Australian Government
Australian Radiation Protection and Nuclear Safety Agency

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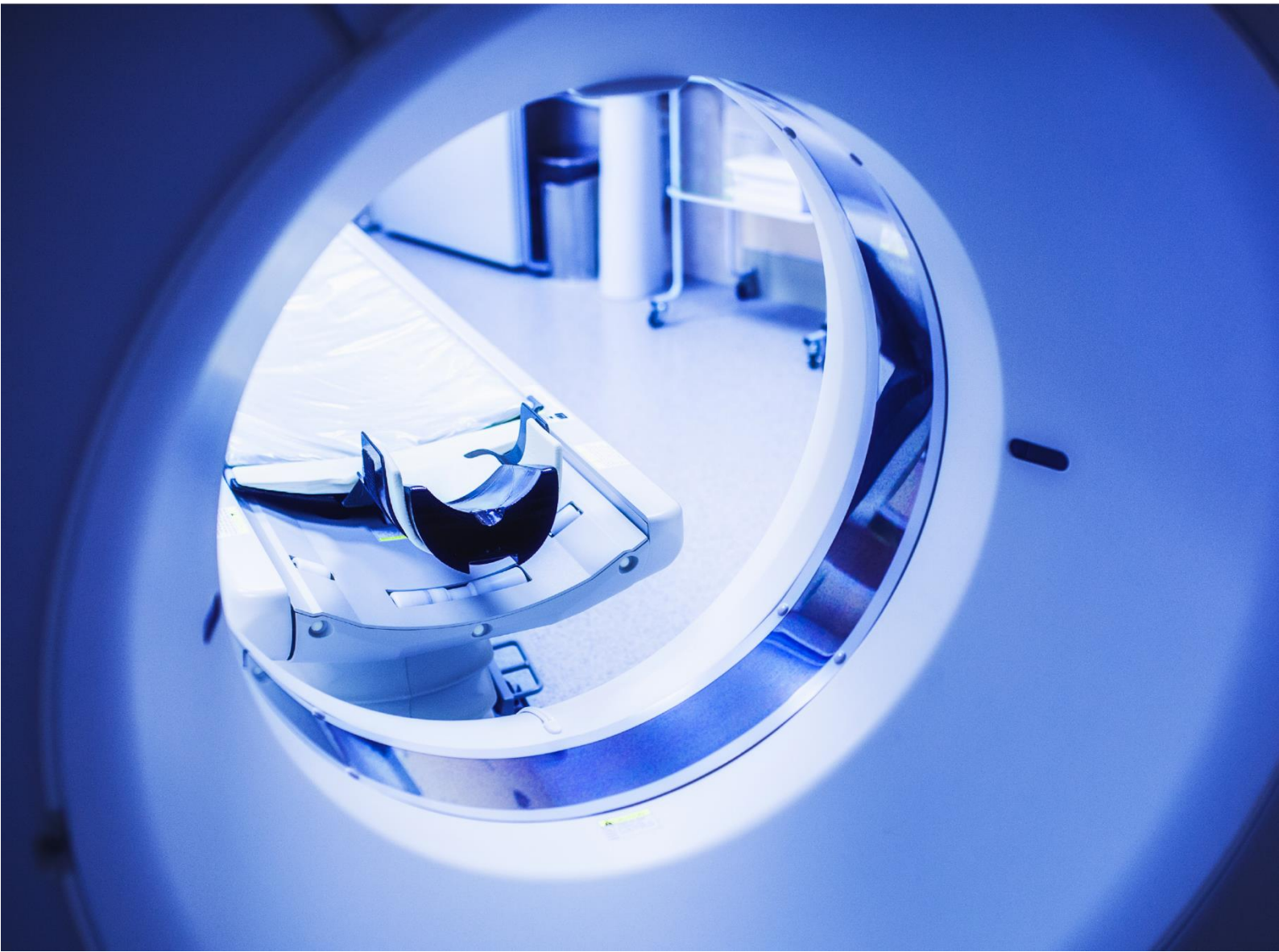
Australian Radiation Incident Register

Annual Report

Report covering incidents occurring in 2023



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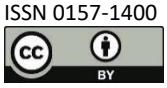

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The mission of ARPANSA is to protect people and the environment from the harmful effects of radiation.

Published by the Chief Executive Officer of ARPANSA in September 2026.

Acknowledgement of Country

From our scientists to the world's first scientists, we respectfully acknowledge Traditional Owners and First Nations communities and their rich cultures. We recognise, respect and continue to learn from Indigenous sciences, and the deep understanding and observations of land, waters and sky carried and shared by First Nations peoples over thousands of years.

Preface

The Australian Radiation Incident Register (ARIR) is a repository of radiation incident information from Commonwealth, state and territory radiation regulators. It is intended to raise awareness of radiation safety and to facilitate the sharing of lessons learnt from radiation incidents across Australia.

The *National Directory for Radiation Protection (2nd Edition, 2021)*, in schedule 4, specifies the types of incidents that must be reported to the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) for compilation in the ARIR. These reporting arrangements are agreed to by all jurisdictions through the Radiation Health Committee (RHC) and the Australian Health Ministers' endorsed National Directory for Radiation Protection (NDRP). Reporting of other radiation incidents is encouraged, including minor events, near misses and other opportunities which could lead to valuable learnings. More information on the RHC and ARIR can be found on the ARPANSA website: arpansa.gov.au.

This report was approved for publication in September 2026, following consultation with professional bodies and state and territory regulators.

Purpose and scope

This report is a summary of data submitted to the ARIR for incidents that occurred in 2023.

By sharing safety outcomes from radiation incidents across Australia, the ARIR can assist in identifying areas where safety efforts may be focused to improve radiation protection for people and the environment.

Geographical or personal data that may lead to the identification of individuals or organisations are not included in an incident report and do not form part of this analysis.

Source of the incident reports

Incidents are reported to regulators by users of radiation in their jurisdiction. The regulator submits incidents to the ARIR based on the user reports received. While the specific requirements for incident reporting vary between jurisdictions, the NDRP outlines the common requirements for reporting incidents to the ARIR. Due to differences in state legislation and differing levels of promotion for reporting to the ARIR, some jurisdictions report more than others. For example, some jurisdictions do not regulate certain types of non-ionising radiation and so do not receive incident reports related to these types of sources.

Incidents are typically investigated by the reporting organisation and, where applicable, the local regulator. The reports identify the direct cause and contributing factors that led to the incident, as well as recommendations or preventative actions implemented to avoid recurrence. No additional investigation is undertaken as part of the preparation of this report. However, additional information may be requested to help categorise incidents and to ensure learnings can be shared.

In some instances, individual incidents that occurred in 2023 are summarised and highlighted. These provide insight into the circumstances of the incident and include the lessons to be learnt, which are typically identified by the reporter or in some instances by the submitting regulator. As such, the learnings may not necessarily represent the views of ARPANSA and may not be appropriate for all situations. Similarly, the reporter-estimated doses are based either on calculated individual dose or, where unavailable, on typical doses for that procedure.

While ARPANSA has performed basic quality assurance on the data, the information presented is based on the reports submitted to ARPANSA and may contain inaccuracies and may be amended from time to time.

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Summary of incidents that occurred in 2023

Radiation is routinely used across Australia by more than 50,000 licensed users who perform millions of tasks each year. The incidents that occur and the nature of the resulting outcomes show that the use of radiation in Australia is generally very safe. However, unexpected events occasionally occur even with safety controls in place. Where such events meet the criteria in the *National Directory for Radiation Protection* (NDRP) they are required to be reported to the Australian Radiation Incident Register (ARIR). The register is managed by ARPANSA, which analyses submitted incidents and publishes the results to raise awareness of common hazards and to identify and promote practices that could prevent future incidents.

A total of 905 incidents were reported in 2023, which is broadly in line with previous years. The nature of incidents is also consistent with previous years. Most incidents in 2023 were related to medical imaging, especially computed tomography (CT), plain film X-ray, and nuclear medicine. The most reported contributing factors involved procedures not being completed as intended, quality assurance checks not detecting issues, and equipment malfunction.

The estimated doses received as a result of these incidents were categorised as 'very low', i.e. below 10 mSv, in 89% of applicable incidents.

An incident will often have several contributing factors, such as not following procedures, quality control errors, or order interpretation issues. However, these factors are not always reported to the ARIR. Preventative measures are the actions reported to avoid recurrence of similar incidents and include reinforcing procedures, improving communication, or conducting regular quality checks.

This is the third year of the short-format report. ARPANSA intends to work with specialists to produce deeper analysis and findings periodically. The annual summary report provides a statistical overview and a snapshot of some of the incidents that occurred.



Overall statistics

Number of incidents reported

There were 905 incidents reported in 2023. Figure 1 shows the number of incidents reported each year from 2018. From 2012 to 2018 there was an overall trend of increased reporting, indicative of increased awareness and positive reporting cultures. Since then, reporting has been more stable, with moderate increases.

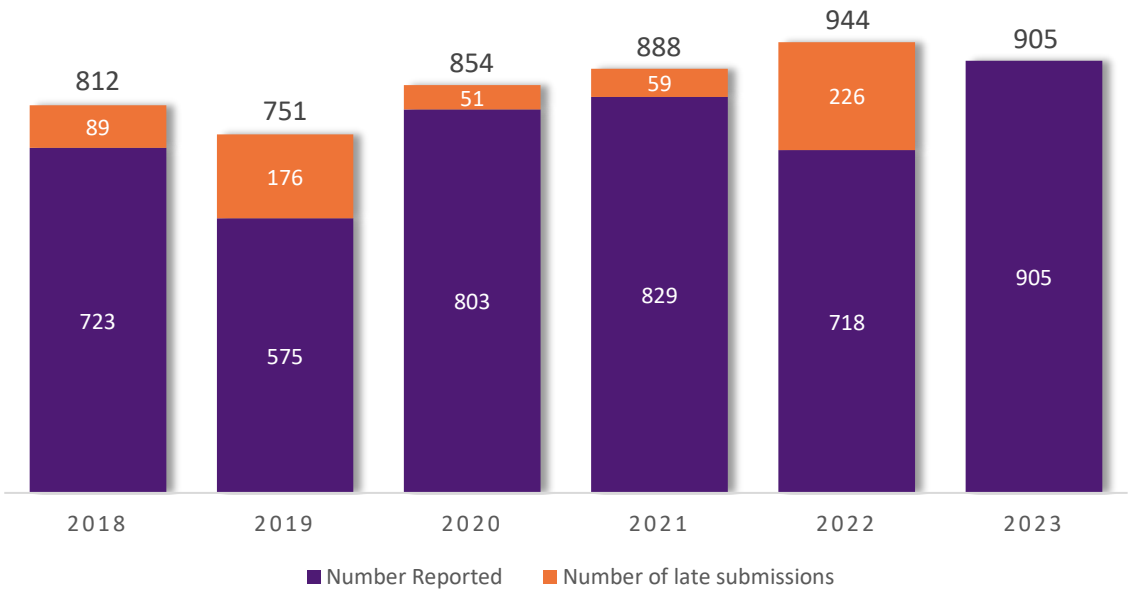

Figure 1: Number of incidents reported to the register over time

The number reported indicates the number of submissions at the time of preparing the report, at least 6 months after the end of the reporting period. Late submissions are those received after the cut-off date. A further 226 incidents were submitted for 2022 after the report had been prepared, bringing the total for 2022 to 944 incidents.

The 905 reported incidents for 2023 is a 26% increase from the 718 incidents reported for 2022, but a 4% decrease compared with the 2022 total when late submissions are included.

Estimated doses received as a result of incidents

Exposure to radiation is reported in terms of effective dose in millisievert (mSv) where possible. Effective dose sums up any number of different exposures into a single number that reflects, in a general way, the overall risk from exposure. It can be used to determine the risk of developing disease later in life[1].

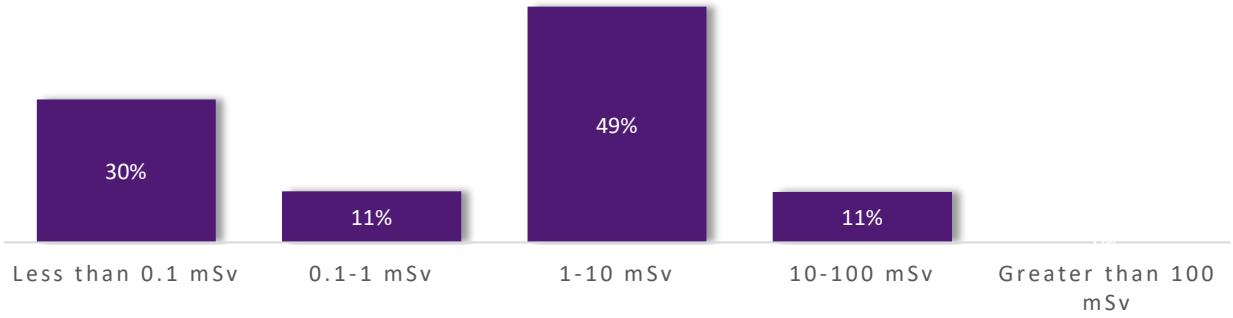

Figure 2: Distribution of effective dose as the result of incidents which occurred in 2023

Figure 2 illustrates the distribution of effective doses across the incidents reported for 2023. No incidents resulted in a dose over 100 mSv, the upper threshold for what is generally referred to as 'low' doses, and 89% were 'very low' or lower (below 10 mSv). At these exposure levels, risk of disease later in life is generally inferred from models, and any later health effect could not be unequivocally attributed to a specific exposure event[2].

Effective dose is not used for exposures that are localised, such as to a specific organ, in which case absorbed dose in gray (Gy) is used. Absorbed dose is a physical measure of the amount of energy deposited by radiation in a mass. Localised tissue reactions may occur after exposures of several Gy. Such exposure levels can be reached, for instance, in interventional procedures and in radiotherapy.

Exposure to non-ionising radiation is generally reported in terms of acute health outcomes and the characteristics of the exposure.

Doses are presented as reported, including doses calculated for an individual patient or estimated based on the procedure. Incident reports are reviewed by regulatory agencies and ARPANSA for quality control. However, doses reported to the ARIR are typically not independently verified, and some information may be missing.

[1] For a discussion on dose and risk, see Publication 147 of the International Commission on Radiological Protection (ICRP) Publications Use of dose quantities in radiological protection

[2] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2012. Report to the General Assembly, with Scientific Annexes. Annex A: Attributing health effects to ionizing radiation exposure and inferring risks. United Nations, Vienna. Available at: https://www.unscear.org/unscear/en/publications/2012.html [Accessed 21 Jul. 2025].

Types of incidents reported

Table 1 shows the number of incidents by category over the previous 5 years. The largest category continues to be medical imaging. This is to be expected as more than 16 million diagnostic medical imaging procedures involving radiation were carried out in 2023 in Australia, according to Medicare Benefits Schedule (MBS) information.

Table 1: Overall ARIR statistics for 2023 compared with previous 4 years

	Incident category	2023		2022		2021		2020		2019	
		No.	%	No.	%	No.	%	No.	%	No.	%
Medical	**Medical - Diagnostic imaging (All)**	**813**	**90**	**585**	**81**	**739**	**89**	**746**	**93**	**533**	**93**
	+ Computed tomography (CT)	*402*	*44*	*255*	36	*312*	*43*	*295*	*36*	*208*	*26*
	+ Plain Film X-ray/ conventional radiography	*189*	*21*	*130*	18	*205*	*29*	*234*	*28*	*143*	*18*
	+ Diagnostic nuclear medicine	*178*	*20*	*175*	24	*166*	*23*	*157*	*19*	*141*	*18*
	+ Interventional / Fluoroscopic imaging	*36*	*4*	*9*	1	*30*	*4*	*46*	*6*	*36*	*4*
	+ Dental	*8*	*1*	*16*	2	*26*	*4*	*14*	*2*	*5*	*1*
	Medical - Radiotherapy	***78***	**9**	**118**	**16**	**78**	**11**	**40**	**5**	**23**	**3**
Non-medical	**Contamination**	**3**	**<1**	**2**	**<1**	**3**	**<1**	**3**	**<1**	**4**	**<1**
	Transport of radiation material	**1**	**<1**	**2**	**<1**	**2**	**<1**	**4**	**<1**	**3**	**<1**
	Imaging (inc. industrial radiography and XRF)	**0**	**<1**	**1**	**<1**	**1**	**<1**	**4**	**<1**	**1**	**<1**
	Found/lost/stolen	**2**	**<1**	**2**	**<1**	**1**	**<1**	**1**	**<1**	**6**	**1**
	Non-Ionising Radiation (inc. laser and IPL)	**1**	**<1**	**0**	**<1**	**3**	**<1**	**1**	**<1**	**2**	**<1**
	Other	**7**	**<1**	**8**	**1**	**2**	**<1**	**4**	**<1**	**3**	**<1**
	Total		**905**		**718**		**829**		**803**		**575**

Note: percentages are rounded, and numbers are as at time of reporting and do not include the late submissions

About Medicare statistics
Medicare statistics are available online and only include the number of procedures for which Medicare payments are made. As such, the true number of procedures undertaken is higher than that indicated by Medicare statistics. For example, state-operated hospitals receive operational funding to perform imaging services that are not rebated against Medicare, and some private imaging is not covered by Medicare.
[http://medicarestatistics.humanservices.gov.au/]



Cause of incidents

Across all incidents that occurred in 2023, human error was reported as the direct cause in 65% (585) of cases. This is consistent with previous years. The direct, or initiating, cause should not be seen as more important than contributing factors. Addressing contributing factors can be more effective in preventing the same type of incident in future or reducing the consequences of outcomes.

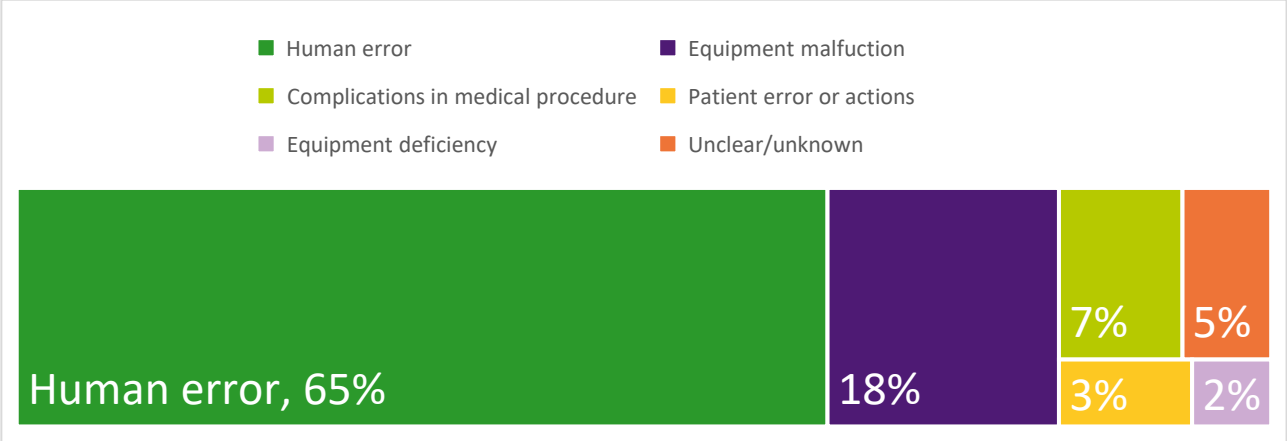

Figure 3: Incidents in 2023 by primary cause

Human error means that something has been done that was not intended, not desired by a set of rules, or that led the task or system outside acceptable limits. Human error does not mean a person is at fault, but only that the outcome of human actions was undesirable. For more information on this and on elements that lead to human error see holistic safety on the ARPANSA website and the Holistic safety guide.

Equipment malfunction includes software and hardware failures. Malfunctions may be caused by human error in the design, manufacture, operation and maintenance of equipment. In contrast, **equipment deficiency** is where the equipment used was not suitable for the task or failed to perform as expected.

Patient factors outside operator control include situations where the patient becomes unwell, suffers anxiety (e.g. claustrophobia), or self-discharges. Incidents involving people who are unknowingly pregnant are also included in this category.

Medical procedure complications can result in a higher-than-normal dose. For example, during a complex surgery a significant fluoroscopic dose may be delivered as the procedure takes longer than is typical. This is reportable as an incident in most jurisdictions.

Contributing factors

An incident will often have several contributing factors. However, these factors are not always identified in the reports submitted to the ARIR. In some instances, such as medical complications during a procedure or equipment failure, these factors may not be readily apparent. Thirty-two percent (32%) of incidents identified 'Other' or 'None provided' for contributing factors. Analysis of contributing factors, such as why a procedure was not followed, can have wider benefits by exposing underlying vulnerabilities that could result in unrelated incidents.

It is possible that the incidents would not have occurred if one of the contributing factors had been addressed. This is the basis for the 'Swiss cheese' model of safety, where an incident or accident occurs only when vulnerabilities align. This demonstrates the value of the 'defence in depth' approach to radiation safety, where several independent controls contribute to overall safety. With effective monitoring of these controls, it is possible to detect positive or negative deviations from expected outcomes. This can lead to issues and improvements being identified, which may result in significant reductions in the likelihood of an incident with significant outcomes occurring.

The most common contributing factor was individuals not following procedures, which was identified in 31% of incidents. The next most common contributing factor was errors in quality control. This is consistent with the findings of previous years.

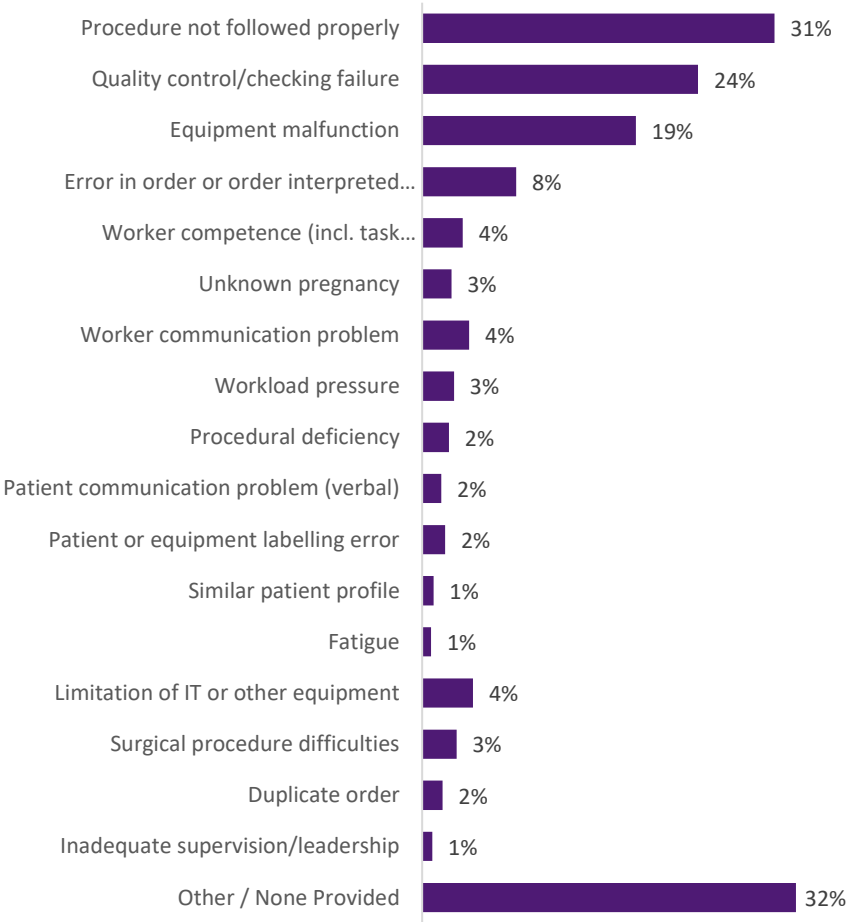

Figure 4: Contributing factors identified in 2023 incidents

Note: As incidents have more than one contributing cause the total causes are more than 100%

Summary of controls and preventative measures implemented

Preventative measures are the actions taken to prevent recurrence of similar incidents; these were identified in most reports. Examples of when no actions were identified include where equipment faults could not be reproduced, unforeseen patient complications, and unknown pregnancies.

Reinforcement of procedures remains the most common action taken after an incident. In 2023, such actions were taken in 43% of incidents. However, administrative controls, such as reinforcing procedures, are unlikely to be effective in the long term if used in isolation, especially if they relate to lapse or slip errors.

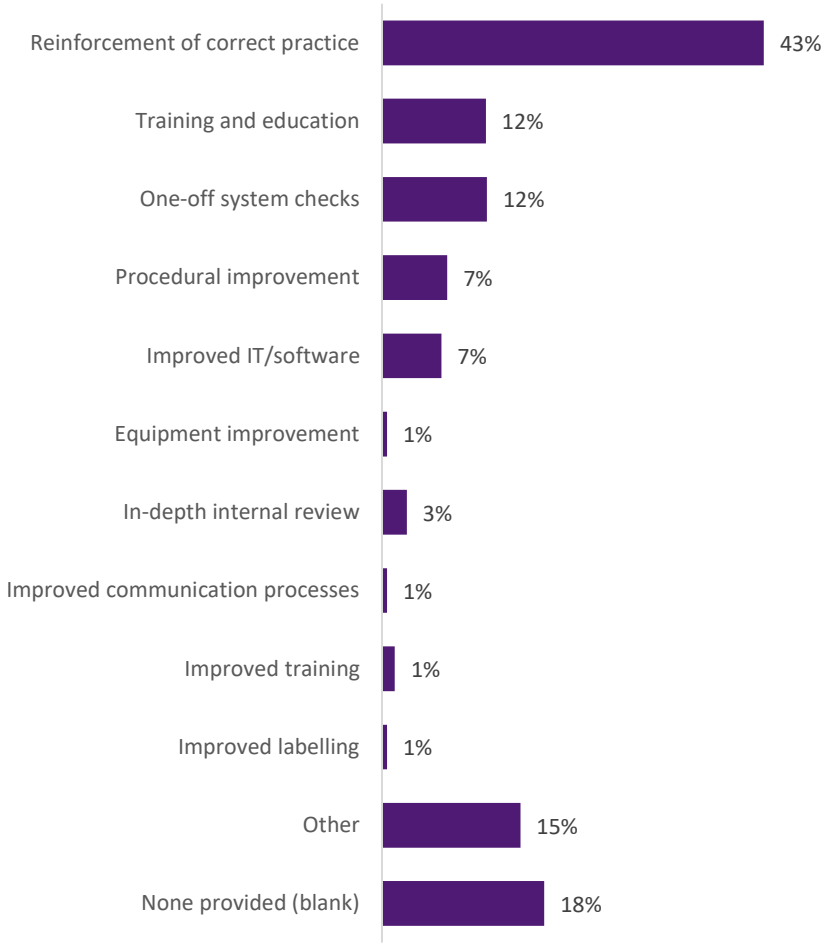

Figure 5: Remedial actions taken to prevent recurrence in 2023

Note: As incidents may have more than one control or preventative measure, the total may be more than 100%

The ARIR Annual Report for incidents in 2020 included nuclear medicine workflows, which provide examples of where a more holistic approach is undertaken.



Incidents by category

Medical

This category covers medical imaging, such as procedures performed using X-ray apparatus.

Table 2: Overall statistics for medical incidents by modality

Modality	Number of incidents reported	% of all medical incidents	Effective dose per incident (mSv) *Note: does not include skin or critical organ doses*		
			Average	Min	Max
Computed tomography (CT)	402	45	5.6	0.0	50.5
General X-ray	189	21	0.6	0.0	18.4
Nuclear medicine	178	20	4.2	0.0	32.2
Fluoroscopic/interventional	36	4	N/A	-	-
Dental	8	1	0.0	0.0	0.2
Radiotherapy	78	9	N/A	-	-
Total	**891**				

Table 3: Overall statistics for 2023 diagnostic imaging (including nuclear medicine imaging) incidents by description

Type	Number of incidents reported	% of medical incidents	Effective dose per incident (mSv) *Note: does not include skin or critical organ doses*		
			Average	Min	Max
Unnecessary scans or scans not as intended	523	64	3.7	0.0	50.5
Equipment failure	121	15	4.0	0.0	37.0
Spills/extravasation	49	6	3.0	0.0	11.8
Medical procedure complications	31	4	1.1	0.0	18.4
Unknown pregnancy	22	3	4.3	0.0	30.0
Other	67	8	6.8	0.0	27.5
Total/average	**813**				

Unnecessary imaging or not as intended

The most common type of incident in the medical category was procedures that were not carried out as intended by the referrer. This includes errors in the referral or during imaging leading to the wrong patient, wrong procedure, wrong site, or an unnecessarily repeated scan. These were discussed in detail in the feature topic of the ARIR Annual Report for incidents in 2017. Many of these incidents identify issues in managing changes across digital systems.

Example case: Unnecessary imaging

A hospital patient had a CT scan of the spine unnecessarily repeated. The patient had already undergone imaging at another site, but this imaging was initially considered incomplete, and a request for repeat imaging was made. After further review, the patient's electronic medical record was amended to indicate that the prior imaging was satisfactory, and the requested scan was not required. However, this cancellation was not entered into the electronic imaging ordering system and radiographers were not informed, resulting in the scan being repeated unnecessarily.

The effective dose from the unnecessary scan was 19 mSv.

Learnings:

This incident highlights the need for a systematic approach to manage changes in the patient's needs, and effective cross-team communication.

Equipment failure

The next most common type of incident was where equipment was selected as the direct cause. This is typically equipment malfunction, but can include other limitations of the equipment.

Equipment-related incidents were the feature topic in the ARIR Annual Report for incidents in 2019.

Example case: Equipment failure

A patient underwent a repeated barium swallow study after a fluoroscopy X-ray unit error occurred. The error resulted in some screening runs not being saved for reporting on the picture archiving and communication system. Therefore, the procedure and fluoroscopy had to be repeated.

Radiotherapy

Radiotherapy is the use of radiation as treatment, often for cancer. This was the feature topic of the ARIR report for incidents in 2018. The ARIR Development Committee is currently working on enhancements to the reporting system to improve the quantity and quality of information received.

Doses in therapy
Radiotherapy doses are different from those in diagnostic imaging. A very large dose is delivered to a specific area for a clinical benefit. Other surrounding areas receive a smaller dose. On rare occasions the high dose might not be delivered to the correct site. As the absorbed dose (measured in Gy) is concentrated on a specific area this is difficult to compare with an effective dose (Sv) for the whole body, see 'Estimated doses received as a result of incidents' section on page 3.

Table 4: Radiotherapy incident statistics in 2023

Category	Number of reports	Fraction of prescription	Dose *(excess/underdose)*	Comment
Planning/Imaging	61	N/A	<30mSv	70% involved equipment failure
Incorrect treatment site	7	20–100%	2.5–4 Gy	Includes misalignment
Incorrect treatment dose	6	20–50%	3–20 Gy	Includes excess and reduced dose
Other	4	N/A	0.1–0.5 mSv	Includes equipment failure during treatment
Total	**78**			

Example cases: Radiotherapy

A patient being treated at an oncology practice with stereotactic radiotherapy received an excess dose to one region of the brain.

The patient had previously received treatment to two brain lesions: 25 Gy and 27 Gy in 5 and 3 fractions, respectively. Several months later, the patient returned for treatment of three different brain lesions, with a planned dose of approximately 25 Gy in 5 to 8 fractions. The radiation oncologist reviewed and accepted a plan that overlapped with a previous treatment area, and treatment commenced. It was later identified that the previously treated right cerebellum region had been contoured rather than the new right cerebellum lesion. The radiation oncologist cancelled the remaining treatment to the right cerebellum. The total dose to the original right cerebellum target area was approximately 41 Gy.

A patient with oesophageal cancer was being treated with external beam radiation therapy when the first treatment fraction was delivered approximately 2 cm superior to the planned target. The prescribed treatment was 20 Gy in five equal fractions. The error occurred because the planning image was taken at the incorrect vertebral level. The remaining four fractions were delivered to the correct target volume.

***Learnings:** These incidents highlight the importance of robust plan review, clear target-volume verification, and independent checks before treatment delivery, particularly where a patient has had previous treatment in a nearby anatomical region.*

Non-medical incidents

Category	Number of reports
Contamination (non-medical, e.g. laboratory)	4
Borehole logging	4
Radiation gauges (incl. portable density/moisture)	2
Sources found/lost/stolen/unauthorised	1
Lasers/IPL	1
Other	2
Total	**14**

Lost/found

Radioactive material that is outside of regulatory control, temporarily or long term, presents a risk as the people who are in possession of the material may not be complying with the same safety standards that are enforced by the regulatory bodies.

Example case: Found source
Two large tanks were lifted by crane and removed from a mine site and sent to a scrap metal yard by truck. On arrival at the yard, above-background levels of radiation were detected, causing the portal/gate monitors at the weighbridge to alarm. The tanks were then sent back to site and returned to their original spot. The movement of the tanks did not follow normal processes, as some processes were assumed not to apply due to the age of the tanks. *No actual contamination or excess exposure occurred.*
Two nuclear density gauges were stolen from a geotechnical consultant. The gauges had been returned from calibration through a third-party transport company, unloaded from the transport truck and not returned to an appropriate locked storage area. *Following an internal investigation, the company is considering installing GPS tracking in all gauges.*

Additionally, a source was lost and found in the Western Australian outback in January 2023. While a report of this incident was not submitted to ARIR, valuable lessons learnt during this event may benefit from inclusion in future reports. Information on the incident is available on the ARPANSA and ANSTO websites, including advice from the Radiation Health and Safety Advisory Council (RHSAC) regarding residual risks.

Contamination with radioactive material

Radioactive materials are frequently used in research laboratories and for industrial purposes across Australia without incident. However, contamination with radioactive material can and does occur. Contamination events have a higher risk of significant exposure to radiation, as skin contact or ingestion is possible due to the material no longer being contained.

Example case: Contamination potential

There was an inadvertent spill of radioactive material in a 'hot lab' of a veterinary practice.

An uncapped syringe was inadvertently placed to the side of the bench instead of directly into the lead-lined syringe holder. The plunger was depressed while the syringe was being picked up to place it in the syringe shield, causing a leak.

The area was cleaned and contaminated items were isolated in the basement of the facility to allow decay. The hot lab was secured from entry until the RSO assessed and advised that the area was cleared for use.

TLD badges were sent for analysis, and no significant increase in dose was recorded.

Learnings:

A number of enhancements were implemented, including:

- *Benchtop to be replaced with stainless steel incorporating a 12 mm lipped edge and coving up the wall.*
- *Contamination surveys to be performed after every administration event and results recorded.*
- *Staff training on incident reporting and what to do in the event of a spill.*

Radiation gauges

Fixed and portable radiation gauges have widespread use across various industries in Australia and are routinely used without incident. Where requirements and guidelines are not followed, the risk of an incident can be increased.

Example case: Damage of radiation gauge

A portable density-moisture gauge (PDMG) was struck by mobile plant (a water truck).

While performing on-site density testing, the gauge was left unattended while the operator was approximately 60 metres away performing other sampling. Portable signage was not used.

The gauge was checked on site to ensure the source was present and shielded, it was then transported off site via a Type A package. No excess exposure resulted from this incident.

Learnings:

This incident highlights the importance of signage and ensuring gauges are not left unattended, as described in the Code of Practice and Safety Guide for Portable Density/Moisture Gauges Containing Radioactive Sources (2004).