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Review of Infrastructure and Capacity

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BreastScreen Australia Evaluation – Review of Infrastructure and Capacity – April 2009

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ACRONYMS

AHMAC	Australian Health Ministers' Advisory Council
AIHW	Australian Institute of Health and Welfare
ASGC	Australian Standard Geographical Classification System
Ax	Assessment(s)
BIS	BreastScreen Australia Information System
BSACT	BreastScreen Australian Capital Territory
BSV	BreastScreen Victoria
BSWA	BreastScreen WA
CAD	Computer aided diagnosis
CR	Computed radiographic mammography equipment
DCIS	Ductal carcinoma in situ
DoHA	Department of Health and Ageing
DMAP	Digital Mammography and PACS Project (South Australia)
DR	Digital radiography
EAC	(BreastScreen Australia) Evaluation Advisory Committee
ECHO	Extending the Capacity of Health Care Organisations
FFDM	Full field digital mammographic equipment
FNA	Fine needle aspiration
FTE	Full time equivalent
IT	Information technology
KPI	Key performance indicator
MBS	Medicare Benefits Schedule
MRI	magnetic resonance imaging
MSAC	Medical Services Advisory Committee (DoHA)
NAS	BreastScreen Australia National Accreditation Standards
NHS(BSP)	National Health Service (Breast Screening Programme) (UK)
NICE	National Institute for Health and Clinical Excellence (UK)
PACS	Picture Archive and Communication System



PGMI	'Perfect', 'Good', 'Moderate', 'Inadequate' (grading system used within BreastScreen Australia to critique images for positioning quality)
RANZCR	Royal Australian and New Zealand College of Radiologists
SAS	Screening and Assessment Service
UK	United Kingdom
US(A)	United States (of America)

EXECUTIVE SUMMARY

In October 2005, the Australian Health Ministers' Advisory Council (AHMAC) agreed to a comprehensive evaluation of BreastScreen Australia. The evaluation consists of a number of projects of which this is one. The focus of this Review is the current and future capacity of the Program, in particular, the availability and distribution of infrastructure and workforce.

Aims and objectives of this Review

There are nine aims and objectives that were endorsed by the Evaluation Advisory Committee (EAC) for the infrastructure and capacity review, which focused on identifying where current and future capacity and distribution of infrastructure and workforce is stretched or underutilised, relating capacity to age, participation and screening/rescreening intervals, assessing the impact of screening outside the Program and identifying potential solutions to address shortfalls.

Methodology

To address the aims and objectives of this Review, the following methodology was adopted:

- developing an evaluation framework for the Review based on a set of performance indicators of workforce and infrastructure capacity identified for the Review;
- undertaking a literature review of domestic and international sources, that was undertaken conjointly with a data audit of primary and secondary data sources;
- piloting and subsequent fielding a national survey of radiographers, sonographers and radiologists working for BreastScreen Australia in each state and territory, which collected information collected about age, gender, location, training, hours of work and remuneration;
- developing – with advice from each state and territory – a primary data collection instrument to collect data for each Screening and Assessment Service (SAS) on throughput, infrastructure and workforce; and
- constructing an economic model to project workforce and infrastructure needs through time, based on projections of the population of women aged 40+ years in each SAS over the projection horizon (2008 to 2027).

The BreastScreen Australia infrastructure and workforce

As at June 2007, there were 168 fixed mammography units, 11 relocatable units and 25 in mobile units, of which 17 were digital.¹ Since that time, at least six additional SASs have converted to digital systems. In all there were around 56 ultrasound units.

As at 30 June 2008, there were 680 radiographers, sonographers, radiologists and non-radiologist readers providing services to BreastScreen Australia – close to 330 full time equivalent (FTE) staff. Based on the workforce survey (for which there was a 35.5% response rate), 67% of respondents were radiographers and sonographers and 33% were radiologists and non-radiologist readers; 15.6% were male and 84.4% female. The hours of work per week provided by professionals to BreastScreen Australia varied greatly, with some people providing as little as one hour per week and others providing more than 60 hours per week. On average, radiographers and sonographers provided 22 hours per week and radiologists and non-radiologist readers provided 12 hours per week.

Shortages of radiographers and radiologists have been identified in most states and territories from the year 2000 to more recent times both from the perspective of BreastScreen Australia as well as more broadly in diagnostic imaging. Other findings include that:

- The radiography and sonography workforce is predominately female.
- There has been a trend to an increased workforce preference for shorter hours per week with implications for the supply of skill hours per head in future.
- There is a risk of the workforce declining due to pending retirement and flagging recruitment, in part related to perceptions among potential BreastScreen Australia employees that breast screening offered limited opportunities compared to the private sector.

Findings from the workforce survey supported the literature findings. Respondents commented that workforce shortages were mainly of radiographers, and that a stressful workload combined with the repetitive nature of the work had caused injuries. Pay rates were also considered relatively poor.

Transition to digital

There is considerable momentum gathering behind the transition from analogue to digital imaging because of the impending obsolescence of analogue systems internationally. The impact on BreastScreen Australia of adopting digital systems is likely to include:

- A cleaner and quieter working environment.
- Digital units generally enable faster screening than analogue units. Time savings are achievable for the most part because film processing is no longer required. However, there are some slower CR units (MSAC 2007, NHS Purchasing and Supply Agency 2008, site visit to digital site). The key assumptions made by MSAC (2007) in its calculations, and which have been adopted for the modelling in this Review were that: the throughput of DR is 1.4 times that of film screen mammography in a screening setting, but the throughput of CR is the same as film screen mammography (MSAC, 2007).

1 Excludes Gippsland, Victoria

- A reduced rate of technical recalls because of the ability to immediately see the image captured. This reduces the need for women to return for repeat screens, and reduces their average dose of radiation. Advice from the EAC suggests technical recall rates would fall by as much as 75% with the adoption of digital systems.
- Sharing images is easier with digital systems, promoting peer review, facilitating consultation and discussion. Faster image transfer has the potential to address localised shortages of radiologists (or alternatively, improve the productivity of radiologists who may be currently under-utilised). There is also, importantly, a more immediate response for women in rural/remote areas.
- While the impact on reading time is uncertain, digital images can be displayed and examined more easily with computer software (eg, zoom in and move around).

As at June 2008, approximately 24% of BreastScreen Australia's imaging units were digital, and this is expected to reach 50% by 2010.

There is no apparent coordination of the transition to digital Australia-wide. Approaches to the transition to digital systems differ across states and territories, in part reflecting local considerations and differences in needs across different areas. An overarching coordination mechanism that facilitates efficient communication about the transition may be useful in ensuring that compatible information management and telecommunications systems protocols are introduced. Compatibility across state and territory BreastScreen Australia services (and potentially, beyond BreastScreen Australia with diagnosis and treatment services) would maximise the capacity to transfer images, improve the potential to address localised radiology staff shortages, facilitate flexible working hours and potentially improve access by diagnostic and treatment services to BreastScreen Australia expertise. Many jurisdictions are on the verge of committing to PACS, so there is an immediate requirement for cross-state/territory coordination. As an additional benefit, greater coordination may increase communication across jurisdictions, facilitating broader transfer of learning (for example, transfer of knowledge/experiences from larger states to the Northern Territory (NT)).

Assessment of new screening technologies

While the move to digital is inevitable, no other new technology is a realistic option for breast cancer screening in the near future. While tomosynthesis is now available for screening, it is unclear whether this is a cost effective alternative to digital mammography screening in Australia. There are two possible additions to the BreastScreen Australia Program for surveillance – magnetic resonance imaging (MRI) and ultrasound – but cost effectiveness studies of the implementation of these in the Australian environment are also lacking. In addition, results of research on effectiveness depend on the screening/surveillance model examined and the skills/proficiency of the health care provider, so even where high quality studies may be available internationally, they are not always applicable to Australia or individually to each state and territory.

There is no nationally coordinated approach to reviewing evidence of new technologies for BreastScreen Australia. Further, there is no evidence that systematic horizon scanning for new technologies and their efficiency and effectiveness is undertaken by states or territories.

The Program needs to develop processes that enable it to respond to the emergence of new technology in a coordinated, considered and timely way – specifically by reviewing the quality of evidence available and then assessing the safety, efficacy and cost effectiveness with a view to the core objectives of BreastScreen Australia and the impact on its performance and sustainability.

Infrastructure efficiency and workforce productivity

One of the key parameters in the model is mammographic images per hour. It is a measure of productivity for both mammography machines and radiographers. According to literature and practice, the number of images it is possible to produce per hour is higher with digital systems than analogue systems, so images per hour was used to model the impact of the transition to digital systems. Images per hour in the model is based on both the number of hours of work supplied by the relevant occupational groups, and equipment hours available (based on operating hours net of non-BreastScreen Australia use of equipment, and downtime due to repairs and maintenance).

Taking into account opening hours, machine downtime due to repairs and maintenance, and hours of machine time allocated to non-BreastScreen Australia services, the mean mammography machine operated for 1,750 hours per year (1,706 hours per year net of downtime) (median 1,794 hours per year or median 1,769 hours per year net of downtime). However, there were substantial differences in net operating hours per year across SASs – with the maximum 2,393 and minimum 827 hours. This is based on a 48 week year consistent with advice from SASs.

On average, 12 images were taken per hour on each fixed mammography unit. Given that there were on average 4.4 images per screen, this is equivalent to around 2.7 women screened per hour. From a workforce perspective, it was estimated that based on the total number of women screened each year by BreastScreen Australia, on average around 2 women per hour were screened per radiographer FTE.

- The slightly lower rate per radiographer compared to per machine, reflects that on some machines there may be more than one radiographer screening.
- While the screen rate per radiographer per hour may appear low, there are a number of factors that may impact on this – for example, time away from screening to perform assessments and additional screening time allowances, for example for larger women.

For all ultrasound units, the mean assessment rate was 1.6 per hour and median assessment rate 1.1 per hour.

Key performance indicator results

Lengthy waiting times for services tend to indicate stretched capacity. Throughput indicators including waiting times were selected to monitor the adequacy of BreastScreen Australia capacity. The results for these throughput key performance indicators (KPIs) (based on data collected for this Review) showed that for the majority of SASs, the length of time women spent waiting for screening, waiting times for screening results and the length of time spent waiting for assessments were longer than the BreastScreen Australia National Accreditation Standards (NAS) benchmarks. Individually, there may be different explanations for each result in each jurisdiction or SAS. However, when the extended waiting times are viewed in concert with a current average participation rate in the target age group of 56% – significantly less than the target participation rate of 70% – the overall picture is of inadequate capacity. This needs to be borne in mind when interpreting future scenarios compared to a base case, which reflects these constraints in the start period, 2008.

The model

A model was built in Microsoft Excel 2007 incorporating parameters drawn from the literature, workforce survey, site visits and data collected from each SAS. The model was split into two modules:

- a demand module (reflecting the need for screening by women according to the policies and practices of BreastScreen Australia); and
- a supply module (reflecting the capacity of BreastScreen Australia to screen women).

The two modules were then brought together and used to undertake a gap analysis of program infrastructure and capacity in addressing the aims and objectives of this Review.

Demand module

- The need for screening was mapped to the female population in the relevant age groups (the target and eligible populations) by SAS, state/territory and region over the projection period. Population estimates by age and by Statistical Local Area (SLA) are based on Australian Bureau of Statistics (ABS) population data.
- Screening was modelled separately from assessment. Participation rates were initially set to the participation rates of each SAS by age as calculated from the data provided by SASs and benchmarked to jurisdictional participation rates presented in the Participation and Performance Trends report (AIHW, 2008, draft).
- Recall to assessment rates were initially set to those reported for each individual SAS and benchmarked to those reported for state and territories in the Participation and Performance Trends report for the period 2001 to 2005 – 9.2% for first screening round and 4.0% for subsequent round. The proportion of assessments involving mammography, fine needle aspiration (FNA), core biopsy and ultrasound are based on the proportions by age group provided by SASs.

Supply module

- The workforce supplied separately incorporated radiographers, sonographers, radiologists and non-radiologist readers by age and gender.
- Workforce inflows and outflows were modelled so as to maintain workforce stability over time based on data from each SAS.
- The supply of images was calculated using images per hour from the infrastructure data supplied by each SAS, multiplied by operational hours. Operational hours depended on the supply of FTEs and equipment.
- Each mammographic unit was modelled separately, with years to replacement based on information provided by SASs and the current transition to digital imaging based on data provided by the states and territories. Once digital equipment was installed, it was assumed that the transition time necessary to achieve the higher throughput associated with digital systems (ie, the learning curve) was two years (based on the literature).

Modelling results

Projections of the demand for and supply of screening services were generated over the period 2008 to 2027.

On the supply side, the **base case** reflects the services currently provided (screens and assessments), the quantum of which reflects the current infrastructure and workforce available to the Program.

On the demand side, in the base case, eligible and target age groups reflect current BreastScreen Australia policies, and participation rates reflect the status quo in each SAS. In aggregate, the participation rate in the target age group (50–69 years) was 56.3%, and participation by women in the eligible age range (40–49 years and 70 years or over) was 16.3% and 17.1% respectively. Recall to assessment rates were also set in accordance with current rates provided by each SAS. These parameters remain constant over the modelling horizon, so the participation rates are the same in 2008 and 2027. However, in the base case, there are changes in the number of women who need to be screened each year because of demographic change occurring in each SAS.

Numerous **scenarios** were modelled and compared with the base case. The scenarios are detailed in Table E 1. As noted in Table E 1, scenarios were divided between changes to policies and practices that impacted on the demand for BreastScreen Australia services, and changes in policies or practices that would affect the capacity of BreastScreen Australia to provide screening (ie, supply).

- In the demand scenarios, only the need for screens (demand) was changed in the model. The capacity to screen (supply) remained the same as in the base case.
- In the supply scenarios, while capacity changed, demand remained the same as the base case, ie, changes in demand over time reflected only demographic change (ageing of the female population), but there was no change in participation rates or target/eligible age groups. It is worth noting, however, that while scenarios E1 and E2 focused on the supply side, there was also a demand element that was captured. Lower technical recall rates with digital mammography than with analogue systems meant that there will be less need for screens (demand) than in the base case.

Table E.1 Scenarios modelled for this review

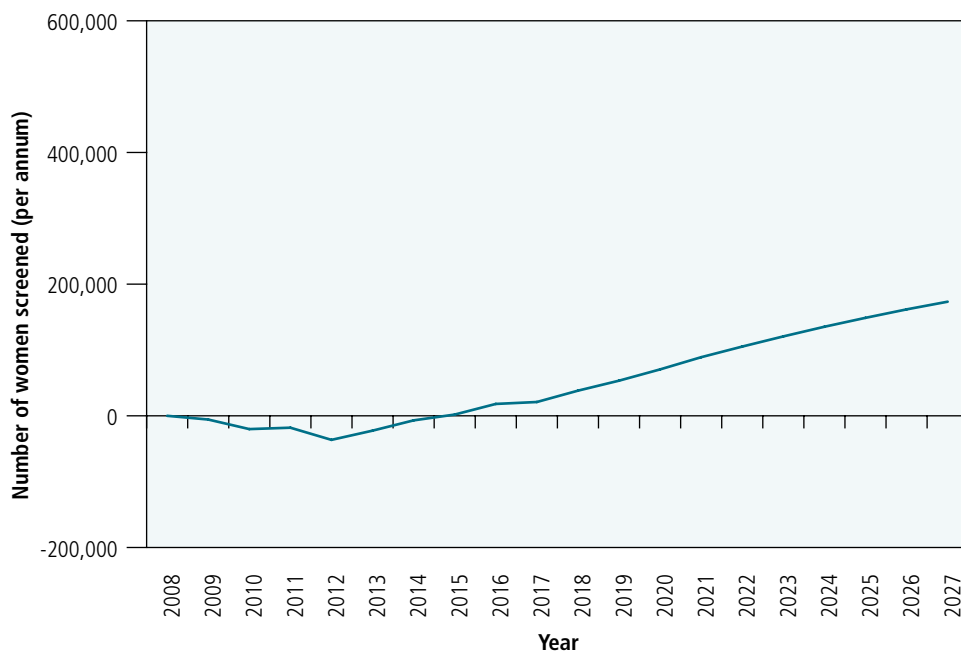
Supply or demand	Scenario summary description
A: Demand	A1: Women aged 45–49 included in the target age group.
	A2: Women aged 70–74 included in the target age group.
	A3: A1 and A2 combined – women aged 45–59 and women aged 70–74 included in the target age group.
	A4: Women aged 70–74 years included in the target age group. Women aged 40–44 years and 75 years or over excluded.
	A5: Women aged 45–49 included in the target age group and receive annual screening. Women aged 70–74 years included in the target age group and receive biennial screening. Women aged 40–44 years and 75 years or over excluded.
	A6: Women aged 45–49 years and 70–74 years included in the target age group and receive biennial screening. Women aged 40–44 years and 75 years or over excluded.
B: Demand	B1: Incremental increase in the participation rate for women aged 50–69 years to 70% by 2027. Women aged 40–49 years and over 70 years continue to attend at the current rates.
	B2: Incremental increase in the participation rate for women aged 50–69 years to 70% by 2027. Women aged 40–44 years and 75 years or over no longer eligible. Women aged 45–49 and 70–74 years remain eligible.
C: Supply	C1: Shortage of radiologists addressed with non-radiologist readers.
	C2: Theoretical increase in radiographer productivity.
D: Demand	D: Change in annual screening policy.
E: Supply	E1: Adoption of digital mammography in five years with soft copy reading.
	E2: Adoption of digital mammography in five years with hard copy reading.
F: Demand	F: A phased reduction in MBS-funded mammography outside the Program and these women redirected to the BreastScreen Australia Program.

Findings

Capacity shortages or excesses were identified by bringing the two modules together, and undertaking a gap analysis. The resultant capacity gaps (excess demand) were examined in terms of size and time horizons.

In the base case, the introduction of digital mammography improves capacity and alleviates shortages at the national level in the near term. However, demand catches supply in the medium term (approximately 2014) due to demographic change, and continues to exceed it through to 2027 (Figure E 1).

Figure E.1: Base case – excess demand for screening



By 2027, in the base case, there would be a shortage of 121.2 FTE radiographers, sonographers and radiologists and a shortage of 35 mammography units. The capacity shortage means that 173,000 women eligible for screening would be unable to receive timely services from BreastScreen Australia – or be unable to be screened at all under the Program (Table E 2).

Table E.2: Base case – excess demand

	2008	2010	2015	2020	2027
Screening (women)	0	-20,170	1,906	70,501	173,329
Assessments (women)	0	0	1,726	4,935	9,632
Workforce (FTE)					
Radiographers	0	10.6	39.1	64	93.7
Sonographers	0	0.5	1.4	2.4	3.6
Radiologists/Non-rad readers	0	2.6	9.7	16	23.8
Total (FTE)	0	13.7	50.3	82.4	121.2
Infrastructure (units)					
Mammography	0	-5	0	14	35
Ultrasound	0	2	7	12	17
Total units	0	-2	7	26	52

Capacity shortages arise sooner or later in all of the scenarios modelled, with the exception of an improvement in the productivity of radiographers (C2).

- Scenario C2 – an improvement in radiographer productivity – showed the greatest potential for expanding the capacity of BreastScreen Australia services.

On the demand side, the only scenarios in which excess demand in 2027 would be lower than in the base case scenarios were those involving:

- participation continuing at current rates together with an extension of the target age group to women aged 70-74, keeping women aged 45–49 eligible and excluding other women (A4); and
- a change in policy on annual screening of women at higher risk (D).

Figure E.2 illustrates the end result of all scenarios modelled (ie, excess demand in the year 2027).

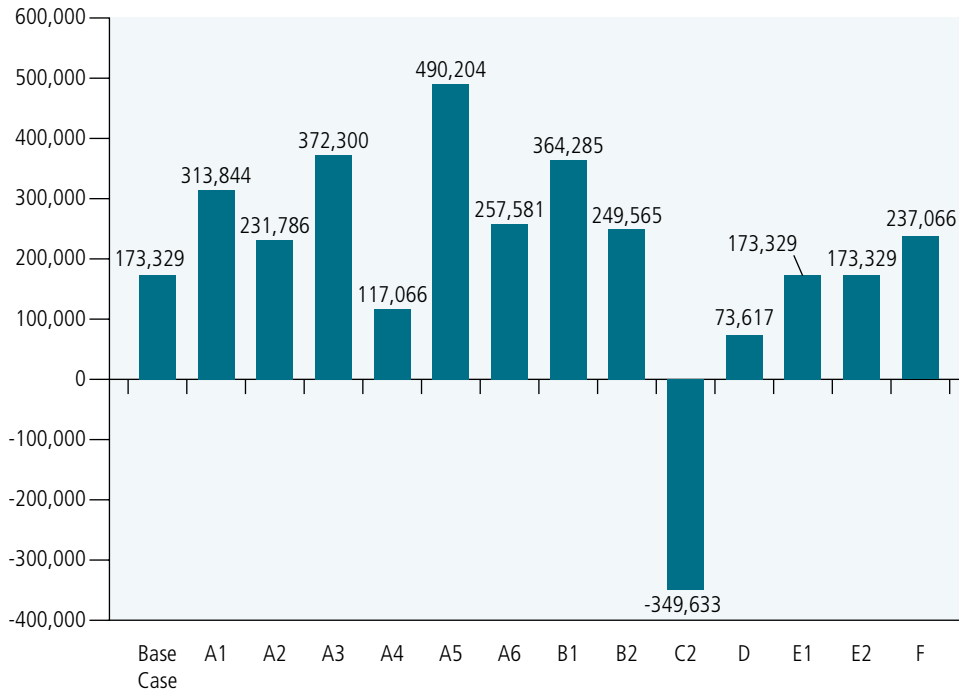
- The blue bar represents excess demand by 2027 in the **base case**;
- the red bars represent the '**demand**' scenarios (which involve changes to participation rates, eligible age groups or rescreening rates); and
- the green bars represent the **supply** scenarios (which involve changes in the capacity of BreastScreen Australia to provide services to women).

In scenarios E1 (soft copy reading) and E2 (hard copy reading), excess demand in 2027 is the same as in the base case by 2027. This is because SASs are already making the transition to digital and this is captured in the base case. Scenarios E1 and E2 simply increase the speed of transition to digital and so there are capacity gains over the medium term, and capacity shortages therefore emerge later than in the base case. Notably, with soft copy reading (E2), a shortage of radiologists which occurs in the base case is delayed for at least ten years under E2.

Scenario A5 (current participation rates; extension of the target age group to women aged 45-74; women aged 45–49 receive annual screening; other women excluded) has the highest excess demand in 2027, followed by scenario A3 (current participation rates and extension of the target age range to women aged 45 to 74 years).

Overall, in the long term, C2 offers substantial potential to ameliorate BreastScreen Australia workforce shortages. E1 improves capacity in the medium term, but offers no long term improvement over the base case.

Figure E.2: Excess demand by women for screening, 2027



- A1 Current participation rates and extension of the target age range to women aged 45 to 69 years.
- A2 Current participation rates and extension of the target age range to women aged 50 to 74 years.
- A3 Current participation rates and extension of the target age range to women aged 45 to 74 years.
- A4 Current participation rates; extension of the target age group to women aged 70-74; women aged 45–49 eligible; other women excluded.
- A5 Current participation rates; extension of the target age group to women aged 45-74; women aged 45–49 receive annual screening; other women excluded.
- A6 Current participation rates, extension of the target age group to women aged 45-74; other women excluded.
- B1 Incremental increase in the participation rate for women in the target age group to 70% by 2027. Eligible age groups remain the same.
- B2 Incremental increase in the participation rate for women in the target age group to 70% by 2027. Eligible age groups changed – women aged 40–44 years and 75+ years excluded.
- C1 not included in the table as it reflects replacing shortages of radiologists with non-radiologist readers. The number of non-radiologist readers required can be calculated from the results of the other scenarios.
- C2 Shorter hours per week per radiographer and higher productivity of radiographers (higher rates of women screened per hour).
- D Women with higher risk screened annually.
- E1 Digital mammography in five years with soft copy reading.
- E2 Digital mammography in five years with hard copy reading.
- F Phased reduction in MBS-funded mammography outside of the Program, with these women attending BreastScreen Australia instead.

Conclusions

At current participation rates and with a continuation of currently applicable BreastScreen Australia policies and practices, capacity shortages will emerge in the next five years or so. Unless action is taken to expand capacity, the BreastScreen Australia program will no longer be able to maintain the current rates of screening and assessment of Australian women. There is potential for rates of early detection of breast cancer among Australian women to decline, with adverse implications for women’s chances of survival.

It is evident from the findings of this review that substantial capacity improvements over the two decades modelled could be realised with an improvement in radiographer productivity. While the transition to digital mammography with soft copy reading (E2) improves capacity in the short to medium term, without additional actions to improve workforce productivity, shortages still emerge in the longer term.

That said, there is apparent scope to improve infrastructure capacity utilisation in some SASs because mammography units appear underutilised during assessment clinics; and assessment equipment is underutilised during screening. At present, assessment and screening are held at different times because of concerns about the impact on the comfort of women attending for screening of sharing a waiting room with women who are attending for assessment. Concurrent screening and assessment would enable more efficient use of radiography staff, and mammography units, but this is only possible if women attending for screening can be physically separated from those attending for assessment.

In regard to workforce, there is a defining line that separates two vital program functions of image acquisition and image analysis, which can be used to further isolate capacity constraints. In the case of image acquisition, radiographers are the only health professionals who necessarily must see every woman attending the screening program. In the case of image analysis, technology provides significant opportunity to 'take the work to the workforce' and utilise radiology capacity where it is available.

The number of women who can be screened by a radiographer each year is influenced by numerous factors, including: scheduling arrangements for screening and assessment, average operating hours of mammography units, the opening hours of breast screen services, and facility layouts. While the correct mix of policies and practices to achieve an increase in workforce productivity is beyond the scope of this review, the modelling provides a framework for assessing the impact from any productivity improvement.

It is important to note that the modelling results reflect the current BreastScreen Australia policy and program environment, the nature of the data available to this review (eg, data were not available by five year age group or for annual screening by SAS), informed assumptions about the improvements in productivity associated with digital systems and the proportion of Medicare Benefits Schedule (MBS) activity represented by screening as opposed to diagnosis. Changes to BreastScreen Australia policies and programs in future would mean new modelling would be required to take account of policy and technological changes.

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