nehta

Diagnostic Imaging (Radiology) Environment Scan

e-Diagnostics

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Final

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Document Information

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Document Authorisation

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Preface

Document Purpose

This document describes:

- The current state analysis of radiology requesting from Medical practitioners under the Medicare Benefits Schedule
- The environment within which the implementation of NEHTA's Radiology package specifications will occur
- The baseline from which a "roadmap" for adoption and implementation of NEHTA's Radiology program.

Intended Audience

The intended audience of this document includes:

- Radiology industry stakeholders (Appendix:A.4)
- Diagnostic Services Reference Group
- Diagnostic Imaging teams
- Clinical Leads
- Other teams within NEHTA directly or indirectly related to Diagnostic Imaging.

Document Map

The following diagram represents the relationship between this document and others that will be developed within the Radiology program.

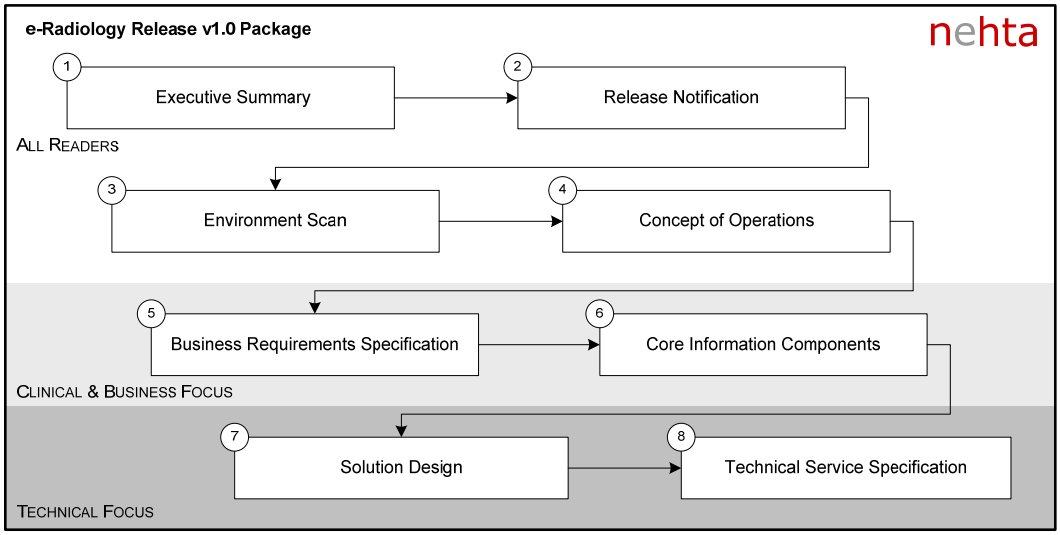


Table 1 Radiology Program – Document Map

Definitions, Acronyms and Abbreviations

For lists of definitions, acronyms and abbreviations, see the Definitions section at the end of the document, on page 43.

References and Related Documents

For lists of referenced documents, see the References section at the end of the document, on page 46.

1 Introduction

1.1 Executive Summary

The Diagnostic Imaging (Radiology) Industry is a high technology environment subject to rapidly changing technology. There are numerous potential system interfaces in the journey of a Diagnostic Imaging (DI) procedure; from the request, to the acquisition of images, the creation and subsequent distribution of reports and images to the relevant healthcare providers involved in the patient's treatment.

Electronic requests are usually computer generated in GP practice, by different practice management systems.

In hospitals and other healthcare providers requests are often handwritten but may be generated electronically.

The requirements for Medicare state that there has to be a signature on the request. There is some uncertainty of security of signatures on electronically transferred requests. Radiology Information systems exist that accept electronic requests but it is more common practice to receive a printed request that can then be scanned into the system.

A large percentage of hand written requests are deemed by the radiology community to have illegible, insufficient or irrelevant information for the suspected diagnosis and clinical request. There are currently no consistent code sets or terminology for diagnostic imaging requests.

The majority of radiology reports are dictated and transcribed. There is no common coding or structure in use for radiology reports in Australia. There is a Quality Use of Diagnostic Imaging (QUDI) project underway to develop guidelines for the written radiology report.

Whilst the DI Industry has embraced digital technology and implemented Picture Archiving and Communication System (PACS)/Radiology Information System (RIS) systems to enable soft copy reporting and electronic transfer of both data and images, downstream healthcare providers may not have the appropriate technology to support the visualization of soft copy images at their desired quality. The variation in the graphical user interfaces of Digital Imaging and Communications in Medicine (DICOM) viewers often slows down the viewing of images and marking up, particularly in pre-surgical assessment, as opposed to looking at film on a light box.

While there are no nationally consistent regulations on the retention of images, a number of states and territories have legislation requiring the retention of health records (which can include images) for minimum periods. Professional guidelines for radiologists also stipulate that retained images and records must be kept for at least 7 years. There is normally no Medicare Australia requirement for an imaging provider to keep images for any length of time.

Syntactic interoperability between operating systems enables effective and efficient movement of data and images and a more timely diagnosis for the patient.

Interoperability may be hampered due to vendor proprietary software, lack of common standards, interfaces between systems, and lack of infrastructure to support the transfer of data and images.

Throughout Australia there are challenges in transferring data and images, in particular, within and between public and private, environments, which may be due to the issues highlighted above.

Though radiology information technology is mission critical in a hospital environment, disaster recovery and redundant servers may not be in place, enabling minimal downtime and protection of data. [RESCW2011]

1.2 Opportunity Analysis

This Environment Scan has identified a number of opportunities to improve patient outcomes by enabling better access to diagnostic image and associated clinical information.

The national diagnostic imaging sector is currently impacted by jurisdictional policies on the transfer of healthcare information. Consequently the availability of digital images is ad-hoc and dependent on the individual radiology provider or corporations to make their own assessment on their retention and storage policies significantly impacting on the potential for national interoperability.

An opportunity exists for the Diagnostic Imaging Sector to collaborate in the development of the nationally agreed specifications and supporting guidelines to support a consistent approach to the ownership, retention, storage, transfer and access to diagnostic images and clinical information resulting in improved access and patient outcomes. It is proposed that with collaboration of industry stakeholders the following should be undertaken as a first step towards addressing these issues:

1. Development of nationally consistent specifications and supporting guidelines for the ownership, retention and storage of digital diagnostic images in conjunction with industry stakeholders.
2. Development of nationally consistent specifications and supporting guidelines for the transfer of and access to diagnostic requests, reports and images across jurisdictional boundaries in conjunction with industry stakeholders.
3. Development of nationally consistent specifications and supporting guidelines in relation to access of diagnostic requests, reports and images in conjunction with industry stakeholders.

Endorsement of the above specifications and supporting guidelines will provide a platform for the development of a suite of open technical standards supporting the following:

- Transfer of digital images between healthcare providers
- Access of digital images by healthcare providers
- Display and manipulation capabilities of images external to the radiology provider.

In conjunction with the technical specifications above NEHTA will continue to develop specifications for:

- Diagnostic Imaging structured requests
- Diagnostic imaging structured reports
- Electronic transfer of Diagnostic Imaging requests
- Electronic transfer of Diagnostic Imaging reports

To enable effective image and associated data exchange it is not only necessary to have the appropriate infrastructure in place but to have a suitably qualified radiology IT workforce to support the change management required and day to day operations of e-radiology. It has been identified that there is a significant shortage of suitably qualified PACS administrators, in particular, throughout Australia. To overcome the current situation and projected shortfall NEHTA suggests the following be explored in more detail by the appropriate organisation/organisations:

- Development of graduate and post graduate courses in Radiology IT
- Provision of Radiology IT courses by appropriate universities
- Ongoing professional development in Radiology IT

It should also be noted that there is an overall shortage of a suitably qualified Healthcare IT workforce in Australia and training for end-users. Provision of similar education as Radiology IT for the broader healthcare sector may be of benefit.

1.3 Introduction

Radiology is a diagnostic specialty within the field of medicine that employs X-rays and other modalities for diagnostic imaging of the inside of the body to contribute to a diagnosis.

It can be further subdivided into the following areas:

- Soft anatomical – Ultrasound, Mammography, Magnetic Resonance Imaging (MRI) and thermal imaging
- Hard anatomical – Computerised Tomography (CT) scans, bone densitometry and x-rays
- Procedural – fluoroscopy, angiography, portable probes for radio-guided surgery
- Functional – Nuclear Medicine, Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET)
- Hybrids – (SPECT) CT, (PET) CT, PET MRI, SPECT MRI.

Diagnostic Imaging services are provided by public hospitals, large private corporate networks, small independent private networks or individuals.

During 2008/2009 17.3 million diagnostic imaging services attracted a Medicare benefit of around $2 billion. Medicare Australia funded approximately 70% of all diagnostic imaging tests undertaken [CDICE2010].

In line with Medicare Benefits Schedule Nov 2010 [CMBS2010][1]. The following medical practitioners can currently request radiology services from the Diagnostic Imaging Services Table:

- Specialists and Consultant physicians can request any diagnostic service
- Other medical practitioner can request any service except from MRI
- Dental practitioners can request specific item numbers
- Chiropractors can request specific item numbers
- Osteopaths can request specific item numbers
- Physiotherapists can request specific item numbers
- Podiatrists can request specific item numbers.

1.4 Scope

The scope of the environment scan is limited to the following business processes:

- Radiology requests from Medical Practitioners eligible under the Medicare Benefits Schedule, DoHA
- Internal processes within a radiology department that have external communication points for requests, images and reports both as imports and exports
- Storage of images and how they are exported to referrers
- Length of storage of images based on clinical benefits and financial aspects
- Export and receipt of reports to medical practitioners

[1] p 538, DoHA, 2010

- Sending and receiving images using the concept of teleradiology and subsequent reporting.

The scope of this environment scan will be based on the following key priorities:

1. A comprehensive review of the radiology request-image-report cycle including:
    a) The whole scope of e-radiology (e.g. request, produce, display, send, query, print, store (archive), process, retrieve medical images and derived structured documents)
2. Communications between medical/clinical practitioners and radiology providers with respect to requests, images and reports and the technology requirements
    a) Current state of PACS adoption within public jurisdictions and the private radiology sector, drivers and detractors
3. The critical elements of an image to the receiving facility, such as:
    a) Quality of images, for example analysis of the content and structure of images and reports currently in use, for example what would constitute a complete and 'quality' image and subsequent report
    b) An overview of the information requirements by speciality
    c) Timely receipt of information
    d) Status updates and notifications required
    e) DICOM as a standard and its integration with HL7, IHE and other standards bodies
    f) The feedback loop to the patient
    g) Patient safety concerns
    h) Information being reported/imported back to medical practitioners
    i) Technology requirements for received images and reports by medical practitioners.
4. Images and reports that cross sectoral boundaries. That is, involving primary, secondary and tertiary care. This includes, but is not limited to:
    a) Images across primary health, with an emphasis on community-based chronic condition management
    b) Public to private interface
    c) Images across jurisdictional boundaries
    d) Inter- and intra- hospital images and reports.

1.5 Approach

The document aims to provide an overall view of the request-image-report cycle irrespective of the location of service i.e. public or private unless otherwise stated.

The Environment Scan is a result of extensive research and consultations with industry stakeholders on various aspects of the current state of Diagnostic Imaging in Australia. There has also been extensive consultation with the members of the NEHTA Diagnostic Services Reference Group (DSRG).

There were two workshops conducted in Melbourne and Sydney with attendees from various Diagnostic Imaging stakeholder organisations. The purpose of the workshops was to obtain stakeholder views on the proposed

content of the Environment Scan in the request-image-report cycle. Aspects from the workshops have been incorporated into the broader content of the environment scan in conjunction with other supporting material

Literature reviews have been conducted on published papers and guidelines relative to the transition of digital technology and interoperability from industry stakeholders within Australia and overseas.

The highlighted problem areas within DI in scope of this Environment Scan are a result of the findings from the workshops and related work in the area by various Colleges, Associations and industry stakeholders.

2 Diagnostic Imaging Industry

2.1 Current State

2.1.1 Model

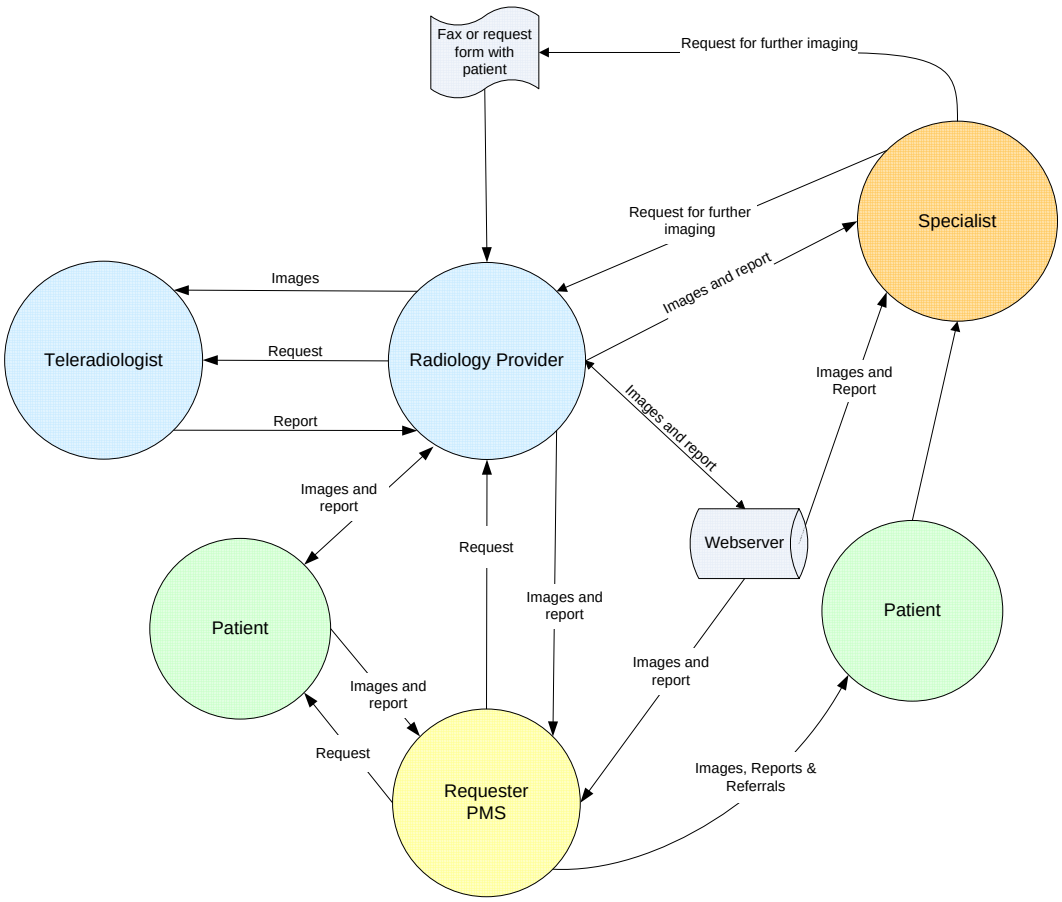


Figure 1 - End-to-End Process

2.1.2 End to end process description

2.1.2.1 Requests

The requestor electronically generates or writes on a request form. Due to signature requirements all requests are in paper format which is either given to the patient and/or is faxed to the provider. The patient may require an appointment for certain tests; this is either scheduled over the phone by the patient, the requester or by the patient attending the premises. The receptionist will advise the patient on any Medicare reimbursement and out of pocket expenses and any instructions for the test once it has been established that there are no contra-indications precluding the patient from having the test i.e. allergies (contrast) or pacemakers etc for MRI scans. In the case of CT and MRI the radiologist may view the request before the test is scheduled. The radiology provider can also receive requests from specialists, such as further imaging or enhancement of images already captured.

The radiologist may question the appropriateness of the request with the requester and substitute a more appropriate test with the patient's consent,

there could be financial implications for the patient which may also influence the test performed. The radiologist may view relevant prior images if available, particularly CT and MRI before a test commences.

2.1.2.2 Images

The radiology provider captures the relevant image as per the request. Relevant prior images if available may be of benefit. The radiographer/sonographer carries out post processing on the captured images especially in the case of (CT) and (MRI). The patient may be given the film/CD/DVD to keep and present when required, or the images may be made available to the requester via a web service. If there is no radiologist on site the images may be reported via teleradiology either within their own organisation or through a 3rd party.

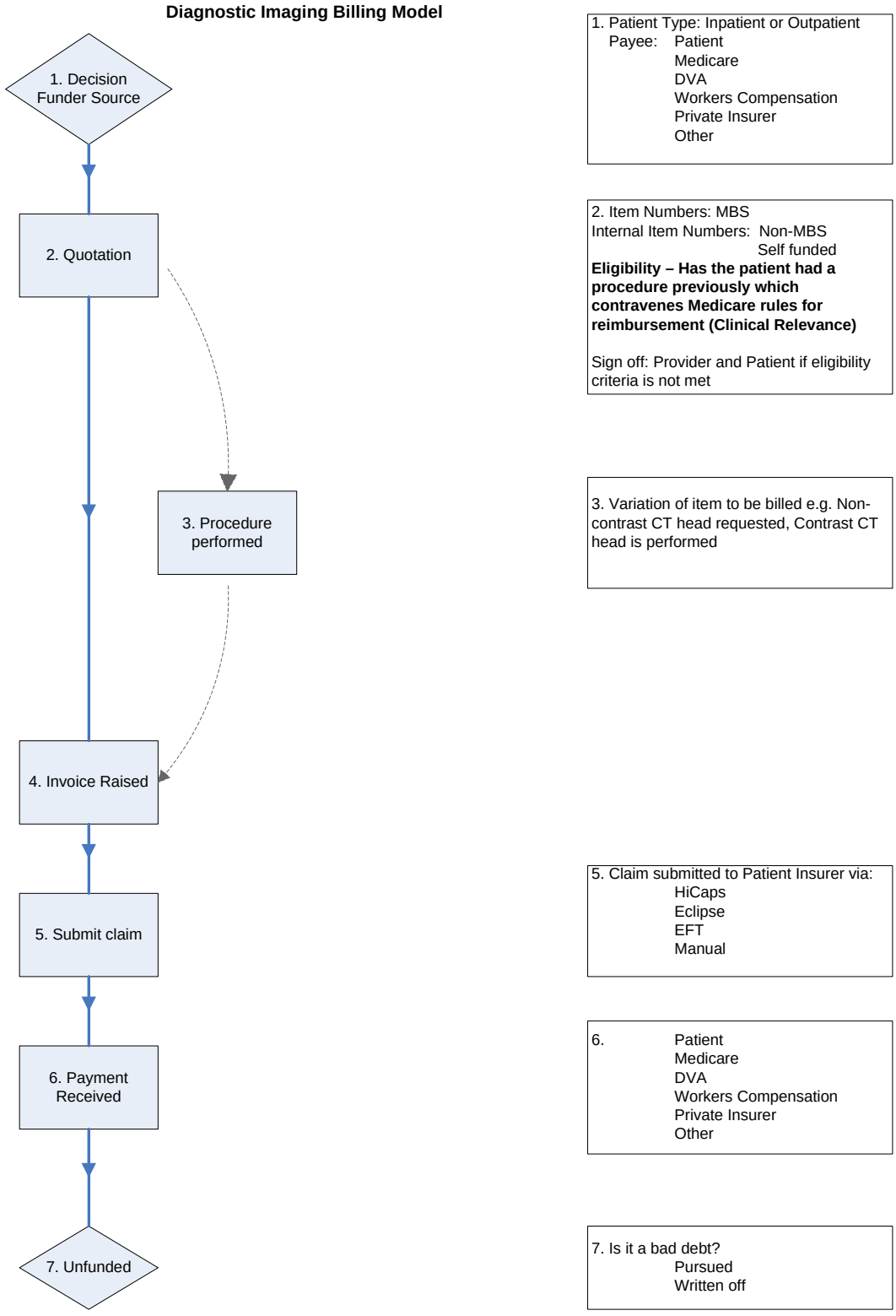
2.1.2.3 Reporting

The radiologist views the images, reviews prior images if available and produces an interim report; this is most often in the form of verbal dictation. An interim report is one that is not yet validated, but is sometimes able to be accessed by the requester or other treating clinical staff, particularly in a public hospital environment. The interim report is then sent to the radiologist's clerical staff for transcription. Once transcribed, the report is then validated and made final for distribution to the requestor.

2.2 Billing in DI

The following diagram depicts the process and decisions that have to be made in the Medicare funded environment. There are many rules governing the reimbursement of radiology tests and the patient must be informed of the cost of the test and what happens in the event that the test is not eligible for reimbursement. If this is the case the patient will be responsible for the full cost of the test, the radiology provider may be successful in recovering this cost or have to write this off as a bad debt.

If the requester at the time of requesting the test or the provider at the time of imaging the patient was easily aware of eligibility before proceeding the situation
described



above could be avoided.

Figure 2 - Diagnostic Imaging Billing

2.3 DI Reimbursement

In Australia, the Medicare Benefits Scheme (MBS) is the primary driver of who is able to refer for reimbursed diagnostic imaging tests.[CMBS2010] [2]

Section 4AA of the Health Insurance Act 1973 (the Act) enables the Health Insurance (Diagnostic Imaging Services Table) Regulations to prescribe a table of diagnostic imaging services and the amount of fees applicable to each item.

The Medicare Benefits scheme is outside the scope of this Environment Scan. Information is provided of a contextual nature only.

2.3.1 Synopsis

A diagnostic imaging service is defined in the Act as meaning an R-type diagnostic imaging service or an NR-type diagnostic imagine service to which an item in the Diagnostic Imaging Services Table (DIST) applies.

A diagnostic imaging procedure is defined in the Act as 'a procedure for the production of images (for example x-rays, computerised tomography scans, ultrasound scans, magnetic resonance imaging scans and nuclear scans) for use in the rendering of diagnostic imaging services'.

As for all Medicare Services, diagnostic imaging services have to be clinically relevant before they are eligible for Medicare benefits. A clinically relevant service is a service that is generally accepted in the profession as being necessary for the appropriate treatment of the patient.

An imaging service specified in the DIST may be provided by:

- A medical practitioner; or
- A person, other than a medical practitioner, who:
  - Is employed by a medical practitioner; or
  - Provides the service under the supervision of a medical practitioner in accordance with accepted medical practice.

Medicare benefits are not payable, for example, when a medical practitioner refers patients to self-employed paramedical personnel, such as radiographers or other persons, who either bill the patient or the practitioner requesting the service.

During 2008/2009 17.3 million diagnostic imaging services attracted a Medicare benefit of around $2billion. Medicare Australia funded approximately 70% of all diagnostic imaging tests undertaken [CDICE2010].

Medicare benefits are not payable for diagnostic imaging services that are classified as R-type (requested) services unless prior to commencing the relevant service, the practitioner receives a signed and dated request from a requesting practitioner who determined the service was necessary. However, there could be exemptions from the written request requirements for R-type diagnostic imaging services.[3]

The following individuals may request a diagnostic imaging service[4]:

- Specialists and consultant physicians
- Other medical practitioners can request any service except Magnetic Resonance Imaging(MRI) Services

3. p.538, DoHA, 2010

[3] ibid p.537

[4] ibid p. 538

- A medical practitioner, on behalf of the treating practitioner, for example, by a resident medical officer at a hospital on behalf of the treating practitioner
- Dental practitioners, physiotherapists, chiropractors, osteopaths and podiatrists registered or licensed under State or Territory laws can request a few services as listed in DIST. [CMBS2010][5]

The responsibility to ensure that there is adequate information for the referee to be able to be understood (as a bare minimum). The reason for the request and the type of service requested should also be clear.

The request must always be:

- In writing
- Signed by the requestor
- Dated
- Contain the name, address and provider number of the requesting practitioner.

It is not necessary that a written request contains the provider's information. A single request may be used to order a number of diagnostic imaging services. After the first service has been rendered, the subsequent services must be rendered within 7 days of the first service.

Concerning R-type requests, it is possible that a practitioner can be fined $1000 for contravening the requirements if they provide (without reasonable excuse) a request which does not fit the request information requirements.

If an additional service is required and this additional service is the outcome of the first request, there is no requirement for a written request. The MBS does list a few other items which are exempt from this rule.

A provider may substitute a service for the originally requested service when:

- A more appropriate service is required for the diagnosis of the patient's condition
- The provider consults with the referrer or takes all reasonable steps to do so before attempting to provide the substituted service
- The substituted service was one that would be accepted as a more appropriate service in the circumstances by the practitioner's specialty group.

There is currently no requirement for a written request for the R-type service in a remote area. The MBS offers a definition of a remote area as one that is more than 30km by road from a hospital or a free standing radiology facility.

If a person loses their request, there is no requirement for a replacement written request as long as the provider is able to obtain confirmation from the requesting practitioner that a request has been made.

The provider must retain the written request for a period of 18 months commencing on the day the service was rendered.

2.3.2 Details Required on Accounts, Receipts and Medicare assignment of Benefit Forms [CMBS2010][6]

In respect to diagnostic imaging services, the details that must be entered on accounts or receipts and Medicare benefits forms include:

- Normal particulars of the patient,

[5] p.538, DoHA, 2010

[6] p.543, DoHA, 2010

- Date of the service
- Services performed
- Fees charged
- The Location Specific Practice Number (LSPN) of the diagnostic imaging facilities
- The name of a diagnostic radiology specialist, their place of practice or provider number
- The name of the diagnostic radiology non-specialist, their practice address or provider number of the practitioner who is claiming the fees
- For "R-type" requested services and service rendered subsequent to lost requests, the account or receipt of the Medicare assignment form must indicate the request date, the provider name and number, or the requesting practitioner name and address
- Services that are self-determined must be endorsed with the letters "SD". These are classified as self determined when rendered:
    - By a consultant physician or specialist in the course of practicing their specialty
    - To provide additional services to those specified in the original request, and the additional services are of the type that would have otherwise required a referral
    - In a remote area\under a pre-existing diagnostic imaging practice exemption
- Substituted services must be endorsed "SS"
- Emergencies must be endorsed "emergency"
- Lost requests must be endorse "lost request"

2.3.3 Maintaining Records of Diagnostic Imaging Services [CMBS2010][7]

Diagnostic Imaging services providers must keep records of diagnostic imaging services for a period of 18 months. These records must be retrievable by patient's name and the date of the service.

The records must include the report by the providing practitioner. For ultrasound services, the report must record the name of the sonographer.

Where the provider substitutes a service for the service originally requested, the provider's records must include:

- Words indicating that the providing practitioner was consulted, and the date of this consultation, or
- Sufficient information to demonstrate that all reasonable steps to consult were undertaken.

The Managing Director of Medicare Australia my request records retained by a providing practitioner. These must be produced to an officer of Medicare Australia within 7 days of the request.

2.3.4 Reimbursement:

It is important to note that eligibility rules exist for the payment of a Medicare Benefit.

[7] P.544, DoHA,2010

3 Analysis

This document also references analysis and recommendations from published papers as identified.

3.1 Requests for a diagnostic imaging procedure

Many diagnostic imaging requests are electronically generated enabling better legibility to a handwritten request. Very little standardised coding is used and the free text used can sometimes be open to interpretation:

- The handwritten request may be illegible
  - The provider may not be able to discern the details of the requestor, the patient's details or type of investigation required. This may include the inappropriate use of acronyms.
- The lack of appropriate information for suspected diagnosis and clinical request can incur time wastage by the radiologist to establish the test being asked for or the most appropriate test for the condition
  - After consultation with the requester and patient, test substitution may occur, due to a more appropriate test for the clinical history or contra-indications of the original test proposed.
  - The patient may not agree if the recommended test incurs more out of pocket expenses for them.
  - The radiologist will have to consult with the requestor before changing the type of investigation ordered.
- The request needs to contain several details for it to be valid as per Medicare Australia rules
  - The requestor needs to ensure that the patient has not had previous procedures that would invalidate the test for Medicare reimbursement.
  -

The project by the Quality of Use in Diagnostic Imaging (QUDI) [RODIR2006] attempted to provide the contextual framework and confirm the issues impacting the efficacy and quality of the DI referral process. It aimed to identify and outline the benefits of improving DI referral practice. The project highlighted that the following was required:

- Provision of the DI referral/request of adequate clinical information to enable the most appropriate investigation/procedure to be selected (that takes into account patient safety/tradition exposure and diagnostic value)
- Provision of the reason for the investigation/clear diagnostic question that the referred wants answered to assist the radiologist in interpretation of results and completion of a pertinent and concise report
- Legible, unambiguous and properly completed DI requests
- Clear instructions for preparation(s) required for the investigation
- Feedback to the referrer from the DI provider confirming that the request has been received.

3.2 Allied Health Requests

In November 2006, the Royal Australasian and New Zealand College of Radiologists (RANZCR) and Quality Use of Diagnostic Imaging (QUDI),

commissioned the Centre for Health Innovation and Solutions, to develop a broad set of principles that must apply when determining what DI services non-medical practitioners should be allowed to request. [FRAHR2007]

Twenty six stakeholders participated from varying backgrounds. A focus group was held to gauge consumer views on diagnostic imaging referrals by Allied Health Professionals (AHPs).

Currently, non-medical practitioners can request a restricted number of investigations, for which, Medicare Australia reimburses them. The restrictions are to the type of investigation and also limited by anatomical region by professional group, based on their registration. The current list of these items as per the MBS is included in Appendix B (of the MBS).

In the paper by the Centre for Health Innovation and Solutions [FRAHR2007][8], the Australian Physiotherapy Association argued that the current Medicare referral arrangement costs taxpayers an additional $1 million and 9500 hours of unnecessary General Practitioner (GP) consultations per year, as well as additional time and monetary costs for patients.

Other incongruities recognised (in the paper) [FRAHR2007][9] were:

- The AHPs had no access to ultrasound investigations which are safer in terms of radiation exposure
- Dentists have access to a wide range of item codes despite specialising mainly in dental, oral, mandibular anatomy and physiology
- The AHPs are allowed to order multi region spinal and pelvic X-rays which carry a higher risk of radiation but are restricted from requesting limb X-Rays.

Most stakeholders agreed that AHP competency in Diagnostic Imaging (DI) is critical. There was emphasis on the importance of inter-professional communication for patient care. A good relationship with the radiologist, who functions as a quality assuror, is imperative to reduce the incidence of repeated diagnostic investigations and to increase patient satisfaction with the process of AHP requests.

The report recommends a review of the current item codes and to establish a standard and rigorous review of the decision making process on various aspects of requesting DI. There was a lot of emphasis on educating health professionals who are able to request DI to have a requirement of competence and currency in the quality use of DI.

3.3 Retention of Images

There is no consistent national legislative framework for retention of images. Retention is influenced by clinical, medico-legal and financial considerations.

If there are no images available, this can be an issue for some specialists or healthcare providers who require the images in preference to the report in order to plan treatment or surgical procedures [DDIR2009]. There is a reliance on the patient to keep the images if they have been given a hard copy, and to present them at their subsequent appointments.

3.4 Storage of Images

There is no national consistency for storage of images with respect to where data should be stored, lossless or lossy compression, summary or full data sets, however RANZCR recommends that the level of compression should not adversely affect the diagnostic outcome of the examination. The European Society of Radiology and the Canadian Association of Radiologists have both

[8] The University of Queensland, 2007

[9] p.11, The University of Queensland, 2007

published papers on the usability and standards for irreversible compression, respectively. The discussion on storage of images should be coupled with the ownership and retention of images issues. [GUICDI2010], [ESRUII2011], [CAR2009]

3.5 Ownership of Images

There is no current position on who owns the image(s). In most cases, in the private sector it would be the patient, in the public sector images generally remain within public facilities in the jurisdiction. More discussion on ownership, responsibility, custodianship is required particularly when additional information is added and intellectual property is taken into consideration.

3.6 Relevance of prior images

Prior images may not always be available at the time a patient attends for a test. The availability of relevant prior images at scheduling may influence the test or protocols used and may enhance the diagnosis of the current test. The radiologist relies on the patient to remember and/or keep images and bring them along. Currently exchange of images (and data) between public-public, public-private and private-private transfer of images and data is problematic. Inhibitors for this data exchange could include firewall restrictions, access policies, inconsistent order codes and inconsistent state–based legislation on data sharing.

3.7 Display requirements for Images

There are various levels of the quality of image that a clinician or healthcare provider may require. A GP may only require the images in a low resolution or non-DICOM format to use as a non-diagnostic tool for discussion of the patients condition. On the other hand a surgeon, for example, requires diagnostic quality high resolution images, accompanied by appropriate hardware and software to enable viewing and manipulation.

If the images are not available via a browser or film the patient will bring them on a CD/DVD, often the DICOM viewer is set to auto-run and does not give the referrer an opportunity to utilise a viewer of their choice. CD's can sometimes be a problem and not always load successfully, thus inconveniencing the consultation. The software and graphical user interfaces of DICOM viewers often have different layouts and functionality, making it difficult to quickly view the images.

To enable better utilisation of DICOM viewer software, outside of the radiology practice, applications training for the end-user would be of benefit. It has been suggested that a more consistent approach and standardisation to viewing software may be beneficial.

3.8 Reports

Generally in the private sector the report is final and definitive. In the hospital setting interim reports are commonly produced which may be updated with addendums. It has been noted that amended reports may not be labelled as such and therefore difficult to keep track of them. Clinicians have also expressed an interest in the ability of Reporting Systems to incorporate/have available charts, graphs, images or links to images as well as just text.

The European Society of Radiology subcommittee on Audit and Standards has recently prepared an article "Good practice for Radiological reporting. Guidelines from the European Society of Radiology (ESR)", February 2011 [ESR2011]. The article was presented at the European Congress of Radiology, Vienna, March 3-7 2011.

The article suggests a framework, which it hopes will be relevant for both radiologists and those who receive reports in the context of structure and contents, and dealing with unexpected findings. It summarises that in the European setting of cross-border healthcare, there are benefits in moving towards a more uniform style and structure of radiological reports. This would provide a more consistent service to patients and referrers. It would also facilitate audit, training and research.

In Australia, Dr Stacy Goergen, Clinical Advisor, QUDI program, RANZCR has published a document for the Radiology Written Report Guideline Project. At the time of going to print the draft guideline is in a 3 month feedback period which is open for public comment [RWRGP2010].

3.9 Transfer of report and images to requestor or end user

Most end-users of diagnostic images have Practice Management Systems (PMS) sometimes there can be a lack of functionality or HTML capability to receive the images and reports as required.

The image data sets can be quite large. Appropriate infrastructure availability and bandwidth can inhibit the transfer of uncompressed or lossless compressed images particularly in remote or regional areas.

Patients may also receive multiple identifying numbers throughout their investigations and this can sometimes be a problem when trying to merge the information.

DICOM and JPEG 2000 are the formats used most regularly to transfer images to and between healthcare providers. Vendors provide DICOM compliance statements and less commonly IHE integration statements to confirm the interoperability capabilities available with their systems. HL7 is the messaging standard used, the majority of Radiology IT systems in Australia are HL7 v2.3.x. The adoption rate in Australia of AS4700.2 is unclear. [ASIHL72006]

This standard covers the implementation of the HL7 version x protocol, for communication between health service providers, pathology providers and medical imaging providers within and between Australia Health care settings

3.10 Teleradiology

Teleradiology is the transmission of patient images from one location to another for the purposes of interpretation and/or consultation [ACRT2002][10]. Teleradiology allows access to radiologists when none are available in the local area, or specialist radiologists. This can improve patient care by speeding up the reporting cycle or enable the patient to have a test closer to home, particularly for those living in rural areas.

Teleradiology utilises standard network technologies such as internet, telephone lines, wide area network (WAN) or over a local area network (LAN). Specialised software is used to transmit the images and enable the radiologist to effectively analyse the images. Technologies such as advanced graphics processing, voice recognition and image compression are often used.

However, the teleradiologist may not receive request information until after the patient has been imaged, and/or may not have access to any prior images. Generally, depending on contract arrangements, the teleradiologist can talk to the requester or the radiographer taking the images and advise on additional imaging or views that may be appropriate.

[10] p.1, American College of Radiology, 2003

3.10.1 QUDI review of teleradiology

Radiology Accreditation Services was engaged by the Quality Use of Diagnostic Imaging (QUDI) program to provide recommendations for technical and practice standards for accreditation requirements for teleradiology [RQUDI2003].

The project was undertaken in four stages.

- Stage 1 was a review of the available literature and other international standards to determine the applications of teleradiology and to define the key components.
- Stage 2 of the project involved obtaining feedback on the issue relating to teleradiology from key stakeholders.
- Stage 3 included a draft final report including recommendations and a snapshot of current Australian teleradiology in the clinical environment. Incorporated into stage 3 of the project was additional feedback from stakeholders and information provided by practices relating to the current technical installation of teleradiology equipment and infrastructure. [11]

The report makes several recommendations in the section titled 'Results' for:

1. Practice management
2. Inter-jurisdictional reporting where inter-jurisdiction is considered (in the report) as between those regions where regulatory or legal requirements differ in relation to any aspect of the performance of an examination; also
    a) "Currently Medicare Australia is not paying for services provided from within Australia and reported from otherwise eligible imaging specialists outside of Australia. This is in contrast to a number of public facilities where non-Medicare eligible services are provided on this basis.
    b) Variable time zones and the problems associated with being able to get a report in time.
    c) Qualifications of the medical imaging specialist
    d) Compliance with accreditation standards
    e) Medico-legal issues associated with reporting."
3. Report Identification/Provider Number Billing
    a) Increase in the incidence of 'figurehead billing'

    This is defined as the use of an eligible provider number other than of the reporting medical imaging specialist whilst maintaining compliance with other aspects of Medicare billing

    i) The paper recommends that:

    The report must state the name of the reporting Medical Imaging Specialist

    The practice must have documented procedures to ensure that the billing of patients is in compliance with all legal requirements.

    Where billing is provided under a provider number that is not allocated to the Medical Imaging specialist providing the report, the practice must have procedures in place to ensure the items provided match the items billed.

[11] p.3, American College of Radiology, 2003

4. Facilities
    a) Reporting environment: There are several recommendations which specify image quality for accurate interpretation
    b) Equipment- functional and appropriate for the scope of work
    c) Workstations and Display
        i) Minimum system software functionality at workstations
        ii) Specification of teleradiology equipment to ensure accurate interpretation of images
        iii) Monitor resolution to keep the highest resolution for images. The report recommends modalities for CR, CT, US, Mammography, MRI and Nuclear Medicine. It also recommends that all monitors used in reporting of images for teleradiology or PACS have been assessed to be compliant with some essential characteristics as listed in the report.
5. Quality improvement and Quality control
    a) An appropriate quality improvement/quality control program must be in place in a practice utilizing teleradiology.
    b) This should document procedures for monitoring and evaluating the effective management, safety and proper performance of acquisition, digitization, compression, transmission, archiving and retrieval functions and back up and recovery of the system.
6. Personnel recommendations including but not limited to
    a) Qualifications
    b) Professional supervision
        i) Delegation of tasks under professional supervision
        ii) Direct supervision
        iii) Indirect supervision
        iv) Professional competence
        v) Imaging requests
        vi) Performance of the Imaging examination
        vii) Interpretation and Reporting
7. Clinical liaison between Referrer and Medical Imaging specialist
    a) The report emphasises the importance of communication between the imaging specialist and referrer
8. Preliminary and final interpretations
    a) The report recommends that all interpretations of images, regardless of whether they are preliminary or final, must be performed on systems that meet the technical specifications specified
9. Examination protocols
    a) These should be made available to the medical imaging team as part of professional supervision arrangements.
10. Safety
    a) Contrast Administration
    b) Data Storage and transmission

c) Redundancy and Back up

11. Patient Management

    a) The patient must be aware that teleradiology may be used in the course of the examination being completed, in order to provide consent

    b) The practice must ensure that patient confidentiality is maintained in accordance with all relevant legislation in this matter

12. Teleradiology/PACS.

    a) Protocols for transmission of imaging data must be available at the transmitting and receiving sites appropriate to the scope of examinations being performed including access to previous studies. Acquisition of teleradiology images must be in DICOM if available. Patient data must be identifiable and contain the stated information.

3.11 IT capabilities

Radiology IT is mission-critical in a hospital. If any part of the chain fails, there can be serious impacts on a patient's diagnosis and treatment. Insufficient viewing capabilities in operating theatres and other clinical areas can impact on the safety of procedures. For example, images may be only available on CD and no CD viewer is available or there are no light boxes and the patient has presented with film from elsewhere.

It was noted in the workshops that hospitals do not always have redundant servers and often have a single point of failure.

Some pertinent issues across the public and private practice sectors are:

- Inadequate costing and planning for upgrades and operational costs when Radiology IT is procured
- Small radiology sites not always having disaster recovery in place
- Lack of redundant servers
- Single points of failure
- Shortage of suitably skilled Picture Archive and Communications systems (PACS) administrators
- Difficulties in recruiting Radiology IT personnel due to workforce shortages of suitably qualified personnel
- Insufficient viewing capabilities in operating theatres and other clinical areas, this applies to both public and private hospitals.

Healthcare providers such as GP's and to a lesser extent specialists and allied health utilise information management systems as part of their daily operations. Many of the points above can be applied to healthcare IT in general.

To enable seamless communications in the radiology request-image-report cycle it is imperative that information technology across the whole healthcare sector is aligned and using common standards.

3.12 Interoperability and Infrastructure

To enable effective transfer or availability of data and images, appropriate supporting infrastructure must be available for intra-hospital, inter-hospital and organisation-to-organisation exchange.

However, some geographical areas may have insufficient network bandwidth to support transfer of images in a timely manner.

There are many suppliers of Diagnostic Imaging equipment which can lead to issues of vendor-to-vendor interfacing and system-to-system interfacing. For example, PACS-to-PACS capability may not be an easily achievable goal, resulting in delays to the availability of images.

There is no nationally consistent Radiology order catalogue. The order codes used can be the Medicare Item number, vendor supplied or generated at a local level by the radiology provider.

A scoping study on ehealth by QUDI for Quality Referrals [RODIR2006] done in 2005-2006 identified some of the following areas for improvement:

- The effective introduction of DI technologies into practice and organise appropriate changes to work processes
- Integration of various components such as PACS, Radiology Information Systems (RIS) and X-Ray equipment to support exchange of data and integration of workflow

- The use of computerised requesting, supported by decision support, improved patient education and electronic transfer of the request to the DI service so that the information required is present when the investigation is scheduled
- A process to gain acceptance by referrers of digital images as a film replacement
- Access to images for historical comparison and to support continuity of care
- Development of a high speed and affordable communication network to support teleradiology, movement of images within DI services and off site reporting.

3.13 Radiology referral template

The project by QUDI [RODIR2006] made some recommendations after developing a common template for radiology referral forms and trialling the use of the form in a variety of contexts (GP, hospital, medical specialists). While some DI services have settled on one multipurpose form, other services have developed a series of forms for particular purposes, based on the type of modality, referrer, patient type and referrer preferences. A new model was developed which maintained the core design principles, while providing choice and flexibility about form design as well as customisation potential.

The conclusions and recommendations for improvement were:

- Encourage referrers to provide additional clinical and relevant information to assist radiologists in performing and reporting DI examinations and procedures
- Improved communication between referrers and DI practice staff and radiologists
- Enable customisation of layout to meet the needs of DI practices as an alternative to their current individually designed and non standard forms
- Support for improved collaboration between referrers and DI providers
- Development and adoption of DI referral guidelines
- The use of computerised information systems by referrers for generating paper referrals (short term) coupled with electronic storage and processing of results and transition to electronic DI referrals in the medium to longer term
- Development of a strategy for assessing and monitoring improvements in the referral process linked to strategies such as referrer education
- Targeting the information needs of patients and referrers to enable improved access to information on DI services, procedures and preparation requirements
- Support for increased RANZCR leadership on these issues, increased liaison with other medical professional groups, and resources to support the above activities.

3.14 Portable Image Media

As per the QUDI paper ‘Can Portable Image Media Work in Practice’? [RODIR2006] published in 2007. Thirty three CDs, containing a CT image and one peripheral joint, were volunteered by radiologists and I.T companies at the 2007 RANZCR annual scientific meeting. These were inspected, tested with IHE compliance tools from the USA and Germany, and loaded on a number of windows PCs and a Macintosh notebook computer simulating the end user process. The results were as follows:

- All but one complied with the ISO 9660 standard for CD formats which support cross platform use
- All CDs contained a varying number of errors in the use of DICOM
- Only one CD used lower resolution images suitable for web viewing on a standard browser
- All CDs contained software for viewing images and most of these auto loaded on windows machines
- Thirteen different viewing programs were found with the most common being used 25% of the time
- Time taken to load images varied from around half to one and a half minutes.

The major areas for improvement included:

- Technical improvement in adherence to parts of the IHE profile covering DICOM viewers
- It is not clear if existing IT systems are capable of supporting a workflow where some form of pre-loading and use of image management software can reside on the user's system
- Need for users to have appropriate computer hardware and software
- Need to have the report augmented by access to images for the purposes of illustration, education or triage
- Need for training for treating doctors to read the images from a CD
- Not possible to load two CDs at one time to compare old and new images
- Lost/misplaced CDs.

Radiology practices should routinely only produce CDs and DVDs that are compliant with the Integrating the Healthcare Enterprise (IHE) Portable Data for Imaging (PDI) integration profile, according to a research team led by Vivek Kalia of Johns Hopkins University in Baltimore [PPRMI2011][12]. Practices should test internally that the disks have burnt correctly and contact institutions or providers who repeatedly send out patients with noncompliant media to encourage compliance.

The three most common reasons cited by respondents as to why outside portable media were not readable or accessible were:

- non-DICOM format/incompatible imaging files;
- corrupt disks (due to scratches, failed data writing, or other reasons); and the
- onboard image viewer does not auto-run and can't be executed.

The researchers noted that future implications from the study's findings include the potential emerging role of limited virtual private network permissions for online access to radiology examinations from frequent referral sites, and also the possible role of regional health information organizations.

3.15 Recommendations for delivery, access and viewing of digital images from the clinician's perspective (DDIR – RACS)

The Royal Australasian College of Surgeons (RACS) published a position paper in September 2009 [DDIR2009]. The aim of the paper is to provide the technical details that will enable a clinician as well as their technical advisors

[12] P.39-48, Kalia et al, 2011

to identify the software and hardware capabilities that will help them make a successful transition to the digital diagnostic imaging environment.

A number of issues were left unresolved in the paper such as retention, ownership and storage of images, interoperability and funding for upgrades and capital purchases required.

3.16 Review of Funding for Diagnostic Imaging Services

Currently there is a DoHA sponsored review of Funding for Diagnostic Imaging underway [RFDI2010]. Funding for Diagnostic Imaging is outside the scope of this environment scan, therefore information provided is from a contextual nature only.

The review of funding for diagnostic imaging services has four key tasks:

- To establish appropriate fee relativities for Medicare Benefits Schedule (MBS) across and within different diagnostic imaging modalities
- To develop alternatives to fee-for-service and establish whether there are areas of diagnostic imaging that would be more appropriately funded through a different mechanism
- To review current funding arrangements for MRI, particularly restrictions around Medicare eligible/ineligible units
- To review current funding arrangements for PET, particularly around what capital arrangements should apply. [RFDI2010][13]

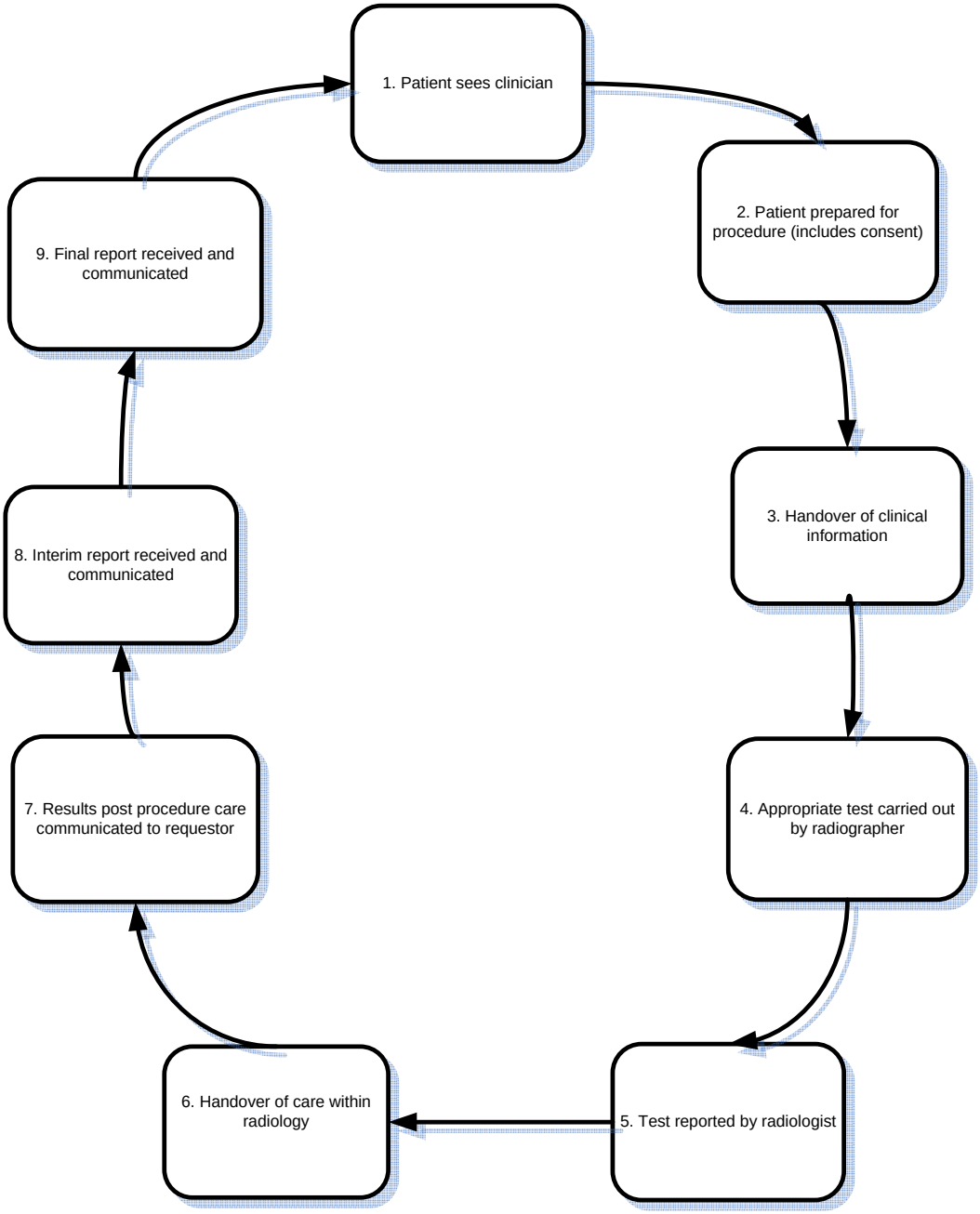
It will also look at the long term viability of diagnostic imaging services in rural, regional and outer-metropolitan areas. It will investigate common minimum requirements and associated costs to provide high quality diagnostic imaging services, in terms of workforce, capital infrastructure, accreditation requirements, consumables, information technology (among others) and how these differ within and between diagnostic imaging modalities.

[13] p. 4-17, Medical Benefits Reviews Task Force, 2010

4 Communication Process

4.1 Message Flows

4.1.1 Communication Cycle



1. Patient sees clinician. During the consultation the clinician decides that the patient needs a Diagnostic Imaging test/procedure. The clinician discusses the need for the procedure and how it would assist in diagnosis and further treatment. A request form is completed and either an appointment is scheduled or the patient attends the radiology provider as a walk-in. The financial costs of the test may be explained and the patient will give consent to proceed.
2. Patient prepared for procedure. The patient prepares for the test/procedure as per instructions from the radiology provider/department. When the patient arrives, the test will be explained and a consent form signed if required. In some circumstances there may be an identified issue where a patient is

unable to provide consent (e.g. dementia or another debilitating condition) and there is no one else for third party consent.

3. Handover of clinical information. The requestor hands over clinical information relevant to the patient either by writing it on the request form or sometimes personally in a hospital environment by an accompanying nurse or doctor depending on the circumstances. If the patient has been prepared for a procedure the preparation will be checked most often by the radiology nurse. At this point, the informed written consent for the procedure is also checked.

4. Appropriate test carried out by the radiographer, sonographer, radiologist or other appropriate staff member. Test substitution may have occurred if the radiologist deems a more appropriate test for the suspected diagnosis than originally requested. It is the responsibility of the person providing the imaging service to:

    - identify the patient,
    - match the patient to the request form,
    - check the correct side and site,
    - ensure that the checklist for the preparation has been done,
    - check the consent and
    - take further consent in cases where the patient is pregnant etc and
    - talk the patient through the procedure. The radiographer/sonographer and the nurse provide emotional and physical support (moving the patient) during the procedure.

    .The radiographer must ensure that the room is prepared for the given procedure before the patient arrives. Several other issues have been identified [AUSCEMI2010][14] such as:

    a) The patient comes from a non English speaking background,

    b) There may be an assumption on the part of the staff within the radiology department that the patient does not comprehend so there is no need to keep the patient informed as well as they should be; and

    c) There is no added process when the patient is unaware of the procedure and what it involves.

5. Test reported by radiologist. The radiologist confirms the correct patient and laterality on the images with the request form. Once the correct information is confirmed, the test is reported.

6. Handover of care within radiology. In some situations, post procedure instructions to the patient or carer will be handover in either/or both verbal and written form.
If the information given is only verbal and understanding is assumed, there is margin for error.

7. Results/post procedure care handed over to the requestor. The radiologist may call the requestor to discuss the results verbally if the findings are critical (a finding which requires the patient to be admitted to the hospital or changes the treatment) and/or unexpected. The radiologist may also reiterate the post procedure instructions to the requestor. This is particularly true in a hospital situation where the ward nurse has a handover from the nurse in the radiology department.

[14] Karen Buckley, 2010
http://www.conferenceworks.net.au/apsf/pdf/downloads/4%20Karen%20Buckley.pdf

8. Interim report received and communicated. In a public hospital environment it is common practice for an interim report to be produced. An interim report is a non-validated written report, often in the patient's records which can also be communicated verbally to the requestor if the finding is significant and unexpected (just as in step 7). The interim report can be used by the requestor to initiate or change treatment.
9. Final report received and communicated. The final report is the dictated and validated by the radiologist in private practice or a senior or consultant radiologist in a public hospital. The radiologist communicates the findings to the requestor especially if the findings in the final report are different to the interim report.
10. Patient sees clinician. The patient is seen by the clinician where the clinician discusses the findings of the final report with the patient. If there are any implications to the patient's care and future treatment, these are discussed. It is possible that the patient may need further imaging or a referral to another specialist.

4.2 Information Requirements

4.2.1 Communicating results to patients

Radiologists traditionally undertake radiologic examinations of the patients at the request of the referring practitioner, return a report to the requestor and assume that it was received and interpreted to the patient.

As stated by Leonard Berlin and Dr Robert Sherman; "Is it not really the patient we are obligated to serve above all others?" [CRRE2007][15] Dr Sherman observed that the radiologists can do an injustice to the patient by withholding their superior knowledge.

In New York, radiologist Harold Schwinger reported that during the period of 1985–1990, communication-related cases constituted more than 15% of radiology malpractice lawsuits. [PECOD2006][16]

A year later the American College of Radiologists (ACR) published its first Standards document dealing exclusively with communication in all aspects of diagnostic radiology. As stated by the Standard;

> "Some circumstances (…) may require direct communication of unusual, unexpected or urgent findings to the referring physician in advance of a formal written report." [ACRPG2010][17]

There are several early court decisions which expand the duty of the radiologist to communicate, in certain situations, to the referring physician. However in New Jersey in 1987 and in Arkansas in 1989 [CRRE2007], two state appeals courts alluded to direct communication between radiologist and patient. The court in one situation stated:

> "…when a patient is in peril of his life, it does him very little good if the examining doctor has discovered his condition, unless the physician takes measures and informs the patient (underlining added), or those responsible for his care, of that fact." [ACRPG2010][18]

The American Medical Association (AMA) Code of Medical Ethics contains language that indirectly if not directly is applicable to the issue of a radiologist's communication to patients

[15] P.42, Robert Sherman, 2007

[16] P.42, Pitman, A.G, 2006

[17] P.3-5, ACR, 2010

[18] P.3-5, ACR, 2010

> "The patient has the right to receive information from physicians and to discuss the benefits, risks and costs of appropriate treatment….Patients are also entitled to obtain copies or summaries of their medical records (and) to have their questions answered…" [AMACME1995][19]

Patients may exhibit great anxiety as they await results of radiologic studies. It is emphasised that patients are most satisfied when they feel fully informed about their medical condition and that patients are more likely to sue their physician if they believe that the physician did not inform them adequately [PECOD2006]. However, there needs to be decisions made on how much information and how the information needs to be delivered to the patient.

The QUDI report on Consumer Consultation project [QUDIC2010][20] (Final report August 2010) explored consumer experiences and common themes of importance to consumers. Consumers wanted the following issues to be addressed:

1. Consumers want to receive high quality information before, during and after testing
2. Consumers want to see more attention paid to their physical and emotional wellbeing
3. Consumers want to be viewed as active partners in their health care and to be given the opportunity to review their own test results
4. Results should be communicated quickly and where possible, practitioners should be on hand to discuss results immediately, including detailed information about the implications of their results
5. Consumers called for better availability of health records and better record keeping relating to their accumulated exposure to radiation
6. Consumers want practitioners to communicate more effectively with one another
7. Consumers want better access to diagnostic imaging services, particularly those living in regional, rural or remote areas.[21]

[19] http://www.ama-assn.org/ama/pub/physician-resources/medical-ethics/code-medical-ethics/opinion1001.shtml

[20] The Quality Use of Diagnostic Imaging Consumer Consultation Project. Final Report. August 2010. Consumers Health Forum of Australia.

[21] p. 8-9, Consumers Health Forum Australia, 2010

5 PACS adoption

5.1 Public Sector Current State

5.1.1 Victoria HealthSMART Program

The Victorian PACS project under the HealthSMART program[22] was concluded in 2008. Several public PACS systems were installed under this program, there are various other PACS throughout the public system installed outside of the program.

The modalities included in the Project's scope include:

- X-Ray
- CT
- MRI
- Ultrasound
- Nuclear Medicine.

The project's scope did not include upgrading of related systems such as:

- Radiology Information System (RIS)
- Specialist modalities e.g. CT, MRI
- Digital Radiology.

This product is now live at various sites in Victoria and the current PACS portfolio has been wound up as of September 2008.

5.1.2 Queensland Radiology Informatics Program (RIP)

Queensland is delivering a state-wide radiology service network and comprises of three major streams of work[23]:

- PACS and the long term state imaging archive
- State wide Radiology Information System(QRIS)
- Build Imaging Network (BIN)

5.1.3 The NSW Health Medical Imaging Program

The A/Program Manager, Joe Hughes of EHR Programs, Health Support Services[24], states that the NSW Health Medical Imaging Program consists of the Picture Archiving Communications System / Radiology Imaging System (PACS/RIS) project, the Enterprise Archive project and the Individual Healthcare Identifier project. The program has implemented PACS and RIS solutions at 72 sites across the state since January 2009. There are 37 more sites to be implemented by late 2011.[25]

Currently, images which are stored on a PACS are only viewable by hospitals within the same Area Health Service. The Enterprise Archive will enable an

[22] Healthsmart: Victoria's Whole of Health ICT Strategy http://www.health.vic.gov.au/healthsmart/pacs.htm

[23] Queensland Health, Radiology Informatics Program http://www.health.qld.gov.au/qhafe/docs/012_rip_id.pdf

[24] Joe Hughes email dated 17/01/2011

[25] Email from Electronic Medical Imaging and Healthlink HER Programs, John Hughes, A/Program Manager

image to be made available to any hospital throughout the State. Clinicians will be able to access images via the Electronic Medical Record (EMR).

5.1.4 Western Australia – WA PACS

Western Australia has a well established PACS/RIS solution bridging the 5 metropolitan tertiary hospitals. It now also incorporates imaging from multiple regional hospitals. Images are available from across the involved sites, with an archive dating back to 2004 [26].

The WA Country Health Service currently has limited one-way image transfer, and there is an intermediary server established for communication between the private and public jurisdictions (WARAD Server), which has been active since 2008. It handles several hundred cases per week.

5.2 Drivers

There are multiple different PACS in radiology practices throughout Australia which make it difficult for images to be transferred from one practice to another. This is especially true in the cases where a radiologist may need a prior image for comparison in order to obtain more information; to provide a better provisional diagnosis. This issue is especially difficult when private radiology practices need access to images from the public sector.

The need for delivering X-Rays and other images speedily is driving the need for state-wide PACS systems. This is an attempt to make the images available to the radiologist quickly and in an appropriate resolution for them to make a clinical decision. Quicker and more efficient access to images will ultimately improve workflow, resulting in better patient care.

A State-wide PACS could have the following perceived benefits:

- Clinician access to images which can be viewed simultaneously from multiple locations
- Reduced delay in reporting or better informed reporting
- Better measurement of the effectiveness of treatment, due to the availability of prior images
- Reduction in duplication of images or investigations ordered, having the added benefit of fewer radiation doses
- Fewer wasted appointments and postponed procedures due to the unavailability of prior images
- Better collaboration between clinicians of various disciplines leading to better communication and a better plan of care for the patient
- Future integration of PACS to patient records in Patient Controlled Electronic Health Records (PCEHR).

5.2.1 Points to consider

The main stumbling block for a State-wide PACS and a long term archive for image storage is the capital purchase cost and ongoing operational costs and upgrades.

To fully optimise the benefits of PACS and digital technology, full integration of PACS systems within a state will be required.

It is not clear as to who will absorb the costs for integrating existing PACS.

There may be significant performance problems in establishing accessible PACS covering a large jurisdiction. In particular ensuring that timely access

[26] Dr. Ashley Bennet, Clinical Lead NEHTA, Consultant Radiologist at the Perth Radiological Clinic, W.A.

to full diagnostic quality images is available with current hardware and infrastructure will prove challenging.

5.3 Private Sector

5.3.1 Current State

The majority of radiology practices in Australia have a PACS of varying size and degrees of sophistication.

5.3.2 Drivers

The advent of multi-slice CT over the last few years has made it impractical for a radiologist to report easily from film. Soft copy reporting on a PACS allows the radiologist to more rapidly view the whole data set. As more modalities transition to fully-digital and reporting becomes solely soft copy, it may become detrimental to work flow when prior images are received on film from elsewhere.

5.3.3 Points to consider

There is normally no requirement by Medicare for a radiology provider to retain images, however state and territory legislation and professional guidelines can require the retention of imaging records for certain periods. State Health Departments often keep images for many years.
Investment in PACS is a significant cost, and radiology providers often use capital purchase or a fee-per-study basis appropriate for their own business arrangements to gain access to PACS benefits.
There is no Australian government funding for PACS or associated technology and infrastructure to enable interoperability.

5.4 Radiology Information System (RIS)

Radiology Information systems have historically driven the PACS. There is a growing trend to fully integrate RIS and PACS.

Radiology information systems are commonplace in radiology departments; they are computerised database systems that have many functions including:

- Appointment booking, patient registration and scheduling
- Interfacing with the modalities via DICOM Modality Worklists
- Workflow management
- Request and document scanning
- Reporting and printout
- Results delivery via fax or email
- PACS workflow
- HL7 interfaces with PACS and/or Hospital information systems
- Billing
- Rules Engines.

6 Standards and Frameworks

6.1 Digital Imaging Communications of Medicine (DICOM)

With the introduction of Computed Tomography(CT) followed by other digital diagnostic imaging modalities in the 1970's and the increasing use of computers in clinical applications, the American College of Radiology (ACR) and the National Electrical Manufacturer's Association (NEMA) recognised the emerging need for a standard method of transferring images and associated information between devices manufactured by various vendors.

The DICOM standard [DICOM2006]:

- Allows transfer of digital images regardless of device manufacturer
- Promotes the development and expansion of picture archiving and communications systems (PACS) that can also interface with other systems of hospital information
- Specifies a general model for the storage of medical imaging information of removable media and provides a framework allowing the interchange of various types of medical images and related information on a broad range of physical storage media
- Supports operation in an off line media environment using industry standard media such as CD-R and MOD and logical file systems such as ISO 9660 and PC File System (FAT16)
- Specifies a standard display function for consistent display of greyscale images
- Allows the creation of diagnostic information data bases that can be interrogated by a wide variety of devices distributed geographically
- Supports operation in a networked environment using the industry standard networking protocol TCP/IP
- Specifies how devices claiming conformance to the Standard react to commands and data being exchanged
- Specifies security and system management profiles to which implementations may claim conformance
- Provides explicit information Objects not only for images and graphics, waveforms, reports, printing etc
- Though DICOM specified standards facilitate interoperability, it does not specify implementation details of any features of the Standard.

6.2 Health Level 7 (HL7)

HL7 Version 2.4 is a healthcare application protocol accredited as a Standard by the American National Standards Institute (ANSI). The Standard includes the data segments and data elements that are mandatory (required), optional or conditional (required, based on a condition). However in Australia it is important to note that a large proportion of organisations are using HL7 Version 2.3.x

Because of HL7's inbuilt flexibility, it is open to differences in interpretation in structure and format. The Standard is for use by Australian health authorities, providers of health services, pathology and medical imaging, health

institutions, health information technology vendors, health information technology consultants and health informatics community. [ASIHL72006][27]

Implementation of HL7 v2.4 for Medical Imaging outlines principles for:

1. General Order management- For example, each ordered test within the episode (as defined by the MBS) or request should have a unique Placer Order Number. The definition of a placer order number can be found in the document. All patient identifiers can be transmitted. Placer (the one who writes the request amongst other responsibilities) and filler (the one who receives the request, amongst other responsibilities) sites are specified uniquely by a code. This can make provision for national unique location identifiers in the future. Right now, it makes provision for local identifiers.
2. Providing structured clinical information with order- Clinical information can be provided in a structured form.
3. Medical Imaging Order management – This transaction is used by the Order Placer to place a new order with the Order Filler.

6.2.1 Messages in HL7

HL7 v2.4 defines several message types and their structural overview in its section 11, Communication Review.[28]

For example, when a message is sent from one system to another system, the first system expects a response message as acknowledgement of receipt of the message. There are other acknowledgement messages, such as the Order Response Message, which is an application acknowledgement message used to signify that the message has been processed by the Filler system.

6.3 Integrating the Healthcare Enterprise (IHE)

IHE is an implementation framework and is not a standard.

Standards such as HL7 and DICOM are vital and provide the tools that imaging services require, in order to create, store and send images and associated reports.

However, the standards are open to interpretation and do not delve into implementation details leaving room for optional variations. There has been cooperative effort between IHE and DICOM allowing for the latter's acceptance in user and vendor communities.

Systems developed in accordance with IHE [IHE2011] are meant to enable:

- Better communication between such systems
- Easier implementation
- More effective use of information by healthcare providers.

[27] p.4, Standards Australia, 2006

[28] ibis p. 32

7 Legislation

Australia's information privacy legislation gives individuals some control over the collection and handling of their personal information. It attempts to strike a balance between competing interests; that is, between the individual's right to privacy and the benefits of the free flow of information. Finding an appropriate balance between these interests is fundamental to the development of e-health in Australia.

Information privacy protection in Australia is legislated under various Commonwealth and state/territory statutes which overlap but are not identical. As a result, NEHTA's approach with regard to the Radiology work program will be by reference to principles that commonly apply under Commonwealth and state/territory statutes. NEHTA recommends that healthcare providers continue to exercise diligence and obtain independent legal advice to ensure that their operations meet the requirements specific to their jurisdiction

At a broader level, existing Commonwealth, state/territory legislation relating to information collection, security, access, use and disclosure, retention, trans-border data flows and anonymity, as well as Commonwealth legislation pertaining to the provision of health services and payments for such services apply to the activities of the diagnostic imaging sector. Moreover, Commonwealth and state/territory legislation on radiation safety and the usage of irradiating devices also extends to the diagnostic imaging sector. A list of applicable legislation is provided in Annexure 1 – note this is not an exhaustive list of relevant legislation. It does not cover common law.

8 Governance

The RANZCR Standards of Practice for Diagnostic and Interventional Radiology provide a structure suite of standards to support specialist practice in Diagnostic and Interventional Radiology in Australia and New Zealand.

The standards are outlined in Section 8 (Accreditation)

In November 2009, the Australian Commission on Safety and Quality in Health Care released the draft the National Safety and Quality Healthcare (NSQH) standards [NSQF2009][29]. They included:

- Governance for Safety and Quality in Health Service Organisations.
- Healthcare Associated Infection
- Medication Safety
- Patient Identification and Procedure Matching
- Clinical Handover.

Stakeholders strongly recommended additional standards in the areas of:

- Blood and Blood product safety
- Consumer engagement.

Work is underway to develop further three along with the above two recommendations. These are:

- Prevention and Management of Pressure Ulcers
- Recognising and responding to clinical deterioration
- Falls Safety.

The above standards have relevance to radiology. Most of the communication errors occur in the areas of patient identification and procedure matching and clinical handover.

8.1 The Australian Radiation Protection and Nuclear Safety (ARPANS) Act 1998

This is an Act [COMLAW2008] which applies within and outside of Australia; to regulate activities involving radiation and related purposes. The object of the Act is to protect the health and safety of people and to protect the environment from harmful effects of radiation.

8.1.1 Australian Radiation and Nuclear Safety Agency (ARPANSA)

ARPANSA is a Federal government agency, charged with the responsibility for protecting the health and safety of people and the environment for harmful effects of ionising and non-ionising radiation [ARPANSA2011]. One of the roles of ARPANSA is to provide accessible information to radiation related issues.

8.2 Patient Safety

The draft paper ‘Improving Quality and Safety by focusing care on patients and consumers’, Australia ranked highly in the demonstrating of a health care professional’s commitment to high quality care. [HSIP2000]

[29] P. 1-9, Australian Commission on Safety and Quality in Health Care, 2009

However, in 2008-2009, a large proportion of the complaints made to Australian healthcare commissioners were about health care professionals 'attitude and manner'. [MOW2010]

In 2009, the Australian Commission on Safety and Quality in Health Care (ACSQHC) released a proposed National Safety and Quality Framework [WSQHC2009] that identified 'patient focused care' as the first of three dimensions required for a safe and high quality health system in Australia.

The World Health Organisation (WHO) describes patient centred care as being related to 'responsiveness', which is intended to describe how a healthcare system meets people's expectations regarding respect for people and their wishes, communication between health workers and patients, and patient waiting times. [NSQF2009]

WHO advocates involving patients and carers as partners in initiatives to improve the safety and quality of care, particularly through its 'Patients for Patient Safety' (PFPS). WHO has established a global network of PFPS 'champions' including thirteen Australian 'champions', who work in partnership with health professionals and policy makers across the world to identify problems, design solutions and implement change.

The WHO paper references several other papers and studies indicating that patient centred care has many benefits which include decreased mortality, decreased emergency department return visits, fewer medication errors, lower infection rates, higher functional status, improved clinical care and improved liability claims experience.

8.2.1 Patient centred care in the Australian health system

8.2.1.1 Radiology Events Register[30]

The Radiology Events Register (RaER) is anonymous and confidential and is a means of improving the quality and safety of radiology. It is peer led and is available online. The project is funded by DoHA and managed by QUDI. It is a National Incident Reporting Database, it also contains case reviews and medico legal case reviews. The RaER is in its fifth year and has 4000 reported incidents. The data in RaER is being analysed and as per a presentation by Dr Catherine Mendel at the Diagnostic Imaging conference on patient safety[31], three main areas of error have emerged:

- Clinical handover, occurring every time a patient attends a radiology practice and covers all information to and from radiology
- Diagnostic error
- Critical Data checks, commonly about patient identification, correct side and site.

WHO [HSIP2000], states that one in three hundred patients are harmed in healthcare. Hence incident reporting is critical since it may stop a near miss becoming an adverse event or the similar situation happening again. It also enables patient care to be made safer by sharing information.

The RaER provides ongoing data analysis and has a continuing role in the radiology curriculum. It continues collaboration with other patient safety bodies and intends to publish its findings.

[30] Radiology Events Register (RaER), http://www.raer.org/

[31] Catherine Mandel, http://www.conferenceworks.net.au/apsf/pdf/downloads/Catherine%20Mandel%201.pdf

8.3 Best Practice

Quality Use of Diagnostic Imaging (QUDI) addresses the issues particular to quality service provision in diagnostic imaging. According to RANZCR QUDI [GUICDI2010], there is no other quality or safety program in Australia that has the people, the structure, or the professional and industry experience and support to do this effectively.

The QUDI program aims to promote the quality use of diagnostic imaging services that are:

- Essential, efficient, effective, safe and affordable procedures for optimal consumer health diagnosis, management and treatment
- Informed and determined by evidence based best practice guidelines for referral for diagnosis and treatment
- Supportive of consumer choice and empowerment
- Delivered by accredited practitioners using evidence based practice guideline
- Sustainable and viable within the national health system and health budget.

9 Accreditation

Under the Diagnostic Imaging Accreditation Scheme there are two levels of accreditation [DIASUG2010][32]:

- Accreditation against entry-level Standards
- Entry level Standards cover regulatory requirements concerning the licensing
- and registration of staff and equipment and radiation safety.

All practices must receive accreditation against the full suite of Standards within two years of obtaining accreditation against entry level standards in order to retain their accreditation.

Diagnostic Imaging Practices that registered for deemed accreditation prior to 30 June 2010 will have until the 30th of June 2011 to obtain as a minimum accreditation against entry level Standards.

From 1 July 2010 all practices providing Medicare eligible diagnostic imaging services are required to be accredited for those services, in order to retain Medicare eligibility.

9.1 Accreditation against the full suite of standards

Practices do not have to obtain accreditation against entry level Standards before applying for accreditation against the full suite of Standards.

Accreditation against the full suite of Standards has been available from 1 July 2010 for both non-accredited and entry level accredited Practices.

Practices that were accredited under Stage I of the Scheme, but had their accreditation withdrawn, will now need to apply for accreditation against the full suite of Standards.

Practices that were accredited under the Medical Imaging Accreditation Program (MIAP) can apply for and have their accreditation recognised against the full set of Standards. MIAP launched in 2004 and jointly administered by the royal Australian and New Zealand College of Radiologists (RANZCR) and the National Association of Testing Authorities Australia (NATA), offers accreditation through a peer review process to sites that demonstrate 'good practice' in accordance with the RANZR Accreditation Standards of Practice for Diagnostic and Interventional Radiology.

The recognition arrangements will grant accreditation under the Scheme through to the date of expiration of the recognised MIAP accreditation. By this date, Practices will need to provide their Accreditor with evidence of renewal of MIAP accreditation or have been granted accreditation against the full suite of Standards under the Diagnostic Imaging Accreditation Scheme.

The scheme[33] outlines requirements for:

1. Organisational Standards
    a) Safety and Quality Governance Standard
    b) Registration and Licensing Standard (Entry Level Standard)
    c) Radiation Safety Standard (Entry Level Standard)
    d) Equipment Inventory Standard (Entry Level Standard)
    e) Equipment Servicing Standard

[32] p. 10-30, DOHA, 2010

[33] ibid p.13

f) Infection Control Standard

2. Pre-Procedure Standards
    a) Provision of Service Standard
    b) Consumer Information Standard
    c) Patient Identification and Procedure Matching Standard
    d) Medication Management Standard
3. Procedure Standards
    a) Diagnostic Imaging Protocol Standard
    b) Technique Charts Standard
4. Post Procedure Standards
    a) Communication with Requesting Practitioners Standard
    b) Results of Self Determined Services Standard
    c) Consumer Feedback and Complaints Management Standard.

10 Overseas Diagnostic Imaging Interoperability Programs

The following highlights some of the major interoperability programs and their approaches.

10.1 Canada Health Infoway

Canada Health Infoway[34] is funded by the Government of Canada and operates as a not-for-profit organisation. Infoway works with the country's ten provinces and three territories to implement, private, secure EHR systems, enabling best practices and successful projects in one region to be shared or replicated in other regions.

Infoways Diagnostic Imaging investment program supports jurisdictional projects that will enable authorised healthcare providers to access and view diagnostic images regardless of where the image was created. To be fully effective, the new DI systems must be supported by modern digital technology (PACS). However, PACS systems are not always financially viable for small facilities so Infoway invests in projects that enable one hospital to act as a centralised PACS repository for other facilities in a region and jurisdiction.

As of September 2010, 24 such DI projects are either in the implementation stage, or complete and fully operational.

10.2 National Health System – England and Wales

PACS have been implemented throughout the UK [NSIRS2009][35], having been largely successful in individual hospitals. However, the implementation has resulted in isolated PACS with poor communication between systems in hospitals particularly between England and Wales. Time-consuming processes such as DICOM push, remote web access and CD encryption for non-emergency patients are required to get access to images and reports which are performed and issued in other NHS trusts.

There is a multi-vendor PACS environment across trusts consisting of National Application Providers, Local Service Provider (LSP) and legacy systems. Contractual arrangements to the Central Data Stores (CDS) through the LSP's did not include radiology image and report sharing. Other weaknesses included:

- Failure to realise the importance of Radiology Information Systems and importance of file sharing that integrated both reports and images
- Absence of data sharing standards such as IHE initiatives or HL7
- Lack of long term strategy on how radiology reports and images are to be integrated into the electronic patient record.

One of the principles that the Royal College of Radiologists (RCR) advocates for successful implementation of a data sharing strategy which will work and be cost effective is the use of vendor agnostic open systems. These allow for interoperability between RIS/PACS systems.

The College has a range of IT guidance documents for the radiology IT environment.

[34] Canada Health Infoway, http://www.infoway-inforoute.ca/ang-en/

[35] p. 2-4, Royal College of Radiologists, 2009

10.3 National Health System – Scotland

Scotland on the other hand has taken a different approach and implemented a common RIS/PACS solution across all 15 health boards consisting of 39 hospitals. The PACS project commenced in 2005 and has been successful in delivering seamless interoperability [CSH2005].

The main advantage achieved is speed, as soon as the images are taken they are available across the establishments along with previous history. Radiologists also have VPN links via their broadband connection into the NHS Net, easing the burden of on-call.

This success is seen as a key stepping stone towards the aim of NHS Scotland to develop a cross-country electronic patient record EPR.

Definitions

This section explains the specialised terminology used in this document.

Shortened Terms

This table lists abbreviations and acronyms in alphabetical order.

Term	Description
ACR	American College of Radiologists
ACSQHC	Australian Commission on Safety and Quality in Healthcare
AHP	Allied Health Professional
AMA	Australian Medical Association
ANSI	American National Standards Institute
ARPANSA	Australian Radiation and Nuclear Protection Agency
CC	Core Connectivity
CD-R	Compact Disc- Recordable
CDS	Central Data Stores
CI	Clinical Information
CR	Computerised Radiography
CT	Clinical Terminology
CT	Computerised Tomography
DI	Diagnostic Imaging
DICOM	Digital Imaging Communications of Medicine
DIST	Diagnostic Imaging Services Table
DoHA	Department of Health and Ageing
EHR	Electronic Health Record
EMR	Electronic Medical Record
EPR	Electronic Patient Record
HER	Health Electronic Record
HI	Health Identifiers
HL7	Health Level 7
HTML	Hypertext Markup Language
IHE	Integrating the Healthcare Enterprise
ICT	Information and Communication Technology
LAN	Local Area Network
LSP	Local Service Provider
LSPN	Location Specific Provider Number
MBS	Medicare Benefits Schedule
MIAP	Medical Imaging Accreditation Program
MOD	Magneto-Optical disc

Term	Description
MRI	Magnetic Resonance Imaging
NASH	National Authentication Service for Health
NATA	National Accreditation and Testing Authority
NEMA	National Electrical Manufacturers Association (USA)
NSQH	National Safety and Quality in Healthcare
PACS	Picture Archiving and Communication System
PCEHR	Personally Controlled Electronic Health Record
PET	Positron Emission Tomography
PFPS	Patients for Patient Safety
PMS	Practice Management System
QUDI	Quality Use in Diagnostic Imaging
RCR	Royal College of Radiologists (UK)
RaER	Radiology Events Register
RANZCR	Royal Australasian and New Zealand College of Radiologists
RIP	Radiology Informatics Program (QLD)
RIS	Radiology Information System
SIL	Service Instance Locator
SNOMED CT	Systemised Nomenclature of Medicine, Clinical Terminology
SPECT CT	Single Photon Emission Computed Tomography
TCP/IP	Transmission Control Protocol/Internet Protocol
UHI	Unique Healthcare identifiers
VPN	Virtual Private Network
WAN	Wide Area Network
WHO	World Health Organisation

Glossary

This table lists specialised terminology in alphabetical order.

Term	Description
Endpoint	Where a web service connects to the network. Source : http://www.looselycoupled.com/glossary/endpoint
Place Order Number	Order number belonging to the person or service that requests the order for an observation.
Interoperability	The ability of software and hardware on multiple machines from multiple vendors to communicate. Source: The Free On-line Dictionary of Computing. Denis Howe. 21 Apr. 2008. From: Dictionary.com – http://dictionary.reference.com/browse/Interoperability
Solutions Architect	The Solutions Architect is typically responsible for matching technologies to the problem being solved. Source : http://www.developer.com
Technical Architect	The technical architect is responsible for transforming the requirements into a set of architecture and design documents

Term	Description
	that can be used by the rest of the team to actually create the solution. Source : http://www.developer.com
Business Architect	A Business Architect is anyone looks at the way work is being directed and accomplished, and then identifies, designs and oversees the implementation of improvements that are harmonious with the nature and strategy of the organisation. Source : http://www.businessarchitects.org
Development Team	The Developer writes the code for the specifications that the Development leads provide. Source : http://www.developer.com

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[ACRT2002]	ACR Standard for Teleradiology	American College of Radiology, 2002	http://imaging.stryker.com/images/ACR_Standards-Teleradiology.pdf
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CAR2009	CAR Standards for Irreversible Compression in Digital Diagnostic Imaging within Radiology	Canadian Association of Radiologists	http://www.car.ca/uploads/standards%20guidelines/Standard_Lossy_Compression_EN.pdf
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[ESR2011]	Good practice for radiological reporting. Guidelines from the European Society of Radiology (ESR)	European Society of Radiology, Subcommittee on Audit and Standards, 2011	http://i3-journal.org/cms/website.php?id=/en/index/read/good_practice_for_radiological_reporting.htm
ESRUII2011	Usability of irreversible image compression in radiological imaging. A position paper by the European Society of Radiology (ESR)	European Society of Radiology	http://www.i3-journal.org/cms/website.php?id=/en/index/read/image_compression.htm
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[RANZCR]	The Royal Australian and New Zealand College of Radiologists (RANZCR)	RANZCR	http://www.ranzcr.edu.au
[RFDI2010]	Detailed review of funding of diagnostic imaging : discussion paper	Medical Benefits Reviews Task Force, Dept of Health and Ageing	http://www.health.gov.au/internet/main/publishing.nsf/Content/0E75EB77B33C1587CA2576A1008220CF/$File/Diagnostic%20Imaging%20Review%20Discussion%20Paper.pdf
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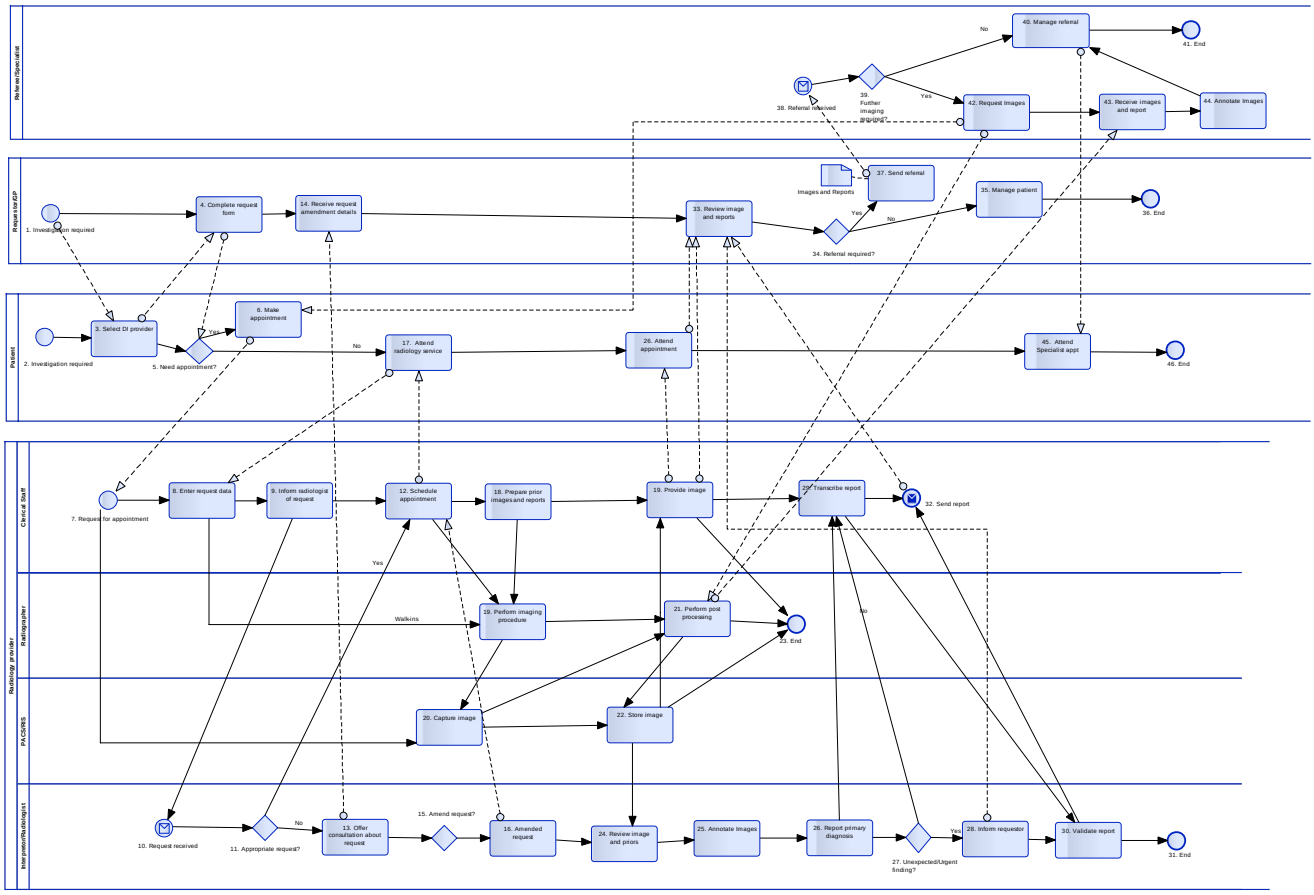
Appendix A: Business Process Models

A.1 Requestor to radiology provider



A.1.1 Business process description

1. Investigation required (requester) - The patient attends the requester and the requester deems that a radiological investigation is required.
2. Investigation required (patient)- The patient agrees that an investigation is required (in this case, an imaging investigation)
3. Select DI provider- The requester asks the patient if they have a preference for provider. However, the patient can change their mind and go to another provider irrespective of the name of the provider on the request.
4. Complete request form- The requestor completes the request form with clinical details and type of investigation required.
5. Need appointment? - The requester informs the patient that an appointment may or may not be required based on the type of imaging required. For Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and Ultrasound (US), for example, there is a need for the patient to make an appointment.
6. Make appointment- The patient contacts the provider for an appointment either by phone or in person.
7. Request for appointment- During this process, the clerical staff at the radiology provider confirms the patient's details which includes their name, address and test details any known allergies and any pacemakers, brain aneurysmal clips etc for MRI procedures. If there

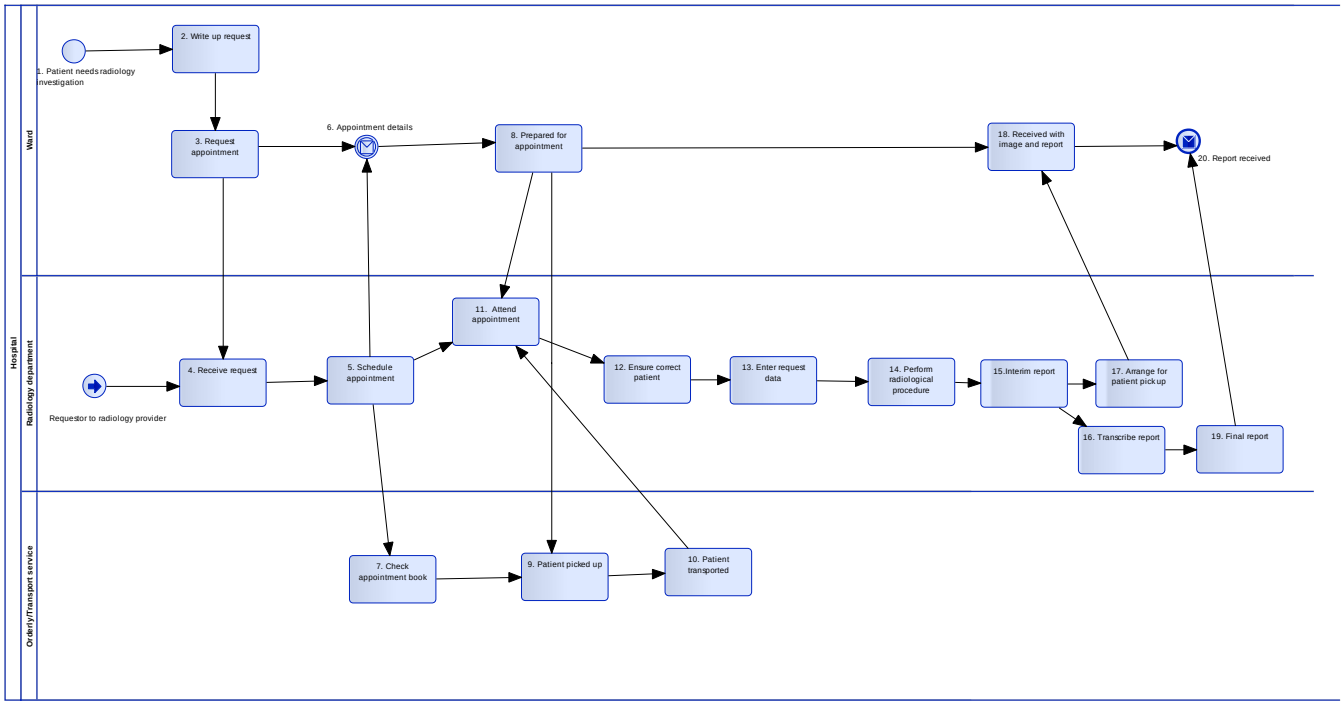
is a need for preparation for the test, at this time, the clerical staff will inform the patient on the phone and post the information.

8. Enter request data- The clerical staff enters the request data in the Radiology Information System (RIS).
9. Inform Radiologist of request- The clerical staff may inform the radiologist of the request. Practice protocol may deem this at the time of receipt of the request if received before the patient attends. Or at the time of the appointment if the request has not been received prior.
10. Request received- For imaging requests that the practice protocol deems that the radiologist must assess the request before the procedure. The request is presented to the radiologist by the clerical staff or the radiographer/sonographer.
11. Appropriate request? - The radiologist reviews the request to make a decision on the appropriateness of the request based on the clinical request and suspected diagnosis.
12. Schedule appointment- The radiologist deems the request and its details to be valid (type of test for the clinical condition) and sends an approval to the clerical staff to proceed with scheduling an appointment.
13. Offer consultation about request- If the request is not appropriate for any reason, the radiologist informs and consults with the requestor.
14. Receive request amendment details- The requester may receive request amendment details by phone or email.
15. Amend request? - If the patient is present the alternative (more appropriate) procedure (test substitution) will be offered to the patient. The patient may refuse due to cost or other reasons. If the patient is still at the requesters practice the requester will discuss the tests as advised by the radiologist.
16. Amended request- The radiologist proceeds to amend the request (usually the test details). This amended request is then sent to the clerical staff, who then, schedules an appointment with the patient if required.
17. Attend radiology service- The patient attends the radiology service if the appointment has been made over the phone.
18. Prepare prior images and reports - The patient may have brought their previous images and reports with them or if the provider stores images the clerical staff/radiographer will retrieve the appropriate prior images from the PACS if available.
19. Perform Imaging procedure- The radiographer performs the imaging procedure as per the request. It is possible that step 8 may lead to step 19 in case of a simple request and if the patient walks in.
20. Capture Image- The images are forwarded to the diagnostic workstation for post processing if required.
21. Perform post processing- The radiographer performs post processing such as display algorithms, measurements, annotations or 3D for example. The images are then forwarded to the PACS or appropriate server for reporting.
22. Store Image- The PACS server at the provider stores the post processed image(s).
23. End process- This is the end of the process for the radiographer.
24. Review Image and priors- The radiologist reviews the prepared image(s) and prior images if relevant to the imaging investigation carried out on the patient.

25. Annotate images-The radiologist may annotate an image to identify an area of interest or measure a lesion, for example.
26. Report Primary diagnosis- The radiologist may produce an interim report, if waiting for the results of a biopsy for example. The final report is definitive.
27. Unexpected/Critical finding? - An unexpected or critical finding is noted.
28. Inform Requester- If a finding is unexpected or critical the radiologist will phone the requester to advise of the findings and discuss the appropriate course of action.
29. Transcribe Report- The clerical staff transcribe the dictated report. Transcription of the report can sometime take considerable time and depends on resources available. Therefore the report is usually unavailable to the requestor immediately.
30. Validate report- The clerical staff send the transcribed report to the radiologist for validation. The radiologist validates the report and sends it back to the clerical staff for sending.
31. End process- The role of the radiologist ends here. However, the radiologist may receive phone or email enquiries about the report.
32. Send Report - Once the radiologist has verified and signed the report, the clerical staff at the radiology provider end the process by sending the report to the requester.
33. Review image and reports-The requester reviews report and images.
34. Referral required? - Based on the findings of the radiology exam, the requester decides if the patient needs a referral to a specialist.
35. Manage patient- If the patient does not need a referral, the requester manages the patient further based on the clinical condition.
36. End process- The process ends with ongoing or a one off treatment of the patient by the specialist.
37. Send referral- If referral to a specialist is required, the requester sends the referral to the appropriate specialist.
38. Referral received- The specialist (referee) receives the referral either by the patient directly or faxed. The specialist receives the images and request.
39. Further imaging required? - The specialist may be satisfied that the imaging is appropriate for the consultation and subsequent treatment or that further imaging is required.
40. Image display – The images received may not be in a format acceptable to the specialist
41. End process- The process ends with the specialist managing the patient as per their clinical condition.
42. Request images- If there is a need for further images, the specialist requests further images. The patient may have to start for step 6 again this could take several days. This step may also be done because, for some examinations such as certain MRIs, can only be requested by a specialist and reimbursed by Medicare
43. Receive images and report- The specialist receives the images and report associated with the image.
44. Annotate images- The specialist may annotate the images prior to surgery or treatment. If for example the radiology provider still has the raw data for the examination, further post processing or manipulation may be possible without the need for the patient to be re-x-rayed.

45. Attend specialist appointment- The patient attends the appointment with the specialist.
46. End process- The process ends with the patient being treated appropriately by the specialist as per their clinical condition.

A.2 Radiology within a hospital

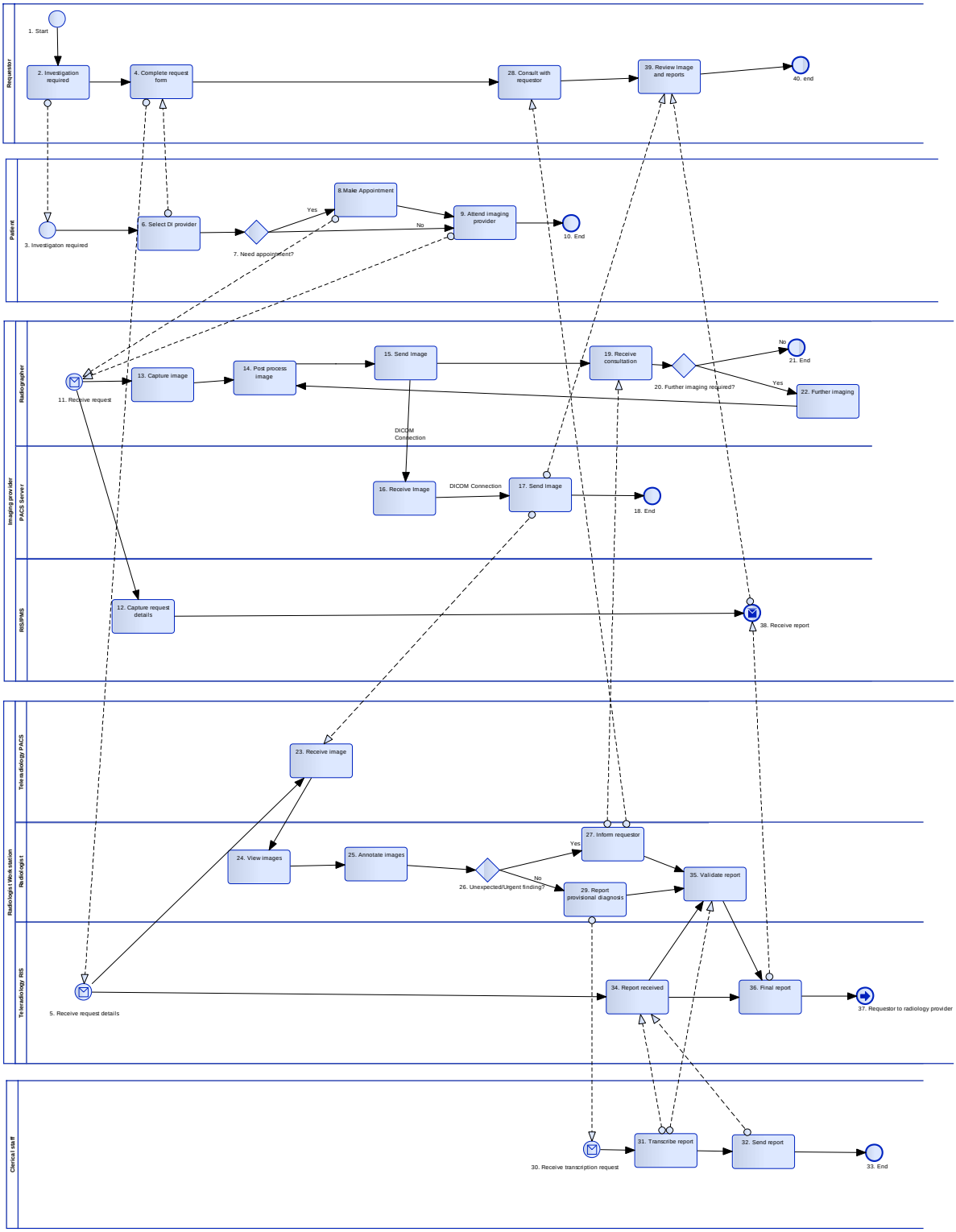


A.2.1 Business process description

1. Patient needs radiology investigation- On daily rounds, it is determined that the patient needs a radiological exam.
2. Write up request- The resident/registrar writes up a radiology request which includes the patient's demographic details and clinical history. The request also explains the reason for the radiological examination.
3. Request appointment- The nurse in the ward/resident requests an appointment with the radiology department. This is done over the telephone.
4. Receive request- The radiology department receives a request for appointment for the exam. At this point, the person who answers the phone (usually the radiographer) takes down the name of the patient, UR number and the type of exam.
5. Schedule appointment- The radiographer schedules an appointment time and date. If there is any specific preparation required for the exam, the radiographer lets the requestor know.
6. Appointment details- The details of the appointment are made known to the clinical staff on the ward (usually the nurse)
7. Check appointment book- The orderly/transport service checks the appointment book for details of the patient, ward to be collected from and the time.
8. Prepared for appointment- The patient is prepared for the radiological exam. This includes collecting all medical notes including recent observations, checking for patent Intravenous line pathology reports and any previous films. If the procedure requires the patient to have a checklist, it is filled in.
9. Patient picked up- The orderly picks up the patient from the ward/ICU.
10. Patient transported- The patient is transported to the radiology department. In cases where the patient needs an ECG monitor, ventilators or other life saving equipment, the patient is accompanied by the nurse.

11. Attend appointment- The patient is escorted to the radiology department with or without a nurse. Depending on local hospital business rules, the patient is escorted by the nurse. If for example, they need oxygen therapy, have impaired level of consciousness, are on intravenous drugs or are being monitored.
12. Ensure correct patient- The radiographer/nurse determine the identity of the patient by checking against the name band, the label on the request form and with the patient. At this time, the patient may also be asked about the nature of the radiological examination they are going to have and answer any questions they may have. The nurse from the ward hands over the patient and goes through the checklist (if any). If there is no nurse in the radiology department, it may be expected of the nurse escort from the ward to administer any medications or dye if required.
13. Enter request data- The radiographer/nurse/receptionist enters data into the Radiology Information System (RIS).
14. Perform radiological procedure- The radiographer/sonographer/nm technologist performs the procedure.
15. Interim report- The radiologist prepares an interim report. This is usually a note in the patient's papers. It may be followed by a phone call to the requestor especially if the finding initiates a new course of treatment.
16. Arrange for patient pick up- The radiographer calls the transport staff and/or the nurse from the ward to pick up the patient.
17. Transcribe report- The clerical staff transcribe the report.
18. Final report- The radiologist reads through the report and validates it making it final.
19. Received with image- The ward nurse receives the patient, gets a clinical handover, the images and the medical records. The report usually does not accompany the image.
20. Report received- The report is received by the ward receptionist/nurse and filed in the patient's file.

A.3 Teleradiology



A.3.1 Business process description

1. Start process
2. Investigation required- The process starts with a need for a radiology investigation. The imaging provider receives a request with the patient details, patient history and need for the radiological investigation.
3. Investigation required- The requestor discusses with the patient about the need for an investigation and the patient consents to the procedure.

4. Complete request form- The requestor completes the request form putting in requestor details, patient details, clinical details and reason for investigation.
5. Receive request details- The teleradiology Radiology Information System (RIS) receives request details (which may be derived from the DICOM header if no request form is present).
6. Select DI provider- The patient selects the DI provider at the time the request is being filled out or after doing some research on available DI providers within close proximity.
7. Need appointment- Based on the type of investigation required, the requestor advises the patient that an appointment may be required.
8. Make appointment- If an appointment is required, the patient calls the DI provider and makes an appointment.
9. Attend imaging provider- The patient attends the imaging provider either as a walk in or as an appointment.
10. End process.
11. Receive request- the radiographer receives the request either before or usually when the patient presents for the procedure.
12. Capture request details- The RIS/PMS
13. Capture Image- The imaging modality (CT Scanner, MRI) captures the requested image.
14. Post process image- The radiographer performs post processing such as display algorithms, measurements, annotations or 3D for example. The images are then forwarded to the PACS or appropriate server for reporting.
15. Send Image- The radiographer makes the image available on the PACS. The process shown is by 'sending the image' and the PACS receiving the image.
16. Receive Image- The PACS server has the images ready to be accessed by the radiologist.
17. Send Image- The PACS server sends the image via a DICOM connection to the teleradiology PACS.
18. End process
19. Receive consultation- The radiographer may receive consultation advice if the radiologist has seen the images. This advice may be related to sending more images from the raw data before post processing or decide if further imaging is required.
20. Further imaging required?- The radiologist and radiographer decide if further imaging is required. In some situations, the patient may still be at the imaging provider and it may be possible to re-image them
21. End process - if there is no need for further imaging
22. Further imaging- If there is need for further imaging, it is done, assuming that the patient is available. This then goes back to step 14.
23. Receive image- The teleradiology PACS receives the image.
24. View Images- The radiologist views the available images.
25. Annotate images- The radiologist may annotate an image to identify an area of interest or measure a lesion, for example.
26. Unexpected/Urgent finding?- The radiologist examines the image and decides if the finding is unexpected or urgent; or worth notifying the requestor immediately.

27. Inform requestor - The requestor is informed by the radiologist of the unexpected or urgent finding. The radiologist may offer advice of the need for further investigations, if any.
28. Consult with radiologist- The requestor consults with the radiologist as described in step 27.
29. Report provisional diagnosis- The radiologist makes a provisional report and sends a transcription request to the clerical staff who may be within or outside Australia.
30. Receive transcription request- The process for the clerical staff starts with a request for a transcription request.
31. Transcribe Report- The clerical staff transcribe the report.
32. Send report- The clerical staff send the report to the teleradiology RIS.
33. End process.

A.4 DI stakeholders

Royal Australasian College of Surgeons	RACS
Royal Australian College of GP's	RACGP
Royal Australian and New Zealand College of Radiologists	RANZCR
Cardiac Society of Australia and New Zealand Cardiac Imaging Council	CSANZ
Royal Australian College of Obstetricians and Gynaecologists	RANZCOG
Australian Institute of Radiography	AIR
Medical Software Industry Association	MSIA
Australian Information Industry Association	AIIA
Royal Australian College of Physicians	RACP
Australian Dental Association	ADA
Integrating the Healthcare Enterprise	IHE Australia
Rural Doctors of Australia	RDAA
Quality Use of Diagnostic Imaging	QUDI
Australian Diagnostic Imaging Association	ADIA
Australian Orthopaedic Association	AOA
BreastScreen Australia	BSA
Department of Health and Ageing associated branches and committees	DoHA
Therapeutic Goods Association	TGA
Australian Radiation Protection and Nuclear Safety Agency	ARPANSA
Australian Healthcare Messaging Laboratories	AHML
Australian Sonographers Association	ASA
Australian Physiotherapy Association	APA
Australian Osteopathic Association	AOA
Chiropractors Association of Australia	CAA
Australian Podiatry Council	APODC
Australian Society for Ultrasound in Medicine	ASUM
Australian College of Physical Scientists and Engineers in Medicine	ACPSEM
College of Biomedical Engineering	
Consumers	
NSW Health	
NT Health	
ACT Health	
Tasmania Health	
QLD Health	
SA Health	
WA Health	
Vic Health	
Standards Australia	
HL7 Australia	