective garment?

		mSv/hr
	Baseline:	
Garment		
	Predicted % reduction	mSv/hr
Single 0.35 mm garment		
Single 0.50 mm garment		
Double 0.50 mm garment		

Section 8 – Procedures for recording patient dose data

Where is the air kerma reference point located on your fluoroscope?

_____

Where can you find the following information?

Information	Location
Patient ID	
Type and date of examination	
System ID	
Reference air kerma ($K_{a,r}$)	
Dose or kerma area product (DAP or KAP)	
Fluoroscopy time	
Peak skin dose (PSD)	

Match the dose metric with its description.

Dose metric		Use
$K_{a,r}$	_____	A. Most closely correlated with risk of skin injury.
KAP	_____	B. Preferred for notification levels as it is widely available and correlated with skin dose.
Fluoroscopy time	_____	C. Best describes total energy imparted to patient, most closely correlated with occupational dose.
PSD	_____	D. Useful for quality improvement but poorly correlated with skin dose and occupational dose.

What is a typical value for fluoroscopy time and $K_{a,r}$ for the procedures performed using your fluoroscope? What would be considered exceptional values?

Metric	Typical value	Exceptional value
Reference air kerma ($K_{a,r}$)		
Fluoroscopy time		

At what $K_{a,r}$ should you be concerned regarding the possibility for a skin reaction? Would you expect this value to be reached in your practice?

	Value of concern	Reached in your practice?
Reference air kerma ($K_{a,r}$)		

end