Patient Skin Dose Management

During some complex fluoroscopically guided interventions, localised areas of the patient's skin can be subject to high doses of radiation, which can induce skin injuries. Therefore, it is important to have a system in place to highlight when it may be necessary to follow-up an individual patient. This is particularly important since the full effects of the radiation may not be evident until some time after the procedure has been completed.

Dose quantities

The following dose quantities are used to indicate patient dose and can be displayed during a procedure and subsequently stored with the images on PACS.

Peak Skin Dose, PSD. This is the maximum skin dose experienced by any section of the skin surface during an examination and is the most useful quantity for estimating the risk of a deterministic skin injury. However, in practice, this cannot be displayed during a procedure and even post-procedure is not readily available, but may be calculated as a skin dose map to indicate where doses are highest.

Cumulative Air Kerma, CAK ($K_{a,r}$). This is intended to represent the total incident Air kerma delivered to a reference point approximating to the patient's entrance surface during a procedure. Since it is specified for a fixed position, it does not take movement of the X-ray tube into account.

Air Kerma Area Product, KAP ($P_{K,A}$) (also referred to as Dose Area Product, DAP). This is a measure of all the radiation entering the patient for a given projection. The displayed KAP is the sum of all such projections, and so does not provide a measure of accumulated dose at any specific point on the patient surface.

Risk of skin effects

If the dose exceeds a certain threshold, a tissue reaction can occur, which increases in severity with the dose from transient erythema and epilation to dry or moist desquamation and even dermal necrosis. The time delay to the onset of the effect can vary from under two weeks to over 8 weeks.

Action levels

Suitable action levels should be defined locally to trigger follow-up of the patient. The example given below is based on COMARE 19, for an average sized patient. The action level is set where 1% of all individuals exposed demonstrate the expected tissue reaction. Therefore, exceeding an action level is only likely to result in an effect in a small proportion of patients.

Dose quantity	Post-procedure action level
Peak skin dose, PSD	3 Gy
Cumulative Air Kerma, CAK	5 Gy
Kerma Area Product, KAP	Cardiac = 300 Gy cm^2; Other IR procedures = 500 Gy cm^2
Cumulative Fluoroscopy time	60 minutes

Patient follow-up

If an action level is exceeded, then the operator performing the interventional examination should ensure that the follow-up procedure is initiated. The purpose of a follow-up clinical examination (usually 2–4 weeks and 6 months after the exam) is to detect skin effects that may require further management or prolonged follow-up. The patient may be asked to evaluate the skin reaction,

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perhaps record through a photograph, and report skin changes to the responsible physician. Patient information on skin care advice should also be provided.

Reference: Committee on Medical Aspects of Radiation in the Environment (COMARE), Nineteenth Report (2021), Radiation doses in interventional radiology: issues for patients and staff within the UK. Available here: www.gov.uk/government/publications/radiological-dose-issues-with-interventional-radiology-in-the-uk

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