



IMPORTANCE OF RADIATION PROTECTION CULTURE FOR BETTER DOSE CONTROL OF CONVENTIONAL RADIOLOGY EXAMINATIONS

Conventional radiology remains, due to the volume of procedures, the third largest contributor to the collective effective dose in France in 2022, after CT scans and nuclear medicine^a. Several significant events involving cohorts of patients who have benefited from examinations at insufficiently optimized doses, show the need for a better appropriation of radiation protection requirements by professionals, particularly in children. The first event in this series, which differs from the following ones by the use of a scopy mode rather than the acquisition of still images, feeds the present sharing of experience.

THE EVENT AT A GLANCE

The ASNR has received a report of a significant radiation protection event (ESR) following a retrograde urethrocytography performed on a child. The event was discovered by the radiologist while writing the report. The first investigations conducted by the hospital identified the use of continuous scopy mode instead of pulsed scopy mode during the examination of the child due to a misconfiguration of the protocol of the X-ray table with which the examination was carried out.

The ESR's instruction led the ASNR to ask the establishment to continue its investigations because this remote-controlled table is also used, in particular, for two other categories of dynamic examinations:

- opaque enemas;
- Gastrointestinal transits.

It appears that over the period 2012-2024, 667 patients, including 451 minors, were exposed to higher doses than those usually observed for one of these three examinations.

For examinations performed between the date of installation of the table in 2012 and the date of installation of the image archiving system (PACS) in 2017, patient doses could not be traced. The identification of the other patients and the collection of the Product Dose Surface (PDS) values of their examination(s) revealed a heterogeneity of the latter. Some were significantly higher than the French reference values (DRLs^b) or those given by the Irish^c or English^d literature in the other cases. These elements have led professionals to question their practices and the hospital to implement immediate and medium-term corrective actions.

ANALYSIS OF CAUSES AND INFLUENCING FACTORS

TECHNIQUES :

- difficulty in removing the anti-diffusion grille from the device;
- ambiguity of the visual interface (console) and of the sound emission at exposure (repetition of beeps in continuous scopy mode).

ORGANIZATIONAL:

- Lack of organization during the commissioning of this X-ray table which led to the use of the equipment in continuous scopy mode instead of pulsed mode (usually configured by default at the factory according to the manufacturer);
- purchasing strategy that did not prioritize the automatic transfer of dosimetric indicators from the remote-controlled table to the RIS^e to be inserted into the patient's examination report;
- lack of organization in the management of users' skills (detection of training needs, planning, monitoring and evaluation of training) after the departure of the medical electroradiology technician (MERM), a referent initially trained in the use of this radiology table, leading to:
 - insufficient training of new referents and new MEMs with regard to:
 - to the indications of the lectern;
 - parameter settings;
 - the use of accessories (anti-diffusing grid, filters, etc.).
 - insufficient knowledge of patient radiation protection professionals to:
 - assess the doses of the examinations in relation to the values of the DRLs;

^a Source: *Report ASNR/2025-00145 relating to the ExPRI 2022 study "Exposure of the population to ionising radiation due to diagnostic medical imaging procedures - Procedures carried out in France in 2022"* (p.18) - published by ASNR on asnr.fr

^b NRD: Diagnostic Reference Level - tools for optimizing patient exposures in the field of medical imaging.

^c HIQA, Guidance on the establishment, use and review of diagnostic reference levels for medical exposure to ionising radiation. December 2023

^d Radiation Protection n°185 European Guidelines on Diagnostic Reference Levels for Paediatric Imaging, European Union, 2018

^e RIS: Radiology Information System

FEEDBACK

FOCUS ON AN EVENT DECLARED TO THE ASNR



- Optimize the doses of the examinations with regard to:
 - good practices for conducting reviews;
 - Imaging system functionality
- understand the value of regularly evaluating and analyzing the doses delivered for different types of examinations.
- lack of authorisation of doctors and electroradiology technicians (MERM) at workstations, in particular the use of the X-ray table for the latter;
- lack of formalization of protocols by type of act, particularly in pediatrics;
- diversity of internal referents in medical physics and lack of clarity of the functions assigned to each of them in the medical physics organization plan (POPM) and inadequacy of missions / resources in medical physics with regard to the volume of radiology acts, their diversity and the size of the radiological equipment leading to:
 - insufficient reflection on the part of the client/service provider on the time to be dedicated to medical physics activities;
 - insufficient involvement by the multidisciplinary team of the radiology department in medical physics activities to design, optimize and monitor examination protocols [4];
 - an imprecise formalization of tasks between the various stakeholders of the establishment, their role(s) and their respective responsibilities (optimization, QC^d, etc.) in the POPM and a lack of knowledge of the staff as to their role;
 - a lack of organization of the collection of doses delivered to patients and their evaluation for the purpose of analyzing practices, particularly for pediatric examinations.
- insufficient consideration of user feedback (alerts, malfunctions, adverse events) when they would probably have made it possible to detect the configuration error earlier.

HUMANS:

- non-systematic reporting of the value of the PDS on the imaging report by radiologists.



REMINDER OF THE OBLIGATIONS TO BE RESPECTED

Staff Training/Empowerment

Any person associated with the performance of acts exposing to ionizing radiation must have received:

- initial training on the risks associated with ionising radiation and on the principle of justification and optimisation of procedures;
- regularly updated continuing education in patient radiation protection;
- an authorisation adapted to the use of the equipment and the workstation, described in the establishment's quality system [1].

Implementation of the Exam Justification Principle

Before requesting and performing any act involving ionising radiation, the doctor requesting the act and the doctor performing the act must check the justification for the indication. This is based on reference guides (ADERIM^e), recommendations from the HAS or expert opinion [2].

Implementation of the principle of examination optimization

GENERAL

The principle of optimization requires:

- the formalization of clinical practices and responsibilities in the quality assurance system [3];
- the adaptation of exposure parameters to each patient;
- regular evaluation of dosimetry indicators on a sample of patients and comparison of its median to the diagnostic reference levels (DRLs) published by the ASNR or to other available data^f [5];
- the conduct of optimisation actions in the event of unjustified exceedances [5].

REGULAR EVALUATION OF DELIVERED DOSES

The director of the act shall ensure:

- in view of the results of the above-mentioned evaluation in the 3rd point for which it is responsible, that its practice is in accordance with the principle of optimisation [5];
- the transmission of the results of the evaluations concerning the acts for which there are DRLs [5];
- the notification, where appropriate, to the ASNR, under the conditions set out in ASNR Guide No. 11^g, of certain exceedances of the values of the average dose recorded in relation to the value of the DRLs [6].

Review Report

The report of an act using ionizing radiation must mention [7]:

- the identification of the patient and the performing physician;
- the date and the elements justifying the act;
- the technique and device used;
- the parameters useful for estimating the dose received (e.g. Product, Dose, Surface, scopy time).



Photos: Cystography - (courtesy of Pr. Jean-François CHATEIL)

REMINDER OF PROFESSIONAL RECOMMENDATIONS

Conducting Examinations

The radiology department has procedures, by type of procedure, for each piece of equipment and each category of patient concerned (Article R. 1333-72 of the Public Health Code).

A typical cystography procedure includes *at least* the following elements (broken down here as an example):

- type of device: remote-controlled table for dynamic scopy tracking equipped with a flat panel sensor;
- use of pulsed scopy, with a low frame rate (<5 images/sec), allowing to keep the scopy images;
- use of an anti-scatter grid: not necessary before the age of 5 if the device allows it to be removed;
- use of additional filtration: 1 mm Al + 0.1 or 0.2 mm Cu (or equivalent);
- size of the collimated field of exploration with diaphragms;
- Sensor positioned as close as possible to the child.

Depending on the equipment, be aware of the effects of the change in field size/secondary magnification on the delivered dose and prefer frozen scopy images if they are of sufficient quality, rather than graph images:

- position the cell for automatic exposure outside the contrast-filled bladder;
- Recommended Impacts:
 - abdomen without preparation of the front before probing. Brief scopies during filling to judge the appearance of reflux;
 - pelvis, bladder in repletion, a scopy preserved; Two voiding images, ideally with and without a catheter, with visualization of the urethra in its entirety and covering the upper pole of the kidneys from the front in girls and obliquely in boys.
- guarded scopy of the abdomen from the front after urination;
- In children who have not been toilet trained, a second systematic filling, or even a 3rd filling, if the catheter has been left in place, is recommended, promoting the discovery of vesicoureteral reflux, most often minor. Only the pervoid x-rays and the end-of-void scopy are performed.

A total of 6 to 8 images are to be provided for this examination, and potentially, depending on the equipment, with as little use as possible of handwriting.

For the doctor performing the act, it is necessary to take into account the paediatric DRLs in force at the time of transcription of the dose delivered in the report or validation of the report.

ADDITIONAL COURSES OF ACTION PROPOSED BY THE REX WG

The REX Imaging WG^h recommends that accreditation to workstations distinguish paediatric practices from those of adults for all or part of the radiological examinations; It underlines the importance of the recommendations made in the guide "Needs, conditions of intervention and staffing levels in medical physics in medical imaging";

It recalls the requirement to report the dosimetric indicators on the examination report and to check their consistency with the dosimetric evaluations carried out [4];

It highlights the importance for healthcare institutions to:

- in the absence of a physicist, they must have MERM referents per radiology system duly trained in their use;
- organise the management of malfunction reports;
- set up and monitor an action plan for the optimisation of examination doses [3];
- ensure that the missions/resources allocated to medical physics are adequate, even when it is delegated to a service provider.

It encourages the evaluation of professional practices and continuing education to prioritize the optimization of doses for pediatric examinations.

It strongly encourages imaging services/centres to provide information on the height, weight and age of each patient, particularly paediatric patients, before acquiring images for the complete patient's file and thus facilitate a dosimetric reconstruction in the necessary cases.

It recommends that health establishments remobilise to:

- take better account of the feedback^l published by the ASNR on ESR in interventional radiology, due in particular to the improper use of imaging equipment or the incorrect configuration of examination protocols;
- organise the acceptance stages of imaging equipment based on the recommendations^k published by the ANSM for the installation of new radiology equipment "Acceptance of MDs^l used for radioguided interventional procedures (2018) – [Healthcare professionals]" and in particular, recommendations 3 to 7;
- provide in their contractual relations with manufacturers for the updating of protocols when the latter can technically implement them on the existing fleet in order to benefit from dose optimization;
- Disseminate awareness-raising materials on patient radiation protection to health professionals, along the lines of the 10 key points identified by the IAEA^m in terms of radiation protection of patients in fluoroscopyⁿ.



SUMMARY OF THE MAIN REGULATORY OBLIGATIONS FOR RADIATION PROTECTION OF PATIENTS

REF.	DOMAIN	MAIN REQUIREMENT	REGULATORY REFERENCES
	Quality control of imaging equipment	The operator is responsible for implementing internal and external quality controls in accordance with the procedures and periodicity provided for by the ANSM's decisions ¹ relating to each type of device. In addition, in the case of devices used during exposure to ionising radiation which do not fall within the scope of any decision, the operator is responsible for the implementation of the internal quality control provided for by the manufacturer.	Art. R. 5212-31 to R. 5212-34 of the Public Health Code (CSP) and decisions of the ANSM relating in particular to certain diagnostic radiology facilities.
[1]	Training and Empowerment	Compulsory initial and continuing, theoretical and practical training in patient radiation protection; Accreditation for workstations as part of the implementation of the quality assurance system in medical imaging.	Art. L.1333-19, R. 1333-68 and R. 1333-69 of the CSP; ASN Decision No. 2017-DC-0585 of 14/03/2017 amended by Decisions No. 2019-DC-0669 of 11/06/2019 and No. 2019-DC0660 of 15/01/2019 (Art. 9).
[2]	Justification of acts	Benefit/risk verification before any exposure.	Art. R. 1333-52 and R. 1333-47 of the CSP.
[3]	Formalization of clinical practices	Implementation of a quality management system applying "from the justification of the choice of the act, the optimization of the doses delivered to patients and the delivery of the result of this act" and the development of written procedures by type of act held near the equipment concerned.	Art. L. 1333-19, R. 1333-70 of the CSP, 1st paragraph of art. 6 of the Order of 19 November 2004 (amended by the Order of 29 July 2009), ASN Decision No. 2019-DC-660 of 15/01/2019 and Art. R. 1333-72 of the CSP.
[4]	Dosimetric optimization	Involvement of a medical physicist in the dose optimization process.	II of Article R. 1333-68 of the CSP.
[5]		Periodic evaluation of doses, analysis of practices, comparison to DRLs and reduction of doses or corrective actions if exceedances not justified.	Articles R. 1333-57 and R. 1333-61 of the CSP and ASN Decision No. 2019-DC-0667 of 18/04/2019.
[6]		Report of a significant radiation protection event if the exposures identified during the periodic assessment are significantly higher than the diagnostic reference levels.	Art. L. 1333-13 of the CSP and ASN Guide No. 11 Index 2 – July 2015.
[7]	Report	In particular, mention of the dosimetric parameters and the elements of justification.	Art. R.1333-66 of the CSP and decree of 22 September 2006 (articles 1 to 6).

^d CQ: Mandatory quality control pursuant to Art. R.5211-5 of the Public Health Code.

^e ADERIM: Assistance with the request for radiology and medical imaging examinations - a reference framework of good practices for all doctors who are required to request or carry out imaging examinations (<https://aderim.radiologie.fr/>).

^f The data available may be specific to the health care facility in relation to other facilities or in relation to other health facilities performing the same examinations or publications from learned societies or national or international organizations.

^g ASNR Guide No. 11, relating to significant events in the field of radiation protection (excluding basic nuclear installations and transport of radioactive materials), specifies the reporting procedures and the codification of the criteria to be used.

^h The REX Imaging WG is a working group set up by ASNR to carry out a multi-professional analysis of significant emblematic radiation protection events and to issue recommendations to enrich the corrective and preventive actions put in place by the establishments that have declared them. These actions allow ASNR to better share feedback from these events with professionals, in accordance with art. R.1333-74 of the CSP.

ⁱ The ASN-SFPM recommendations relating to the needs, conditions of intervention and staffing in medical physics and medical imaging are published on the ASNR website, under the heading "ASNR Guides".

^j Series: Patient Safety Bulletin - The Mastery of Medical Devices in Radio-Guided Interventional Practices: A Team Affair [May 2023]

^k The ANSM's recommendations on the acceptance of radiological equipment for interventional practices are posted on the ANSM website in the item "Interventional radiology – [2018]" in the "Recommendations for MD" sub-section of the "Reference document" section. The regulatory provisions applicable to the operator indicated in this document have become obsolete, in particular points 2.2 and 2.3, for which reference should be made to the ASNR compendium "Main regulatory provisions for radiation protection applicable in medical and dental radiology" accessible from the "regulations" section of its website, in the list of "ASNR Guides". The "Associated regulations" section of its ASNR website refers to the page relating to medical devices on the ANSM website with regard to quality control procedures, in particular for certain diagnostic radiology facilities.

^l DM: Medical devices.

^m IAEA: International Atomic Energy Agency.

ⁿ The 10 key points on the radiation protection of patients in fluoroscopy are presented in the form of a poster. The latter has been translated into French and is online on the IAEA website (www.iaea.org) under the heading Home / Resources / Radiation / Protection of Patients (RPOP) / Resources / Posters and leaflets about radiation protection. It is entitled "Poster - 10 Pearls: Radiation protection of patients in fluoroscopy".

¹ ANSM: National Agency for the Safety of Medicines.