NSW Ministry of Health

Sonography - Horizons Scanning and Scenario Generation Report

March 2019

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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 sonography 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 Sonography 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 2016, there were 5,486 qualified sonographers nationally on the Australian Sonographer Accreditation Registry (ASAR). Sonographers are highly trained medical imaging practitioners that perform specialised diagnostic investigations that are used to examine the body, specifically for diagnosing and guiding the management for many medical conditions. The Sonography Workforce Horizons Scanning and Scenario Generation Project (the Project) supported stakeholders in the profession to participate in the development of a driver model that articulates key demand and supply drivers for the sonography workforce in NSW.

The research and analysis conducted during the Project identified several demand drivers for the sonography workforce. These include 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 sonography 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 sonographer roles.

As indicated by stakeholders, this Project also recognised the key challenges and future opportunities for the sonography workforce. Challenges identified by the participants for the workforce were related to musculoskeletal injuries, funding constraints and the impacts of over-ordering tests. Emerging opportunities suggested from the participants included involvement in service planning and design, education of sonography best practice, and within training and availability of clinical placements.

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 Sonography 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.

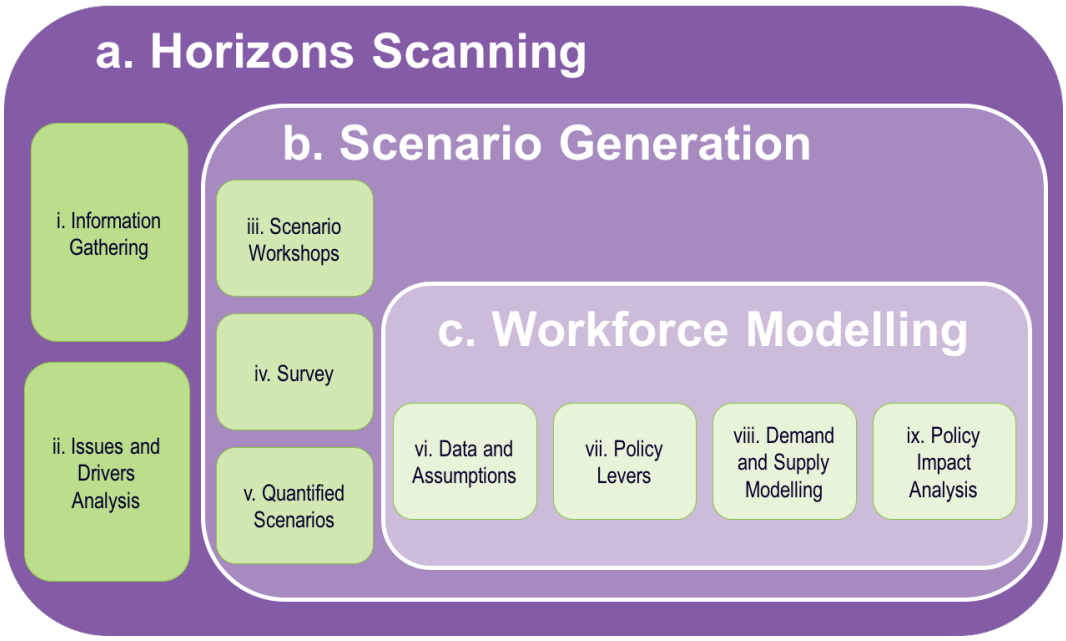
The Horizons Scanning and Scenario Generation Project offered an opportunity for stakeholders in the sonography workforce to take a short, medium and long-term view for their field. In taking these views, participants suggested several system-wide influencing factors require consideration, including (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 sonographers' 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 sonography 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** below.

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 the literature review. To augment the initial findings, a comprehensive search of organisational and grey literature was undertaken. Key words relevant to the sonography workforce 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 Australia was also utilised, including summaries of studies conducted in the United Kingdom and United States of America. Whilst the health systems in the United States and United Kingdom 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 sonographers working within NSW Health. The survey consisted 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 their perceived level of impact.

2.1.3 One-to-one stakeholder interviews

A series of one-to-one interviews were also conducted with representation from various sectors including; Local Heath Districts (LHDs), Specialty Health Networks (SHNs), NSW based universities, and professional bodies. 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 3rd September 2018 and formed the basis for the development of a supply and demand driver model for the sonography workforce.

Key sonography stakeholders representing LHDs, SHNs, universities, and representatives from professional bodies – including the Australasian Sonographers Association (ASA) – 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 sonography 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 24th September 2018 and built upon themes that were explored in the horizons scanning workshop. To maintain consistency in the methodology, the same participants as the horizons scanning workshop were engaged as well as additional sonographers from cardiac and vascular specialties.

The workforce driver model was presented to further validate what was emerging as the key demand and supply drivers for the sonography workforce. Stakeholders were invited to validate the concepts contained within the workforce driver model. 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 could aim to address them.

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

3 Overview of the Workforce

This section details the scope of practice for the sonography workforce, and the roles and functions of the relevant professional boards and bodies.

3.1 Scope of Practice

Sonographers are highly trained medical imaging practitioners that perform specialised diagnostic investigations using an ultrasound machine (Australasian Sonographers Association, 2018). Ultrasound tests are used to diagnose and guide management of medical conditions.

Sonographers capture and record sonographic images while tailoring the examination based on the anatomical and physiological characteristics of a patient. They are responsible for patient care, assessment, communication to the patient/family and subsequent actions based on the examination. Sonographers also assist the radiologist by generating a written interim report exploring diagnoses for the radiologists' reference.

Sonographers in Australasia may practice across a range of disciplines including:

- Abdomen and chest
- Breast
- Cardiac
- Musculoskeletal
- Obstetric and Gynaecological (O&G)
- Paediatric
- Small parts
- Vascular (Australasian Sonographers Association, 2018).

In addition to being used for diagnosis, sonography may be used to guide medical interventions. Examples of this include fine needle aspiration biopsy, taking samples of breast tissue to test for cancer, or injecting medication directly into joints and soft tissue such as cortisone (Australasian Sonographers Association, 2018).

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 sonography workforce.

3.2.1 Australasian Sonographers Association

The Australasian Sonographers Association (ASA) is the peak body for sonographers in Australia and New Zealand. With over 5,800 members, ASA represents more than 70% of accredited sonographers in Australia and have a growing base in New Zealand.

ASA's objectives are to lead the sonography profession in the provision of excellent ultrasound delivery for the community through:

- Providing high quality sonographer education and research
- Advocating for the role of sonographers in the healthcare system

- Promoting best practice in medical sonography (Australasian Sonographers Association, 2018).

3.2.2 Australasian Society for Ultrasound in Medicine (ASUM)

The Australasian Society for Ultrasound in Medicine (ASUM) is the premier multidisciplinary society advancing the clinical practice of diagnostic medical ultrasound for the highest standards of patient care.

The purpose of ASUM is to promote the highest possible standards of medical ultrasound practice in Australia and New Zealand through the following:

- Dissemination of scientific information
- Providing education
- Setting standards of practice within the speciality (Australasian Society for Ultrasound in Medicine, 2018).

3.2.3 Australian Sonographer Accreditation Registry (ASAR)

The Australian Sonographer Accreditation Registry (ASAR) maintain the registry of accredited sonographers in Australia.

The main functions of ASAR are as follows:

- Provide accredited sonography education programs within Australia
- Maintain a register of Accredited Sonographers and Accredited Student Sonographers
- Establish minimum standards of Continuing Professional Development (CPD) and to monitor the CPD requirements for sonographers to remain on the register.
- To support activities that advance the profession of sonography
- To provide registration information about sonographers to Medicare Australia
- To provide public access to the name, registration number, state or territory, current type of accreditation and area of specialty for active sonographers (Australian Sonographer Accreditation Registry, 2018).

It should be noted that ASAR maintains the registry but are not a registration board, and they do not have the authority to remove a sonographer from the registry.

It should be noted that ASAR maintains the registry but are not a registration board; therefore, they do not have the authority to receive complaints, enforce practice standards or remove a sonographer from the registry unless they fail to pay the annual registration fee or maintain CPD requirements.

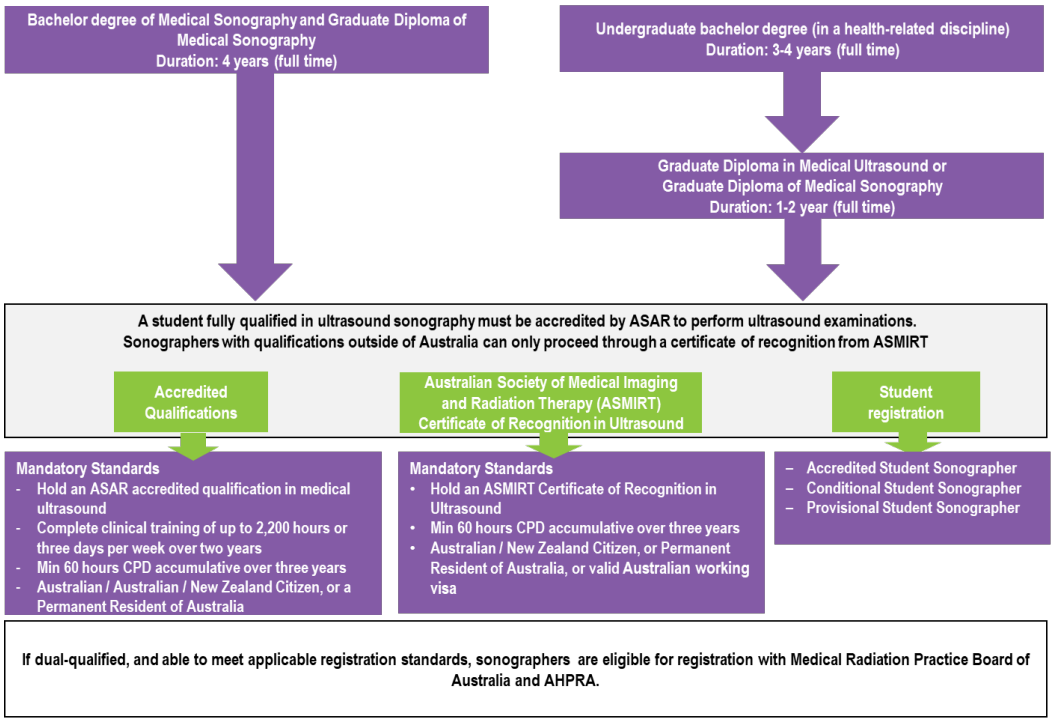
3.3 Entry to the Profession

To enter the profession, a qualified sonographer needs to have completed an accredited program and undertaken at least 2,000 hours of clinical training. Students wishing to be accepted into a post-graduate sonography course must have already received a bachelor's degree in diagnostic imaging or a related health science degree (Australasian Sonographer Association, 2018).

Sonographers and student sonographers must be accredited by ASAR to perform clinical ultrasound examinations eligible for Medicare rebates. Some sonographers may be dual

trained in sonography and diagnostic radiography, nuclear medicine or radiation therapy where they are registered with the Medical Radiation Practice Board of Australia (MRPBA). **Figure 2** below depicts the pathways for entry to the sonography profession.

Figure 2: Pathways for entry into the sonography profession



(The Australian Sonographer Association Registry ASAR, Sonographer Accreditation)

3.4 Workforce Characteristics

The following section details the key workforce characteristics for the sonography profession.

3.4.1 NSW Sonography workforce characteristics

As sonographers may be dual-trained and therefore fall under two distinct awards, state-wide workforce data was collected separate to this Project. It was determined that a total of 537 qualified sonographers (as headcount) were working within NSW Health as of November 2018.

3.4.2 National Sonography workforce characteristics

The Australian Sonographer Accreditation Registry has recorded relevant statistics for all accredited qualified and student sonographers. However, it should be noted that these figures are approximates. A breakdown has been provided below:

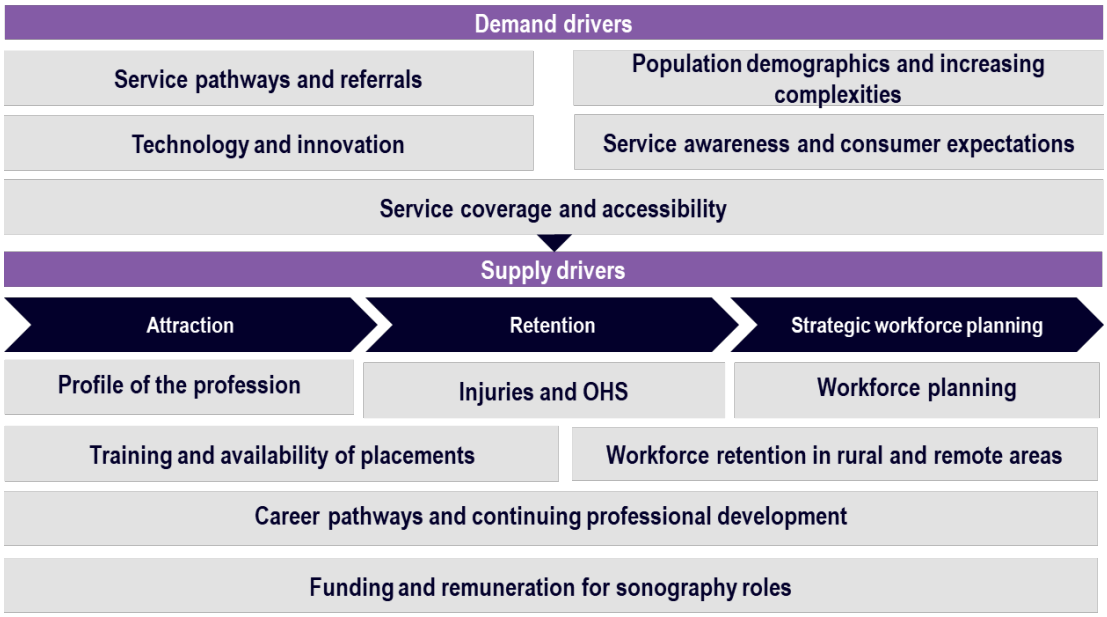
- In 2016, there were 5,486 qualified sonographers and 1,028 student sonographers on the ASAR Register
- There has been a steady increase in the number of qualified sonographers, amassing to an 18% increase from 2012 to 2016
- The sonography workforce is predominately female, comprising 76.21% of the qualified workforce

- Sonographers work in a variety of disciplines. A granular breakdown has been provided below. In 2016:
    - 75% of all sonographers worked in general sonography
    - 18% worked in cardiac
    - 3% worked in vascular
    - 3% worked in breast
    - 1% worked in obstetrics (Australian Sonographer Accreditation Registry, 2018).

4 Summary of the Key Demand and Supply Drivers

This section provides an overview of the key demand and supply drivers impacting the sonography 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 sonography stakeholders. These drivers are summarised in **Figure 3** below.

Figure 3: Sonography - Demand and Supply Driver Model



4.1 Demand Drivers

Informed by the literature and stakeholders, an analysis of the demand drivers currently impacting the sonography workforce is detailed in this section. Demand drivers may be defined as the factors that shape and influence demand for a workforce's services.

Table 1 below provides a high-level overview of the demand drivers, followed by a more detailed explanation and analysis of each driver.

Table 1: Overview of the key demand drivers for the Sonography workforce

Demand Driver	Description
Service pathways and referrals	The referral pathways and ordering practices to accessing sonography services
Population demographics and increasing complexity	Incidence and prevalence of complex/chronic diseases and cancer based on population growth, demographic characteristics and geographic distribution
Technology and innovation	Emerging technologies and innovations that lead to new interventions and work practices
Service coverage and accessibility	The coverage and accessibility of sonography services based on geographical, social and economic distribution
Service awareness and consumer expectation	Public awareness of sonography services based on increased consumer expectations and knowledge

4.1.1 Service pathways and referrals

There are several service and referral pathways for sonography services:

- 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.

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

The demand and use of imaging services has grown exponentially over the last decade. Medicare Australia statistics show an increase in the number of diagnostic imaging services requested from 1.5 million examinations per annum in 2004/05 to 3.4 million per annum in 2017/18, with a 46% increase in ultrasound services (Department of Health, 2018). Stakeholders perceived there to be an increasing reliance on the use of ultrasound on patients as an exploratory measure, rather than used to support clinical decision making. As

a result, some held the belief that some referrals were either inappropriate or too broad but recognised that it is becoming more common practice to use ultrasound as part of specific medical pathways or models of care.

4.1.2 Population demographics and increasing incidence of chronic and complex disease

The estimated population of Australia at 31 March 2018 was 24.9 million people. Since last year, Australia's population growth has increased by 1.6% overall, with NSW growing by 1.4% (Australian Bureau of Statistics, 2018). Stakeholders agreed that changing population demographics – such as the increasing population, an increasingly ageing population, increased birth rates, and survival rates – along with the rise of chronic and complex disease was contributing to increasing demand for sonography services.

Ageing population

Australia's ageing population significantly impacts on the ability of sonography services to maintain and support the health needs of a population. In 2017, 15% of the population were aged 65 years and older, with projections stating this will rise to 22% of the population by 2057, amounting to 8.7 million older people nationally (AIHW, 2017).

While advancements in medicine have led to increased longevity of life, the implication is more people are living with chronic and complex diseases. Conditions such as heart disease, cancer, musculoskeletal conditions and respiratory diseases are more prevalent as people get older and contribute to a greater number of hospitalisations within NSW. In 2016-17, patients aged 65 and over accounted for 42% of all hospitalisations and 21% of all emergency department presentations; this is significantly disproportionate considering that this cohort of patients only represents 15% of the overall population (AIHW, 2017).

Stakeholders reported that ultrasound is a well-established diagnostic technique and the preferred initial screening procedure in a variety of clinical situations. The non-invasive nature of ultrasound allows it to be particularly suitable for investigation in elderly patients, for example in patients with sarcopenia. Sarcopenia, a condition associated with the loss of muscle mass and strength, is one of the leading causes of functional decline and loss of independence in the older population. If sarcopenia is detected early enough, management and treatment of the condition is relatively inexpensive and easy (Stringer & Wilson, 2018). However, the diagnostic tool used must be able to adequately calculate the muscle mass and quality of the patient, which can be difficult to do with frail and elderly patients. Research suggests that ultrasound is an effective way to diagnose sarcopenia and facilitate appropriate dietary and exercise intervention for those who suffer from it (Nijholt, Scafoglieri, Jager-Wittenaar, Hobbelen, & van der Schans, 2017).

The introduction of screening procedures such as the example provided has gradually increased the demand for these services; this is demonstrated in the Medicare figures showing an increasing amount of ultrasound services are being performed (Department of Health, 2018). Due to the ageing population, ultrasound is increasingly used more for guidance of interventional therapy and as a method for managing pain in patients with degenerative conditions.

Stakeholders indicated that as the ageing population continues to rise, the demand for sonography services – as with all other health care services – will rise proportionally.

Chronic and Complex Diseases

The rising incidence of chronic and complex diseases in Australia has a significant impact on the demand for all health care services. In 2015-16, 48% of all 'potentially preventable hospitalisations' were due to chronic conditions (Australian Institute of Health and Welfare , 2017).

Stakeholders considered that the overall health of the community played an important part in increasing demand for sonography services. Risk factors such as obesity, drug and alcohol abuse, and tobacco use are expected to steadily increase the occurrence of conditions, such as heart disease and respiratory diseases over time (Primary Health Care Advisory Group , 2015). For example, heavy alcohol consumption causes alcoholic liver disease and may lead to a number of other concomitant diseases. Ultrasound can identify the manifestations of chronic liver disease such as liver fibrosis and cirrhosis which are characterised by the presence of vascularised fibrotic septa and regenerating nodules (Allan, Thoirs, & Phillips, 2010).

Cardiovascular disease (CVD) is one of the leading causes of death and hospitalisations in Australia. In 2010, cardiovascular disease was responsible for 25.8% of the burden of disease in Australia, based on years of life lost (YLL) – or premature death. Based on YLL, the burden attributable to CVD in Australia is second only behind cancer (33.7%). (National Heart Foundation of Australia, 2018). It is estimated that 4.2 million (22%) Australian adults aged 18 years and over have had one or more cardiovascular diseases, including coronary heart disease, stroke, heart failure and hypertension (Australian Institute of Health and Welfare, 2018). In 2012-13, $5 billion was spent providing healthcare to admitted patients with CVD, accounting for approximately 11% of total admitted health expenditure – the largest share of health expenditure of any disease group (Australian Institute of Health and Welfare, 2017).

Cardiac sonography is the specialised practice of acquiring images of the heart and aiding in initial diagnosis and management of the disease (Al-Kaisey, et al., 2015). In recent years, there has been a significant growth in the use of echocardiography to aid in non-invasive diagnostic imaging of several heart conditions, including CVD (Pearlman, Ryan, Picard, & Douglas, 2007).

Women and Birth

In 2016, 310,247 women gave birth in Australia—an increase of 12% since 2006. Additionally, the average age of women giving birth continues to rise, from 28.1 years of age in 2006 to 29.0 years of age on average in 2016 (Australian Institute of Health and Welfare, 2018). Studies have shown that the increase in average age of first-time mothers can have an increased likelihood of certain medical complications (Lampinen, Vehvilainen-Julkunen, & Kankkunen, 2009).

An increased understanding of ultrasound and its benefits for maternity services has had a significant impact on demand for sonography services. Stakeholders reported that only one decade ago, on average two to three ultrasound scans were performed during the course of a women's pregnancy. Nowadays, diagnostic ultrasound has provided an alternate, safer way of undertaking antenatal scans, evaluating foetal development and diagnosing foetal, uterine and placental abnormalities (Glazebrook, et al., 2004). The knowledge that ultrasound is an inexpensive, safe, and effective way to check on the development of mother and child has increased expectations around the requirements for ultrasounds in both

patients and referrers. Stakeholders reported that approximately, all expectant mothers have on average at least three or more ultrasound scans throughout their pregnancy.

Ultrasound is not limited to detecting and diagnosing conditions relating to birth. In 2018, it is estimated that 1,613 new cases of ovarian cancer will be diagnosed in Australia and the risk of a female being diagnosed with ovarian cancer by her 85th birthday will be 1 in 77 (AIHW, 2018). Abdominal and transvaginal ultrasound scans are often used as a primary screening tool for different types of cancers, allowing for early detection and treatment of the illness. It is expected that cancer screening will continue to drive demand for sonography services.

4.1.3 Technology and innovation

As the overall health system moves towards better utilising new technologies to aid efficient and effective patient care, technology and innovation is a significant factor driving demand for sonography services. Stakeholders reported that using emerging technologies in new ways of working continues to impact upon demand for services.

One example of this is the use of the ultrasound in emergency departments. Point of care ultrasound (POCUS) is a relatively new, progressive use of ultrasound technology. In using POCUS, the ED physician/sonographer performs all image acquisition and interpretation at the bedside and uses the information immediately to address specific hypotheses and to guide ongoing therapy (Whitson & Mayo, 2016). This posits two ways that POCUS could impact the demand for sonographers:

- Sonographers placed in the ED performing the scan at the bedside
- Sonographers training medical professionals to accurately perform POCUS.

Some stakeholders advised that the portability, ease of use, and perceived biological safety of ultrasound lends itself to be used as a bedside diagnostic service. There was some concern expressed by stakeholders that POCUS could prove to be challenging for the sonography workforce in the future with increased use; not only does it increase the workload of sonographers, there was also some concern about the safety of other medical professionals not adequately trained in ultrasound performing the tests.

There is an increasing trend in the use of interventional imaging in healthcare. Procedures such as musculoskeletal ultrasound therapy, where the sonographer uses ultrasound to guide steroid injections, are optimal for patient outcomes and experience (Hart & Dixon, 2008).

In addition, ultrasound imaging resolution has increased significantly over the last 50 years, allowing sonographers to see anatomical structures that would otherwise be impossible to see through ultrasound. For example, in 2009, it was reported that a 35-year-old pregnant woman presented to the ultrasound department to check for foetal anomalies. The ultrasound found the foetus to have a fully formed brain, base of skull and facial structures, but lacking the cranium (Umar Amin,, Mahmood, Nafees, & Shakoor, 2009). However, it is important to understand that innovations and technological advancements will have an impact on the sonography workforce. The increased workload and complexities faced by sonographers will need to be considered when aligning workforce numbers to meet demand in the future.

4.1.4 Service coverage and accessibility

In March 2018, an inquiry focusing on the availability and accessibility of diagnostic imaging in Australia was held (Senate Community Affairs References Committee, 2018). Submissions made to the Senate outlined the concerns of accessibility of diagnostic imaging machines to rural and remote areas. Patients living in these areas are subject to consequences such as limited access to appropriate diagnostic imaging services, and additional costs to access services.

The availability of imaging services varies between regions in rural and remote areas. It was noted that often, if the patient receives a required scan in a regional area, it is likely to be more expensive than in metropolitan or regional areas (Senate Community Affairs References Committee, 2018). The added financial burden to patients required to travel to access services also needs to be considered when understanding accessibility in rural and remote areas.

Stakeholders acknowledged that poor access to diagnostic imaging services may contribute to poorer health outcomes in rural and remote communities. The delay in receiving imaging services, coupled with higher out-of-pocket costs, has the potential to postpone diagnosis and treatment for people living in rural and remote areas. Solutions, such as outreach services, could be explored as an alternative to reaching remote – particularly Aboriginal – communities to provide increased accessibility and equity of service provision.

4.1.5 Service awareness and consumer expectations

With the prevalence of the internet and social media, the public is now more exposed to a variety of health-related sources. Several studies have shown that the web has become a popular source of information for pregnant women, influencing their expectations of, and decision making regarding healthcare (Lagan, Sinclair, & Kernohan, 2011) (Lee, Holden, & Ayers, 2016). Some of the impacts of the increase in patient expectations include:

- An increase in the number of ultrasound scans performed during pregnancy. As previously explored, stakeholders reported that as ultrasound scans are inexpensive, safe and effective, patients request routine early pregnancy scans to detect foetal abnormality in the early stages of pregnancy.
- The relationship between sonographer and patient, whereby the patient assumes that the sonographer can communicate the health of the foetus immediately (Thomas, O'Loughlin, & Clarke, 2016). This places pressure on the sonographer as they feel obligated to provide foetal diagnoses to parents, without the appropriate training or governance to do so (Menzes, Hodgson, Sahhar, & Metcalfe, 2013). This leads to potential medico-legal issues and burnout of sonographers as they grapple with the burden of responsibility. Stakeholders agreed that this was a challenge for the future workforce. Legal susceptibility for sonographers could be high as the profession participates in activities that would be classified as role extension (Mitcalf & Harrison, 2003).

Stakeholders volunteered that the ease of use, safety and the inexpensiveness of ultrasound drove an increase in patients being referred for sonography services. Anecdotally, general practitioners and specialists are more likely to use ultrasound as a first-point-of-call imaging modality due to its portability, accessibility and ease of patient preparation. Ultrasound imaging technology has matured, has the ability to gather high-quality soft tissue images, making it ideal for detecting cysts, abdominal fluids, and supporting guided biopsies.

4.2 Supply Drivers

This section provides a detailed analysis of the supply drivers currently impacting the sonography 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 2 below provides a high-level overview of the supply drivers, followed by a more detailed explanation and analysis of each supply driver.

Table 2: Overview of the key supply drivers for the Sonography workforce

Supply Driver	Description
Profile of the profession	Professional voice, image and representation of the sonography profession
Training and availability of placements	Availability and quality of training and placement positions for recent graduates
Career pathways and continuing professional development	Availability of career progression opportunities for sonographers
Workforce recruitment and retention in rural and remote areas	Workforce retention of sonographers based on geographic location and lifestyle preferences
Workplace injuries and OH&S	Occupational health and safety issues and workplace injuries that impact the quality of a sonographer's career
Workforce planning	Aligning the needs and priorities of the system with those of its workforce
Funding of sonography roles and award structure	Funding of public sector sonography positions and activities

4.2.8 Profile of the profession

The profile of a profession plays an important part in attracting employees to the workforce. Throughout the Project, stakeholders suggested that increasing the awareness of the sonographer scope of practice may encourage more students to consider sonography as a potential career option.

Internationally, there has been targeted attempts at addressing the undersupply of sonographers by increasing the profile of the profession to school-aged children. In the US, in response to an undersupply of qualified sonographers in the workforce, an outreach program designed for high school students was developed to raise awareness of the sonography workforce. The program resulted in 60% of participating students indicating that their level of interest in pursuing a sonography career had increased after the presentation (Merton, 2011). The undersupply of qualified sonographers can result in reduced access for

patients as resources become stretched, with practicing sonographers shouldering the burden (Merton, 2011).

Stakeholders also acknowledged that their profession requires more recognition from the public and other medical professionals. During the Scenario Generation Workshop, participants raised the importance of having their own professional voice – specifically focussing on the ability to be their own "masters of destiny". Stakeholders felt that there was an opportunity to further develop the profile of the profession which in turn could further advancements in clinical practice, involvement and service design and planning, and greater cohesion of the sonography workforce.

4.2.9 Training and availability of placements

The availability and quality of training and clinical placements for student sonographers is a significant supply driver affecting the workforce. ASUM recognises that for the past ten years there has been a shortage of trained sonographers in NSW, compounded by the fact that there are not enough clinical training places for the number of available graduates (Senate Community Affairs References Committee, 2018). Stakeholders across all disciplines collectively agreed that the ability to align sonography students to placements has been a complex issue for some time.

It was reported by stakeholders that the private sector seemingly does not provide the number of clinical placements to sonography students to the same degree as public institutions (Docherty, Foran, Burnett-Roy, & May, 2017). Historically, training has been perceived as a time-consuming task. The time required to train a sonographer to work independently is significant, often requiring over six months of time to achieve practice at a competent level. Supervisors are required to have hands on involvement during the clinical placement, until both the supervisor and the trainee feels adequately competent in their role. (Ryan, 2017).

Stakeholders noted the burden of time and resources to take on trainee sonographers. The nature of the 'one-to-one' training model for a student sonographer was acknowledged by stakeholders as a time consuming, but nonetheless important part of training proficient sonographers. However, literature suggests that the existing ratio of one-to-one supervision is not a sustainable model and that there is an opportunity for innovating the training model (Sim, 2016)

It was raised that hospital imaging departments are currently at capacity training sonographers for the required 2,000 hours. Stakeholders reported that additional, dedicated resourcing for training – such as a clinical educator position - would increase their capacity to train students whilst leading to a greater level of knowledge amongst students and graduates.

Stakeholders suggested fostering better relationships between universities and public imaging departments would be beneficial to align clinical placements with the number of students. Some mentioned that incentive models, where universities provide incentives to hospitals or imaging departments to provide placements to students, could be one potential way to ensure clinical placements are adequately resourced.

4.2.10 Career pathways and continuing professional development

Opportunities for further career progression and development was noted by stakeholders as a supply driver. Certain stakeholders identified that there were limited opportunities to access further training once qualified as a sonographer.

During the interviews, stakeholders indicated that there were some challenges to working in distinct areas of sonography practice, especially in rural and remote areas. Sonographers in rural and remote areas are particularly valued if they are either generalist sonographers, or dual-trained in sonography and diagnostic radiography, as it means facilities are better able to provide a full suite of imaging services. Some noted that whilst sub-specialisation should be seen as a professional development opportunity, it can also hinder career options should the sonographer wish to practice in a generalist capacity.

For the past 30 years in the UK, sonographers have been autonomously performing and reporting on obstetric ultrasounds under little-to-no medical guidance (Alex & Dixon, 2008). Stakeholders advised that sonographer role extension or sonographer practitioner development in Australia is less widely accepted. During the scenario generation portion of this Project, some stakeholders suggested that there may be potential advantages to role extension for sonographers, including increased job satisfaction, career progression, and efficiencies for patients.

4.2.11 Workforce recruitment and retention in rural and remote areas

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

During the development of the Australian College of Rural and Remote Medicine (ACRRM) National Radiology Program in 2000, the need for an obstetric ultrasound program was identified (Glazebrook, et al., 2004). The study found that obstetric ultrasound education was an area of high need in continuing professional development for rural and remote non-specialist doctors.

The ACRRM submitted that an absence of specialist staff requires rural practitioners (such as nursing or medical professionals) to take on added responsibilities, especially with respect to imaging (Senate Community Affairs References Committee, 2018). This may suggest the requirement for additional sonographer resource in these areas to meet the demands of the service. Stakeholders stated that there are opportunities to travel to remote and regional areas for periods of time to train other medical professionals in sonography, and to share advanced training with colleagues.

Stakeholders advised that providing monetary incentives could be used to attract and retain sonographers in regional, rural and remote areas. Incentives such as additional remuneration, training opportunities or further education could lead to better recruitment to and attainment of sonographers – particularly dual-trained sonographers/radiographers – in rural and remote areas.

4.2.12 Workplace injuries and OH&S

Musculoskeletal condition are injuries and disorders that affect the human body's movement or musculoskeletal system (muscles, tendons, ligaments, nerves, discs, blood vessels, etc) (World Health Organisation , 2018). In Australia, it is estimated musculoskeletal conditions cost businesses somewhere between $5 to $20 billion per year; through loss of income,

paying out Medicare benefits, and the monetary value of a worker's injury (Murphey & Coffin, 2002).

Stakeholders identified sonography as a manually intensive role. Some stakeholders mentioned incidences of musculoskeletal injuries, with potential for repetitive stress on their neck, shoulders and arms. As a result, some sonographers may retire early or change to part-time positions as their condition worsens. There are predicted costs to organisations to increase staffing to cover injuries (Pallotta & Roberts, 2016). The WorkSafe Commission of Australia suggested that a 10% reduction in workplace injuries nationwide would result in an increase in the Gross Domestic Product of $340 billion (Murphey & Coffin, 2002).

Improvements in ultrasound technology have led to higher quality imaging and faster processing. Whilst advancements in technology is seemingly advantageous for patient outcomes, the converse of this is that sonographers are scanning more complex patients, resulting in longer examinations, and sometimes more minute movements of the transducer than traditionally used. This can mean less time in between patients for their muscle to properly repair, increasing their risk of injury or pain.

Stakeholders suggested that for the future workforce, it is important to focus on educating sonographers on safe workplace practices, such as including visible reminders about posture, self-care, and stretch sessions identified as ways to reduce stress and injury.

4.2.13 Workforce planning

Most sonographers agreed on the need to align the priorities of the healthcare system and those of its workforce, both now and into the future. With ever-rising healthcare demands, stakeholders noted that strategic planning will ensure there is sufficient capacity and capability available to meet these demands.

One of the themes that emerged when discussing workforce planning is related to the ageing workforce. Several stakeholders reported that there are increasing numbers of retiring sonographers; a concern for the workforce given the known undersupply in Australia. While there is no data to corroborate the increasing numbers of retirees, the survey conducted as part of the Project indicated that 18.75% of the survey respondents stated they were planning to retire in the next 10 years. Another related issue is that as an ageing workforce, the stakeholders felt that they are more disposed to musculoskeletal injuries in an already high-risk industry as previously identified. Stakeholders felt there needs to be consideration regarding succession planning to ensure that institutional knowledge is not lost due to retirement. An opportunity would be to consider elevating the older workforce into training positions such that knowledge is appropriately passed on.

4.2.14 Funding of sonography roles and award structure

Funding was recognised as a crucial driver impacting the supply of the sonography workforce.

Stakeholders suggested that additional funding of roles could support better delivery of sonography services. As previously highlighted, stakeholders reported dedicated educational resources would lead to improved training whilst reducing the burden practicing professionals. It would also raise the professional standards of the workforce and introduce a more standardised training model.

Stakeholders also focused on the potential of funding being used to promote more research and CPD opportunities within the sonography workforce. Ongoing professional development

is essential for maintaining and enhancing health practitioners' skill sets and ensuring future opportunities for career progression. While this may not be the view of the entire workforce, some stakeholders had the perception that there were limited opportunities for further training within sonography.

Another key theme that emerged was the award structure. There are two main types of awards that sonographers can fall under:

- Medical Radiation Science (MRS) Award: sonographers who have a relevant undergraduate MRS degree and an appropriate accreditation with the relevant body (Industrial Relations Commission Of New South Wales, 2018).
- Health Employees (State) Award: sonographers that have a postgraduate qualification in sonography and an undergraduate degree in sonography or a different healthcare related undergraduate degree) meet the requirements as a Cardiac Technician as determined in this Award (Industrial Relations Commission Of New South Wales, 2018).

There was discussion surrounding the appropriateness of the different award structures for sonographers. Some stakeholders felt that there is a disparity between the opportunities available to a dual trained sonographer (that falls under the MRS award) compared to those that fall under the Health Employees (State) award. Stakeholders suggested a restructure of the award as a potential solution to this disparity but recognised that there are multiple avenues to consider.

5 Challenges Encountered by the Sonography Workforce

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

5.1 Funding constraints

When discussing the likelihood of potential challenges for the future workforce, funding constraints emerged as the most significant driver that will impact on the future workforce.

It was reported by participants that additional funding is required in areas such as training and education (i.e. funded training positions or dedicated educator resourcing), rural and remote service consideration (i.e. implementing hub and spoke models and incentive programs in these areas), and promotion of the sonography workforce (i.e. involvement in service design and planning). Sonography participants suggested that being able to appropriately respond to funding constraints will ensure that the workforce can adequately deliver services into the future.

5.2 Musculoskeletal pain and injury

Pushing a transducer and a heavy cord while simultaneously leaning over a patient, using the keyboard and viewing the screen can often result in the sonographer sitting in awkward positions (Pallotta & Roberts, 2016). If left unaddressed, poor scanning posture can cause significant stress on the neck, shoulders and right arm. Research has highlighted the potential effect on the workforce, including:

- 80–95% of sonographers experience work-related pain
- 90% experience this pain for more than half their career
- One in five sonographers sustain a career ending work-related injury (Pallotta & Roberts, 2016).

It was also reported that sonographers are less likely to report injuries or pain as they don't want to be perceived as unnecessarily complaining or that their claims are not serious enough (Pallotta & Roberts, 2016). Stakeholders agreed that this was a significant challenge for the sonography profession.

Throughout the engagement process, stakeholders reported that employing dual trained sonographers could be a potential solution for this challenge. The sonographer could split their time between the sonography and another imaging modality, effectively reducing the repetitive nature of performing ultrasound examinations.

5.3 Over-ordering and inaccurate referrals

Stakeholders identified that the impact of over-ordering and inaccurate referrals will continue to be a key challenge for the future workforce. It was suggested that the quality of ultrasound referrals was due to an over-reliance on diagnostic imaging.

This has been reported as adding to sonographer caseloads, and the potential to add to occupational fatigue. Stakeholders also reported that over-ordering can cause duplication of tests (i.e. if the first was ordered pre-emptively), longer waiting periods for patients and potentially negative health outcomes as a consequence.

6 Opportunities Available to the Workforce

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

6.1 Involvement in Service Planning and Leadership

When considering the future, stakeholders placed involvement in service planning and leadership as an important opportunity for the workforce. Stakeholders noted that increased inclusion in planning decisions would result in greater professional recognition for the workforce and allow for more cohesion of the workforce overall.

6.2 Education about Sonography Industry Best Practice

As previously noted, stakeholders mentioned sonographers are at risk of musculoskeletal injuries during the course of their careers. Stakeholders agreed that promotion and education of proper posture, self-care and ergonomic equipment could lead to less injury and a healthier workforce. Less experienced sonographers require education regarding the possibility of suffering from a musculoskeletal injury from prolonged incorrect posture and ensuring proper scanning technique is taught during the early stages of their career should be a vital aspect of the job.

As stated above in the *challenges* section, dual trained sonographers would have the potential to work across different imaging modalities thereby reducing the risk of repetitive injury to their muscle tissue.

There is an opportunity for industry vendors to better utilise advancements in technology to design more ergonomic equipment for the future. Improvements in this space would reduce cost of injury to the sonography workforce and place the workforce in a better position to meet growing service demands.

6.3 Role Extension

In the UK, sonographers have been performing their roles autonomously for several years now and have created opportunities to further develop and extend their role. Stakeholders advised that sonographer role extension or sonographer practitioner development in Australia is somewhat accepted.

While the ability to independently report ultrasound examinations without the overview of a radiologist is not yet prevalent in Australia, it does have potential for the sonography workforce. Some stakeholders suggested that opportunities to develop their career and enhance professional development could potentially be more widespread if they were able to perform autonomously. Additionally, sonographers could experience enhanced job satisfaction and develop a more prominent voice amongst other medical and allied health professions.

6.4 Training and Clinical Positions

There are lessons to be taken from international settings on how private and public practices can improve the way that sonographers are trained.

For example, the Canadian National Institute of Health in Ottawa embarked on a research project to develop and research a scanning protocol that could integrate the student sonographer without impacting patient volumes (Docherty, Foran, Burnett-Roy, & May,

2017). This involved a 2:1 trainee to educator module, relying on the idea that trainees assist each other through the training program, learning from each other and their mistakes.

In 2013, the University of Auckland formed a working group to address the acute national shortage of sonographers. They agreed on a model of training whereby new trainees commenced their first three months of training on campus with a 3:1 staffing ratio from both public and private institutions. Outcomes of this trial showed that less clinical supervision was required, trainee sonographers were productive in the workplace and clinical supervisor productivity less compromised (Sim, 2016).

Stakeholders also suggested initiatives such as fostering partnerships between facilities and universities, dedicated educator or trainee positions shared across hospitals or Districts, and a standardisation of training and qualifications to align the clinical placements to the number of students entering the workforce would enhance the training quality and availability.

7 Appendices

7.1 Sonography stakeholders engaged in the project

Name	Organisation
Olasunbo Olalere	HNELHD
Sharyn Derwin	CCLHD
Rachel Hellyer	SLHD
Karen Dorsett	MLHD
James Nol	WSLHD
Sharon Watson	NBMLHD
Drew Rikdas	SWSLHD
Gavin Fuller	SNSWLHD
Sandra Howell	ISLHD
Anna Abeska	NSLHD
Jacqueline Spurway	WNSWLHD
John Thomas	SESLHD
Solange Obeid	St Vincents Health Network
Sasko Kadiev	Sydney Children's Hospital Network
Amanda Crow	Sydney Children's Hospital Network
Jodie Long	Australasian Sonographers Association (ASA)
Amanda Chandler	Charles Sturt University
Paul Stoodley	Western Sydney University
Luke Fay	Australian Institute of Health Care Education
Donna Oomens	WSU
Allan Federicks	NNSWLHD
Rachel Taoho	NBMLHD
Pauline Reilly	SESLHD
Leigh Schneider	NSLHD
Alison Burnett	SLHD
Jacqui Robinson	SWSLHD
Kenny Ng	NSLHD
Christine Allman	SWSLHD
John Cates	HNELHD

Amy Clark	CCLHD
Christina Farr	SLHD
Brendan Mein	NBMLHD
Shakun Kishore	SWSLHD
Jane Wilkinson	SNSWLHD
Kate Pollock	NSLHD
Corey Hemopo	WNSWLHD
Sharon Williams	SESLHD
Fiona MacNaught	Australian Institute of Health Care Education
Lyndal Macpherson	ASUM
Ann Quinton	CQ University
Anita Bowman	CQ University
Paul Neilsen	CQ University
Vanessa Henderson	CQ University
Robyn Boman	CQ University
Rebecca Armstrong	CQ University

7.2 Sonography Approved Programs of Study in Australia

Organisation	Accredited Course
Australian Institute of Healthcare Education (AIHE)	Graduate Diploma of Diagnostic Medical Ultrasound (General Discipline)
Charles Sturt University	Graduate Diploma of Medical Ultrasound Master of Medical Ultrasound
CQUniversity	Graduate Diploma of Medical Sonography Graduate Diploma of Echocardiography
Monash University	Master of Medical Ultrasound, incorporating the Graduate Diploma (both the Master of Medical Ultrasound and the Graduate Diploma are accredited) Graduate Diploma in Medical Ultrasound Master of Medical Radiations (Medical Ultrasound)
Queensland University of Technology	Graduate Diploma in Medical Ultrasound Graduate Diploma in Cardiac Ultrasound
University of South Australia	Graduate Diploma in Medical Sonography Master of Medical Sonography Graduate Certificate in Breast Imaging
Western Sydney University	Graduate Diploma in Cardiac Sonography Master of Cardiac Sonography

8 Bibliography

ABS. (2017). *Australian Demographic Statistics, June 2017*. Retrieved 2017, from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3101.0

AIHW. (2015). *Cardiovascular disease, diabetes and chronic kidney disease—Australian facts: Aboriginal and Torres Strait Islander people*. Retrieved 2018, from https://www.aihw.gov.au/reports/heart-stroke-vascular-disease/cardiovascular-diabetes-chronic-kidney-indigenous/contents/summary

AIHW. (2015). *The health and welfare of Australia's Aboriginal and Torres Strait Islander peoples: 2015.* Canberra: Australian Institute of Health and Welfare. Retrieved from The health and welfare of Australia's Aboriginal and Torres Strait Islander peoples: 2015.

AIHW. (2017). *Australia's hospitals 2016–17 at a glance.* Canberra: Australian Institute of Health and Welfare .

AIHW. (2017). *Older Australia at a glance*. Retrieved October 2017, from Australian Institute of Health and Welfare: https://www.aihw.gov.au/reports-statistics/population-groups/older-people/overview

AIHW. (2018, October). *Australian Institute of Health and Welfare* . Retrieved from Cancer compendium: information and trends by cancer type: https://www.aihw.gov.au/reports/cancer/cancer-compendium-information-trends-by-cancer/report-contents/cervical-cancer

Alex, H., & Dixon, A.-M. (2008). Sonographer Role Extension and Career Development; a Review of Evidence. *Ultrasound*, 31-35.

Al-Kaisey, A., Jones, E., Nadurata, V., Farouque, O., De Silva, D., & Ramchand, J. (2015). Appropriate use of echocardiography in an Australian regional centre. *Internal Medicine Journal*.

Allan, R., Thoirs, K., & Phillips, M. (2010). Accuracy of ultrasound to identify chronic liver disease. *World Journal of Gastroenterology* , 3510–3520.

Australasian Society for Ultrasound in Medicine. (2018, August). *About ASUM*. Retrieved from Australasian Society for Ultrasound in Medicine: https://www.asum.com.au/about-the-australasian-society-for-ultrasound-in-medicine/

Australasian Sonographer Association. (2018, August). *Sonographer accreditation*. Retrieved from Australian Sonographer Association: http://www.sonographers.org/our-profession/sonographer-accreditation/

Australasian Sonographers Association. (2018, July). *About us*. Retrieved from Australasian Sonographers Association: http://www.sonographers.org/about/

Australian Bureau of Statistics. (2018). *Australian Demographic Statistics*. Retrieved October 2018, from http://www.abs.gov.au/AUSSTATS/abs@.nsf/mf/3101.0

Australian Institute of Health and Welfare . (2017). *Admitted patient care 2015–16: Australian hospital statistics.* Canberra : Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare. (2017). *Australian health expenditure — Hospital admitted patient expenditure 2004–05 to 2012–13.* Canberra: Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare. (2017). *Older Australia at a glance*. Retrieved 2017, from Australian Institute of Health and Welfare: https://www.aihw.gov.au/reports-statistics/population-groups/older-people/overview

Australian Institute of Health and Welfare. (2018). *Australia's mothers and babies 2018 in brief .* Australian Institute of Health and Welfare.

Australian Institute of Health and Welfare. (2018, July). *Heart, stroke & vascular diseases.* Retrieved from Australian Institute of Health and Welfare (AIHW): https://www.aihw.gov.au/reports-statistics/health-conditions-disability-deaths/heart-stroke-vascular-diseases/reports

Australian Sonographer Accreditation Registry. (2018, August). *About Us*. Retrieved from Australian Sonographer Accreditation Registry: https://www.asar.com.au/about

Department of Health. (2018, August). *Statistics under Medicare - Diagnostic Imaging.* Retrieved from The Department of Health: http://health.gov.au/internet/main/publishing.nsf/Content/Diagnostic+Imaging+Statistics-1

Docherty, M., Foran, K., Burnett-Roy, S., & May, S. (2017). Integrating the student Sonographer without iImpacting patient care. *Journal of Ultrasound in Medicine*, 1841–1849.

Glazebrook, R., Manahan, D., Chater, B., Barker, P., Row, D., Steele, B., . . . McLellan, T. (2004). Educational needs of rural and remote Australian non-specialist medical practitioners for obstetric ultrasound . *Australian Journal of Rural Health* , 73–80.

Hart, A., & Dixon, A.-M. (2008). Sonographer Role Extension and Career Development; a Review of the Evidence. *Ultrasound* , 31-35.

Industrial Relations Commission Of New South Wales. (2018, October). *Remuneration and Conditions.* Retrieved from NSW Health: https://www.health.nsw.gov.au/careers/conditions/Pages/m.aspx

Lagan, B., Sinclair, M., & Kernohan, W. (2011). What is the impact of the Internet on decision-making in pregnancy? A global study. *Birth*, 336–45.

Lampinen, R., Vehvilainen-Julkunen, K., & Kankkunen, P. (2009). A Review of Pregnancy in Women Over 35 Years of Age. *The Open Nursing Journal*, 33–38.

Lee, S., Holden, D., & Ayers, S. (2016). How women with high risk pregnancies use lay information when considering place of birth: A qualitative study. *Women and Birth*, 13-17.

Menzes, M. A., Hodgson, J. M., Sahhar, M., & Metcalfe, S. A. (2013). The challenges of working in fetal medicine. *Birth*, 52–60.

Merton, D. A. (2011). Enhancing Awareness of the Diagnostic Medical Sonography Professions. *American Institute of Ultrasound in Medicine*, 1077-1084.

Mitcalf, R., & Harrison, G. (2003). Trends in litigation activity against sonographers . *BMUS Bulletin* , 33-36.

Murphey, S., & Coffin, C. (2002). Ergonomics and Wellbeing in Practice. *Precision Interconnect*.

National Heart Foundation of Australia. (2018, August). *Burden of disease fact sheet*. Retrieved from Heart Foundation Organisation : https://www.heartfoundation.org.au/about-us/what-we-do/heart-disease-in-australia/burden-of-disease-fact-sheet

Nijholt, W., Scafoglieri, A., Jager-Wittenaar, H., Hobbelen, J., & van der Schans, C. (2017). The reliability and validity of ultrasound to quantify muscles in older adults: a systematic review. *Journal of Cachexia Sarcopenia Muscle, 8*(5), 702–712.

NPS MedicineWise. (2018). *Choosing Wisely Australia: eliminating unnecessary tests, treatments and procedures*. Retrieved 2018, from http://www.choosingwisely.org.au/home

Pallotta, O. J., & Roberts, A. (2016). Musculoskeletal pain and injury in sonographers, causes and solutions. *Sonography*, 5-12.

Pearlman, A., Ryan, T., Picard, M., & Douglas, P. S. (2007). Evolving Trends in the Use of Echocardiography: A Study of Medicare Beneficiaries. *Journal of the American College of Cardiology* , 2283-2291.

Primary Health Care Advisory Group . (2015). *Better Outcomes for People with Chronic and Complex Health Conditions.* Commonwealth of Australia as represented by the Department of Health.

Ryan, F. (2017). The clinical education of sonographers: The effective supervision of sonographer trainees. *Sonography* , 63–69.

Senate Community Affairs References Committee. (2018). *Availability and accessibility of diagnostic imaging equipment around Australia.* Canberra: Commonwealth of Australia.

Sim, J. (2016). Preparing work-ready sonography trainees: An accelerated model of ultrasound training by the University of Auckland. *Sonography*, 134-141.

Stringer, H., & Wilson, D. (2018). The role of ultrasound as a diagnostic tool for sarcopenia. *The Journal of Frailty & Aging*.

The Royal Australian and New Zealand College of Radiologists. (2017). *Inside Radiology*. Retrieved 2017, from Radiographer medical imaging technologist: https://www.insideradiology.com.au/radiographer-medical-imaging-technologist/

Thomas, S., O'Loughlin, K., & Clarke, J. (2016). Organisational and professional structures shaping the sonographer role in obstetrics. *Sonography*, 125–133.

Umar Amin,, M., Mahmood, R., Nafees, M., & Shakoor, T. (2009). Fetal Acrania - Prenatal Sonographic Diagnosis and Imaging Features of Aborted Fetal Brain. *The Journal of Radiology Case Reports* , 27-34.

Whitson, M. R., & Mayo, P. H. (2016). Ultrasonography in the emergency department. *Critical Care*.

World Health Organisation . (2018, October). *Musculoskeletal conditions*. Retrieved from World Health Organisation : http://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions