Radiation Act 2005

Annual report for the financial year ending 30 June 2021

VICTORIA State Government | Department of Health


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Radiation Act 2005

Annual report for the financial year ending 30 June 2021

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Available from the department's Radiation Act annual report homepage <https://www2.health.vic.gov.au/public-health/radiation/radiation-regulatory-framework/radiation-laws/radiaction-act-annual-report>.

Contents

Radiation regulation in Victoria in 2020–21 – a snapshot 1
Machinery-of-government changes 1
Impacts of the coronavirus (COVID-19) pandemic 1
Expansion of resources 1
Licensing 1
Licensing compliance monitoring 2
Coronial inquest into death due to anaphylactic reaction to contrast administered for a CT scan 2
Enforcement 2
Radiation incidents in 2020–21 2
Mandatory testing of medical diagnostic X-ray units 3
Radiation shielding requirements 3
Mineral sand mining and processing 3
National policy development 4
Other activities 4
Introduction 5
Regulating radiation safety and impacts of the pandemic 5
Legislation 7
Radiation Act 7
Radiation Regulations 7
Stakeholder engagement and communication 8
Integrated Regulatory Review Service mission 9
New licensing system 10
Automatic mutual recognition 11
Summary of department-issued authorities 12
Enforcement action 14
Available enforcement actions 14
Enforcement actions taken in 2020–21 16
Prosecutions 16

Focused activities **17**

Compliance monitoring program and regulatory focus 17

Implementing the Code for Radiation Protection in Planned Exposure Situations 17

Radiation shielding assessments 18

Coronial inquest into death due to anaphylactic reaction to contrast administered for a CT scan 18

Concerns about skin cancer radiotherapy treatments at a private clinic 19

Commercial tanning practices 19

Mineral sands mining and processing 19

Mandatory testing of medical diagnostic X-ray units 23

Emergency response function 24

Representation on national committees 24

New national standards 24

National policy development 25

Secretariat support for the Radiation Advisory Committee 28

Radiation incidents **29**

Focus on medical radiation incidents 32

Appendix 1: Radiation incident details **34**

Radioactive sources 34

Pharmaceuticals 34

Imaging modality abbreviations 34

Radiation Act incident summary, 2020–21 35

Appendix 2: Overview of reported incidents for the past 10 years, per financial year **75**

Appendix 3: Diagnostic imaging services over the past 10 years in Victoria **76**

Appendix 4: Diagnostic imaging involving the use of CT and nuclear medicine over the past 10 years in Victoria **77**

Glossary **78**

Radiation regulation in Victoria in 2020–21 – a snapshot

The purpose of the *Radiation Act 2005,* which took effect in September 2007, is to protect the health and safety of Victorians and the environment from the harmful effects of radiation. The Act requires that the Secretary of the Department of Health publishes an annual report that describes the activities of the Secretary under the Act and summarises all authorities issued, renewed, suspended, cancelled, varied, transferred or surrendered during that year. The report must also detail all radiation incidents investigated and summarise all prosecutions for offences in that year.

Machinery-of-government changes

On 1 February 2021, the Department of Health and Human Services separated into two new departments: the Department of Health and the Department of Families, Fairness and Housing. The Department of Health ('the department') is now responsible for regulating radiation safety and administering the Act.

Impacts of the coronavirus (COVID-19) pandemic

Although the need to deploy specialist radiation safety staff to the COVID response reduced this financial year, regulating radiation safety was nevertheless affected by the pandemic. This impact saw one specialist staff member deployed for most of the year. Routine compliance inspections were heavily impacted, and Radiation Team members worked from home for almost all the financial year.

Expansion of resources

The November 2020 Victorian State Budget allocated more resources to the department. The additional funds increased 'boots on the ground' and has allowed a 45 per cent expansion in the number of specialist radiation safety officers. This will improve the quality and speed of assessing the thousands of licence applications the department receives every year and, importantly, ensures an increasing field presence to assess compliance with the licensing requirements. The new staff were onboarded late in the financial year, so we will not see the impact of the staffing increase until the next financial year and not fully until after lockdowns have ended.

Licensing

Under the Act, only licence holders can conduct a radiation practice or use a radiation source. As of 30 June 2021 there were 15,241 'use licences' and 2,738 'management licences' issued in Victoria, most of which are held in the medical and dental sectors.

A new licensing system began operation in October 2019, which had about 14,500 registered users as of 30 June 2021.

Work is still progressing to move the other more complex types of radiation authorisations onto the new system.

Preparing for new laws allowing automatic mutual recognition of existing licences in other jurisdictions was a focus of the second half of the financial year.

Licensing compliance monitoring

The department conducted 136 inspections in the 2020–21 financial year as part of its licensing compliance monitoring program. This was below the Victorian State Budget target of 480 inspections. This shortfall was due in large part to the number and length of lockdowns and the inability of authorised officers to perform routine targeted inspections. During the lockdowns the department conducted 66 virtual audits of radiation practices.

Coronial inquest into death due to anaphylactic reaction to contrast administered for a CT scan

The department followed a coronial inquest conducted into the death of a patient following a cardiac computed tomography (CT) procedure. The department will review the transcript of the coroner's inquest and await the coroner's findings.

Enforcement

The department initiated three prosecutions for alleged breaches of the commercial tanning ban in 2020–21. A radiation source was rendered inoperative and a 'show cause' notice was issued for the proposed cancellation of the management licence for the radiation source.

Radiation incidents in 2020–21

In 2020–21, 213 radiation-related incidents were reported to the department, 208 of which were in the medical sector. Most of the medical incidents involved unplanned or incorrect medical imaging scans on patients.

There has been an increase of about 220 per cent in the number of incidents reported to the department over the past 10 years and a similar increase in the number of incidents involving medical use of radiation over this period.

The number of reported medical incidents in 2020–21 was about 17 per cent higher than the previous year.

The increased number of medical radiation incidents over the past 10 years is most likely due to three significant factors – increased awareness of the requirement to report medical incidents, a rapid increase in the use of medical radiation procedures and an increase in the use of CT and nuclear medicine procedures that usually result in a dose to the patient greater than the reporting threshold of 1 mSv.

Mandatory testing of medical diagnostic X-ray units

A prescribed radiation source may only be used for human diagnostic purposes if there is a current certificate of compliance in place. The department continued to monitor licensees for compliance with the testing requirements in 2020–21. We also monitored approved testers for compliance both with the conditions of their authorisation and with the provisions of the Act. We saw a high level of compliance (81 per cent) during 2020–21.

Radiation shielding requirements

The department is finalising a new radiation shielding assessment framework that will include accrediting shielding assessors, a shielding assessment standard, and generic shielding assessments for certain low-risk practices.

Mineral sand mining and processing

The department continues to resource the regulation of mineral sand mining, in particular the processing, storage, transport and disposal of the associated naturally occurring radioactive material.

There are currently five mineral sands mining projects across the state at various stages of obtaining the necessary development approvals. There are also two companies licensed under the Act to conduct mineral sand mining and processing in Victoria – Iluka Resources Limited and Donald Mineral Sands Pty Ltd.

National policy development

There was a significant focus on working with other Australian jurisdictions through the Radiation Health Committee of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and the newly established Radiation Health Expert Reference Panel to respond to the International Atomic Energy Agency's Integrated regulatory review service report (see below) and, more broadly, to develop national radiation safety policy on a variety of issues.

The department has participated in projects in the following areas:

- a major revision of the *National directory for radiation protection*
- developing accreditation standards for personal radiation monitoring service providers
- developing national radiation safety standards for medical diagnostic x-ray units
- the security of high-consequence radioactive material
- nationally agreed expectations of compliance with the 2019 Medical Code.

Other activities

Other activities the department undertook during the year include:

- attending Radiation Health Committee meetings
- assessing proposed national standards and codes of practice
- attending meetings of the Radiation Health Expert Reference Panel
- continuing to deliver a 24/7 emergency response service
- carrying out two education sessions.

Introduction

Diagnostic, therapeutic, industrial and other uses of radiation have contributed to the safety and quality of life for all Victorians. However, radiation does involve hazards if it is used inappropriately or unnecessarily. For this reason, the department regulates the use of radiation to protect people and the environment from its harmful effects by licensing users of radiation sources and managers of radiation practices under the Radiation Act.

Section 134 of the Act requires that the Secretary of the Department of Health, in respect of each financial year, publishes a report that:

(a) describes the activities of the Secretary under the Act
(b) includes a summary of all authorities issued, renewed, suspended, cancelled, varied, transferred or surrendered during that year
(c) includes all radiation incidents investigated in that year
(d) includes a summary of all prosecutions for offences against the Act or the Regulations commenced in that year
(e) includes any other prescribed matter.

This 2020–21 annual report describes the activities of the Secretary for the financial year from 1 July 2020 to 30 June 2021.

Regulating radiation safety and impacts of the pandemic

The department's Environmental Health Regulation and Compliance Unit oversees the regulation of radiation safety in Victoria. The unit administers two other regulatory areas – Legionella risk management and regulation of pest control operators. The unit's Radiation Team regulates radiation safety.

At the start of this financial year, the Radiation Team had 10.5 equivalent full-time staff dedicated to radiation safety regulation. The work is also supported by a manager and team of support staff who are shared with the two other regulatory areas mentioned earlier. These support staff included an investigations officer, a three-person customer service team, a project officer, and an information systems officer.

In November 2020, the Victorian State Budget allocated more funding to the department's heath protection regulatory areas, and the bulk of this has been allocated to regulating radiation safety. It has allowed a 45 per cent expansion in the number of specialist radiation safety officers, taking the total number of the officers to 14.5 equivalent full time staff.

The funding will enable the department to significantly increase its field presence through actively inspecting regulated entities to assess compliance with the Act. The increase in staff will also improve the quality and speed of assessing the thousands of licence applications the department receives every year.

The funding was used to recruit 4.5 more specialist radiation safety officers and to form a new regulatory team within the Radiation Team to enable the department better to regulate these diverse radiation practices. The Radiation Team now has three specialist teams:

- Medical & Veterinary Radiation Practices
- Industrial Radiation Practices
- Dental & Non-ionising Radiation Practices.

The new staff were onboarded late in the financial year, so we will not see the impact until the next financial year and not fully until lockdowns have ended.

These changes mean that the Radiation Team will have 14.5 full-time equivalent staff and will be supported by the new Operations Team during the coming year.

Impact of coronavirus

Although the need to deploy specialist radiation safety staff to the COVID response reduced during this financial year, regulating radiation safety was nevertheless impacted by the pandemic. The department's response required the Environmental Health Regulation and Compliance Unit manager to be deployed elsewhere until September 2020. A senior radiation safety officer from the Radiation Team was seconded out of the unit until April 2021.

Victoria's lockdowns had a heavy impact on routine compliance inspections, and Radiation Team members worked from home for almost the whole financial year.

Legislation

Radiation Act

The Radiation Act began on 1 September 2007. The Act gives effect to Victoria's commitment to ARPANSA's *National directory for radiation protection*. The directory outlines a common approach for Commonwealth, state and territory governments in regulating radiation practices.

The purpose of the Act is 'to protect the health and safety of all persons and the environment from the harmful effects of radiation' and incorporates:

- the radiation protection principle
- a requirement for the Secretary of the department to have regard to both the radiation protection principle and the *National directory for radiation protection*
- the concept of licensed activities; in particular, the licensing framework created by the Act features:
  - management licences to authorise the conduct of radiation practices (such as possessing a radiation source)
  - use licences to authorise a natural person to use a radiation source
  - radiation facility construction licences
- the concept of approved testers and the testing of prescribed radiation sources against declared radiation safety standards
- the concept of approved assessors of security and transport security plans.

The Act creates significant offences including:

- conducting a radiation practice without a management licence (the maximum penalty in the 2020–21 period for a body corporate for this offence was $1,486,980)
- using a radiation source without a use licence (the maximum penalty in the 2020–21 period for an individual for this offence was $198,264)
- noncompliance with the conditions of a licence (the maximum penalty in the 2020–21 period for a body corporate for this offence was $991,320).

Radiation Regulations

The Radiation Regulations 2017 prescribe:

- licensing fees, including changes to place-enclosed X-ray analysis units and dental 3D volumetric X-ray units into a different fee category and eliminating the fee to vary an existing licence or transfer an existing management licence
- definitions of radioactive material
- radiation dose limits
- those radiation sources that must be tested and issued with a certificate of compliance before use.

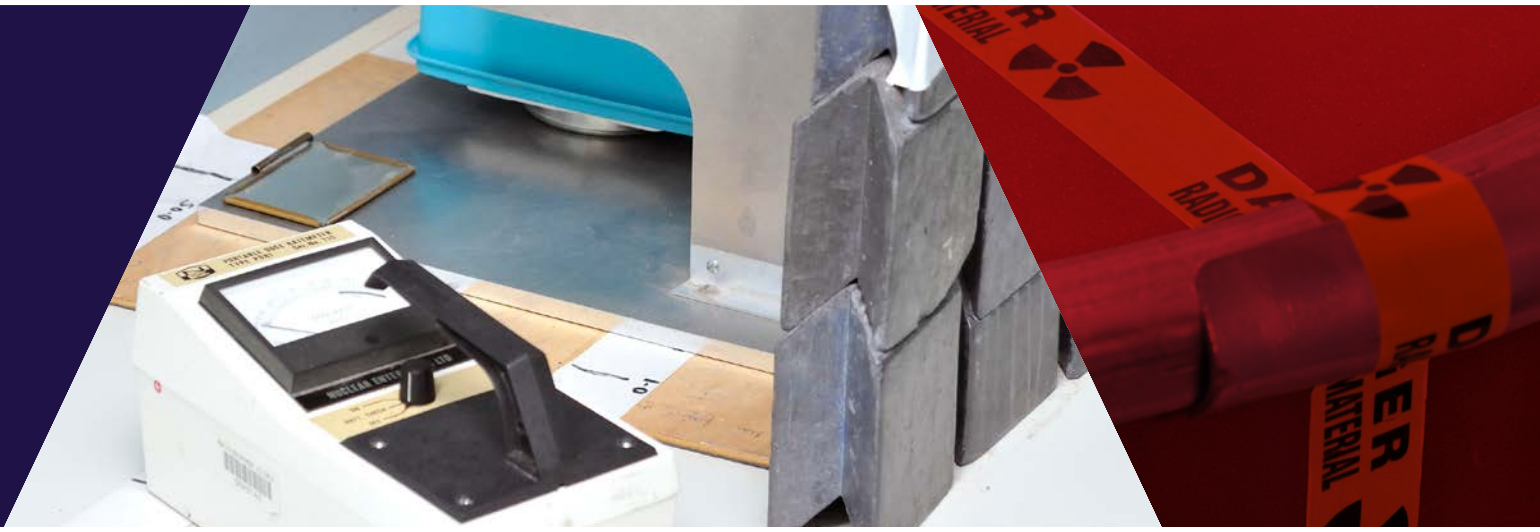
The Regulations also:

- strengthen the security of high-consequence radioactive material
- implement changes to the occupational dose limit to the lens of the eye to reflect recent international and national developments.

Stakeholder engagement and communication

Informed stakeholders are more likely to work in partnership with the department. They are more aware not only of the laws that govern them but also of the potential risks associated with their practices and of ways to mitigate those risks. Informing and engaging with stakeholders is critical to the overall regulatory objective and allows for collaboration and education to achieve regulatory objectives.

The department has been making a significant effort to increase email communication with regulated entities to distribute information. As a result of the need for the department's staff, like other Victorians, to work from home where possible from the last quarter of the financial year, the department accelerated this effort and is now distributing all written communications by email. Implementing the new licensing system (discussed in the 'New licensing system' section) has greatly assisted in this effort, as has the redeveloped radiation website <https://www2.health.vic.gov.au/public-health/radiation>.



Integrated Regulatory Review Service mission

The International Atomic Energy Agency's (IAEA) Integrated Regulatory Review Service (IRRS) mission visited Australia from 5 to 16 November 2018. IRRS reviewed the legal and governmental framework of Australian states and territories and the Commonwealth for nuclear and radiation safety against the IAEA's safety standards. A follow-up mission will be conducted in 2021–22.

The IRRS report on the mission <https://www.arpansa.gov.au/sites/default/files/irrs_australia_report_2018.pdf> has been published on ARPANSA's website.

The IRRS report made four notes of good practice, 23 recommendations and 12 suggestions for improvement. The recommendations centred on issues of national uniformity, emphasising the importance of ensuring a consistent level of protection of people and the environment through effective coordination and harmonised implementation of codes and guides by the Commonwealth, states, territories and regulatory bodies.

The Environmental Health Standing Committee (enHealth) of the Australian Health Protection Principal Committee led development of an IRRS action plan to address the IRRS recommendations. The Radiation Health Expert Reference Panel supported enHealth in this work.

Australian jurisdictions are expected to have substantially addressed the observations, recommendations and suggestions in the IRRS mission report by the time of the follow-up IRRS mission due to occur in 2022.

New licensing system

The department's new radiation licensing database launched in October 2019. It will eventually replace a legacy database that has been used for 15 years.

The first stage of implementing the new licensing database focused on the approximately 15,000 licences and approvals issued to individuals – for example, use licences and approvals for testers and assessors.

The remaining stages will focus on the more complex management licences, usually held by companies and other organisations. These are the licences that authorise possession of radiation sources as well as many other practices. There are over 2700 such licences.

The new system features a much more contemporary model where users first register their contact details on a web portal. New applicants can then apply for licences or approvals. Based on the type of licence that the person wishes to apply for, the system advises the applicant of the documents that must be supplied with the application. The new system removes the need for data entry by the department, which allows the application to be assessed more quickly than in the past. Similarly, where a fee must be paid for the individual licence, this fee payment occurs when the application is lodged, which eliminates one of the reasons for the processing delays in our current system.

When an existing individual licence holder registers for the first time, the system verifies their details. They can then:

- download a copy of their licence
- apply for variations to an existing licence or approval
- renew their licence at the appropriate time
- make credit card payments
- update their contact details.

As of 30 June 2021 there were more than 14,500 registered users of the new system. Existing licence holders are invited to register in a staged approach before their licence expires. As of 1 July 2021 there were about 1,800 licence holders who had not yet registered on the system. It is expected that almost all will have registered by the end of the 2021–22 financial year.

Another feature of the new system is that it accommodates those workers who wish to apply for a licence under the mutual recognition laws that operate across Australia. The system allows the person easily to apply under these arrangements.

The system also features an improved public register of licence holders <https://licensing.dhhs.vic.gov.au/public/use-licence>.

Development of a module for management licences has been delayed because of the coronavirus (COVID 19) pandemic but is expected to be implemented during the second half of 2021. The management licence module, like the system used for use licences, is based on a set of business rules that the system uses to advise users on the documents that they will need to upload with their application. Initially, the department will not require fees to be paid at the time the application is lodged but will invoice the applicant before the application is decided. However, the department will monitor the use and performance of the system and expect to transition to the 'upfront' payment of fees at a later date.

Another new feature of the system is aimed at the applicants and licence holders who seek to possess radiation sources. The system will ask the user to identify the make and model of the radiation source they wish to acquire. Business rules are then used to complete the application, saving time for the applicant and improving data quality.

Automatic mutual recognition

In late 2020, National Cabinet agreed to implement automatic mutual recognition (AMR).

In principle, AMR allows a person who is licensed or registered for an occupation in one jurisdiction to be considered registered to perform the same activities in another jurisdiction, without the need to go through further application processes or pay additional registration fees. This makes it easier for workers who need to be licensed or registered for their job to work in another state and territory.

AMR for occupational licences became available from 1 July 2021 in certain states and territories. Victoria entered the scheme on this date. Other states will join in the coming months.

In the 2020–21 financial year, significant work was undertaken to understand the implications and processes required for AMR. Interim systems and training of staff had to be developed at short notice to meet the deadline of 1 July 2021.

It is mandatory for workers wishing to use AMR to work in Victoria and use radiation sources to notify the department before starting that work. A smartform has been developed and is available on the department's website for this purpose. The department will publish an interim public register.

In the longer term, the department will modify the licensing system to accommodate AMR as an option and modify the public register to provide a consolidated view of those who are legally permitted to work in Victoria.

Summary of department-issued authorities

Section 12 of the Act creates an offence for a person to conduct a radiation practice unless the person holds a management licence or is exempted under s.16 of the Act.

The most common radiation practice requiring a management licence is possessing a radiation source. Other radiation practices include:

- transporting radioactive material
- selling radiation sources
- procuring or arranging research that involves exposing people to radiation
- mining or processing radioactive material.

Section 13 of the Act creates an offence for a person to use a radiation source unless the person holds a use licence or is exempted under s. 16 of the Act.

Table 1 lists the number of authorities issued, renewed, suspended, cancelled, varied, transferred and surrendered under the Act in 2020–21.

Table 1: Number of authorities issued, renewed, suspended, cancelled, varied, transferred and surrendered under the Radiation Act, 1 July 2020 to 30 June 2021

Authority	Management licence	Use licence	Tester	Assessor
Issued	194	1,962	4	1
Renewed	749	6,789	19	0
Suspended	0	1	0	
Cancelled	0	0	0	0
Varied	488	330	1	0
Transferred	27	n/a	n/a	n/a
Surrendered	39	14	0	0

Table 2 lists the number of current authorities under the Act as of 30 June 2021.

Table 2: Number of authorities issued as of 30 June 2021

Authority	Number
Use licences	15,241
Management licences	2,738
Approved testers	43
Approved assessors	8

Table 3 estimates the sectors in which these licences are held.

Table 3: Estimate of the sectors in which licences are held under the Radiation Act, 1 July 2020 to 30 June 2021

Sector	Management licence	Use licence
Dental	1,473 (48.34%)	5,019 (32.73%)
Veterinary	388 (12.73%)	2,148 (14.01%)
Medical	214 (7.02%)	6,122 (39.92%)
Industrial	241 (7.91%)	1,556 (10.15%)
Sales	159 (5.22%)	n/a
Chiropractic	63 (2.07%)	129 (0.84%)
Transport	46 (1.51%)	n/a
Education	35 (1.15%)	74 (0.48%)
Mining	3 (0.10%)	n/a
Other	425 (13.95%)	286 (1.87%)

Enforcement action

Providing advice and education to duty holders will always be the first step in seeking compliance with the Act and the Regulations. However, there may be some instances in which enforcement action is required.

The Act provides the department with several enforcement tools in addition to the power to prosecute.

Available enforcement actions

Improvement notices

The Secretary, or a delegate of the Secretary, may issue this type of notice if they believe that a person has contravened a provision of the Act or the Regulations in circumstances that make it likely that the contravention is continuing or will reoccur, or is likely to contravene a provision of the Act or the Regulations. If issued, the notice will require the person to remedy the contravention or likely contravention or the matters or activities causing the contravention or likely contravention.

Prohibition notices

Like improvement notices, these notices may be issued by the Secretary or a delegate under the same circumstances. The notice prohibits the person from carrying on the activity, or the carrying on of the activity in a specified way, until the Secretary or the delegate has certified in writing that the contravention has ceased or that the likelihood of the contravention occurring has passed.

Show cause notice

The Secretary or a delegate may issue a show cause notice notifying a licence holder of an action the Secretary or a delegate proposes taking in relation to a contravention of a requirement of the Act, with an invitation to the holder to show cause why the proposed action should not be taken.

Executing a search warrant

While the Act provides power for authorised officers to enter certain places to monitor compliance with the Act or the Regulations, under some circumstances it is necessary first to obtain a search warrant to authorise that access. An authorised officer of the department may apply to a magistrate to issue a search warrant if the authorised officer believes on reasonable grounds that there is, or may be within the next 72 hours, a particular thing (including a document) at the place that may afford evidence of an offence against the Act or the Regulations.

Seizure of articles

The Act gives certain powers to authorised officers, including the power to seize anything (including a radiation source or a document) if the authorised officer reasonably believes:

- the seized thing is connected with an alleged contravention of the Act or the Regulations, or
- there is a serious risk to the health or safety of any person or the safety of the environment if the thing is not seized.

Making a radiation source inoperative

The Act gives an authorised officer power to make a radiation source inoperative. As an example of an action that could be taken in certain circumstances, authorised officers during this year rendered inoperative an X-ray unit used to treat skin cancers to prevent its use.

Sealing a radiation source

The Act gives an authorised officer the power to seal a radiation source. In practice, sealing a radiation source may be required where it is impractical to seize the source but it is necessary to prevent its further use.

Suspending or cancelling an authority

The Act provides that the Secretary, or a delegate, may suspend or cancel an authority.

Prosecution

There are several significant offences contained within the Act and, under certain circumstances, the department may feel it is necessary to begin prosecutions for these offences.

Enforcement actions taken in 2020–21

Table 4 summarises the formal enforcement actions the department took during the year. These enforcement actions are discussed in more detail later in this report. In general, the lockdowns have affected the numbers of compliance-related inspections, which has affected the number of enforcement actions.

Table 4: Enforcement actions, 2020–21

Enforcement action	Number
Improvement notice	0
Prohibition notice	0
Show cause notice	2
Executing a search warrant	6
Sealing a radiation source	2
Seizure of a commercial tanning unit	5
Prosecutions initiated	0
Licences suspended	2

Prosecutions

During the 2020–21 financial year, the department did not initiate any new prosecutions. One matter reported in the 2019–20 annual report continued to progress through the court system and is expected to be resolved in 2021–22.

Focused activities

Compliance monitoring program and regulatory focus

Monitoring the compliance of radiation practices with the requirements of the Act is primarily carried out through inspecting the practices. Where possible, the department works to promote compliance by providing advice and constructive guidance and by using technology and systems to help licence holders to interpret and comply with the laws and standards applicable to them.

The department conducted 136 inspections in the 2020–21 financial year as part of its licensing compliance monitoring program. This was well below the Victorian State Budget target of 480 inspections but was due in large part to the number and length of lockdowns and the impact of this on the department's ability to perform routine targeted inspections. During the lockdowns the department performed 66 virtual audits of radiation practices.

The compliance monitoring program included inspections of:

- medical imaging practices
- medical practices involving nuclear medicine
- medical practices involving interventional fluoroscopic apparatus
- operations involving mineral sand mining and processing
- practices using industrial radiography equipment
- practices using industrial gauges
- practices using dual-energy X-ray absorptiometry (DXA) units
- practices using high-consequence radioactive material
- licence holders who had not renewed management licences by the due date.

Implementing the Code for Radiation Protection in Planned Exposure Situations

The department has worked through a number of issues relating to implementing the ARPANSA Code for Radiation Protection in Planned Exposure Situations (2020). Some of the key elements of the code are the universal nature of the applicability of the code and the requirement to develop a safety assessment to be conducted that is either generic or specific to the radiation source or facility (a 'graded approach') and submitted to the regulator before the granting of an authorisation. The code is included in a package of policy and standards that are currently awaiting endorsement by Australian health ministers. This endorsement is anticipated to occur in the second half of 2021.

The department has recently advised stakeholders of its intention (pending this endorsement) to make variations to all management licences to require compliance with this code from 1 January 2023.

The department has also amended its licensing prerequisites to bring them into line with other jurisdictions and will be requiring a radiation management plan (RMP) to be submitted with:

- applications for new management licences
- variations to existing management licences
- applications to transfer an existing management licence to another person or body corporate.

This will enable a more gradual move to the use of RMPs by all practices before implementing the code.

Radiation shielding assessments

The department had identified deficiencies in the quality of radiation shielding assessments and the adequacy of installed radiation shielding in three key areas:

- insufficient shielding being specified at the initial shielding design stage
- insufficient shielding being installed or shielding being installed incorrectly
- lack of regular review to ensure the shielding parameter values (for example, workload, occupancy and distances from radiation sources) on which the shielding design was based are not exceeded.

The department is developing a shielding standard that prescribes the requirements for a shielding assessment. The standard will specify the information that must be provided in the shielding requirements report, including how the shielding will be installed.

In conjunction with the standard, the department is working to introduce an approval framework for shielding assessors. This approval framework would require assessments to be performed by an approved shielding assessor and approved shielding assessors to comply with the shielding design standard.

The department will also introduce an online shielding self-assessment tool for low-risk practices (for example, small animal veterinary radiography) where standard building construction materials usually provide enough shielding.

Coronial inquest into death due to anaphylactic reaction to contrast administered for a CT scan

Following media reports, departmental officers observed the coronial inquest conducted into the death of a patient following a cardiac CT procedure.

The patient underwent a CT coronary angiography scan with intravenous contrast administration. After administering contrast the patient was reported to have had a severe anaphylactic reaction and was transferred by ambulance to hospital. The patient's condition deteriorated further and the patient died several days later.

The department will review the transcript of the inquest and await the coroner's findings before deciding what, if any, action it should take in relation to matters of radiation safety.

Concerns about skin cancer radiotherapy treatments at a private clinic

The department was notified of a hospital's concerns about the diagnosis and treatment of more than 30 patients by a small private radiotherapy clinic after the patients were referred to that hospital. The department has undertaken an investigation into the clinic's compliance with the Act. The department's response in relation to the clinic's compliance is ongoing. A specialist clinic was established through Safer Care Victoria offering a review for anyone who was a patient at the first clinic and who was concerned about their diagnosis or treatment.

Commercial tanning practices

The *Radiation Amendment Act 2013* began on 1 June 2014. This Act amended the 2005 Radiation Act to give effect to the Victorian Government's decision to prohibit commercial tanning services from the end of 2014, among other things.

The department has taken a strong approach to enforcing the legislative prohibition of commercial tanning practices through such measures as recruiting an experienced investigator to lead investigations of all allegations of illegal practices.

Despite the restrictions in place because of the COVID-19 pandemic, the department is still receiving complaints of illegal commercial solariums, although the figures are down from previous years.

The department executed six search warrants in 2020–21 and, in these, we seized five tanning beds. We also have another four investigations underway, with warrants to be applied for in each case.

Mineral sands mining and processing

The department regulates the processing, storage, transport and disposal of the naturally occurring radioactive material associated with mineral sand mining and processing. The mining of mineral-rich sands within Victoria generally triggers the need to regulate the radiation safety aspects of the operations due to the presence of naturally occurring radioactive material in low concentrations. Mineral sands within Victoria are usually mined from ancient beaches, like those that existed in the Murray Basin. Mineral sands were deposited on shores where the large density of the mineral sand grains allowed them to settle close to the then existing shore and be concentrated there while lighter sands tended to be washed out to sea. There are currently two companies licensed under the Act to conduct mineral sand mining and processing in Victoria – Iluka Resources Limited and Donald Mineral Sands Pty Ltd.

Other projects have been proposed and are currently at varying stages of the required development assessment process, which typically includes a formal environmental effects assessment. The first five mineral sands projects discussed below are in the Murray Basin; the sixth is in eastern Gippsland.

Iluka Resources Limited – existing operations

Iluka Resources Limited has been mining mineral sands in the west of Victoria since 2005. Part of its operation includes disposing of waste by-products that were generated by processing heavy mineral concentrate (HMC) at its mineral separation plant in Hamilton into the disposal pit at its Douglas mine site in western Victoria, known as Pit 23. The mineral separation plant in Hamilton is currently not operating. Disposal of the by-products from the processing of HMC into Pit 23 began in 2011. The HMC was produced by mining activities at various Iluka mines, including those at Ouyen and in South Australia. The continued disposal of these by-products involved Iluka obtaining a planning permit from Horsham Rural City Council. The department sits on the technical reference group that advises Horsham Rural City Council in relation to Iluka's planning permit for disposing of waste by-products into Pit 23. The department's regulation of Iluka's operations involving the possession of radioactive material will continue until the rehabilitation of the mine sites has been completed.

Iluka Resources Limited – Wimmera Mineral Sands Project

Iluka Resources Limited proposes to develop the Wimmera Mineral Sands project, which has an approximate area of 2,600 hectares and is about 35 kilometres southwest of Horsham. This WIM100 deposit is reported to have about 200 million tonnes of heavy mineral sands ore, which is proposed to be extracted and refined onsite to produce zircon, titanium oxide and rare earth products.

The proposal includes:

- developing a mineral sands mine
- processing plants (including a mineral separation plant, zircon refinery and rare earth refinery)
- an ore receival and liquification system
- mine by-products transport and containment infrastructure
- offsite infrastructure such as powerlines, water pipelines, access roads and a temporary construction camp
- more offsite infrastructure such as administration buildings, water storage dams, fuel storage and laydown areas.

The proposed mining method is likely to be progressive mining using mobile earthmoving equipment. Nine to 10 million tonnes of ore per annum is proposed to be extracted, which will be refined onsite to produce 192,000 tonnes of recoverable mineral product per annum, over the projected 25-year life of the mine. The Department of Environment, Land, Water and Planning (DELWP) has convened a technical reference group to advise the proponent and the department, as appropriate, on scoping and adequacy of the studies while preparing the environment effects statement. The department's Radiation Team is part of this group. Find out more from the DELWP website <https://www.planning.vic.gov.au/environment-assessment/browse-projects/projects/wimmera-mineral-sands>.

Donald Mineral Sands

The site for this project is about 17 km southeast of Minyip. Donald Mineral Sands is planning to mine the shallow, fine-grained sand deposit containing accumulations of titanium and zirconium minerals. The valuable minerals (ilmenite, rutile, leucoxene and zircon) will be separated into a heavy mineral concentrate and then exported. The remaining non-valuable clays and sands will be returned to the soil profile. The final rehabilitation of the mined area is intended to produce a landscape similar to that prior to the mining project, including restoring native vegetation, drainage and agriculturally productive land. The project underwent an environment effects assessment process in 2008. Donald Mineral Sands Pty Ltd was issued, and still holds, a radiation management licence to undertake mining and processing of mineral sands. The company has not yet begun operations. The department has, in previous financial years, carried out a program of radon monitoring in the area of the proposed mine to establish a baseline level of radon for comparison with levels during any future mining activities. Find out more about the project from the Astron website <http://www.astronlimited.com>.

VHM Limited – Goschen Mineral Sands and Rare Earths project

VHM Limited proposes to develop the Goschen Mineral Sands and Rare Earths project, which has an approximate area of 8,300 ha and is about 20 km south of Swan Hill. The Goschen deposit is reported to contain have around 300 million tonnes of ore and is proposed to produce a zircon and rutile concentrate, titanium concentrate and a rare earth concentrate. The proposal includes:

- a mineral sands mine
- a mining unit plant
- a wet concentrator plant
- an interim tailings storage facility
- solar drying beds for tailings
- slurry pipelines to transfer ore from pits to the processing facilities
- additional site infrastructure (site office, warehouse and workshop facilities, loading facilities and fuel storage).

Proposed mining methods involve open-pit mining to extract approximately five million tonnes of ore per annum, increasing to 10 million tonnes of ore per annum over a projected mine life of 30 years. Mine products are proposed to be transported via road or by rail for export overseas. DELWP has convened a technical reference group to advise the proponent and the department, as appropriate, on scoping and adequacy of the studies while preparing the environment effects statement. The federal government has awarded Major Project status to unlisted VHM's proposed Goschen zircon and rare earth minerals project. The department's Radiation Team is represented on this group. Find out more about this project from the DELWP website <https://www.planning.vic.gov.au/environment-assessment/browse-projects/projects/goschen-mineral-sands-and-rare-earths-project>.

WIM Resources – Avonbank Heavy Mineral Sands project

WIM Resources Pty Ltd proposes to develop the Avonbank Heavy Mineral Sands project, which has an approximate area of 2,500 ha and is about 15 km northeast of Horsham. The Avonbank deposit is reported to contain around 300 million tonnes of ore, and the company proposes to produce a heavy mineral concentrate containing zircon, rare earths and titanium minerals.

The proposal includes:

- a mineral sands mine
- a wet concentrator plant
- starter ore and overburden stockpiles
- slurry pipelines
- more site facilities such as a site office, warehouse, workshop, rail loading facilities and fuel storage.

The proposed mining methods involve open-pit mining to extract 9–15 million tonnes of ore per year over a projected mine life of 30 years to produce 350,000–600,000 tonnes of heavy mineral concentrate per year. Mine products are proposed to be transported via road or rail for export overseas. Preliminary meetings were held with WIM Resources to discuss Radiation Act requirements and broader environmental assessment processes in Victoria. DELWP has subsequently convened a technical reference group to advise the proponent and the department, as appropriate, on scoping and adequacy of the studies while preparing the environment effects statement. The department's Radiation Team is part of this group. Find out more about this project from the DELWP website <https://www.planning.vic.gov.au/environment-assessment/browse-projects/projects/avonbank-mineral-sands>.

Kalbar Operations – Fingerboards Mineral Sands Project

Kalbar Operations Pty Ltd proposes to develop the Fingerboards Mineral Sands Project, which has an approximate area of 1,675 ha and is about 20 km northwest of Bairnsdale in East Gippsland.

The proposal includes:

- a mineral sands mine
- two mining unit plants
- a wet concentrator plant (comprising mineral separation processing and tailings thickening plant)
- water supply infrastructure
- a tailings storage facility or centrifuge facility to offset any requirement for tailings storage
- more site facilities such as a site office, warehouse, workshop, loading facilities and fuel storage.

The proposed mining methods involve open-pit mining to extract about 170 million tonnes of ore over a projected mine life of 20 years to produce around eight million tonnes of mineral concentrate. Mine products are proposed to be transported via road or by rail for export overseas. DELWP convened a technical reference group to advise the proponent and the department, as appropriate, on scoping and adequacy of the studies while preparing the environment effects statement. The department has been actively involved in the technical reference group meetings for this project to ensure potential radiation exposures are properly addressed and that the project establishes programs to obtain and collate the information the department needs to assess the potential radiation impact on human health and the environment. The department made a submission to the inquiry established by the Minister for Planning to assess the environmental impacts of the project. As of 30 June 2021, the inquiry had not been completed. Find out more from the DELWP website <https://www.planning.vic.gov.au/environment-assessment/browse-projects/projects/fingerboards-mineral-sands>.

Mandatory testing of medical diagnostic X-ray units

The Act requires that a prescribed radiation source only be used for human diagnostic purposes if there is a current certificate of compliance in place. In recognition that the ability for management licence holders to comply with compliance testing requirements may be limited during the COVID-19 pandemic, the department advised relevant licence holders that enforcement action would not be undertaken if a prescribed radiation source is used between 30 March and 30 September 2020 for human diagnostic purposes without a current certificate of compliance. However, licence holders were advised that, when possible, compliance testing should be undertaken to ensure prescribed radiation sources have a current compliance certificate when these radiation sources are used for human diagnostic purposes.

Despite difficulties associated with COVID-19, the level of compliance during the 2020–21 financial year was about 81 per cent.

Emergency response function

Under Victoria's emergency management arrangements, the department is the control agency for radiological emergencies where radiation is the principal hazard. As part of this responsibility, the department maintains a 24/7 response capability involving specialist radiation safety staff. Staff have access to vehicles with specialist radiation safety detection equipment and ancillary equipment. More equipment was purchased during the year using a portion of the funds allocated in the November 2020 Victorian State Budget.

The radiation monitoring equipment the department has includes:

- radiation survey meters
- a telescopic radiation monitor survey meter (approximately 3 m extension)
- handheld radionuclide identification instruments
- contamination monitors
- wipe sample counting systems that can be deployed in the field
- an air-sampling instrument that can be deployed in the field
- personal electronic radiation dosimeters for all radiation regulatory staff
- a radiation portal monitor for high-volume screening of people for radioactive material contamination.

One of the challenges for the department is how best to maintain a response capability for what are clearly extremely low-likelihood but high-consequence events.

Representation on national committees

During 2020–21 the department was represented on ARPANSA's national Radiation Health Committee by the manager of Environmental Health and Compliance up to 10 February 2021 (inclusive) and a senior radiation safety officer of the Radiation Team from 24 March 2021. The role of the Radiation Health Committee is to advise ARPANSA's chief executive officer on matters relating to radiation protection, including formulating draft national policies, codes and standards for consideration by the Commonwealth, states and territories. Four meetings of this committee were attended during the financial year.

ARPANSA publishes the agendas and minutes of these committee meetings <https://www.arpansa.gov.au/about-us/advisory-council-and-committees/radiation-health-committee/agendas-and-minutes>.

New national standards

Standard for Limiting Exposure to Radiofrequency Fields – 100 kHz to 300 GHz

ARPANSA published the Standard for Limiting Exposure to Radiofrequency Fields – 100 kHz to 300 GHz in February 2021. The new standard was developed after a thorough review of all relevant scientific literature and an extensive public consultation process. The standard provides protection against all scientifically substantiated adverse health effects due to electromagnetic field exposure in the 100–300 GHz range.

The new standard <https://www.arpansa.gov.au/sites/default/files/rps_s-1.pdf> provides better and more detailed exposure guidance in particular for the higher frequency range, above 6 GHz, which is important to 5G and future technologies using these higher frequencies.

National policy development

In 2020–21, there was a significant focus on working with other Australian jurisdictions through the Radiation Health Committee and the newly established Radiation Health Expert Reference Panel firstly to respond to the IRRS report referred to earlier and also to consider other mechanisms to advance radiation safety in Australia. This work has required the department to lead or contribute to several related projects throughout the year.

Accreditation standards for radiation dosimetry service providers

The conditions placed on management licences usually include requirements for monitoring radiation doses to individuals using personal radiation monitoring devices. Radiation dose monitoring is a cornerstone of radiation safety. However, there are no nationally agreed guidelines that personal radiation monitoring service providers need to follow to guide aspects such as quality assurance. Regulation of these service providers is inconsistent across Australia. There is currently no direct regulation in Victoria of the providers of these personal radiation monitoring services.

The current service providers include both internationally and locally based companies and organisations.

The department is leading a national project to develop nationally agreed accreditation requirements to assess and approve these service providers and the associated personal dosimeters that they issue to their customers. The proposed requirements include:

- traceability of radiation doses to Australian national standards
- the requirement that personal dosimetry laboratories have a system in place to notify the service user of abnormal doses
- the requirement for a quality management system to be implemented for dose reports, including requirements to ensure consistent data reporting
- requirements both for the laboratory-based activities and for the services that support them
- a requirement for the service providers to provide radiation dose monitoring records to the Australian National Radiation Dose Register hosted by ARPANSA.

If a national agreement on the scheme can be reached, then Victoria will need to make minor amendments to the Radiation Act to incorporate a new regulatory scheme to regulate in this area and to support these accreditation standards.

Portable density/moisture gauge secured for transport.

National radiation safety standards for medical diagnostic X-ray units

The department has been working with other jurisdictions on developing nationally consistent radiation safety standards for certain types of medical diagnostic X-ray units. If adopted, these standards would replace the current Victorian radiation safety standards for these types of X-ray units.

Security of high-consequence radioactive material

The department has been working with other jurisdictions on the review of ARPANSA's Code of Practice for the Security of Radioactive Material (2007). While Victoria and other jurisdictions have implemented requirements of the code of practice, there are aspects that have proven extremely difficult to implement. This, coupled with emerging international guidance and a specific recommendation of the IRRS report described earlier, has triggered a review of the current arrangements including the potential to set up a national register of sealed radioactive sources.

Australian National Radiation Dose Register

The Australian National Radiation Dose Register (ANRDR) is a database designed to store and maintain radiation dose records for occupationally exposed workers. The ANRDR launched in 2011 for the Australian uranium mining and milling industry. The register now accepts dose records from all industries working with radiation, including the mining, medical, veterinary, industrial, aviation, research and university sectors. Much of the records are drawn from the records of the personal radiation monitoring service providers discussed earlier.

ARPANSA established the ANRDR to make sure workers' radiation dose records are kept in a centralised register, regardless of where or for whom a person is working.

The ANRDR is the nationally approved central record keeping agency for the dose records of all Australian workers who are occupationally exposed to ionising radiation.

The department has been advocating for improvements and a strengthening of the role of the ANRDR as a central part of Australia's radiation safety system. This advocating has led in part to focusing the project on developing nationally agreed accreditation standards for personal radiation dose monitoring service providers discussed earlier in this report. The department has also advocated for a stronger governance system to guide development of the ANRDR and was pleased to see this progress during this financial year. The department now has a representative on an advisory body for the ANRDR and will continue to advocate for initiatives that result in strengthening the ANRDR as a cornerstone of Australia's radiation safety system.

Find out more about the ANRDR <https://www.arpansa.gov.au/our-services/monitoring/australian-national-radiation-dose-register>.

The department sees a strong relationship between developing the accreditation scheme for personal radiation dose monitoring service providers and the success of the ANRDR.

Nationally agreed expectations of compliance with the 2019 Medical Code

ARPANSA published the Code for Radiation Protection in Medical Exposure, Radiation Protection Series C-5 (better known as the 'Medical Code') in July 2019.

Given that compliance with the Medical Code will eventually become mandatory through variations to existing management licences and use licences authorising medical diagnostic and therapeutic practices, it is critical that the health sector understands what Australian radiation safety regulators expect licence holders to be able to show when the Medical Code becomes mandatory. A new model has been developed that will feature publication of regulatory expectations for specific types of radiation practices. The finalised draft has not yet been published.

Australian Radioactive Waste Agency

The Commonwealth Government set up the Australian Radioactive Waste Agency in July 2020. The agency was set up to:

- manage Australia's radioactive waste in line with domestic and international regulations
- deliver and operate Australia's National Radioactive Waste Management Facility
- facilitate communication between government, industry, stakeholders and local communities
- centralise best practice and knowledge about radioactive waste management, including developing a disposal pathway for intermediate level radioactive waste.

The department has been asked to collect information from waste holders within Victoria to help create an national radioactive waste inventory. We anticipate that such an inventory will inform decisions relating to the Commonwealth's design and construction of the proposed National Radioactive Waste Management Facility in South Australia.

Education sessions and conference presentations

The department carried out two presentations on radiation safety and the Act and the Regulations to dentists and dental therapists in 2020–21 – one at La Trobe University in Bendigo and one at the Melbourne Dental School.

Secretariat support for the Radiation Advisory Committee

During the year, the department continued to provide secretariat services to the Radiation Advisory Committee <https://www2.health.vic.gov.au/public-health/radiation/radiation-regulatory-framework/radiation-advisory-committee>, established under Part 10 of the Act.

A report of this committee's work <https://www2.health.vic.gov.au/public-health/radiation/radiation-regulatory-framework/radiation-advisory-committee> is tabled in the Victorian Parliament each year.

Radiation incidents

Management licence holders must, by a condition of their licence, report incidents that are described in the department's document *Mandatory reporting of radiation incidents* <https://www2.health.vic.gov.au/public-health/radiation/licensing/management-licenses-businesses/general-conditions/incident-reporting>.

The document describes the following as triggers for reporting an incident to the department:

- becoming aware of the loss or theft of a radiation source
- any breach of security relating to the possession or transport of a high-consequence sealed source
- a worker, patient or a member of the public has or may have received an unplanned or abnormal exposure to ionising radiation, other than a justified medical exposure, exceeding 1 mSv total effective dose
- the activity of the material administered to a patient during the administration of radioactive material for human diagnostic purposes exceeds the activity prescribed in the hospital/practice standard protocol for that test by 50 per cent or more
- the activity administered to a patient during the administration of a radioactive material for human therapeutic purposes differs from that prescribed by 15 per cent or more
- the dose delivered during administration of a human therapeutic dose of radiation to a patient from a radiation apparatus or a sealed radioactive source differs from the total prescribed treatment dose by more than 10 per cent and the difference between the total prescribed dose and the delivered dose was not anticipated or accepted as part of the treatment plan
- any human therapeutic treatment delivered to either the wrong patient or the wrong tissue, or using the wrong radiopharmaceutical

Local shielding of radiopharmaceuticals vials

- any human diagnostic procedure other than as prescribed that could lead to an effective dose exceeding 1 mSv (including the wrong patient or the wrong body part examined)
- any human diagnostic procedure resulting in an observable acute radiation effect
- any unplanned exposure to a child (under 18 years old)
- any unplanned exposure to a pregnant female
- a human diagnostic procedure that results in a skin dose that exceeds 6 Gy
- any observable radiation injury (note that effects such as erythema, which are expected to occur following therapeutic procedures, do not need to be reported)
- where a radiation source is or has been out of control (this includes situations where, for example, the source is not safely secured or shielded, or contamination is not confined)
- where an ionising radiation apparatus, sealed source or sealed source apparatus is or has been damaged or has malfunctioned in a manner that could result in a person receiving a higher radiation dose than would be received under normal circumstances
- where a surface, substance or material is or has been contaminated by radioactive material in excess of:
  - 1 kBq within any square metre in the case of alpha-emitting radioactive material, or
  - 1 MBq within any square metre in the case of beta-emitting or gamma-emitting radioactive material
- any observable radiation injury
- a worker or a member of the public has or may have received an unplanned or abnormal exposure to ionising radiation (other than a justified medical exposure) exceeding 1 mSv total effective dose
- a transport accident involving radioactive material where there has been damage or possible damage to containers that contain a sealed source, sealed source apparatus or radioactive material
- a transport accident involving radioactive material where there has been a spill or release of radioactive material into the environment.

During 2020–21, 213 incidents were reported to the department compared with 182 in the previous year. Of the 213 incidents in 2020–21, 208 were in the medical sector. Most medical incidents involved unplanned or incorrect exposures to patients. None of the incidents involved any compromise in security of high consequence sealed sources.

There has been a significant increase in the number of incidents reported to the department over the past 10 years. The number of reported medical radiation incidents in 2020–21 is about 17 per cent higher than the number reported in the previous financial year.

The incidents reported in 2020–21 are summarised in Appendix 1.

Appendix 2 presents an overview of reported incidents over the past 10 years. This overview shows an increase of about 220 per cent in the number of incidents reported to the department over this period and, in particular, in the number of incidents involving medical use of radiation over this period.

The number of reported medical incidents in 2020–21 continues the trend of increasing numbers of such incidents over the past 10 years. This increase reflects the increase over the past 10 years of the number of medical procedures that involve radiation in Victoria. Appendix 3 shows the numbers of diagnostic imaging services over this period based on Medicare Australia statistics.

The increased number of reported medical radiation incidents over the past 10 years may also be due to an increased awareness among licensees of the requirement to report medical incidents as a direct result of the department's increased focus on regulating the medical use of radiation over this period. For example, the requirement to report incidents is now stressed as a part of compliance inspections of medical radiation practices carried out by the department's authorised officers.

Another possible factor contributing to the increased number of reported medical radiation incidents over the past 10 years is the increase in the use of medical imaging procedures such as CT, nuclear medicine and positron emission tomography that result in a radiation dose to the patient that exceeds 1 mSv. Incidents involving general X-ray are often not reportable because the radiation dose to the patient does not often exceed the reporting dose of 1 mSv.

The numbers of medical radiation procedures that involve the use of CT or nuclear medicine, where the doses are almost always greater than 1 mSv, is shown in Appendix 4 for the past 10 years. There is a significant upwards trend in the number of these procedures over that period.

Focus on medical radiation incidents

Table 6 lists the numbers of incidents in the various medical radiation incident categories per financial year from 2015 to 2021. The data are only presented from 2015 because medical incidents were not categorised in previous years.

Table 6: Medical radiation incidents by categories per financial year, 2015–16 to 2020–21

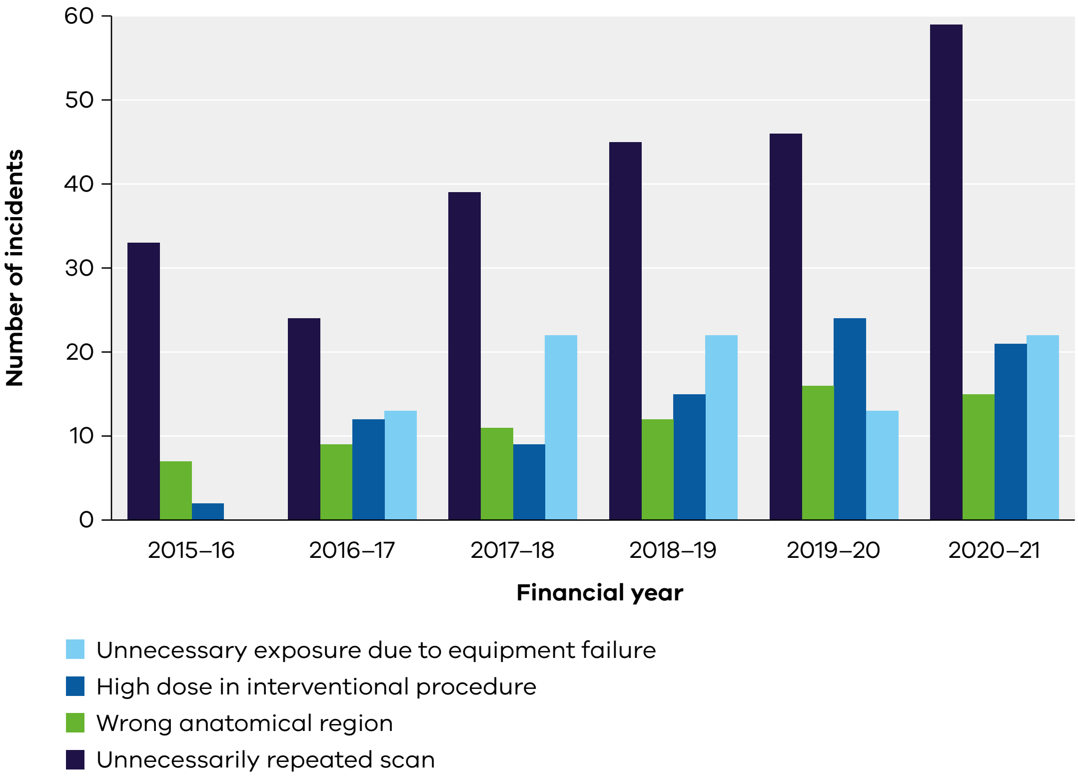
Medical incident	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21
Unnecessarily repeated scan	33	24	39	45	46	59
Unnecessary/unrequested/unapproved scan	25	15	10	27	15	21
Wrong patient	11	21	29	33	12	16
Wrong procedure	16	19	20	24	9	12
Wrong anatomical region	7	9	11	12	16	15
Wrong imaging modality	1	0	0	2	2	6
High dose in interventional procedure	2	12	9	15	24	21
Unnecessary exposure due to equipment failure	0	13	22	22	13	22
Maladministration of radiopharmaceuticals	2	16	10	13	8	11
Radiotherapy – high/low dose or healthy tissue irradiated	3	5	7	2	2	3
Scan failed due to patient problem	1	3	1	4	5	3
Scan on pregnant person	11	11	13	16	16	14
Contamination of person/articles with radiopharmaceuticals	2	2	2	2	10	4

The only categories in Table 6 for which there appears a significant upward trend are 'Unnecessarily repeated scan', 'Wrong anatomical region', 'High dose in interventional procedure' and 'Unnecessary exposure due to equipment failure'.

The numbers for these incident categories are shown in Figure 1.

Nuclear medicine hybrid SPECT-CT

Figure 1: Numbers of medical incidents by category per financial year



For these categories, there appears to be a reasonably consistent increase in the numbers over the financial years indicated. The increase in numbers in these categories is probably due to the factors indicated above in this report – increase in numbers of medical procedures, particularly from higher dose modalities, and increased reporting of incidents. The increase in number of the incidents in the category 'Unnecessary exposure due to equipment failure' may also be due to ageing of medical equipment and medical equipment components such as X ray tubes. It should also be noted that most of the incidents involving equipment failure involved CT scanners. CT scanners are complex X-ray units with many hardware and software components, so a failure is more likely than with a plain X ray unit.

Appendix 1: Radiation incident details

As a guide to the radiation doses mentioned in the incident summary, the public exposure limit is an effective dose of 1 millisievert (1 mSv) per year, while for occupational exposure the limit is an effective dose of 20 mSv per year.

The **becquerel (Bq)** is the standard unit of radioactivity.

1 kBq = 1,000 Bq

1 MBq = 1,000 kBq

1 GBq = 1,000 MBq

1 TBq = 1,000 GBq

The **sievert (Sv)** is the unit of effective dose of radiation and is used as a measure of risk of developing cancer and other late-onset effects.

1,000 mSv = 1 Sv

The **gray (Gy)** is the unit of absorbed dose of radiation and is used as a measure of the likelihood of developing foetal malformations and acute effects such as skin burns.

1,000 mGy = 1 Gy

Radioactive sources

^{18}F = fluorine-18

^{51}Cr = chromium-51

^{68}Ga = gallium-68

^{131}I = iodine-131

^{177}Lu = lutetium-177

^{99m}Tc = technetium-99m

Pharmaceuticals

dotatate = an amino acid peptide (tyrosine-3-octreotate)

FDG = fluorodeoxyglucose

HDP = hydroxydiphosphonate

sestamibi = methoxy-isobutyl-isonitrile

Imaging modality abbreviations

CT = computed tomography

PET = positron emission tomography

PET/CT = positron emission tomography / computed tomography

MRI = magnetic resonance imaging

Note that medical terms are defined in the glossary at the end of this report.

Radiation Act incident summary, 2020–21

Unnecessarily repeated medical imaging procedures

Incident no.	Description of incident
Incident 1	**A patient had an unnecessarily repeated CT scan of the chest due to booking and communications issues and poor review of previous imaging.** A hospital patient was booked for a CT scan of the chest with and without contrast. Due to a delay in getting clearance for oral contrast, the scan was deferred pending clearance. The scan without contrast was, nevertheless, carried out that day. The patient presented again for the CT scan three days later after the clearance for oral contrast had been obtained and underwent a scan with and without contrast. The CT scan without contrast was unnecessarily repeated. Radiographers were confused as to whether the second scan was justified because it may have been looking for other changes, or if it was a repeat. Investigation determined the failure as being multifactorial: failure to check previous imaging, failure to cancel the CT scan without contrast (and order only the required scan), and failure to re-protocol the scan to reflect the change in imaging. The effective dose due to the unintended scan was approximately 5 mSv. Radiographers involved were reminded to cancel requests for imaging already carried out and to review past imaging thoroughly. They were reminded to seek clarification where doubt existed in relation to scans.
Incident 2	**A patient had an unnecessarily repeated CT scan of the brain due to failure of the radiographer to identify that the contrast line was not connected to the patient.** A hospital patient was referred for a CT scan of the brain with and without contrast because of an acute stroke episode. The patient underwent the non-contrast brain CT first. For the scan with contrast, the radiographer did not note that the contrast line was not connected to the patient. The effective dose for the unnecessary scan was approximately 7.3 mSv. The radiographer involved was reminded to review the scan setup carefully before scanning.
Incident 3	**A patient had an unnecessarily repeated CT scan of the brain due to contrast injection failure.** The patient was cannulated by a nurse for contrast injection and flushed with saline. The scan proceeded upon visible contrast enhancement following contrast injection. Upon review of the scan, it was apparent that the contrast had extravasated and the contrast enhancement seen by the radiographer was motion artefact. The scan was repeated successfully. The effective dose due to the first (failed) scan was approximately 2 mSv. No further action was necessary.
Incident 4	**A patient had an unnecessarily repeated CT scan of the cervical spine due to radiographer error.** A hospital patient underwent an unnecessarily repeated CT scan of the cervical spine. The patient was to have a CT scan of the cervical spine and carotids. The carotids portion of the scan request was missed by the radiographer, who was also dealing with another patient, resulting in the CT scan of the cervical spine being carried out without contrast. The radiographer noticed their mistake and successfully rescanned with contrast. The effective dose for the repeated components of the scan was approximately 5 mSv. The radiographer involved was reminded to remain fully focused on the current patient.

Incident no.	Description of incident
Incident 5	**A patient had an unnecessarily repeated CT scan of the abdomen and pelvis due to radiographer error.** A patient presented at a medical imaging procedure for at CT scan of the abdomen and pelvis with contrast. The student radiographer involved got distracted by a conversation between fellow radiographers when scanning the patient and did not inject contrast before performing the scan. This scan therefore had to be repeated. The effective dose to the patient as a result of the scan without contrast was approximately 12 mSv. The staff members involved have been reminded of the required levels of supervision for students.
Incident 6	**A patient had an unnecessarily repeated nuclear medicine scan of the gallbladder due to nuclear medicine technologist (NMT) error.** A patient at a medical imaging practice presented for a nuclear medicine hepatobiliary scintigraphy scan of the gallbladder. The radiopharmaceutical was administered normally, but the gallbladder was not visualised after 60 minutes. The procedure, in this case, is to wait a couple of hours and then try to image the gallbladder again and, if still not successful, to give the patient a fatty meal to stimulate the gallbladder to contract. The NMT, however, fed the patient a fatty meal before attempting to visualise the gallbladder a second time without consulting a nuclear medicine specialist, which compromised the scan results. The patient required a repeat scan. The effective dose to the patient as a result of the first scan was approximately 3 mSv. Medical imaging staff were reminded to follow the practice's protocols.
Incident 7	**A patient had an unnecessarily repeated myocardial perfusion study due to nuclear medicine technologist error.** A patient at a medical imaging practice presented for a nuclear medicine myocardial perfusion study using ^{99m}Tc-sestamibi, with the rest test on one day and the stress test scheduled for the following day. The stress test had to be rescheduled for a week later due incorrect patient preparation on the original appointment day. In the interim, the initial rest study data was deleted during routine weekly data clean-up for the imaging camera. The rest study therefore needed to be repeated. The effective dose from this unnecessarily repeated rest study was approximately 2.6 mSv. A method was introduced whereby a study that is performed over multiple days is marked as protected on the imaging camera.
Incident 8	**A patient had a section of a CT scan unnecessarily repeated due to radiographer error.** A patient presented to a medical imaging practice with a referral for a CT angiogram that read 'from aorta to toes'. The radiographer decided that, because all the clinical details in the referral referred to the patient's lower limbs, the standard protocol for scanning from diaphragm to toes had to be used. On reporting, the on-site radiologist informed the radiographer that the entire heart had to be scanned. The patient was then called to come back for rescanning of the heart to pelvis section. The effective dose from the repeated diaphragm to pelvis portion of the scan was approximately 10 mSv. The radiographer was reminded to be vigilant when carrying out procedure identification processes and to seek advice in cases of uncertainty.
Incident 9	**Two patients had injections of radiopharmaceuticals repeated due to a thunderstorm knocking out power to a generator.** Two patients at a medical imaging practice were administered with 770 MBq and 800 MBq of ^{99m}Tc-HDP for bone scans. Prior to imaging taking place (after uptake time) a large thunderstorm knocked out power to the practice. The patients had to be rebooked to have the scans done and therefore received another dose. The effective doses from the injections of the radiopharmaceutical were 3.2 mSv and 3.5 mSv respectively. No further action was necessary.

Incident no.	Description of incident
Incident 10	**A patient had had an unnecessarily repeated administration of radiopharmaceutical due to nuclear medicine technologist error.** A patient attended a medical imaging practice for a rest/stress myocardial perfusion study (one-day protocol). The patient was injected with 315 MBq of ^{99m}Tc-sestamibi. It was then noticed that the patient had already undergone the test the previous week. The patient did not inform the staff of this previous test. The incident occurred because of poor communication between the practice and the cardiology department of the hospital to which the practice was attached. The effective dose from this unnecessary administration of radiopharmaceutical was approximately 2.5 mSv. All medical imaging staff members were reminded of the practice's pre-examination policy, which details the requirements at various stages to check for previous imaging. In addition, staff members were reminded of the importance of good communication between departments.
Incident 11	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A patient presented to a medical imaging practice for CT scan of the neck and chest (with contrast). Due to multiple staff members being involved in the scan setup, the scan as protocolled by the radiologist was not carried out correctly, with inadequate contrast of the vessels in the chest. The scan had to be repeated. The effective dose from this unnecessary scan was approximately 19 mSv. All radiographers at the practice were reminded of the potential issues when multiple staff members are directly involved in carrying out the scan of a single patient.
Incident 12	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A patient presented to a medical imaging practice for a non-contrast CT scan of the chest. The referrer's request indicated that the scan was to be performed in three months. The radiographer did not review the referral adequately and carried out the scan three months before it was required. The scan had to be repeated three months later. The effective dose to the patient due this incident approximately 6.6 mSv. The radiographer involved was reminded to review referrals thoroughly.
Incident 13	**A paediatric patient had abdominal fluoroscopic imaging unnecessarily repeated due to requesting clinician error.** A paediatric hospital patient underwent a fluoroscopy-guided stomagram via the medial stoma as requested by the clinician. During the procedure it was observed that the medial stoma was not the mucous fistula (the stoma that allows mucus to be collected), was the required procedure. The stomagram via the mucus fistula was carried out at a later date. The effective dose for the unnecessary abdominal fluoroscopic imaging was approximately 0.01 mSv. The requesting clinician was reminded of the importance of providing correct details on imaging requests.
Incident 14	**A patient had a CT scan unnecessarily repeated due to a nurse not communicating medical information.** A hospital patient underwent a CT mapping scan of the chest and upper abdomen in preparation for a biopsy. The CT scan was carried out, but the biopsy was not performed when it was noted that the patient had recently taken an anticoagulant medication. The patient should have withheld the medication before the biopsy. The incident arose because a graduate nurse had not advised medical staff and senior nursing staff that the patient had taken the medication. The effective dose due to the CT scan was approximately 6.5 mSv. The graduate nurse was counselled on the incident and was reminded to ensure better communication with other medical staff.

Incident no.	Description of incident
Incident 15	**A patient had unnecessarily repeated CT scans due to improper setup of contrast injections.** A hospital patient underwent two failed CT head perfusion scans due to improper setup of the contrast injections. The first scan failed because of a technical problem with a poor connection between the contrast injector and the patient's line resulting in an unsatisfactory scan. After resetting the protocol, the system automatically removed the pre-scan delay and disabled the integration between the injector and scanner, so the second attempt resulted in a failed scan. The second scan was aborted when the failure was realised. The effective dose due to the two failed scans was approximately 12 mSv. A senior radiographer discussed the incident with the staff involved to stress the importance of checking settings before scanning.
Incident 16	**A paediatric patient had a CT scan unnecessarily repeated due to the parent not providing information to the radiographer.** A paediatric patient and the patient's parent presented to an emergency department (ED) with elbow pain. An ED consultant generated a request for an elbow X-ray to query supracondylar fracture. After imaging, the parent informed the ED nurse that the patient had had the same X-ray from an external provider. The effective dose from this unnecessarily repeated procedure was approximately 0.001 mSv. No further action was necessary.
Incident 17	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A hospital patient was booked to have a CT scan of the brain as an outpatient. The patient had presented to the ED the day before for an isolated and separate investigation of worsening shortness of breath. During this ED admission, a CT scan of the brain was ordered to investigate a delirium diagnosis. This CT scan was performed as requested, but the CT brain scan booked for the following day was not cancelled. The radiographer performed the CT scan of the brain the next day without checking for previous imaging. The effective radiation dose due to the unnecessarily repeated scan was approximately 2 mSv. The radiographer involved was reminded to review previous imaging before performing scans.
Incident 18	**A patient had a CT scan unnecessarily repeated due to radiologist and radiographer error.** A hospital patient presented with a referral for a CT scan of the kidneys, ureters and bladder (KUB) to query poor renal function. In a pre-scan discussion, the patient indicated that an MRI scan for the condition had been carried out previously. The on-duty radiologist protocolled the patient for a single-phase CT scan of the KUB. When reporting on the scan, the radiologist noted that a CT scan had been performed 18 days before. The scan performed 18 days before was a CT scan not an MRI scan and the referral was a photocopy of the original referral. The effective dose due to the repeated scan was approximately 5 mSv. The radiologist involved was reminded to review previous imaging before ordering scans. The radiographer involved was reminded to review previous imaging before performing scans.
Incident 19	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A patient in a hospital ED was referred for a CT scan of the brain and ultrasound carotid scan. The CT scan of the brain was completed and the patient was returned to the ED. Following treatment, the patient was discharged with instructions to complete the ultrasound carotid scan as an outpatient. The patient presented to a medical imaging centre attached to the hospital with the original referral for a CT scan of the brain and ultrasound carotid scan. The CT scan of the brain was performed again in addition to the ultrasound scan. The effective dose from the CT brain scan was approximately 2.5 mSv. The radiographer who performed the first CT scan of the brain was reminded to annotate referrals to indicate the scans that had been completed. The radiographer who performed the second CT scan of the brain was reminded to check for prior imaging.

Incident no.	Description of incident
Incident 20	**A patient had a radiopharmaceutical administration unnecessarily repeated due to radiopharmaceutical impurity.** A hospital patient underwent a second ^{99m}Tc-ECD administration and imaging because the first image showed altered biodistribution potentially due to radiopharmaceutical impurity. The radiopharmaceutical passed all required quality control before administration, but more intensive quality control on the batch after the first image was aborted identified radiochemical impurity. The effective dose due to the radiopharmaceutical administration was approximately 5.3 mSv. The hospital implemented improved stability testing for batches of ECD used for clinical studies.
Incident 21	**A patient had a CT scan unnecessarily repeated due to a request duplication.** A hospital patient presented with a referral for a CT scan of the abdomen. The on-duty radiologist protocolled the patient for the scan. The radiographer noted the patient had previously undergone a CT scan of the abdomen and thought this was a follow-up scan. When reporting the scan, the radiologist noted that the CT scan of the abdomen had been performed using an identical referral to the previous CT scan. An investigation showed the request was a duplicate due to faxing of the request to the radiology department. The effective dose due to the unnecessarily repeated scan was approximately 7 mSv. Hospital staff members were reminded to destroy original requests after confirmation that a faxed request had been received.
Incident 22	**A patient had a CT scan unnecessarily repeated due to lack of communication between medical imaging practices and medical practitioners.** A patient at a medical imaging practice had a request from a general practitioner for a CT of the lumbar spine and a left-sided epidural steroid injection of the L5-S1 level spine. This request was based on a neurosurgeon's recommendation. On reviewing the available images and discussion with the patient, a radiologist determined that an L5 S1 nerve root injection was more appropriate. The neurosurgeon who had requested the epidural subsequently advised the radiologist that this was not appropriate. An investigation revealed that more recent imaging, performed at another centre, was not available to the radiologist. The radiologist was not aware that the neurosurgeon requested the epidural, and this led to the flawed decision to amend the procedure. The effective dose due to the unnecessarily repeated CT scan for the epidural for the epidural injection of the L5-S1 spine was approximately 6 mSv. The radiologist involved was reminded to engage in thorough consultation before changing medical imaging requests.
Incident 23	**A patient had a CT scan unnecessarily repeated due to a contrast administration error.** A hospital patient underwent an unnecessarily repeated CT pulmonary angiogram scan due to a contrast administration error. The saline and contrast syringes were accidentally swapped during preparation. The patient was then rescanned without further incident. The effective dose due to the first scan was approximately 8 mSv. The radiographer involved was reminded to be careful when preparing saline and contrast syringes.
Incident 24	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A hospital patient was referred for a CT scan of the chest, abdomen and pelvis for oncology staging. Several radiographers were involved in the booking and justification process. After scanning the patient, the radiographers discovered that the patient had undergone a CT scan of the chest for oncology staging two days before. The effective dose due to the unnecessarily repeated CT scan of the chest was approximately 2.2 mSv. The radiographers involved were reminded to check for previous imaging before performing scans.

Incident no.	Description of incident
Incident 25	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A hospital patient underwent an unnecessarily repeated CT scan of the cervical spine. A CT scan of the cervical spine and carotid region with contract was requested, but the radiographer overlooked it due to high workload. Once the mistake was noticed, the patient was informed and the scan correctly repeated with appropriate scan range and contrast administration. The effective dose due to the repeated the scan was approximately 7 mSv. Radiographers at the hospital were reminded to adhere to the hospital's timeout procedures even if the shift is busy.
Incident 26	**A patient had a CT scan unnecessarily repeated due to nurse error.** A hospital patient was brought to the radiology department for a CT scan of the brain, abdomen and pelvis with rectal contrast. Upon scanning, it was discovered that the contrast had in fact been introduced into the patient's bladder, not the rectum. The scan was repeated with the contrast medium introduced into the rectum. The error occurred because the patient had both a rectal catheter and a urinary catheter in place. The nurse involved chose the wrong catheter. The effective dose from the first scan was approximately 14 mSv. Nurses at the hospital were asked to be more diligent in checking catheters before introducing a contrast medium.
Incident 27	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A hospital patient underwent a CT scan of the brain and cervical spine that resulted in a higher radiation dose than intended. The CT scan of the brain and cervical spine was requested and then planned on the CT scanner by the radiographer. After completing the scout view, the radiographer changed the protocol to a CT axial brain scan because of the patient's dental fillings. After scanning the brain, the radiographer selected a high-dose cervical spine protocol that resulted in the cervical spine component being scanned with higher tube output settings than required. The estimated effective dose due to the higher tube output settings was approximately 2 mSv. The CT supervisor discussed the incident with radiographer and reminded the radiographer of the importance of checking scanner settings before carrying out a scan.
Incident 28	**A patient underwent an unnecessarily repeated CT cholangiogram scan due to contrast being administered by the wrong route.** A hospital patient underwent an unnecessarily repeated CT cholangiogram scan. In the first scan, the nurse delivered the contrast through a nasogastric tube rather than intravenously, as required. The effective dose due to the first scan was approximately 26 mSv. The nurse was reminded to be more vigilant in future.
Incident 29	**A patient had a CT scan unnecessarily repeated due to medical practitioner error.** A CT scan of the brain was performed on a patient without a surgical frame in place for surgical planning when a CT brain scan with the frame in place was required. The patient then required another CT brain scan with the frame in place. The error occurred because the radiographer received a call from the neurosurgery resident asking that the patient receive a preoperative CT scan. A radiology registrar then approved the CT brain scan (without a surgical frame). The effective dose from the unnecessary scan was approximately 1.5 mSv. The neurosurgery resident involved was reminded to consult with surgical staff in situations of this kind.
Incident 30	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A hospital patient underwent an unnecessary CT scan for transcatheter aortic valve implantation (TAVI) planning. The patient had already undergone a TAVI planning scan as an inpatient for expedited care, while this TAVI scan was (unnecessarily) scheduled as a future outpatient scan. The outpatient scan was not cancelled, resulting in the patient attending for an unnecessary scan. The effective dose due to the unnecessarily repeated scan was approximately 14 mSv. Radiographers at the hospital were reminded to check for previous scans.

Incident no.	Description of incident
Incident 31	**A patient underwent an unnecessarily repeated cardiac stress test due to a leakage of adenosine during the test.** A hospital patient was undergoing the adenosine infusion component of a cardiac stress test when adenosine started to leak from the syringe four minutes into the five-minute infusion. The patient was not adequately stressed pharmacologically. This leakage occurred because the NMT did not screw the syringe end of the connection tightly enough. The ^{99m}Tc-sestamibi was injected at the two-minute mark of the infusion. The stress test was rebooked for another day. The effective dose due to the incomplete procedure was approximately 7.4 mSv. The NMT involved was reminded to ensure all connections are secure before administering radiopharmaceuticals.
Incident 32	**A patient underwent an unnecessarily repeated CT scan of the thoracic spine.** A hospital patient was undergoing a CT scan of the thoracic and lumbar spine. After initiating the CT scan of the thoracic spine, a nurse that had accompanied the patient entered the CT scanner room from the adjoining nurse preparation area/workstation between the scanner room and the radiographer control room. The radiographer immediately aborted the CT scan. The door to the scanner room was closed and all warning signs were in place and functioning at the time of the incident. The radiographer restarted the scan of the thoracic spine and repeated the scan of the section already imaged. The effective dose to the patient due to the incomplete CT scan was approximately 3.4 mSv. The nurse involved was reminded not to enter CT scanner rooms when the scanner is in operation.
Incident 33	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A hospital patient underwent a CT scan of the brain and spine; however, the radiographer did not perform a reformat of the CT brain scan. As the raw data was not retained, the patient had to return for a second CT scan of the brain. The effective dose due to the first CT scan of the brain was approximately 1.1 mSv. The supervisor radiographer spoke to the radiographer involved and worked through the handling error contributing to this incident.
Incident 34	**A patient had a CT scan unnecessarily repeated due to an incorrectly connected cannula.** A hospital patient underwent two unnecessary CT head perfusion scans due to a loose connection of the cannula delivering the contrast agent. A third perfusion scan was successfully performed. The effective dose due to the first two CT scans of the brain was approximately 8.1 mSv. The nurse involved was asked to be more diligent in checking cannula connections before introducing a contrast medium.
Incident 35	**A patient had a CT scan unnecessarily repeated due to an incorrectly connected cannula.** A hospital patient presented for a CT scan of the abdomen and pelvis. The CT pressure injector and scanner did not pair correctly and the radiographer did not recognise this. Not realising this problem, the radiographer began the bolus tracking acquisition. The radiographer then realised the problem had occurred and stopped the scan. The radiographer corrected the setup of the scan and undertook the required post-contrast acquisition. The effective dose due to the first CT scan was approximately 3.3 mSv. A supplier investigation of the problem could not determine the cause. The radiographer involved was educated about identifying this issue in the future.
Incident 36	**A patient had a CT scan unnecessarily repeated due to radiographer error.** A hospital patient underwent an unnecessarily repeated CT carotid angiogram because the radiographer involved accidently initiated the CT carotid angiogram before the contrast had reached the aortic arch. The scan was repeated with adequate contrast. The effective dose due to the first CT scan was approximately 3.3 mSv. The radiographer involved was reminded to adopt more care in future.

Incident no.	Description of incident
Incident 37	**A patient had a CT scan unnecessarily repeated due to radiation oncologist error.** A hospital patient underwent an unnecessary radiotherapy planning CT scan of the brain due to the radiation oncologist specifying an insufficient scan range in the request form. The scan was performed to the third cervical vertebra (C3). The disease, however, extended to C4, and the scan had to be repeated at a later date. The effective dose due to the first unnecessary scan was approximately 3 mSv. The radiation oncologists at the hospital were reminded to document correct scan ranges on booking forms.
Incident 38	**A patient had a CT scan unnecessarily repeated due to contrast leaking onto the CT scanner detectors.** A hospital patient was referred for a CT scan of the brain with contrast. After completing the scan, the radiologist reviewed the image and requested a repeat of the scan due to a ring artefact in the image. The scan was completed on a different scanner without concern. An engineer from the supply company was contacted and found that some contrast had leaked on to the detectors, causing the artefact. The engineer identified a design fault that allowed contrast to leak through small gaps between a mylar window and the outer CT casing. The effective dose due to the first unnecessary scan was approximately 1.1 mSv. The engineer from the supply company applied a workaround in the short term and then sourced parts to fix the design fault.
Incident 39	**A patient had a CT cystogram unnecessarily repeated due to an incorrectly positioned cannula.** A hospital patient underwent an unnecessarily repeated CT cystogram because the ward nurse positioned the catheter in the wrong location. The effective dose due to the first unnecessary cystogram was approximately 15 mSv. Ward staff members were given refresher training on catheter insertion.
Incident 40	**A patient had a CT angiogram unnecessarily repeated due to radiographer error.** A hospital patient underwent an unnecessarily repeated CT angiogram because the radiographer missed injecting the intravenous contrast for the arterial phase imaging. The effective dose due to the first unnecessary angiogram was approximately 9 mSv. The radiographer involved was reminded to concentrate on the imaging procedure being carried out.
Incident 41	**A patient had a radiopharmaceutical administration unnecessarily repeated due to extravasation of a radiopharmaceutical.** A hospital patient was to be administered with 150 MBq of ^{99m}Tc macro aggregated albumin (^{99m}Tc MAA) for a nuclear medicine ventilation/perfusion study but the radiopharmaceutical was inadvertently injected extravenously. The estimated maximum skin dose was 0.35 Gy. This dose is not expected to produce any noticeable tissue reaction. No further action was necessary.
Incident 42	**A patient had a radiopharmaceutical administration unnecessarily repeated due to extravasation of a radiopharmaceutical.** A hospital patient was to be administered with 150 MBq of ^{99m}Tc MAA for a nuclear medicine ventilation/perfusion study but the radiopharmaceutical was inadvertently injected extravenously. The estimated maximum skin dose was 0.6 Gy. This dose is not expected to produce any noticeable tissue reaction. The effective dose due to the first unnecessary administration was less than approximately 2.3 mSv. No further action was necessary.

Incident no.	Description of incident
Incident 43	**A patient had a radiopharmaceutical administration unnecessarily repeated due to nuclear medicine technologist error.** An hospital patient was booked in for a whole-body bone scan in the nuclear medicine department. The patient indicated that they had not had a previous bone scan when asked by the NMT. The NMT, however, did not check the hospital's electronic imaging system to confirm that the patient had not recently had a scan. The patient was injected with 860 MBq of ^{99m}Tc-HDP. When the images were sent to the radiologist it was discovered that the patient had already had a bone scan seven days prior with an identical referral. The effective dose due to the second unnecessary administration was approximately 4.6 mSv. The NMT involved was reminded to check thoroughly for previous scans before injecting radiopharmaceuticals.
Incident 44	**A patient underwent a repeated scan for a CT carotid angiogram due to a radiographer error.** The scan was set up to initiate automatically on detection of iodinated contrast. The radiographer, however, believed the scan was not timing correctly with the contrast administration and started the scan manually, earlier than required. The resulting scan showed a lack of appropriate contrast and necessitated a repeat scan. The effective dose due to the first scan was approximately 5 mSv. The radiographer involved was familiarised with the timing of contrast injection on the scanner.
Incident 45	**A patient underwent a repeated CT scan of the chest and neck due to clerical error.** A patient at a medical imaging practice had been referred for a CT scan of the chest, neck and brain. Only the chest and neck were scanned initially. The patient was recalled for the CT brain and, as a result of an administrative error, a CT scan of the chest and neck was incorrectly protocolled and performed. Subsequently, on the same day, the required CT scan of the brain was completed. The effective dose due to the repeated scan of the chest and neck was approximately 10 mSv. The clerical staff members involved were reminded to exercise care when entering patient and procedure details on imaging requests.
Incident 46	**A patient underwent a repeated CT scan for attenuation correction purposes due to nuclear medicine technologist error.** A hospital research participant underwent a repeated CT acquisition scan for attenuation correction purposes as part of a PET/CT scan. The NMT selected the wrong scan range. A repeat of the CT scan with the correct scan range had to be performed. The effective dose for the first scan was approximately 5 mSv. The NMT involved was instructed to review imaging protocols and work instructions before scanning.
Incident 47	**A paediatric patient underwent a repeated chest X-ray due to a failure to request copies of previous imaging.** A paediatric patient presented to a hospital for a chest X-ray to help remove a foreign body in the airway. Chest imaging had been performed the previous day at another hospital. No attempt had been made by the treating team to access copies of the images when the patient arrived the previous evening. Medical Imaging made an urgent request to the other hospital for the images to be transferred, but the ward nurse and the patient's parents were concerned that the patient might lose their spot in theatre if they had to wait for the images to be transferred. It was decided between the treating team, the medical imaging team and the patient's parents that the chest imaging would be repeated to avoid potential delays to the procedure. The effective dose for the unnecessary chest X-ray was approximately 0.05 mSv. Staff members involved were reminded to request the transfer of images acquired at other locations to avoid having to repeat imaging and radiation exposure.

Incident no.	Description of incident
Incident 48	**A paediatric patient underwent a repeated X-ray of the abdomen due to clerical error.** A paediatric hospital patient underwent an unnecessarily repeated X-ray of the abdomen. Clerical staff had recorded the patient under two unit record numbers (URN) in the electronic system. As a result, two separate abdominal X-rays were ordered. The effective dose due to the unnecessary X-ray was approximately 0.3 mSv. The clerical staff were reminded to use care to ensure patients are assigned unique URNs.
Incident 49	**A patient underwent a repeated CT scan of the brain due to inadequate contrast injection for the first scan.** A hospital patient presented for a CT scan of the brain from the circle of Willis to the aortic arch (CTA COW scan). After the CTA COW scan was performed, one of the radiographers involved noticed that the images lacked the appropriate amount of contrast to be of diagnostic quality. The radiographer discovered that they had injected 9 mL of intravenous contrast instead of the required 60 mL. The CTA COW scan was repeated with the correct amount of contrast. The effective dose due to the unnecessary CT scan of the brain was approximately 8 mSv. The radiographer involved was counselled about the incident by the senior CT radiographer.
Incident 50	**A patient underwent a repeated CT scan of the chest due to radiographer error.** A hospital patient was referred for CT scan of the chest, abdomen and pelvis with contrast. The scanning radiographer reviewed prior imaging and made note of a recent CT scan of the chest with contrast but did not consider this prior imaging as relating to the current request and therefore proceeded with the scheduled imaging. During image reporting, the radiology registrar noted that the recent CT scan of the chest with contrast was for similar indications. The chest portion of the current imaging examination was considered unnecessary. The effective dose due to the unnecessary CT scan of the chest was approximately 5 mSv. The radiographer was reminded to seek further advice when uncertain about previous imaging. The radiographer who justified and approved the scan was cautioned that this was the responsibility of a radiologist, not a radiographer.
Incident 51	**A patient underwent a repeated CT scan of the brain due to neurologist error.** A hospital patient presented for a pre-surgical CT scan of the brain with intravenous contrast and fiducial markers. The patient reported a prior reaction to contrast so the radiology registrar liaised with a neurosurgical resident to see if contrast was necessary for the scan. The resident advised that neither contrast nor fiducial markers were required. After the scan was performed, the radiology registrar was contacted by a neurosurgery registrar and advised that the fiducial markers had been required and that the patient would need to be rescanned. The effective dose due to the unnecessarily repeated CT scan was approximately 2.5 mSv. The neurosurgery resident involved was counselled by the neurosurgery registrar regarding the incident.
Incident 52	**A patient underwent an unnecessarily repeated bone scan due to extravasation of ^{99m}Tc-HDP during the test.** A hospital patient presented for a bone scan with 800 MBq of ^{99m}Tc-HDP. The patient arrived from the ward with a cannula inserted in the right arm. The NMT flushed the cannula with saline to confirm patency of the line. The NMT proceeded to inject the HDP. The patient experienced no pain during the injection. During blood pool imaging no activity was seen distributed throughout the body. A second cannula was inserted in the other arm to complete the scan. The effective dose due to the first HDP injection procedure was approximately 4 mSv. No further action was necessary.

Incident no.	Description of incident
Incident 53	**A paediatric patient underwent a repeated CT scan of the chest, abdomen and pelvis due to radiographer error.** A paediatric hospital patient was to undergo a CT scan of the chest, abdomen and pelvis. A senior radiographer stayed in the room wearing a lead apron and a junior radiographer operated the CT scanner from the CT control room. The senior radiographer had a control device to perform most of the scanner setup except for arming of the intravenous contrast injector. The senior radiographer was leaning over the control device to ensure the patient's cannula had not moved and, in doing so, their lead apron inadvertently touched a button that aborted the scanner delay. Only 67 mL out of 100 mL had been injected when the scan began. The radiology fellow and consultant assisting the scan reviewed the images and decided that the scan would need to be repeated. The effective dose for the unnecessary CT scan was approximately 8.5 mSv. The radiographer involved was reminded to take care when using lead aprons.
Incident 54	**A paediatric patient underwent a repeated CT scan of the chest, abdomen and pelvis due to radiographer error.** A paediatric hospital patient required a scan of the chest, abdomen and pelvis. After the scan was performed, the radiologist reviewing the images requested a delayed CT scan of the lung base alone. The radiographer repeated the scan without editing the scan range to include only the lung bases, resulting in the chest, abdomen and pelvis being scanned again. The effective dose for the unnecessary scan range was approximately 0.6 mSv. The radiographer involved was reminded to concentrate on the imaging procedure being carried out.
Incident 55	**A patient underwent a repeated CT scan of the chest due to radiographer error.** A hospital patient presented for a CT scan of the chest. The radiographer involved did not inject the contrast when required, necessitating a repeat scan. The effective dose for the unnecessarily repeated CT scan was approximately 7.5 mSv. The radiographer involved was reminded to ensure contrast monitoring scans are performed before starting contract injections.
Incident 56	**A paediatric patient underwent a repeated panoramic dental X ray due to radiographer error.** A paediatric patient attended a medical imaging practice for a panoramic dental X-ray. The image was printed and given to the patient's father and they were sent home. However, the radiographer forgot to save the image on the medical imaging database and the image was deleted from the system. The patient was called back to the practice for a repeat panoramic dental X ray. The effective dose for the unnecessarily repeated panoramic dental X ray was approximately 0.01 mSv. The radiographers at the practice were reminded to check that all images are reviewed and saved to the database after performing an examination.
Incident 57	**A paediatric patient underwent a repeated CT scan of the chest due to radiographer error.** A paediatric hospital patient required a contrast CT scan of the chest. The procedure was interrupted after the patient was cannulated (but prior to imaging) due to a trauma patient requiring an urgent CT scan. When the patient returned to the scanner for the scan, the radiographer loaded the contrast and the saline barrels into the injector incorrectly. The patient was scanned and the radiographer then realised the error when minimal contrast was evident in the CT images. The patient had to be scanned again. The effective dose for the unnecessarily repeated CT scan was approximately 1.5 mSv. The radiographer involved was reminded to take care when carrying out scans.

Incident no.	Description of incident
Incident 58	**A patient underwent a repeated nuclear medicine sentinel node scan and CT scan due to a power outage.** A hospital patient was to undergo a nuclear medicine sentinel node scan (a lymph node scan) with 20 MBq ^{99m}Tc antimony colloid and a biopsy. A power outage occurred (a code yellow event) due to severe weather conditions after the ^{99m}Tc was injected. The patient's nuclear medicine scan was cancelled in line with hospital procedure. The sentinel biopsy and a CT scan, which were not cancelled, were performed but the patient could not proceed to theatre because of the power outage. Both scans had to be repeated. The effective dose for the unnecessarily repeated scans was approximately 1.8 mSv. Staff members were reminded of code yellow requirements for cancelling medical procedures.
Incident 59	**A patient underwent an unnecessarily repeated CT scan due to nuclear medicine technologist error.** A hospital patient was referred for an FDG PET scan. After the PET radiopharmaceutical was administered, the patient was told to wait in the uptake room until called for their examination. The NMT correctly recorded the administration time onto the patient's worksheet, but the scanning NMT misread the time and performed the CT attenuation correction scan portion (top of head to knees) of the examination before the required scan time. The scanning NMT noticed the error after the CT had been performed and took the patient back to the uptake room to wait for the appropriate scan time. The CT portion of the examination had to be repeated at the correct time. The effective dose for the unnecessary first scan was approximately 4.3 mSv. The NMT involved was counselled about the importance of double-checking scan time labels.

Unnecessary, unrequested or unapproved medical procedures

Incident no.	Description of incident
Incident 60	**A patient underwent an unnecessary CT scan of the chest with inspiration and expiration imaging due to radiographer error.** A hospital patient underwent a CT brain scan that was not necessary. The patient came in for a CT NCAP (neck, chest, abdomen and pelvis) scan but was booked into the system for a CT BNCAP (brain, neck, chest, abdomen and pelvis) scan by a junior radiographer. The effective dose due to the unintended scan was approximately 1.3 mSv. A senior radiographer counselled the junior staff about the incident.
Incident 61	**A patient underwent an unnecessary CT scan of the brain due to radiographer error.** A patient attended a medical imaging practice for a CT scan of the chest, abdomen and pelvis with contrast. The radiographer identified the patient with the correct referral but inadvertently completed a CT scan of the brain with and without contrast in addition to the requested imaging. This occurred because the radiographer saw another referral next to the current patient's referral that had similarities to the identified patient's request. The effective dose from the CT scans of the brain was approximately 4 mSv. The radiographer was reminded to ensure that correct imaging is performed and to be vigilant when carrying out patient and procedure identification processes.
Incident 62	**A patient underwent an unnecessary CT scan of the brain due to emergency department registrar error.** A hospital patient presented to the radiology department for a CT scan of the head following an imaging request by an ED registrar. The request was correctly protocolled and performed. After the scan was performed, the referring doctor advised the radiographers involved that the scan was not required. The effective dose due to this unnecessary scan was approximately 2.8 mSv. The ED registrar was reminded to notify the radiology department promptly of changes in scan requirements.

Incident no.	Description of incident
Incident 63	**A paediatric patient underwent unnecessary X-rays of the right clavicle due to radiographer error.** A paediatric patient underwent unnecessary imaging of the right clavicle. The patient underwent an anterior-posterior (AP) and 20 degrees angled AP X-ray of the right clavicle. The imaging request was for the left clavicle but the radiographer inadvertently imaged the right clavicle. The radiologist identified the inconsistencies in the images while reporting the images. The effective dose for the unnecessary imaging of the right clavicle was approximately 0.01 mSv. The radiographer involved was reminded of the importance of completing patient and procedure identification processes correctly. A reminder was sent to all radiographers that they ensure imaging of the correct body side.
Incident 64	**A paediatric patient underwent unnecessary X-rays of the wrist due to clerical error.** A paediatric hospital patient underwent an unnecessary radiographic bilateral wrist examination, totalling four images. The patient was booked for follow-up imaging seven months after a fracture. The appointment was incorrectly booked five months after the fracture. The patient's parent noticed the incorrect timing of the booking after imaging had already taken place. The effective dose due to the unnecessary wrist scans was approximately 0.01 mSv. Clerical staff members were reminded to double-check the scan date before confirming booking times.
Incident 65	**A patient underwent an unnecessary CT scan of the pelvis due to radiographer error.** A hospital patient underwent follow-up general X-ray imaging and a CT examination of the pelvis when only general X-ray imaging was required. The radiographer assumed that the referring practitioner had selected both CT and general X-ray imaging on the radiology department's electronic request form, which was not the case. Furthermore, under the examinations requested section of the request it was not clear that only general X-ray imaging was required. The effective dose was approximately 6 mSv for the CT scan. Modifications to the electronic form were implemented that make it clear what type of radiological examination is being requested to minimise chances of this type of error occurring in the future. The radiographer involved was reminded to check referral details thoroughly and to seek advice in cases of uncertainty.
Incident 66	**A patient underwent an unnecessary CT scan of the whole lumbar spine due to radiologist and radiographer error.** A hospital patient underwent a CT scan of the whole lumbar spine instead of a single slice. This error was due to unclear protocolling by the radiology registrar and the radiographer missing important information (single slice only) when reading the referral. The effective dose due to the unintended scan was approximately 40 mSv. The senior radiographer had a discussion with the junior radiographer involved in the incident. A communication was also sent to the radiology registrar about the importance of accurate protocolling.
Incident 67	**A patient underwent a CT scan of a greater anatomical region than intended due to radiographer error.** A hospital patient underwent a CT thoracic angiogram that was scanned to the lower trochanters rather than to the base of the diaphragm, as intended, due to the radiographer entering the wrong scan parameters. The effective dose for the additional scan length was approximately 8 mSv. The radiographer was reminded to pay more attention to the detail in protocolled requests.

Incident no.	Description of incident
Incident 68	**A patient underwent a CT scan of a greater anatomical region than intended due to radiographer error.** A hospital patient presented for a CT scan of the chest and abdomen (quad-phase liver protocol) to assess organ donation suitability following brain death. The imaging request was correctly protocolled, but the radiographer involved incorrectly scanned the entire chest, abdomen and pelvis rather than just the liver. The effective dose due to the CT scan of the pelvis was approximately 3.8 mSv. The radiographer involved received counselling from the hospital's chief radiographer.
Incident 69	**A patient underwent an unnecessary attenuation correction CT scan due to radiographer error.** A patient presented to a medical imaging practice for a CT scan but underwent an attenuation correction CT scan due to the radiographer selecting the wrong protocol. The patient was then reloaded into the scanner and the correct protocol was selected. The effective dose from the attenuation correction CT scan was approximately 9.5 mSv. The radiographer involved was reminded to be careful when selecting CT scan protocols.
Incident 70	**A patient underwent an unnecessary attenuation correction CT scan due to radiographer error.** A hospital patient had a CT scan of the brain and facial bones requested. The scan was protocolled by a radiologist as a CT scan of the brain, facial bones (including mandible) and cervical spine. The effective dose for the CT scan of the cervical spine was approximately 5 mSv. The radiologist involved was reminded to check request orders thoroughly. The radiographer involved was reminded to crosscheck order requests against protocolled scans before imaging.
Incident 71	**A patient underwent an unnecessary CT scan of the lumbar spine due to clerical error.** A patient presented to a medical imaging practice for a CT scan of the brain and lumbar spine. On a date prior to the examination, the referring doctor had called the clinic and requested that the CT scan of the lumbar spine be cancelled and an MRI scan of the lumbar spine be performed instead. A clerical staff member had cancelled the CT scan of the lumbar spine in the radiology information system and annotated the order notes to indicate that only the CT scan of the brain was to be performed. However, because the referral itself was not amended, the receptionist on the day of the scan reinstated the CT scan of the lumbar spine and a radiographer performed both CT scans as per the referral. The effective dose from the unnecessary CT scan of the lumbar spine was approximately 8.3 mSv. The clerical staff member involved was reminded to make changes to all relevant documents when a change in required scans is made.
Incident 72	**A patient underwent an unnecessary CT scan of the chest and pelvis due to radiographer error.** A CT pulmonary angiogram (CTPA) and CT scan of the abdomen was requested for a hospital patient. A CTPA plus a portal venous CT scan of the chest, abdomen and pelvis were performed in error by the radiographer, who was distracted at the time due to assisting with lunch relief and image reconstructions. The effective dose from the unnecessarily scanned regions was approximately 1.8 mSv. The radiographer involved was cautioned to focus on the task at hand when carrying out scans.
Incident 73	**A patient underwent an unnecessary CT scan of the chest due to radiographer error.** A hospital patient underwent an unrequested CT scan of chest in addition to the requested CT scan of the abdomen and pelvis. This incident occurred because the radiographer did not thoroughly verify the CT scan requested by the referring practitioner that had been correctly protocolled by the radiologist. The effective dose from the unnecessarily scanned regions was approximately 2.5 mSv. The radiographer was reminded to carry out patient and procedure identification processes thoroughly.

Incident no.	Description of incident
Incident 74	**A patient underwent an unnecessary CT scan of the brain due to radiographer error.** A hospital patient underwent a CT scan of the brain without a written request. The radiographer assumed the received request for a CT scan of the spine would also include a CT scan of the brain because both are most frequently requested when a patient presents with the patient's history and associated clinical symptoms. The effective dose from the unnecessary brain scan was approximately 5 mSv. The radiographer was reminded to carry out only the procedure requested on the referral form.
Incident 75	**A patient underwent an unnecessary CT scan of the brain due to radiographer error.** A hospital patient underwent an unnecessarily repeated CT scan of the chest. The patient moved 5 cm down on the scanning table after the scout scan. The radiographer did not repeat the scout scan. Consequently, the bottom of the lungs was missed and so the entire study had to be repeated. The effective dose due to the unintended scan was approximately 4.4 mSv. The radiographer was reminded of the importance of repeating the scout scan if the patient has moved on the scanning table.
Incident 76	**A patient underwent an unnecessary scan of the wrist due to radiologist error.** A hospital patient underwent a CT scan of the right wrist. Several hours after this scan was performed, the reporting radiologist noticed that the CT request had the written note 'cancel – duplicate as per ortho'. The radiologist registrar had made a cancellation note in the protocol section of the order but did not verbally advise the emergency CT radiographers at the time that the order was cancelled. The effective dose due to the unnecessary scan was approximately 3.3 mSv. The radiologist registrar involved was reminded to advise radiographers when orders are cancelled.
Incident 77	**A patient underwent an unnecessary CT scan of the brain due to referring practitioner error.** A hospital patient had a non-contrast CT scan of the brain. After the scan, the referring practitioner asked the radiography staff why the requested 'BrainLab' CT scan had not been performed. The referring practitioner had telephoned radiology earlier that day to request that the scan be changed from a non contrast CT scan of the brain to a BrainLab CT scan. The referring practitioner did not cancel the request for the non-contrast CT scan of the brain on the electronic ordering system. The effective dose due to the unnecessary scan was approximately 2.3 mSv. The referring practitioner was reminded to cancel procedures no longer required using established hospital procedures.
Incident 78	**A patient underwent an unnecessary CT scan of the cervical spine due to radiology registrar error.** A hospital patient was referred for a CT scan of the cervical spine. Following presentation for imaging, the radiographer noted that a CT stroke perfusion study had recently been carried out that included imaging of the cervical spine. The CT stroke perfusion study was discussed with a radiology registrar, who gave approval to proceed with the CT scan. While reviewing the images, the reporting radiologist noted the previous CT perfusion study and felt that the previous examination would have answered the clinical question. The effective dose due to the unnecessary scan was approximately 1.7 mSv. The radiology registrar involved was reminded to use more care when approving scans where other scans that have been carried out on a patient may provide sufficient information.

Incident no.	Description of incident
Incident 79	**A patient underwent an unnecessary CT scan of the chest due to radiographer error.** A hospital patient was referred for a CT scan of the chest, abdomen and pelvis (CAP) with contrast. The radiographer reviewed prior imaging and noted a recent angiogram phase CT scan of the chest but felt that that chest portion of the CAP CT scan was different from the angiogram previously performed and decided it was appropriate to proceed. A radiologist later determined that the chest portion of the CAP CT scan was not required and that the previous chest CT angiogram was sufficient. The effective dose due to the unnecessary scan was approximately 6.1 mSv. The radiographer involved was reminded to seek advice when any doubt arises about the need for medical imaging.
Incident 80	**A patient underwent a CT scan of a greater anatomical region than intended due to radiographer error.** A hospital patient inadvertently underwent an unnecessary radiation exposure of the chest and upper abdomen. The study requested and protocolled was a CT femoral angiogram (aortic bifurcation to toes). The scan was performed with the scan range inadvertently set to aortic arch to toes. The scan therefore included the chest and upper abdomen. The effective dose due to the unnecessarily scanned regions was approximately 10 mSv. The radiographer involved was reminded to be careful setting up CT scans.

Wrong patient underwent a medical procedure

Incident no.	Description of incident
Incident 81	**A hospital patient underwent a CT scan of the abdomen and pelvis intended for a different patient.** A hospital patient had a CT scan of the abdomen and pelvis. The referring unit called after the patient underwent the scan to advise that the scan was intended for another patient. The referring unit identified the incident after the scan had been completed. The radiographer had performed all patient and procedure checks. The dose due to the unnecessary CT scan was approximately 10 mSv. The medical practitioner involved was reminded to be careful when placing patients' names on referrals.
Incident 82	**A patient underwent a CT scan intended for a different patient due to referring practitioner error.** A patient attended a medical imaging practice with a referral for a CT scan that was intended for another patient. The incorrect patient label was placed on the referral by the referring practitioner. The effective dose from this unnecessary scan was approximately 8 mSv. The referring practitioner was reminded to be careful when placing patients' names on referrals.
Incident 83	**A paediatric patient underwent an abdominal X-ray intended for a different patient due to referring practitioner error.** A paediatric patient presented to the radiology department of a hospital with a referral for an abdominal X-ray. After checking three points of identification, the radiographer performed the scan. The ward then called to say they were sending down a referral with the correct patient details. The referring clinician had attached the incorrect patient identification sticker to the initial request. The effective dose due to the X-ray procedure was approximately 0.03 mSv. The referring practitioner was reminded to be careful when placing patients' names on referrals.

Incident no.	Description of incident
Incident 84	**A paediatric patient underwent a chest X-ray intended for a different patient due to referring practitioner error.** A paediatric patient underwent a chest X-ray that was intended for another patient because the referring practitioner placed the wrong patient's name on the referral. The effective dose due to this unnecessary chest X-ray was approximately 0.02 mSv. The referring practitioner was reminded to be careful when placing patients' names on referrals.
Incident 85	**A patient underwent X-rays intended for a different patient due to radiographer error.** A patient at a medical imaging practice had a plain X-ray of chest and pelvis and a CT scan of the brain intended for another patient. This occurred because the wrong patient's name was written on the request form. The radiographer did not identify the patient adequately and match the procedure to the patient. The effective dose from these unnecessary examinations was approximately 1.5 mSv. The radiographer involved was reminded to be vigilant when carrying out patient and procedure identification processes.
Incident 86	**A paediatric patient underwent a chest X-ray intended for a different patient due to referring practitioner error.** A medical imaging practice patient presented with a referral for a CT scan of the abdomen and pelvis. The radiographer confirmed the patient and procedure. Midway through the scan the radiographer noticed that, while some clinical indications were relevant, some notes on the referral were not. The radiographer stopped the scan and checked with the referring physician. The radiographer was advised that the wrong patient label was placed on the referral. The effective dose from this unnecessary scan was approximately 21 mSv. The referring practitioner was reminded to be careful when placing patients' names on referrals.
Incident 87	**A patient underwent a CT scan intended for another patient due to radiographer error.** A patient at a medical imaging practice had a CT scan of the neck, chest abdomen and pelvis intended for another patient with a similar name. Various imaging staff members were involved with patient handover. Full patient identification and procedure matching was not carried out by the radiographer involved. The effective dose from this unnecessary scan was approximately 21 mSv. The radiographer involved was reminded to carry out patient and procedure identification processes thoroughly.
Incident 88	**A patient underwent a CT scan intended for another patient due to radiographer error.** A patient at a medical imaging practice had a CT scan of the abdomen and pelvis intended for another patient. When the patient arrived at the department the staff member was distracted by a telephone call. As a result, ineffective patient identification and procedural matching was carried out, resulting in the wrong patient receiving the scan. The effective dose from this unnecessary scan was approximately 4.3 mSv. The radiographer involved was reminded to carry out patient and procedure identification processes thoroughly.
Incident 89	**A patient underwent a chest X-ray intended for another patient due to referring practitioner error.** A patient attended a medical imaging practice with a referral for a CT scan of the abdomen and pelvis intended for another patient. The radiographer correctly identified the patient but did not adequately match the procedure to the patient. An ED physician had put the wrong patient details on the referral form. The effective dose from this unnecessary scan was approximately 4.2 mSv. The referring practitioner was reminded to be careful when placing patients' names on referrals. The radiographer was reminded to match the procedure to the patient in future.

Incident no.	Description of incident
Incident 90	**A patient underwent a nerve root injection/branch block under CT guidance intended for another patient due to patient confusion.** A patient presented to a medical imaging practice for a nerve root injection/branch block under CT guidance. The patient's carer, who was also a patient, underwent the procedure instead of the patient because the carer said the scan was for them (the carer). The patient and the carer shared the same first name, address and phone number. A clerical staff member discovered that it was the wrong patient, but by this time the procedure had been completed. The effective dose from this unnecessary scan 1.5 mSv. No further action was necessary.
Incident 91	**A patient underwent a CT scan intended for another patient due to referring practitioner error.** A patient at a medical imaging practice underwent a CT scan of the full spine intended for another patient. The referring physician had placed the incorrect patient label on the referral. The effective dose from this unnecessary scan was approximately 21 mSv. The referring practitioner was reminded to be careful when placing patients' names on referrals.
Incident 92	**A patient underwent a CT scan intended for a different patient due to referring practitioner error.** A patient attended a medical imaging practice with a referral for a CT scan of the brain (non-contrast) that was intended for another patient. The referring practitioner had placed the incorrect patient label on the referral. The effective dose from this unnecessary scan was approximately 2 mSv. The referring practitioner was reminded to be careful when placing patients' names on referrals.
Incident 93	**A patient underwent a CT scan intended for another patient due to radiographer error.** A hospital patient underwent a CT scan of the abdomen intended for another patient. The radiographer involved did not follow patient identification and procedure-matching requirements. The effective dose due to the unintended scan was approximately 6.6 mSv. The radiographer involved was reminded of the importance of proper patient identification and procedure matching.
Incident 94	**A patient underwent a CT scan intended for another patient due to ward staff and radiographer error.** Hospital staff transporting a ward patient to the radiology department for a CT scan of the pelvis had been directed to the wrong patient bed by ward staff. The radiographer did not follow the appropriate identification protocol before conducting the CT scan. The error was discovered after the scan was completed. The effective dose due to the unnecessary CT scan was approximately 6 mSv. The radiographer involved was reminded to carry out patient and procedure identification processes thoroughly.
Incident 95	**A patient underwent a nuclear medicine scan intended for another patient due to referring practitioner error.** A nuclear medicine gated blood pool scan (GBPS) using ^{99m}Tc-labelled red blood cells was performed on the wrong patient because the incorrect patient sticker was put on the referral by the referring practitioner. The effective dose from the unnecessary scan was approximately 6 mSv. The referring practitioner was reminded to be careful when placing patients' names on referrals. The NMT involved was reminded to carry out patient and procedure identification processes thoroughly.

Incident no.	Description of incident
Incident 96	**A patient underwent a CT scan intended for another patient due to medical practitioner error.** A hospital patient underwent a CT scan of the brain intended for another patient. A ward doctor selected the incorrect patient for the scan. Ward staff identified the error after the request had been actioned. The effective dose from the unplanned exposure was approximately 2 mSv. The ward doctor and radiographer involved were reminded of the hospital's requirement that patient Identification and procedure matching be carried out thoroughly.

Patient underwent incorrect medical procedure

Incident no.	Description of incident
Incident 97	**A patient underwent a CT scan of the temporal bones instead of the soft tissue larynx due to radiographer error.** A patient presented to a medical imaging practice for a CT scan of the soft tissue larynx with contrast to investigate a maxillary mass. The scan was incorrectly booked as a CT scan of the temporal bones. The radiographer did not identify the procedure correctly by consulting the original referral. The effective dose from these unnecessary scans was approximately 2 mSv. The radiographer was reminded to be vigilant when carrying out patient and procedure identification processes.
Incident 98	**A patient underwent a CT scan of the knee instead of the hip due to radiographer error.** A patient presented to a medical imaging practice with a referral for a CT scan of the right hip using a 'MyHip' protocol. The radiographer inadvertently chose the 'MyKnee' protocol, which looked similar. The effective dose from this unnecessary scan was approximately 4 mSv. The radiographer was reminded to be vigilant when carrying out patient and procedure identification processes.
Incident 99	**A patient underwent a CT scan of the kidneys, ureters and bladder in the wrong view due to radiographer error.** A patient attended a medical imaging practice for a CT KUB scan in prone view. He was accidentally scanned in supine view. The effective dose from this unnecessary scan was approximately 3.9 mSv. The radiographer involved was reminded to pay more attention to detail when scanning patients.
Incident 100	**A patient underwent a CT scan of the abdomen and pelvis instead of a CT scan of the chest due to radiographer error.** A patient at a medical imaging practice underwent a CT scan of the abdomen and pelvis instead of a CT scan of the chest as requested. The radiographer did not adequately check the referral but assumed a student radiographer had done so. The effective dose from this unnecessary scan was approximately 6 mSv. The radiographer involved was reminded to carry out patient and procedure identification processes thoroughly.
Incident 101	**A patient underwent a CT cholangiogram with a no contrast protocol instead of a CT cholangiogram with contrast due to radiographer error.** A patient presented to a medical imaging practice with a request for a CT cholangiogram with contrast. A CT scan of the abdomen without intravenous contrast was performed. The patient returned for the CT with intravenous contrast on another occasion. The effective dose from this unnecessary scan was approximately 19 mSv. The radiographer involved was reminded to carry out patient and procedure identification processes thoroughly.

Incident no.	Description of incident
Incident 102	**A patient underwent a nuclear medicine bone scan instead of a dual X-ray absorptiometry scan due to nuclear medicine technologist error.** A patient at a medical imaging practice underwent a nuclear medicine bone scan when a dual X-ray absorptiometry scan was required, due to the misinterpretation of the referral. The referral requested a 'bone scan' and the clinical indications did not help to clarify which modality was required. 695 MBq of ^{99m}Tc-HDP was injected for the bone scan. Before the patient was scanned, the referrer was called to request additional clinical information. It was at this stage that the referrer stated that it was actually a dual X-ray absorptiometry scan that was required. The effective dose from this unnecessary injection of 695 MBq of ^{99m}Tc-HDP was approximately 3 mSv. All medical imaging staff at the practice were reminded to seek advice in cases of uncertainty.
Incident 103	**A paediatric patient underwent a CT scan of the patella instead of a CT scan of the brain due to radiologist error.** A paediatric hospital patient underwent a CT scan of the patella instead of the requested CT scan of the brain. The radiologist reviewing the request justified and approved the referral with protocol information relating to a CT scan of the patella. The radiologist did not realise that the request was for a CT scan of the brain. When the patient arrived at the radiology department for the CT scan, the radiographer noted that the request was for a CT scan of the brain but the 'comments' and 'current clinical problem' noted on the referral related to a CT scan of the patella. The radiographer also noted that the ordering physician was an orthopaedic surgeon, so a request for a CT scan of the patella might have been expected. The radiographer contacted the requesting unit and they confirmed that they required a CT scan of the patella, not a CT scan of the brain. The patient underwent a CT scan of the patella, but a parent of the child subsequently stated that the scan requested was a CT scan of the brain. The effective dose from this unnecessary scan was approximately 0.1 mSv. The radiologist was reminded to review requests appropriately and the radiographer was reminded to review previous imaging.
Incident 104	**A patient underwent a CT scan of the femur instead of a CT leg angiogram due to requesting physician error.** A hospital patient underwent a CT scan of the femur when a CT leg angiogram was required. The requesting physician ordered the incorrect examination. The effective dose for the CT scan of the femur was approximately 4.5 mSv. The requesting physician was reminded to complete requests correctly.
Incident 105	**A patient underwent the wrong CT scan due to radiographer error.** A hospital patient underwent a portal-venous phase CT scan of the abdomen and pelvis instead of the requested arterial phase CT scan of the abdomen and pelvis, CT scan of the brain and CT scan of the brain (circle of Willis). The radiographer involved did not thoroughly verify the CT scan requested by the referring physician. The effective dose for the portal-venous phase CT scan of the abdomen and pelvis was approximately 9.2 mSv. The radiographer involved was reminded to be vigilant when carrying out patient and procedure identification processes.
Incident 106	**A patient underwent the wrong CT scan due to radiographer error.** A patient at a medical imaging practice underwent a CT scan of the thoracic spine instead of the requested CT scan of the cervical spine. The radiographer involved did not thoroughly verify the CT scan requested by the referring physician. The effective dose for the CT scan of the thoracic spine was approximately 9 mSv. The radiographer involved was reminded to be vigilant when carrying out patient and procedure identification processes.

Incident no.	Description of incident
Incident 107	**A patient underwent the wrong CT scan due to radiologist error.** A hospital patient presented for a CT TAVI workup scan. The scan was approved by a radiologist. Upon later review, the radiologist determined that the patient's clinical indications suggested a CT cardiac scan would have been more appropriate. The TAVI scan was of diagnostic quality but involved a higher radiation dose. The additional effective dose from the TAVI scan was approximately 5 mSv. The radiologist involved was reminded to be more vigilant when approving medical imaging procedures.
Incident 108	**A patient underwent the wrong CT scan due to radiologist error.** A hospital patient underwent a CTPA scan when the patient was scheduled to undergo a non-contrast CT scan of the brain. The radiographer performing the exam did not thoroughly review the CT scan request and patient details. Contributing to this error was that the fact that two patients with similar surnames were scheduled on this CT scanner at approximately the same time, one requiring a non-contrast CT scan of the brain and the other a CTPA scan. The effective dose from the CTPA scan was approximately 3.7 mSv. The radiographer involved was reminded thoroughly to check patient and procedure details before scanning.

Patient underwent a medical procedure on the wrong anatomical region

Incident no.	Description of incident
Incident 109	**A patient underwent a CT scan of the wrong anatomical region due to radiology registrar error.** A hospital patient underwent a CT scan of the abdomen and pelvis when a CT scan of the brain, facial bones, cervical spine and thoracic spine was requested. The error occurred due to an incorrect CT imaging protocol being assigned by the radiology registrar. The radiographers performing the exam did not thoroughly verify the CT scan request. The effective dose due to the unnecessary scan approximately 8.5 mSv. The hospital's radiation safety officer counselled the radiology registrar and radiographers involved about the incident, stressing the importance of assigning the correct protocol and identifying incorrect protocols using the hospital's timeout process.
Incident 110	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient presented for a CT scan of the cervical and thoracic spine. The imaging request was correctly protocolled, but the radiographer involved incorrectly performed a CT scan of the thoracic and lumbosacral spine. The radiographer did not read the imaging request carefully. The effective dose due to the unnecessary scan was approximately 17 mSv. The radiographer involved received counselling from the chief radiographer concerning the incident.
Incident 111	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient inappropriately underwent a CT scan of the right elbow instead of the left elbow. The request from orthopaedics had been correctly protocolled on the request form, but the radiographer incorrectly scanned the right elbow. The effective dose due to this unnecessary exposure was approximately 11 mSv. The radiographer received counselling from the hospital's radiation safety officer concerning the incident.

Incident no.	Description of incident
Incident 112	**A patient underwent a CT scan of the wrong anatomical region due to clerical error.** A hospital patient presented with a referral for a CT scan of the chest and neck with contrast. The scan was booked by reception as a CT scan of the neck, chest, abdomen and pelvis. The CT radiographer did not read the referral properly at the time of scanning and scanned the patient's pelvis in addition to the chest and neck. The effective dose due to the unnecessary scan of the pelvis was approximately 2 mSv. The radiographer involved was reminded to carry out patient and procedure verification properly. Clerical staff members were reminded to exercise care when entering patient and procedure details on imaging requests.
Incident 113	**A paediatric patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A paediatric hospital patient presented to an ED with left hip pain after falling from a height. A lateral left hip X-ray was requested to determine if there was a fracture. The radiographer performed a lateral right hip X-ray. The radiographer realised the mistake and then performed a lateral left hip X-ray. The effective dose due to the wrong procedure was approximately 0.25 mSv. The radiographer involved was reminded to carry out patient and procedure identification processes thoroughly.
Incident 114	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A patient was referred to a medical imaging centre for plain X-rays of the lumbar spine. The radiographer performed X-rays of the thoracic spine in error. The effective dose for the X-rays of the thoracic spine was approximately 2 mSv. An email was sent to all radiographers at the practice reminding them of their obligations to read referrals carefully to ensure they carry out the correct imaging.
Incident 115	**A paediatric patient underwent an X-ray of the wrong anatomical region due to radiographer error.** A paediatric hospital patient underwent an unnecessary X-ray of the right femur. The patient had presented for an X-ray of the left femur following a fracture some months previously to assess alignment and healing. The intern radiographer asked the patient's mother which leg was to be imaged and the mother indicated that it was the right leg. The intern radiographer proceeded to image the right. The error was identified by the supervising radiographer. The left femur was subsequently imaged. The effective dose for the unnecessary radiographs of the right femur was approximately 0.01 mSv. The radiographer was reminded of the importance of completing procedure identification correctly. All medical imaging technologists at the hospital were reminded to ensure they image the correct side.
Incident 116	**A patient underwent a CT scan of the wrong anatomical region due to referring practitioner and radiographer error.** A hospital patient presented for a CT scan of the spine with no region of the spine specified. The clinical notes indicated that a fractured spine was being queried and that the patient had been thrown from a bike. The radiographer performed a CT scan of the cervical spine because of the mechanism of injury when the referring doctor, in fact, required a CT scan of the thoracic spine. The effective dose due to the unnecessary CT scan of the cervical spine was approximately 1.8 mSv. The referring practitioner was reminded to be more specific when filling out imaging requests. The radiographer involved was reminded to consult with the referring physician whenever there is any uncertainty over a requested scan.

Incident no.	Description of incident
Incident 117	**A patient underwent a CT scan of the wrong anatomical region due to referring practitioner and radiographer error.** A patient at a medical imaging practice presented for a CT scan of the spine with no region of the spine specified. The patient underwent a CT scan of the abdominal and pelvic regions instead of a CT scan of the thoracic region. The clinical notes indicated that a fractured spine was being queried and that the patient had been thrown from a bike. The effective dose due to the unnecessary CT scan of the abdominal and pelvic regions was approximately 5 mSv. The referring practitioner was reminded to be more specific when filling out imaging requests. The importance of proper identification and procedure confirmation was stressed to the radiographer involved. The importance of completing a CT pre-scan worksheet was also stressed.
Incident 118	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient had an unnecessary CT KUB scan. The patient was originally booked to undergo a CT KUB, but the booking was changed to a CT scan of the abdomen and pelvis with contrast. When the patient was scanned, the radiographer did not check the updated protocol and performed the originally requested CT KUB scan. The effective dose for the CT KUB scan was approximately 6 mSv. Radiography staff members were reminded that they must confirm the correct scan request and protocol details before scanning a patient.
Incident 119	**A paediatric patient underwent an X-ray of the wrong anatomical region due to radiographer error.** A paediatric patient attended a medical imaging practice for a general X-ray of the cervical spine. The radiographer did not review the referral form, reviewing instead the internal patient documentation for details of the examination requested. The radiographer then misread this form and carried out an anteroposterior and lateral lumbar spine X-ray and an anteroposterior thoracic spine X-ray before realising that only a cervical spine X-ray was requested. The effective dose due to the unnecessary scans was approximately 1.5 mSv. The radiographer involved was cautioned to review the referral form in future.
Incident 120	**A paediatric patient underwent an X-ray of the wrong anatomical region due to referring physician error.** A paediatric hospital patient was referred an ED for an X-ray of the leg. The patient was referred for an X-ray of the left leg when the referral should have been for an X-ray of the right leg. The referring physician later realised that the wrong leg was imaged. Imaging of right leg was subsequently performed without error. The effective dose for the X-ray of the left leg was approximately 0.03 mSv. The medical practitioner involved was reminded to be careful when filling out referrals.
Incident 121	**A patient underwent a CT scan of the wrong anatomical region due to radiologist error.** A hospital patient underwent a CT nerve root injection procedure. The request was for an injection at the level of the 4th and 5th lumbar vertebrae (L4–5), but the radiologist injected the incorrect level (L3–4). The effective dose for the unnecessary scan was approximately 5 mSv. The radiologist involved was reminded to be careful when carrying out imaging procedures.
Incident 122	**A patient underwent a CT scan of the wrong anatomical region due to referring physician error.** A hospital patient underwent a CT scan of the elbow when a CT scan of the shoulder was required. The referring physician requested the incorrect procedure. The effective dose for the unnecessary scan was approximately 6.1 mSv. The medical practitioner involved was reminded to be careful when filling out referrals.

Incident no.	Description of incident
Incident 123	**A paediatric patient underwent a CT scan of the wrong anatomical region due to radiologist error.** A paediatric hospital patient was referred for a CT scan of the forearm (full length) as an outpatient. The order was incorrectly justified and approved by a radiologist as a CT scan of the leg, which was then performed by a radiographer. The effective dose for the unnecessary scan was approximately 0.22 mSv. The radiologist involved was reminded to be careful when justifying and approving procedures.

Patient underwent a medical procedure using the wrong modality

Incident no.	Description of incident
Incident 124	**A patient underwent a CT scan of the of the brain instead of an MRI scan due to clerical error.** A request was faxed to a medical imaging practice for an MRI scan of the brain. Clerical staff at the practice entered a non-contrast CT scan of the brain on the request form and the radiographer completed the scan according to the clinical notes. The following week, the patient's guardian called the practice questioning the MRI result, at which point the error was picked up. The error occurred because a small, faded tick on the imaging request to indicate an MRI was not clear and, given the patient' history, CT was performed instead of MRI. The effective dose for the CT brain scan was approximately 1.9 mSv. The clerical staff members at the practice were reminded to exercise care when entering patient and procedure details on imaging requests and to seek advice when there is uncertainty about the imaging requested.
Incident 125	**A patient underwent an X-ray of the thoracic and lumbar spine instead of a dual energy X-ray absorptiometry (DXA) scan due to radiographer and clerical error.** A hospital patient had a referral for a DXA scan, the clinical indication being fracture to the thoracic and lumbar spine. A plain X-ray of the thoracic and lumbar spine was erroneously booked and then performed. The clerical staff member and the radiographer did not fully read the referral and assumed the request was for a plain X-ray. The effective dose due to this unnecessary procedure was approximately 2.5 mSv. Multiple discussions were held with the radiographer involved about the importance of appropriately reading referrals. The incident was discussed at the next team meeting. The clerical staff member was reminded to exercise care when entering patient and procedure details on imaging requests.
Incident 126	**A patient underwent a CT scan of the kidneys, ureters and bladder instead of a plain film X-ray of the kidneys, ureters and bladder due to radiographer error.** A patient presented to a medical imaging practice after a booking was made by phone for a CT KUB scan. The brought the request form with them. The scan was entered in the radiology information system as a CT KUB scan. On completion of the scan the radiographer reviewed the request form and realised that the scan was actually meant to be a plain X-ray of the kidneys, ureters and bladder, not a CT scan. The effective dose due to the unnecessary CT scan was approximately 8 mSv. The radiographer involved was reminded to consult the referral before carrying out any scan.
Incident 127	**A patient underwent a fluorodeoxyglucose (FDG) PET scan instead of a dotatate PET scan due to nuclear medicine physician error.** A patient arrived at a medical imaging practice with a referral for a PET scan. The scan was booked as an FDG PET scan when, in fact, a dotatate PET scan had been ordered. The nuclear medicine physician did not notice this. The effective dose due to the FDG scan was approximately 9.6mSv. The nuclear medicine physician involved was reminded to review referrals thoroughly before approving scans.

Incident no.	Description of incident
Incident 128	**A patient underwent a plain X-ray of the lumbar spine instead of a CT scan of the lumbar spine due to radiographer error.** A hospital patient presented with a referral for a scan of the lumbar spine. The radiographer noted the region to be scanned but did not notice the scan requested was a CT scan. The radiographer carried out a plain X-ray of the lumbar spine instead. The effective dose due to the plain X-ray was approximately 1.1mSv. The radiographer involved was reminded to carry out patient and procedure identification processes thoroughly before scanning.
Incident 129	**A patient underwent a plain X-ray of the lumbar spine instead of an MRI scan of the lumbar spine due to radiographer error.** A hospital patient was requested to have an MRI scan of the lumbar spine to investigate acute back pain with a history of falls. The radiographer misinterpreted the request and completed a plain X-ray of the lumbar spine study instead. The effective dose due to the plain X-ray was approximately 1.5 mSv. The radiographer involved was reminded of the of the importance of patient and procedure matching.

High patient dose during an interventional or fluoroscopic procedure

Incident no.	Description of incident
Incident 130	**A patient underwent a cerebral procedure that resulted in a high radiation dose to the skin.** A hospital patient required a cerebral procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as possible, the skin entrance dose for the procedure was approximately 13 Gy. The patient developed mild erythema. No further action was necessary.
Incident 131	**A patient underwent a cerebral procedure that resulted in a high radiation dose to the skin.** A hospital patient required a cerebral procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.5 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 132	**A patient underwent a cardiac interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient required a cardiac interventional procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.4 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 133	**A patient underwent three splenic/pancreatic bleed embolisation procedures that resulted in a high radiation dose to the skin.** A hospital patient underwent three difficult splenic/pancreatic bleed embolisation procedures in a period of six days under fluoroscopic guidance. Although steps were taken throughout the procedures to keep the dose as low as possible, the skin entrance dose for the procedures was approximately 14 Gy. The patient did not develop any erythema. No further action was necessary.

Incident no.	Description of incident
Incident 134	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cerebral interventional procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.6 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 135	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cerebral interventional procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 8 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 136	**A patient underwent a cardiac interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cardiac interventional procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.1 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 137	**A patient underwent an interventional angiography procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an interventional angiography procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 7.2 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 138	**A patient underwent an interventional angiography procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an interventional angiography procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 8.7 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 139	**A patient underwent two interventional angiography procedures that resulted in a high radiation dose to the skin.** A hospital patient underwent two interventional angiography procedures on successive days under fluoroscopic guidance. Although steps were taken throughout the procedures to keep the dose as low as possible, the skin entrance dose for the procedures was approximately 7 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 140	**A patient underwent an interventional angiography procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an interventional angiography procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.4 Gy. The patient did not develop any erythema. No further action was necessary.

Incident no.	Description of incident
Incident 141	**A patient underwent two interventional angiography procedures that resulted in a high radiation dose to the skin.** A hospital patient underwent two interventional angiography procedures on the same day under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 7.6 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 142	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cerebral interventional procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.3 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 143	**A patient underwent an interventional angiography procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an interventional angiography procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 7.6 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 144	**A patient underwent an interventional abdominal endovascular aneurysm repair (EVAR) procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an abdominal endovascular aneurysm repair procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.4 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 145	**A patient underwent an interventional arteriovenous fistula embolisation procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an arteriovenous fistula embolisation procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 9.2 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 146	**A patient underwent an interventional radiofrequency ablation and vertebroplasty angiography procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a radiofrequency ablation and vertebroplasty angiography procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.4 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 147	**A patient underwent an interventional percutaneous pulmonary valve implantation procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a percutaneous pulmonary valve implantation procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.5 Gy. The patient did not develop any erythema. No further action was necessary.

Incident no.	Description of incident
Incident 148	**A patient underwent an abdominal angiogram with embolisation of bleeding arterial vessels that resulted in a high radiation dose to the skin.** A hospital patient underwent an abdominal angiogram with embolisation of bleeding arterial vessels under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 13 Gy. The patient developed mild erythema. No further action was necessary.
Incident 149	**A patient underwent an interventional angiography procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an interventional angiography procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.5 Gy. The patient did not develop any erythema. No further action was necessary.
Incident 150	**A patient underwent an interventional coronary angiography procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an interventional coronary angiography procedure under fluoroscopic guidance. Although steps were taken throughout the procedure to keep the dose as low as possible, the skin entrance dose for the procedure was approximately 6.3 Gy. The patient did not develop any erythema. No further action was necessary.

Unnecessary radiation exposure due to equipment failure

Incident no.	Description of incident
Incident 151	**A patient underwent an unnecessarily repeated CT scan of the brain due to a fault in the graphics card of the CT scanner.** A patient was scheduled for a CT scan of the brain and cervical spine. The cervical spine scan was performed without incident. The brain scan, however, stopped before it reached the end of the prescribed scan range. The scan was repeated and the same thing happened. The effective dose due to the terminated CT scans of the brain was approximately 1.4 mSv. The supplier was contacted about the incident and identified the fault as a power supply problem with the graphics card. The graphics card was replaced.
Incident 152	**A patient underwent two unnecessary cardiac attenuation/localisation CT scans due to a fault in the PET acquisition tower.** A hospital patient underwent two unnecessary cardiac attenuation/localisation CT scans due to a failure of the PET scanner equipment. This required the CT imaging to be repeated. After completing the patient's whole-body PET exam, a further PET cardiac static image acquisition was planned. The initial whole-body CT scan was to be used to obtain the static PET images; however, an error message appeared on the screen stating that the PET imaging was not possible. Following consultation with a senior NMT it was decided that a new attenuation/localisation CT scan over the region of interest would need to be performed, but the same error message was returned when the PET imaging was attempted. The effective dose due to the two unnecessary CT scans was approximately 4.6 mSv. The supplier was immediately contacted and determined that the PET acquisition tower had frozen and required rebooting.

Incident no.	Description of incident
Incident 153	**A patient underwent an unnecessary CT scan due to a fault in the CT computer.** A hospital patient presented for a CT-guided chest wall carbon localisation interventional procedure. A non-contrast CT scan of the patient's chest was performed in preparation for the interventional procedure. The CT scanner computer froze upon completion of the scan. The radiographers involved rebooted the scanner, but the images obtained before the reboot could not be used for planning the interventional procedure. A second non-contrast CT scan of the patient's chest was obtained, but the CT scanner computer froze again. The radiographers contacted the CT supervisor radiographer who advised that the CT scanner was not to be used for imaging patients. The patient was transferred to another CT scanner and the non-contrast CT scan of the chest was carried out successfully. The effective dose due to the unnecessary CT scans was approximately 15 mSv. The supplier was contacted and rectified the problem.
Incident 154	**A patient underwent a repeated CT scan of the brain due to a CT scanner malfunction.** A hospital patient underwent a repeated brain CT scan due to CT scanner malfunction. During the scan, the images were seen to contain artefacts, and the scan was aborted. The patient was moved to a different scanner and the scan was repeated successfully. The effective dose due to the brain scan was approximately 1 mSv. Engineers from the supplier attended to investigate the cause and replaced a component.
Incident 155	**A patient underwent a repeated CT scan of the brain due to a CT scanner malfunction.** A hospital patient underwent a CT scan of the head during which the scanner failed during the scan. The patient was transferred to another scanner for the same scan. The effective dose due to the failed scan was approximately 1.1 mSv. Engineers from the supplier attended to investigate the cause. The scanner was out of action for two days while waiting for parts to be delivered and replaced.
Incident 156	**A patient underwent a repeated CT scan of the brain due to a CT scanner malfunction.** A patient at a medical imaging practice was having a CT scan of the brain when a tube arc error occurred during the main volume scan. The scan needed to be repeated due to a tube arc artefact. The repeat scan image was acquired without any issues. The effective dose from the first scan was approximately 3.3 mSv. The supplier was contacted and rectified the problem.
Incident 157	**A patient underwent a repeated CT scan of the brain due to a CT scanner malfunction.** A patient attended a medical imaging practice for a CT scan of the brain. The scanner had a tube arc error that produced artefacts through the lower section of the brain scan. The effective dose from this scan was approximately 2 mSv. A full service was carried out on the scanner by the supplier, with additional tube conditioning. The scanner then functioned without errors.
Incident 158	**Four patients underwent repeated CT scans on separate dates due to a CT scanner malfunction.** An X-ray tube arc occurred on a CT scanner at a medical imaging practice on four separate dates, resulting in artefacts on the resultant images. The scans had to be repeated. The doses to the four patients involved were 4.8 mSv (brain scan), 4 mSv (brain scan), 5.5 mSv (abbreviated lumbar spine scan) and 3.5 mSv (brain scan). The supplier investigated these errors, replacing the X-ray tube and generator components. A software update was also applied, as well as changes in daily quality assurance processes.

Incident no.	Description of incident
Incident 159	**A patient underwent a repeated CT scan of the abdomen due to a CT scanner malfunction.** A patient was undergoing a CT scan of the abdomen when the scanner malfunctioned. A scanner error occurred during the planning scan and the scanner was restarted. The scan was repeated but the scanner malfunctioned again during the contrast administration and monitoring scans, resulting in another aborted scan. The effective dose due to the aborted scans was approximately 1.1 mSv. The supplier was contacted and rectified the problem.
Incident 160	**A patient underwent a repeated CT scan of the head due to a CT scanner malfunction.** A hospital patient presented for a CT scan of the head. Imaging consisted of two main acquisitions. The first acquisition was completed successfully. On performing the second acquisition, a large imaging artefact was noted across the region of interest. A repeat acquisition was carried out due to the severity and location of the artefact. The patient was transferred to a different CT system to complete the imaging. The effective dose due to the failed second acquisition was approximately 1.6 mSv. The supplier was contacted and a service engineer determined that there was a detector module failure. The detector module was replaced.
Incident 161	**A patient underwent a repeated CT scan of the abdomen due to a CT scanner malfunction.** A hospital patient was undergoing a CT scan of the abdomen when the CT scanner stopped scanning midway through the examination. The patient had to be rescanned on a different scanner. The effective dose from the failed CT scan was approximately 3 mSv. The supplier was contacted and rectified the problem.
Incident 162	**A paediatric patient underwent a repeated CT scan of the chest due to a CT scanner malfunction.** A contrast-enhanced CT scan of the chest and neck was to be undertaken on a paediatric hospital patient. During the CT chest scan an equipment malfunction caused the system to stop mid-scan. This problem was escalated to the supervising radiographer and then onto the paediatric radiology fellow, who advised that the chest scan be repeated on another scanner. The effective dose from the failed CT scan was approximately 0.8 mSv. The supplier was contacted and rectified the problem.
Incident 163	**A patient underwent a repeated CT scan of the brain and face due to a CT scanner malfunction.** A hospital patient underwent a repeated CT scan of the brain and face due to an equipment malfunction. A tube arc occurred during scanning, rendering the resultant images undiagnostic and necessitating a rescan on another scanner. The effective dose due to the failed scan was approximately 1.6 mSv. This was an unavoidable error, and tube arcs may occur sporadically. No actions could have been taken to avoid this incident. No changes have been implemented since the incident.
Incident 164	**A patient underwent a repeated CT scan of the abdomen and pelvis due to a CT scanner malfunction.** A hospital patient underwent a CT scan of the abdomen and pelvis that was aborted halfway through due to a scanner malfunction. The patient's scan was completed on another scanner. The effective dose due to the failed scan was approximately 9.5 mSv. The supplier was contacted and rectified the problem.

Incident no.	Description of incident
Incident 165	**A patient underwent a repeated CT scan due to radiopharmaceutical injector malfunction during a PET/CT scan.** A patient presented to a medical imaging practice for a PET/CT scan. The radiopharmaceutical injector registered errors, but the dose was assumed to be administered correctly. When scanning the patient, images showed minimal radiopharmaceutical had been administered, rendering the scan non-diagnostic. The patient was reinjected and the PET/CT scan completed normally. The effective dose due to the first CT scan was approximately 5.2 mSv. The NMT involved was reminded to seek advice when there is any doubt about whether radiopharmaceuticals have been administered correctly.
Incident 166	**A paediatric patient underwent a repeated injection of radiopharmaceuticals due to a malfunction with a gamma camera.** A paediatric patient attended a medical imaging practice for a nuclear medicine gastric emptying study. The meal consisted of scrambled eggs with 40 MBq ^{99m}Tc-sulfur colloid and a glass of water with 18.8 MBq ^{67}Ga. The gamma camera broke down just before the scan could be started. The effective dose due to the injected radiopharmaceuticals was approximately 4.4 mSv. The supplier was contacted and rectified the problem with the gamma camera.
Incident 167	**A patient underwent a repeated injection of a radiopharmaceutical due to a malfunction of the building cooling system.** A patient at a medical imaging centre was injected with 271.1 MBq of ^{18}F-FDG for a PET/CT scan. Ten minutes before the scan was to start, an error message on the PET/CT scanner warned that the scanner cooling system was not operating correctly and the system would shut down due to overheating in 15 minutes. The facilities maintenance advised that they would address the problem in about an hour. The scanner supplier was consulted and advised that, following the cooling system repair, the PET/CT scanner would require a full reboot and quality control check, a process that would take approximately 60 minutes. The supplier also recommended that the scanner sit idle with power to the gantry for two hours prior to patient imaging. Given this delay and the short half-life of ^{18}F, the patient had to return the following day for a repeat procedure. The effective dose to the patient due to the ^{18}F-FDG injection was approximately 5.2 mSv. No further action was necessary.
Incident 168	**A patient underwent a partially repeated CT scan due to a CT scanner malfunction.** A hospital patient underwent a partially repeated CT scan of the chest, abdomen and pelvis due to a CT scanner malfunction. During scanning, an error message indicated an issue with the scan. Review of the patient images after the scan revealed the majority of the image dataset was not reconstructed correctly. The patient was moved to an alternate scanner and a repeat scan performed. The effective dose due to the first scan was approximately 25 mSv. The scanner was restarted, and routine quality control tests were performed before the scanner was returned to service.
Incident 169	**A patient underwent a repeated CT scan of the head due to a CT scanner malfunction.** A hospital patient underwent an unnecessarily repeated CT brain scan due a scanner malfunction. Upon review of the CT brain image-set, the reconstructed images appeared dark and undiagnostic. The patient was moved to another scanner and the examination was completed successfully. The effective dose due to the first scan was approximately 1.6 mSv. The scanner was restarted and routine quality control tests were performed before the scanner was returned to service. The equipment supplier subsequently replaced the control board for the CT scanner detector.

Incident no.	Description of incident
Incident 170	**A patient underwent a repeated scan of the chest, abdomen and pelvis due to a CT scanner malfunction.** A hospital patient underwent a repeated CT scan of the chest, abdomen and pelvis due to a scanner malfunction. Upon review of the CT image-set, it was evident that image reconstruction had failed for most image slices. The patient was moved to another scanner and the examination was completed successfully. The effective dose due to the first scan was approximately 33 mSv. The equipment supplier replaced a detector control board on the scanner.
Incident 171	**A paediatric patient underwent an unnecessary topogram of the chest due to a CT scanner malfunction.** A posterior–anterior topogram of the chest was performed on a paediatric hospital patient prior to performing a CT scan. Immediately after the topogram, the CT scanner started to make a noise and the CT scanner was shut down and taken out of service. The effective dose for the unnecessary CT topogram of the chest was less than approximately 0.1 mSv. Service engineers attended the same day and replaced a broken gasket.
Incident 172	**A patient underwent a repeated administration of a radiopharmaceutical due to a malfunction with a gamma camera.** A gamma camera at a hospital experienced a failure following the radiopharmaceutical administration for the ventilation component of a ventilation–perfusion (VQ) scan of a patient. The patient had been administered with approximately 20 MBq ^{99m}Tc-Technegas. The estimated dose to the patient from the unnecessary ^{99m}Tc administration was approximately 0.3 mSv. The supplier was contacted and rectified the problem with the gamma camera.

Maladministration of radiopharmaceutical

Incident no.	Description of incident
Incident 173	**A patient underwent a failed Ga-68-dotatate PET scan due to poor quality tracer.** A patient attended a medical imaging practice for a Ga-68-dotatate PET scan. The tracer passed quality control tests, but the NMT noted that the tracer was cloudy. On imaging, it was noted that most of the tracer was in the lungs, with very limited dotatate biodistribution where it was expected. The scan was undiagnostic. The effective dose due to the failed scan was approximately 12 mSv. Radiochemists who synthesised the tracer reviewed their processes.
Incident 174	**A patient was administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** A patient was referred to a medical imaging practice for a nuclear medicine bone scan of the knees. The patient was injected in the morning and early imaging was obtained. The patient was then brought back three hours later for delayed imaging. Delayed imaging showed unusual bone scan uptake and it was determined that the patient had been injected with ^{99m}Tc-sestamibi (a cardiac agent) rather than ^{99m}Tc-HDP (a bone agent). The NMT in the hot lab dispensing the radiopharmaceutical had inadvertently drawn up the incorrect tracer. The patient was rebooked and a repeat bone scan was performed. The effective dose to the patient due to the maladministration was approximately 6.2 mSv. The NMT involved was reminded to check labelling on vials thoroughly.

Incident no.	Description of incident
Incident 175	**A patient was administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** A patient at a medical imaging practice presented for a PET scan. The patient was injected with 147 MBq ^{68}Ga-dotatate. The NMT subsequently noticed that an ^{18}F-FDG PET scan had been requested on the referral. The scan had been protocolled incorrectly prior to booking. The NMT did not look at the referral and followed the indication on the PET worksheet. The effective dose from administering the wrong radiopharmaceutical was approximately 3.7 mSv. All medical imaging technologists at the practice were reminded to check referrals before scanning.
Incident 176	**A patient was administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** A patient attended a medical imaging practice for a parathyroid scan. The NMT correctly identified the patient but did not adequately review the referral or match the examination thoroughly enough. The patient subsequently underwent a thyroid scan with 219 MBq ^{99m}Tc-pertechnetate instead of the parathyroid scan as requested. This was due primarily to the NMT misreading the referral. The error was noticed only after completing the examination. The effective dose from this unnecessary scan was approximately 2.7 mSv. All medical imaging technologists at the practice were reminded to check referrals before scanning.
Incident 177	**A patient was administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** A patient at a medical imaging practice was injected with 200 MBq ^{99m}Tc-sestamibi. This was the wrong radiopharmaceutical for the scan. The error occurred due to a change in preparation workflow. The dose calibrator in the main hot lab was broken, so preparation was being carried out in the practice's PET hot lab. The prepared dose was not checked before administration. The effective dose from this unnecessary scan was approximately 1.6 mSv. The NMT involved was reminded to check labelling on vials thoroughly.
Incident 178	**A patient was administered with an excess activity of radiopharmaceutical due to nuclear medicine technologist error.** During a routine ^{18}F-FDG PET brain examination, a patient was inadvertently injected with 351 MBq of ^{18}F-FDG rather than the intended 200 MBq. The NMT administered an activity appropriate for a body scan when a brain scan was protocolled. The effective dose due to the additional 151 MBq ^{18}F-FDG was approximately 2.8 mSv. The NMT involved was reminded to ensure the right activity of radiopharmaceutical is drawn up before administration. The administration protocol was altered so another check is performed immediately before administration.
Incident 179	**A patient was administered with an excess activity of radiopharmaceutical due to nuclear medicine technologist error.** A hospital patient underwent a nuclear medicine rest/stress myocardial function test where the activities of ^{99m}Tc-sestamibi administered for both the rest and stress phases of the test were greater than required: 357 MBq instead of 260 MBq for the rest phase; and 1,078 MBq instead of 780 MBq for the stress phase. This maladministration was due to the NMT misreading the handwritten patient's weight from the worksheet and subsequently overestimating the body mass index of the patient. The effective dose due to this maladministration was approximately 3.2 mSv. The NMT involved was reminded to double-check patients' weights before administering radioisotopes.

Incident no.	Description of incident
Incident 180	**A patient was administered with an excess activity of radiopharmaceutical due to nuclear medicine technologist error.** A hospital patient underwent a nuclear medicine rest/stress myocardial function test where the activities of ^{99m}Tc-sestamibi administered for both the rest and stress phases of the test were greater than required: 250 MBq instead of 196 MBq for the rest phase; and 780 MBq instead of 589 MBq for the stress phase. This maladministration was due to the NMT misreading the handwritten patient's height from the worksheet and subsequently overestimating their body mass index. The effective dose due to this maladministration was approximately 2 mSv. The NMT involved was reminded to double-check patients' heights before administering radioisotopes.
Incident 181	**A patient was administered with an excess activity of radiopharmaceutical due to nuclear medicine technologist error.** A hospital patient presented for a PET/CT scan of the brain. In preparing the radiopharmaceutical for administration, the NMT inadvertently multiplied the patient's weight by three instead of two to calculate the ^{18}F-FDG activity. The hospital protocol for calculating the ^{18}F-FDG activity required is to multiply the patient's weight by two for brain studies and by three for body studies. The effective dose due to this the extra activity of radiopharmaceutical administered was approximately 1.9 mSv. The NMT involved was reminded to be careful when applying multiplicative factors to calculate the ^{18}F-FDG activity required in PET/CT scans.
Incident 182	**A patient was unnecessarily administered with a radiopharmaceutical due to nurse error.** A hospital patient presented for a nuclear medicine myocardial perfusion stress/rest test. The patient underwent the rest component of the examination and was assessed as requiring chemical stress with adenosine. The patient was attended by a nurse and a nuclear medicine physician. The nurse injected 1,026 MBq ^{99m}Tc-sestamibi instead of the adenosine, and the stress procedure had to be repeated. The effective dose due to the unnecessary injection of the radiopharmaceutical was approximately 8.1 mSv. The nurse involved was reminded to focus attention on the task at hand in future.
Incident 183	**A patient was administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** A patient at a medical imaging practice was scheduled for a nuclear medicine myocardial perfusion scan. After successfully completing the resting images, an adenosine stress test was performed. Once imaging for the stress component began it was apparent that the wrong radiopharmaceutical had been injected. Instead of ^{99m}Tc-tetrafosmin, ^{99m}Tc-HDP (a bone agent) had been administered. The effective dose due to injecting the wrong radiopharmaceutical was approximately 4.8 mSv. The NMT involved was reminded to double-check radiopharmaceuticals before administration.

Radiotherapy – unintended irradiation of healthy tissue or over/underdose to target tissue

Incident no.	Description of incident
Incident 184	**A patient undergoing radiotherapy had healthy tissue irradiated due to a planning image mismatch.** A patient at a medical oncology practice was prescribed to receive external beam radiotherapy (three-dimensional conformal) to a planning target volume (PTV) in the thoracic vertebrae. The PTV encompassed the T5 and T6 thoracic vertebrae. The prescribed dose was 34 Gy in 20 fractions (1.4 Gy/fraction). An image mismatch occurred prior to treatment for fractions 15, 19 and 20; fractions 19 and 20 were on the same day (bi-daily treatment regimen). This resulted in a partial geographical miss. The discrepancy was not detected at the time of the patient treatments. The error was detected at the subsequent treatment summary follow-up during offline review of images used for treatment. The planning target volume was underdosed by approximately 4.7 Gy and healthy tissue was irradiated with approximately 5 Gy. Radiation therapists at the practice were reminded to be careful with image matching in radiotherapy.
Incident 185	**A patient undergoing radiotherapy received an overdose to target tissue due to physician error.** A hospital patient was referred for treatment with ^{177}Lu-dotatate for neuroendocrine cancer. A request form was completed to administer 8 GBq of dotatate and registered in the radiology information system, the treatment planner and the electronic medical record (EMR). Pathology and estimated glomerular filtration rate results from the day prior to treatment showed impaired renal function in the patient. The nuclear medicine consultant and fellow decided to reduce the administration to 6 GBq dotatate. This change in dotatate administration was made in the EMR but not updated in either the radiology information system or the treatment planner. The radiopharmacist dispensing the dotatate prepared an administration of 8 GBq as per the treatment planner. The kidneys were overdosed by approximately 1.2 Gy. The hospital has instigated a protocol to use the EMR as the sole source document for radiopharmacists to dispense radiopharmaceuticals.
Incident 186	**A patient undergoing radiotherapy had healthy tissue irradiated due to a planning image mismatch.** A hospital radiotherapy patient had a fractional dose of 4 Gy delivered to a position displaced by 2.4 cm from the prescribed location. The treatment site (clinical disease) was the thoracic eighth vertebral body (T8), with a treatment margin to include T7 and T9, using a rectangular field of nominal size of 7.5 cm by 9.0 cm. The radiation incident delivered the prescribed dose to the affected T8 vertebra but under-dosed T9 by 4 Gy. T6 received an unintended dose of 4 Gy. This incident only occurred for one of the five prescribed treatment fractions. The prescription was for 20 Gy in five fractions. The radiation therapist involved was reminded to take more care when selecting the field of irradiation.
Incident 187	**A patient undergoing radiotherapy had healthy tissue irradiated due to the patient not being set up properly for one fraction.** A hospital patient was prescribed to receive an external beam radiotherapy dose of 20 Gy in five fractions of 4 Gy. For one of the fractions the field had not been set up properly in relation to the isocentre. The patient setup was not reviewed by a second radiation therapist. The patient received a dose of approximately 1 Gy to healthy tissue. All radiotherapy staff at the hospital, including the radiation therapist involved, underwent refresher training stressing the importance of independent checks of patient setups.

Medical procedure failed due to patient non-cooperation or other patient problem

Incident no.	Description of incident
Incident 188	**A patient was administered with a radiopharmaceutical but was not scanned afterwards.** A medical imaging practice patient was injected with 615b MBq of ^{99m}Tc-pyrophosphate for an amyloid bone scan. When the ward was asked to bring the patient for the image acquisition later that day the NMT was informed that the patient had been transferred to a hospital because other test results made the case more urgent. The effective dose from injecting the radiopharmaceutical was approximately 3.0 mSv. No further action was necessary.
Incident 189	**A patient received the same scan twice due to the patient using the wrong referral.** A patient attended a clinic for a CT scan of the neck. This was performed without incident. Two months later, a different referring practitioner requested a CT scan of the chest for the patient. The patient booked in for the CT scan of the chest at another clinic but had misplaced the request form and used the previous referral for the CT scan of the neck. The CT scan of the neck was performed again. The error was noted and a CT scan of the chest was also performed upon discussion with the second referrer. The effective dose from the repeated CT scan of the neck was approximately 4.6 mSv. No further action was necessary.
Incident 190	**A patient was administered with a radiopharmaceutical but was not scanned afterwards.** A patient at a medical imaging practice was injected with 905 MBq ^{99m}Tc-HDP for a nuclear medicine bone scan. The patient deteriorated quickly during the period required for uptake of the radiopharmaceutical. The referring physician and the nuclear medicine radiologist decided to cancel the bone scan and the patient was scheduled for an urgent surgical procedure. As a result, the bone scan was not completed. The effective dose from injecting the radiopharmaceutical was approximately 3.8 mSv. No further action was necessary.

A pregnant person was exposed to radiation

Incident no.	Description of incident
Incident 191	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient presented to a hospital for an X-ray and a CT scan. The patient indicated that she was not pregnant. The following month, after a follow-up ultrasound scan, the reporting radiologist identified that the patient was approximately six weeks pregnant. The patient was approximately two weeks pregnant at the time of the X-ray and CT scan. The dose to the foetus was approximately 4 mGy. The correct procedures were followed in this case.
Incident 192	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient attended a medical imaging practice for a CT scan of the abdomen and pelvis with contrast. The patient indicated that she was not pregnant. The scan was completed. Two weeks later the patient's referring physician contacted the practice and advised that the patient had just found that she was in the early stages of pregnancy. She was two to three weeks pregnant at the time of the scan. The dose to the foetus was approximately 18 mGy. The correct procedures were followed in this case.

Incident no.	Description of incident
Incident 193	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient attended a medical imaging practice for a four-phase liver protocol CT scan. The patient indicated that she was not pregnant. The third phase of the CT scan, which included the uterus, identified that the patient was in fact pregnant. The fourth phase was not completed due to the pregnancy finding. The dose to the foetus was approximately 11 mGy. The correct procedures were followed in this case.
Incident 194	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient attended a medical imaging practice for a PET/CT scan as part of her ongoing assessment of chemotherapy treatment for Hodgkin's lymphoma. The patient indicated that she was not pregnant. A radiologist called the patient's referring physician to advise that the PET/CT scan showed that patient was, in fact, pregnant. The dose to the foetus was approximately 17 mGy. The correct procedures were followed in this case.
Incident 195	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient presented to a hospital for an X-ray and a CT scan of the sacroiliac joint. The patient indicated that she was not pregnant. It was subsequently determined that the patient was approximately two to three weeks pregnant at the time of the X-ray and CT scan. The dose to the foetus was approximately 4.6 mGy. The correct procedures were followed in this case.
Incident 196	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient presented to a hospital for a CT scan of the cervical spine, two lumbar sacral spine X-rays and four bilateral knee X-rays after a car accident. The patient indicated that she was not pregnant. It was subsequently determined that the patient was approximately two to three weeks pregnant at the time of the X-rays and CT scan. The dose to the foetus was approximately 1 mGy. The correct procedures were followed in this case.
Incident 197	**A pregnant nurse attended to a patient who had been administered with a radiopharmaceutical.** A small dose of radiation was received by the foetus of a pregnant nurse attending to a patient who had been administered with 700 MBq of ^{99m}Tc-MDP. This incident occurred because the nursing team did not follow instructions given by the department of molecular imaging and therapy about advising relevant staff. The dose to the foetus was approximately 0.04 mGy. Nursing staff at the hospital were reminded to ensure instructions given to them are followed.
Incident 198	**A patient who underwent a CT scan of the pelvis was subsequently found to have been pregnant at the time of the procedure.** A patient presented to a hospital for a CT scan of the pelvis. The patient indicated that she was not pregnant. It was subsequently determined that the patient was approximately two to three weeks pregnant at the time of the X rays and CT scan. The dose to the foetus was approximately 2 mGy. The correct procedures were followed in this case.

Incident no.	Description of incident
Incident 199	**A patient who underwent a series of mammographic x-ray examinations was subsequently found to have been pregnant at the time of the procedure.** A patient at a medical imaging practice underwent a series of mammographic X-ray scans. At the time of scans the patient declared she was not pregnant. The next day, the patient's general practitioner contacted the imaging practice advising that the patient had returned a positive pregnancy test. The patient was in the first trimester. The dose to the foetus was approximately 0.0002 mGy. The correct procedures were followed in this case.
Incident 200	**A pregnant patient underwent an unnecessary procedure.** A pregnant patient (30 weeks gestation) presented to the nuclear medicine department of a hospital from a second hospital for a VQ study. The patient told the NMT at the first hospital that she had had a CTPA the previous day. The nurse who had accompanied the patient from the second, nearby hospital advised the NMT that the referring doctor still wanted the VQ study carried out. The NMT raised this with a nuclear medicine physician who went to review the CTPA report while the VQ study took place. The ventilation part of the study was completed. Before starting the perfusion part of the study, the patient expressed concerns again about the need for this study. The nurse contacted the referring physician at the second hospital who advised that the VQ study was not required and in fact had been cancelled. The incident occurred because there was no link between the electronic ordering systems of the two hospitals. The dose to the foetus due to the ventilation part of the VQ study was approximately 0.01 mGy. A link between the electronic ordering systems of the two hospitals was configured to prevent this error from occurring again.
Incident 201	**A patient who underwent a series of full spine X-ray examinations was subsequently found to have been pregnant at the time of the procedure.** A patient at a medical imaging practice underwent a full spine X-ray series. At the time of scan the patient declared she was not pregnant. It was later discovered that the patient been pregnant at the time of the scan. The dose to the foetus was approximately 2 mGy. The correct procedures were followed in this case.
Incident 202	**A patient who underwent a CT scan of the abdomen and pelvis was subsequently found to have been pregnant at the time of the procedure.** A patient presented to a medical imaging practice with a request for a CT scan of the abdomen and pelvis. The patient declared she was not pregnant. On review of the subsequent images, the radiologist advised that a pregnancy test be conducted. The patient was approximately nine weeks pregnant at the time of the exposure. The dose to the foetus was approximately 15 mGy. The correct procedures were followed in this case.
Incident 203	**A patient who underwent a CT scan of the abdomen and pelvis was subsequently found to have been pregnant at the time of the procedure.** A patient presented to a medical imaging practice with a request for a CT scan of the abdomen and pelvis. The patient declared she was not pregnant. Subsequent tests revealed that she was 20 weeks pregnant at the time of the CT scan. The dose to the foetus was approximately 10 mGy. The correct procedures were followed in this case.
Incident 204	**A patient who underwent a CT scan of the abdomen and pelvis was subsequently found to have been pregnant at the time of the procedure.** A patient at a medical imagine practice underwent a CT scan of the abdomen and pelvis with intravenous contrast. The patient declared she was not pregnant before the scan. Subsequent tests revealed that she was nine weeks pregnant at the time of the scan. The dose to the foetus was approximately 15 mGy. The correct procedures were followed in this case.

Contamination of persons or articles with a radiopharmaceutical

Incident no.	Description of incident
Incident 205	**Hospital equipment was contaminated with a radiopharmaceutical after a spill.** A hospital patient was referred for treatment with 9.4 GBq of ^{177}Lu-octreotate (Lutate). At the end of Lutate infusion, the nuclear medicine physician noticed that the connections between the saline flush and three-way tap had leaked, despite being checked before infusion. The leaked Lutate was contained in a plastic tray that is always positioned under the infusion set. Contamination was also detected on a stainless-steel trolley and the mobile patient shield. All surfaces were decontaminated and waste was placed in a lead box and transferred to the hospital's radioactive waste room. It was estimated that at about 8 GBq of Lutate had leaked. No staff member received a dose in excess of 1 mSv as a result of the spillage. No further action was necessary.
Incident 206	**A hot lab was contaminated with a radiopharmaceutical after a spill.** A NMT at a medical imaging practice accidentally threw an eluate vial of ^{99m}Tc-pertechnetate (10 GBq) into the hot waste sharps container. The technologist extracted the vial from the sharps container using tongs but then dropped the vial onto the floor, where it smashed. 10 GBq ^{99m}Tc-pertechnetate spilled onto the hot lab floor. The technologist cleaned up the liquid and glass, placed absorbent pads on the floor and sealed the hot lab. No staff member received a dose in excess of 1 mSv as a result of the spillage. No further action was necessary.
Incident 207	**A small area of a hospital floor was contaminated with a radiopharmaceutical after a spill.** During a routine cardiac stress test at a hospital, the nuclear medicine registrar inadvertently spilled approximately 20 MBq of ^{201}Tl, where 52 MBq had been drawn up, contaminating about one square metre of the floor in the nuclear medicine department. The area was subsequently decontaminated and the remaining activity was injected into the patient. A diagnostic image was still acquired despite the lower administered activity because the patient was quite small. The effective doses to the four staff members involved were less than 10 μSv. No further action was necessary.
Incident 208	**A patient's arm and a treadmill were contaminated with a radiopharmaceutical after a spill.** A patient was undergoing an exercise stress to facilitate myocardial perfusion imaging. During administration, 62 MBq of ^{99m}Tc-sestamibi spilt on the patient's left arm and treadmill. Staff members involved were not contaminated. Both the patient's skin and treadmill surface were decontaminated immediately. The images generated were diagnostic. The maximum external radiation exposure of any staff due to the spill or decontamination procedure was less than approximately 2 μSv. No further action was necessary.

Sealed source apparatus damaged

Incident no.	Description of incident
Incident 209	**A portable density/moisture gauge being used on a construction site was run over by an excavator.** A portable density/moisture gauge was being used on a construction site close to an excavator. The operator of the gauge was asked to perform extra testing and then walked off to speak to the site foreman, leaving the gauge where it was. An excavator working near the gauge was unable to turn around before tracking back. The excavator driver checked that the operator of the gauge was out of the way but was unable to see that the gauge was still on the ground. The excavator then rolled over the gauge. The rod handle and gauge case were damaged. No damage was sustained by the radiation source and the source remained inside the gauge. The gauge was sent to the supplier for repair.

Incident involving unsealed radioactive material

Incident no.	Description of incident
Incident 210	**An authorised officer of the department attended a chemical plant where potentially radioactive material was igniting.** Fire Services Victoria contacted the department to attend a chemical plant where potentially radioactive material was smouldering. The material was spent desiccant being stored in the open at the company premises and that had been used as part of the process of conversion of alkanes to alkenes. The material was smouldering because of the exothermic (heat-releasing) nature of (a) the oxidation of residual alkenes in the desiccant, and (b) the wetting of the desiccant. The incoming alkane gases used by the company as 'feedstock' incorporate a small amount of radon. One of the decay products of radon, lead 210 (^{210}Pb; half-life of approximately 22 years), plates out in the desiccant. The officer could not monitor the radiation levels in the vicinity of the material due to the combustion hazard, but a Fire Services Victoria science officer and the radiation safety officer of the company determined that the radiation hazard was negligible. The department's authorised officer agreed with this determination due to the nature of the radioactive material. No further action was necessary.

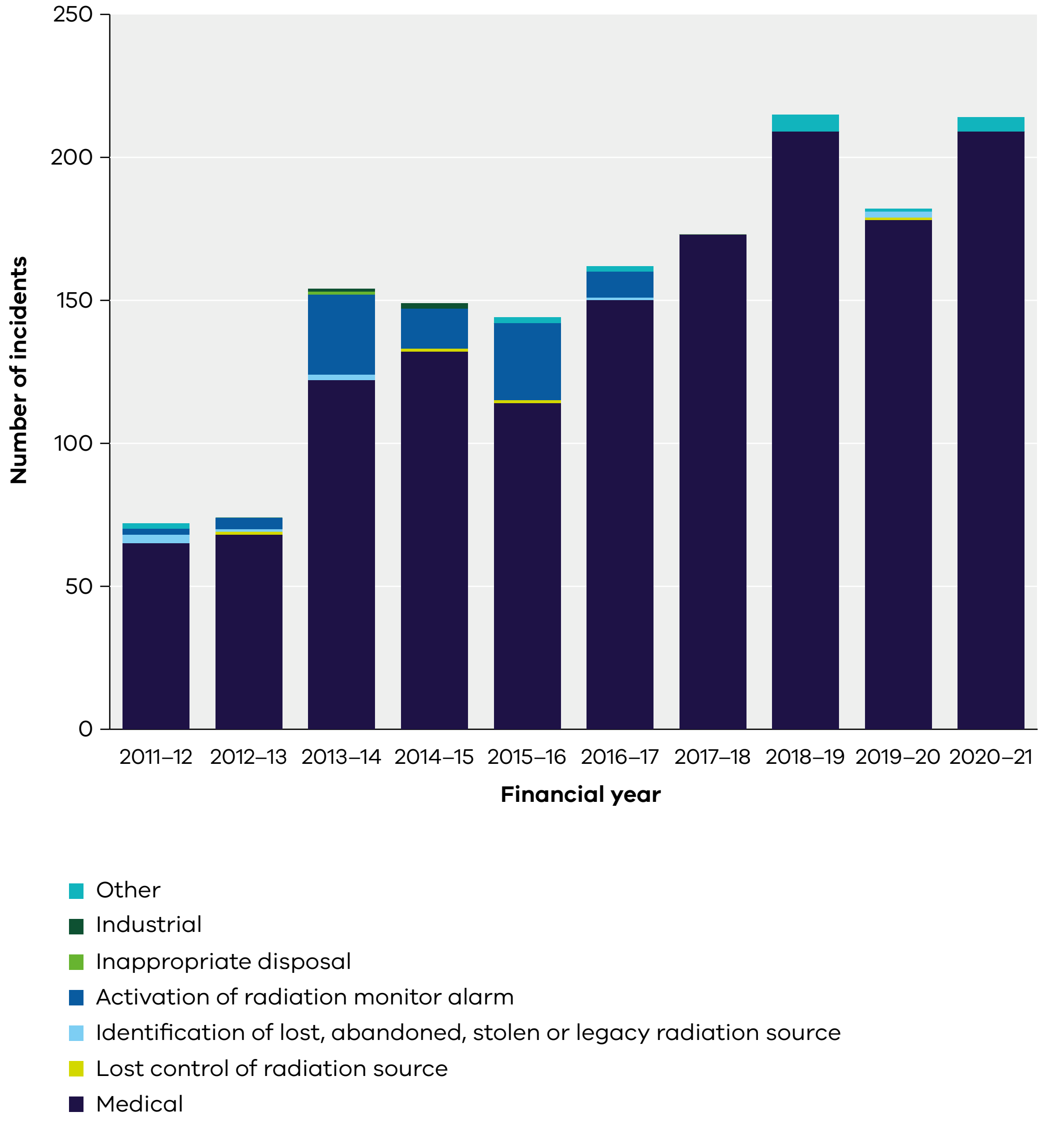
Radioactive material collected by the department

Incident no.	Description of incident
Incident 211	**An authorised officer of the department collected radium paint from an institution.** The department was contacted by an institution that had found radium paint in its possession and wished to dispose of the paint. An authorised officer of the department attended the institution and took possession of the radium paint.
Incident 212	**An authorised officer of the department attended the house of a person who wished to dispose of a timepiece with radium painted dials.** The department was contacted by a person who owned a timepiece with radium-painted dials. The person wanted to dispose of the timepiece if the radiation levels presented a hazard. An authorised officer of the department attended the house and measured the radiation levels around the timepiece. The measured levels were not high and the timepiece did not pose a hazard to the person. The person decided to keep the watch.

Radiation doses exceeding prescribed limits

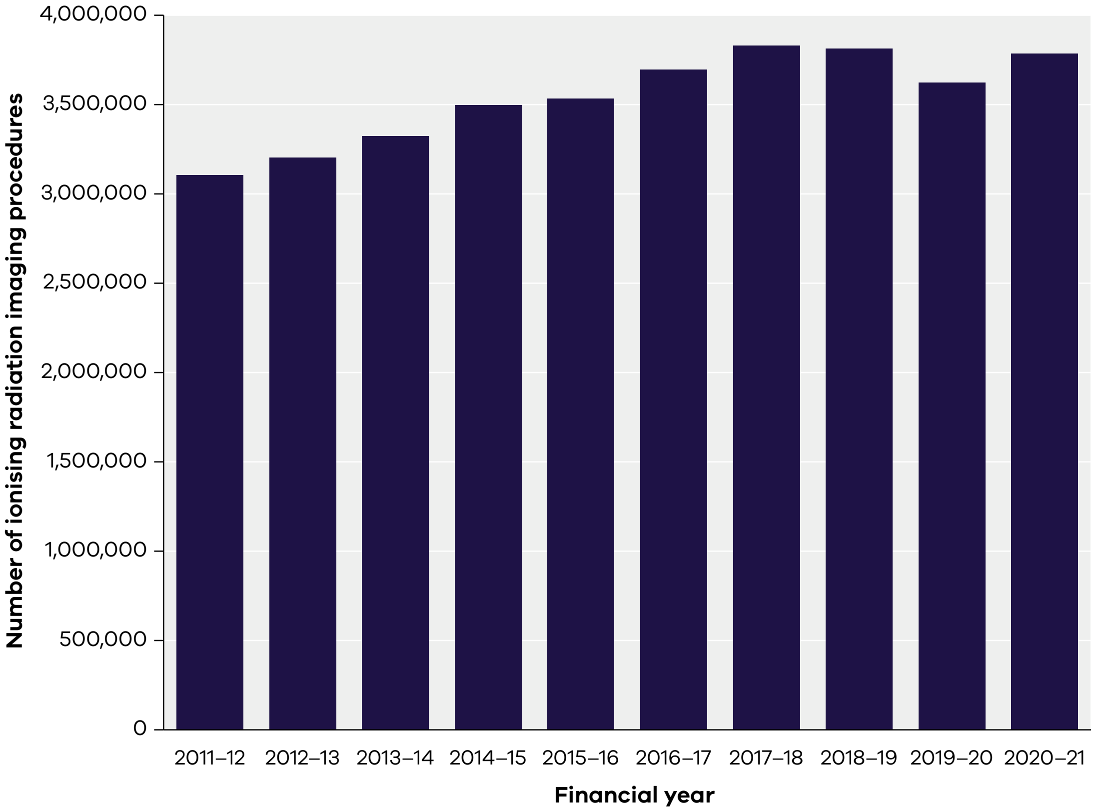
Incident no.	Description of incident
Incident 213	**A radiopharmacist received an extremity dose in excess of a prescribed dose limit.** The department received notification from a personal radiation monitoring service provider of a high radiation dose recorded by a finger monitor issued to a radiopharmacist. The dosimetry report showed that the finger monitor recorded a dose of 146 mSv over a period of 30 days. The department's investigation into the incident found that the radiopharmacist received a skin dose over a 12-month period that was in excess of the prescribed dose limit of 500 mSv. The department's response to the incident is ongoing.

Appendix 2: Overview of reported incidents for the past 10 years, per financial year

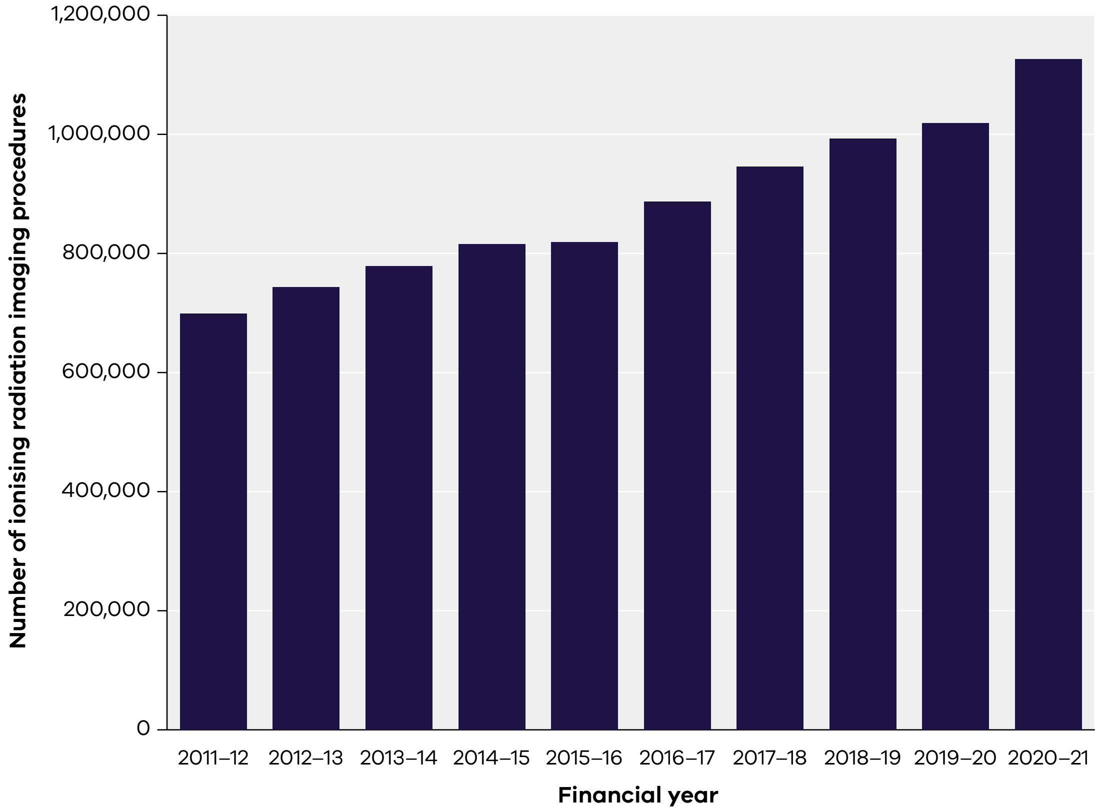


Appendix 3: Diagnostic imaging services over the past 10 years in Victoria

Number of diagnostic imaging services for CT, diagnostic radiology and nuclear medical imaging from Medicare Australia statistics



Appendix 4: Diagnostic imaging involving the use of CT and nuclear medicine over the past 10 years in Victoria



Glossary

Term	Definition
Angiography/ angiogram	The use of X-rays and contrast to image the arteries in the brain, heart or kidneys.
Becquerel (Bq)	The standard unit of radioactivity 1 kBq = 1,000 Bq; 1 MBq = 1,000 kBq; 1 GBq = 1,000 MBq; 1 TBq = 1,000 GBq
Cholangiography/ cholangiogram	X-ray imaging of the bile ducts and gallbladder
CT	Computed tomography – a medical diagnostic X-ray tool
Dotatate	An amino acid peptide (tyrosine-3-octreotate)
Extravasation	The leakage of intravenously infused medications into the extravascular tissue around the site of infusion
Extravenous	Existing or taking place outside of, or administered outside of, a vein or veins
FDG	Fludeoxyglucose – a radiopharmaceutical used in PET
Fiducial markers	Markers that provide a method of ensuring accurate target localisation for tumours or organs for radiotherapy
^{18}F	The symbol for the radionuclide fluorine-18
Gamma camera	A device that detects the radiation from radiopharmaceuticals that have been administered to a patient in order to diagnose a medical condition
Gray (Gy)	The unit of absorbed dose of radiation used as a measure of foetal malformations and of developing acute effects such as skin burns 1,000 mGy = 1 Gy
HDP	Hydroxydiphosphonate – used in nuclear medicine bone scans
k	Symbol for 'kilo' or 1,000
G	Symbol for 'giga' or 1,000,000,000
^{68}Ga	The symbol for the radionuclide gallium-68
Intravenous (IV)	Existing or taking place within, or administered into, a vein or veins
^{177}Lu	The symbol for lutetium-177

Term	Definition
m	Symbol for 'milli' or 1/1,000
mSv	A unit of effective dose of radiation used as a measure of risk of developing cancer and other late-onset effects 1,000 mSv = 1 Sv
^{99m}Tc-pyrophosphate	A radiopharmaceutical used in nuclear medicine heart scans
Sestamibi	Methoxy-isobutyl-isonitrile – used in nuclear medicine blood perfusion studies
MRI	Magnetic resonance imaging
NMT	Nuclear medicine technologist/technician
PET	Positron emission tomography
Sievert (Sv)	The unit of effective dose of radiation used as a measure of risk of developing cancer and other late-onset effects 1,000 mSv = 1 Sv
Stoma	An opening on the abdomen that can be connected to either the digestive or urinary system to allow waste (urine or faeces) to be diverted out of the body
^{99m}Tc	The symbol for technetium-99m, which is a radioisotope that can be attached to various pharmaceuticals for use in nuclear medicine scans