

Dubunking Radiation Myths



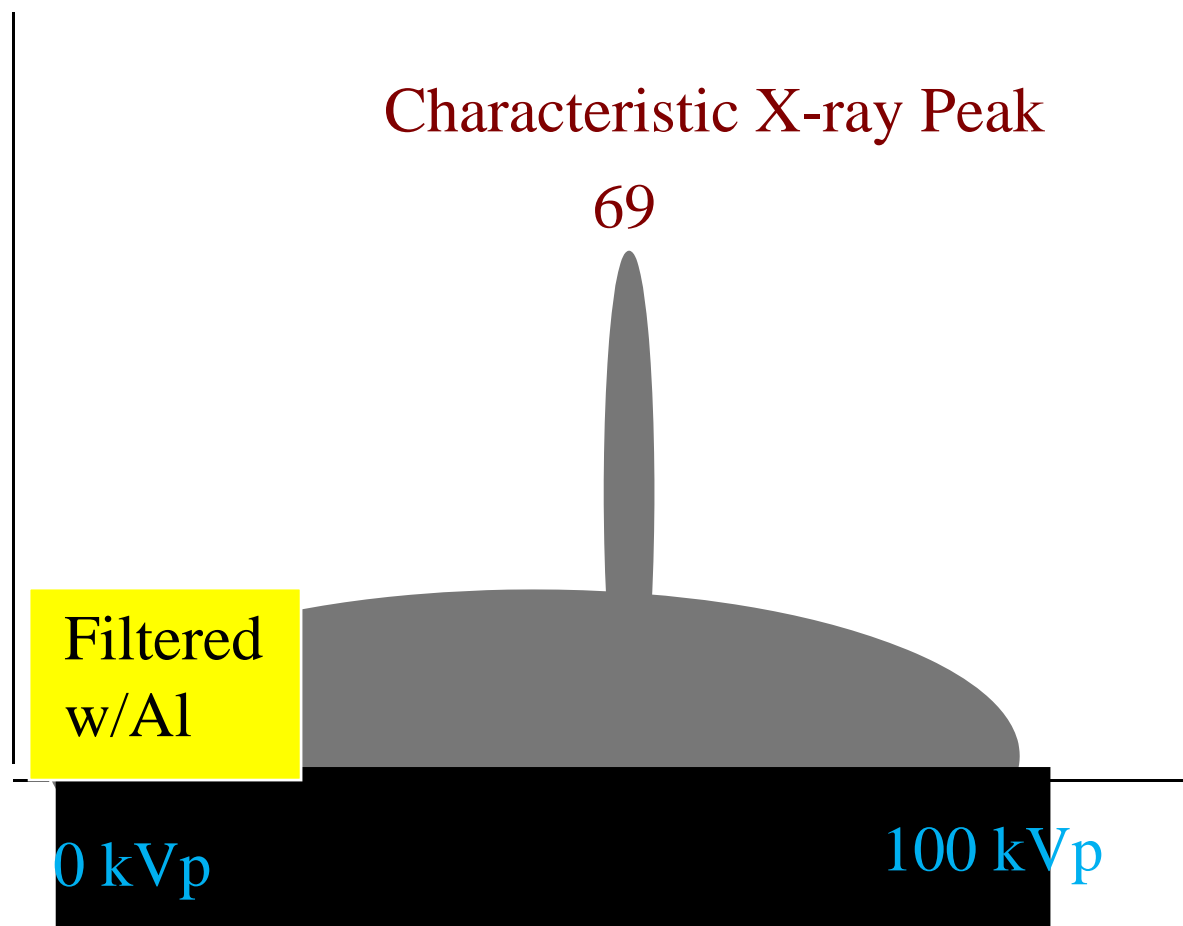
**Presented by: Walter L. Robinson, M.S., D.A.B.S.N.M.,
D.A.M.P., and D.A.B.R.**

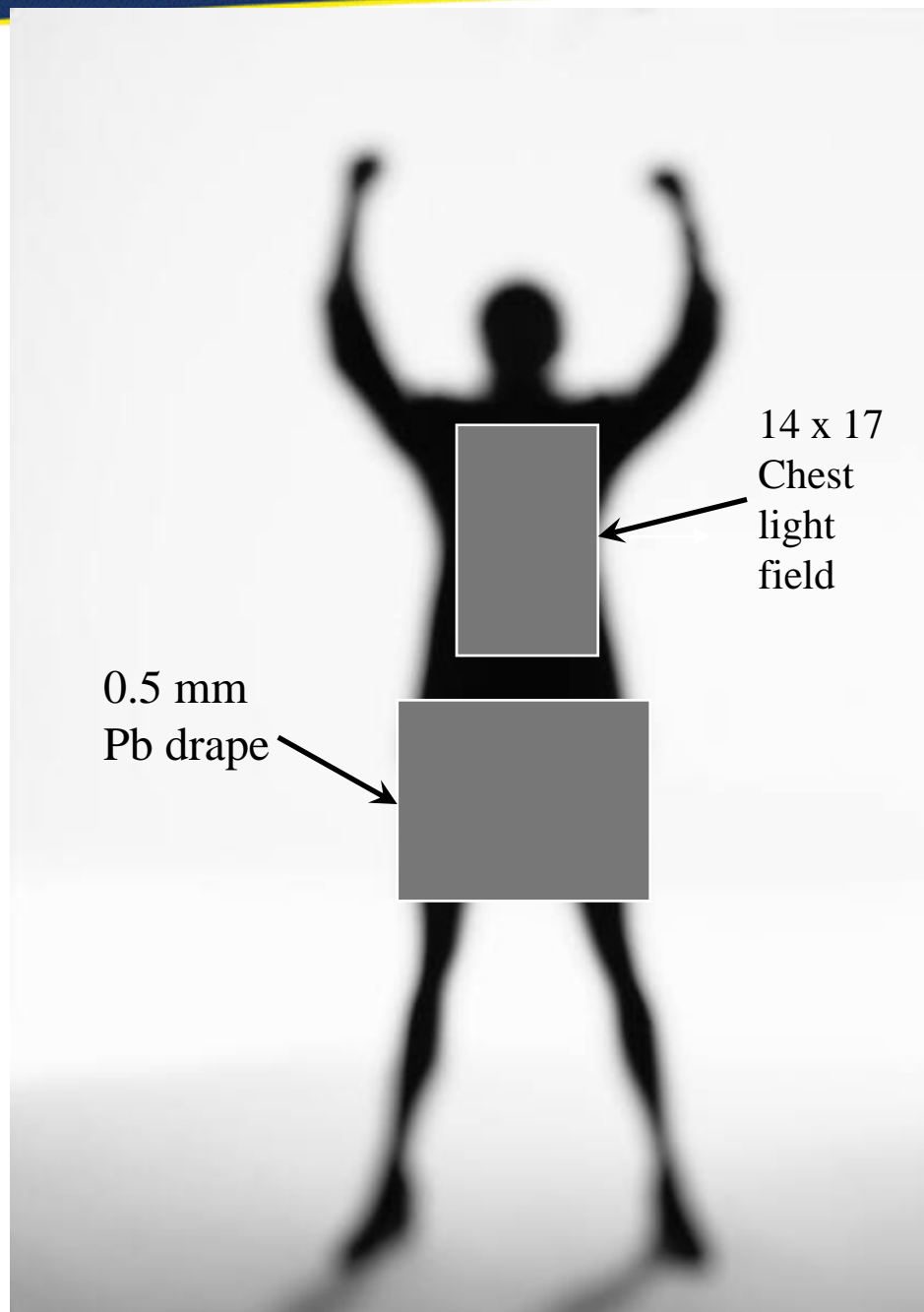
**Consultant Certified Medical Radiation Health and Diagnostic
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The Myths

1. Santa Claus, the Easter Bunny, the Tooth Fairy, the Earth is flat, and that “catching a cold” is caused by cold temperature, etc.....
2. That lead drapes are useful to protect most radiographic and CT patients from harmful radiation.
3. That an employee of the hospital cannot be exposed to ionizing X-irradiation occupationally without being monitored with a badge or dosimeter.

Chest X-ray Setting 100 kVp (Max. is 100 kV not all)

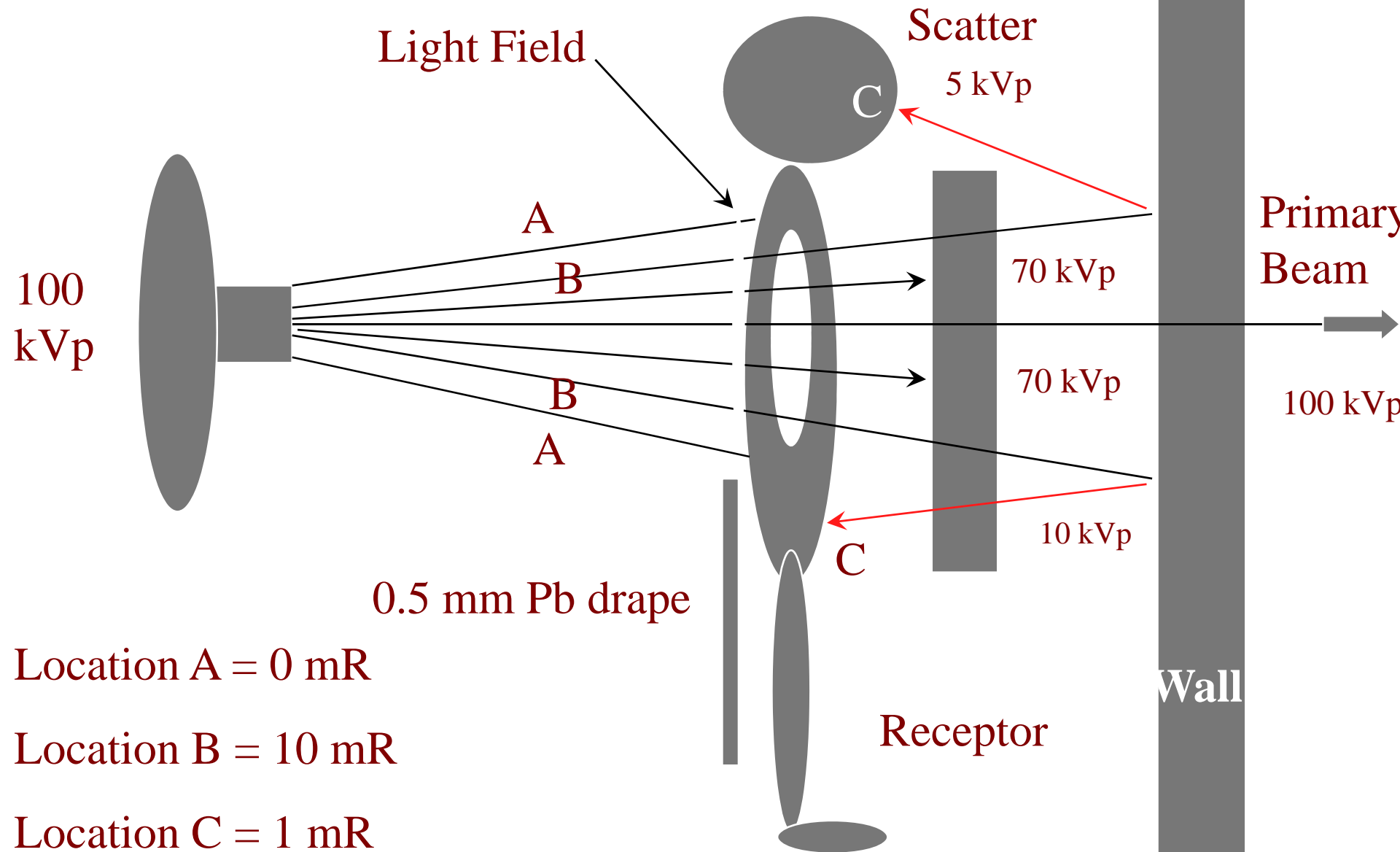




14 x 17
Chest
light
field

0.5 mm
Pb drape

PA View



Where did the myth come from?

Over 50 years ago medical X-rays were projected from cones, without a collimator or light field. It was almost impossible to tell whether you didn't "spill" a few X-rays over into an area that wasn't of clinical interest. The advent of lighted collimators obsolesced this problem in medical radiography. A few procedures, such as fixed cone cystoscopy, retained fixed cones in hospitals until about the 1990's. Today, it is almost impossible to find a fixed cone X-ray machine in medicine. The exposure outside the lighted field, for all intents and purposes, is zero. Therefore, there is no X-ray radiation hazard outside the light field.

Dental radiography units still have open cone technology. For this reason, a lead apron or drape in the patient's lap is appropriate to protect the gonads or a fetus. No such need exists today with medical radiography.

So why do so many hospitals and clinics continue to provide lead drapes to their medical radiography patients? The answer is that many hospitals and clinics have allowed an uninformed lay public to demand “the same protection afforded by my dentist”. Hospitals and clinics, in an effort to not lose market share, were afraid to deny and educate the patient for fear that the patient would think that they did not care for them appropriately. Many hospitals and clinics understood that they were perpetrating a myth, but chose not to educate the public of their misconception, and continue to do so today.

Some schools of radiologic technology still teach that lead sheets should be placed on a patient, as a carry-over from the past. Some schools had the misconception that the requirement to shield the gonads of a patient meant that lead needed to be placed over the patient's gonads for almost any non-gonadal procedure, even a hand exposure. The regulation for protecting the gonads states that the gonads are to be protected from X-rays (as best that is possible) when the gonads are in the field of view of the radiographic projection, if doing so does not cover or interfere with the area of clinical interest.

An apparent myth of the public that X-rays continue to scatter around the room after an X-ray exposure, has possibly fostered the myth that to place a lead sheet over the gonads during extremity projections (for instance) will allow the patient's gonads to get less radiation exposure.

Well maybe it does, infinitesimally , but it is not worth the effort, and it perpetrates the myth to the patient that to not shield them is a careless oversight. I believe it best to educate the patient that today's modern technological X-ray equipment is so safe that this type of shielding is no longer necessary, since it isn't. Today's healthcare consumer is more educated, and can understand and will trust your judgment if you explain the issue in a calm fashion-why shielding is no longer needed.

A patient information brochure can be prepared for the waiting room to minimize the discussion between patients and the technologists. If the patient insists, (basically, “don’t confuse me with the facts, my mind is made up”), then the “customer is always right” philosophy applies: give them a lead drape upon demand-if they have been privileged to you sharing your informative knowledge.

Anyone not monitored with a badge is required by their employer to have any occupational exposure, that they might get, kept below 500 mREM-not kept to zero. Below 500 mREM is considered to be “absolutely safe”, since it is consistent with unavoidable background radiation.

Regulations for Personnel Monitoring

Pennsylvania's regulations are not equal to Maryland's or New Jersey's or New York's, but they are like Delaware's.

PA Title 25 Chapter 219.6 defers to the NRC regulations, which state in 10 CFR 20.1502 (a):

Each licensee shall monitor occupational exposure to radiation from licensed and unlicensed sources under the control of the licensee and shall supply and require the use of individual monitoring devices by adults, LIKELY TO RECEIVE IN ONE YEAR FROM SOURCES EXTERNAL TO THE BODY, A DOSE IN EXCESS OF 10% OF THE LIMITS IN 10 CFR 20.1201 (a), (which is 5000 mREM/yr). 10% of 5000 is 500 mREM, or 41.67 mREM/month. So, anyone known to receive less exposure than 500 mREM/yr, need not be monitored individually.

Although these employees have no badge, it does not mean that radiation protection practices do not apply-they do. They must follow all the global radiation safety rules rooted in minimizing time, maximizing distance, and optimizing shielding and by utilizing the radiation safety philosophy of A.L.A.R.A. Although these employees have no badge, they may be occupationally exposed to ionizing radiation.

Some persons feel that since they were once badged, they need to be badged forever. This is an unfortunate misconception.

When the risky exposure duties are eliminated from their job, the staff should be reassured by the fact that the RSO feels that they no longer need to be monitored. Some may try to hypothesize scenarios of exposures to themselves getting exposures over the 500 mREM limit, and ask how the RSO would know of the high exposure, if no badge was present.

If, for instance, the radiation therapists in Radiation Oncology had their badges deleted (since their exposures are always less than 500 mREM/yr.), and in the process of an emergency removal of a therapy patient from a linear accelerator vault that had a treatment unit that got stuck with the beam on, and the staff had no personnel monitor. How would we know what exposure they got? We would check to see if anyone had a monitor and performed duties in the emergency, and do inverse square and time calculations to determine the likely exposure of the others in the emergency operation.

If no one was monitored, we would have to reconstruct the emergency exposure condition, and make measurements to determine the likely exposures to the staff. Personally, I would never recommend the deletion of badges from radiation therapists, since the potential for them getting a high exposure in such a hypothetical scenario is high. Contrast this with the potential for a high exposure in mammography. Mammography exposures to staff are so low that mammographers are no longer required to be badged in most hospitals and clinics.

Most mammographic primary beams are <28 kVp, the scattered X-rays are <2 kVp, which is easily stopped by the acrylic barrier provided for all mammographic units, and is below the energy threshold of detectability of the Landauer Luxel badge. As long as the technologist follows the procedures, protocols, and radiation safety rules to stay behind the barrier, they will get no exposure at all. I cannot conceptualize how they might get any exposure, inadvertently. This is a perfect example of a person who no longer needs to be badged.

The question arises as to then how do we know if our changing job duties have put us back into an environment that justifies personnel monitoring? This is where requesting pocket ionization chamber dosimeters from the authorized distributor in your hospital comes in. Upon your supervisor's request to the RSO, authorization for you to wear a pocket ionization chamber dosimeter for a month or so will be granted. This dosimeter can be read-out instantly, so you will know if the new procedure produces radiation exposure high enough to need routine monitoring.

When we multiply your one exposure by the number of patient cases per month, we can determine if routine Luxel badge monitoring should be started or resumed. The RSO will also look at the total exposure that you accrued in a month. Another advantage of the pocket dosimeter is that it can be shared by several members of your staff (unless it is dedicated to one individual for their specific evaluation). A disadvantage is that they are breakable, and cost \$150.

Remember, the personnel monitor itself cannot protect you from radiation. Only time, distance, and shielding can do that. So what is the value of the monitors that are in use? They are used to see if any one person badged has exposures higher than the norm for their job.

The RSO reviews all the badge reports, and personally discusses exposures that he or she considers are “high” with the wearer, in an effort to reduce that individual’s exposure. “High” exposures are usually those above 30% of MPD (125 mREM/month).

Some interventional radiologists and cardiologists performing catheterizations, etc. get exposures to the collar badge exceeding the annual exposure limit of 5000 mREM. Fortunately, they are wearing lead acrylic glasses and a lead apron (or equivalent); therefore, we are allowed to apply a calculation of the actual Effective Dose Equivalent (EDE) to their records. If one badge is worn on the collar, the EDE formula is simply $0.3 \times \text{collar badge reading} = \text{EDE}$.

If you are required, by the RSO, to wear two badges, then one is worn under the lead apron at waist level, and the other outside the lead apron at collar level. This EDE is $= 1.5 \times \text{waist} + 0.04 \times \text{collar}$ badge readings. This usually produces the lowest EDE; however, it carries some pitfalls. You must not switch the badges around, or it destroys the data/records. Sometimes non-physician personnel in I.R. and the C.C.L. are provided with the EDE calculation, called the “assigned” dose by Landauer.

This is perfectly acceptable to the State of PA and Delaware inspector and regulators as a way to record the ACTUAL exposure to someone wearing a lead apron. The EDE must then be less than 5000 mREM in a year. For example, a collar badge reads 15,000 mREM (15 REM) in one year, what is the EDE? With the first formula, it is $15,000 \times 0.3 = 4500$ mREM, or less than the limit. In the second formula it is $15,000 \times 0.04 + 1.5 \times 600 = 1500$ mREM-much less than the limit.

As a quick refresher in radiation biology facts will remind:

- 1. There are no somatic cell changes to doses of 5000 mREM/yr. This is why the limit was chosen.**
- 2. The dose that produces twice the natural rate of radiation-induced mutations (in genetic cells) is about 70,000 mREM.**
- 3. Patients receiving fetal doses less than 10,000 mREM rarely terminate the pregnancy, and go on to have biologically-normal children.**
- 4. Doses in excess of 25,000 mREM are required to produce the first change seen in any cell (decrease in WBCs), and this dose must be delivered all in one day, not protracted over a year, when the cells recover and repair.**
- 5. Low exposures to ionizing radiation has actually decreased levels of anticipated cancers (i.e. Radon above EPA recommended levels). This phenomenon is called hormesis.**

Another myth about ionizing radiation is that any radiation can harm or injure a fetus, so you should not get any exposure if you are pregnant. Well, yes radiation can harm a fetus, but only at exposures above 10,000 mREM. The International Council on Radiation Protection (ICRP), in an up-coming publication, will state that there is no difference in children exposed to less than 10,000 mREM during pregnancy, than children receiving no exposure. This includes childhood leukemia, diminished head size, and diminished I.Q. The regulatory limit for a declared occupationally-exposed pregnant woman is 500 mREM, a number considered to be **ABSOLUTELY SAFE**.

Therefore, it is the policy, and should be the understanding, for all hospital departments that there is no need to alter job duties for pregnant staff that have a history of under-lead apron exposures of less than 500 mREM/9 months. Some departments (or sections of departments) with large staffs can alter job duties to keep the exposures A.L.A.R.A., but they are not required to do so. It may be “reasonable” for them to establish this precedent. For other smaller divisions, it would be “unreasonable”, as well as unnecessary, to apply such restrictions and limitations of duties. Remember, the only pregnant staff to get a second “baby” badge are those in fluoroscopy!

Remember: Do not get confused or swayed by media hype/fictional entertainment or anti-nuclear extremists. Liars use statistics, and statistics can lie. For example:

It is true to say, “For every 1 REM (1000 mREM) of exposure a woman receives during pregnancy, increases the risk to that child of acquiring leukemia by 40%”. Now that sounds pretty dramatic, because if we got a 40% increase in salary-that would be “large”. But let’s explore what 40% of a risk is. Risk is portrayed as a rate.

The risk to leukemia for a child whose mother got **NO** radiation is 1 in 100,000 or 10^{-6} , as it is often written. $1/100,000 \times 1.4$ (a 40% increase from 1.0) = 1.4 in 100,000. This is the increase to the risk rate by 40%. Now that change from 1.0 to 1.4 in 100,000 doesn't look/sound so "large". Be careful on who and what influences your perception of the hazards of ionizing radiation. Don't let continued misconceptions from uninformed patients influence your understanding.

Humans perceive risks as accepted risks or risks that they are subjected to against their will. Occupational risks are usually considered to be somewhere in-between. You take the risk, but you are paid. (Risk/benefit) Your risk is (and should be) much smaller than the patient's risk (exposure), but then the benefit of the proper diagnosis should be huge to the patient-outweighing their miniscule risk.

Some examples of risks we take or have a greater risk of cancer than 1000 mREM of ionizing radiation:

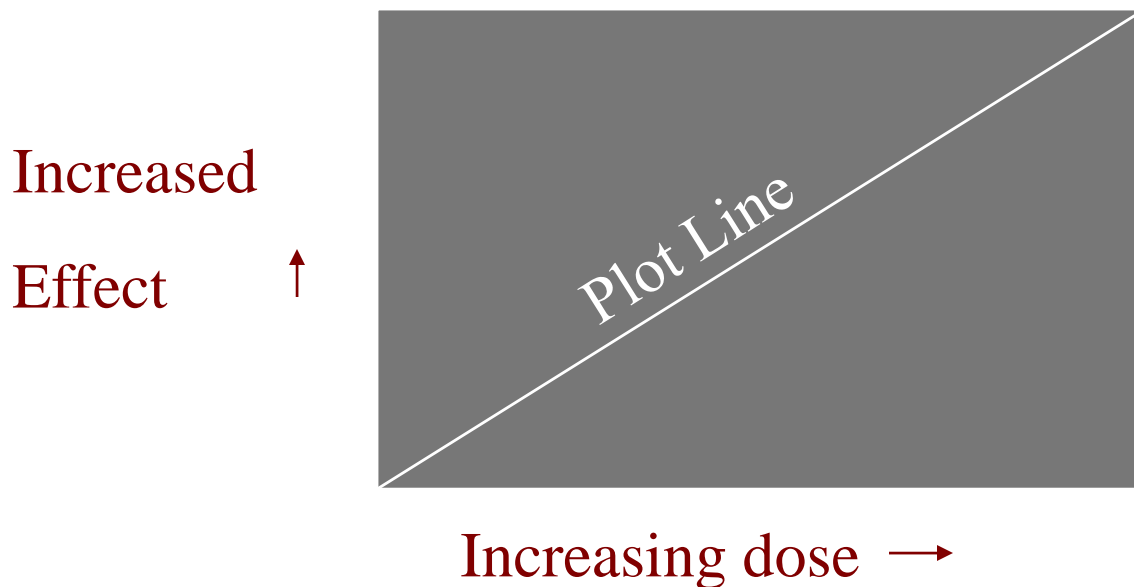
1. Tanning salon/beds
2. Sunbathing – with or without sunscreen
3. Charcoal-grilled meat-blackened
4. Eating a meal in a restaurant that is not “smoke-free”

All these risks cause cancer, but how about other routine risks we choose to take like:

1. Riding/driving a car
2. Flying in a plane
3. Extreme sports, including motorcycle riding

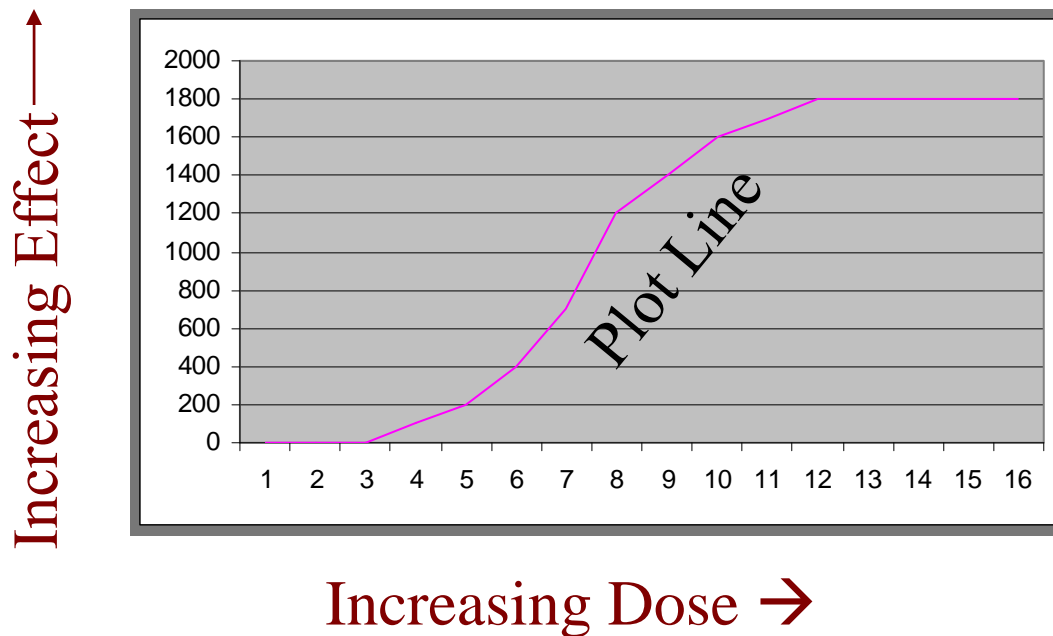
We know all these things are hazardous, but we continue to do them. We have the choice to accept the risk. Personnel who are exposed in their occupation have a choice also. Remember, there has never been any radiologic technologist or nuclear medicine technologist who was ever proven to have developed a cancer from their occupational exposure to ionizing radiation, and today's exposures are much lower than those in the past. People today have an increased awareness to radiation exposure. It must be understood that you can get a small amount of radiation exposure with no adverse effect to you.

Linear or Stochastic Dose Effect Plot



The linear no threshold dose and effect plot is assumed for its conservatism (erring on the safe side) for the production of regulations. All health physics scientists know that the dose effect plot with a threshold is more reasonable, and better represents the actual situation. The threshold “plot line” is flat from 0 – 5000 mREM, then the effect increases with increasing dose.

The Threshold or Non-stochastic Dose-Effect Plot



A quick primer on lead protective personnel garb.

1. Since the thyroid exposure limit is 50,000 mREM/yr, and only interventionalists and cardiologists get more exposure than 10% of this (5000 mREM, or 417 mREM/mo.), they are the only ones who **MUST** wear a leaded thyroid collar. For all others, it is recommended to reduce their exposures A.L.A.R.A.
2. Lead acrylic wrap-around glasses **MUST** be worn when exposures are greater than 10% of the Lens Dose Limit of 15,000 mREM/yr, or a 1250 mREM/mo. collar badge reading.
3. Total thickness must be at least 0.25 mm Pb in the posterior, and 0.5 mm Pb on the anterior side of personnel working around fluoroscopy. Make sure that vests overlap the chest entirely, as each side is 0.25 mm Pb equivalent, and two full panels are required to achieve 0.5 mm Pb equivalent.

Who must wear a lead apron?

1. Any personnel who are required to work within 6 feet of a fluoroscopic X-ray unit.
2. Any personnel who are required to work within 6 feet of a mobile radiographic unit.
3. Anyone accompanying a patient in the X-ray room within 6 feet of the X-ray unit.
4. Anyone required to be within 6 feet of the gantry inside a C.T. scan room, or mobile C.T. unit.

Note: Conspicuous in its absence is when to shield the patient?

The patient is to be protected by at least a 0.25 mm Pb equivalent apron or protective shield if the patient cannot be moved further than 6 feet from where adjacent X-ray exposures are being taken.

This brings us to our newly Radiation Shielding Policy. If you do not already have a copy, a copy will soon be provided to you by your supervisor. This new policy has been instituted to be consistent with the science behind the previous presentation and to fulfill the mission of the hospital to educate patients and staff. It has been formulated and reviewed by the Radiation Safety Officer, The Radiation Safety Committee, and Radiology Department Management.

Proper Care of and with Lead Aprons

1. Do not leave badges on lead aprons
2. Do not leave lead aprons clumped on the floor, hang them on the racks provided, or drape them over something soft
3. Choose a properly-fitting size of lead apron. For instance, a 0.25 mm Pb wrap-around vest type lead protective device must be able to totally overlap in the front to provide the 0.5 m Pb protection that is required.
4. One-piece wrap around lead aprons may seriously cause spinal compression when worn frequently, as could other lead aprons with a greater amount of lead than 0.5 mm.

Are there any questions?

If not, thank you for the opportunity to bring this information to your attention.