FRANCIS HEALTH

NSW Ministry of Health

Medical Radiation Sciences - Horizons Scanning and Scenario Generation Report

July 2018

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1 Executive Summary

The purpose of this document is to outline the methodology, approach and themes raised by the literature and medical radiation science stakeholders to inform the Workforce Modelling phase (Stage C in Figure 1 below) of the NSW Ministry of Health's Workforce Planning Methodology. It should be noted that the views expressed in the report are not necessarily those of the NSW Ministry of Health.

The Medical Radiation Sciences (MRS) Horizons Scanning and Scenario Generation Project is driven by the NSW Health *Health Professionals Workforce Plan 2012-22* (the Plan), which sets out the framework for addressing the workforce implications of increasing demand for health services in NSW. The Plan establishes that simply increasing staffing without considering changing workforce practices and introducing more efficient and effective models of care is unsustainable.

The Plan outlines that the Workforce Planning and Development Branch (WPD) is responsible for developing and modelling projections for the Allied Health workforce in line with forecast health service delivery requirements.

In December 2017, there were 16,150 registered MRS practitioners in Australia with 33% working within NSW.

There are three professions which make up the MRS workforce:

1. Diagnostic radiographers
2. Nuclear medicine technologists
3. Radiation therapists.

All three professions are integral to the delivery of high quality diagnoses and patient treatment. The MRS Workforce Horizons Scanning and Scenario Generation Project (the Project) supported stakeholders in their respective professions to participate in the development of a driver model that articulates key demand and supply drivers for the MRS workforce in NSW.

Whilst the driver model developed considers high level factors that will impact on the overall MRS workforce, this report also articulates some of the unique differences between each of the professions and what they view as key challenges and priorities.

Demand drivers may be defined as factors that shape and influence demand for a workforce's services. This Project identified several demand drivers for the MRS workforce including service pathways and referrals, changing population demographics, government funding and policy, technology and innovation, service awareness, and service coverage and accessibility.

Supply drivers may be defined as factors that contribute to the availability, sustainability and size of the workforce. Several supply drivers were identified for the MRS workforce including training and availability of placements, profile of the profession, career pathways and continuing professional development, workforce retention in rural and remote areas and funding of public medical radiation sciences roles.

The purpose of this document is to outline the methodology, approach and findings of the project to inform workforce modelling activities as part of the NSW Ministry of Health's Workforce Planning Methodology.

2 Introduction

The MRS Horizons Scanning and Scenario Generation project is driven by the NSW Health *Health Professionals Workforce Plan 2012-22* (the Plan), which sets out the framework for addressing the workforce implications of increasing demand for health services in NSW. The Plan establishes that workforce planning requires consideration of changing workforce practices and the emergence of more efficient and effective, but increasingly more complex, models of care. The Plan outlines that the Workforce Planning and Development Branch (WPD) is responsible for developing and modelling projections for the Allied Health workforce in line with forecast health service delivery requirements.

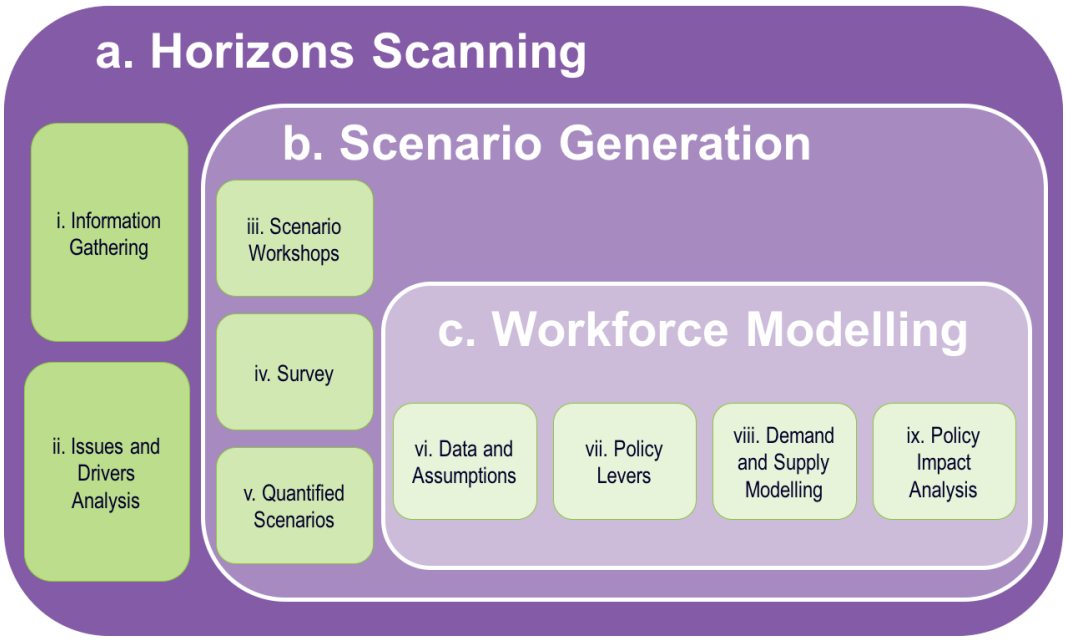
The Horizons Scanning and Scenario Generation Project offered an opportunity for stakeholders in the MRS workforce to participate in the development of a short, medium and long-term vision for their field. In developing this vision, several system-wide influencing factors require consideration, including (but not limited to):

- The need to shift the provision of service from an institutional focus, towards a patient-centric model
- An increasing focus on Activity Based Management, encouraging services to consider more efficient models of care, such as community-based settings
- Impacts of Information and Communication Technology (ICT) on MRS roles, how technology supports the workforce, it's capabilities and challenges with access, and the overarching state-wide eHealth NSW ICT strategies
- An emphasis on collaborative, multidisciplinary teams across care settings and balancing health profession specialisation with generalisation to address the increased demand for care, particularly amongst patients with chronic and complex conditions and cancer
- A need to consider the geographic distribution of workforce to align with changing population demographics and health needs
- Broader NSW wide and national programs and priorities, for example the NSW Premier's Priority in relation to Emergency Treatment Performance and national cancer screening programs.

The purpose of this document is to outline the methodology, approach and themes raised by the literature and medical radiation science stakeholders to inform the Workforce Modelling phase (Stage C in Figure 1 below) of the NSW Ministry of Health's Workforce Planning Methodology. It should be noted that the views expressed in the report are not necessarily those of the NSW Ministry of Health.

The Horizons Scanning and Scenario Generation phases are set out in the Ministry of Health workforce planning methodology represented in Figure 1.

Figure 1: Ministry of Health Workforce Planning Methodology



2.1 Methodology

The methodology used to conduct the Project comprised of two components: an information gathering phase, and an issue and driver analysis phase.

Different approaches were used in each phase to draw out relevant information as described below.

2.1.1 Literature search and review

An initial literature search was conducted within Google Scholar, which was used as the foundation of a literature review. To augment the initial findings, a comprehensive search of organisational and grey literature was undertaken. Key words relevant to the MRS workforce professions were identified and utilised. Major databases, including Wiley Online, JSTOR and MEDLINE, were accessed to supplement the search results. Recent publications were prioritised, and available published data were considered.

Literature published outside of NSW and Australia were also utilised, including summaries of studies conducted in the United Kingdom, United States of America and other parts of Europe. Whilst the health systems in the United States and Europe are different to the Australian system, some of the social studies remain relevant.

2.1.2 Stakeholder online survey

An online survey was designed and distributed to Local Health District (LHD) and Specialty Health Network (SHN) nominated MRS stakeholders from across the three professions as well as representatives from academic institutions and professional bodies. The survey contained a series of questions relating to the workforce demand and supply drivers, in addition to the potential challenges and opportunities faced by the workforce. The questions were informed by the initial findings of the literature review. Stakeholders were required to identify the level of significance of the drivers, challenges and opportunities in addition to prioritising them based on the perceived level of impact.

2.1.3 One-to-one stakeholder interviews

A small series of one-to-one interviews were conducted in parallel with the online survey. These interviews provided an opportunity for a 'deeper dive' into what stakeholders perceived to be key workforce drivers, challenges and opportunities. Combined with the online survey and literature review, conclusion of the interviews completed the information gathering stage and provided a focused framework for development of the horizons scanning and scenario generation workshops.

2.1.4 Horizons scanning workshop

The horizons scanning workshop was conducted on the 7th February 2018 and formed the basis for the development of a supply and demand driver model for the MRS workforce. Some of the drivers identified by stakeholders were unique to their individual profession and have been captured throughout this report as such.

Key MRS stakeholders representing LHDs, SHNs, NSW based universities and representatives from professional bodies – including the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT), the Australia and New Zealand Society of Nuclear Medicine (ANZSNM) and Indigenous Allied Health Australia (IAHA) – participated in the workshop and as a group identified overarching workforce demand and supply drivers. A list of the stakeholders engaged throughout this project and that attended both workshops is available in the *Appendices.*

Validation of the high-level drivers identified in the literature review combined with those raised by stakeholders in the workshop informed the initial development of the MRS driver model to be validated at the subsequent scenario generation workshop.

2.1.5 Scenario generation workshop

The scenario generation workshop was conducted on the 7th March 2018 and built upon themes that were explored in the horizons scanning workshop. To maintain consistency in the methodology, the same horizons scanning workshop participants were engaged.

The workforce driver model was presented to further validate what was emerging as the key demand and supply drivers for the MRS workforces. Stakeholders were invited to validate the concepts contained within the MRS workforce driver model. They were also asked to consider the key differences and prioritisations within the driver model for their individual profession. At this point it became apparent there were agreed overarching drivers for the MRS workforces but also some unique ones. In addition, stakeholders explored a series of future scenarios to determine their plausibility, potential impacts on the workforce and the method by which the workforce aimed to address them.

2.1.6 Profession-specific focus groups

Three profession specific focus groups were conducted on 17th and 18th May 2018 to explore:

- The unique issues that apply to each component of the driver model for the three professions
- The referral pathways to the services offered by each profession to further understand how they are accessed and key constraints impacting on workforce demand and supply

- The training pathways available to each profession.

The findings of the research activities discussed above are detailed in the Medical Radiation Sciences Horizons Scanning and Scenario Generation Report (this document).

The purpose of this document is to outline the methodology, approach and findings of the project from the literature and themes raised by stakeholders to inform the Workforce Modelling phase of the NSW Ministry of Health's Workforce Planning Methodology.

3 Overview of the Workforce

This section details the scope of practice for each of the three professions in the MRS workforce, and the roles and functions of the relevant professional boards and bodies.

3.1 Scope of Practice

There are three professions which make up the MRS workforce in NSW. Each professions' scope of practice differs, with roles and responsibilities as detailed below.

3.1.1 Diagnostic radiographer

A diagnostic radiographer is responsible for the production of medical images that assist specialists and practitioners to describe, diagnose, monitor and treat a patient's injury or illness. The medical equipment used in this practice is highly technical and involves state of the art technology (Australian Society of Medical Imaging and Radiation Therapy, 2017).

Diagnostic radiographers can train in specialised areas such as:

- Trauma radiography, which usually involves working in emergency departments
- Mobile radiography, which involves using special machines for patients who are too sick to travel
- Computed tomography (CT) scans
- Magnetic resonance imaging (MRI) scans
- Fluoroscopy – an X-ray test that examines the internal body and shows continuous moving images
- Angiography – imaging of blood vessels and the heart
- Working in operating theatres to assist surgeons with special X-ray equipment during operations (The Royal Australian and New Zealand College of Radiologists, 2017).

3.1.2 Radiation therapist

A radiation therapist works as part of a multi-disciplinary team that manages a patient's cancer treatment. They are responsible for the overall planning and delivery of the radiation dose prescribed by the radiation oncologist. They will administer the treatment using advanced medical technology.

A radiation therapist's tasks include:

- Patient assessment including psychosocial issues
- Patient positioning and immobilisation
- Patient education and advocacy
- Manufacture/construction of ancillary equipment
- Simulation, including tumour localisation, treatment planning and dosimetry
- Treatment by superficial to megavoltage external beams and verification
- Imaging for planning and treatment verification purposes
- Mentoring, clinical reasoning and research and education, for both patients and staff

- Quality assurance and quality improvement (Australian Society of Medical Imaging and Radiation Therapy, 2018).

3.1.3 Nuclear medicine technologist

A nuclear medicine technologist is a trained specialist that works with a nuclear medicine physician in administering minute radioactive material to patients to detect and treat cancer, brain and immunity system diseases (Australian and New Zealand Society of Nuclear Medicine, 2017).

A nuclear medicine technologist is qualified to perform the following:

- General nuclear medicine procedures
- Nuclear cardiology procedures
- Nuclear breast procedures
- Positron Emission Tomography (PET) procedures
- CT attenuation correction and localisation at entry level (SNMMI-TS Scope of Practice Task Force, 2017)

3.2 Professional Boards and Bodies

The following section outlines the professional boards and bodies that oversee and represent the professions that make up the MRS workforce.

3.2.1 Medical Radiation Practice Board of Australia

The Medical Radiation Practice Board of Australia (MRPBA) is responsible for registering and developing guidelines for each of the three MRS professions. The functions of the MRPBA are as follows:

- Developing standards, codes and guidelines for the MRS workforces
- Approving accreditation standards and accredited courses of study
- Registering medical radiation practitioners and students
- Handling notifications, complaints, investigations and disciplinary hearings
- Assessing overseas-trained practitioners who wish to practise in Australia (Medical Radiation Practice Board of Australia, 2017).

3.2.2 Australian Health Practitioner Regulation Agency

The Australian Health Practitioner Regulation Agency (AHPRA) works in partnership with 14 National Health Practitioner Boards to implement the National Registration and Accreditation Scheme, under the Health Practitioner Regulation National Law across Australia. The MRPBA is one of the National Boards that AHPRA works with to uphold the values set out in the Health Profession Agreement (Australian Health Practitioner Regulation Agency, 2017).

3.2.3 The Australian Society of Medical Imaging and Radiation Therapy

The Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) is the peak body representing medical radiation practitioners in Australia. The aim of the body is to promote, encourage, cultivate and maintain the highest principles of practice and proficiency

of medical radiation science, and always being mindful that the welfare of the patient should be at the centre of everything they do. Their mission is 'to empower medical radiation practitioners for the health of all Australians'. (Australian Society of Medical Imaging and Radiation Therapy, 2018).

3.2.4 Australian and New Zealand Society of Nuclear Medicine

The Australian and New Zealand Society of Nuclear Medicine (ANZSNM) is one of the oldest professional societies for those practicing in the field of nuclear medicine in Australia and New Zealand. The society's objectives are to support and encourage professional, technological and scientific development for people involved in the field of nuclear medicine (Australian and New Zealand Society of Nuclear Medicine, 2017).

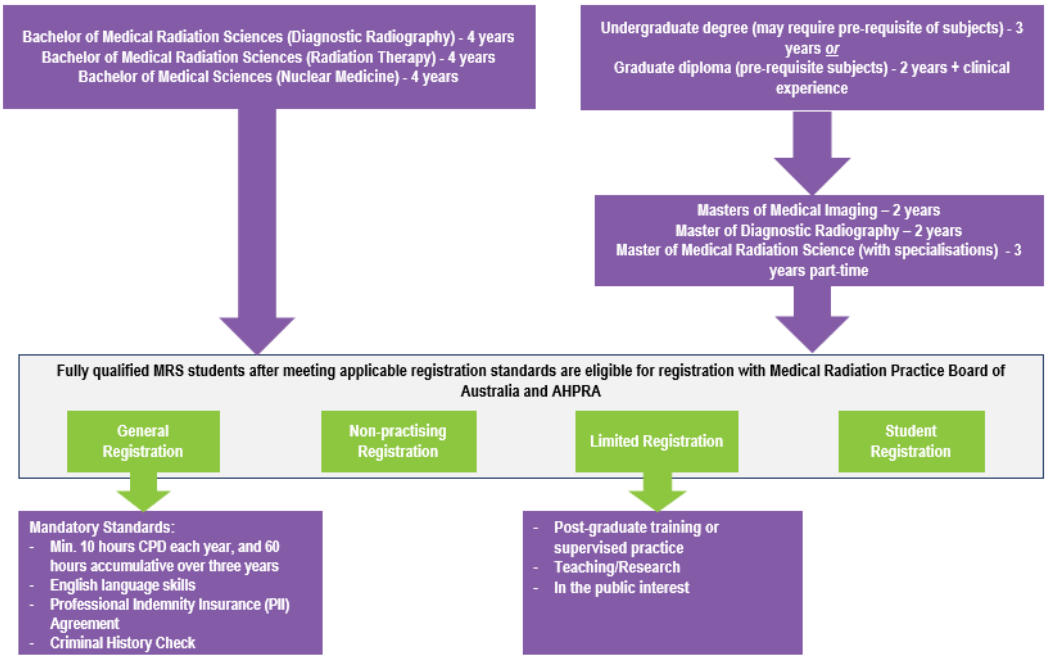
3.3 Entry to the Profession

For the purposes of this project, the MRS workforce is limited to one of the three following professions: radiation therapists, diagnostic radiographers, and nuclear medicine technologists. This is consistent with the *Health Employees' Medical Radiation Scientists (NSW State) Award 2017*.

All three professions are registered by the MRPBA once successful completion from an approved course of study. Approved programs of study in NSW are included in the *Appendices*.

The accredited program of study can either be a four-year full-time equivalent program at Bachelor or Honours level, or a two-year program full-time equivalent program at graduate-entry Masters' level (Medical Radiation Practice Board of Australia, 2017). Figure 2 below depicts the pathways for entry to the MRS professions.

Figure 2: Pathways for entry to the Medical Radiation Sciences professions



The Bachelor level degrees were previously a three-year university course – the last pool of graduates from the three-year degrees entered the workforce in 2018 and from 2019, all graduates will have completed a four-year degree.

3.4 Workforce Characteristics

The following section details the key workforce characteristics for the MRS professions.

3.4.1 National MRS workforce characteristics

In the December 2017 statistics published by the MRPBA, the MRS workforce compromised of:

- 16,150 registered MRS practitioners across Australia
- A gender distribution of 68% female and 32% male
- The age range in which most MRS practitioners were employed was 25-29 years of age (19%) closely followed by 30-34 (18%)
- 33% of the workforce is based in NSW, whilst the Northern Territory had the lowest number of practitioners with less than 1% (Medical Radiation Practice Board of Australia, 2018).

The distribution of MRS professionals across Australia is highlighted in Table 1 and Table 2 below. If a registrant has not defined a place of practice, they are represented in the category 'No Principle Place of Practice (No PPP)'.

Table 1: Registration type and subtype by principal place of practice

Registration Type	Subtype	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	No PPP	Total
General		271	5,022	96	3,243	1,174	320	3,691	1,317	244	**15,378**
Provisional		4	275	5	53	1	4	168	5	1	**516**
Limited	**Postgraduate training or supervised practice**					1				1	**2**
Non-practising		5	65	2	24	14	5	87	18	34	**254**
Total		**280**	**5,362**	**103**	**3,320**	**1,190**	**329**	**3,946**	**1,340**	**280**	**16,150**

Table 2: Profession division by principal place of practice

Divisions	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	No PPP	Total
Diagnostic Radiographer	197	4,104	90	2,597	958	246	2,962	1,091	220	**12,465**
Diagnostic Radiographer & Nuclear Medicine Technologist		2		10	1	1	1	2		**17**
Diagnostic Radiographer & Radiation Therapist				1			1			**2**
Nuclear Medicine Technologist	24	466	2	176	79	16	350	67	19	**1,199**
Radiation Therapist	59	790	11	536	152	66	632	180	41	**2,467**
Total	**280**	**5,362**	**103**	**3,320**	**1,190**	**329**	**3,946**	**1,340**	**280**	**16,150**

The MRS registrant age distribution across Australia is depicted in Figure 3 and Table 3 below. The under-35 age group represents the largest portion of MRS registrants overall, as well as across all three professions.

Figure 3: MRS Registrant Age Distribution

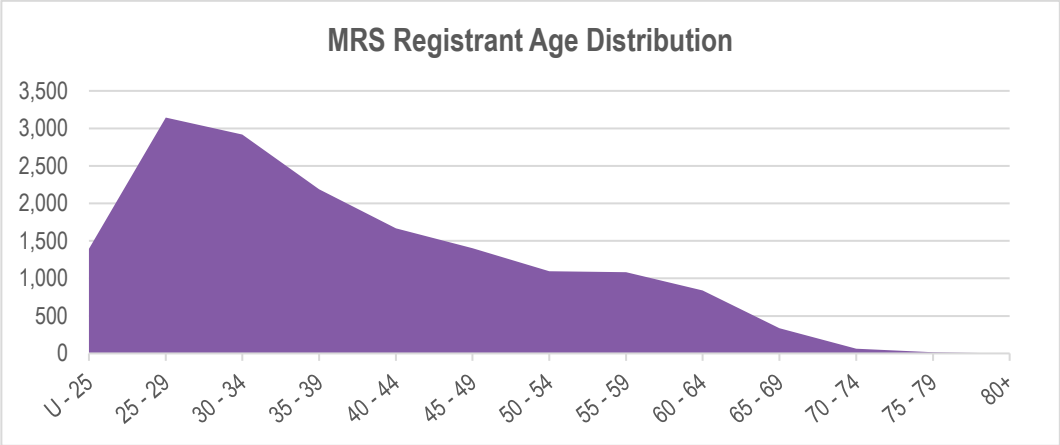


Table 3: MRS Registrant Age Distribution by Profession

Age group	Diagnostic Radiographer	Nuclear Medicine Technologist	Radiation Therapist	Diagnostic Radiographer and Nuclear Medicine Technologist	Diagnostic Radiographer and Radiation Therapist	Total
U - 25	1,022	159	214			**1,395**
25 - 29	2,395	258	490	1		**3,144**
30 - 34	2,116	224	579			**2,919**
35 - 39	1,620	176	386	4		**2,186**
40 - 44	1,264	128	273	3	1	**1,669**
45 - 49	1,108	98	193	5	1	**1,405**
50 - 54	922	57	115	2		**1,096**
55 - 59	908	42	132	2		**1,084**
60 - 64	724	45	69			**838**
65 - 69	312	9	15			**336**
70 - 74	59	2	1			**62**
75 - 79	14	1				**15**
80+	1					**1**

Figure 4 below shows the gender distribution of the MRS workforce across all Australian states and territories.

Figure 4: Gender distribution of the MRS workforce by principal place of practice

Gender	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	No PPP	Total
Female	65.0%	67.5%	62.1%	67.1%	73.8%	69.9%	67.3%	68.4%	77.1%	**68.0%**
Male	35.0%	32.5%	37.9%	32.9%	26.2%	30.1%	32.7%	31.6%	22.9%	**32.0%**

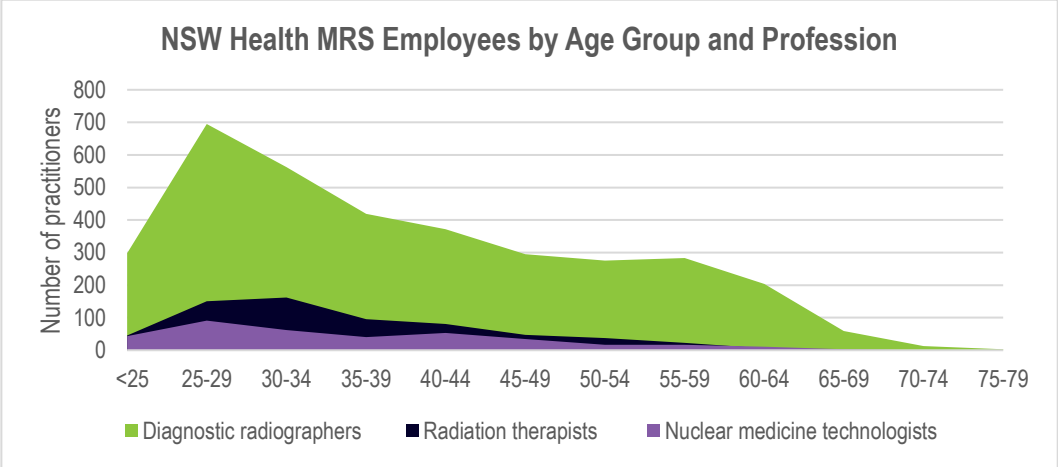
MRS professionals that identified as being of Aboriginal or Torres Strait Islander descent accounted for 0.4% (60 practitioners registered with MRPBA) of the MRS workforce nationally (Indigenous Allied Health Australia, 2018).

3.4.2 NSW MRS workforce characteristics

The MRS workforce in NSW Health is comprised of:

- A total of 2,328 MRS practitioners employed in NSW Health across the three professions
    - 1,710 diagnostic radiographers
    - 460 radiation therapists
    - 158 nuclear medicine technologists
- The gender distribution is 65% female and 35% male
- Most MRS practitioners were aged under 35 across all the three professions, as depicted in Figure 5.

Figure 5: NSW Health MRS Employees by Age Group and Profession



The figures below depict the distribution across each of the three professions employed by NSW Health across the grades stipulated in the NSW Health Award, their position type (full-time, part-time or casual) and gender.

Figure 6: NSW Health Diagnostic Radiographers – By Level and Position Type

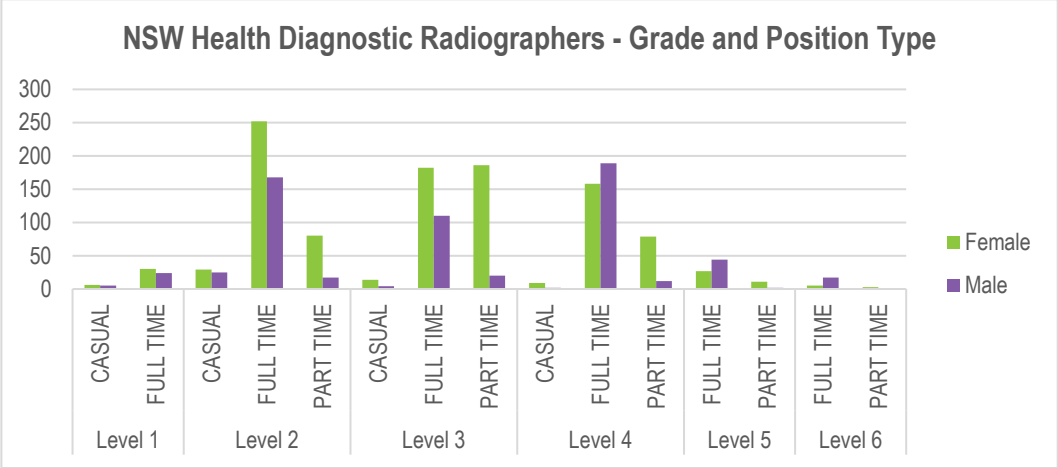


Figure 7: NSW Health Nuclear Medicine Technologists – By Level and Position Type

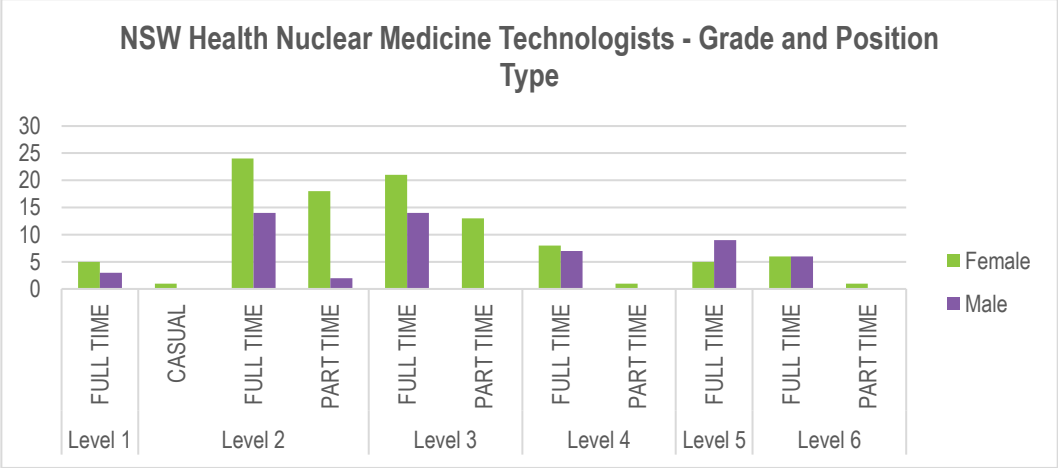
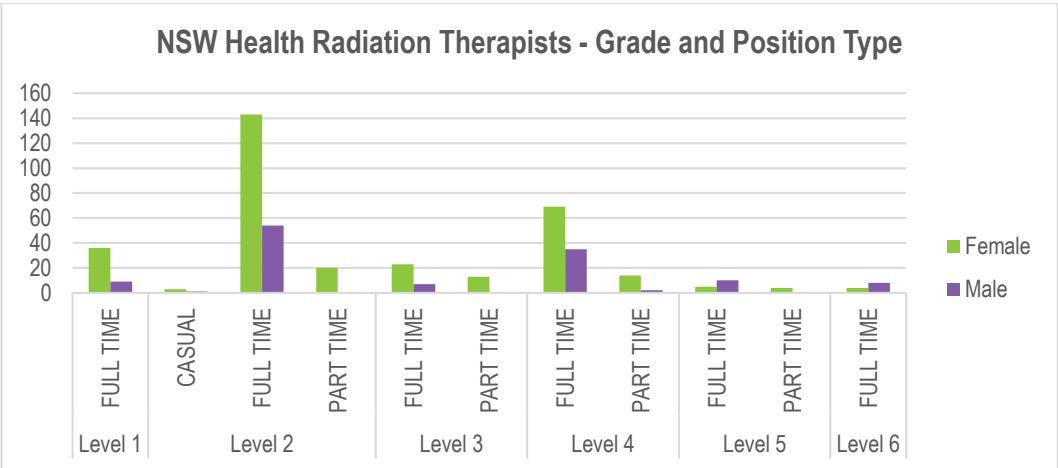


Figure 8: NSW Health Radiation Therapists – By Level and Position Type



(Figures: NSW Ministry of Health)

3.4.3 Geographical distribution of the NSW workforce

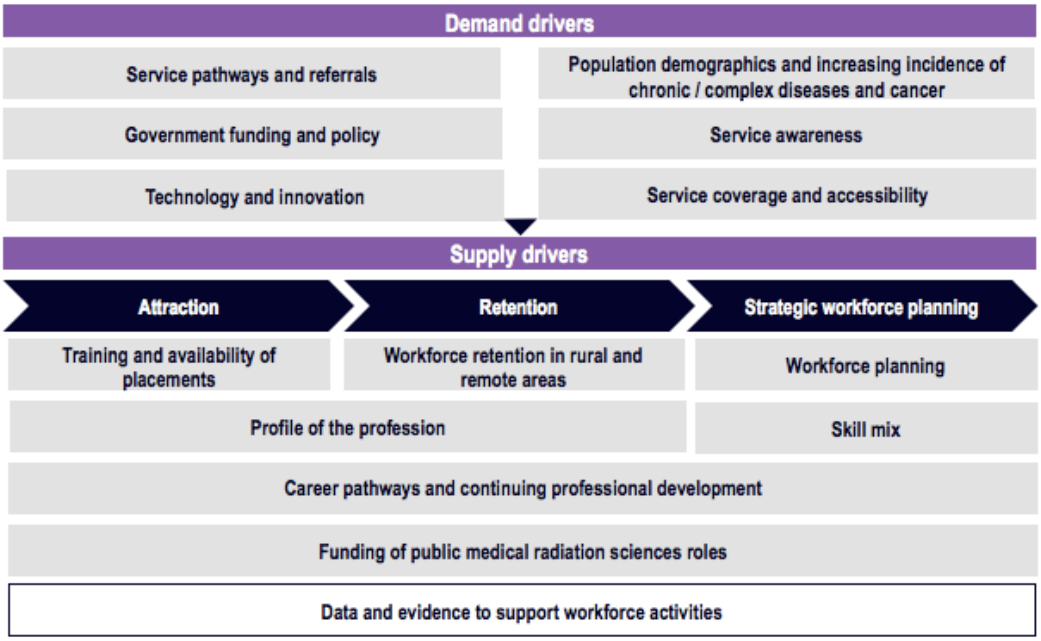
It was noted by stakeholders that while the radiography workforce is more widely dispersed across NSW due to the availability of relevant services in rural areas, challenges continue to remain in attracting and retaining graduates to areas west of the Great Dividing Range. For the professions of medical radiation therapy and nuclear medicine technology, the distribution remains even more centralised in metropolitan and coastal areas aligned with the service available of nuclear medicine imaging and radiation therapy treatment for the NSW population.

4 Summary of the Key Demand and Supply Drivers

This section provides an overview of the key demand and supply drivers impacting the MRS workforce. The driver model brings together those demand and supply drivers that were identified, developed and validated through the horizons scanning and scenario generation process with key MRS stakeholders across the three professions. These drivers are summarised in Figure 9 below.

The model below identifies those drivers that impact upon the MRS workforce as a whole. However, it is important to note that specific drivers may impact to varying degrees on each individual profession. These nuances are examined throughout the report.

Figure 9: Medical Radiation Sciences – Demand and Supply Driver Model



4.1 Demand Drivers

As identified through the literature and by stakeholders, a detailed analysis of the demand drivers currently impacting the MRS workforce is detailed in the following section. Demand drivers may be defined as factors that shape and influence demand for a workforce's services.

Table 4 below provides a high-level overview of the demand drivers, followed by a more detailed explanation and analysis of each.

Table 4: Overview of the key demand drivers for the MRS workforce

Demand Driver	Description
Service pathways and referrals	The referral pathways and ordering practices to accessing MRS services
Population demographics and increasing incidence of complex and chronic disease and cancer	Incidence of complex/chronic diseases and cancer based on population growth, demographic characteristics and geographic distribution
Government funding and policy	Scope, focus, and access of services based on government funding (e.g. Medicare, ABM, rebates) and policy
Technology and innovation	Emerging technologies and innovations that lead to new specialities, procedures and integration between systems and practitioners
Service coverage and accessibility	The coverage and accessibility of MRS services based on geographic distribution as well as specific population groups (culturally and linguistically diverse people, Aboriginal people)
Service awareness	Public awareness of MRS services based on consumer expectations, knowledge and perceptions

4.1.1 Service pathways and referrals

Stakeholders reported that service pathways are one of the most significant drivers of demand for services provided by the MRS workforce. The referral patterns from relevant health practitioners for various scans, tests, procedures and treatment impact significantly on demand.

The MRS workforce is employed across both the public health system (in public hospitals) as well in the private system (either in private practices or private hospitals) which, depending on the origin of referral, influences the referral pathways to their services. The referral pathways are also dependent on the type of service required by the patient, and therefore the workforce requirements around each varies. The following examples outline a possible service pathway for each of the professions:

- Diagnostic radiographer – a patient is referred for diagnostic imaging, such as x-ray, in a public hospital during a presentation at an emergency department. The

diagnostic radiographer is required to undertake this imaging for the radiologist, sometimes in consultation with the radiographer, to interpret and report back in a timely manner.

- Nuclear medicine technologist – a patient is referred by their doctor for a PET scan to see what stage their cancer is at. The nuclear medicine technologist will perform the PET scan as well as review the patient's medical history to understand their illness and talk them through the procedure.
- Radiation therapists – a patient with cancer is referred to the radiation oncologist for radiotherapy. They attend either one or a series of appointments where the radiation therapist administers planning and treatment either internally or externally depending on their condition.

During the project, three focus groups were conducted with representatives focused on the referral pathways for each of the profession to understand the process for referrals and constraints encountered by the workforce. The referral pathways maps are available in the *Appendices* and areas for consideration in terms of how service pathways impact on the workforce demand looked at in further detail below.

Diagnostic radiography referral and service pathways

Patients can be referred to the services provided by the diagnostic radiography profession through the following pathways:

- Referral by a general practitioner or medical specialist
- Referral by another professional in a multidisciplinary team or clinic, such as a physiotherapist
- Referral during triage upon presentation at an emergency department
- Referral during admission as a public hospital inpatient.

The referrals for diagnostic radiography services come from a broad base of sources and the demographics also covers the whole lifespan (from babies through to elderly patients). Stakeholders reported that up to 70% of referrals can come from emergency departments, meaning that a large portion of their caseload is unscheduled and unpredictable. As a 24/7 service, there is an added complexity to the referral patterns to services provided by the diagnostic radiography profession.

Diagnostic radiography stakeholders engaged throughout this project reported that referring clinicians – particularly those based within hospitals – are over-ordering diagnostic imaging. Stakeholders reported this has a direct impact on the caseloads, and therefore the resourcing requirements, in NSW public hospital imaging departments. This is a high priority demand driver for the diagnostic radiographer profession. Being embedded within the hospital means the profession has Key Performance Indicators (KPIs) to meet, especially in terms of imaging and reporting turnaround times. This is closely tied to the Emergency Treatment Performance priority that is being implemented state-wide in NSW.

This is a significantly different challenge for diagnostic radiography professionals compared to other professions within the MRS workforce; for example, a radiation therapist has a clearly defined referral pathway for patients requiring radiotherapy and would therefore not receive nearly as many inappropriate referrals.

Following studies that show some 20 to 50 per cent of diagnostic imaging services are potentially redundant or unnecessary (RANZCR, 2012), Australian Federal Government initiatives have also sought to ensure diagnostic imaging orders are appropriate by improving the requesting practices of medical practitioners (NPS MedicineWise, 2018; ANAO, 2014). These initiatives are being implemented throughout Australia. For example, at the Royal Brisbane and Women's Hospital in Queensland, a 'Choosing Wisely' culture is being embedded within the organisation by including the principles in the hospital performance framework, orientation for new staff, policy statements and role descriptions. Hospital-based programs to reduce unnecessary imaging requests, and therefore reduce the overall cost to the hospital for delivering patient care, have also been successful both in Australia (Ritchie, et al., 2014; Stuart, et al., 2002) and internationally (Vegting, et al., 2012).

NSW Health is looking at improving the imaging ordering practices within facilities to ensure higher levels of appropriateness. A trial of a Clinical Decision Support (CDS) tool is currently underway at Liverpool and Royal North Shore hospitals, providing evidence-based referral guidelines to address appropriate imaging for many patient presentations. It is expected that the CDS will better inform clinicians to appropriately request studies and ensure radiology departments receive these requests with pertinent clinical information (Clinical Excellence Commission, 2017).

By reducing unnecessary and inappropriate referrals and procedures, diagnostic radiographers will be able to more effectively manage the demands and caseloads of their role and focus on those patients that require scans, tests or procedures in a timelier manner.

Nuclear medicine technologist referral and service pathways

Referrals to the services provided by nuclear medicine technologists only come from specialists or general practitioners; compared to diagnostic radiography, they do not have as broad base of referral sources just because of the specialised nature of the procedures provided.

Stakeholders from the nuclear medicine technology profession reported one of their biggest challenges to overcome was the public fear that radiation contributes to cancer and the associated risk of driving referral patterns away from nuclear medicine procedures. More public education and increasing general knowledge on the safety of nuclear medicine would assist with debunking myths associated with radiation (Siegel, et al., 2017), as would ensuring doctors and radiologists being able to explain to patients why the radiation is necessary, what the risks are, and what benefits they will gain from having the test.

Radiation therapist referral and service pathways

The radiation therapy profession highlighted significant challenges in raising awareness of the services they provide and ensuring they are receiving enough referrals in line with evidence-based practice and optimal utilisation rates.

Almost 9% of all cancer patients in Australia have at least one treatment of chemo-radiotherapy during their illness. Research into optimal radiotherapy utilisation shows that the proportion of new cases of registered cancer in Australia that should receive external beam radiotherapy at some time during the course of their illness, based upon the best available evidence, is 52.3% (Barton, et al., 2014). However, since 2003 the overall radiotherapy utilisation rate decreased due to changes not only in the way the data was collected but also changes to radiotherapy indication and refinements of the model structure (Barton, et al., 2014). In 2011, it was estimated that 38.1% of newly diagnosed cancer

patients are receiving radiotherapy, well below the optimal utilisation rate (Radiation Oncology Reform Implementation Committee, 2011). This will continue to drive demand for the services provided by the radiation therapy profession; therefore, ensuring the workforce is appropriately resourced to meet growing demand and optimal utilisation rates will be a challenge for the profession.

4.1.2 Population demographics and increasing incidence of chronic and complex disease and cancer

The estimated population of NSW was 7.9 million people as of 30 June 2017, representing an increase of 1.6% from the previous year (ABS, 2017). In 2016-17 there were almost 2.8 million attendances in NSW public hospital emergency departments, an increase of nearly 48,000 on the previous year (NSW Health, 2017). These demographic factors were reported to also be affecting the demand for services provided by the MRS workforce, in addition to the ever-increasing ageing population, as well as increasing incidences of chronic and complex disease, and cancer.

Ageing population

In 2016, there were 3.7 million (15%) Australians aged 65 and over. By 2056, older Australians are projected to more than double in size with approximately 8.7 million older Australians (22% of the population); by 2096, 12.8 million people (25%) will be aged 65 years and over (AIHW, 2017a).

With age, comes a multitude of increased health risks, including increasing risk of chronic and complex disease, co-morbidities and other health conditions. Cardiovascular disease and cancer are considered the leading causes of burden for older Australians followed by neurological conditions, musculoskeletal conditions, and respiratory conditions (AIHW, 2017a).

Chronic heart disease is the leading cause of death in older Australians, accounting for 15% of all deaths in the country (AIHW, 2017a). Coronary artery disease (CAD) is the most common type of heart disease, which can cause chest pain or a heart attack. Non-invasive testing is crucial to diagnose CAD early and manage and guide treatment (Shaw, et al., 2005). In recent years, technical advances in cardiac CT and MRI have increasingly become more widely available (Nikolaou, et al., 2011). The increase in both the availability of these machines as well as incidence of cardiovascular disease in older people suggests demand for the technical operation skills and roles for diagnostic radiographers and nuclear medicine technologists may also continue to rise.

The number of people affected by osteoporosis is also increasing due to ageing. Osteoporosis is a chronic musculoskeletal disease that affects an increasing amount of older people. The decrease in bone density in older people causes vertebral or hip fractures and has significant social and economic implications on patients. There is a push for early diagnosis which is shown to be an effective tool in circumnavigating the effects of musculoskeletal conditions in older populations (Guglielmi, et al., 2011). Developments in new imaging modalities such as micro-CT and high-resolution MRI can help diagnose osteoporosis in its early stages, thereby reducing associated social and economic costs and prevent patient suffering.

As the ageing population continues to increase, the demand for the services that the MRS workforce provides – along with all healthcare services – will grow.

Increasing incidences of cancer and screening

Cancer is a major cause of illness, disability and death in Australia and incidences continue to rise. People living in Australia generally have a better relative survival rate for cancer compared to other countries (Allemani, et al., 2014), despite cancer incidence rates being relatively high. These survival and incidence rates can likely be contributed to the significant investments that the federal and state and territory governments have made in screening, early detection and treatment over many years. Whilst the incidence of all cancers continues to rise, the mortality rates overall have fallen (AIHW, 2012).

However, there is still significant variation in survival outcomes between different types of cancers and various population groups in Australia. Cancer is still amongst the top five leading causes of death in the older population in Australia with 71% of new cancer cases in those aged 60 and over (AIHW, 2017a). Rural and remote cancer patients, as well as those in low socio-economic groups, have lower cancer survival rates than their metropolitan counterparts (Jong, et al., 2004; AIHW, 2017b). Additionally, Indigenous Australians have a higher incidence of cancer and are 1.3 times more likely to die from cancer than non-Indigenous Australians (AIHW, 2017b).

All three professions play an important part in the detection and treatment of cancer, leveraging the technology and their skills in breast imaging, MRI, CT and PET scans (AIHW, 2017a) as well as the administration of radiation therapy. Figures show that the number of courses of radiation therapy is increasing year-on-year, which will have an impact on the workforce requirements for skilled radiation therapists (AIHW, 2017b). Screening for certain cancers is also important, as it not only assists with the early detection of cancer, it increases both cure and salvage rates, and assists with overall cost effectiveness of treatment (Treskova, et al., 2017). This can be expected to continue to drive demand for the services provided by the MRS workforce as the incidences of cancer rise, and early detection and treatment becomes more prevalent.

Increasing incidences of chronic and complex disease

Tackling chronic disease is considered the biggest challenge facing the health system as the leading cause of illness, death and disability currently in Australia. One in every two Australians have self-reported as having at least one prominent (i.e. arthritis, asthma, back pain, cancer, cardiovascular disease, chronic obstructive pulmonary disease, diabetes or mental health conditions) chronic condition; nearly a quarter of all Australians (23%), and three in every five Australians (60%) aged over 65 years, had two or more chronic conditions (AIHW, 2016).

Chronic and complex diseases impact on the general population as an increasingly prevalent rate; however, conditions such as cardiovascular disease, diabetes and chronic kidney disease have greater incidence rates and at a younger age in Aboriginal and Torres Strait Islander populations compared to non-Indigenous adults. Research shows that:

- Indigenous adults have a higher rate of cardiovascular disease than non-Indigenous adults (27% and 21%, respectively) and the rates increase with age, from 9% at age 18-34 to 60% at age 65 and over;
- Indigenous adults are 3.5 times more likely compared to non-Indigenous adults to have diabetes (18% compared with 5%) and at ages 35-44, the rate is four times as high (11% compared with 3%);

- Indigenous adults are twice as likely as non-Indigenous adults to have biomedical signs of chronic kidney disease (22% compared with 10%) and at ages 45-54, the rate is four times as high (25% compared with 6%) (AIHW, 2015).

Hospitalisation rates for Indigenous adults with these conditions is also higher compared to non-Indigenous population (AIHW, 2015), which has a direct impact on the public health system and the demands for the services provided by the MRS workforce.

Stakeholders across all three professions agreed that demand for the services of the MRS workforce will continue to grow in line with increasing incidences of chronic and complex disease, particularly as it relates to comorbidities associated with ageing and increasing incidences of cancer.

4.1.3 Government funding and policy

Stakeholders identified that government funding and policy direction currently has a direct impact on the MRS workforce and the services they provide in the public health system. A number of funding and policy initiatives were noted as having the potential to impact on demand, such as Activity Based Management (ABM) and the Medicare Benefits Scheme (MBS).

The constraints related to government funding is also provided in more detail in the *Challenges Encountered by the MRS Workforce* section.

Activity Based Management

Activity Based Management (ABM) is the system of funding hospitals whereby they get paid for the number and mix of patients they treat. Because some patients are more complicated to treat than others, ABM also takes this in to account (IHPA, n.d.).

Stakeholders reported that the ABM system of funding hospitals does not necessarily directly benefit the MRS workforce. Because of the way ABM is paid to the hospital for each episode of care, there was a perception by stakeholders that there is insufficient recognition of the demand placed on the MRS services for their efforts in the provision of timely and effective care. This particularly impacts on the diagnostic radiography profession as their services are often provided in either emergency department (non-admitted) or inpatient (admitted) episodes.

Medicare Benefits Scheme

Stakeholders reported that the Medicare systems also have the potential to drive inappropriate referrals.

The Medicare Benefits Scheme (MBS) pays general practice to see patients as well as for each referral, which the MRS workforce believe should be paid to the imaging provider for their services rendered. Additionally, general practice is paid more through MBS for more complex treatments or additional referrals so there is some concern amongst stakeholders that GPs are systemically incentivised to generate referrals in this way. This could be contributing to demand for MRS services.

Diagnostic radiographers also reported challenges with the Medicare system, that does not allow them to set up their own private clinic or business as MBS is tied to a radiologist being the main provider. This also limits the career opportunities for diagnostic radiographers to go into private business should they wish.

Emergency Treatment Performance

The NSW Government is working towards achieving 12 Premier's Priorities and 18 state priorities to grow the economy, deliver infrastructure, protect the vulnerable, and improve health, education and public services across NSW. One of the 12 Premier's Priorities is focused on improving service levels in hospitals with a target of 81% of patients being seen within emergency departments within four hours by 2019.

Diagnostic radiography stakeholders reported the increased pressure within emergency departments in NSW public hospitals to achieve this target in turn influences the overall caseload and time pressures placed upon their workforce. Similar to the patterns of inappropriate referrals outlined previously, stakeholders believe clinicians are ordering diagnostic tests too quickly either without clinical reason or as a way to circumnavigate the ETP targets. This is a specific challenge for the diagnostic radiography workforce given their close alignment and interdependency with the emergency department.

4.1.4 Technology and innovation

Technology is a significant factor driving demand to the MRS workforce. Equipment employed by the workforce is highly technical as are the tests, procedures and interventions performed, with the overall health system moving increasingly toward new technology to aid efficient and effective patient care.

As new technologies emerge, this leads to further specialisations developing within the MRS workforce and its related professions. Some emerging innovative procedures – such as stereotactic brain and lung radiosurgery in cancer treatment or interventional imaging procedures – are leading to better patient outcomes but additional complexity and resourcing requirements. Another example is the advent of hybrid imaging, which is also seeing an increase in patient demand for these services. In planning for the future, it will be important for the health system to ensure the MRS workforce is appropriately skilled and resourced to adequately respond to new innovations and technologies.

The introduction of more closely integrated systems also has the potential to open communication pathways between providers and reduce duplicative and unnecessary testing. For example, NSW Health's Medical Imaging program is designed to create an integrated system of digital imaging and radiology information that allows for universal access to images across NSW (eHealth NSW, 2017). At the centre of this program is the Enterprise Image Repository (EIR), an amalgamation of the Picture Archiving and Communications System (PACS) and Radiology Information System (RIS) that brings together digital images and reports in an easy to access database. One of the outcomes of this program is the reduction of costly and time-consuming repeat tests. This benefits patient care as specialists across the state can also view diagnoses and provide advice as required.

4.1.5 Service coverage and accessibility

In 2012:

- 90% of all Australians lived within 100 km of a comprehensive diagnostic imaging facility, providing MRI, CT, ultrasound and diagnostic radiology
- Some 83% of patients lived within 10km of a CT machine
- 63% of patients lived within 10km of a Medicare eligible MRI unit (RANZCR, 2012).

Despite these figures which indicate that large numbers of people do live relatively close to diagnostic imaging services, stakeholders reported that rural and remote service considerations were still a demand driver for the MRS workforce, but is a specific demand challenge for the radiation therapy workforce as provided in more detail below. It is interesting to note that service coverage and accessibility is not as much of a demand driver for the nuclear medicine technology profession as it is a metropolitan-focused workforce, with services only available in the tertiary or teaching public hospitals in NSW. Stakeholders from the nuclear medicine profession noted this was because there is not as large of a demand for their services in rural and remote areas in the public hospital system; if patients require certain scans or procedures they can be referred to local private facilities.

Stakeholders from across all three professions reported the continuing challenges of communicating with patients from culturally and linguistically diverse (CALD) populations in relation to ensuring they understand their treatment plan and subsequent test, procedure or intervention. This impacts on their ability to provide culturally appropriate services if there are issues or delays in accessing interpreters in a timely manner.

Radiation therapy and service coverage

Service coverage is a significant demand issue for the radiation therapy profession with an increasing need for radiotherapy services – and therefore radiation therapists – in rural and regional areas. Survival rates for Australians with cancer who live in rural and regional areas are comparatively worse than in metropolitan areas, stemming from issues such as geographical isolation, delayed diagnosis, lower socioeconomic status and workforce shortages (Grimison, et al., 2013). Rural patients, carers and health professionals reported that their biggest concerns when it came to cancer care was not only a lack of health professionals to address questions about their treatment, but to also provide emotional support when needed (Grimison, et al., 2013). A key component of the radiation therapists' role is in building that support role and acting as an advocate on behalf of the patient when it came to their treatment (Sale et al, 2016).

Furthermore, research shows that there is a significant difference between the number of Aboriginal patients treated for cancer compared to non-Aboriginal people (Radiation Oncology Tripartite Committee, 2012). On average, the mortality rates for Aboriginal people are 1.3 times higher than non-Aboriginal people (Australian Institute of Health and Welfare, 2017). This could be due to several factors, including lack of availability to treatment facilities, education level, cultural considerations and a lower socio-economic status (Australian Institute of Health and Welfare, 2017). A study on the survival rates of Indigenous and non-Indigenous Queenslanders after a diagnosis of lung cancer found the percentage of Indigenous patients who received radiotherapy was 31% compared to 42.8% for non-Indigenous patients (Coory, et al., 2008). The study concluded that the differences in treatment between the two groups were mainly responsible for the difference in survival rates.

4.1.6 Service awareness

Nowadays, the public can more easily access a wider range of health-related information, particularly through the internet and social media. With this comes an increased knowledge of various illnesses and possible treatment options. Stakeholders reported that whilst consumers have an increased knowledge, they may also therefore have heightened expectations of what their healthcare should look like.

Particularly when it comes to cancer, there is an increased awareness around the positive benefits of radiation therapy as a viable and successful treatment plan that may be driving increased demand for the services provided by radiation therapists (Radiation Oncology Targeting Cancer, 2017), although not necessarily to the optimal utilisation levels as previously explored.

Patient-centric initiatives to ensure people are receiving treatment closer to home – and reduce the need to travel – may also be affecting demand in certain regions or locations.

4.2 Supply Drivers

This section provides a detailed analysis of the supply drivers currently impacting the MRS workforce as identified through the literature and by stakeholders. Supply drivers are defined as factors that contribute to the availability, sustainability and size of the workforce.

Table 5 below provides a high-level overview of the supply drivers, followed by a more detailed explanation and analysis of each supply driver.

Table 5: Overview of the key supply drivers for the MRS workforce

Supply Driver	Description
Training and availability of placements	Availability and quality of training and placement positions for recent graduates
Profile of the profession	The MRS profession's voice, image and presentation to the public and other relational occupations
Career pathways and continuing professional development	Availability of career progression and continual professional development and education opportunities for practitioners
Workforce retention in rural and remote areas	Workforce retention of MRS practitioners based on geographic location and lifestyle preferences
Workforce planning	Aligning the needs and priorities of the system with those of its workforce
Skill mix	Advanced practice, hybrid imaging and other combinations of skills/knowledge that contribute to the future of the workforce
Funding of public medical radiation sciences roles	Funding of public sector MRS positions and activities

4.2.1 Training and availability of placements

The number of MRS students and their alignment to the availability and quality of clinical placements was identified as a key supply driver to the MRS workforce. Stakeholders reported that there were often not enough placements offered by the system, and that universities were putting undue pressure on the public system to provide those student placements. As at 30 June 2017, there were 3,895 medical radiation practice students nationally, representing an increase of 13% from 2015/16 (Medical Radiation Practice Board of Australia, 2017). Being able to provide the appropriate placements for these students will be a challenge if graduate numbers continue to rise. This was particularly pertinent to the diagnostic radiographer and radiation therapist professions. In comparison, stakeholders from nuclear medicine technologist profession reported adequate amount of placement opportunities and graduate positions available as small and highly specialised workforce with only a few course options in NSW.

The Radiation Oncology Reform Implementation Committee (RORIC) Workforce Reform Framework (the Framework) noted an increasing radiation oncologist – and therefore

radiation therapy – workforce limits the training capacity both of the higher education sector as well as at a clinical placement level (Radiation Oncology Reform Implementation Committee, 2011). Stakeholders reported that clinical training places are more likely to be provided by public facilities (compared to private organisations) and have reportedly been in short supply for many years. Future workforce supply modelling will need to consider how to balance the number of students with the number of placements available and will require careful planning now and into the future. This was reported as a concern across all three of the MRS professions, and not just related to the radiation therapists.

Stakeholders reported their desire to enhance the quality of clinical placements to ensure graduates and students are adequately trained and can enter the workforce appropriately skilled. A study of radiation therapy students in Queensland noted the most important factors in a quality clinical placement are being provided a named mentor, as well as the availability of a clinical educator (Bridge & Carmichael, 2014). This was echoed throughout conversations with stakeholders and during the workshops run during the project.

In the scenario generation phase of the project, stakeholders considered the optimal way to ensure students had the appropriate skill level upon graduation from university. They saw the importance of a clinical educator role that would have both the capability and capacity required to provide training and support to the future workforce. An educator role could provide a transition from the theoretical teachings of the university setting, to the more practical application within the workplace

Stakeholders also identified that the university course structure has an impact on MRS student recruitment and capabilities. Developments over the past few years have seen a transition away from the 3-year MRS degree plus a year of clinical experience, to a 4-year degree that includes clinical practice as part of the degree. It was noted by some that there is a perception that the 4-year degree had less focus on the clinical experience and therefore there was a potential gap in knowledge between these two groups of students.

4.2.2 Career pathways and continuing professional development

Clear career pathways and ensuring access and time to undertake continuing professional development was identified as a key supply driver by the stakeholders. To promote workforce recruitment and retention, more focus is required on establishing structured career pathways and further training opportunities for MRS practitioners (Chan, 2007).

Ongoing professional development is essential for maintaining and enhancing health practitioners' skill sets and ensuring future opportunities for career progression. Stakeholders identified that there is a perception of limited career progression for all three professions within the MRS workforce. As a result, practitioners can become apathetic in their role which can impact the retention of good employees but also attraction of the right practitioners to the workforce.

Professional development opportunities such as being able to attend conferences, knowledge sharing sessions, and annexed time and budget to contribute to research or partake in clinical trials were identified as potential options for maintaining enthusiasm and engagement amongst staff. Increasing training opportunities and ensuring structured career progression would re-invigorate current staff and better the retention rates amongst MRS professionals.

Stakeholders identified that the introduction and support of advanced scopes of practice for the MRS workforce would also provide another opportunity for career progression.

Advanced practice can be defined as a practitioner regularly performing duties beyond the core practice boundaries of the profession with appropriate availability of resources, educational underpinning and professional mentorship (Advanced Practice Advisory panel, 2013). In New Zealand and the UK, the opportunity for advanced practice has shown improvements in job satisfaction, professional recognition and career advancement, (Colemana, et al., 2009). The potential of this is explored in further detail in the *Skill Mix* section below.

Interestingly, stakeholders suggested that some students perceive MRS to be a "stepping stone" career to other medical professions. Emphasis on examining the current career structure would assist in changing this perception, as well as ensuring the workforce is engaged in opportunities for ongoing professional development. The training pathways and professional development for each of the professions looks different.

For diagnostic radiographers and nuclear medicine technologists, there are a number of post-graduate opportunities (either as a Masters, Graduate Diploma or Graduate Certificate level) available in NSW for practitioners to undertake further study and enhance their knowledge or specialisation.

There are also certifications available via the professional body, ASMIRT, to advance skills in specific imaging modalities such as MRI, CT and angiography. However, stakeholders reported that training provided 'on-the-job' is valuable and relevant for practitioners wishing to enhance their skills, despite the ASMIRT courses not necessarily being a requirement to operate these modalities.

However, unlike diagnostic radiographers and nuclear medicine technologists, there are no radiation therapy-specific post-graduate degrees, but there are a number of short courses available should practitioners wish to develop a specialisation. Stakeholders reported that radiation therapists can choose to do a Masters by Research, but this requires the support and mentoring of a radiation oncologist and there are few opportunities available. On-the-job training is provided as necessary if practitioners wish to specialise in a certain treatment type or cancer.

4.2.3 Profile of the profession

Stakeholders acknowledged that profile of the MRS workforce is a key driver in attracting potential students and professionals into the workforce.

A study conducted to investigate the reasons why students chose MRS as a career path showed that their reasons for undertaking a MRS degree at university was:

- Altruism
- Working in a healthcare profession
- Working with technology (Bamba, et al., 2008)

Whilst stakeholders agreed with these factors that attract potential students, they also expressed that students may lack in-depth knowledge of the profession upon commencement of their studies, causing a misalignment of student expectations and reality of the position once they have completed university. Aspects such as placements upon graduation, career progression, continuing professional development and scope of practice were likely not considered when making an informed career choice. This could potentially

influence workforce retention if graduates are disillusioned with their role upon entering the workforce and choose to leave.

Stakeholders also identified that the recognition of the MRS workforce in the public and amongst other medical occupations is not as high as they believe it should be. They felt undervalued by their peers, and as result often felt that their "professional voice" was stifled. For example, radiation therapists mentioned that patients often mistook them as nurses and were unaware of any difference between the professionals. The radiographer profession also identified that they felt 'stifled' in their career progression because of the structure of their departments and reporting lines to radiologists.

4.2.4 Workforce recruitment and retention in rural and remote areas

Attracting and retaining allied health professionals in rural and remote areas is a recognised problem in Australia and is a key supply driver for the MRS workforce.

Stakeholders noted that there needs to be incentives to attract the workforce to rural and remote areas when there are positions available. Radiation therapists raised that the demand for radiotherapy continues to increase but recruitment of appropriately skilled professionals is still difficult, despite remuneration and an apparent over-supply in metropolitan areas. Factors such as work-life balance, career opportunities and training often play a vital role in contributing to the shortage of MRS practitioners in these areas. (Schoo, et al., 2005).

Additionally, separation from immediate family responsibilities and inability to find part-time work that provides income to support their studies are believed to be other reasons attraction to rural and remote areas can be problematic for students and graduates (Radiation Oncology Reform Implementation Committee, 2011).

4.2.5 Workforce planning

Several stakeholders recognised that workforce planning was important to ensure that there is sufficient and sustainable capability and capacity to deliver the service demands of the future. They noted that more strategic planning by the health system would be important to ensure that workforce requirements are aligned with service requirements, and dedicated modelling of the impact on the MRS workforce is needed.

One factor that potentially influences this modelling related to maternity leave and ensuring there is capacity and flexibility to backfill these roles. As a large proportion of the workforce is female and relatively young, there needs to be advance consideration of maternity leave being taken and how the department can respond to this.

Another factor affecting appropriate workforce planning is the ability to recruit to positions in a timely manner. Stakeholders reported that the HR systems within organisations and the overall health system inhibits their ability to recruit prior to positions becoming vacant. This means there is often a delay in recruitment, and empty positions which affects the overall workloads of the MRS workforce. Ensuring that recruitment systems are streamlined will alleviate the pressures that this causes.

Stakeholders also identified that as the MRS department structure was relatively tiered, there were few management positions available for practitioners to work towards. There are not enough positions for senior staff members to strive towards, and this may also cause disillusionment for the MRS workforce.

4.2.6 Skill Mix

Healthcare organisations worldwide are always exploring innovative ways to get the best from their workforces to meet growing service demands. There has been an increasing focus on enhancing 'skill-mix' for healthcare professionals, which can be defined as the combination of different skills within the workforce. For the MRS workforce, this could mean introducing advanced scopes of practice, sub-specialisation and hybrid imaging roles.

Stakeholders identified advanced practice and hybrid imaging as an important supply driver that has the potential to drive attraction to the workforce, increase retention rates and ensure appropriate resource planning. All three professions were particularly vocal in their desire to be an autonomous workforce, working at their full potential and at the top of their scope.

It is now common in the UK National Health Service (NHS) for postgraduate-trained radiographers to deliver a range of services (such as radiographer-led reporting and interpretation) that were previously delivered by radiologists (Le Mausier & Price, 2007). This has not only addressed the growing demand for immediate reporting, the benefits have also been seen in greater potential for recruitment and retention of radiographers, and increased levels of job satisfaction amongst the workforce (Baird & Smith, 2007). Skill-mix initiatives also have supplied opportunities for radiographers, nuclear medicine technologists and radiation therapists to develop their roles, advance their careers and help promote motivation and retention (Field & Snaith, 2013). However, in Australia, the peak body for radiologists does not support the idea for radiographer-led reporting (RANZCR, 2018) and within NSW Health this remains the domain of radiologists. In some Local Health Districts, imaging departments use a "flagging" or red dot system which enables early identification of potential concerns to fast track reporting to radiologists. At times "words" are used to describe the concern identified which enables the images to be prioritised for reporting by radiologists and therefore more prompt access to diagnosis and early treatment for patients where otherwise a significant amount of time may pass delaying access to essential treatment. This is not considered a first line report or "commenting" and remains within the current scope of radiography practice.

Another potential skill-mix opportunity available to diagnostic radiographers and nuclear medicine technologists is in hybrid imaging. Hybrid imaging is the combination of two or more imaging technologies into a single, new form of imaging and different modalities currently being utilised include ultrasonography (US)/magnetic resonance imaging (MRI), MRI/angiography, CT/angiography, single photon emission computed tomography (SPECT)/CT, positron emission tomography (PET)/CT, and soon PET/MRI hybrid imaging. The success of hybrid imaging depends on strong relations being fostered between radiology and nuclear medicine departments to combine their respective knowledge. These technological advancements into hybrid imaging have the potential to better patient diagnosis and care (Hricak, et al., 2010). Whilst there is an obvious need for nuclear medicine technologists and diagnostic radiographers to undertake different, profession related training, there is also an opportunity for cross-training so that practitioners can operate both the radiographic and nuclear medicine components of the hybrid imaging suite (Hricak, et al., 2010).

For radiation therapy, emerging models of care around Image Guided Radiation Therapy (IGRT) allows for the advanced use of imaging, usually CT scans and x-rays, to help precisely target the cancer with radiation therapy leading to the adaptive planning of treatment (for example, the ability to change a treatment plan "on the fly"). Similarly, hybrid

imaging requires communication between two departments and the two professions (radiation therapy and diagnostic imaging). Working horizontally across departments will continue to increase as precision medicine and new models of care emerge for the MRS workforce.

Advanced practice and hybrid imaging roles also have significant potential to motivate and challenge the workforce as well as increase overall job satisfaction. However, despite the benefits, there may be challenges as traditional roles change, confusion or concern over an individual's professional identity can potentially cause conflict among related professions.

4.2.7 Funding of public medical radiation sciences positions

Stakeholders identified funding of public MRS positions as a significant supply driver impacting on the workforce. Stakeholders reported that training and upskilling of students and graduates would be significantly improved if there were dedicated human resources to support education and training. At the moment, the educator role is usually performed by an experienced member of staff (Level 3 and above) in addition to their day-to-day responsibilities. Stakeholders reported this would increase the professional standards of the entire MRS workforce.

The MRS workforce is a technologically driven workforce and as such, stakeholders also focused on technology as another factor requiring funding and investment. The new equipment for hybrid imaging, as well as the more utilised diagnostic imaging equipment such as CT and MRI, are costly. Stakeholders reported that the funding needs for both the purchase of equipment and the adequate provision of training and change management to support the implementation of new technologies is required. It was reported by stakeholders that the capital investment in both the technology and the profession is not always fully understood and this is challenging in NSW when facilities are undergoing redevelopment. Stakeholders recognised that technological advancements in the MRS workforce is inevitable, but also stated that adequate training is crucial for effective patient care.

5 Challenges Encountered by the MRS Workforce

This section details some of the key challenges encountered by the MRS workforce, both currently and those anticipated in the future.

5.1.1 Impacts of constrained funding models

Constrained funding models can impact both on the supply and demand for services, with stakeholders identifying sustainable funding as a significant challenge if the workforce is to meet the expected demands of the future.

It was reported that more funding and resourcing is required in areas such as technology (i.e. implementing appropriate infrastructure and IT support services particularly in rural and remote locations), innovation (i.e. implementing new treatment delivery techniques) and research (i.e. enriching evidence-based techniques and exploring new medicine). Being able to progress at the same rate as new emerging technologies are introduced will ensure the workforce can adequately to deliver services in the future.

Despite the impacts of constrained funding models, stakeholders felt that they had little control over the design of such models and the allocation of government funding. These issues affect the entire health system, not just the MRS workforce.

5.1.2 Rural and remote service considerations

Stakeholders described the challenges of recruiting appropriately skilled professionals across the MRS workforce to rural and remote areas. This is also closely related to attracting certain skill sets (for example, a diagnostic radiographer with sonography training) which are required in rural and remote areas and has significant impacts on the ability of individual facilities to offer the full breadth of services available, even if they may have the technology and specialist equipment in place.

Stakeholders from the diagnostic radiography and radiation therapy professions reported that despite an apparent over-supply of skilled professionals and graduates in metropolitan areas, it is still difficult to recruit and retain MRS graduates and professionals to rural and remote areas. This difficulty is despite competitive remuneration and more opportunities to work at the full scope of their practice compared to metropolitan areas. People in rural and remote areas often develop more generalist skill sets and the opportunity to work with different technologies is often available. This will continue to present itself as a challenge now and into the future.

5.1.3 Enhancing medical radiation sciences' professional voice, representation and image

Stakeholders identified that the professional voice, representation and image of the MRS workforce was impacting on its ability to provide full input into the design of new models of care. Whilst part of the allied health workforce, all three professions would argue that they did not naturally fit under the 'allied health' umbrella.

It was highlighted organisational structures across the NSW public health system vary. For example, radiation therapists may work within the oncology department or under the allied health division, whilst diagnostic radiographers and nuclear medicine technologists could report either through medical or clinical streams, the radiology / nuclear medicine department or allied health divisions.

5.1.4 Workforce sustainability

As outlined within the *Workforce planning* section previously, some of the key challenges around ensuring sustainability of the MRS workforce now and into the future will be:

- Ensuring graduate numbers are aligned with the number of clinical placements as well as positions available post-graduation
- Flexibility to backfill maternity leave
- Ensuring the public health system remains attractive to skilled professionals
- Timely recruitment to vacant positions.

The literature also identified concerns about the potential for occupational burnout that are specific to the radiation therapy workforce, which was also raised amongst stakeholders. A study undertaken in 2017 gauged the burnout levels of radiation therapists in Australia, with the respondent noting:

- 93% had high emotional exhaustion
- 87% had high depersonalisation
- 61% had low personal accomplishment (Singh, et al., 2017).

The study identified that staff shortages, increased workloads, challenging interpersonal relationships and new advancements in technology contributed to the overall stress levels of radiation therapists. Therefore, ensuring the right supports are in place to assist staff through these issues will need to be considered in workforce planning to ensure sustainability of the profession into the future.

5.1.5 Sonography

Challenges related to attracting and retaining skilled sonographers in NSW was raised by stakeholders throughout the project. Whilst out of scope for this project, NSW Health is currently planning to undertake a separate process for understanding the state-wide workforce demand and supply challenges for the sonography profession.

6 Opportunities Available to the Workforce

There are several opportunities available to the MRS workforce that can be explored and developed in the future.

6.1.1 Advanced scopes of practice, hybrid imaging and skills-mix

As previously noted, there are significant opportunities available to the MRS workforce either by advancing their scopes of practice, working with hybrid imaging technologies, or exploring the potential of skill-mix roles. All of these options offer the potential to provide more opportunities for the workforce to further develop their career and enhance professional development opportunities. Additionally, these initiatives would also have the benefit of increasing the autonomy of the professions and lead to increased job satisfaction.

6.1.2 Emerging technologies

As the healthcare system continues to innovate and looks for ways to deliver optimal patient care and increase efficiencies, the MRS workforce will also need to remain adaptable to changing circumstances. The introduction of clinical decision-making tools supported by artificial intelligence is one significant opportunity that will potentially support the MRS workforce with the aim of promoting evidence-based practice and hopefully lead to better patient care (AHHA, 2014).

Stakeholders reported that while technology opens up many opportunities for the workforce, they also fear that their roles may be resigned to 'button pushing' that does not aid patient care.

6.1.3 Partnering with education providers to identify skills and experience required from graduates

MRS professionals would like the opportunity to reconfigure university courses in a way that meets the needs of the workforce but also ensures graduates are 'employment ready' when finishing courses.

If the number of MRS graduates continues to grow, it will be a challenge to ensure appropriate placements are provided for students with the adequate clinical supervision requirements. Therefore, partnering with education providers will be key to ensuring that both parties can support the development of the future MRS workforce.

6.1.4 Development of clear career progression pathways and continuing professional development

Stakeholders identified that there is an opportunity to develop clear continuing professional development pathways to re-engage and 're-excite' the workforce. Some of the areas identified to re-engage the workforce included:

- Annexing time for MRS professionals to undertake continuing professional development courses or opportunities – including support around appropriate rostering
- Opportunities for cross-training and skill mix roles
- Opportunities to be involved in research and clinical trials.

As a driver of supply for the MRS workforce, with the potential to significantly impact on retention, developing clear career pathways and opening opportunities for continuing

professional development will lead to greater job satisfaction, create a more skilled workforce and ultimately improved patient care and outcomes.

7 Appendices

7.1 MRS stakeholders engaged in the project

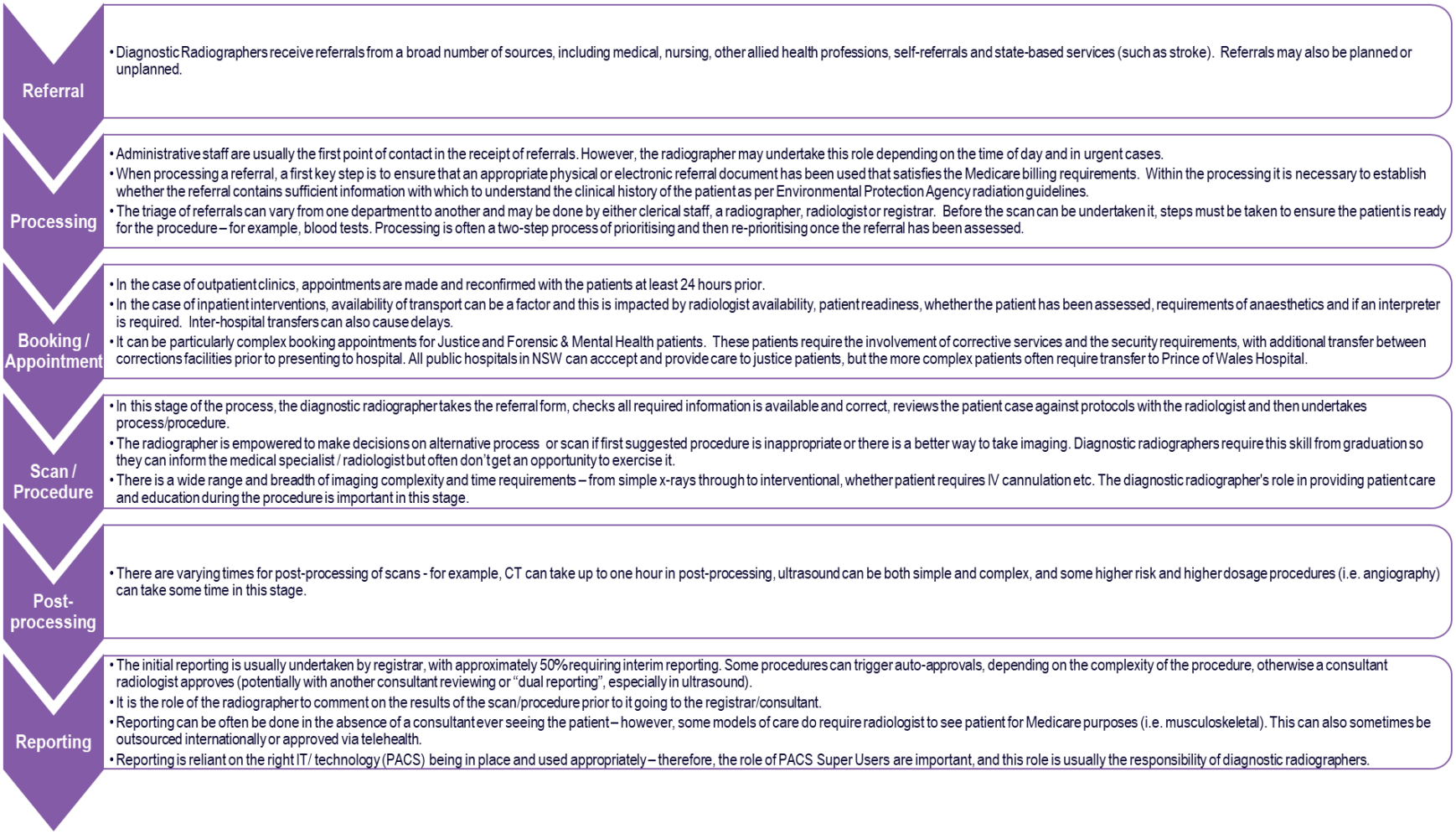
Name	Job Title	Organisation
Diagnostic Radiographers		
Adrian Snowden	Chief Radiographer	Hunter New England LHD
Andrew Teece	Diagnostic Radiographer	Nepean Blue Mountains LHD
Anthony Akle	General X-Ray Section Manager	St Vincent's Health Network
Anthony O'Donnell	Chief Radiographer	Murrumbidgee LHD
Brian Sorensen	Chief MRS Diagnostics Services Department Manager	St Vincent's Health Network
Gloria Olivieri	Chief Radiographer, Westmead Co-Chair, ACI Radiology Network	Western Sydney LHD
James Nol	Operations Director Medical Imaging, Blacktown Mt Druitt Hospitals	Western Sydney LHD
Johanna Hawkins	Radiographer	Murrumbidgee LHD
John Thomas	Radiology Services Manager, St George Hospital	South Eastern Sydney LHD
Jonathan Lewis	Associate Head of School at Charles Sturt University School of Dentistry and Health Sciences	Charles Sturt University
Kathrin King	Manager - Radiology Services	Justice Health & Forensic Mental Health Network
Nadine Thompson	Chair - Advanced Practitioner Advisory Panel Chief Radiographer at Sydney Adventist's Hospital	Australian Society of Medical Imaging and Radiation Therapy
Nathan Emanuel	Chief Radiographer, Royal North Shore Hospital	Northern Sydney LHD
Pat Redmond	Radiology and Pathology Services Manager	Southern NSW LHD
Patrick Wong	Diagnostic Radiographer	Western Sydney LHD
Paul Green	Manager Medical Imaging, Lismore Base Hospital	Northern NSW LHD
Phillipa O'Brian	Interventional Radiology Section Manager	St Vincent's Health Network
Sarah Lewis	Associate Professor in Diagnostic Radiography, Discipline of Medical Radiation Sciences	University of Sydney
Shila Jeram	Chief Medical Radiation Scientist, Radiology, Royal Prince Alfred Hospital	Sydney LHD
Steve Adams	General Manager Imaging Services	Western Sydney LHD
Nuclear Medicine Technologists		
Angela Brewer	Deputy Chief Medical Radiation Scientist, Department of PET and Nuclear Medicine, Royal Prince Alfred Hospital	Sydney LHD
Caryl Christian	Chief Technologist, Nuclear Medicine and PET/CT Department, Prince of Wales Hospital	South Eastern Sydney LHD
David Wilkinson	Chief Medical Radiation Scientist (Nuclear Medicine)	Illawarra Shoalhaven LHD

Dr Daphne James	Nuclear Medicine, Program Convenor Medical Radiation Sciences	University of Newcastle
Dr Peter Kench	Senior Lecturer in Nuclear Medicine and Medical Radiation Sciences, University of Sydney	Australia and New Zealand Society of Nuclear Medicine
Elizabeth Bailey	Nuclear Medicine Chief Technologist Co-Chair, ACI Nuclear Medicine Network	Northern Sydney LHD
Geoff Currie	Associate Professor in Nuclear Medicine	Charles Sturt University
Jodie Brackenreg	Chief Medical Radiation Scientist, PET & Nuclear Medicine, Royal Prince Alfred Hospital	Sydney LHD
Justine Trpezanovski	Chief Nuclear Medicine Scientist	Sydney Children's Hospital Network
Nicole Kearney	Assistant Chief Nuclear Medicine Technologist	Hunter New England LHD
Sharon Alam-Fotias	Chief Nuclear Medicine Technologist	Nepean Blue Mountains LHD
Radiation Therapists		
Amie Ross	Lecturer in Radiation Therapy	Charles Sturt University
Anthony Arnold	Director of Cancer Services	Illawarra Shoalhaven LHD
Brian Porter	Deputy Chief Radiation Therapist	Northern Sydney LHD
Darren Martin	Chief Radiation Therapist, St George Hospital	South Eastern Sydney LHD
Jo Page	Former President Director of Radiation Therapy, Chris O'Brien Lifehouse	Australian Society of Medical Imaging and Radiation Therapy
Karen Jovanovic	Radiation Therapist, Calvary Mater Newcastle	Hunter New England LHD
Kevin Van Tilberg	Director of Radiation Therapy	Nepean Blue Mountains LHD
Jill Harris	Director of Radiation Therapy, Westmead	Western Sydney LHD
Rodney Hammond	Chief Radiation Therapist, Central West Cancer Care Centre	Western NSW LHD
Shane Dempsey	Associate Professor, Radiation Therapy and Head of the School of Health Sciences	University of Newcastle
Stephen Manley	Deputy Chief Radiation Therapist, Lismore Cancer Centre	Northern NSW LHD
Stuart Greenham	Area Manager, Radiation Therapy	Mid North Coast LHD
Other		
Allan Groth	Chief Operating Officer	Indigenous Allied Health Association

7.2 MRS Approved Programs of Study in NSW

Education Provider	Program of Study
Charles Sturt University	Bachelor of Medical Radiation Science (Medical Imaging)
Charles Sturt University	Bachelor of Medical Radiation Science (Medical Imaging) (Honours)
Charles Sturt University	Bachelor of Medical Radiation Science (Nuclear Medicine)
Charles Sturt University	Bachelor of Medical Radiation Science (Nuclear Medicine) (Honours)
Charles Sturt University	Bachelor of Medical Radiation Science (Radiation Therapy)
Charles Sturt University	Bachelor of Medical Radiation Science (Radiation Therapy) (Honours)
University of Newcastle	Bachelor of Medical Radiation Science (Diagnostic Radiography)
University of Newcastle	Bachelor of Medical Radiation Science (Nuclear Medicine)
University of Newcastle	Bachelor of Medical Radiation Science (Radiation Therapy)
University of Sydney	Bachelor of Applied Science (Diagnostic Radiography)
University of Sydney	Master of Diagnostic Radiography

7.3 Diagnostic Radiographer Referral and Service Pathway



7.4 Nuclear Medicine Technologist Referral and Service Pathways

Referral

- Nuclear medicine technologists can either receive referrals from specialists (including from the private sector) or general practitioners. In paediatrics, approximately 80% of referrals come from paediatric specialists (with 20% from GPs); for adult patients, it is approximately a 50-50 split between specialists and general practitioners as the referring source.

Processing

- This stage of the process is varied, depending on the individual facility or department internal processes – it may either be an administrator or clerk receiving the referral and making the patient appointment, or some referrals may be sent directly to the nuclear medicine technologist to review the patient case prior to an appointment being booked.
- The prioritisation of the patient referral is highly dependent on the urgency of the procedure, as well as on patient requirements such as if they are required to be fasted or if they are taking certain medications, for example.
- Outpatients from private specialists may be booked into public facility for nuclear medicine procedures if it is more convenient for the patient. Stakeholders reported that private patients can also choose, if presenting to a private nuclear medicine facility, to pay a premium to "jump the queue" and be seen quicker.

Booking / Appointment

- It is then the responsibility of the administration / clerk role to make the appointment – an SMS is sent the day prior to the patient with information and instructions on preparation requirements.
- One constraint identified in this stage is who takes responsibility for providing information, obtains informed consent and education to the patient once they present for their appointment.

Scan / Procedure

- Nuclear medicine imaging is usually performed on an outpatient basis, but can also be done for inpatients as well.
- Nuclear medicine technologists, and the procedures they administer, have a role in both the diagnosis as well as therapy of patients. The imaging and therapeutic procedures are usually non-invasive (with the exception of intravenous injections, particular for radiotherapy), and it is role of the nuclear medicine technologist to assist patients when the use radioactive materials is required.

Reporting

- Following the scan or procedure, the reporting is done by the nuclear medicine physician.
- The role of nuclear medicine technologist in the reporting stage needs further consideration as stakeholders believe they should be a larger role as the data analysis associated is important. Students require this skill and are taught it in university but not translated into their practice.
- Specialists often ring the nuclear medicine technologist for clarification (rather than physician) in private referrals so they need to have skills in explaining / clarify results.

7.5 Radiation Therapist Referral and Service Pathway

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