Radiation Exposure
Radiation Protection
from a Technician's Point of View

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Disclosure

Speaker name:
Alexander Gangl

I have the following potential conflicts of interest to report:
- Consulting
- Employment in industry
- Stockholder of a healthcare company
- Owner of a healthcare company
- Other(s)

I do not have any potential conflict of interest
Radiation Exposure

In a perfect world:

**NO** Patient Dose

**NO** Radiation Exposure of the staff

… so try to minimize the patient dose as much as you can ??
Radiation Exposure

But:

\[ \text{Detectability} \sim \text{physical contrast} \cdot \text{object diameter} \cdot \sqrt{\text{dose at detector}} \]

- Low Dose goes in hand with less visibility

- Higher Image Quality requires (among other factors) higher dose

- Lesion detectability $\propto$ detector dose
… says regarding staff radiation protection:

„Reducing the patient dose will lower staff dose too. However the opposite is not true as staff dose can be reduced by a large number of factors.“
Scattered Radiation

Reduced Image Quality

Radiation Exposure

today's topic
Radiation Exposure

- Elastic collision – Rayleigh Scatter
- Inelastic collision – Compton Scatter

Various energies

Rayleigh Scatter

Compton-Scatter

Incident X-ray Beam

Transmitted X-rays
Reducing the patient doses will lower staff dose too (IAEA.org)
e.g. by reducing the penetrated volume
...or by changing several technical parameters:

- pulse rate (4, 7.5, 15, 30 p/s)
- frame rate (0.5, 1, ..., 6, 10 f/s)
- decrease radiation time

...or by using some useful programs:

- low-dose programs
- Automap-function, 3D Fusion (CTA, MRA-Overlay)
- stored C-arm positions, Last Image Hold (LIH)
Inverse-Square-Law

Intensity $\propto \frac{1}{\text{distance}^2}$

**Constant** Dose-Area-Product (DAP)

http://www.healthcare.siemens.com/
Scattered radiation without any protection devices

The more LAO-rotation of the C-arm, the higher the radiation exposure for the staff.
Effectivity of protection devices:

Scattered radiation [µGy] without protection devices

Scattered radiation [µGy] with protection devices
...what still remains:

RAO-projection: Low protective effect (~ 28%)

LAO-projection: High protective effect (~ 90%)
## Radiation Exposure

### Table 1: Scattered radiation [µGy] without protection devices

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### Table 2: Scattered radiation [µGy] with protection devices

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...as a consequence:

X-ray tube should be positioned at the staff’s opposite side.

Try to minimize the number of RAO-projections.
Additional several protection devices

...but only the correct and permanent usage of these devices guarantees a proper protection.

Scattered radiation [μGy] with protection devices

Radiation Protection
Radiation Exposure

• What about the Magnification Factor?

Skin Dose [$\mu$Gy] as a function of the Magnification Factor
Radiation Cataract

History:

• 1897: 2 years after discovery of x-rays radiation cataract was mentioned (Chalupecky)
• 1930: detailed description of radiation cataract (Rohrschneider)
• 1957: ‘A clinical study of radiation cataracts and the relationship to dose’ (Merriam/Focht)

Radiation can cause cataract at **high dose** (>2 Gy)
Threshold Dose

Recent studies:
- „Risk of Cataract after Exposure to Low Doses of Ionizing Radiation: A 20-Year Prospective Cohort Study among US Radiologic Technologists“ (Chodik et al. 2008)

Controversial Existence of Threshold Dose
Delayed (Stochastic) Effects vs. Prompt (Deterministic) effects
Reduction of the Threshold Dose from 150 mSv/a to 20 mSv/a
Radiation Exposure

...today we are laughing about these curiosities.
...but what will we laugh about in 20 or 30 years?
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