

Sonography Workforce in Victoria

Final Report for Department of Human Services, Victoria

On behalf of

The Australian Health Workforce Institute

Project Team

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1 SUMMARY

There is anecdotal evidence suggesting that the sonography workforce in the Victorian public health system is facing significant shortages. At present, the public sector is challenged in the provision of sonography training programs and this is resulting in fewer sonographers being trained in the public system. There is also anecdotal evidence that many qualified sonographers are leaving the public sector to work in the private sector.

The Victorian Department of Human Services therefore commissioned a study which aimed to establish whether the sonography workforce in the Victorian public and private health system faces significant shortages and how these shortages might be addressed. This will be achieved by establishing a solid body of evidence and data relating to the sonography workforce, including in-depth stakeholder consultations and forecasting future demand of ultrasound services.

A summary of findings are below.

- Average annual growth in the number of sonographers was steady at just over 5% (or 51 additional accredited sonographers per year) in Victoria between 2003 and 2008, whilst the utilisation of Medicare-funded sonography has grown by an average of 6.4% per year and is predicted to grow by up to 7.7%. This suggests that supply has not been keeping pace with demand.
- Use of ultrasound in inpatient settings has been growing at a faster rate (18% per annum), but this is only around 2% of all ultrasounds conducted in Victoria. There is some evidence of a recent upward trend in the Victorian birth rate, which would suggest an increase in demand for antenatal ultrasound.
- Much of the growth in utilisation of ultrasound is being driven by technological change, such as smaller and less expensive machines, and use in a wider range of clinical areas.
- Although more clinicians are using ultrasound, this is unlikely to reduce demand for sonographers and may even increase demand if litigation concerns lead to increasing referrals to sonographers for detailed scans. The use of ultrasound in new clinical areas should be carefully evaluated as to its diagnostic accuracy and cost-effectiveness compared to other diagnostic tools.
- There are anecdotal reports of shortages of sonographers, and some evidence of difficulty filling positions, particularly in non-metropolitan regions.
- There is an argument for an increased supply of sonographers, particularly in inpatient settings, assuming the growth rate in utilisation represents the cost-effective use of ultrasound. This would require increasing the number and proportion of clinical training placements in inpatient settings and/or changing the pay and conditions of sonographers, including on-call arrangements, to increase retention.

- The limited data suggest there is a shortage of clinical training positions and this presents the main barrier to increasing supply in a timely manner. Additional funding may need to be provided to cover the costs of supervision, additional trainees, as well as facilities and equipment. While measures to reduce the clinical training period or to allow for sub-specialisation could potentially increase the number of clinical placements, this may reduce workforce flexibility due to some sonographers performing only limited types of procedures.
- The quality of available data to identify shortages of sonographers is poor. The administrative data on the utilisation of ultrasound do not include data on outpatient ultrasound in public hospitals, including antenatal ultrasound. Trends and projections of utilisation in the public sector are therefore severely underestimated. Data on the number of health professionals providing sonography in Victoria are also incomplete and inaccurate. It is therefore not possible to determine future requirements for sonographers. The results included in this report should be interpreted with this in mind, and filling the gaps in these data is an important avenue for further work.

2 INTRODUCTION

The Department of Human Services engaged The Australian Health Workforce Institute (AHWI) to conduct a study into Victoria's sonography workforce with the objectives of the project to:

- establish a solid body of evidence and data relating to the sonography workforce in Victoria;
- to conduct a comprehensive audit of the sonography workforce in the Victorian health system, inclusive of public and private health services; and
- to provide a forecast of future demand of ultrasound services.

More generally, the study aims to establish through empirical analysis whether the sonography workforce in the Victorian public and private health system faces significant shortages and how these shortages might be addressed.

The project included a literature review and desktop analysis, of the national and international literature that identifies the issues and key drivers of demand and supply. Combinations of the following search terms were used: "Sonographer, ultrasonographer, ultrasound, ultrasonography, sonography, shortage, workforce, labour, technology, training". We searched Google, Google Scholar and Medline. Many important references were found by targeted browsing and searching of relevant websites, especially for Australian-specific information: Australasian Sonographer Accreditation Registry (ASAR), Australasian Society for Ultrasound in Medicine (ASUM), Australian Institute of Health and Welfare (AIHW), Australian Diagnostic Imaging Association (ADIA), Royal Australian and New Zealand College of Radiologists, Department of Human Services (Victoria), Department of Health and Ageing (Federal Government), Medical Services Advisory Committee, Universities.

The next phase of the project identified and analysed existing data sources on both the supply of and demand for sonography in Victoria. This included data from the Australian Sonography Accreditation Registry, the ABS Census, Victorian Department of Human Services, and Medicare Australia. Following this, a forecasting of future utilisation of ultrasound services was undertaken.

Consultations with key stakeholders to refine the key issues, identify the drivers of demand and supply, and uncover evidence of shortages. Discussions with key stakeholder groups were held to further identify issues and attempt to uncover fundamental workforce recruitment and retention aspects, as well as general suggestions for alleviating projected workforce shortages. Thirty one key stakeholders were interviewed face-to-face or over the telephone (shown in Appendix 1) and the questions that were used to guide discussion in the consultations are shown in Appendix 2.

3 BACKGROUND

Sonography can be defined as "a diagnostic imaging technique utilising reflected high-frequency sound waves to delineate, measure, or examine internal body structures or organs" (Random House, 2006). A notable characteristic of sonography is its wide application across areas of medicine, as a screening, diagnostic and therapeutic tool. It has been used widely in obstetrics (Kurjak and Chervenak, 2004; Bricker et al., 2000) cardiac care (Levin et al, 2004;

Collins et al, 2007; Wardlaw et al., 2006), and urology. Its use is growing in many other clinical areas as the technology becomes less expensive and more portable. Recent growth areas include breast ultrasound (Berg et al, 2008) musculoskeletal ultrasound (Backhaus et al, 2001) cancer staging and detection including ovarian, gastro-oesophageal, breast, prostate, colorectal and lung cancer (Bell et al., 1998; Harris et al., 1998). Ultrasound is also being used in guiding/monitoring procedures or treatments, including intravascular ultrasound in angioplasty and atherectomy for the insertion of a central venous catheter (NICE, 2002) and in the treatment of varicose veins (NICE, 2007). Ultrasound is being used more widely by clinicians and it has recently been referred to as the “new stethoscope” (Wise, 2008).

There are examples of new ultrasound technology being used in Australia through the increase in applications to the Department of Health and Ageing Medical Services Advisory Committee (MSAC). MSAC advises the Commonwealth government on whether new surgical procedures should be funded through the Medicare Benefits Schedule. Of the six applications for new techniques involving ultrasound between 1999 and 2008, four were approved (MSAC 1999, 2002, 2002a, 2007, 2007a, 2008). Recently approved technologies include endoscopic ultrasound for evaluating pancreatic and gastric neoplasms (MSAC 2007a), and endoscopic and endobronchial ultrasound for lung cancer (MSAC 2007, 2008).

The rapid increase in the use of this technology has a number of implications. The first is the accuracy (sensitivity and specificity) of ultrasound as a diagnostic tool and the issues of false positives and false negatives. Ideally, ultrasound should only be routinely used in clinical areas where there is evidence of cost-effectiveness. Although there is evidence supporting its use in its main areas of application such as obstetrics and cardiology (for example, Bricker et al., 2000; Goodacre et al., 2006), overall there appears to have been very little rigorous evaluation of the diagnostic accuracy of ultrasound in its new areas of application (for example, Dinnes et al, 2003; Collins et al., 2007; Cullum et al., 2001). This implies that until such evidence becomes available, a cautious approach should be taken when funding and supporting the use of ultrasound in new clinical areas.

A second implication, and the subject of this report, is the workforce implications of the growth in the use of ultrasound. The growth in utilisation has implications for the supply of health professionals undertaking sonography, including the education, training and registration of those providing ultrasound.

4 THE SUPPLY AND DISTRIBUTION OF SONOGRAPHERS

4.1 Who provides ultrasounds?

Sonographers and medical specialists are the principal health professionals conducting ultrasound. While radiographers have some limited training in ultrasound they would only conduct ultrasound examinations in unusual or emergency situations. The exception is where radiographers have specialised specifically in ultrasound and are accredited. Medical specialists may conduct ultrasounds themselves and claim MBS benefits provided that they have conducted the procedure within the scope of their specialist practice – regarded as a self-referral – or they have employed a registered sonographer to conduct the examination. Due to a lack of data it is not possible to determine exactly how many or what proportion of ultrasounds are conducted by sonographers, medical specialists or radiographers.

Sonography is regarded as a specialist area of imaging and the sonographer is part of a separate professional group, even though some will continue to hold membership of the radiography professional group if they trained as radiographers.

While there has been a trend towards non-sonographers undertaking ultrasound, there is little evidence that this has extended to them taking on the role of sonographers as providers of detailed ultrasound examinations. The other professional groups tend to use ultrasound as an adjunct to their normal professional practice, but with the exception of some obstetric ultrasound, which is undertaken entirely by Obstetricians, and some gynaecology ultrasound undertaken by Gynaecologists, this is comparatively rare and is likely to occur only in private practices where the patient co-contribution is significant.

In any circumstances in which ultrasound is used, the cost of having this undertaken by non-sonographers is prohibitive, given the time required to conduct a detailed examination. Therefore, there would appear to be little scope for this trend to lead to a reduction in the need for sonographers unless the MBS payment for self-referral is increased significantly, which is unlikely.

The consultations with medical imaging technologist (MIT) groups indicated that they tend to prefer sonographers to come from the radiography profession. This was partly due to the perception that it was easier to train an MIT specialist to super-specialise. Public hospital sonographers also tend to have a broad scope of practice and in some of the smaller hospitals might continue occasionally to perform radiography work to meet demands during busy periods. However, the consultations also produced strong arguments favouring sonographers being used entirely in ultrasound because there is always a need for sonography services and it would be wasteful to use highly specialised staff to undertake less specialised work in general MIT roles, such as X-Rays.

The obstetrics and cardiac areas are commonly seen as being so specialised that a general sonographer would be unlikely to take on such a role except in unusual circumstances or in country areas where there are no specialist sonographers available. There was no evidence in the consultations that the private sector was any more specialised in the use of sonographers, with most of them indicating that sonographers are used as generalists because they need to meet the demands of the patients being referred to the practice.

The impressions from the consultations were that sonographers will tend to work across all areas, although there are two major sub-specialties in obstetrics and cardiac who would seem to concentrate only on those areas. Indeed the training course for cardiac ultrasound is a separate one from general sonography courses. There is a tendency for specialist sonographers to work in specialist clinical settings and it would be expected that a specialist sonographer would be reluctant to undertake examinations of a general kind because they would not be confident of their skills.

The consultations suggested that the roles of radiographers and sonographers differ because in the case of sonography, it is the sonographer's skill that identifies problems using moving images. The specialist tends to rely more on the skills and judgement of the sonographer in identifying the specific still images that should be referred. In the case of radiography, the specialist will receive all of the images taken and make a diagnosis. While in the latter case there might still be a referral back to the radiographer to capture some alternative images, in the case of sonography this is more difficult because if the sonographer has missed detecting a

problem it will have been lost. In this sense, there is more of a preliminary diagnosis element in the work of a sonographer, and it is this argument that is used by many in the profession to argue that sonographers are in fact a higher order group and should be recognised as such.

There are some within the profession who argue for the role of sonographers to be extended to include reporting on their examinations without the intervention of a specialist radiologist. This is a position that is being argued strongly by the Australian Sonographers Association, which has recently been funded to undertake a study of the implications and effectiveness of role extension. Consultations found however that there was by no means a unanimity of views, with several sonographers saying that they would not wish to take on the additional responsibility.

There is some evidence that the reduction in the size of ultrasound equipment and the improvements in the quality of the images has led to medical specialists learning how to use the devices to provide them with complementary tools, but any more detailed examination is then referred to a sonographer. One example of this is the use being made of ultrasound by emergency physicians, who use it as an extension of their examination to confirm that there is no internal bleeding before making a decision on the next stage of treatment.

This trend is likely to continue as imaging becomes better, making it easier for a non-specialist to interpret the images. At the moment, it is not anticipated that this will have a marked impact on services provided by sonographers; firstly for the cost reasons indicated earlier and secondly because the safety, ease and inexpensive nature of the technology may lead to an increase in referrals as a precautionary measure. However, we cannot rule out the potential for substitution in the future as the technology and institutional factors change.

4.2 The sonography workforce in Victoria

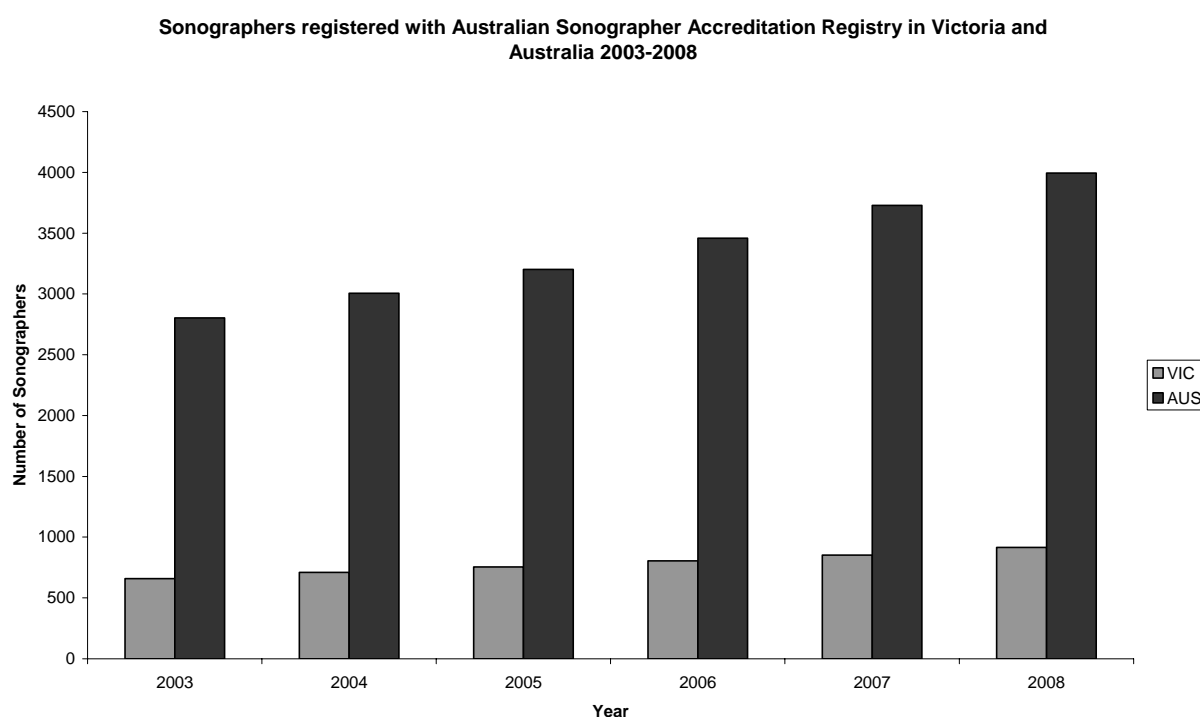
The Australian Sonography Accreditation Register (ASAR) is the national body that accredits sonography courses, determines acceptable course content and duration and registers sonographers to practise. Medicare legislation requires that sonographers have ASAR registration. The ASAR recorded an increase in registered sonographers in Australia from 2,803 in 2003 to 3,995 in October 2008, an average annual increase of 7.3% (ASAR 2008). This represents 1.87 sonographers per 10,000 population in 2008. In Victoria, the number of health professionals accredited as sonographers and registered with the ASAR grew from 659 in 2003 to 916 in 2008, an average annual increase of 6.8%, slightly lower than the national average (Figure 1). This represents 1.8 per 10,000 population. After adjusting for population growth, the growth rate of the number of sonographers per capita in Victoria is between 5.1% and 5.3%. The growth in Figure 1 is linear and equates to an average of around 51 additional sonographers per year.

This is likely to be an overestimate of those actually providing sonography given that a proportion of those registered may be out of the sonography workforce for various reasons. For example, in nursing and midwifery around 85% of those registered are working as nurses (AIHW, 2005). The ASAR registration form (<http://www.asar.com.au/forms/Application-AMS-2008.pdf>) collects data on the field of sonography in which they are registered to practise (general, obstetric, vascular, cardiac, breast, cerebrovascular) gender, date of birth, practice name and address, whether an Australian citizen or permanent resident, type of practice (public/private/teaching), type of ultrasounds performed, and details of sonography qualifications. The form does not collect data on whether sonographers are currently practising

and the register data from ASAR on the number of sonographers was not available at a disaggregated level.

The 2006 census data could be regarded as an underestimate of total numbers as occupation is self-reported. However, the ASAR data may be an overestimate of total numbers as they do not tell us whether a sonographer is currently practising, so would not give a good picture of the numbers currently working in ultrasound. For example, according to AIHW data only 85% of those on the nursing register are currently working as nurses. Furthermore, the ASAR data do not include hours of work, and so we cannot estimate FTEs, which is particularly important for estimating workforce requirements. The ASAR data provide limited information on each sonographer, and their data are incomplete as registrants are not compelled to provide the information asked of them. The census data provided more information than the registry data, e.g. data on hours of work.

Figure 1



Data from the ABS census contain information on the characteristics of sonographers in Victoria, although the total number of sonographers is lower because of the self-reporting of occupation in the census and because some sonographers remain on the Register even though they are not currently practising as sonographers (see Appendix 3 for census questions). Some of those registered to conduct ultrasound may have reported their occupation as radiographers (unlikely), health care managers, or clinicians. The number of individuals that report being a sonographer in Victoria in the census has increased from 125 in 1996 to 449 in 2006, an annual average increase of 13.6% (AIHW, 2001; AIHW, 2003). It is, however, unclear whether this reflects changes in the reporting of occupation.

There is anecdotal evidence to indicate that many radiographers and sonographers travel overseas to work, although it should be noted that Australia only recognises sonography qualifications from the UK, Canada and New Zealand, with sonographers from other countries

having to upgrade their qualifications in order to practise in Australia. The Australian workforce is trained to a higher level of independence and would probably find it difficult to work in countries other than those from which Australia accepts sonographers. At the same time, it has been reported that several overseas trained doctors are training to be sonographers.

The following analysis of the distribution and characteristics of sonographers in Victoria uses data from the ABS 2006 Census. Although the data do not reflect the total numbers reported in the Register, they give an idea of their characteristics. Table 1 shows the numbers of persons (males and females) employed as sonographers at the time of the 2006 Census by location of residence in the Melbourne Local Government Areas (LGAs), the Melbourne Statistical Division, non-metropolitan Statistical Divisions, Victoria and Australia. These data show that there were 449 persons reporting that they were employed as sonographers in Victoria, or 21 per cent of the Australian total. The Melbourne Statistical Division accounted for 348, or 77 per cent of the Victorian total. Within the Melbourne Statistical Division, sonographers were distributed relatively evenly, but with a significant concentration living in the high socio-economic LGA of Boroondara. As this represents location of residence, however, no conclusions can be drawn about the actual distribution of sonographers by practice.

Table 1 Distribution of persons employed as Sonographers in Melbourne Local Government Areas, Victorian non-metropolitan Statistical Divisions and Australia, 2006

	Numbers			Per cent Victoria			Per cent Melbourne Statistical Division		
	Males	Females	Persons	Males	Females	Persons	Males	Females	Persons
Melbourne	9	4	13	6	1	3	9	2	4
Port Phillip	0	11	11	0	4	2	0	4	3
Stonnington	8	9	17	5	3	4	8	4	5
Yarra	0	15	15	0	5	3	0	6	4
Brimbank	3	5	8	2	2	2	3	2	2
Hobsons Bay	3	6	9	2	2	2	3	2	3
Maribyrnong	7	6	13	5	2	3	7	2	4
Moonee Valley	7	13	20	5	4	4	7	5	6
Melton	0	3	3	0	1	1	0	1	1
Wyndham	0	6	6	0	2	1	0	2	2
Moreland	3	7	10	2	2	2	3	3	3
Banyule	4	11	15	3	4	3	4	4	4
Darebin	4	3	7	3	1	2	4	1	2
Hume	0	0	0	0	0	0	0	0	0
Nilfumbik	6	3	9	4	1	2	6	1	3
Whittlesea	0	4	4	0	1	1	0	2	1
Boroondara	6	30	36	4	10	8	6	12	10
Manningham	0	9	9	0	3	2	0	4	3
Monash	4	10	14	3	3	3	4	4	4
Whitehorse	3	17	20	2	6	4	3	7	6
Knox	3	8	11	2	3	2	3	3	3
Maroondah	0	6	6	0	2	1	0	2	2
Yarra Ranges	0	6	6	0	2	1	0	2	2
Bayside	5	9	14	3	3	3	5	4	4
Geln Eira	4	11	15	3	4	3	4	4	4
Kingston	0	9	9	0	3	2	0	4	3
Gr Dandenong	3	3	6	2	1	1	3	1	2
Cardinia	4	3	7	3	1	2	4	1	2
Casey	7	3	10	5	1	2	7	1	3
Frankston	0	8	8	0	3	2	0	3	2
Mornington Pen.	4	13	17	3	4	4	4	5	5
Melbourne SD	97	251	348	65	84	78	100	100	100
Wimmera SD	3	0	3	2	0	1			
Western District SD	8	5	13	5	2	3			
Ovens-Murray SD	7	6	13	5	2	3			
Mallee SD	0	3	3	0	1	1			
Loddon SD	7	3	10	5	1	2			
Golburn SD	6	14	20	4	5	4			
Gippsland SD	0	0	0	0	0	0			
East Gippsland SD	0	0	0	0	0	0			
Central Highlands SD	11	4	15	7	1	3			
Barwon SD	10	14	24	7	5	5			
Non-metropolitan Victoria	52	49	101	35	16	22			
Victoria	149	300	449	100	100	100			
Australia	485	1,641	2,126						

Source: Australian Bureau of Statistics, Alternative View - Health Occupations, 2006 Census tables

Table 2 shows the numbers of persons employed as sonographers in Victoria, as indicated by the 2006 Census, disaggregated by age, sex and hours worked in the week prior to the Census. Table 2 identifies 440 sonographers employed in Victoria. This is slightly below the 449 identified in Table 1¹.

¹ The total number of sonographers indicated in Table 1 (compiled from standard ABS 2006 Census tables) varies slightly from the number presented in the subsequent tables (derived from a customised 2006 Census data set). This is due to the randomisation of small person counts by the Australian Bureau of Statistics in conformity with the requirements of privacy legislation. The effect of this on the analysis presented is negligible.

Table 2 Persons employed as Sonographers* by sex, age and weekly hours worked, Victoria, 2006

Hours worked		20 to 34 years	35 to 44 years	45plus years	Total
		<i>Numbers</i>			
<35 hours	Males	4	3	11	18
	Females	33	85	45	163
	Persons	37	88	56	181
>35 hours	Males	37	36	47	120
	Females	55	36	42	133
	Persons	92	72	89	253
<i>Total**</i>	Males	41	42	58	141
	Females	91	121	87	299
	Persons	132	163	145	440
		<i>Share by age (Per cent)</i>			
<35 hours	Males	22	17	61	100
	Females	20	52	28	100
	Persons	20	49	31	100
>35 hours	Males	31	30	39	100
	Females	41	27	32	100
	Persons	36	28	35	100
<i>Total**</i>	Males	29	30	41	100
	Females	30	40	29	100
	Persons	30	37	33	100
		<i>Share by hours (Per cent)</i>			
<35 hours	Males	10	7	19	13
	Females	36	70	52	55
	Persons	28	54	39	41
>35 hours	Males	90	86	81	85
	Females	60	30	48	44
	Persons	70	44	61	58
<i>Total**</i>	Males	100	100	100	100
	Females	100	100	100	100
	Persons	100	100	100	100
		<i>Share by sex (Per cent)</i>			
<35 hours	Males	11	3	20	10
	Females	89	97	80	90
	Persons	100	100	100	100
>35 hours	Males	40	50	53	47
	Females	60	50	47	53
	Persons	100	100	100	100
<i>Total**</i>	Males	31	26	40	32
	Females	69	74	60	68
	Persons	100	100	100	100

Source: Australian Bureau of Statistics, customised 2006 Census data set, held by CPUR

* ASCO code 239117 1996 Edition

**Total includes weekly hours worked not stated.

4.2.1 Sex and age composition

Of the 440 persons employed as sonographers in Victoria at the time of the 2006 Census, 32 per cent were male and 68 per cent female. The male sonographers were also older than their female counterparts. Twenty-nine per cent of female sonographers were aged 45 years and over. By comparison, the proportion of male sonographers aged 45 years and over was 41 per cent.

Cross-tabulation of sex and age shows that the proportion of males is greatest amongst sonographers aged 45 years and older (40 per cent). The data therefore suggest that the female share of the sonography workforce is increasing over time.

4.2.2 Weekly hours worked

As with some other health-related professions, such as Optometry, a shift in workforce composition in favour of women is affecting weekly hours worked and thus the size of the effective full-time workforce. While only 13 per cent of all male sonographers worked less than 35 hours per week², 55 per cent of females did so. Conversely, the respective proportions of men and women working more than 35 hours per week were 85 per cent and 44 per cent.

An examination of weekly hours worked by age shows a marginally greater propensity for older males to work part-time (less than 35 hours), with 10 per cent of males aged 20 to 34 years, compared with 19 per cent among those aged 45 years and over. This may be due to males taking on managerial roles or reducing their participation in the workforce for other reasons. There is a similar but stronger pattern for females. The proportion of females aged 20 to 34 years working less than 35 hours per week was 36 per cent, rising to 52% among females aged 45 years. The implication is that the female sonography workforce not only has a greater propensity to work part-time, including among its younger practitioners, but that the rate at which women transfer from full-time to part-time hours with age is greater than for male practitioners.

Nevertheless, it is notable that the quite low proportion of female sonographers aged 35 to 44 years who work more than 35 hours per week (30 per cent) changes for the 45 years and over age group. The share of this older age group who work more than 35 hours per week increases to 48 per cent. It is likely that this reflects the ageing of children.

The consultations confirmed these workforce practices, with many interviewees reporting that younger and newly-qualified sonographers worked full-time for some years and then either travelled or moved out of the workforce to care for children. There were reports of many female sonographers returning to the workforce on a part-time basis and, as children aged, returning to work on a more full-time basis, although there is still anecdotal evidence that female practitioners do not tend to return to full-time work.

4.2.3 Employment sector

Table 3 shows the distribution of the workforce between the public and private sector. The data show that 76 per cent of persons employed as sonographers were employed in the private sector in 2006. This pattern varies with age. Whereas 70 per cent of sonographers in the 20 to 34 years age group were employed in the private sector, the proportion increases to 80 per cent for those aged 45 years and over. This pattern holds true for both sexes. However, the propensity to work in the private sector is marginally greater among the female sonography workforce. Again, the consultations indicated that this was due to the capacity of the private sector to offer more flexible and predictable working hours than the public sector, where on-call duties were required.

² The Australian Bureau of Statistics uses 35 hours as the threshold between part-time and full-time work.

Table 3 Persons employed as Sonographers* by sex, age and employment sector, Victoria, 2006

		Government sector	Private sector	Total**
		Numbers		
20 to 34 years	Males	13	28	41
	Females	23	65	91
	Persons	36	93	132
35 to 44 years	Males	11	31	42
	Females	26	95	121
	Persons	37	126	163
45 plus years	Males	13	45	58
	Females	16	71	87
	Persons	29	116	145
Total	Males	37	104	141
	Females	65	231	299
	Persons	102	335	440
<i>Share by sector (Per cent)</i>				
20 to 34 years	Males	32	68	100
	Females	25	71	100
	Persons	27	70	100
35 to 44 years	Males	26	74	100
	Females	21	79	100
	Persons	23	77	100
45 plus years	Males	22	78	100
	Females	18	82	100
	Persons	20	80	100
Total	Males	26	74	100
	Females	22	77	100
	Persons	23	76	100
<i>Share by age (Per cent)</i>				
20 to 34 years	Males	35	27	29
	Females	35	28	30
	Persons	35	28	30
35 to 44 years	Males	30	30	30
	Females	40	41	40
	Persons	36	38	37
45 plus years	Males	35	43	41
	Females	25	31	29
	Persons	28	35	33
Total	Males	100	100	100
	Females	100	100	100
	Persons	100	100	100
<i>Share by sex (Per cent)</i>				
20 to 34 years	Males	36	30	31
	Females	64	70	69
	Persons	100	100	100
35 to 44 years	Males	30	25	26
	Females	70	75	74
	Persons	100	100	100
45 plus years	Males	45	39	40
	Females	55	61	60
	Persons	100	100	100
Total	Males	36	31	32
	Females	64	69	68
	Persons	100	100	100

Source: Australian Bureau of Statistics, customised 2006 Census data set, held by CPUR

* ASCO code 239117 1996 Edition

**Total includes employment sector not stated.

Table 3 also shows that the age structures of the government and private sector sonography workforces differ, with the government sector having 28 per cent of sonographers aged 45 years

or more, compared with 35 per cent of those employed in the private sector. The converse is true for younger sonographers aged 20 to 34 years. This age group accounted for 35 per cent of those in the government sector and only 28 per cent of those in the private sector. This outcome holds for both sexes, although the tendency for males aged 45 years or more to work in the private sector is greater than for females. The proportion of the male private-sector sonography workforce, which is aged 45 years or older, is 43 per cent, compared with 31 per cent of the female private-sector sonography workforce.

One possibility for this, which has also been suggested anecdotally in the consultations, is that younger sonographers initially gain professional experience in the government sector and subsequently seek employment in the private sector. Further investigation would be required to verify such a tendency. Alternatively, there may be a generational difference in preferences and/or employment opportunities relating to employment sector. While data are not available to confirm this, the impression that sonographers largely train in the public sector and then move to the private sector is not supported by the consultations, which suggest that the private sector trains more sonographers than the public sector. One factor that may be having an impact on these data is that the predominant group training to be sonographers are already qualified and experienced radiographers, so one would expect the sonography workforce to be generally older than the radiography workforce.

4.2.4 Employment sector by weekly hours worked

Table 4 shows that the proportions of sonographers who work part-time and full-time in the government sector and private sector are nearly identical. In each sector, 41 per cent of persons worked less than 35 hours during the week prior to the 2006 Census. While the proportion working part-time varies considerably according to age, the differences between government and private sectors within each age group are not great. The most marked difference in weekly hours worked between sectors is found in the 20 to 34 years age group. In this age group, 25 per cent of sonographers worked part-time in the government sector compared with 30 per cent in the private sector.

The age structure of sonographers who worked full-time (>35 hours per week) was younger in the government sector than for the private sector. In the government sector, 45 per cent of sonography employees were aged 20 to 34 years, compared with 34 per cent in the private sector. Conversely, while only 28 per cent of full-time sonographers employed in the government sector were aged 45 years and over, 37 per cent in the private sector were in this age group.

It is notable that in both sectors the proportion working full-time drops fairly abruptly between those aged 20 to 34 years and those aged 35 to 44 years. This is likely to reflect female commitments to child-raising activities. This decline is more marked in the government sector. However, although the proportion working full-time rises among those aged 45 years and over in the private sector, relative to the 35 to 44 year age group, no similar increase is observed for the government sector.

Table 4 Persons employed as Sonographers* by age, weekly hours worked and employment sector, Victoria, 2006

		Government Sector	Private sector <i>Numbers</i>	Total*
20 to 34 years	<35 hours	9	28	37
	>35 hours	27	65	92
	Total**	36	93	132
35 to 44 years	<35 hours	21	67	88
	>35 hours	16	56	72
	Total**	37	126	163
45 plus years	<35 hours	12	44	56
	>35 hours	17	72	89
	Total**	29	116	145
Total	<35 hours	42	139	181
	>35 hours	60	193	253
	Total**	102	335	440
<i>Share by sector (Per cent)</i>				
20 to 34 years	<35 hours	24	76	100
	>35 hours	29	71	100
	Total**	27	70	100
35 to 44 years	<35 hours	24	76	100
	>35 hours	22	78	100
	Total**	23	77	100
45 plus years	<35 hours	21	79	100
	>35 hours	19	81	100
	Total**	20	80	100
Total	<35 hours	23	77	100
	>35 hours	24	76	100
	Total**	23	76	100
<i>Share by age (Per cent)</i>				
20 to 34 years	<35 hours	21	20	20
	>35 hours	45	34	36
	Total**	35	28	30
35 to 44 years	<35 hours	50	48	49
	>35 hours	27	29	28
	Total**	36	38	37
45 plus years	<35 hours	29	32	31
	>35 hours	28	37	35
	Total**	28	35	33
Total	<35 hours	100	100	100
	>35 hours	100	100	100
	Total**	100	100	100
<i>Share by hours (Per cent)</i>				
20 to 34 years	<35 hours	25	30	28
	>35 hours	75	70	70
	Total**	100	100	100
35 to 44 years	<35 hours	57	53	54
	>35 hours	43	44	44
	Total**	100	100	100
45 plus years	<35 hours	41	38	39
	>35 hours	59	62	61
	Total**	100	100	100
Total	<35 hours	41	41	41
	>35 hours	59	58	58
	Total**	100	100	100

Source: Australian Bureau of Statistics, customised 2006 Census data set, held by CPUR

* Total includes employment sector not stated.

** Total includes hours worked not stated.

4.3 Key drivers of supply

4.3.1 Education and training

The ASAR accredits postgraduate qualifications for sonographers in Australia – the qualifications and institutions that are currently accredited by the ASAR are listed in Appendix 4. Sonographer trainees may come from any health science or relevant science background, including radiographers, nurses, medical scientists or doctors, but to become a qualified and registered sonographer they must complete one of the accredited courses, all of which are currently postgraduate. The consultations indicated that the great majority of sonographers come from a radiography background.

While radiographers can also provide sonography without the relevant postgraduate qualifications, the consultations suggest that this is rare because they do not feel adequately trained and because MBS benefits are only payable for ultrasound examinations undertaken by a registered sonographer.

All accredited courses in sonography can be taken by distance or on-line learning, in association with a clinical placement, so there is some evidence of students taking courses from an institution outside their state of residence. In view of the nature of the training and the number of courses available, there are no limits on the number of students that can be enrolled. The courses that are most likely to attract Victorian students, at Monash, RMIT, Charles Sturt or the ASUM have no quotas on their places, and there is little indication that staffing those courses would be a concern if student numbers were to increase. As indicated earlier, the major limiting factor is the availability of clinical training places.

Monash offers the Graduate Diploma in Medical Ultrasound (Monash University, 2008) and RMIT offers the Graduate Diploma in Ultrasonography (RMIT University, 2008) (for a brief description refer to Appendix 5). Both courses are distance-education postgraduate courses with large amounts of on-line learning. Students are usually graduates from radiography or medical imaging undergraduate degrees. The Monash Graduate Diploma has 104 currently enrolled students, which has increased from approximately 85 enrollees in 2005 (Lombardo, 2008). Similarly, the RMIT course numbers have increased from 44 students in 2004 to 100 students in 2007 (Davidson, 2008). The coordinator of the RMIT course suggests the numbers of students taking courses would have little relation to the workforce in Victoria as many students enrol from interstate or overseas (Davidson, 2008).

The Diploma of Medical Ultrasonography (DMU) offered by the ASUM (ASUM, 2008) is a vocational qualification which requires a combination of home study and practical experience, following the type of training structure that is common to the specialist medical colleges. The DMU is a general sonography qualification but provides the option of being endorsed in General, Cardiac, Vascular or Obstetric Ultrasonography. In 2006, 168 students sat the DMU examinations while 156 students sat the examinations in 2007 (Hong 2006, 2007).

ASUM also offers a Diploma of Diagnostic Ultrasound (DDU) for appropriately qualified medical specialists who wish to perform ultrasound examinations within their scope of specialist practice.

There are also courses that feed into the accredited courses aimed at preparing potential trainees for accredited courses (refer to Appendix 5), but while these have been identified as fast-track courses, they are only fast-tracking the training in preparation for the accredited course,

although some courses do give credit for these courses. Such courses do not replace any element of the clinical training, and every trainee in an accredited course must be in a formal clinical training position that is approved by the accredited course provider in order to complete the clinical components of the course.

There are several alternative training courses for medical practitioners who wish to use ultrasound (Appendix 5), but these are not directly relevant to this project as they are not aimed at replacing sonographers but rather to ensure that specialists are appropriately trained in the use of ultrasound as a diagnostic tool. For example in 2007, the ASUM introduced the Certificate in Clinician Performed Ultrasound (CCPU) (Hong, 2007). The Certificate is offered as a credential for medical practitioners who are not imaging specialists but who may use ultrasound as a diagnostic tool at the point of care. The Certificate offers specialist courses in Emergency Medicine, Neonatal Medicine, Obstetrics and Gynaecology, Critical Care and Surgical.

4.3.2 Alternative Training Pathways

The sonography profession is very conscious of its status as a postgraduate qualified profession, so any alternative training pathways are likely to be met with significant opposition. On the other hand several of the stakeholders interviewed in the consultations suggested that different approaches should be explored.

Some of the options that were identified during the consultation phase included an undergraduate degree in ultrasound which might be built around the radiography qualification but with a specialist stream that would lead directly to sonography practice. A recent initiative along these lines from the University of South Australia failed, but there is still support for it both from the universities and some practitioners.

An alternative suggestion is to enable undergraduate radiography students to specialise in the ultrasound techniques that are required for a common set of ultrasound procedures, such as pelvic and abdominal ultrasound, so that they could be given limited privilege to undertake ultrasound examinations, with subsequent further specialisation to achieve general ultrasound training and registration.

While those opposing this approach were concerned that clinicians would be limited in their scope of practice and not be as easily deployed in the work environment, thus reducing flexibility in the workforce (an argument also put forward by some hospital sonographers to argue for sonographers to come from radiography), the alternative argument was that in a large practice it would be quite feasible to have specialists of this type.

The argument was also advanced that there are already sonographers who specialise in Obstetrics and Gynaecology and others who specialise in cardiac ultrasound. Similarly, those arguing for a wider group of MIT professionals or health professionals to be accepted into ultrasound training reported that in large practices and even in some of the major hospitals, the additional cost of using sonographers to undertake general radiography services is such that in fact very few would be working significantly outside the sonography area.

The ASAR and Medicare legislation currently require that all sonographers be qualified through a postgraduate course, so any change would need to be recognised and approved by the ASAR and the Medicare legislation would need to be amended.

4.3.3 Clinical Training Placements

The consultations suggested that a major limiting factor on the number of qualified sonographers is the availability of clinical training places. In all cases in which students are admitted to a sonography course, they must be able to demonstrate that they have a clinical training appointment that will enable them to complete the clinical component of the course. Students can be placed in private and public clinical settings, provided that the setting meets the requirements of the course. The consultations revealed that a relatively small number of trainees are in the major public hospitals – as few as 1 and not more than 3 in any one setting – with the private sector seeming to take a greater number at any one time – as many as 15 in one case. The distribution of clinical placements for those undertaking the Graduate Diploma at Monash University are 32 in private settings and 55 in public settings (Appendix 5). The private sector therefore seems to play a substantial role.

The consultations indicated a preference for training qualified radiographers as sonographers rather than admitting other health professionals to sonography courses. Some employers use the prospect of gaining a sonography training place as an element in attracting and retaining radiography staff. Several public and private providers see it as a responsibility to train sonographers if they are to meet their own staffing needs.

However, the problem is the ability to provide adequate supervision to trainees, especially during the first six to twelve months of the two-year course. There was a general consensus from the consultations that supervising sonographers would have their service delivery functions reduced by as much as 50% in the first few months of a trainee's training period, reducing to some 25% by the end of the first year. This is based on opinion rather than empirical data. If the trainee is progressing well, it is anticipated that he or she will be able to contribute to the service delivery functions of the training centre in the second year of training. The general estimate provided, which seems reasonable, is that supervisors of trainees should be given an average 20%-25% reduction in their case-load if they are to perform the task adequately. There is also a need for ultrasound equipment and rooms to be available for trainees. Therefore, the cost of each training post should be based on a full Grade 2 salary plus on-costs for the trainee, some 25% of the salary and on-costs of the supervisor (based on a Grade 4 position), and the cost of appropriate space and equipment.

4.3.4 Pay and conditions

One aspect in determining the supply of sonographers in Victoria is the level of wages, relative to other sectors, states and other countries with high migration to Australia (for example, UK, New Zealand). In circumstances where wages are relatively high, an inflow of qualified sonographers from outside Victoria and an increase in supply from Victorians considering a career in nursing or as an Allied Health Professional (including student radiographers) would be expected. In 2001, sonographers in Australia were better paid than other medical imaging workers (AIHW, 2003), but reliable data are not available to provide state comparisons. Halsall (2007) notes that differences in the recognition of sonography by state governments, especially where sonography is recognised separately from radiography, leads to wage differences between states. For example, in Victoria all allied health professionals are covered by the same industrial agreement, yet are appointed on different points on the scale from radiographers. Trainee sonographers are placed on Grade 2 of the scale and qualified sonographers are automatically placed on Grade 3 or Grade 4, while radiographers reach those Grades more slowly. Beyond that point, the only avenue for career progression is to move into supervisory or management positions. Public sector positions are constrained by the Award, so there is little

scope for further classification, although overtime is a feature that would increase the take home pay of sonographers. Halsall (2007) comments that private sector hospitals are able to pay above regulated award rates and are therefore more capable of paying the “market rate” to attract and retain sonographers. The information gained from the consultations supports this view. The private sector uses the Award as a guide to minimum standards, but is able to pay above award rates while retaining sonographers in the clinical environment.

Sonographers are seen as specialists within the MIT group and are remunerated at a higher level than radiographers. Conflicting views were expressed about the difference in pay and conditions for those working in the private and public sectors. There was a general perception from the consultations that private practice does pay more, but a good deal of evidence emerged to suggest that the difference is not substantial. What is not questioned is the fact that private practice provides significantly more flexibility and is more attractive to women who have young families as well as to those who decide to return to work after a period of child-rearing, many of whom prefer to work part-time. In the private sector these professionals can choose their hours of work and plan around them. In the public sector sonographers are required to be on call and the hours are dictated by the 24 hour cycle of a normal public hospital. On the other hand the consultations also raised the complexities of the work and the ability to follow the patient journey as an advantage of working in the public sector, whereas in the private sector the job entails undertaking the examination but not being involved in the subsequent follow up of the patient.

Apart from remuneration, other job characteristics, especially working conditions, may be an important determinant of sonographer supply. International literature points to workplace stress including long hours, role ambiguity and occupational injuries (Penny, 2005) and strategies proposed to improve recruitment and retention include improving orientation practices and continuing medical education (Clay, 2004). In Australia in 2001, sonographers worked fewer hours than radiographers “...39.8% of sonographers worked part-time compared to 29.5%, 22.6% and 21.6% respectively for radiographers, radiation therapists and nuclear medicine technologists. At the other end of the scale, 5.5% of sonographers worked long hours (49 hours or more per week) compared to 9.5% of radiographers, 4.9% of radiation therapists and 8.8% of nuclear medicine technologists (Table A.16)” (AIHW, 2003, p20).

The prevention of occupational injuries was mentioned frequently in the consultations and in some cases employers reported providing specific and regular rest periods as part of the work day, while in others sonographers might spend time working on other medical imaging modalities if they were also qualified radiographers.

One change that could increase demand for sonographers’ services is an increase in responsibility given to sonographers to both conduct and analyse the results of an ultrasound without additional analysis by a radiologist. A substitution of workloads of this type is advocated by some sonographers internationally (Lockhart et al 2003) and within Australia (ASA, 2005). A case study has reported that additionally-trained sonographers were able to write accurate reports of ultrasound examinations in the place of a radiologist (Bude et al 2006). There is some understandable caution about this suggestion among radiologists (KL2, 2006; RANZCR, 2006a) who may be concerned about encroachment by sonographers on their roles and responsibilities. One Australian study argued that optimal patient management requires radiologists working alongside sonographers (Ramsay and Fraccia, 1999).

4.3.5 Public-private mix

A large proportion of ultrasound examinations take place in private diagnostic imaging clinics. The ABS 2006 census data suggested that 76% of sonographers work in the private sector. This high proportion is confirmed by other data. Some evidence suggests that 50% of those practising ultrasonography do so only in the private sector with 61% practising in only the private sector or both private and public sectors (Department of Human Services, 2007). The Australian Diagnostic Imaging Association claims that private clinics account for around 60% of all diagnostic imaging (ADIA, 2008).

Some recent regulatory changes have been made to ensure the appropriateness of diagnostic imaging services (including ultrasound) provided in private clinics and funded through Medicare. The first change is prohibition of certain relationships between the 'requesters' and 'providers' of imaging services, especially when the two parties are 'connected', for example by joint ownership of a medical practice (Department of Health and Ageing, 2007a). The second change is the introduction of an accreditation scheme for the providers of diagnostic imaging services (including ultrasound) (Department of Health and A, 2008a). This legislation addresses (among other things) the issue of 'self-referral' for diagnostic imaging (when doctors refer procedures they undertake themselves) may have caused rising health care costs in the United States (Ho, 2008). If self-referral fails due to rising costs it could lead to more demand for sonographers. Currently medical specialists can claim for self-referred sonography services they provide as part of their medical specialisation. However, the fee for self-referred services is lower than for referred ones. There is therefore a tendency for self-referred episodes to be brief, because anything more extensive is better done by a sonographer working with the specialist, who can still claim payment for the service. Guidelines for the use of ultrasound can be found at:

<http://www.health.gov.au /internet/main/publishing.nsf/Content/diagnosticimagingquality.htm>).

5 THE UTILISATION OF SONOGRAPHY

5.1 Current Utilisation of Sonography in Victoria

The utilisation of sonography depends on the epidemiological characteristics of the population and the clinical practice and availability of sonographers and clinicians. This section presents data on the utilisation of ultrasound services in Victoria from Medicare claims data and Victorian Admitted Episodes Data (VAED). Neither of these datasets specifies who conducted the ultrasound. The two data sources used include ultrasound examinations conducted in different circumstances. Neither data source includes all the ultrasound examinations conducted in Victoria.

The VAED includes all ultrasound episodes carried out as part of an inpatient episode in a public or private hospital in Victoria. An important omission is all outpatient and emergency episodes where many ultrasounds are conducted (especially obstetric ultrasounds). For example, of the 68,244 births in Victoria in 2006, almost 64% were as public patients and 35% as private patients (Department of Human Services, 2008). If each birth in a public hospital had a conservative two antenatal ultrasounds (one at 10-12 weeks and one at 19-20 weeks of gestation), this conservative estimate represents at least 87,500 outpatient antenatal ultrasounds per year that are not included in routinely available data.

Secondly, the Medicare claims data include all ultrasounds carried out outside the public sector. This includes ultrasound examinations that occur for private patients in public and private hospitals, in addition to those that are billed in private out-of-hospital diagnostic imaging facilities.

The differences between the two data sources are reflected in the number of episodes or claims for ultrasound procedures in Victoria reported in each. In the VAED, the data shows 23,121 episodes in 2007 whilst the Medicare data shows 1,239,439 claims. Adding our estimate of 87,500 antenatal ultrasounds in public outpatients, this is a total of 1,350,060, which is likely to be an underestimate. Therefore only around 2% are conducted in inpatient settings, 6% in public antenatal outpatients, and 92% in private out of hospital settings.

5.1.1 Medicare claims data

Apart from exceptions for rural areas and emergencies, ultrasounds claimed through Medicare must occur, “under the professional supervision of a specialist or consultant physician” (Department of Health and Ageing, 2007). The emphasis is on the physician, rather than the sonographer for claiming Medicare benefit. Specialists are only able to claim from Medicare if the nature of the ultrasound is directly related to their area of specialty. In some cases specialists would undertake the ultrasound themselves only as an initial assessment rather than a detailed ultrasound examination. The main exception to this is obstetric ultrasound by specialists in the private sector. As a result while there has been an increase in the number of Medicare claims for ultrasound services this is probably masking the fact that most of the services are claimed by specialists for work undertaken under their supervision by sonographers. The MBS requires that any sonographers “performing medical ultrasound examinations on behalf of a medical practitioner” be registered with ASAR (see Appendix 6)

Medicare claims data were downloaded from the Medicare Australia website and were available for individual Medicare item numbers. All item numbers in the 2007 MBS in “Group I1 – Ultrasound” were selected (see Appendix 6 for relevant section of the MBS). The online data reporting system maps old and new item numbers when they have changed over time.

In Victoria, the total Medicare claims for ultrasound procedures was 1,330,849 in 2008, an average growth of 8.5% per year since 1995 when there were 425,503 claims. Figure 2 shows growth in per capita terms, that is, after controlling for the growth in population. These per-capita figures indicate there is significant growth in ultrasound utilisation (around 6.7% per year) over and above any increase that is due to population growth. To assist in identifying a time trend in overall Medicare ultrasound claims over time in Victoria, a comparison with New South Wales can be made to show that the upward trend is also occurring in other jurisdictions. Both states have similar trends: on average 6.7% per year for Victoria and 6.0% per year for NSW.

Figure 3 shows the proportions of claims across the major diagnostic areas defined in the MBS for Victoria in 2007/8 (General, Obstetrics/Gynaecology, Vascular, Cardiac, Musculoskeletal, Urological). The most common ultrasound procedures are the General (31%) and Obstetrics/Gynaecology (28%) subgroups, followed by Musculoskeletal, (16%), Cardiac (12%), Vascular (12%) and Urological (0%).

Figure 2

Per Capita Medicare claims for All Ultrasound Procedures in Victoria and New South Wales 1995-2008

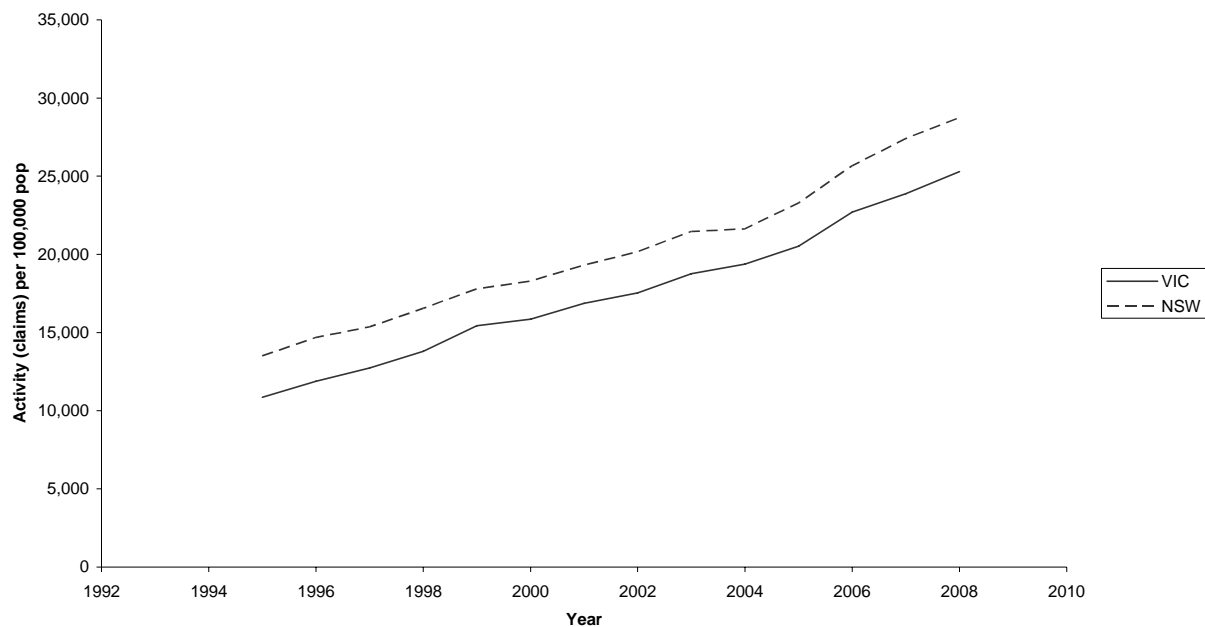


Figure 3

Medicare claims for ultrasound procedures in Victoria 2007/2008

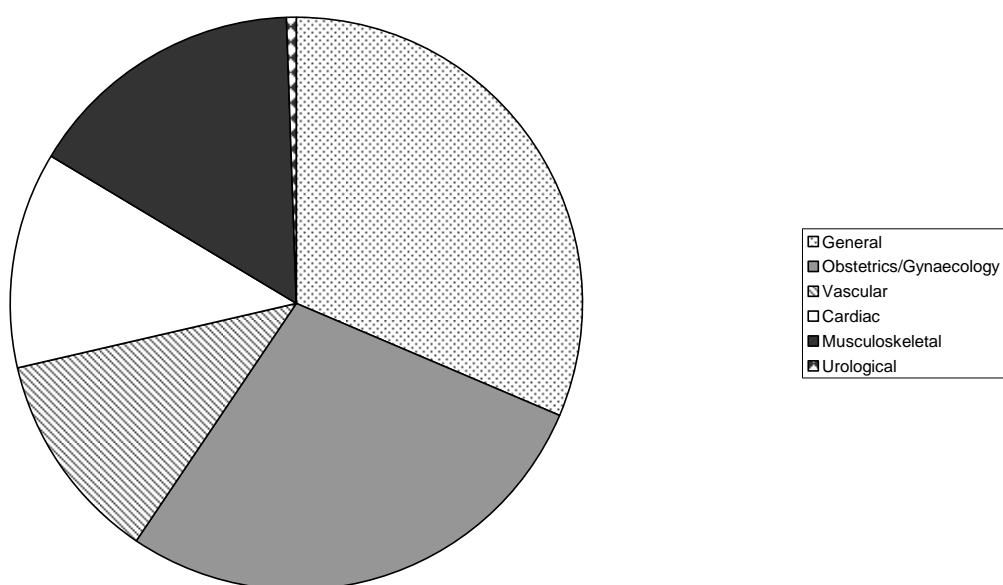


Figure 4

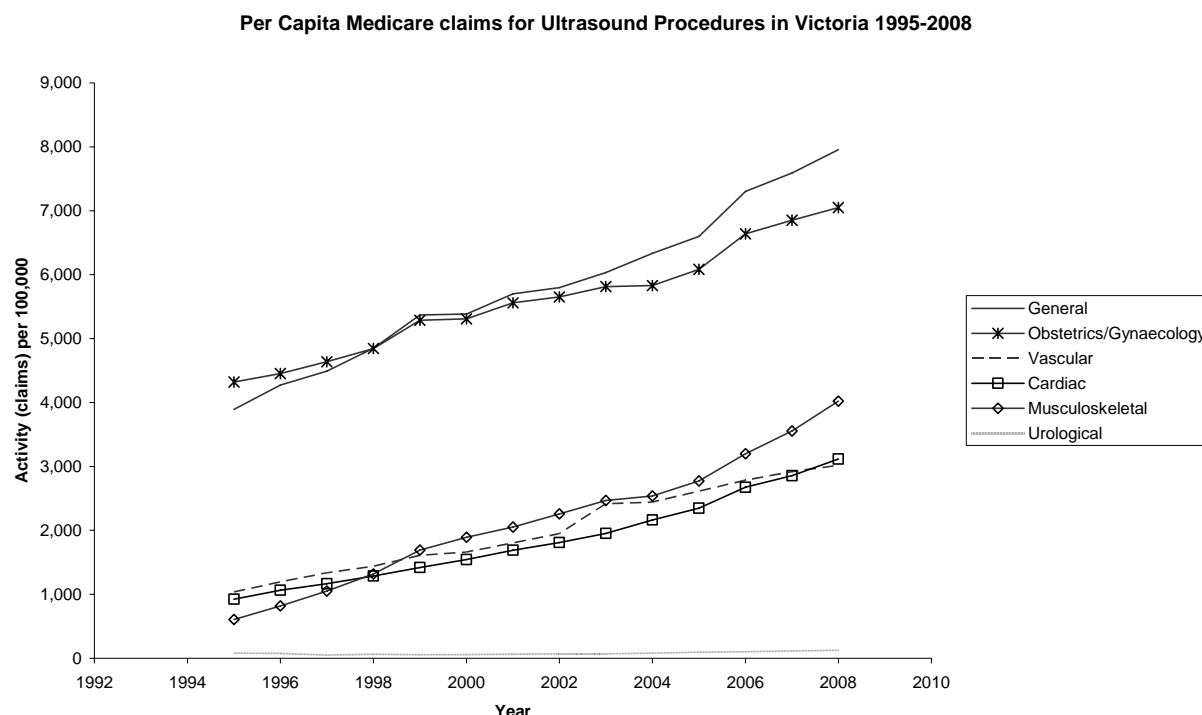


Figure 4 shows a strong upward trend in the number of per-capita claims for all procedure sub-groups apart from urological which has a very low number of claims. This controls for population growth over the period. The average annual percentage growth rates vary from 3.9% for Obstetrics/Gynaecology to 16.0% for Musculoskeletal (although the latter high growth rate is mainly due to its low starting level). There is a relatively sharp rise in 2004/5, around the time of the introduction of the Medicare Safety net.

5.1.2 Victorian Admitted Episodes Data

The second source of data is VAED, which includes details of all inpatient encounters in Victorian public and private hospitals. These data have an advantage over Medicare data because they include data on ultrasounds conducted on inpatients in public hospitals. One disadvantage is that the data omit outpatient care, including antenatal ultrasound examinations, because this information is not collected by the Department of Human Services. The data will also therefore contain ultrasounds billed to Medicare in private hospitals and for private patients in public hospitals that are also captured in the Medicare data. The VAED include episodes where at least one procedure code (Department of Human Services, 2008) corresponds to an ultrasound procedure (see Appendix 7).

The total number of episodes including ultrasound procedures over time is shown in Figure 5. From 2001 to 2007, the number of episodes with at least one ultrasound has nearly tripled from 7,975 to 23,121, representing an average growth rate of 18 % per year. This can also be shown in Figures 6 and 7. Figure 6 presents the trend in the total number of episodes in VAED for the period 2001/2 to 2006/7. Total episodes increased from 1,669,697 in 2001/2 to 2,075,659 in 2006/7, an average annual increase of 4.25%. Given that the growth rate for ultrasound episodes was 18 % per year over the same period, it can be seen that approximately one quarter

of the growth in ultrasound episodes in Victorian hospitals is attributable to the overall growth in hospital utilisation. This suggests that there is an increased intensity with which ultrasound is being used.

Figure 5

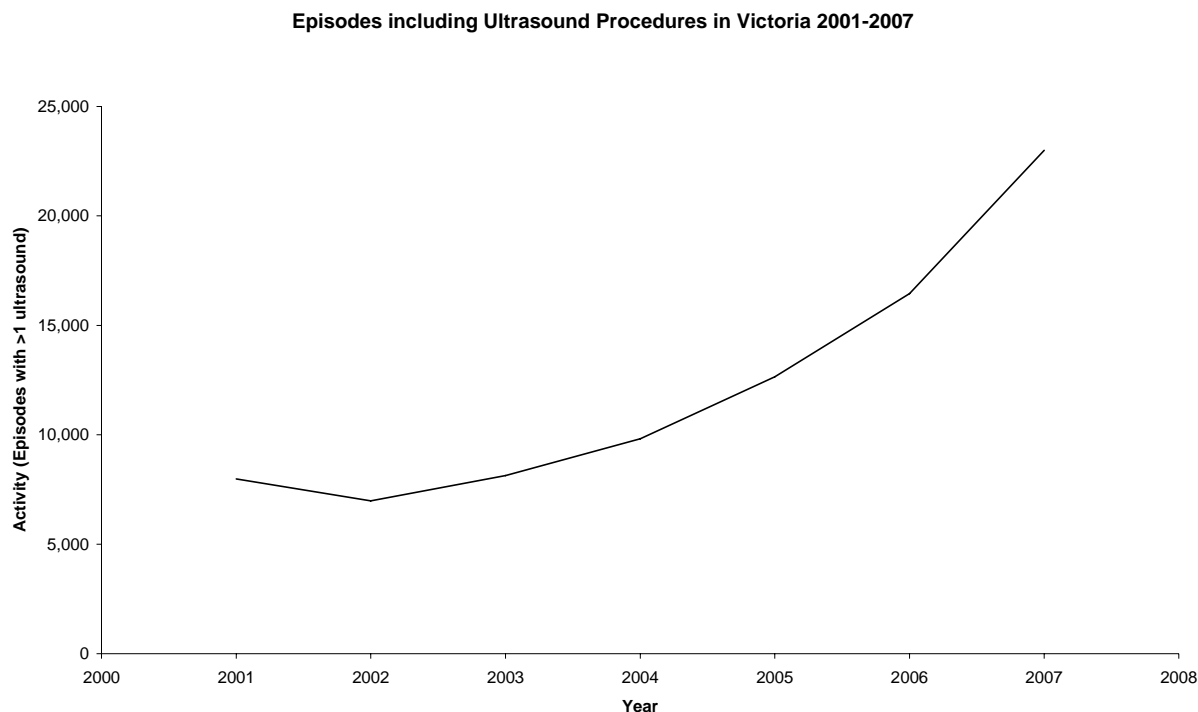


Figure 6

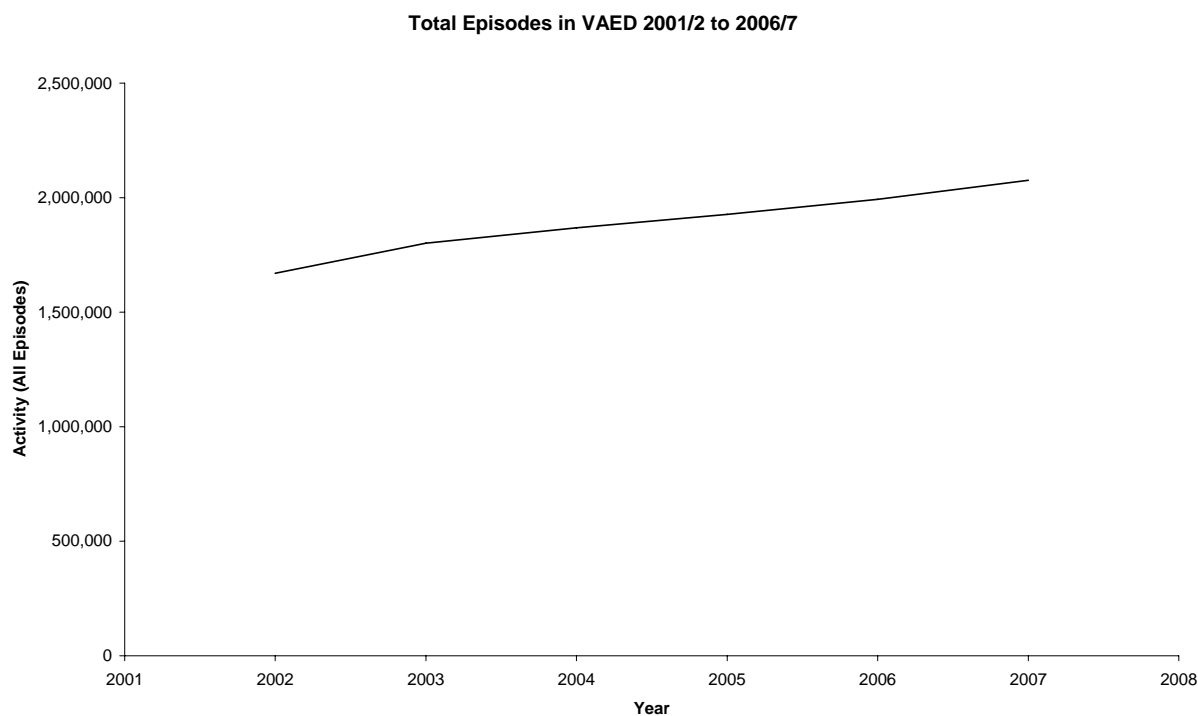


Figure 7

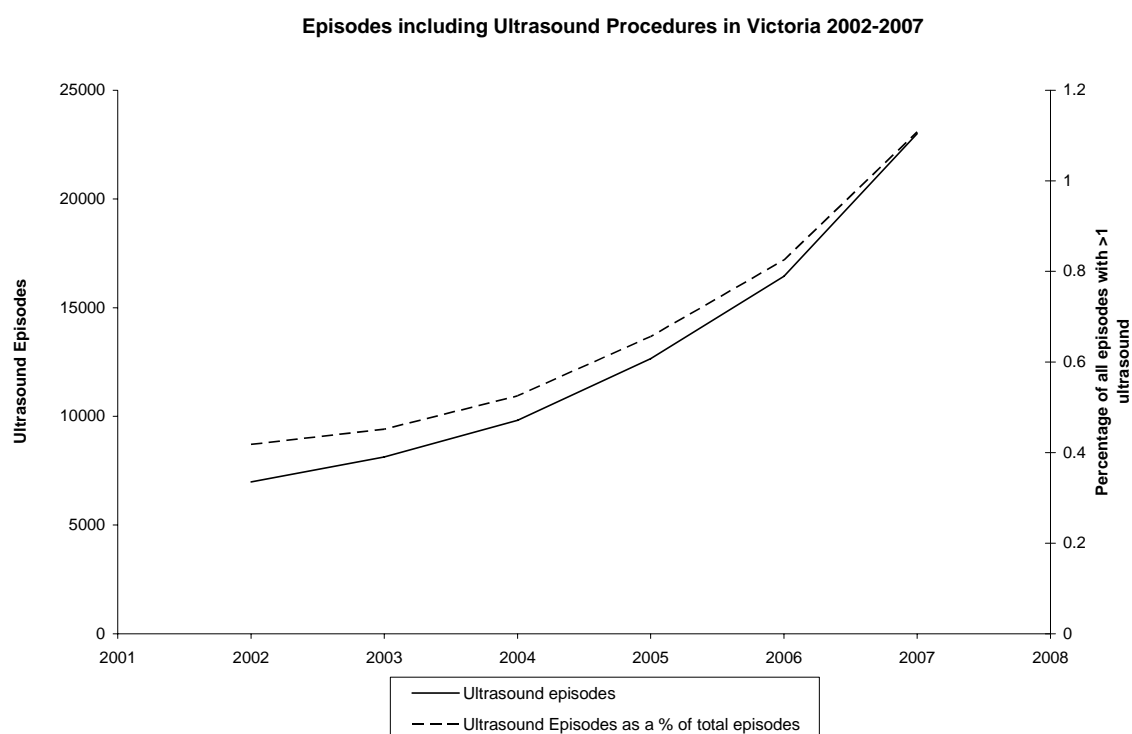


Figure 7 shows the percentage of all VAED episodes including an ultrasound procedure. This percentage increases from 0.42% in 2001/2 to 1.1% in 2006/7. This confirms the number of ultrasound episodes increased substantially in the period, independent of the growth in the overall number of hospital episodes in Victoria. The growth is therefore largely due to an increase in the number of ultrasounds per episode, rather than the number of episodes. Ultrasound services are likely to grow at rates substantially higher than growth rates for overall health care utilisation.

The data are now presented disaggregated by specialty: first a pie chart showing the proportion of activity in different specialties in 2006/7 (Figure 8), then changes over time in activity in each specialty (Figures 9). The specialties are mapped from groups of Diagnosis-Related Groups (DRGs).

Figure 8 shows that the largest areas of ultrasound were in 'other' (36%), cardiac care and cardiology (34%), obstetrics and gynaecology (21%) and urology (19%). The other category includes a large number of DRGs with varying rates of growth. The trends over time in Figure 9 show very high rates of growth since 2005 in obstetrics and gynaecology and in the 'other' category, and slower growth in cardiology. Some of these data may be unreliable as there were changes in the DRG coding used during the time period the data were collected (Department of Health and Ageing, 2008b), however the significant changes by specific DRGs that would possibly affect how ultrasound is coded were not identified.

Figure 10 shows the public/private mix for ultrasound patients in the VAED in 2007 including the hospital type (public/private) and the patient type (public/private). The largest group is private patients in private hospitals (11,346 - 49%) followed by public patients in public hospitals (9934 - 43%), private patients in public hospitals (1263 - 5%) and public patients in private hospitals (457 - 2%). The growth rates of public and private ultrasound patients are

remarkably similar over time (Figure 11). There has been some growth in the number of private ultrasound patients in public hospitals.

Figure 8

Episodes including Ultrasound Procedures in Victoria in 2006/2007 by specialty

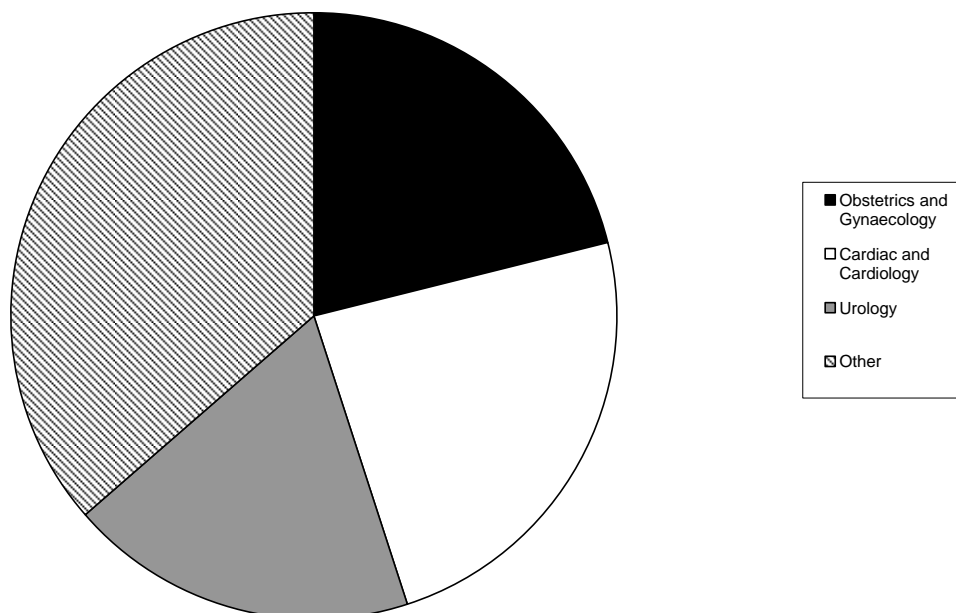


Figure 9

Episodes including Ultrasound Procedures in Victoria 2001-2007 by specialty

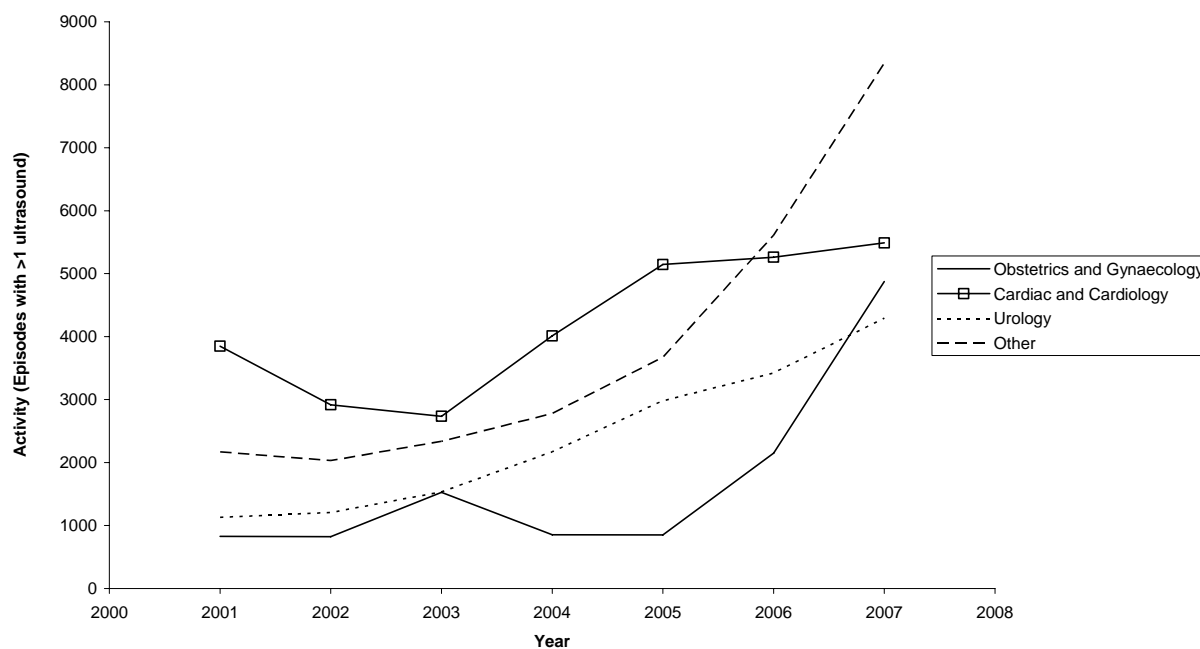


Figure 10

Episodes including Ultrasound Procedures in Victoria in 2006/2007 by hospital and patient type

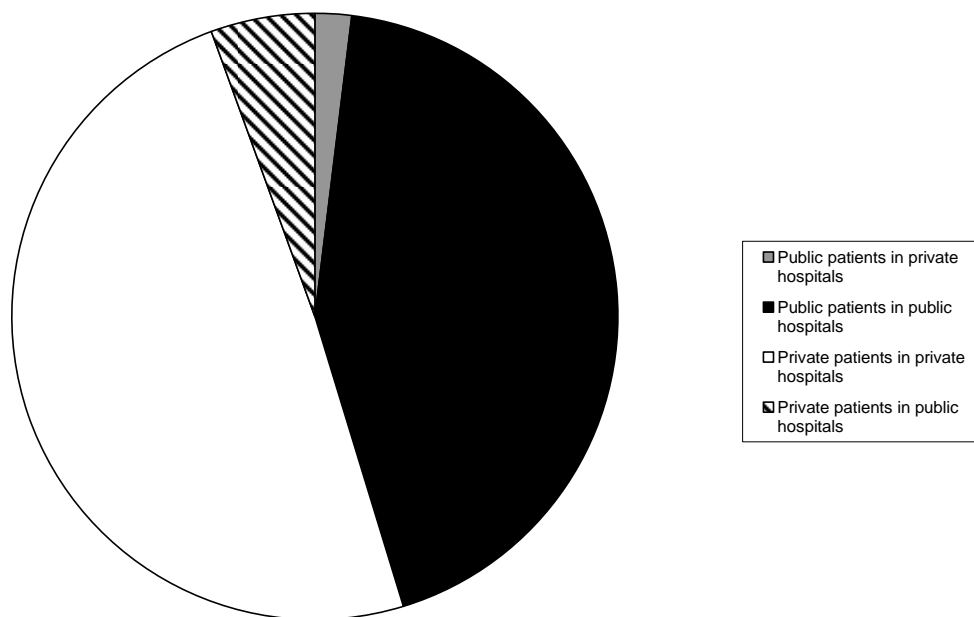
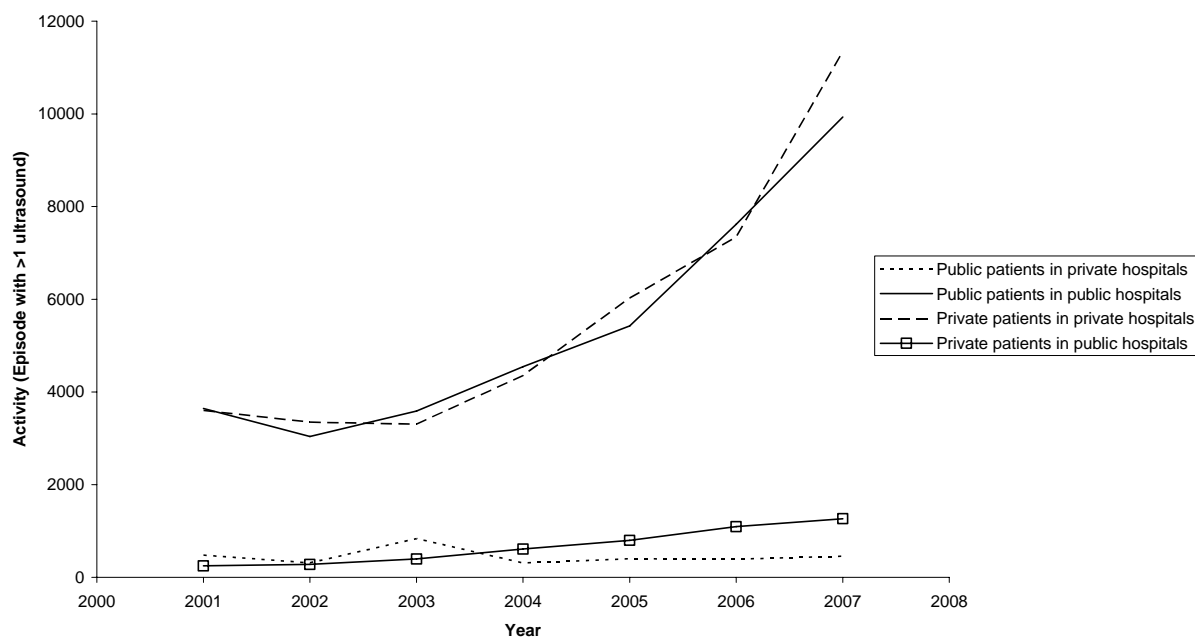


Figure 11

Episodes including Ultrasound Procedures in Victoria 2001-2007 by hospital and patient type



5.2 Key drivers of utilisation

The observed growth in the utilisation of ultrasound is influenced by both demand and supply factors. Variations in utilisation between different disease areas at a given point in time will reflect the relative incidence and prevalence of these diseases. Growth over time is unlikely to reflect changes in epidemiological factors as they will have changed little over the period of analysis, and the per capita growth figures control for population growth.

5.2.1 *Technology and clinical practice*

The most likely causes of past growth in the use of ultrasound are on the supply side, including changes in clinical practice and preferences, changes in technology, and changes in funding arrangements and incentives for both patients and providers. For example, the availability of funding through the MBS is a key driver of utilisation of all diagnostic imaging, not just ultrasound, with high growth observed in other areas of imaging. This is evident in Figure 4 (page 24) with a relatively sharp increase in utilisation in 2005 around the time of the introduction of the Medicare safety net. In addition, the fact that growth is apparent for all types of medical imaging suggests that it is changes in clinical practice and the development of technology that is driving the growth in utilisation. These trends are likely to continue.

Technological improvements may affect utilisation by rendering ultrasound equipment smaller and less expensive, increasing the breadth and depth of clinical application (Parhar, 2006; Wise, 2008). For example, handheld ultrasound units allow bedside assessment of volume status in cardiac patients (Nuguyen et al, 2008) and three dimensional sonography (echocardiography) allows analysis of surgical interventions intraoperatively (Lang et al, 2006). Advances in ultrasound equipment, including the availability of 'compact, specially-formed ultrasound probes', allow new applications in urology (Ukimara et al, 2008). In a more traditional application, new developments in four-dimensional ultrasound allow analysis of foetal behaviour to assess foetal neurodevelopment (Kurjak et al, 2005).

Improvements in technology can increase utilisation by increasing the productivity of sonographers and clinicians so that problems are identified more accurately and quickly, and by increasing the range of clinical conditions in which ultrasound can be used. It could also reduce the use of ultrasound by reducing the need for repeat scans and false positives and negatives. Technological advances for other imaging techniques such as CT scans and MRI may also reduce the need for ultrasound in some circumstances. Medical indemnity issues may also contribute to increased utilisation, including cases where a clinician's preliminary scan identifies a possible problem which can only be eliminated or confirmed by a more detailed scan by sonographers.

5.2.2 *Changes in utilisation by age and disease area*

In terms of changes in the use of ultrasound in different clinical areas and for different types of patient, changes in the patterns of utilisation by age and disease area help to identify the drivers of changes in utilisation. Age is an important determinant of health care use as patients have different average health care needs at different stages of life. The VAED can be used to gain an understanding of how patient age is associated with the use of ultrasound services in Victorian hospitals. First activity is plotted across all 5-year age groups from 0 - 5 to 85 +. Figure 12 plots the distribution for the first year of data (2001/2) and the last year (2006/7).

There are two peaks in the distribution common to both years: the age range 30 to 40 and the age range 55 to 75. The peaks are more pronounced in 2006/7. The first peak in 2006/7 is at a

slightly higher age than in 2000/1. In contrast the second peak in 2006/7 is at a slightly younger age than in 2000/1. This suggests that the utilisation of ultrasound has remained relatively constant for different age groups, with more intensive use across all age groups over time. Figures 13 and 14 explore how the age distribution differs between public and private patients in 2001/2 and 2006/7.

Figure 12

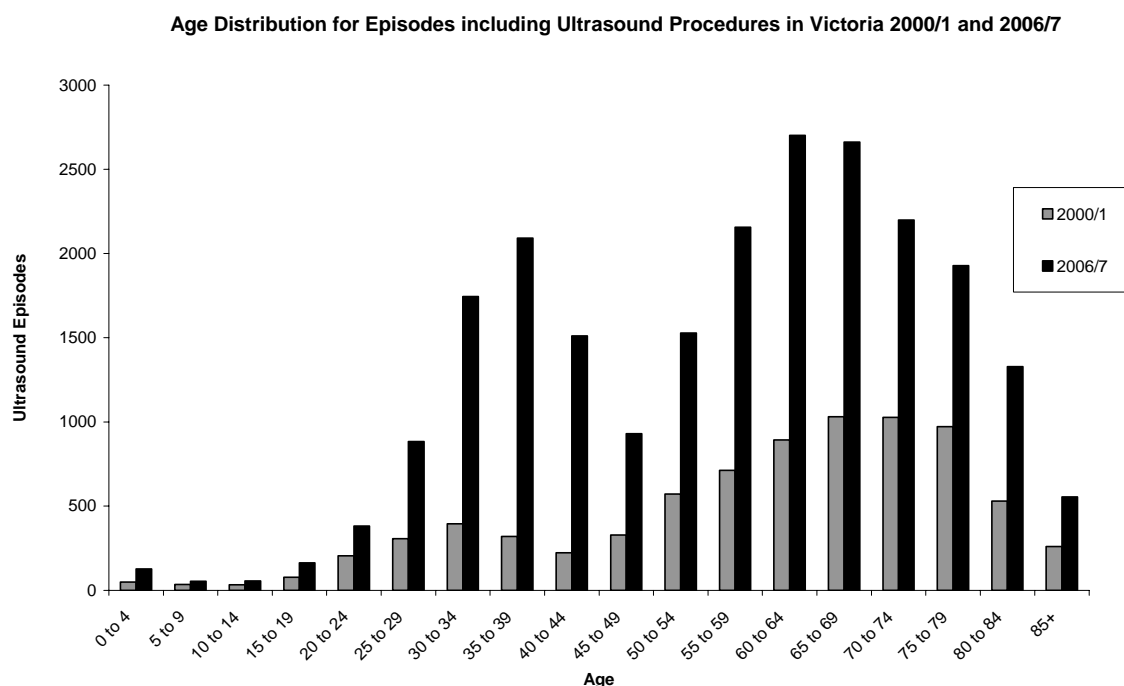


Figure 13 shows that utilisation amongst public patients has grown across all age groups between 2000/1 and 2007/8, with the highest growth in the older age groups. However, in the private sector by 2007/8 (Figure 14) utilisation has expanded most heavily in younger age groups. This suggests that the use of ultrasound has changed in different ways between the public and private sectors.

In summary, whereas in 2001/2 ultrasound for inpatients in public hospitals (mean age = 56.5) was on average much younger than private sector in patients (63.6), by 2006/7 private ultrasound patients (mean age = 56.1) are on average younger than public patients (57.1).

Figure 13

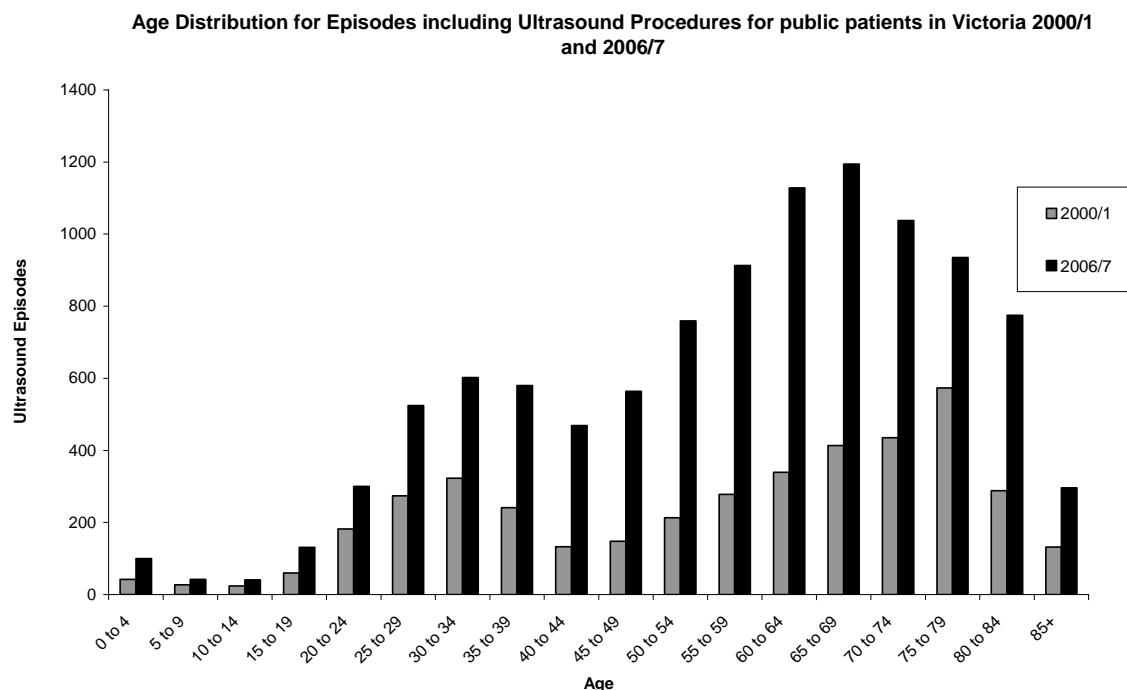
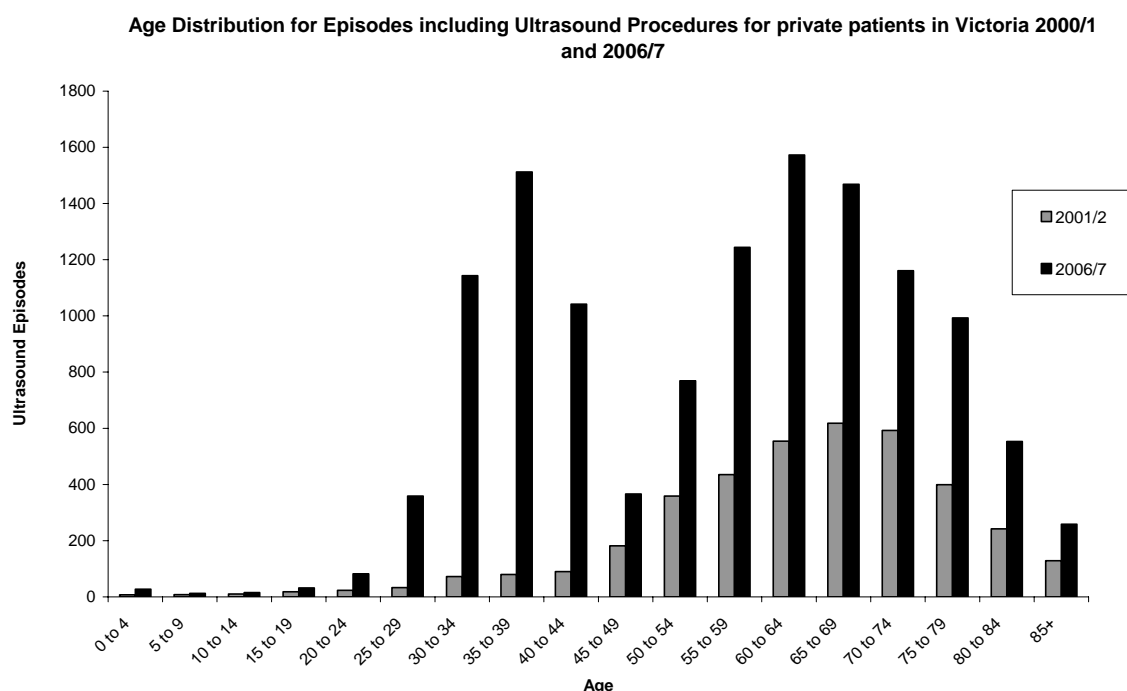


Figure 14



Figures 15, 16 and 17 show changes in the age distribution across the three largest volume clinical areas: (1) Cardiology and Cardio-Thoracic; (2) Urology; and (3) Obstetrics and Gynaecology. Figure 15 plots the age distributions for 2001/2 and Figure 16 for 2007/8.

Figure 15

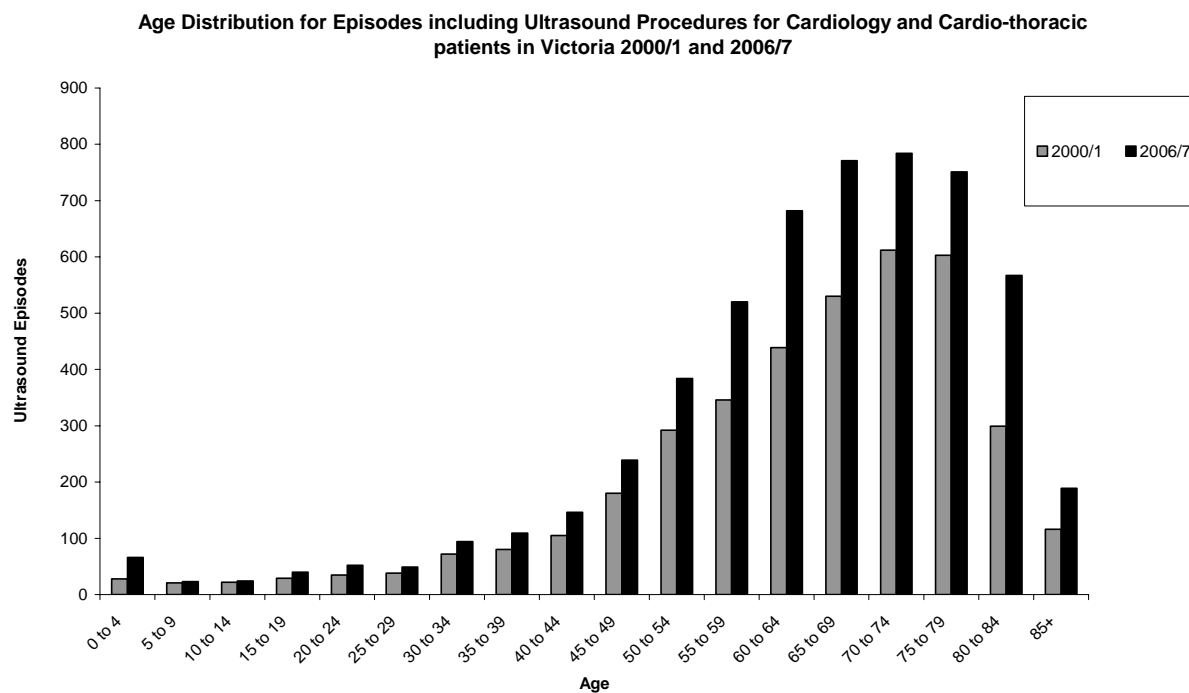


Figure 16

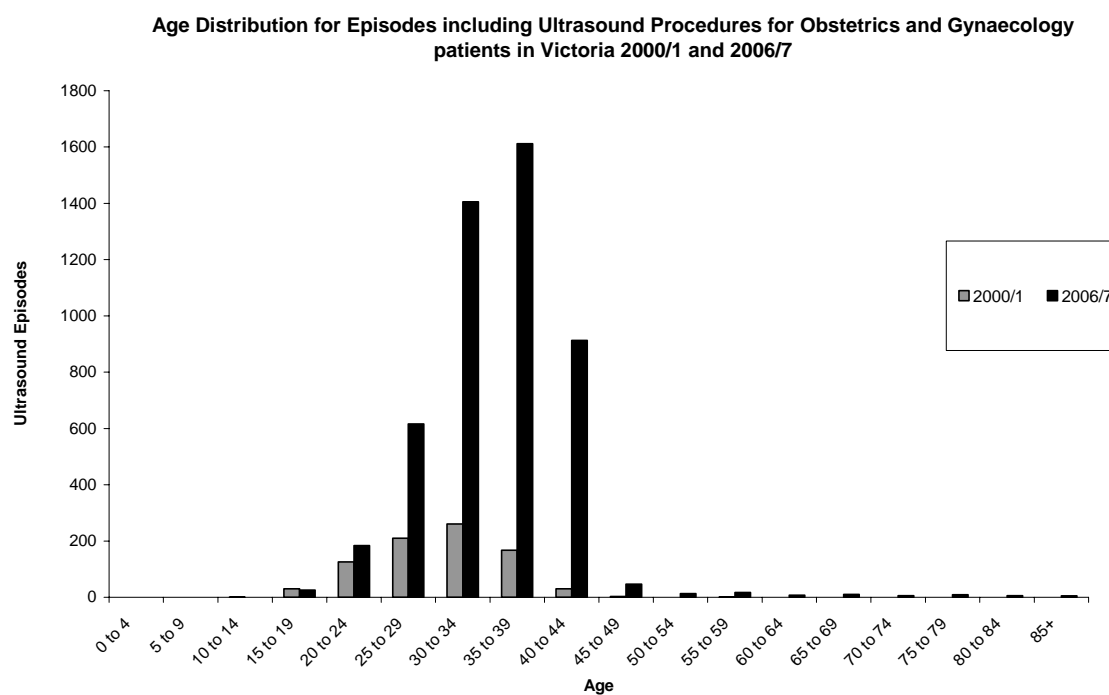
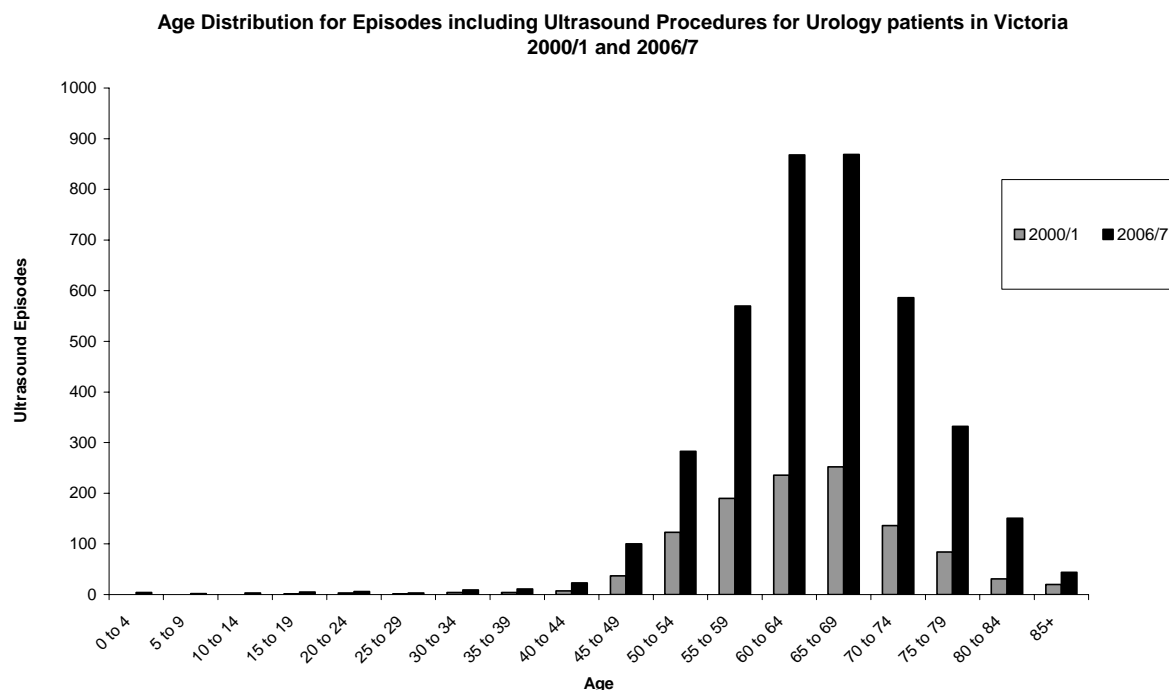


Figure 17



The three disease-specific age distributions give some insights into the determinants of demand in different sections of the age distribution. There has been a modest increase for cardiology and cardio-thoracic patients, especially amongst older age groups. The largest absolute and proportionate growth has been in obstetrics and gynaecology. The number of episodes with ultrasound is around seven times higher in 2006/7 than in 2000/1, and the ultrasounds are being conducted on women in older age groups. Urology ultrasound episodes are four times as high as they were in 2000/1, with growth occurring across all age groups.

The age distributions give some insight into the factors that may drive future utilisation. A growth in admitted episodes with ultrasound procedures in Obstetrics and Gynaecology (Figures 16) corresponds to the increasing volume of younger patients in the private sector (Figures 13 and 14). Therefore we might expect any future growth in the demand for these services, from young, female patients, to be through the private sector. In contrast, any growth in cardiac or urology patients is more likely to increase the use of ultrasound in public hospitals.

6 FORECASTS FOR ULTRASOUND UTILISATION

The forecasts of utilisation are based on simple linear and non-linear extrapolations of existing trends for both Medicare and VAED data presented above in Figures 2 to 11. The linear trend assumes utilisation increases by the same fixed amount (for example, 10,000 cases) each year. This can be considered to be the minimum growth in the future, assuming ultrasound is not replaced by other technologies. The exponential trend assumes utilisation increases at the same rate (for example, 5%) each year. For the Medicare data, where there are more years of data available, forecasts allowing a quadratic and cubic trend are presented, which puts fewer restrictions on the growth rate. The exponential trend indicates an upper estimate of maximum

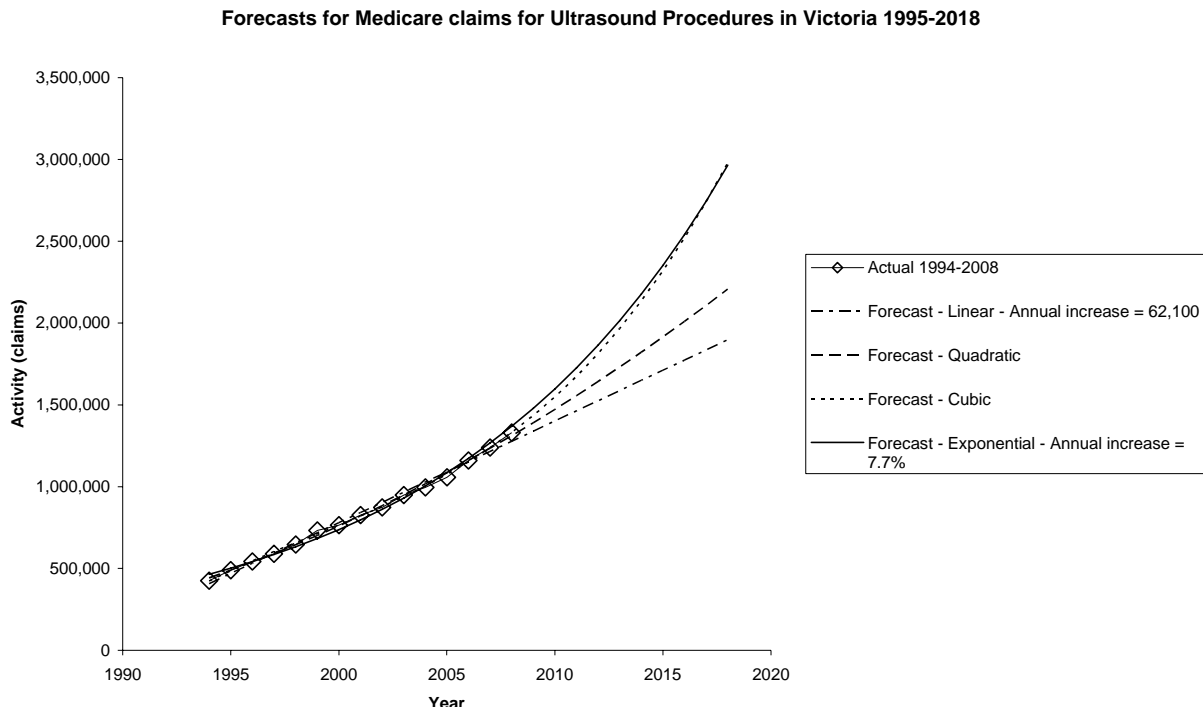
growth in the future, assuming all else remains the same. In each graph, the difference between the ‘minimum’ linear trend and the upper estimate of growth from the exponential trend, gives an expected range of future growth in utilisation.

Extrapolating current trends of ultrasound utilisation into the future is problematic as it relies on strong assumptions about the processes underlying the growth in utilisation. First, it assumes the determinants of utilisation will continue to change according to current trends. For example, it assumes that the population will continue to grow (or decline) at the same rate (or that the rate of growth will grow at the same rate). The forecasts also assume that the growth in utilisation for specific age-sex groups will remain at the same rate. It also assumes that the current trends in technological change, productivity, clinical practice, and use of ultrasound in new disease areas remain at the same rate. Second, the extrapolation puts equal weight on the observed rates of growth throughout the time period of the data. For example, in the Medicare data, the trend from 1994 to 2000 is as important in the extrapolation as the trend from 2000 to 2008.

6.1 Medicare Data

Figure 17 presents forecasts using the Medicare claims data presented in Figures 2 to 4. This is largely for ultrasounds conducted in private settings, but will also include private patients in public hospitals. It is not possible to identify hospital versus other settings in these data. Activity has been forecast in terms of the total number of claims, as opposed to the per-capita figures included in Figures 2 and 3.

Figure 17



The trend in actual Medicare claims shows a steady increase between 1994 and 2008, the trend appears quite linear. The linear forecast is based on an annual increase of 62,100 claims, on average 4.0% per year with the total increasing from 1,276,196 in 2007/8 to reach 1,897,172 by 2018.

2018. In contrast, the exponential forecast predicts a 7.7% annual increase with total claims increasing to 2,965,628 by 2018. The cubic forecast is very close to the exponential forecast and the quadratic forecast lies between the linear and the exponential, predicting growth to 2,207,780 by 2018, on average 5.4% per year. Summarising this forecast, the utilisation of Medicare rebatable ultrasound is predicted to grow by between 4.0% and 7.7% annually over the next 10 years, (between 2007/8 and 2017/8).

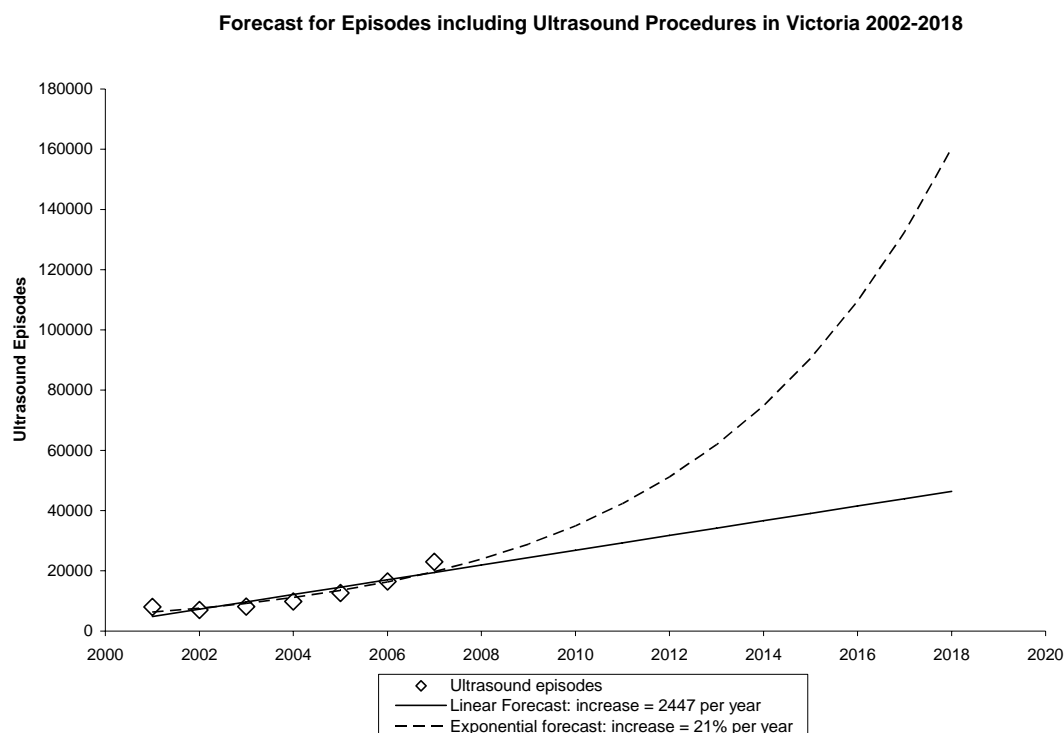
6.2 Inpatient data (VAED)

Figure 18 forecasts utilisation using the VAED presented in Figures 4 to 11. Included are all VAED on episodes including ultrasound procedures (private and public patients in private and public hospitals). For these data the squared and cubic forecasts have been omitted due to the limited number of data points.

The linear forecast predicts an annual increase of 2,447 episodes, 7% per year on average, with total episodes reaching 46,405 by 2018. The exponential forecast is based on an annual increase of 21% with total episodes reaching 160,309 by 2018. This gives a range of 7% to 21% annual growth in the next 10 years (between 2007/8 and 2017/18).

The VAED shows a much larger difference between the linear and exponential forecasts compared to the forecast for the Medicare data. This discrepancy may be influenced by the data being available for a fewer number of years for the VAED forecasts. The high rate of growth estimated in the exponential forecast is influenced by the strong growth rate observed in the data between 2005 and 2007. Growth in the public and private sectors of inpatient use of ultrasound are similar, so separate forecasts have not been presented.

Figure 18



7 DISCUSSION AND CONCLUSIONS

From the literature and consultations, there is anecdotal evidence of a shortage of sonographers in the state's public and private sectors, although no empirical data exist to support this. In a recent survey of radiologists in Australia (RANZCR, 2006b pp28) 509 out of 770 radiologists identified sonographers as being 'in short supply'. Furthermore, a submission by RANZCR in 2005 suggests, "It is clearly recognised that there is already a shortage of radiographers and sonographers in Australia" (RANZCR, 2005). There is also some evidence of a shortage in the United States (Craig, 2003, Clay 2004), which may be representative of a worldwide shortage.

In order to obtain a greater understanding of these shortages, a number of workforce factors were explored including a review of the Sonography workforce demographics, current utilisation and forecasted, as well as considerations for future supply including training issues and changing pay and conditions,

7.1 The Sonography Workforce

Sonography, as it is practised in Australia, is an accredited specialisation within the Medical Imaging Technology (MIT) profession and sonographers must be registered to practise through inclusion in the Australian Sonographer Accreditation Registry (ASAR). Only registered sonographers may perform ultrasound services under the Medical Benefit Schedule (MBS) and all registered sonographers must have completed a course that is accredited by the ASAR.

Data from the ASAR register are likely to overestimate the number of sonographers undertaking sonography, since a proportion will be registered but not working as a sonographer. Data from the 2006 census are likely to be an underestimate due to the self-reporting of occupation. The ASAR register contains limited and incomplete information on the characteristics of sonographers, whilst the census contains more detailed information.

There were 916 sonographers on the ASAR register in Victoria in 2008, around 1.8 per 10,000 population. This has been growing at an average rate of just over 5% per year, or around 51 additional accredited sonographers per year in Victoria.

In the 2006 census, 68% of sonographers were female, with the female share of the workforce increasing over time. 55% of female sonographers work less than 35 hours per week, compared to 13% of males. The changing gender distribution suggests a gradual decline in total FTEs as the size of the workforce grows. 76% percent of sonographers were employed in the private sector in 2006, and this increases slightly with age. The pattern of part-time work is the same in the public and private sector.

The average annual growth in the number of accredited sonographers has been 6.8%, and just over 5% in per capita terms. There is some evidence that future growth in the number of FTEs will slow, as women are accounting for an increasing share of the sonography workforce.

A more detailed workforce survey of sonographers, similar to the registration surveys conducted for other health professionals, could be conducted using the ASAR register.

7.2 Utilisation of sonography

Sonography is being used across a growing number of clinical areas, due to reductions in the cost and increasing portability and flexibility of equipment and the utilisation of sonography is growing in Victoria. In 2008, there were 1,330,849 Medicare claims for ultrasounds. After adjusting for population growth, since 2003 utilisation has increased by an average of 6.4% per year. There was particularly strong growth around the time of the introduction of the Medicare Safety net.

The number of inpatient episodes in public and private hospitals involving ultrasound has more than doubled since 2002, to 23,121 in 2007. The average annual growth rate is 18%. There is some evidence of increased intensity of use (more ultrasounds per episode), rather than simply growth in the total number of episodes.

In Victoria, there are no centrally collected data on use of ultrasound in public outpatient settings (for example, antenatal ultrasound) or emergency departments and this is a major gap in the utilisation data. The birth rate in Victoria has remained relatively stable, although the recent upward trend suggests an increase in demand for ultrasound. Growth rates in the use of inpatient ultrasound in public and private hospitals are similar, and similar growth is apparent for other types of medical imaging. Ultrasounds are now being conducted on much younger patients in private hospitals compared to 2001/2, whilst utilisation in public hospitals has increased across all age groups since 2001/2.

The recent growth in utilisation is likely to be due to changes in technology and changes in the use of the technology by clinicians, rather than changes in epidemiological factors or population growth. Technological change is likely to have driven increases in productivity and the application of ultrasound in new clinical areas. A cautious approach should be taken when funding and supporting the use of ultrasound in new clinical areas, until evidence of cost-effectiveness becomes available. While ultrasound is being used by more clinicians there is little suggestion that this is replacing sonographers and the need for detailed ultrasounds. This trend maybe increasing the demand for sonographers if increased use by clinicians coupled with litigation concerns lead to a higher rate of referral for detailed ultrasounds.

The use of hand-held ultrasound machines among doctors is becoming so pervasive that ultrasound machines may become “the stethoscope of the 21st century” (Wise, 2008). While this may constitute additional utilisation to that undertaken by sonographers, it is unlikely to represent a substitute for more detailed scans due to litigation concerns. The increased use of ultrasound by clinicians may in fact increase referrals to sonographers. However, there are no empirical data to support this. This growth in the use of sonography due to technological advances could also indicate that the productivity of sonographers has increased by making ultrasound examinations quicker and reducing the need for re-scans due to false positives and false negatives. However, there is little empirical on changes in productivity. If such productivity gains continue, then there may be less need for additional trained sonographers. However, this would need to be balanced against an increased use of ultrasound in a wider range of clinical applications and by clinicians themselves. The increased use of ultrasound in a wider range of clinical areas may in fact increase the demand for trained sonographers.

7.3 Forecasts of utilisation

The use of ultrasound is likely to continue to increase as technology continues to change, and as the general tendency to refer patients for detailed scans continues to be driven by factors such as medical indemnity. The utilisation of Medicare rebatable ultrasound is projected to grow by between 4.0% and 7.7% per year between 2007/8 and 2017/8 and the utilisation of inpatient ultrasound is projected to grow by between 7% and 21% per year between 2007/8 and 2017/18. This is similar in both public and private hospitals.

Due to the absence of centrally collected data on outpatient ultrasound in public hospitals, trends and projections of utilisation in the public sector are therefore severely underestimated. Data on the number of health professionals providing sonography in Victoria are also incomplete and inaccurate. It is therefore not possible to determine future requirements for sonographers. The results below should be interpreted with this in mind. Filling the gaps in these data is an important avenue for further work.

The data do, however, clearly indicate that the utilisation of sonography has increased and is likely to continue to increase. This is largely due to technological change and consequent changes in the clinical application of ultrasound. This is likely to have led to net increases in the productivity of sonographers, and an expansion of clinicians conducting ultrasounds themselves in new areas of clinical application.

7.4 Forecasts of shortages

In assessing whether there is a shortage of sonographers, vacancy data are not available and in any case may not be an accurate measure due to differences in recruitment practices across hospitals. The consultation phase sought to establish whether there were high vacancy rates for sonography positions. One metropolitan hospital suggested that they find it very difficult to recruit and that they have a vacancy listed almost year round. However, they were reporting having a full complement of staff sonographers. On the other hand anecdotal evidence suggests that because positions are hard to fill some organisations have stopped advertising positions and rely on word of mouth or more formal “head-hunting” methods using search firms. In one country hospital there is a steady flow through of sonography trainees because they tend to lose sonographers shortly after they qualify, but again there is a form of balance in the workforce. To the extent that sonographers are hard to find, the difficulties are most acute in country and outer metropolitan regions.

Using waiting list data to provide evidence of shortages of sonographers is not possible. Although waiting list data provided some evidence of general shortages in the public sector across specialties and for elective surgery, they cannot be used to identify shortages of specific resources, such as sonographers, and provide no information on possible shortages in the private sector. Overall, the quality of the data available to identify shortages is poor and not suitable for estimating workforce requirements for sonography.

7.5 Increasing supply

7.5.1 Training issues

The growth in the use of ultrasound is higher than the growth in the number of sonographers, which suggests a need for increasing the number of sonographers.

One of the main barriers to increasing the supply of qualified sonographers is a shortage of clinical training places, which are essential to meet sonography course requirements. Most courses require that applicants have a clinical placement organised before they begin the course and the workload of clinical supervisors may fall by as much as 25% when providing supervision. Therefore, the cost of each training post should be based on a full Grade 2 salary plus on-costs for the trainee, and 25% of the salary and on-costs of the supervisor (based on a Grade 4 position), in addition to the cost of appropriate space and equipment.

While seven universities and the Australian Society for Ultrasound in Medicine (ASUM) offer accredited postgraduate courses in sonography, there are no intensive courses leading to qualification as a registered sonographer. There is some debate about whether ultrasound training is too long, especially compared to what was required in the past. It is relatively expensive to train sonographers compared to other health professionals due to their need to be independent and the apparent need to have one-to-one supervision at least for the first few months.

There is a view in the sonography profession that ultrasound should continue to be a specialisation and a degree of professional pride in the fact that sonographers are seen as specialists in the MIT area. This view is not held by all in the profession and some believe that the shortage of sonographers could be alleviated if there were an undergraduate course leading to sonography registration or even to allow for limited scope of practice rather than all sonographers being general sonographers – this would require a change to the Medicare legislation and the ASAR's registration and accreditation requirements.

While it is not clear where trainees are located, it seems that the perception of a majority of sonographers training in the public sector and then moving to the private sector is incorrect as the private sector is training a significant number.

7.5.2 Changing pay and conditions

Qualified sonographers are paid more than radiographers, providing some financial incentives for increased supply. Pay is likely to be higher and working conditions are considered more flexible in the private sector. However, there are no data available on the differences in non-pay working conditions between the public and private sectors, such as unsocial hours, stress, job satisfaction, or training opportunities. Anecdotal evidence from the consultations suggests that public sector staff are required to be on call whereas in the private sector sonographers can work regular and more flexible hours, although have less experience of continuity of care. More flexible on-call arrangements in public sector settings may increase retention.

There is also no evidence of the costs and effects of changing pay and conditions to increase the supply of sonographers in inpatient settings, and whether this is more cost-effective than increasing the number of clinical training places.

7.6 Conclusion

The central conclusion of this report is to suggest that an investment in additional clinical training places is required. This conclusion was based mainly on the consultations, within the context of predicted increases in utilisation that were likely to be larger than expected increases in supply. However, the data are not of sufficient quality to estimate how many additional training places are required. Further work is required to improve the quality and scope of the data available.

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9 The Consultants

The Australian Health Workforce Institute (AHWI) was engaged by the Department of Human Services to undertake this project. Fellows of the Institute include Prof. Anthony Scott, Dr. Catherine Joyce, and Prof. Vin Massaro.

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10 Appendix 1 - Consultations

HOSPITALS

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Richard van Dreven, Chief Radiographer, Ballarat Health Service

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and

Paula King and Tanya McDonald, Chief Sonographers (job share), The Royal Melbourne Hospital

Faye Temple, Chief Sonographer, St Vincent's Hospital (and Vice-President, Australian Sonographers Association; Board Member, Australasian Sonographer Accreditation Registry; Tutor for Monash University and RMIT University)

Bert Thorbecke, Chief Medical Imaging Technologist, Peninsula Health (Frankston Hospital)

Professor Ken Thomson, Director of Radiology
and

Gillian Tickall, Acting Chief Radiographer
and

Ben Grinsted, Sonographer Tutor, Alfred Health

Dr Mandy Sampson
and

Dr Louise Kornman, Royal Women's Hospital and on behalf of the Royal Australian and New Zealand College of Obstetricians and Gynaecologists

Dr Stuart Dilley, Emergency Physician, St Vincent's Hospital

Luke Adorni, Chief Medical Imaging Technologist, Bendigo Health

RADIOLOGY SERVICES

Matthew Swain, General Manager, Southeast Radiology

Rod Roncari, General Manager Victoria, I-Med and on behalf of the Australian Diagnostic Imaging Association

TRAINING PROVIDERS

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Rob McGregor, Clinical Director, Australian School of Medical Imaging

Associate Professor Marilyn Baird, Head, Department of Medical Imaging and Radiation Science

and

Paul Lombardo, Ultrasound Course Coordinator, Monash University (and Board Member, Australasian Sonographer Accreditation Registry)

Suean Pascoe, Director, Ultrasound Training Solutions

ASSOCIATIONS

Don Swinbourne, Chief Executive Officer, Royal Australian and New Zealand College of Radiologists

Elaine Trevaskis, Chief Executive Officer, Australian Sonographers Association

Fleur Harbridge, Australian Health Services Union

Caroline Hong, Chief Executive Officer

and

Keith Anderson, Education Manager, Australian Society for Ultrasound in Medicine

Chris Sykes, Chair

and

Diane Jackson, Board Member (representing Cardiac Sonographers), Australasian Sonographer Accreditation Registry

Dr Mathew Andrews, on behalf of the Royal Australian and New Zealand College of Radiologists (Convenor of the Ultrasound Group) (and Director of Radiology, Sandringham Hospital; Immediate Past President, Australian Society for Ultrasound in Medicine)

Professor Ron Benzie, President, Australian Society for Ultrasound in Medicine and Director of Perinatal Ultrasound, University of Sydney and Nepean Hospital

David Collier, Chief Executive Officer, Australian Institute of Radiography

Australian Diagnostic Imaging Association – see Roncari above

Royal Australian and New Zealand College of Obstetricians and Gynaecologists – see Sampson and Kornman above

11 Appendix 2 - Issues and topics for consultations

Supply

1. Are there high vacancy rates for sonography positions in the public/private sector?
2. Are there any patterns of recruitment problems (for example, rural areas only, particular sectors)?
3. What is the perception of how many Victorian (or Australian)–trained sonographers migrate overseas and are there many immigrant sonographers working in Victoria?
4. How do the current training opportunities for sonographers in Victoria (through RMIT, Monash or the DMU through ASUM) affect the number of sonographers working in Victoria?
5. Are there possible alternative training pathways?
6. Are award (employee) conditions a disincentive to attract and retain sonographers to the profession? How do awards differ between states, between the private and public sector and in comparison to radiographers?
7. Do working conditions for sonographers in Victoria help or hinder recruitment and retention? Examples of relevant working conditions include long hours, frequency of occupational injuries and continuing professional development.
8. What opportunities for career progression are available to sonographers?
9. What are your suggestions for ensuring that there is an adequate workforce to meet sonography services in Victoria?

Distribution

10. Are there differences between the public and private sectors in terms of attractiveness to:
 - * men/women
 - * younger/older
 - * Australian trained/overseas trained sonographers (for example, in relation to income potential, flexibility, opportunities for part time work etc)?
11. What are the perceptions of how this has changed over time (if so)?

Utilisation

12. Are there waiting lists for sonography services? What sectors/patient groups/service types? What factors contribute to these?
13. What are the perceptions of how provision of sonography services has changed over time? In other words, is it the case that other providers – radiologists, obstetricians, cardiologists, urologists – are now performing ultrasound procedures whereas in the past they did not or to a lesser extent? What factors have contributed to changes? Is this trend likely to continue? What impact is it likely to have on the sonography profession?

14. How has new ultrasound technology affected the provision of ultrasound services? For example, is ultrasound much more widely used than 10 years ago because of new applications and increasing activity in existing applications? Is this trend likely to continue?
15. How does government funding, through the Medicare benefits schedule, influence what ultrasound services are provided and who provides them?
16. How broad or narrow are clinical sonography jobs in practice (for example, across different clinical conditions or patient groups)?
17. Does this breadth differ by context – private versus public, hospital-based versus community-based?
18. What are employers' expectations in regard to 'sub-specialisation'? For example, if someone is qualified or experienced in sonography for antenatal care, can they easily move into a role doing sonography for cardiac or other groups?
19. What are the perceptions of how the role has changed over time (if so)? Have sonographers been given more responsibility, for example as 'ultrasound practitioners'?
20. How does the role of sonographers differ from radiographers, for example in terms of responsibility? How much overlap is there between the two professions - sonographers doing some work as radiographers and radiographers doing some work as sonographers?

Note: Not all questions will be asked of those consulted. Below is an indicative list of which questions are relevant to which target group.

Question	Target group			
	Hospitals	Radiology services	Training providers	Associations
1	✓	✓		
2	✓	✓		
3			✓	✓
4			✓	
5	✓	✓	✓	
6	✓	✓		✓
7	✓	✓		✓
8	✓	✓		
9	✓	✓	✓	✓
10	✓	✓		✓
11	✓	✓		✓
12	✓	✓		
13	✓	✓		✓
14	✓	✓		
15	✓	✓		
16	✓	✓		
17	✓	✓		
18	✓	✓		
19	✓	✓	✓	✓
20	✓	✓	✓	✓

12 Appendix 3 - 2006 Census questions on occupation

38. In the main job held last week, what was the person's occupation?

39. What are the main tasks that the person usually performs in the occupation reported at Question 38.

The self-reported answers to these questions are coded using the Australian and New Zealand Standard Classification of Occupations (ANZSCO) 2nd edition (cat. no. 1220.0).

13 Appendix 4 - ASAR accredited training providers and qualifications

Conferring Body	ASAR Accredited Qualifications
Australasian Society for Ultrasound in Medicine (ASUM)	Diploma of Medical Ultrasonography (Cardiac) Diploma of Medical Ultrasonography (General) Diploma of Medical Ultrasonography (Vascular) Diploma of Medical Ultrasonography (Obstetric)
Charles Sturt University	Graduate Diploma of Applied Science (Medical Ultrasound) Master of Applied Science (Medical Ultrasound)
Curtin University of Technology	Post Graduate Diploma in Medical Imaging Science — Ultrasound (for students enrolled prior to 1/1/2000) Master of Medical Sonography, incorporating the Graduate Diploma
Monash University	Graduate Diploma in Medical Ultrasound Master of Medical Ultrasound
Queensland University of Technology	Graduate Diploma in Applied Science (Medical Ultrasound) Master of Applied Science (Medical Ultrasound) Graduate Certificate in Applied Science (Breast Ultrasound) Graduate Diploma in Cardiac Ultrasound Master of Cardiac Ultrasound
RMIT University	Graduate Diploma (Sonography) Graduate Diploma of Ultrasonography Master of Applied Science (Sonography)
University of South Australia	Graduate Diploma in Medical Sonography Master of Medical Sonography Graduate Certificate in Medical Radiation (Breast Imaging)
University of Sydney — Cumberland Campus	Graduate Diploma of Health Science (Medical Sonography) Graduate Diploma of Health Science with Certificates of Specialisation in Vascular Sonography Graduate Diploma of Health Science with Certificates of Specialisation in Cardiac Sonography (for students enrolled prior to 31/3/2006) Master of Health Science (Medical Sonography) Master of Health Science with Certificates of Specialisation in Cardiac and Vascular Sonography (for students enrolled prior to 31/3/2006)

14 Appendix 5 – Characteristics of selected courses

1. RMIT UNIVERSITY – School of Medical Sciences

Master of Applied Science (Sonography) incorporating the Graduate Diploma in Sonography

[http://www.rmit.edu.au/browse;FORMQRY=ADV%253DSearch%2526typ%253D0%2526any%253DSonography%2526Submit.x%253D20%2526Submit.y%253D14;ID=MC131;STATUS=A?QRY=%2B\(Sonography\)%20%2BTYPE%3D\(|%22PROGRAM%22\)](http://www.rmit.edu.au/browse;FORMQRY=ADV%253DSearch%2526typ%253D0%2526any%253DSonography%2526Submit.x%253D20%2526Submit.y%253D14;ID=MC131;STATUS=A?QRY=%2B(Sonography)%20%2BTYPE%3D(|%22PROGRAM%22))

Who are the programs for?

Medical Radiation graduates who want to become qualified sonographers (Graduate Diploma) and sonographers who wish to develop research skills and broaden their professional outlook (Master of Applied Science).

What do the programs offer?

- * Broaden and extend knowledge in ultrasound.
- * Acquire skills and understanding in the use and application of information technology in the rapidly evolving fields of e-learning and e-health.
- * Direct self learning and acquire independent and lifelong learning skills.
- * Develop competence in scientific investigation and communication.

Duration

Masters: three years part-time. This duration incorporates the Graduate Diploma: two years part-time.

All courses are offered for distance learning using the OnLine@RMIT resources to distribute learning materials via the internet. Communication between lecturers/tutors and students is maintained in an ongoing basis using e-mail, electronic conferences and online chat sessions. There are no on-campus requirements.

Pathways

If you are a medical radiations graduate (or equivalent) seeking an ultrasound qualification you may complete the Graduate Diploma program and then exit. Alternatively, you may choose to also complete the Masters extension to the Graduate Diploma program and then exit. If you have already completed a Graduate Diploma equivalent you may enter the Masters extension directly, bypassing RMIT's Graduate Diploma, and then exit.

Professional Recognition

The Graduate Diploma is fully accredited with the Australasian Sonographers Accreditation Registry.

Entrance Requirements

You must have a recognised qualification in an allied medical discipline, for example, Bachelor of Applied Science (Medical Radiations), Diploma of Applied Science (Medical Radiography, Nuclear Medicine Technology or Therapy Radiography), or an equivalent qualification.

Enrolments and graduations

	2004	2005	2006	2007	2008	Total
Graduate Diploma						
Enrolments	45	38	42	86	69	280
Graduations	N/A	N/A	N/A	N/A	29	29
Masters						
Enrolments	3	0	1	2	8	14
Graduations	N/A	N/A	N/A	N/A	1	1

2. MONASH UNIVERSITY - Department of Medical Imaging and Radiation Sciences

Master of Medical Ultrasound (<http://www.med.monash.edu.au/radiography/>)

Course overview

This course is offered by the Department of Medical Imaging and Radiation Sciences as a distance education course. The course is structured to enable exit at:

- * Graduate Certificate in Medical Ultrasound
- * Graduate Diploma in Medical Ultrasound
- * Master of Medical Ultrasound

The Graduate Certificate introduces the student to the introductory concepts of ultrasound and then enables a focus in a particular branch of clinical ultrasound. A Graduate Diploma is required to obtain accreditation with the Australasian Sonographer Accreditation Registry (ASAR) which will enable the successful graduate to practise as a qualified sonographer. The Masters extension of the program enables development of advanced practice and research skills. The course resources are provided mainly on-line. The material is structured to guide the student through the material on a weekly schedule with exercises that ensure the course retains a clinical focus.

Admission requirements

Applicants will generally be graduates of a degree program in Radiography and Medical Imaging or equivalent. Applicants holding degrees in related disciplines, (such as Medicine, Nursing, Biomedical Sciences, Radiation Therapy, Nuclear Medicine or other Health Sciences) will be assessed on a case-by-case basis by the Department of Medical Imaging and Radiation Sciences for admission.

Clinical placements

Prior to admission to the two sonographic clinical units, applicants must provide evidence verifying that they are actively engaged in clinical ultrasound for the equivalent of at least three days a week. The university does not accept any responsibility for finding clinical placements.

In 2008 the spread of clinical training placements for the Graduate Diploma course were as follows:

	Metro	Non-metro	Total
Private settings	21	11	32
Public settings	42	13	55
Total	63	24	87 ¹

Note 1. The number of student placements is less than the enrolments for 2008 (see table below) as not all students have secured a placement.

Enrolments and graduations

	Up to 2005	2006	2007	2008	Total
Graduate Certificate¹					
Enrolments					
Graduations					5
Graduate Diploma²					
Enrolments		80	88	102	270
Graduations	32	25	30	32	119
Masters					
Enrolments		4	6	6	16
Graduations	3	3	5	6	17

1. Course does not lead to accreditation

2. Course commenced in 2001

The Department of Medical Imaging and Radiation Sciences also offers the following short courses

General Radiography: Introduction to the Principles and Practice (a distributed learning program for general practitioners practicing in rural areas with a need for a local GP provided X-ray service) - <http://www.med.monash.edu.au/radiography/docs/genradiographyflyer.pdf>

Introductory Sonography for Emergency Physicians and Surgeons (a series of intensive four-day seminars jointly offered by the Australian School of Medical Imaging and Monash University) -

<http://www.med.monash.edu.au/radiography/docs/asmiemergencyphysiciansandsurgeons.pdf>

3. AUSTRALIAN SOCIETY FOR ULTRASOUND IN MEDICINE - <http://www.asum.com.au/>

Offers:

- * Certificate in Clinician Performed Ultrasound
- * Diploma of Medical Ultrasonography
- * Diploma of Diagnostic Ultrasonography with specialisations in General, Cardiac, Vascular or Obstetric. This course is accredited by the ASAR.

4. AUSTRALIAN INSTITUTE OF ULTRASOUND - <http://www.aiu.edu.au>

Based at the Gold Coast.

Offers an extensive range of courses, 7 of which are accredited by ASUM:

- * General Sonography -5
- * Vascular-5
- * Echocardiography – 1
- * Musculoskeletal – 3 (for physiotherapists and podiatrists)
- * O and G- 4
- * Clinician focused -9
- * Other -3 (Veterinary Practice, Physiotherapists, Podiatry)

5. EMED ULTRASOUND - <http://www.emedultrasound.com.au>

Based in Sydney.

Offers a broad range of courses in clinical ultrasound that respond to the increasing demand for more sophisticated training in focused clinical ultrasound, aimed specifically at those clinical specialties involved in acute patient care.

Currently offers six courses all of which are accredited by ASUM:

- * 1-Day Basic Emergency Ultrasound Course
- * 2/3-Day Advanced Emergency Ultrasound Course
- * 2-Day Emergency Echocardiography Course
- * 1-Day Emergency Hepato-Biliary and Renal Ultrasound Course
- * 1-Day Emergency Vascular Course
- * 1-Day Emergency Gynaecological Ultrasound Course
- * ½-Day Ultrasound – Guided Vascular Access Course

Developing 4 additional 1-Day Advanced Course to respond to the increasing demand of the expanding role of focused ultrasound in emergency medicine.

Also offers individually developed courses to be run in organisations' own departments.

6. ULTRASOUND TRAINING SOLUTIONS - <http://www.u-t-s.com.au/>

Is a new Melbourne based medical ultrasound training provider.

Currently offers six courses all of which are accredited by ASUM:

- * Introductory Ultrasound for Emergency Medicine (IUEM) - a five day course designed for candidates with little or no prior ultrasound experience.
- * Advanced Emergency Medicine Ultrasound (AEMU) - a three day course designed for candidates who have previously completed an introductory ultrasound course and who wish to extend their scanning skills.
- * Ultrasound Workshop for Critical Care (UWCC) - a two day course designed as a refresher for candidates with prior ultrasound experience.
- * Start-up Ultrasound Workshop in FAST (SUWF) - a one day course designed as an introduction to FAST suited for registrars or for those with limited time.
- * Ultrasound for Intensive Care (USIC) - a two day course designed for intensivists with little or no prior ultrasound experience.
- * Vascular Access Ultrasound Workshop (VAUW) - a one day workshop designed as a brief introduction to needle guidance technique and is especially suitable for registrars or those with little time.

7. AUSTRALIAN SCHOOL OF MEDICAL IMAGING - <http://www.asmi.edu.au/>

Based in Sydney.

Offers four graduate programs in medical ultrasound for:

- * Radiographers
 - * Non-radiographers
 - * Registered nurses
 - * Radiology managers
- with components in
- * Physics and instrumentation
 - * Abdominal
 - * Vascular
 - * Small parts
 - * Obstetrics
 - * Gynae
 - * MSK
 - * Intro to female pelvic sonography

15 Appendix 6 - Extract from MBS

DIK GROUP I1 - ULTRASOUND

Professional supervision for ultrasound services – R-type eligible services

Ultrasound services (items 55028 to 55854) marked with the symbol (*R*) with the exception of items 55600 and 55603 are not eligible for a Medicare rebate unless the diagnostic imaging procedure is performed under the professional supervision of a:

- (a) specialist or a consultant physician in the practice of his or her specialty who is available to monitor and influence the conduct and diagnostic quality of the examination, and if necessary to personally attend the patient; or
- (b) practitioner who is not a specialist or consultant physician who meets the requirements of A or B hereunder, and who is available to monitor and influence the conduct and diagnostic quality of the examination and, if necessary, to personally attend the patient.

A. Between 1 September 1997 and 31 August 1999, at least 50 services were rendered by or on behalf of the practitioner at the location where the service was rendered and the rendering of those services entitled the payment of Medicare benefits.

B. Between 1 September 1997 and 31 August 1999, at least 50 services were rendered by or on behalf of the practitioner in nursing homes or patients' residences and the rendering of those services entitled payment of Medicare benefits.

If paragraph (a) or (b) cannot be complied with, ultrasound services are eligible for a Medicare rebate:

- (i) in an emergency; or
- (ii) in a location that is not less than 30 kilometres by the most direct road route from another practice where services that comply with paragraph (a) or (b) are available.

Note: Practitioners do not have to apply for a remote area exemption in these circumstances.

Sonographer accreditation

Sonographers performing medical ultrasound examinations (either R or NR type items) on behalf of a medical practitioner must be suitably qualified, involved in a relevant and appropriate Continuing Professional Development program and be Registered on the Register of Accredited Sonographers held by Medicare Australia. For further information, please contact the Medicare Australia, Provider Liaison Section, on 132150 for the cost of a local call or the Australasian Sonographer Accreditation Registry on (02) 8850 1144 or through their website at <http://www.asar.com.au>

Eligibility for registration

In general, to be eligible for registration, the person must:

- hold an accredited postgraduate qualification in medical ultrasound; or
- be studying ultrasound; or
- have worked as a sonographer under the direction of a medical practitioner in Australia or New Zealand (conditions apply - for assessment of eligibility status, please contact the Australasian Sonographer Accreditation Registry).

Report requirements

The sonographer's initial and surname is to be written on the report. The name of the sonographer is not required to be included on the copy of the report given to the patient. For the purpose of this rule, the "name" means the sonographer's initial and surname.

Benefits payable

As a rule, benefit is payable **once only** for ultrasonic examination at the **one attendance**, irrespective of the areas involved. Except as indicated in the succeeding paragraphs, *attendance* means that there is a clear separation between one service and the next. For example, where there is a short time between one ultrasound and the next, benefits will be payable for one service only. As a guide, Medicare Australia will look to a separation of three hours between services and this must be stated on accounts issued for more than one service on the one day.

Where more than one ultrasound service is rendered on the one occasion and the service relates to a non-contiguous body area, and they are "clinically relevant", (i.e., the service is generally accepted in the medical profession as being necessary for the appropriate treatment or management of the patient to whom it is rendered), benefits greater than the single rate may be payable. Accounts should be marked "non-contiguous body areas".

Benefits for two contiguous areas may be payable where it is generally accepted that there are different preparation requirements for the patient and a clear difference in set-up time and scanning. Accounts should be endorsed "contiguous body area with different set-up requirements".

Subgroup 1 – General Ultrasound

Post-void residual items 55084 and 55085

When a post-void residual is the only service clinically indicated and/or rendered, it is inappropriate to report a pelvic, urinary or abdominal ultrasound, instead of or in addition to this service (55084 or 55085). Similarly, if a complete pelvic, urinary or abdominal ultrasound is billed, it is inappropriate to bill separately for a post-void residual determination, since payment of this has already been included in the payment for the complete scans.

The report must contain an entry denoting the post-void residual amount and/or bladder capacity as calculated/estimated from the ultrasound device. In addition, the medical record must contain documentation of the indication for the service and the number of times performed.

Subgroup 2 – Cardiac ultrasound

Transoesophageal echocardiography - Item 55135 and consequential amendment to Item 55130

The Medical Services Advisory Committee (MSAC) has reviewed intra-operative transoesophageal echocardiography and recommended that public funding for this procedure be supported on an interim basis and be restricted to assessment of cardiac valve competence following valve replacement or repair. Item 55135 has been developed for these indications in consultation with the Australian Society of Anaesthetists, the Australian Medical Association and the Cardiac Society of Australia and New Zealand. Indications other than those recommended by MSAC will continue to be funded under item 55130. Further research will be undertaken to assist MSAC in its future evaluation of the use of intra-operative transoesophageal echocardiography.

Subgroup 3 - Vascular ultrasound

Benefits payable

Medicare benefits are only payable for:

- a maximum of two vascular ultrasound studies in a seven-day period. A vascular ultrasound study may include one or more items. Additionally where a patient is referred for a bilateral study of both arms or both legs (eg both arms for item 55238), the account should indicate 'bilateral' or 'left' and 'right' to enable benefit to be paid.
- clinically relevant services, that is, the service is generally accepted in the medical profession as being necessary for the appropriate treatment or management of the patient to whom it is rendered. Any decision to have a patient return on a different day to complete a multi-area diagnostic imaging service should only be made on the basis of clinical necessity.

Multiple Vascular Ultrasound Services – refer to DIJ

Separation of services on the one day/contiguous and non-contiguous body areas

These rules do not apply to the vascular ultrasound items and therefore will not impact on the MVUSSR.

Examination of peripheral vessels

Vascular ultrasound services can be claimed in conjunction with item 11612.

Subgroup 4: Urological ultrasound

Transrectal ultrasound (Items 55600 and 55603)

Benefits for these items are payable where the service is rendered in the following circumstances:

- a digital rectal examination of the prostate was personally performed by the medical practitioner who also personally rendered the ultrasound service; and
- the transducer probe or probes used meets specifications of normal frequency of 7 to 7.5 megahertz or a nominal frequency range which includes frequencies of 7 to 7.5 megahertz and which can obtain both axial and sagittal scans in 2 planes at right angles; and
- the patient was assessed prior to the service by a medical practitioner recognised in one or more of the specialties specified, not more than 60 days prior to the ultrasound service.

Item 55600 covers the situation where the service was rendered by a medical practitioner who **did not** assess the patient, whereas item 55603 covers the situation where the service was rendered by a medical practitioner who **did** assess the patient.

Subgroup 5: Obstetric and Gynaecological ultrasound

NR Services

Medicare benefits are not payable for more than three NR-type ultrasound services in Subgroup 5 of Group II (ultrasound) that are performed on the same patient in any one pregnancy.

Clinical indications

For items where clinical indications are listed (items 55700, 55704, 55707, 55718, 55759 and 55768), or where a clinical indication is required (items 55712, 55721, 55764 and 55772) for performance of subsequent scans the referral must identify the relevant clinical indication for the service. It should be noted that a patient must have previously had either a 55706 or 55709 ultrasound in the same pregnancy to be eligible to claim for either a 55712 or 55715 obstetric service. To be eligible to claim for either a 55721 or 55725 obstetric service, a patient must have previously had either a 55718 or 55723 ultrasound in the same pregnancy. If the service is self-determined (items 55703, 55705, 55708, 55715, 55723, 55725, 55762, 55766, 55770 and 55774), the clinical condition or indication must be recorded in the medical practitioner's clinical notes.

Dating of pregnancy

When dating a pregnancy for the purpose of items 55700 to 55774, a patient is:

- a) "less than 12 weeks of gestation" means up to 11 weeks and 6 days of pregnancy;
- b) "12 to 16 weeks of gestation" means from 12 weeks 0 days of pregnancy up to 16 weeks plus 6 days of pregnancy (inclusive);
- c) "17 to 22 weeks of gestation" means from 17 weeks 0 days of pregnancy up to 22 weeks plus 6 days of pregnancy (inclusive); or
- d) "after 22 weeks of gestation" means from 23 weeks 0 days of pregnancy onwards
- e) "after 24 weeks of gestation" means from 25 weeks 0 days of pregnancy onwards.

Nuchal Translucency Testing

Where a nuchal translucency measurement is performed when the pregnancy is dated by a crown rump length of 45-84mm in conjunction with items 55700 (R) or 55703 (NR) or 55704 (R) or 55705 (NR), then items 55707 (R) or 55708 (NR) should be claimed. If nuchal translucency measurement for risk of foetal abnormality is performed in conjunction with any additional condition in items 55700, 55703, 55704 or 55705, only one fee is payable.

It should be noted that the Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) provides a credentialling program for providers of nuchal translucency scans. It is anticipated that use of items 55707 and 55708 will be restricted to credentialed medical practitioners and sonographers in the future.

Multiple pregnancies

Obstetric ultrasound items 55759 to 55774 cover scanning of a patient who is experiencing a multiple pregnancy. The items incorporate a fee adjustment in recognition of the added complexity and costs associated with scanning multiple pregnancies. Based on the recommendations of the profession, the items apply only to patients where a multiple pregnancy has been confirmed by ultrasound. The items include identical restrictions and provisions as the second and third trimester items (55706-55725), and include items for referred and non-referred services.

Obstetric ultrasound and non-metropolitan providers (Items 55712, 55721, 55764 and 55772)

Where a practitioner has obstetric privileges at a non-metropolitan hospital and refers for items 55712, 55721 and 55764 and 55772, the practitioner must confirm his/her eligibility by stating 'non-metropolitan obstetric privileges' on the referral form. In relation to items 55712, 55721, 55764 and 55772, non-metropolitan area includes any location outside of the Sydney, Melbourne, Brisbane, Adelaide, Perth, Greater Hobart, Darwin or Canberra major statistical divisions, as defined in the Australian Standard Geographical Classification 1999 published by the Australian Bureau of Statistics (publication number 1216.0 of 1999).

Subgroup 6: Musculoskeletal (MSK) ultrasound

Personal attendance

Medicare Benefits are only payable for a musculoskeletal ultrasound service (items 55800 to 55854) if the medical practitioner responsible for the conduct and report of the examination personally attends during the performance of the scan and personally examines the patient. Services that are performed because of medical necessity in a remote location are exempt from this requirement – see DID for definition of remote area. Note: Practitioners do not have to apply for a remote area exemption in these circumstances.

Equipment

Items 55800 to 55854 only apply to an ultrasound service performed using an ultrasound system which has available on-site a transducer capable of operation at, at least 7.5 megahertz.

Multiple Musculoskeletal Ultrasound Scans - items 55800 to 55846

Generally Medicare benefits are payable for more than one musculoskeletal ultrasound scan performed on the same day, however the scans are subject to Rule A of the general diagnostic imaging multiple services rules. It is not

permitted to split a bilateral scan. Where bilateral ultrasound scans are performed (or more than one area is scanned under items 55844 or 55646) the relevant item should be itemised once only on accounts and receipts or Medicare bulk billing forms. For example if both shoulders are scanned, Item 55808 (or 55810 as the case may be) should be claimed once only. This is because the item descriptor for these items covers one or both sides, or one or more areas.

Shoulder and knee (Items 55808 and 55810 and 55828 and 55830)

Benefits for shoulder ultrasound items 55808 and 55810 are only payable when referral is based on the clinical indicators outlined in the item descriptions. Benefits are not payable when referred for non-specific shoulder pain alone. Benefits for knee ultrasound items 55828 and 55830 are only payable when referral is based on the clinical indicators outlined in the item descriptions. Benefits are not payable when referred for non-specific knee pain alone or other knee conditions including:

- meniscal and cruciate ligament tears; and
- assessment of chondral surfaces.

16 Appendix 7 – Procedure Block Numbers used to select data in VAED analysis (Department of Human Services, 2008)

Procedure block number	Description
1940	Ultrasound of head or neck
1941	Ultrasound of breast
1942	Ultrasound of heart
1943	Ultrasound of abdomen or pelvis
1944	Duplex ultrasound of cranial, carotid or vertebral vessels
1945	Duplex ultrasound of intrathoracic or intra-abdominal vessels
1946	Duplex ultrasound of limb
1947	Duplex ultrasound of artery or cavernosal tissue of penis
1948	Duplex ultrasound of other vessels
1949	Intraoperative ultrasound
1950	Ultrasound of other sites