

Mobile Digital Breast Screening: An Evaluation of the Queensland Experience

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Abstract

This paper analyses the social and economic impact on providers and their clients associated with the adoption of digital mammography in BreastScreen Queensland's mobile services to rural and remote parts of Queensland Australia. Using both quantitative secondary data from Queensland Health and qualitative workforce interviews the paper focuses on outcomes that are already becoming apparent with the transition to digital mammography. Benefits include reduced rates of technical recalls for clients and enhanced job satisfaction on the part of the radiographers who staff the service. Significantly the declines in technical recall rates are greater than that which has hitherto been reported in the literature. The paper provides comparative estimates of the costs associated with technical recall rates in pre and post digital environments.

Keywords: *Mammography, Digital Breast Screening, Mobile Breast Screening Service, Benefits Realisation*

1 Introduction

BreastScreen Australia (BSA) was established in 1991 with the participation of all Australian States/Territories including BreastScreen Queensland (BSQ). In its initial year of operation just under 25,000 Queensland women were screened [11]. By 2007-8 almost ten times as many women (217,892) were participating in the program. Participation rates in the Queensland program have risen in the target age groups of 50 to 69 from 42.6% in 1996-7 to 56.4% in 2006-7 [2]. For the previous year (2005-6) 55.8% of women in the 50 to 69 year age group who were living in urban areas took advantage of the services offered by BSQ, while 61% of women living in rural and remote areas participated.

The comparatively high participation of rural women is an outcome of the mobile screening service BSQ operates. Accommodating this population is a fleet of 6 mobile screening units, which operate in various rural and remote sectors of the state. Over the first three months of 2009 analogue film technology on the services was replaced with either digitally computed

or direct digital mammography equipment. Associated with this upgrade the project also undertook to train and familiarise the occupational groups associated with the BreastScreen program in use of the new technology. Typically, mobile services with digital technology now visit between 20 and 25 communities over a two year cycle. The Townsville BreastScreen Service visits about 12 communities from Townsville on the Queensland eastern seaboard to Mt. Isa which is 1200 km to the west. In contrast the Toowoomba BreastScreen Service operates in 26 communities from Toowoomba in the Darling Downs to Charleville which is 600 km to the west. (see Figure 1, below).

Other studies have suggested that the operational costs of digital mammography versus film mammography are higher, but that investment in digital mammography is required because film mammography is being superseded and is becoming unsupportable. [10] This paper complements and extends such studies by focusing on the client and workforce impacts of adopting digital technology in mobile breast screening operations.

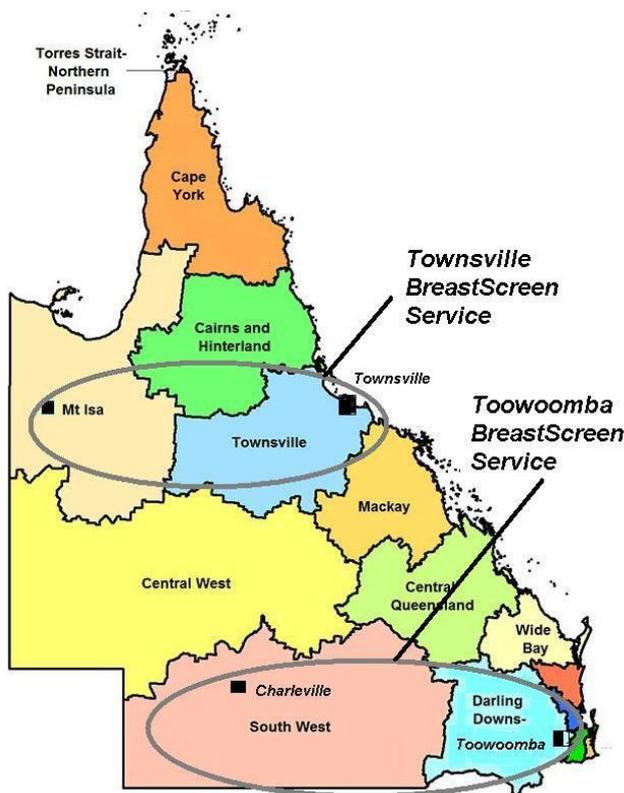


Figure 1: Map of Queensland

This study examines in more detail the socio-economic impacts of digital mammography on clients and radiographers in the BreastScreen Queensland service immediately prior to and after the transition to a digital work environment. The study analyses data from the first two mobile screening services in Queensland to make the transition to digital mammography, Toowoomba and Townsville.

1.1 Digital Screening Technologies

Given that ‘the tyranny of distance’ has been shown to be an important determinate in the participation of women in breast screening programs [5], the availability of a mobile service has played an important role in enhancing the participation rates of non-metropolitan based populations. While current participation rates fall short of the 70% target rate of participation set by BSA, it is significant that death rates from breast cancer per 100,000 population have declined in Queensland by 23% between 1996 and 2006 [3]. Mortality from the disease had been in decline by 0.6% per year between 1982 and 1993, but the rate of reduction has since increased to 2.4% per annum following the introduction of the breast cancer screening program.

Digital technologies, especially in spatially mobile screening venues, are seen to offer a number of advantages that have already been alluded to in existing litera-

ture. With digital technologies, radiographers can now determine in the presence of the client image quality and determine whether the image will suffice for screening purposes by a radiologist. In other words, a real time in situ decision can be made by the radiographer as to whether or not additional images are required [7]. In the pre-digital era, if additional images were required the client would have to be recalled for additional images to be taken at a later date. This process is termed a “technical recall”

Previous studies in Norway [13] and the US [8] have found that following the introduction of digital technologies the technical recall rate of clients has reduced. In the latter study, technical recall rates in digital remote sites were reduced by as much as 50%. Several impacts on the provider and the client arising from of any reduction in technical recall rates have been hypothesized.

Minimally, it could be suggested that a decline in recall rates will diminish inconvenience and cost to clients as well as potential anxiety [9,12]. It has also been hypothesised that real time image production and timely follow-up assessment readings will increase both client uptake of breast screening services and compliance with requirements for technical recalls which can often be done at the same time as the original appointment [6]. These considerations seem especially important in the context of rural/remote breast screening, where assessment services are usually performed at a significant distance from the mobile service. For example when a women screened by a mobile service at a remote location is recalled for further images this can involve considerable travel back to the site of the original appointment, to another site where the van is now located or to a location which has a permanent breast screening facility. Up to 3 days of travel and accommodation can be required at additional cost to the woman and the health system. Added to these direct material costs are the time and anxiety that accompany travel for supplementary screening. Any technology that diminishes the need for such travel will have direct economic and psychological benefits.

The Medical Services Advisory Committee (MSAC) to the Australian Government analysed a wide range of possible impacts of digital mammography [10]. When discussing workforce impacts MSAC highlighted the improvements digital mammography can make to the safety and efficiency of the work performed by radiographers. Digital image capture does away with the use of noxious chemicals in the film production process. When fully operationalised through the employment of a Picture Archive and Communication System (PACS), it will also do away with the work of physically having to transport and store films [10, pages 71-75].



Figure 2: A BreastScreen Queensland Mobile



Figure 3: The digital mammography screening room

These aspects are examined more closely in this study of the first BSQ services to transition to digital technology immediately prior to and after the adoption of a digital work environment.

1.2 Mobile Digital Mammography

Each of the 6 mobile van units in the Queensland service is equipped with a fully functional mammography room with the digital mammography equipment, change room, waiting area, reception, staff amenities and a clinical examination area. Improved client access has been catered for with automatic door entry/exit, and wheelchair access. An exterior view of a van is shown in Figure 2. An interior view of the digital mammography screening room is shown in Figure 3.

The workflow process for mobile digital mammography is based on worklists and appointments contained in the client information system known as BSQR2. This is a client information system which contains demo-

graphic data on clients. It is also employed as a booking appointment system. The workflow that is associated with the mobile service from first point of contact to end point disposition is described below:

- client books an appointment over the phone;
- booking clerk enters booking in breastscreen information system;
- breastscreen information system generates a work list of appointments;
- the work list is transmitted over a 3G wireless connection to a client system in a mobile screening van;
- on the day of the appointment the radiographer selects the client from the work list and links the images to the client record;
- the radiographer checks the image quality and re-takes any images that are not adequate;
- the client is sent home;
- images are sent by courier on a DVD on a daily basis to the assessment service for reading; and
- in the assessment service the images are re-linked to the client record, stored on a PACS and a radiologist produces a report.

A Picture Archive and Communication System (PACS) to store breast screen images is currently being implemented by Queensland Health. Images from mobile Services will only be transferred electronically when the mobile is connected to a Queensland Health hospital via a cable or a WiFi connection due to the high cost of data transfers on commercial 3G wireless services. However these services are suitable to provide the communications medium for the web based client information system (BSQR2).

2 Methodology

The object of this study was to evaluate the social and economic impact on providers of breast screening services and their clients that were a consequence of moving to digital mammography in the BSQ mobile service.

This study was not able to consider many other consequences of moving to digital mammography that were identified in the MSAC report [10], including clinical outcomes, or undertake a cost benefit analysis for breast screen service providers of digital mammography due to

the short time between the introduction of the technology in Queensland and our evaluation. In other words, the focus of the research is on the socio-economic rather than the medical impacts of digital mammograms.

It is important to recognise that roll-out of digital breast screening technology in Queensland only commenced in 2009 around Toowoomba and Townsville so the elapsed time between the introduction of the technology and our evaluation is relatively short. Consequently, it is possible to measure certain outcomes, in limited geographical areas. The effects of the technology when immediate electronic transmission of images to assessment centres becomes widespread on clinical outcomes such as overall cancer detection rates in Queensland, follow up assessment rates, or longer term variations in technical recall rates will require a longer period of elapsed time before accurate evaluations can be carried out.

2.1 Technical Recalls

A goal of digital mammography implementation was to enhance the efficiency of the Queensland mobile breast screen service. One obstacle to efficiency of the service is that a certain proportion of the client base is recalled back to a screening centre for the taking of additional, repeat images. In a certain percentage of cases, the reason for these recalls is that the original film images were found not to be of optimal standard and the radiologist would request additional images. Such technical recalls required additional bookings and work for the radiographers, who otherwise could have been spending such time screening new clients. As a result of imperfect images, technical recalls diminish the efficiency (i.e. screening capacity) of the service.

Additionally, such recalls can exacerbate anxiety for the women who have been recalled back for a second mammography screen. In rural and remote areas, technical recalls can also increase the costs incurred for screening. Moreover, in such settings, if the mobile operation has moved on from the site of the original screening, a second set of images will have to be taken at another, more likely, distant location. In some cases this could be the new location of the mobile service, while in other cases technical recalls could necessitate travel to the nearest fixed site location. Regardless of whether the recall was back to the original site or to a new mobile or fixed location site many additional kilometres and hours of travel could be involved.

2.2 Radiographer Interviews

As some of the hypothesised effects of using digital equipment also involve the workforce, interviews of radiographers at one of the mobile sites were also conducted. This involved the use of a qualitative interview protocol focused on the ways in which digital technology was changing the work of the radiographers, as well as the adequacy of the training received on the new equipment.

3 Results

Our principal source of data is secondary quantitative data in the form of client information collected by BSQ at the time that breast screens are conducted. Such data is available to researchers on an almost real time basis. It is thus possible to compare results for before and after the introduction of digital mammography. The client information available includes such items as number of screenings conducted, number of technical recalls required, and costs to clients associated with having to conduct re-work between 2008 and most of 2009.

3.1 Client Perspectives

In our study we first examined technical recall rates for three of the mobile services for the 12 months preceding the introduction of digital screening and for the 11 months following its introduction. The following points emerge:

- In the pre-digital environment technical recall rates could fluctuate wildly, from zero in some months to well over 10% in other months. However a longer time series for this data would be required to establish if this variation is a random one, or a long term trend exists.
- On all three mobiles, the recall rate drops to less than 1% following the introduction of digital mammography.
- This represents a decline in the recall rate of from 70% in one case to 100% in another.
- It is thus safe to conclude that a reduction in technical recall rates has been realised through the introduction of digital mammography to BSQ's mobile rural/remote service. The decline in recall rates is greater than that which has hitherto been reported in the Australian and international literature. [4].

An idea of the savings invoked by reducing the technical recall rate can be garnered by taking a closer

look at the actual operation of the mobiles between January 2008 and October 2009. For illustration purposes we will focus on the services that operate out of Toowoomba and Townsville, Australia respectively. Digital mammography was introduced to both services in early 2009. The former regional city is located in south-east Queensland, while the latter city is located on the coast in the northern tropics of the state (refer to Figure 1 above). In 2008, the Toowoomba operation had 325 technical recalls or 5 per cent of all screenings required a second recall screening, while the Townsville mobile breast screen service performed 80 technical recalls which equates to 2.5% of total screenings conducted. Such activity involves both direct and indirect costs that are either borne by the client or, in some cases, government if travel subsidies are paid. Direct travel costs are related to the distance from the client's residence to the BSQ location where the second screening is conducted. Table 1 shows the estimated costs associated with technical recalls for BSQ Toowoomba and Townsville Mobile operations, prior to the implementation of digital screening.

Using data supplied by Queensland Health we are able to calculate the direct costs to clients due to the additional kilometres travelled as a result of having to return for re-screening in these two areas. Costs are calculated by taking the distance travelled by each recalled client from home residence to screening site and applying the standard Australian Tax Office (ATO) allowance for use of vehicles for income tax deductibility purposes, which is 75 cents per kilometre.

Indirect costs to clients are incurred by virtue of the fact that during the travel and appointment times associated with technical recalls people could be doing other things. Taking time out for a second appointment takes people away from other activities such as paid labour, farm work, or domestic labour. All of this entails economic costs, either in foregone earnings and production in the case of paid labour or in added household expenses such as payments for child care. Following the Access Economics methodology [1], opportunity costs can be calculated as $.75 \times \text{average state wage/salary} \times \text{hours lost due to travel and time spent having the re-screening done}$.¹

In the case of Townsville, technical recalls for clients created an additional 1,238 kms of travel that required

over 36 hours. This includes an average of 12 minutes per breast screen. Summing direct and indirect costs for Townsville equates to \$1,638 of additional costs as a result of required re-screenings. The case of the Toowoomba operation is more dramatic. The Toowoomba operation had to perform an additional 325 screenings as a result of initial technical imperfections in the images. This equated into an additional 16,042 kms of travel at a cost of \$12,031. Indirect costs meanwhile involved 255 additional hours at an estimated cost of \$5,098. Technical recalls in the case of the Toowoomba breast screening mobile involved some \$21,141 of additional costs.²

Table 2 shows that following implementation of digital mammography the percentage of clients recalled dropped significantly for both mobile units.

Both the direct and indirect costs associated with the recalls prior to the implementation of digital mammography have been almost totally eliminated as a result of adopting digital technology. In the case of the Townsville service the cost saving to clients per recall event equates to \$14.7 and in the case of Toowoomba the cost saving to clients equates to \$13.6 per recall event.

3.2 Workforce Perspectives

Another key consideration for digital mammography are the effects that the adoption of this technology is imputed to have on the employees who administer the program. The adoption of digital breast screening has been thought to lead to improved job satisfaction [10, pages 71-75] for a number of reasons including:

- a better occupational health and safety environment
- a perceived higher quality of work with fewer recalls
- improved client interaction
- higher levels of satisfaction among the clientele and more positive feedback from users of BSQ.

In qualitative, follow-up interviews that were conducted with the staff on one of BSQ's mobile units the following points were made:

- the digital equipment was easier to operate; there are no cassettes to change before each screening

¹Average wages for Queensland are derived from the Australian Bureau of Statistics, Regional Wages and Salary Earner Statistics. The last data in this series is for 2005-6. Using this data has the effect of slightly underestimating opportunity costs. The average hourly wage has been calculated assuming a 38 hour standard working week and breast screening procedures have been averaged to 12 minutes per client, which may also be a slight under-estimation.

²These travel estimates exclude recalled clients who provided a post office box address. Many of these clients may live on rural properties and have to travel significant distances. About 20% of clients gave post office box addresses.

| Pre-Digital | Clients | Recalls | Recall Rate % | Recall Travel (kms) | Travel Costs | Client Time (Hours) | Total Indirect Costs | Total Costs |
|-------------|---------|---------|---------------|---------------------|--------------|---------------------|----------------------|-------------|
| Townsville | 3,300 | 80 | 2.42% | 1,238 | \$928 | 36 | \$710 | \$1,638 |
| Toowoomba | 6,496 | 325 | 5.00% | 16,042 | \$12,031 | 255 | \$5,098 | \$21,141 |

Table 1: Estimated costs associated with technical recalls for BSQ Toowoomba and Townsville Mobile operations, prior to the implementation of digital screening

| Post-Digital | Clients | Recalls | Recall Rate % | Recall Travel (kms) | Travel Costs | Client Time (Hours) | Total Indirect Costs | Total Costs |
|--------------|---------|---------|---------------|---------------------|--------------|---------------------|----------------------|-------------|
| Townsville | 7,088 | 8 | 0.11% | 39 | \$29 | 1 | \$27 | \$46 |
| Toowoomba | 4,555 | 15 | 0.33% | 483 | \$725 | 14 | \$288 | \$771 |

Table 2: Estimated costs associated with technical recalls for BSQ Toowoomba and Townsville Mobile operations, after the implementation of digital screening

and the machine is easily positioned for different image angles with the push of a button. As a result, physical labour is no longer required for positioning the machine. When demonstrating these points to the researcher, one radiographer commented that she should be a marketing agent for the manufacturer, such was her level of enthusiasm for the new technology.

- digital technology provides immediate “feedback” to the operator. Previously, radiographers would only get delayed feedback if something was wrong, such as unreadable images. As a result, radiographers would only receive negative feedback. Now they can see for themselves when they have done a good job and when further images are required. Positive affirmation provided in real time should not be underestimated for its positive effects on the workforce.

Staff were asked about the training they received with the new digital technology. One long serving radiographer was satisfied with the training she received on the new machines. This included 3 days of client-free side-by-side training followed by 2 days of client screenings in the presence of a trainer. This was viewed as adequate. The other radiographer was a new hire. She concurred that this was an adequate amount of training, although she had not been able to take advantage of it, having been hired after the training had been rolled out.

4 Discussion

Readers may notice that there are significant differences in the travel savings between the Townsville and Toowoomba operations. Costs associated with technical

recalls are over 10 times greater in the pre-digital comparison between the two jurisdictions and are greater, although still minimal, in the post-digital work environment. We hypothesize that this is an effect of the circuit that the vans traverse over their assigned two year cycles. In other words, data for 2008 may reflect the fact that in that year the Townsville van visited less distant locales. In order to test this explanation, costs for 2007 were also calculated for the Townsville van, (not shown in Table 1). For 2007, 3,716 additional kilometres were travelled at a cost of \$5,573 on account of technical recalls. The indirect costs associated with this travel are estimated to be \$1,682. The elimination of technical recalls in 2007 for the Townsville mobile breast screen operation would have resulted in a savings of approximately \$7,255. This greater savings is partly the result of the van visiting more distant locations such as Mt. Isa in 2007 (see Figure 1).

An examination of the complete two year circuit for the Townsville van showed a lower differential in savings between the two case studies. This may be a product of different settlement patterns with southern Queensland having a greater number of small settlements that are not directly visited by BSQ. Alternatively, the mobile rosters could be different with the Townsville mobile staying for greater periods of time in specific centres and re-screenings consequently being conducted in the same (i.e. closest) site as the initial screening.

The interviews conducted with mobile van staff appear to coincide with those from a larger survey conducted by BSQ of its total radiographer workforce. This research found that 95% of respondents (N=50) had high to very high job satisfaction, 73% indicated a high to very high reduction in physical workloads associated with digital technology, while 52% indicated that digital

technology was either an important or very important factor for deciding to stay in their current jobs.

5 Conclusions

The virtual elimination of technical recalls in 2009 saved in the neighbourhood of \$23,000 for clients in the case of our two case study operations. As to why the savings are greater in one case than the other should be the object of further investigation over a longer period of time that would need to analyse the data from other Queensland breast screen services as digital mammography is implemented across the state. The reduction in technical recall rates in our study has been appreciably greater than what has been reported thus far in both the Australian and in the international literature [8,13]. The effects on workforce morale have also been in the predicted direction, that is, highly positive. Whether this translates into diminished attrition rates and more successful recruitment of radiographers are interesting issues for a longer term analysis.

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