

Ask EuroSafe Imaging Tips & Tricks

Paediatric Imaging Working Group

Dose Management in Digital Radiography

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- Digital radiography has been replacing screen-film radiography systems

Digital systems have the potential to increase practicality and throughput in the imaging department

BUT...

Patient dose may increase by suboptimal use of digital imaging systems

Major contributing factors to dose increase

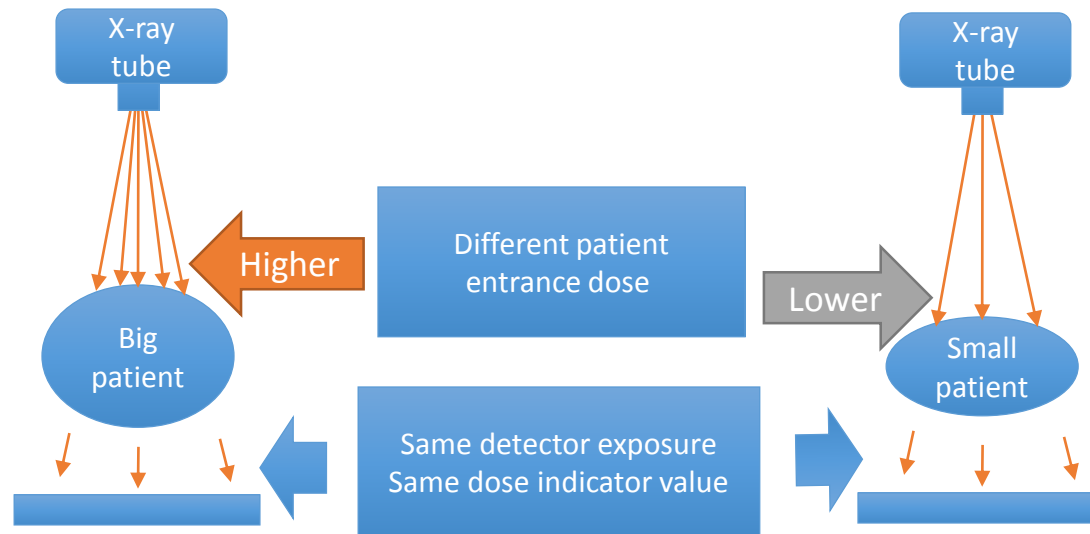
- Repeating images
 - Digital imaging systems may easily produce new images. Some users may be tempted to repeat an exposure if the image does not seem good to their subjective perception, even if the original image is good enough for diagnosis
- Producing images of higher quality than needed
 - Due to their wide dynamic range digital systems may produce usable images at various exposure ranges. Crisp, low noise images will be produced at the high dose range. However, noise levels do not need to be so low in order for the images to be useful for diagnosis. This is an example of unnecessary over-exposure.

Understanding dose indices/indicators

- Dose indicators are in fact image quality metrics that correspond to the signal levels produced by a digital detector for a given incident exposure (transmitted through the patient) reaching the detector (Seibert and Morin, 2011).
- Thus dose indicators are directly correlated to the radiation incident of the detector. On average, a specific amount of radiation to the detector produces a specific dose indicator value.

Understanding dose indices/indicators

- However, a multitude of situations could lead to a given amount of radiation to the detector. For example, imagine a small and a big patient imaged with different radiography technique settings. The dose indicator value may be exactly the same but the patient doses will be different. The big patient needs to receive higher dose than the small patient to achieve the same detector incident exposure (and thus same dose indicator value).



Understanding dose indices/indicators

- Patient dose depends on many technique and patient specific factors (kV, mAs, grid, collimation, beam quality and the size and area of the body irradiated, etc.).

If technique and patient information is unavailable it is impossible to calculate patient dose from dose indicator values (*Seibert and Morin, 2011*).

Using dose indices/indicators for patient dose management

- The key to using dose indicators for patient dose management lies in understanding the capability of digital radiography devices to automatically correct for under- and overexposure conditions
- Practically the steps to be followed are:
 1. Through a team approach (radiologist, radiographer, physicist) the optimal dose indicator values for each situation must be determined (exposure settings, patient size, body region, etc.)
 2. Dose indicator values should be monitored. Systematic deviation from the optimal values should be investigated.

Monitoring dose indicator values may help prevent unwanted changes in patient dose levels.

Dose indicators in CR

Manufacturer	Exposure indicator	Mean receptor air KERMA		
		5 μGy	10 μGy	20 μGy
Fuji	S	400	200	100
Kodak	EI	1700	2000	2300
Agfa	IgM	1.9	2.2	2.5

Exposure indicator is related to the air KERMA at the detector and the signal produced by the detector, and correlates with entrance skin air KERMA (Vano, et al, Phys Med Biol 2008, 53:3365-80).

Dose indicators in DR

Manufacturer	Exposure indicator	Mean receptor air KERMA		
		5 μGy	10 μGy	20 μGy
Canon (brightness = 16, contrast = 10)	REX	50	100	200
IDC (ST = 200)	F#	-1	0	1
Philips	EI	200	100	50
Fuji, Konica	S	400	200	100
Carestream (CR, STD)	EI	1700	2000	2300
Siemens	EI	500	1000	2000

(Adapted from Seibert and Morin, 2011)

- Imaging parameters should be chosen by patient size, not age
- Collimation is important not only for the patient exposure, but also the appropriate function of the post-processing systems
- Collimation and optimal image quality depend on the indication of imaging
 - More noise might be acceptable in control imaging (e.g. scoliosis angle)
- No noise in paediatric radiography often indicates too high dose

- Also post-processing protocols may need optimisation according to patient's size and skeletal development
 - Aeration of the lungs
 - Portion of cartilage/bone

Dose management

- Patient dose should be available for all users in the image data
- Regular evaluation of the dose levels should be part of QA
 - right function KAP/DAP meters should be secured also with low dose levels
- The dose quantity chosen should:
 - Be directly obtainable from the equipment OR easily measurable
 - Preferably permit direct measurements on the patient during an examination
 - Be representative of, or related to, the dose received by the patient in terms of organ doses or effective dose
- Recommended quantities for radiography are air kerma-area product (KAP- P_{ka}) (former DAP) and entrance-surface air kerma (ESAK- $K_{a,e}$) (former ESD)

- Even very high excessive dose is not seen in the image
 - Numerical value of the dose indicator in the image may hint users about whether proper technique is used during patient exposure. If the value is higher than the optimal values determined then the patient may have been over-exposed
- Collimation vs. Digital cropping
 - Right collimation is crucial to patient's exposure
 - Right collimation is important for the image quality
 - Digital cropping of the image **after** the exposure may improve the image quality
 - Routine use of digital cropping may prevent QC of collimation

Conclusion

Digital imaging may help achieve low dose, high throughput and good quality in medical imaging by:

- Adopting a team approach to dose management
- Appropriate staff training
- Continuous monitoring of dose parameters and imaging practices

References

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