RESEARCH ARTICLE

Influence of Service Characteristics on High Priority Performance Indicators and Standards in the BreastScreen Australia Program

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Abstract

Background: Data from BreastScreen Australia Screening and Assessment Services (SAS) for 2002-2010 were analysed to determine whether some SAS characteristics were more conducive than others to high screening performance, as indicated by high priority performance indicators and standards. Materials and Methods: Indicators investigated related to: numbers of benign open biopsies, screen-detected invasive cancers, and interval cancers, and wait times between screening and assessment. Multivariate Poisson regression was undertaken using as candidate predictors of performance, SAS size (screening volume), urban or rural location, year of screening, accreditation status, and percentages of clients from culturally and linguistically diverse backgrounds, rural and remote areas, and socio-economically disadvantaged areas. Results: Performance standards for benign biopsies and invasive cancer detection were uniformly met irrespective of SAS location and size. The interval cancer standard was also met, except in 2003 when the 95% confidence interval of the rate still incorporated the national standard. Performance indicators improved over time for: benign open biopsy for second or subsequent screening rounds; rates of invasive breast cancer detection for second or subsequent screening rounds; and rates of small cancer detection. No differences were found over time in interval cancer rates. Interval cancer rates did not differ between non-metropolitan and metropolitan SAS, although state-wide SAS had lower rates. The standard for wait time between screening and assessment (being assessed ≤28 days) was mostly unmet and this applied in particular to SAS with high percentages of culturally and linguistically diverse women in their screening populations. Conclusions: Gains in performance were observed, and all performance standards were met irrespective of SAS characteristics, except wait times to assessment. Additional descriptive data should be collected on SAS characteristics, and their associations with favourable screening performance, as these may be important when deciding on SAS design.

Keywords: BreastScreen - meeting accreditation standards - system characteristics

Asian Pac J Cancer Prev, **15 (14)**, 5901-5908

Introduction

Australia's national breast cancer screening program, BreastScreen Australia, was introduced by Commonwealth, state and territory governments in 1991 and directed primarily at 50-69 year old women using biennial mammography (BreastScreen Australia, 2009). The principal aim of the program is to reduce breast cancer mortality and morbidity.

During biennial 2009-2010, over 1.3 million women aged 50-69 years were screened through the program, comprising 55% of the Australian female population in that age range (AIHW, 2012). Currently the program is delivering screening services at over 600 locations, using fixed, relocatable and mobile units administered by 32 Screening and Assessment Services (SAS) (AIHW, 2012). SAS vary in their coverage, with some covering states and territories with comparatively small populations (i.e., the Australian Capital Territory, Northern Territory, Tasmania, South Australia and Western Australia) and others covering regions within the larger states (i.e., New South Wales, Victoria, Queensland) (BreastScreen Australia, 2009; AIHW, 2010; 2012).

The performance of the BreastScreen Australia program in reducing breast cancer mortality has been evaluated in four observational studies that point collectively to a mortality reduction of around 45% in 50-69 year old women who participate in the screening (Taylor et al., 2004; Roder et al., 2008; DOHA, 2009; Morrell et al., 2012; Nickson et al., 2012). This is a larger

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reduction than indicated from the original field trials in North America, the United Kingdom and Scandinavia, which was estimated by an expert panel of the International Agency for Research on Cancer to be around 35% in 50-69 year old screening participants (WHO and IARC, 2002). More recently, Australian researchers found the reduction to be around 25% in a meta-analysis of trial data for screening women of all ages (i.e., also including women under 50 and over 70 years of age) (Glasziou and Houssami, 2011). Other research has explored breast cancer outcomes in Aboriginal women who participated in screening (Roder et al., 2012).

Evaluations of screening in other countries have generally indicated reductions in breast cancer mortality of similar or greater magnitude to trial results, although varying widely from little or no benefit to reductions of up to 76% (Olsen and Gotzsche, 2001; Gabe and Duffy, 2005; Kalager et al., 2010; Paap et al., 2010; Autier et al., 2011; Broeders et al., 2012a; 2012b; Otto et al., 2012; Paci, 2012; Moss et al., 2012; Njor et al., 2012; Burton et al., 2012). Recent reviews of screening in Europe have indicated mortality reductions of similar magnitude to the Australian results which are higher than estimated from trial data (Broeders et al., 2012; Otto et al., 2012; Paap et al., 2010; Paci, 2012; Broeders et al., 2012a; 2012b; Moss et al., 2012; Njor et al., 2012).

Over-diagnosis is also being used in screening evaluation. It is a controversial subject with estimates of its magnitude varying widely from negligible levels to 30% or more of all breast cancers (Marmot et al., 2013). Estimates vary so widely that interpretation is difficult and a consensus is lacking (Marmot et al., 2013). Only one Australian study has been published to date, which suggested a level of over-diagnosis in New South Wales at the higher end of the scale (Morrell et al., 2010). Further research is underway in other Australian states to broaden the evidence base.

Apart from studies of mortality reductions and over-diagnosis, cost-effectiveness studies are commonly used to evaluate screening performance, including in Asian and other countries where breast cancer incidence may be relatively low and the economics of mammography screening may be more questionable (Kang et al., 2013; Yoo et al., 2013).

In addition, screening performance is evaluated in Australia using service performance indicators and accreditation standards for screening participation, cancer detection, benign biopsies and timelines along the screening pathway (BreastScreen Australia, 2004; 2005; 2009; National Quality Management Committee, 2004; BreastScreen Australia, 2009). BreastScreen Australia has a national system of accreditation and undertakes an annual monitoring of performance indicators for individual SAS against pre-determined standards (BreastScreen Australia, 2004; 2005; 2009; National Quality Management Committee, 2004). Data reports are monitored by the SAS themselves and by a National Quality Management Committee (NQMC) to gain a timely system-wide perspective of BreastScreen Australia performance (BreastScreen Australia, 2004; 2005; 2009). Performance indicators and standards relate to screening effectiveness (as indicated by cancer detection rates and interval cancer rates), potential for unnecessary investigations (as indicated by high rates of recall to assessment or high benign biopsy rates), and timeliness (times between screening and assessment) (BreastScreen Australia, 2004; 2005; 2009; National Quality Management Committee, 2004).

The NQMC was established at the outset of the program (initially called the National Advisory Committee) to recommend and monitor performance against national performance indicators and accreditation standards (BreastScreen Australia, 2009). These standards have been reviewed three times since inception of the program, taking account of new scientific evidence and screening experience in Australia and elsewhere (BreastScreen Australia, 2009). The present standards, which have operated since 2005, pertain to cancer detection, benign biopsy rates, rates of recall to assessment to investigate screen-detected abnormalities, waiting times from screening to assessment, screening participation rates, other specified measures to assess overall timeliness of service delivery, management and data management practices, equitable service participation across population groups, information provision, service continuity, and counselling and support (BreastScreen Australia, 2004; 2005; 2009).

The program aims to derive its performance indicators from the best evidence available, in order to achieve positive screening outcomes (BreastScreen Australia, 2009). Indicators are classified by importance as: Level 1 - where high risks of poor outcomes are expected if standards are not met; Level 2-directed at avoiding major and significant risks; and Level 3-directed at avoiding moderate, low or very low risks (BreastScreen Australia, 2004; 2005; 2009). SAS performance is monitored against performance indicators, and national accreditation standards, and levels of accreditation are awarded using a decision-making tool (BreastScreen Australia, 2004). Depending on the outcome, Services may be asked to provide additional monitoring data or undergo additional site visits by expert teams for quality improvement purposes.

To assist in its monitoring role, the NQMC obtains annual data reports from BreastScreen Australia's 32 SAS. In this study, SAS level data from these reports are analysed for the 2002-2010 period to assess performance against selected high priority performance indicators and standards (i.e., the Level 1 standards outlined in Figure 1) (BreastScreen Australia, 2004; 2005; 2009; AIHW 2012).The purpose is to determine screening performance and extent to which standards have been met overall, by calendar year, and by SAS classified by: (1) screening volume, SAS location, and SAS accreditation status; and (2) client characteristics, such as percentages of screening participants in metropolitan and non-metropolitan areas, percentages from areas of differing socioeconomic status, and percentages from culturally and linguistically diverse backgrounds (National Quality Management Committee, 2004). Similar investigations were planned by percentages of screening participants classified as Indigenous, but these were discontinued due to small numbers of Indigenous

participants in individual SAS settings.

A BreastScreen Australia Data Dictionary was employed by Services to promote operational consistency in data recording (National Quality Management Committee, 2004). Accreditation measures and performance indicators selected for this study comprised benign open biopsy rates, detection rates for invasive cancers (all sizes) and small invasive cancers (≤15mm diameter), invasive interval cancer rates, and time between screening and assessment. These were chosen to assess SAS performance in achieving a cancer diagnosis without need for open biopsy, avoiding unnecessary open biopsies, achieving an acceptable cancer detection rate, and avoiding unnecessary anxiety in women from undue delays in obtaining assessment of screen-detected abnormalities.

Overall monitoring reports for the BreastScreen Australia program are provided annually by the Australian Institute of Health and Welfare (BreastScreen Australia, 2009; AIHW, 2010; 2012).The present study is complementary in that it focuses on screening performance by characteristics of individual SAS, using BreastScreen Australia accreditation standards and performance indicators.

The McKeon review of health and medical research in Australia recommended that increased emphasis be placed on health-systems research for achieving better Service performance (McKeon, 2012).We regard this study as consistent with that recommendation in seeking a health-system perspective of BreastScreen Australia performance by characteristics of individual SAS.

Materials and Methods

Data collection

Annual data reports are provided by SAS to the NQMC for performance monitoring. Data from these reports were classified in this study by 12-month period. They were drawn from an electronic database of reports for 2002-2010. Data entry was prospective for 2008-2010 and retrospective for earlier years. Changes in classification criteria occurred for some indicators and standards in 2003-2004 but data mapping was undertaken to produce a consistent dataset for 2002-2010 that accorded with current classification criteria (National Quality Management Committee, 2004). Data cleaning was undertaken that included retrieving missing data, validating unusual values, and correcting values that did not accord with BreastScreen Australia Data Dictionary Standards (National Quality Management Committee, 2004). This process resulted in a "cleaned" database of 257 useable sets of annual data from 32 SAS.

Data recording practices of SAS are checked routinely against data-collection standards in site visits as part of the accreditation process, which would have promoted data consistency across BreastScreen Australia (BreastScreen Australia, 2004; 2005; National Quality Management Committee, 2004). Nonetheless, missing fields presented in the database, especially for the early years, and analyses were restricted in this study to datasets that were complete for the respective performance indicators.

Statistical analyses

Performance indicator data were analysed for the high priority (i.e., Level 1) standards listed in Figure 1. Initially unadjusted analyses were undertaken of these data, expressed as percentages or means as relevant. Analyses were undertaken by calendar year, SAS location (i.e., predominantly metropolitan (classified as major cities), non-metropolitan, or state/territory-wide) (National Quality Management Committee, 2004), and numbers of women screened (to indicate screening volume), using STATA version 12 software (StataCorp, 2013). Statistical independence of observations was assumed for these initial analyses, such that any violations of this assumption may have led to conservative confidence intervals (Gahlinger and Abramson, 1995; StataCorp, 2013).

Multivariate Poisson regression modelling was then undertaken of predictors of values for each performance indicator (Gahlinger and Abramson, 1995; StataCorp, 2013). Two models were used, the first including a limited range of predictor variables that were generally available through the 2002-2010 period, namely, SAS location (i.e., metropolitan, non-metropolitan or state/territory-wide), SAS screening volume per annum (i.e., 4000-12000, 12001-21000, 21001-36000, 36001-92000 screens of 50-69 year old women), SAS accreditation status (2-year or 4-year accreditation) and calendar year of reporting, adjusting for state/territory jurisdiction (StataCorp, 2013). Model 1 included data from up to 243 useable annual reports on the database for 2002-2010 where SAS boundaries had been unchanged or the data could be reconstructed into common SAS boundaries for analysis purposes.

Poisson Model 2 included a more extensive range of predictor variables than Model 1. Due to under-reporting, particularly in the retrospective component of the database, Model 2 was limited to a maximum of 201 useable reports for 2004-2010. The same predictor variables were used as for Model 1, plus variables relating to characteristics of women undergoing screening in the respective SAS. These characteristics included the percentage of screened women

NAS 2.8.1 ≤0.35% of women who attend for their first screen are found not to have invasive cancer or DCIS after a diagnostic open biopsy ¶

NAS 2.8.2 ≤0.16% of women who attend for their second or subsequent screen are found not to have invasive cancer or DCIS after a diagnostic open biopsy ¶

NAS 2.8.3 ≤4.0% of women assessed after their first screen are found not to have invasive cancer or DCIS after a diagnostic open biopsy ¶

NAS 2.8.4 ≤3.2% of women assessed after their second or subsequent screen are found not to have invasive cancer or DCIS after a diagnostic open biopsy ¶

NAS 2.1.1 ≥50 per 10,000 women aged 50-69 years who attend for their first screen are diagnosed with invasive breast cancer ¶

NAS 2.1.2 ≥35 per 10,000 women aged 50-69 years who attend for their second or subsequent screen are diagnosed with invasive breast cancer ¶

NAS 2.2.1 ≥25 per 10,000 women aged 50-69 years who attend for screening are diagnosed with small (≤15mm) invasive breast cancer ¶

NAS 2.4.2 (a) <7.5 per 10,000 women aged 50-69 years who attend for screening are diagnosed with an invasive interval breast cancer within 12 months of receiving a negative screen; and **(b)** the number per 10,000 women aged 50-69 years who attend for screening who are diagnosed with an invasive interval breast cancer between 12 and 24 months following a negative screen (this number is monitored but no standard is set) ¶

NAS 3.7.2 ≥90% of women requiring assessment attend for assessment within 28 calendar days of screening ¶

Figure 1. BreastScreen Australia Level 1 National Accreditation Standards (NAS) and Performance Indicators Used in this Study

who were classified as culturally and linguistically diverse, socioeconomically disadvantaged, and resident of rural and remote areas, using BreastScreen Data Dictionary definitions and standards (National Quality Management Committee, 2004). These definitions were based on indices developed by the Australian Bureau of Statistics, including the Socio-Economic Index for Areas (SEIFA) Index of Relative Socio-economic Disadvantage and annual updates of the Australian Standard Geographical Classification (National Quality Management Committee, 2004).

Regression models were adjusted to account for clustering of observations within SAS to obtain accurate confidence intervals (StataCorp, 2013). Results of Model 1 are presented in this report due to larger numbers of observations, with Model 2 results also being provided where they point to additional predictors of SAS performance.

Results

Benign open biopsy rates

Standards for numbers of benign open biopsies (i.e., NAS 2.8.1, 2.8.2, 2.8.3 and 2.8.4) were uniformly met by year, SAS location and size (Table 1). Regression analysis confirmed that State-wide SAS had a higher rate of benign open biopsies than metropolitan SAS among women undergoing assessment following their first screen [rate ratio (95% confidence interval) for State-wide compared with metropolitan rates=1.39 (1.11-1.73)]

Table 1. Women having Benign Open Biopsy (95%CI) by Performance Standard

Grouping variable (valid reports)	NAS 2.8.1: ≤0.35% of first screened women who had benign open biopsy	NAS 2.8.2: ≤0.16% of second or subsequent screened women who had benign open biopsy	NAS 2.8.3: ≤4.0% of first screened women assessed who had benign open biopsy	NAS 2.8.4: ≤3.2% of second or subsequent screened women assessed who had benign open biopsy
Year				
2002 (14)	0.27 (0.23-0.30)	0.10 (0.09-0.11)	3.16 (2.77-3.56)	2.60 (2.35-2.84)
2003 (30)	0.26 (0.23-0.29)	0.12 (0.11-0.13)	2.60 (2.31-2.90)	2.63 (2.43-2.82)
2004 (30)	0.25 (0.22-0.28)	0.12 (0.11-0.13)	2.45 (2.17-2.74)	2.85 (2.65-3.05)
2005 (34)	0.25 (0.23-0.28)	0.10 (0.09-0.11)	2.42 (2.17-2.68)	2.38 (2.21-2.55)
2006 (33)	0.20 (0.17-0.22)	0.09 (0.08-0.09)	1.87 (1.64-2.09)	1.95 (1.80-2.11)
2007 (34)	0.20 (0.18-0.23)	0.08 (0.07-0.08)	1.79 (1.58-2.00)	1.76 (1.62-1.89)
2008 (31)	0.24 (0.21-0.27)	0.09 (0.08-0.10)	2.07 (1.84-2.30)	1.91 (1.77-2.06)
2009 (33)	0.25 (0.22-0.27)	0.09 (0.09-0.10)	2.15 (1.93-2.36)	2.00 (1.86-2.14)
2010 (18)	0.22 (0.18-0.26)	0.08 (0.07-0.09)	1.64 (1.36-1.93)	1.57 (1.39-1.76)
Service location				
Metro (100)	0.24 (0.23-0.26)	0.10 (0.10-0.11)	2.17 (2.07-2.29)	2.15 (2.08-2.23)
State-wide (22)	0.25 (0.23-0.27)	0.08 (0.07-0.08)	2.80 (2.56-3.04)	2.58 (2.41-2.75)
Non-metro (135)	0.21 (0.20-0.23)	0.10 (0.09-0.10)	1.93 (1.79-2.07)	2.00 (1.90-2.09)
Service size				
4000-12000 screens (29)	0.25 (0.20-0.31)	0.10 (0.09-0.11)	1.88 (1.50-2.26)	1.78 (1.53-2.03)
12001- 21000 screens (82)	0.23 (0.21-0.26)	0.10 (0.09-0.10)	2.03 (1.81-2.25)	2.00 (1.86-2.13)
21001-36000 screens (42)	0.22 (0.20-0.25)	0.10 (0.09-0.10)	2.02 (1.83-2.23)	1.97 (1.83-2.10)
36001-92000 screens (104)	0.24 (0.238-0.25)	0.10 (0.09-0.10)	2.30 (2.19-2.40)	2.28 (2.20-2.35)

Table 2. Multivariate Poisson Regression Rate Ratios (95%CIs) for Benign Open Biopsies Rates by Performance Standard*

Predictor Variables	Rate ratios (RR) (95% CIs)			
	RR of first screened women who had benign open biopsy (NAS 2.8.1)	RR of second or subsequent screened women who had benign open biopsy (NAS 2.8.2)	RR of first screened women assessed who had benign open biopsy (NAS 2.8.3)	RR of second or subsequent screened women assessed who had benign open biopsy (NAS 2.8.4)
Service location				
Metro	1	1	1	1
State-wide	0.99 (0.74-1.35)	0.79 (0.61-1.03)	1.39 (1.11 -1.73)	1.26 (1.03-1.55)
Non-metro	0.76 (0.54-1.08)	0.85 (0.56-1.30)	0.95 (0.69-1.30)	1.01 (0.74-1.38)
Service size (screens)				
4000-12000	1	1	1	1
12001-21000	1.00 (0.79-1.28)	1.03 (0.76-1.42)	1.01 (0.76-1.35)	1.08 (0.82-1.44)
21001-36000	0.81(0.57-1.14)	0.98 (0.58-1.68)	0.89 (0.61-1.29)	0.94 (0.61-1.43)
36001- 92000	0.81 (0.61-1.06)	0.98 (0.69-1.36)	1.05 (0.75-1.46)	1.24 (0.93-1.67)
Calendar year				
Reference year	1	1	1	1
5 years later	0.96 (0.72-1.25)	0.77 (0.62-0.94)	0.80 (0.63-1.00)	0.66 (0.52-0.82)
Accreditation status				
4-year	1	1	1	1
2-year	1.04 (0.85-1.27)	1.14 (0.94-1.38)	1.05 (0.85-1.31)	1.10 (0.88-1.33)
Number of reports	243	243	243	243

*Adjusted for state/territory jurisdiction

(Table 2). By comparison, the rate for non-metropolitan services was similar to that for metropolitan SAS [rate ratio=0.95 (0.69-1.30)]. Similarly the State-wide SAS had higher rates of benign open biopsies than metropolitan SAS among women undergoing assessment following their second or subsequent screen [rate ratio=1.26 (1.03-1.55)] but a similar rate applied for non-metropolitan as metropolitan SAS [1.01 (0.74, 1.38)]. The proportion of women having a benign open biopsy reduced over five years in all women having second or subsequent screens [rate ratio=0.77 (0.62-0.94)] and among women assessed following second or subsequent screens [rate ratio=0.66 (0.52-0.82)] (Table 2).

Invasive cancer detection rates

Standards for invasive cancer detection rates, both for first screening rounds (NAS 2.1.1) and subsequent screening rounds (NAS 2.1.2), and for small cancers (<=15mm) (NAS 2.2.1), were met uniformly by year, NAS location and size (Table 3). Increases in annual cancer detection rates were suggested for these standards (Table 3) and multivariate regression analysis confirmed that there were 5-year increases for second or subsequent screening cancer detection rates [rate ratio=1.11 (1.06-

Table 3. Invasive Cancer Screen-Detection Rates (95%CIs) by Performance Standard

Grouping variable (n valid reports)	Rate per 10,000 women (95% CIs)				
	≥50 invasive cancer rate at first screen (NAS 2.1.1)	≥35 invasive cancer rate at second or subsequent screen (NAS 2.1.2)	≥25 small invasive cancer (≤15mm) screen detection rate (NAS 2.2.1)	<7.5 /10,000 interval cancer rate at 0-12 months (NAS 2.4.2a)	Interval cancer rate at 12-24 months (NAS 2.4.2b)
Year					
2002 (15)	62.2 (55.3-69.0)	43.8 (41.5-46.1)	30.0 (28.2-31.7)	7.3 (6.5-8.1)	12.7 (11.3-14.0)
2003 (30)	64.4 (57.7-71.1)	43.0 (40.9-45.0)	29.3 (27.7-30.8)	7.7 (6.9-8.6)	12.7 (11.5-13.9)
2004 (29)	63.4 (57.0-69.7)	43.1 (41.3-45.0)	28.8 (27.4-30.3)	7.1 (6.4-7.9)	12.0 (10.9-13.0)
2005 (33)	66.8 (60.6-72.9)	41.3 (39.6-43.1)	28.5 (27.2-29.9)	7.0 (6.3-7.6)	7.5 (6.9-8.1)
2006 (33)	55.1 (49.8-60.3)	42.0 (40.3-43.7)	27.6 (26.3-28.8)	6.0 (5.4-6.6)	11.5 (10.6-12.4)
2007 (34)	64.9 (59.1-70.7)	43.1 (41.4-44.7)	28.6 (27.3-29.9)	6.1 (5.5-6.8)	12.0 (11.1-12.8)
2008 (31)	66.8 (60.9-72.7)	46.4 (44.7-48.2)	30.5 (29.1-31.8)	5.8 (5.2-6.4)	13.1 (12.2-14.0)
2009 (33)	68.6 (63.0-74.2)	47.6 (45.9-49.3)	31.0 (29.7-32.3)	6.8 (6.2-7.5)	11.9 (11.0-12.7)
2010 (18)	67.5 (58.9-76.2)	47.4 (44.8-50.0)	30.2 (28.2-32.2)	7.4 (6.3-8.5)	12.5 (11.1-14.0)
Service location					
Metro (99)	64.5 (61.7-67.4)	44.5 (43.6-45.4)	29.5 (28.8-30.2)	6.7 (6.4-7.1)	10.9 (10.5-11.3)
State-wide (22)	66.5 (61.7-71.4)	45.1 (43.7-46.4)	30.0 (28.9-31.0)	6.2 (5.7-6.7)	11.4 (10.7-12.1)
NNon-metro(135)	62.3 (58.5-66.1)	42.9 (41.8-44.1)	28.6 (27.8-29.5)	6.8 (6.4-7.3)	12.2 (11.6-12.9)
Service size					
4000-12000 screens (29)	63.0 (50.5-75.4)	41.2 (37.8-44.6)	26.3 (23.7-28.9)	6.4 (4.9-7.8)	10.6 (8.7-12.6)
12001- 21000 screens (82)	67.5 (61.3-73.6)	43.3 (41.6-44.9)	28.9 (27.6-30.1)	7.2 (6.5-7.8)	12.8 (11.9-13.6)
21001-36000 screens (42)	63.1 (57.7-68.5)	45.2 (43.5-46.9)	31.3 (30.0-32.6)	6.5 (5.8-7.2)	12.2 (11.2-13.2)
36001-92000 screens (103)	64.0 (61.6-66.5)	44.3 (43.5-45.0)	29.2 (28.6-29.7)	6.5 (6.2-6.8)	11.0 (10.6-11.4)

Table 4. Multivariate Poisson Regression Rate Ratios (95CIs) for Invasive Cancer Screen-Detection Rates and Interval Rates by Performance Standard*

Predictor Variables	Rate ratios (RR) (95% CIs)				
	RR for invasive cancer rate at first screen (NAS 2.1.1)	RR invasive cancer rate at second or subsequent screen (NAS 2.1.2)	RR for small invasive cancer (≤15mm) screen detection rate (NAS 2.2.1)	RR for interval cancer rate at 0-12 months (NAS 2.4.2a)	RR for interval cancer rateat at 12-24 months (NAS 2.4.2b)
Service location:					
Metro	1	1	1	1	1
State-wide	0.98 (0.80-1.18)	1.01 (0.97-1.05)	1.00 (0.95-1.06)	0.86 (0.77-0.98)	0.85 (0.74-0.96)
Non-metro	0.88 (0.76-1.00)	0.96 (0.91-1.02)	0.96 (0.89-1.02)	0.93 (0.81-1.08)	0.93 (0.77-1.13)
Service size (screens):					
4000-12000	1	1	1	1	1
12001-21000	1.13(0.87-1.47)	1.07 (0.98-1.17)	1.11 (0.98-1.26)	1.17 (0.91-1.53)	1.25 (0.86-1.81)
21001-36000	0.96 (0.71-1.31)	1.10 (1.03-1.18)	1.18 (1.04-1.33)	1.01 (0.74-1.38)	1.14 (0.77-1.67)
36001-92000	0.92 (0.90-1.08)	1.04 (0.98-1.10)	1.06 (0.95-1.19)	1.02 (0.76-1.36)	1.12 (0.79-1.60)
Calendar year:					
Reference year	1	1	1	1	1
5 years later	1.07 (0.99-1.16)	1.11 (1.06-1.17)	1.08 (1.02-1.13)	0.92 (0.80-1.04)	0.99 (0.91-1.07)
Accreditation status:					
4 years	1	1	1	1	1
2 years	0.99 (0.90-1.09)	1.00 (0.97-1.04)	1.00 (0.95-1.05)	0.96 (0.83-1.10)	0.90 (0.80-1.02)
Number of reports	241	241	241	231	217

*Adjusted for state/territory jurisdiction

Table 5. Percentage of Women (95%CIs) Requiring Assessment Who Attended for Assessment within 28 Calendar Days of Screening (≥90% Attend ≤28 days (NAS 3.7.2))

Grouping variable (n valid reports)		≥90% of women needing assessment assessed ≤28 days of screen (NAS 3.7.2)
Year	2002 (10)	38.1 (37.4-38.8)
	2003 (20)	46.6 (45.9-47.3)
	2004 (27)	68.0 (67.5-68.5)
	2005 (33)	71.4 (71.0-71.9)
	2006 (33)	67.3 (66.9-67.7)
	2007 (34)	67.9 (67.4-68.3)
	2008 (31)	65.7 (65.3-66.2)
	2009 (33)	65.0 (64.6-65.4)
	2010 (18)	68.8 (68.2-69.4)
Service location		
	Metro (93)	63.9 (63.7-64.1)
	State-wide (21)	75.1 (74.7-75.5)
	Non-metro (125)	61.1 (60.8-61.4)
Service size		
	4000-12000 screens (25)	78.8 (78.1-79.5)
	12001- 21000 screens (77)	58.6 (58.2-59.0)
	21001-36000 screens (40)	68.5 (68.2-68.9)
	36001-92000 screens (97)	64.3 (64.1-64.5)

1.17)] and small cancer detection rates [rate ratio=1.08 (1.02-1.13)] (Table 4). Meanwhile first screening cancer detection rates tended to be lower in non-metropolitan than metropolitan SAS locations [rate ratio=0.88 (0.76-1.00)]. Compared with SAS with the lowest screen numbers (i.e., 4000-12000 per annum), those with 21001-36000 screens per annum had higher cancer detection rates [rate ratio=1.10 (1.03-1.18)] for second or subsequent screens and for small cancers [rate ratio=1.18 (1.04-1.33)] (Table 4).

Interval cancer rates

The main performance standard of fewer than 7.5 per 10,000 women aged 50-69 years having an invasive interval breast cancer within 12 months of a negative screen was uniformly met by SAS location and size, and for all years apart from 2003, where the performance was lower although within the 95% confidence interval (Table 3). Multivariate regression analysis indicated that State-wide SAS had a lower interval cancer rate than metropolitan SAS both for 0-12 months [rate ratio=0.86 (0.77-0.98)] and 12-24 months [rate ratio=0.85 (0.74-0.96)] post diagnosis (Table 4). By comparison, interval cancer rates were similar for non-metropolitan and metropolitan SAS [rate ratios of 0.93 (0.81-1.08) and 0.93 (0.77-1.13) respectively].

Time from recall to assessment

The standard of 90% or more of women requiring assessment being assessed within 28 calendar days of screening (NAS 3.7.2) was unmet by SAS grouped by year, location and size (Table 5). While the percentage of women meeting this standard was lower in 2002 and 2003 than for subsequent years, multivariate regression results did not reveal a significant time trend. Regression model 1 indicated that the proportion of women attending

Table 6. Multivariate Poisson Regression Rate Ratios (95%CI) for Percentage Requiring Assessment who were Assessed within 28 Days of Screening (NAS 3.7.2)*

Predictor	Rate ratio (RR) (95%CIs) Model 1	Model 2
Service location:		
Metro	1	NA
State-wide	1.16 (0.93-1.45)	
Non-metro	0.96 (0.76-1.16)	
Service size (screens):		
4000-12000	1	1
12001-21000	0.74 (0.59-0.94)	0.93 (0.74-1.15)
21001-36000	0.73 (0.53-1.02)	1.06 (0.86-1.30)
36001-92000	0.73 (0.60-0.89)	1.04 (0.83-1.32)
Calendar year:		
Reference year	1	1
5 years later	1.06 (0.88-1.27)	0.90 (0.78-1.03)
Accreditation status:		
4 years	1	1
2 years	0.82 (0.69-0.96)	1.05 (0.92-1.19)
Percentage of women screened:		
CALD	NA	0.36 (0.17-0.75)
Rural and remote	NA	0.84(0.68-1.05)
Socioeconomically disadvantaged	NA	0.79 (0.50-1.24)
Number of reports	229	154

assessment within 28 days was higher for the services with the lowest screening volume, such that rate ratios tended to be lower for SAS with 12001-21000 screens per annum at 0.74 (0.59-0.94), SAS with 21001-36000 screens per annum at 0.73 (0.53-1.02), and SAS with 36001-92000 per annum at 0.73 (0.60-0.89) (Table 4). These differences were not evident in Regression model 2, which indicated lower rates of assessment within 28 days for SAS with higher percentages of culturally and linguistically diverse women [rate ratio=0.36 (0.17-0.75)] (Table 6).

Discussion

Results indicate that BreastScreen Australia Screening and Assessment Services (SAS) performed well against high priority standards and performance indicators for benign biopsy rates, cancer detection rates and interval cancer rates, regardless of SAS size, location and calendar year. Increases were found over time in invasive cancer detection for second and subsequent screens and in small cancer detection rates. The decline in benign open biopsies over the same period in women following second or subsequent screens, and in those having an assessment after second or subsequent screens, indicates that SAS were increasing their breast cancer detection while decreasing the need for open biopsy. This is likely to reflect increased utilization of core biopsies, including vacuum assisted core biopsies, for achieving a pre-operative diagnosis for many lesions. Potentially the decreased need for open biopsy would have reduced levels of surgically related co-morbidity and patient anxiety.

A relatively high invasive cancer detection rate applied to 2008-2010 which may be due to increased screening sensitivity from the introduction of digital mammography. It is not known whether this will lead to increases in survivals. The reason for the relatively low cancer detection rate in 2006 is not known. This observation was

consistent for invasive cancers (all sizes) at first screens and second or subsequent screens, and small invasive cancers. It may reflect an increasing concentration of women at the low end of the screening target age range in a "steady state" program, where incidence rates would be lower.

Women being assessed following their first or subsequent screens in State-wide SAS tended to have a higher rate of open biopsies than women having corresponding screens in a metropolitan SAS. Many State-wide SAS have centralized assessment and some may take the opportunity to refer women living at some distance from specialized cancer centres for open biopsy while they are "in town" following assessment. Notably State-wide SAS tended to have lower interval cancer rates than metropolitan SAS. The potential for this to reflect higher more intensive investigation of screen-detected abnormalities warrants further investigation.

The only high priority standard, which was not usually met, was time between screening and assessment in that a far lower proportion than the standard of 90% of women requiring assessment had an assessment within the specified 28 days. This standard was not met, regardless of year, SAS size and location. The associated performance indicator score was especially low in 2002 and 2003 at 38% and 47% respectively before increasing to around 65-71% for 2004-2010. This standard has been problematic and shortfalls in performance have been investigated in many settings. Sometimes they have been attributed to radiology workforce shortages or to less ready access of women from rural areas to city-based assessment services. Choice is also thought to have been a factor for some women.

A striking aspect of the results was the high uniformity of performance across SAS categories. Mostly performance standards were uniformly met, although for time between screening and assessment, the standard was mostly not met. It is likely that BreastScreen Australia Services are relatively consistent in their operational standards, reflecting the uniform national quality improvement and accreditation program (BreastScreen Australia, 2004; 2005; National Quality Management Committee, 2004). Evaluations of breast cancer mortality reductions from screening have also presented broadly similar results, irrespective of study design and whether conducted nationally or in New South Wales, South Australia or Western Australia (Taylor et al., 2004; Roder et al., 2008; DOHA, 2009; Morrell et al., 2012; Nickson et al., 2012).

The present analysis of data at a SAS level has provided a health-system perspective of performance. A notable finding was the higher probability of SAS with higher percentages of culturally and linguistically diverse screening participants not meeting the standard for time between screening and assessment. Australian health policy places an emphasis on the needs of culturally and linguistically diverse people and it is important to determine the reasons for this finding. The extent to which longer times to assessment for these clients contribute to the longer times to assessment at the SAS level is not known, but warrants investigation. Either way, it is possible that the longer times to assessment in these SAS would impact on these women.

The study demonstrates the value of using routine data reporting for assessing performance characteristics of BreastScreen Australia at a system level. It is recommended that more detailed descriptive characteristics of SAS be collected in the future to add value to these types of analyses. These characteristics could relate, for example, to Service access, workforce characteristics, client satisfaction levels, technology differences, and hours of service. Descriptive data of this type could assist identification of SAS characteristics that are the most predictive of optimal performance, with implications for planning service design.

Interval cancer rates are an important marker of screening sensitivity. It is reassuring that performance standards were uniformly met by SAS category, but the lower rates of interval cancers for state-wide than metropolitan SAS were unexpected and further investigation into possible reasons is required, including the possible contribution of higher screen-reader volume and consequent expertise in state-wide SAS. Small SAS tended to have lower small-cancer detection rates, which may have been influenced by smaller screen-reader volume. These and other possible reasons need further exploration.

In conclusions, all high priority standards were met nationally by the Breast Screen Australia Service categories used in this study, apart from the proportion meeting the standard for wait time from screening to assessment. The higher the percentage of culturally and linguistically diverse women among those being screened by the Service, the lower was the percentage of screened women meeting the national accreditation standard of 28 days or less between screening and assessment. Results indicate that rates of detection of invasive cancers of all sizes and of small cancers specifically have increased over time, while the need for benign open biopsy has reduced, and interval cancer rates have stayed within acceptable limits. Further data are needed on Service characteristics to better identify those characteristics associated with better Service outcomes, in order to inform Service design planning.

Acknowledgements

This paper was prepared on behalf of the BreastScreen Australia National Quality Management Committee (NQMC). Members of the Committee not listed as authors include Dr Tracey Bessell (Acting Chair), Ms Pam Brackman, Ms Roberta Higginson, Associate Professor Warwick Lee, Mr Warwick May, Ms Helen Porritt, Ms Michelle Tornabene, Ms Jan Tresham and Clinical Associate Professor Liz Wylie. Cancer Australia provided the Secretariat support to the NQMC, including undertaking the analysis for this paper. The authors particularly acknowledge Mr Simeon Jones' contribution to this analysis. Funding for this study was provided by the Australian Department of Health. The authors would also like in particular to acknowledge a past member of the NQMC, the late Professor John Buckingham, who inspired this work.

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