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Radiation exposure risks: backscatter and the anesthesiologist

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FINANACIAL DISCLOSURES

- None

EXPANSION OF SERVICE

- Gastroenterology
- CT Scanner
- Neuro-IR
- Cardiac suites

PHYSICS OF RADIATION

- Electromagnetic energy
  - 0.01 to 10 Nanometer Wavelength
  - 10 eV to 100 keV
- Similar to gamma rays
  - X-rays – electrons
  - Gamma rays – atomic nucleus

PHYSICS OF RADIATION

- Ionizing radiation
  - Able to disrupt molecular bonds
    - — Radiation sickness
    - — Cancer risk

RADIATION MEASUREMENT

- Gray (Gy; joules/kg)
  - Amount of radiation to create 1 joule in 1 kg
    - — Rad (obsolete): 100 rad = 1 gray
- Equivalent dose
  - Measures biological effect
  - rem (Roentgen equivalent man)
    - — 10 millijoules/kg
    - — Equivalent to rad
  - Sievert (Sv)
    - — Equivalent to Gray (Gy)

RADIATION EXPOSURE

- Direct exposure
- Scattered radiation
- Leakage radiation

PHYSICS OF BACKSCATTER

- X-Ray energy reflected back
- Scatters after reflecting off target
- Present in varying degrees with all X-ray exams
  - Traditional E-ray
  - Flouroscopy
  - Angiography

PHYSICS OF RADIATION EXPOSURE

- Distance
  - $1/\chi^2$
- Attenuation
  - Lead apron protection
    - — 0.3 mm to 0.5 mm thickness
  - Leaded glass/lucite
    - — «Lead-equivalent shielding»

MEDICAL IMPLICATIONS OF RADIATION EXPOSURE

- Atomic bomb survivors
  - Japanese longitudinal studies
- Chernobyl clean-up workers
- Longitudinal studies of radiologic technologists
- Risk increases linearly
  - No apparent threshold

EXPOSURE OF TISSUE

- Average background radiation
  - 6.2 mSv per year
- Chest X-ray 0.3 mSv
- Head CT 2 mSv
- Chest CT 10-40 mSv

EXPOSURE OF TISSUE

- Effective tissue doses
- Weighted for specific tissues
  - Marrow, Lung 0.12
  - Gonads 0.08
  - Bladder, liver, thyroid 0.04
  - Brain 0.01

EXPOSURE OF EYE

- Atomic bomb survivors
- Chernobyl clean-up workers
  - < 1 Gy
- Radiation technologists
  - Threshold < 0.5 Gy
  - 20 mSv/y averaged over five years
  - No year with > 50 mSv

EXPOSURE OF EYE

- Not typically protected
  - Non-proceduralists
  - Assumed minimal exposure
- Deterministic type of damage
  - No real threshold
  - Damage accumulates over exposures

EXPOSURE OF EYE

- Posterior subcapsular cataracts
  - Similar to diabetes
  - Seen also with steroid use
- Occupational exposure in radiologists
  - Increase in light-scattering
  - Thought to be early PS cataracts[1]

EXPOSURE OF EYE

- Urologists
  - Exposure ranged from 0.05 to 0.66 mSv
- Far less than recommendation of 150 mSv/yr for eye exposure maximum
- Only nine months of data[2]

EXPOSURE OF EYE

- Interventional radiologist
  - Vertebroplasty
- 32 Consecutive procedures
  - Eye lens 11.9 mSv
  - Thyroid 31.2 mSv
- Doses extrapolated to yearly dose[3]

EXPOSURE OF ANESTHESIOLOGY PERSONNEL

- Electrophysiology laboratory
- Addition of laboratory to anesthesia coverage
- Radiation measured six month periods
  - Exposure 0.5 mSv prior
  - 1.0 mSv after[4]

NEWER RADIOLOGY EQUIPMENT

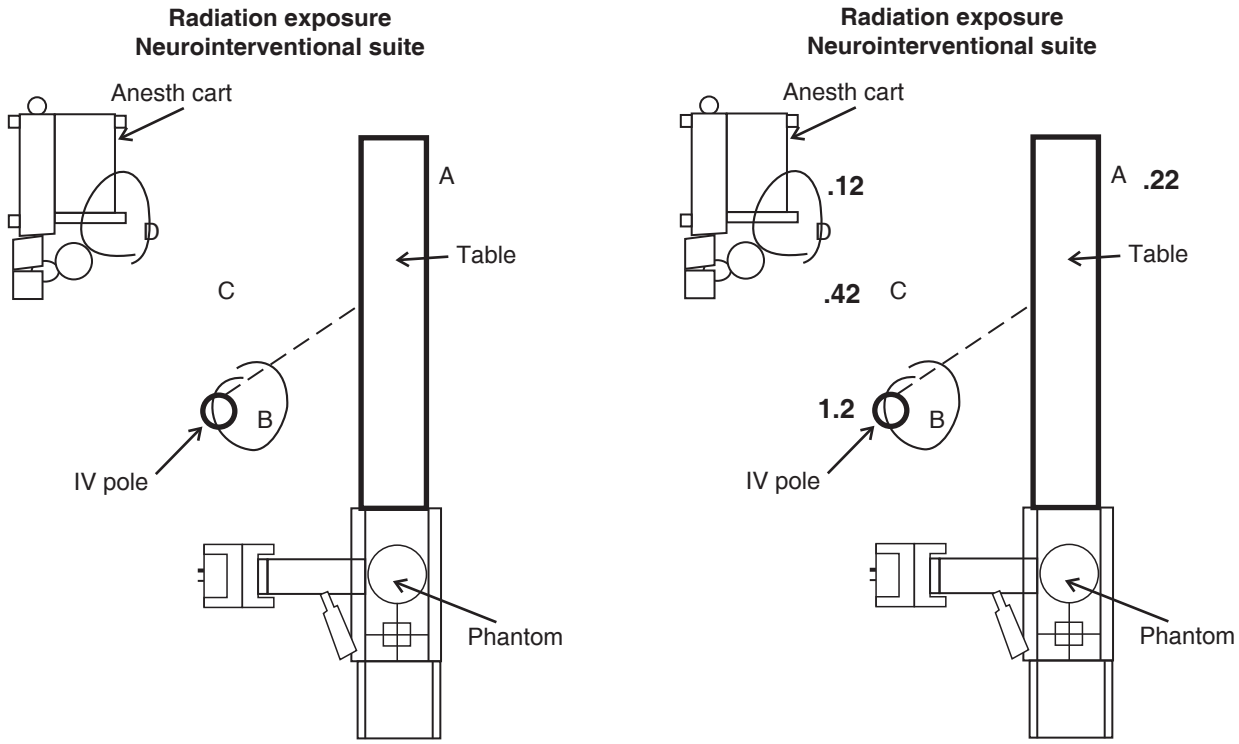
- Late model equipment better for performance
- Less leakage radiation
- Better focus

IS DIGITAL BETTER?

- Same energy must be used
- Radiation dosage is similar
- Backscatter will be similar
- Greater resolution of subject examined
  - No effect on backscatter

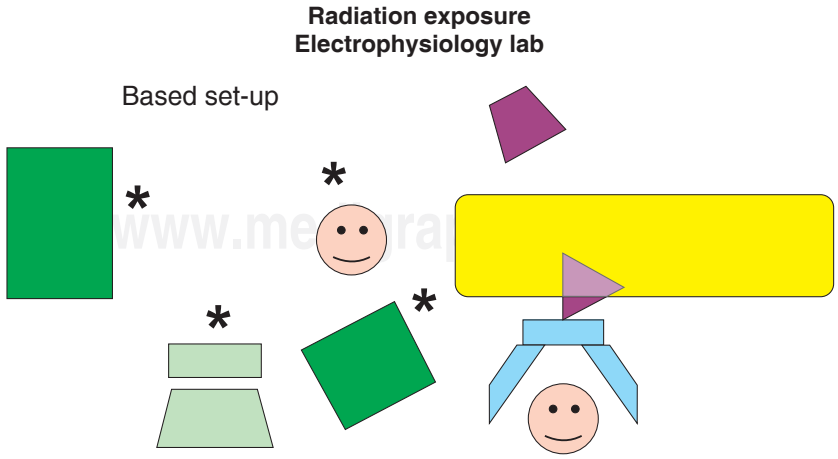
RADIATION EXPOSURE

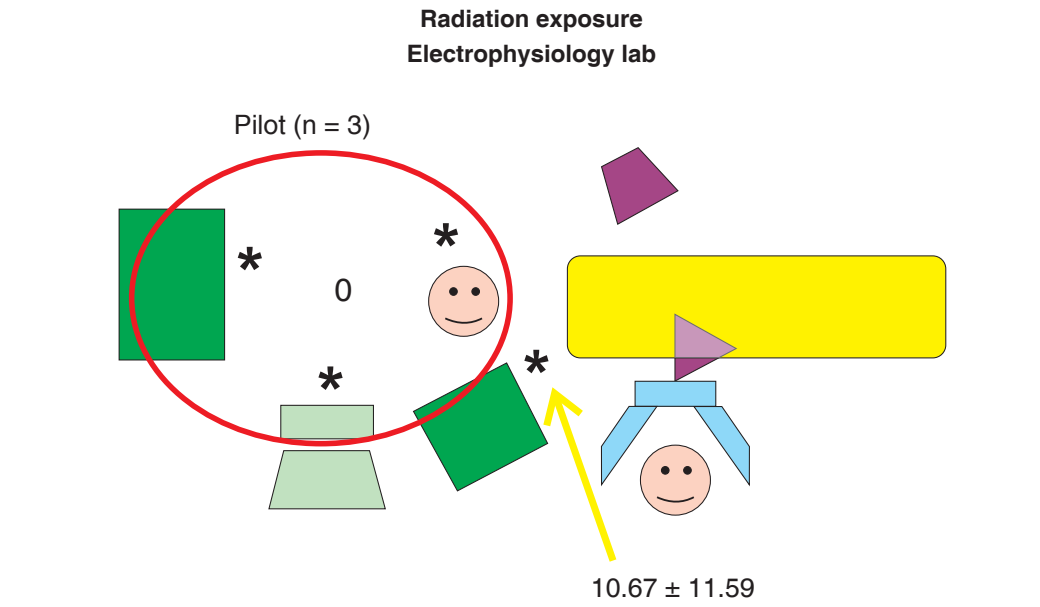
- Neurointerventional radiology
- Electrophysiology

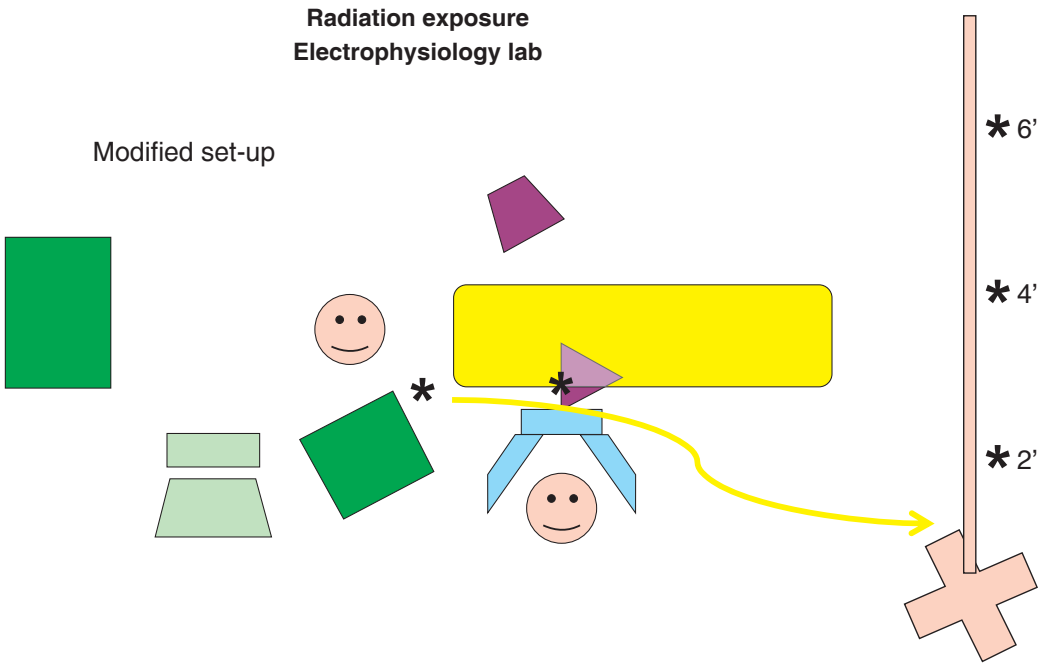


RADIATION EXPOSURE
ELECTROPHYSIOLOGY LAB

- Providers close to radiation source
  - Not in direct line

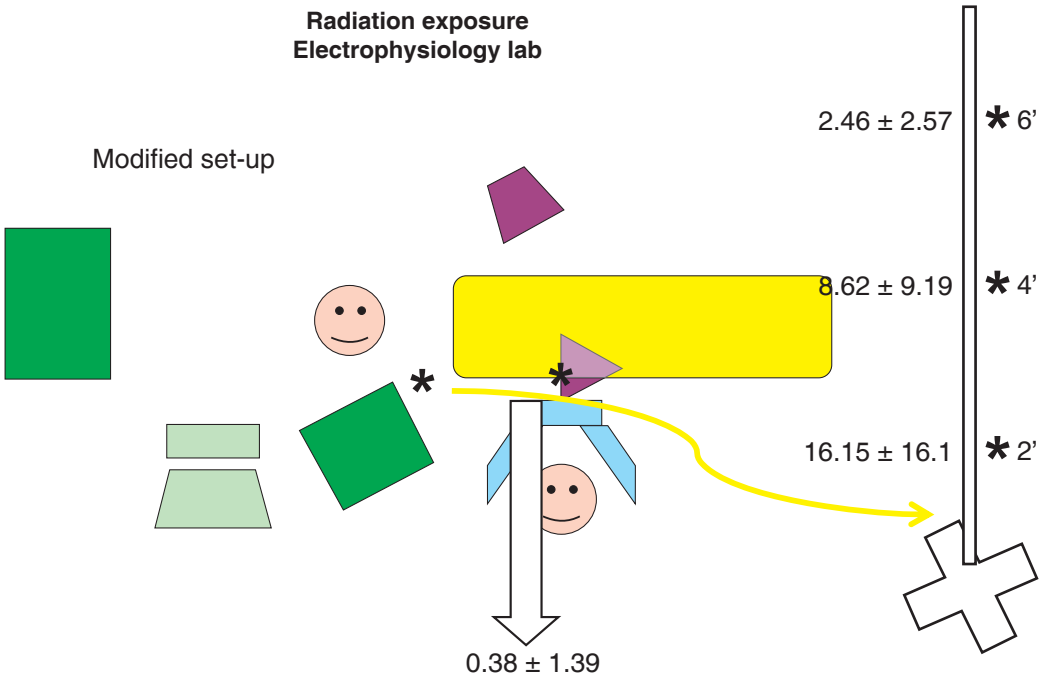






RADIATION EXPOSURE
LEAD PROTECTION

- Monitored exposures
  - Spine surgery
  - Outside and inside of lead
    — 64 patients
  - Thyroid: 27.7% - 41.1% reduction
  - Trunk: 38.0% - 48.3% reduction[5]



SUMMARY

- Distance decreases exposure
- Cataracts can result from lower radiation doses
- No detectable radiation for anesthesia provider
- Unknown recommendations for further protection

REFERENCIAS

1. Abe T, Furui S, Sasaki H, Sakamoto Y, Suzuki S, Ishitake T, et al. Quantitative evaluation of light scattering intensities of the crystalline lens for radiation related minimal change in interventional radiologists: a cross-sectional pilot study. J Radiat Res. 2013;54:315-321.
2. Taylor ER, Kramer B, Frye TP, Wang S, Schwartz BF, Köhler TS. Ocular radiation exposure in modern urological practice. J Urol. 2013;190:139-143.
3. Harstall R, Heini PF, Mini RL, Orler R. Radiation exposure to the surgeon during fluoroscopically assisted percutaneous vertebroplasty: a prospective study. Spine (Phila Pa 1976). 2005;30:1893-1898.
4. Katz JD. Radiation exposure to anesthesia personnel: the impact of an electrophysiology laboratory. Anesth Analg 2005;101:1725-1726.
5. Hyun SJ, Kim KJ, Jahng TA, Kim HJ. Efficiency of lead aprons in blocking radiation - how protective are they? Heliyon. 2016;2:e00117.