



Fluoroscopy Credentialing Training Program for Non-Radiologist Physicians

Department of Radiology





Why Physician Credentialing?

FDA....

- *“That all facilities assure appropriate credentials and training for physicians performing fluoroscopy”*

NCRP (National Council on Radiation Protection).....

- *“credentialing and privileging physicians to use fluoroscopic equipment”*
- *“Every person who operates fluoroscopically guided equipment or supervises the use of fluoroscopically guided equipment shall have current training in the safe use of that specific equipment”.*

ACR (American College of Radiology).....

- *“Each facility should have a policy for credentialing all physicians who perform fluoroscopy”*

Radiation Right....

- *“Each facility should have a policy for credentialing all physicians and Licensed Independent practitioners who perform fluoroscopy.”*





Why Physician Credentialing?



Continued.....

- **The Joint Commission.....Sentinel Event Alert Issue 47, August 24, 2011, page 3:**



“Ensure all physicians and technologists who prescribe diagnostic radiation or use diagnostic radiation equipment receive dosing education and are trained on the specific model of equipment being used. Institute a process for annual education, review and competency testing.”





Exposure

(The intensity of the radiation emitting from the fluoroscopy machine)

- ***The Roentgen (R) – (mR) milli-roentgen is the classical unit for quantifying any exposure from radiation. Some C-arms are capable of producing up to **20R/min** when in use.***
 - ***The Roentgen is the unit of measure when using a Geiger Counter to measure radiation: (mR/hour)***
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Absorbed dose

(The energy deposited in tissue)





- The rad (radiation absorbed dose) was the classical unit used to measure dose and 1 rad is 100ergs of energy deposited per gram of tissue. The rad has now been replaced with International Unit called the gray (Gy).***
- The gray (Gy) is the international unit for absorbed dose. (1Gy = 1000 mGy = 100 rads)***





Effective dose

(Rem/Sievert)

- *Makes judgments about what effect radiation will have on a human.*
 - *Several considerations are taken into account, including which organs were exposed, how sensitive each organ is to radiation, and the overall effect to the whole human body.*
 - *The classical unit of measurement was the rem (radiation equivalent in man) and has now been replaced with the international unit: the Sievert (1Sv = 100 rem).*
 - *The rad/rem/sievert are equivalent units of measure for calculating damage produced in body tissue.*
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Natural Background Radiation



We are all exposed to ionizing radiation from natural sources at all times. This radiation is called natural background radiation, and its main sources are the following:

- *Radioactive substances in the earth's crust;*
- *Emanation of radioactive gas from the earth;*
- *Cosmic rays from outer space which bombard the earth;*
- *Trace amounts of radioactivity in the body*





Radiation Doses to the U.S. Population



Sources

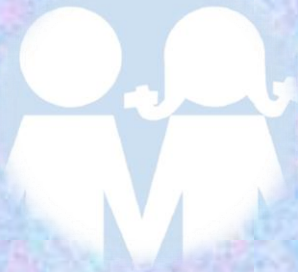
Average annual whole body dose (mrem/year)

- *All natural sources except Radon gas* • **150**
- *Radon Gas* • **200**
- These exposures are generally greater than the exposure you should get from fluoroscopy during any 90 day period as recorded on your radiation badge.



Permissible Dose Limits and Occupational Doses:

Radiation Worker	mrem/year
Whole body	5,000
Lens of eye	1,500
Skin	5,000
Hands, wrist, feet and ankles	5,000
Thyroid	5,000
Minor (under 18 years old)	500
Fetus of radiation worker	500
Member of public	500



What is ALARA?



ALARA is an acronym for

As **L**ow **A**s **R**easonably **A**chievable.





What is ALARA?



This is a radiation safety principle for minimizing radiation doses to:

- ***Patients***
- ***Radiation workers, and***
- ***Members of the public***





How to Achieve ALARA?



- **Time:** Try to work as fast as possible while x-rays are on. In the case of physicians using fluoroscopy, short, quick exposures will result in drastic reductions in exposures to everyone in the room including the patient. Some fluoroscopic units (**Ziehm**) have pulsed x-ray (low dose mode) that reduces exposure to both patient and staff. Last image hold should be used whenever possible instead of continuous fluoroscopic exposure to the patient.
- **Distance:** Distance offers great protection for any kind of radiation. All radiation falls off generally as the inverse square of the distance. This means that if you move twice as far away, the radiation exposure will drop by a factor of 4. In general, one should maximize their proximity to the source of radiation (patient).
- **Shielding:** Always stand behind a protective barrier (control booth) or wear lead protective devices when performing fluoroscopic procedures. These include aprons, thyroid shields and eyewear.







Biological Effects



The occurrence of particular health effects from exposure to ionizing radiation is a complicated function of numerous factors including:

- **Type of radiation involved.** All kinds of radiation can produce health effects. The main difference in the ability of alpha and beta particles and Gamma and X-rays to cause health effects is the amount of energy they have . Their energy determines how far they can penetrate into tissue and how much energy they are able to transmit directly or indirectly to tissues.
 - **Size of dose received.** The higher the dose of radiation received, the higher the likelihood of health effects.
 - **Rate the dose is received.** Tissue can receive larger dosages over a period of time. If the dosage occurs over a number of days or weeks, the results are often not as serious if a similar dose was received in a matter of minutes.
 - **Part of the body exposed.** Extremities such as the hands or feet are able to receive a greater amount of radiation with less resulting damage than blood forming organs housed in the torso, the eyes, the thyroid and the reproductive organs.
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Biological Effects..... continued

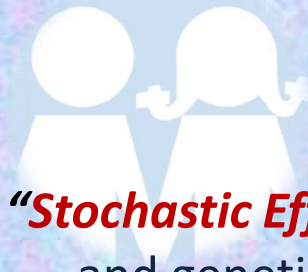


- **The age of the individual.** As a person ages, cell division slows and the body is less sensitive to the effects of ionizing radiation. Once cell division has slowed, the effects of radiation are somewhat less damaging than when cells were rapidly dividing. (Children vs. Adults)
- **Biological differences.** Some individuals are more sensitive to the effects of radiation than others. Studies have not been able to conclusively determine the differences.

Fluoroscopic guided procedures are an effective tool for live saving. However , the radiation dose may cause **Stochastic Effect and Non-Stochastic Effect** injuries.



Biological Effects.....continued



“Stochastic Effects are those that occur by chance and consist primarily of cancer and genetic effects.” As the dose to an individual increases, the probability that cancer or a genetic effect will occur also increases. However, at no time, even for high doses, is it certain that cancer or genetic damage will result. It should also be noted that the effects caused by radiation exposures are cumulative over a lifetime.

“Nonstochastic Effects also called **Deterministic Effects** typically result when very large dosages of radiation are received in a short amount of time.” In addition, the magnitude of the effect is directly proportional to the size of the dose. Examples of nonstochastic effects include erythema, skin and tissue burns, cataract formation, sterility, radiation sickness and death.

Each of these effects differs from the other in that both its threshold dose and the time over which the dose was received cause the effect (i.e. acute vs. chronic exposure).





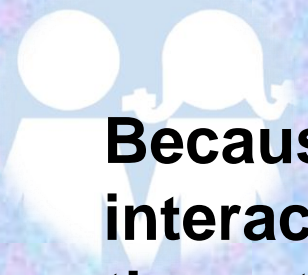
Deterministic Effects

(Non-Stochastic)

Possible Effects

Effect	Threshold (rad/Sv)	Hours of Fluoro On-Time, 5 R/min	Time to onset of effect
Transient Erythema	200/2	0.7	2-24 hr
Epilation	300/3	1	~3 wk
Erythema	500/5	2	~10 day
Pericarditis	800/8	2.7	>10 wk
Dermal Necrosis	1800/>12	6	>10 wk
Skin Cancer	None Known	N/A	>5 yr
Eye Lens Opacity	100-200/1-2	0.5-0.7	>5yr
Eye Lens/Cataract	600/6	2.5	>5yr



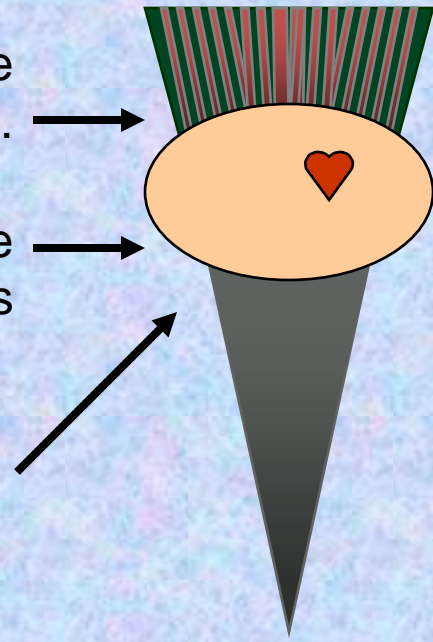


Because image production requires the beam to interact differentially in tissues, the beam entering the patient must be of much greater intensity than that exiting the patient.

Only a small percentage (typically ~1%) penetrate through to create the image.

As beam penetrates patient, X-rays interact in tissue causing biological changes

Beam entering patient typically **~100x** more intense than exit beam



Reproduced with permission from Wagner LK and Archer BR. Minimizing Risks from Fluoroscopic Radiation, R. M. Partnership, Houston, TX 2004.

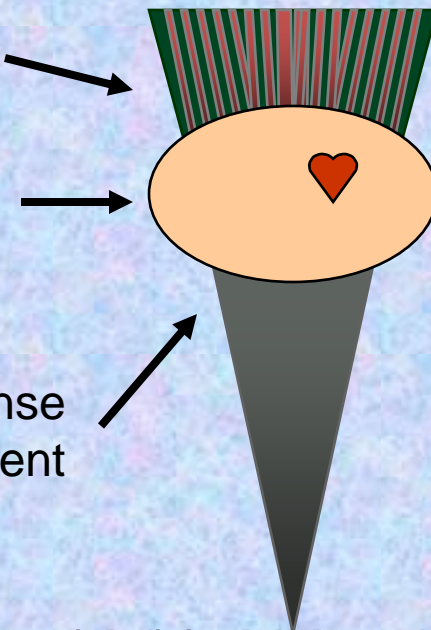


Lesson:
Entrance skin tissue receives highest dose of x-rays and is at greatest risk for injury.

Only a small percentage (typically ~1%) penetrates through to create the image.

As beam penetrates patient X-rays interact in tissue causing biological changes

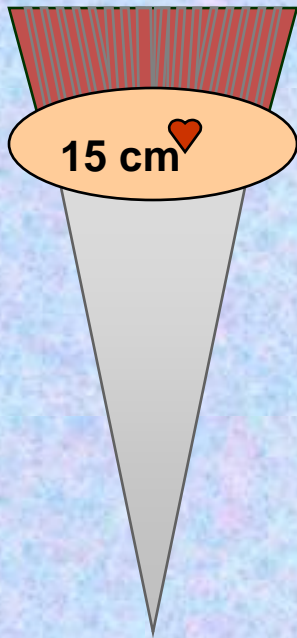
Beam entering patient typically ~**100x** more intense than exit beam in average size patient



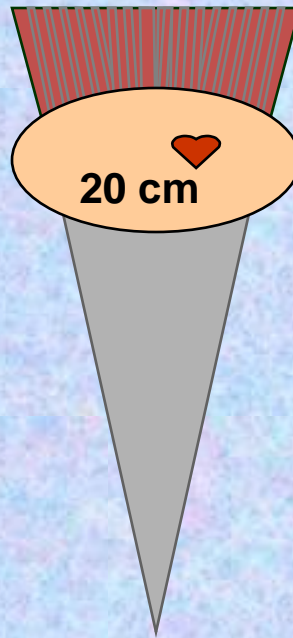
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Patient Weight and Habitus

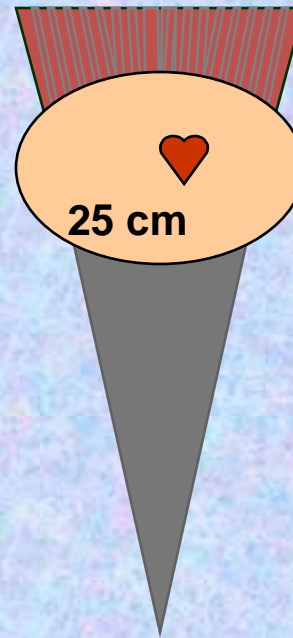
Thicker tissue masses absorb more radiation, thus much more radiation must be used to penetrate a large patient. Risk to skin is greater in larger patients!
[ESD = Entrance Skin Dose]



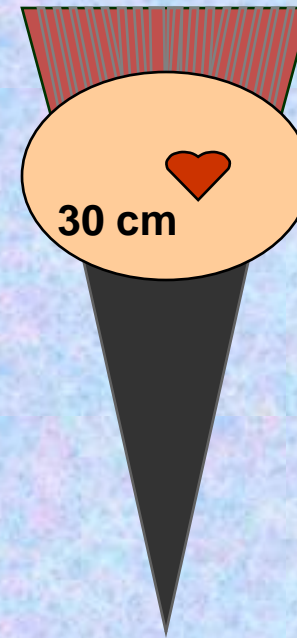
ESD = 1 unit
Example: 2 Gy



ESD = 2-3 units
Example: 4-6 Gy



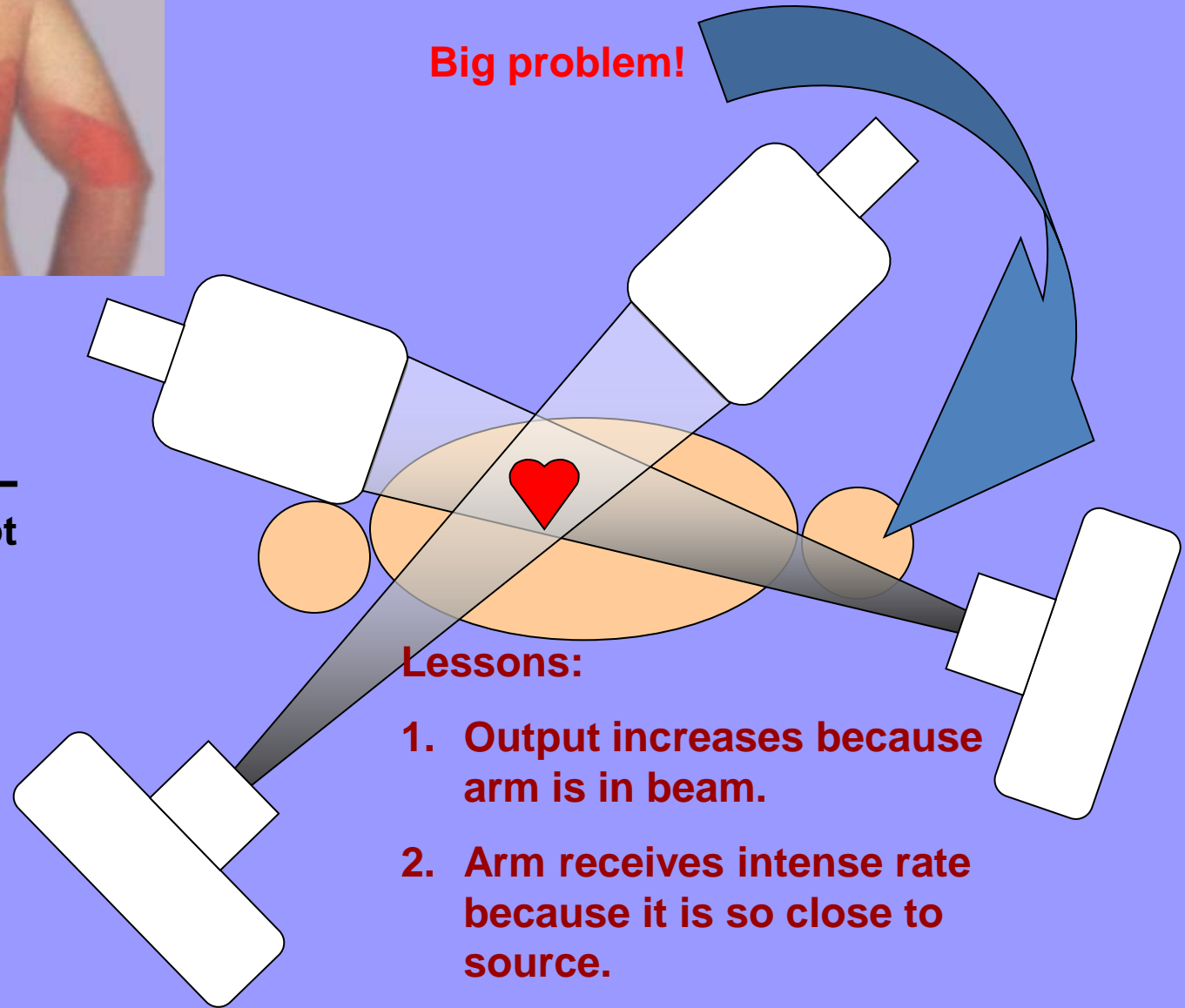
ESD = 4-6 units
Example: 8-12 Gy



ESD = 8-12 units
Example: 16-24 Gy



**Arm positioning –
important and not
easy!**



Big problem!

Lessons:

- 1. Output increases because arm is in beam.**
- 2. Arm receives intense rate because it is so close to source.**

Wagner and Archer. Minimizing Risks from Fluoroscopic X-RAYS.



At 3 wks



At 6.5 mos

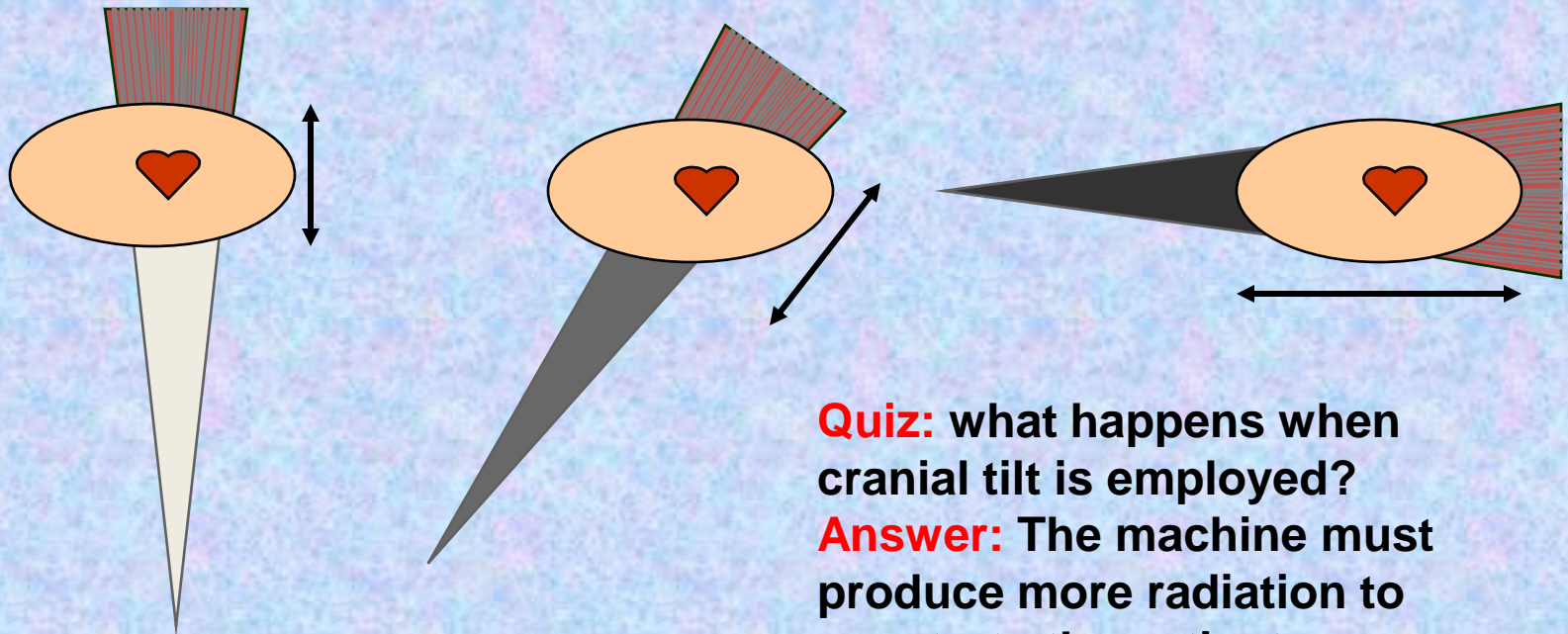


Surgical flap

Following an ablation procedure with arm in beam nearest the x-ray tube. About 20 minutes of fluoroscopy.

Tissue Mass and Beam Orientation

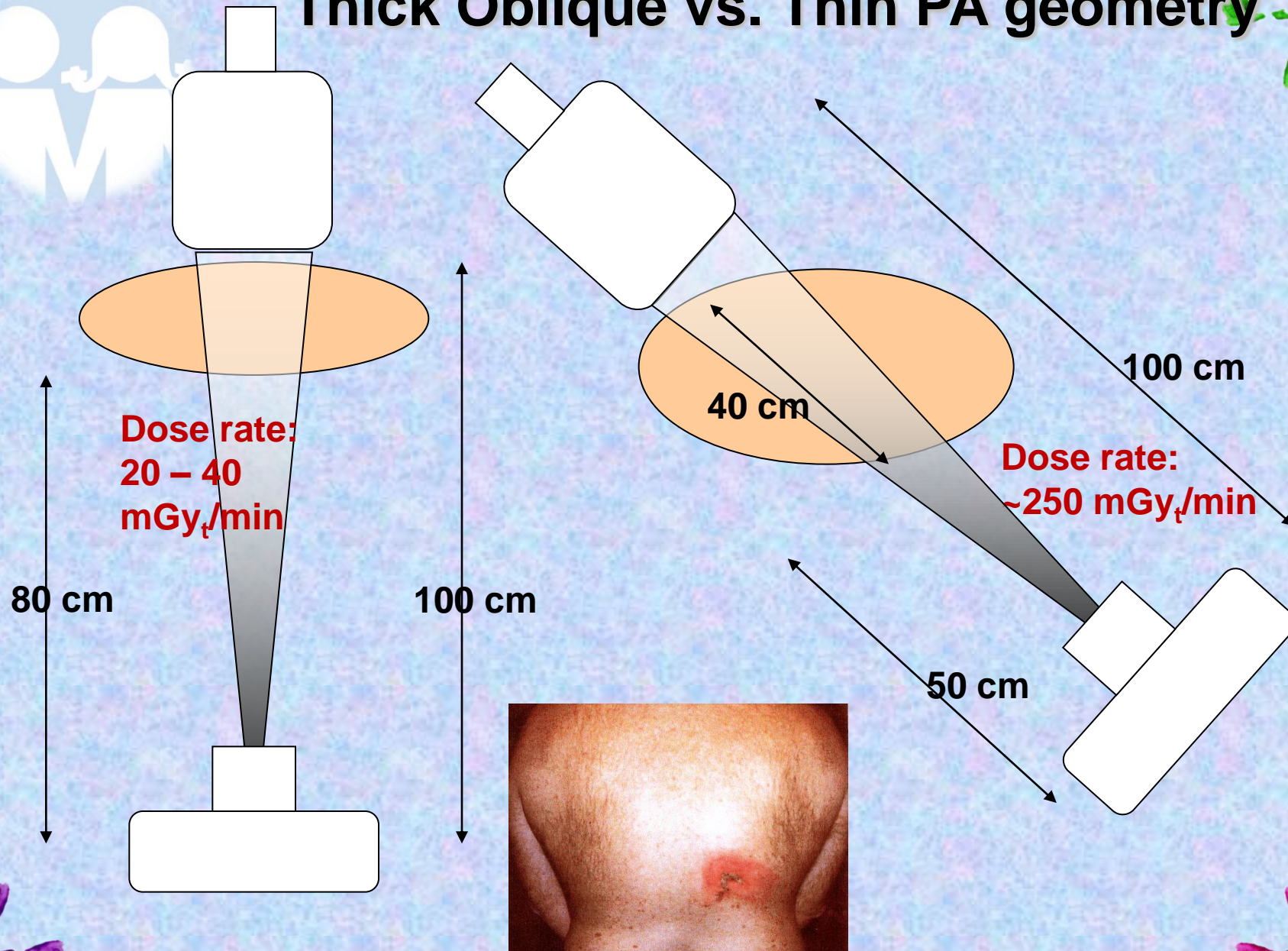
Thicker tissue masses absorb more radiation, thus much more radiation must be used when steep beam angles are employed. Risk to skin is greater with steeper beam angles! Note: the C-arm will automatically increase radiation output to accommodate for the increased patient mass.



Quiz: what happens when cranial tilt is employed?

Answer: The machine must produce more radiation to penetrate the patient.

Thick Oblique vs. Thin PA geometry





Physicians must be able to recognize radiation – induced skin changes.

The patient should be asked about previous procedures, and the patient's skin should be examined, when appropriate, for prior radiation-induced skin changes.



Advantages of Pulsed Fluoroscopy

- Improvement in temporal resolution. Motion blur occurring within each image is reduced because of the shorter acquisition time, making pulsed fluoroscopy useful for examining rapidly moving structures such as those seen in cardiovascular/vascular applications.
- Pulsed fluoroscopy can be used as a method of reducing radiation dose.





Things to Keep in Mind



- Keep unnecessary body parts, especially arms and female breasts, out of the direct beam.
- Physicians must be able to recognize radiation induced skin changes.
- Keep the patient as close to the “image receptor” as possible.





Things to Keep in Mind:



.....Continued

- Thicker tissue masses absorb more radiation, thus much more radiation must be used to penetrate a large patient. Risk to skin is greater in larger patients!
- More radiation must be used when steep beam angles are employed. Risk to skin is greater with steeper beam angles!
- ***Remember: the C-arm will automatically increase radiation output to accommodate for the increased patient mass.***





What to Do.....

- *Responsible physicians must balance between radiation injuries and clinical benefits.*
- *Responsible physicians must know when to stop and when to proceed!*

