Mobile digital breast screening: an evaluation of the Queensland experience

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Abstract.
This paper analyses some of the outcomes associated with the adoption of digital mammography in BreastScreen Queensland’s mobile services to rural and remote parts of the state. A fleet of six mobile services, equipped with digital mammography equipment service these locations.

Digital technologies, especially in spatially mobile screening venues, are seen to offer a number of advantages. First being able to immediately check the image quality to determine whether the image will suffice for screening purposes by a radiologist and can help reduce the number of client recalls due to technical issues. Secondly it has been suggested that digital mammography leads to enhanced job satisfaction on the part of radiographers, though the removal of the need to handle hazardous chemicals, and improved design of the mammography equipment.

The digital technology is supported by a web based client information systems connected to BSQ databases through commercial 3G wireless services.

The roll-out of digital breast screening technology only commenced in 2009 so the elapsed time between the introduction of the technology and our evaluation is relatively short. Therefore this paper focuses on outcomes that are already becoming apparent such as reduced rates of client recall due to technical issues with the images, while other benefits such as increased cancer detection rates will take time to accrue.

The outcomes of the adoption of digital mammography in BreastScreen Queensland’s mobile services are examined from the perspective of the client and the radiographer workforce. Using recent data we have found that for three mobile services, the technical recall rate drops to less than 1% following the introduction of digital mammography. This represents a decline in the technical recall rate of from 70% in one case to 100% in another. This decline in technical recall rates is greater than that which has hitherto been reported in the literature.

Interviews and surveys of the BSQ workforce have shown that the digital mammography equipment was easier to operate and provides immediate “feedback” to the operator. This research found 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 in deciding to stay in their current jobs.

Savings in the cost of client travel and time have been quantified, and significant difference between the amount of the costs savings were observed between services operating in different regions of Queensland.

Introduction
BreastScreen Australia (BSA) was established in 1991 with the participation of all States/Territories including BreastScreen Queensland (BSQ). In its initial year of operation just under 25,000 Queensland women were screened (Office for Women, 2009). By 2007-8 almost ten times as many women (217,892) were participating in the program (Queensland Health, 2009). 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 (BreastScreen Queensland, 2009; Foster, 2007). 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 six 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.

This purpose of this paper is to provide an evaluation of the transition from analogue to digital technology in mobile breast screening operations. The paper identifies some of the important benefits associated with entering the digital age.

Background
Given that ‘the tyranny of distance’ has been shown to be an important determinate in the participation in screening (Engelman, et al, 2002), 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% from 1996 and 2006 (QCR 2007). Mortality...
from the disease had been in decline by 0.6% per year between 1982-93, 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. First being able to immediately check image quality and determine whether the image will suffice for screening purposes by a radiologist. With digital technologies, radiographers can now determine in the presence of the client whether or not additional images are required (Kelly et al, 2006). In theory, this should significantly reduce the client recall rate of clients as has been found to be the case in Victoria’s rural broadband digital mammography project (Echo, 2008) as well as in studies carried out in Norway (Vigeland et al, 2008) and the US (Leader et al, 2006). In the latter study, recall rates in digital remote sites were reduced by as much as 50%. Minimally, it could be suggested that a decline in recall rates will diminish inconvenience and cost to clients as well as potential anxiety (Sandin et al, 2002; Lindfors et al, 2001). It has also been hypothesised that ‘near real time’ image production and follow-up readings will increase both client uptake of breast screening services and compliance with recall for further assessment (Gitlin et al, 2003). These considerations seem especially important in the context of rural/remote breast screening, where assessment services are usually a significant distance from the mobile service incurring significant time and inconvenience in addition to the anxiety the women will experience having been recalled. For example, when a women screened by a mobile service at Mt Isa is recalled for further assessment at Townsville (the nearest assessment service) up to 3 days of travel and accommodation will be required at additional cost to the woman and the health system.

It has also been suggested that digital mammography leads to enhanced job satisfaction on the part of 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. The ability to almost instantaneously see the results of one’s work may lead to greater job satisfaction directly as well as indirectly via enhanced interaction with clients (Echo, 2008; Medical Services Advisory Committee, 2008).

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

Digital Mammography

Each unit 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.

The workflow process for mobile digital mammography is based on worklists and appointments contained in the client information system BSQR2.
A Picture Archive and Communication System (PACS) to store breastscreen images is being implemented. 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).

Methodology
The object of this project was to evaluate any changes that were a consequence of moving to digital mammography in the BSQ mobile service. Our principal source of data was client information collected by BSQ at the time that breastscreen is conducted – primary, quantitative data. Such data is available to researchers on an almost real time basis. It is thus possible to compare results for such items as number of screenings conducted, number of technical recalls required, and costs associated with having to conduct re-work between 2008 and most of 2009.

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.

It is important to recognise that roll-out of digital breast screening technology only commenced in 2009 so the elapsed time between the introduction of the technology and our evaluation is relatively short. Consequently, it is possible to measure certain outcomes, while ascertaining the effects of the technology in other areas will require a longer period for evaluation to be carried out.

Outcomes of the Mobile Digital Breast Screen Initiative (I): Client Perspectives
One goal of the project was to enhance the efficiency of the service. One obstacle to efficiency was the need to recall a certain proportion of the client base for repeat images. In a certain percentage of cases, 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, which otherwise could have been spent 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 had been recalled back to the service. In rural and remote areas, technical recalls could also increase the costs incurred for screening. Moreover, in such settings, if the mobile 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.

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.
• 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 literature.

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 in 2008. For illustration purposes we will focus on the services that operate out of Toowoomba and Townsville respectively. 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 can be computed as the distance from the client’s residence to the BSQ location where the second screening is conducted. Table 1 provides information on the additional kilometres travelled as a result of having to return for re-screening in 2008. Applying the standard ATO allowance for use of vehicles for income tax deductibility purposes (75 cents per kilometre) yields a very accurate estimate of the direct costs involved in having to undertake technical recalls.

It is also possible to estimate indirect or opportunity costs associated with technical recalls. These are costs that 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 (2003), opportunity costs can be calculated as $0.75 x average state wage/salary x hours lost due to travel and time spent having the re-screening done.\(^1\)

The results of these calculations are presented in Table 1. In the case of Townsville, technical recalls for clients created an additional 1277 kms of travel that required over 40 hours. This includes an average of 12 minutes per breastscreen. Summing direct and indirect costs for Townsville equates to $1567 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 17,094 kms of travel at a cost of $12,819. Indirect costs meanwhile involved 284 additional hours at an estimated cost of $4,260. Technical recalls in the case of the Toowoomba breast screening mobile involved some $17,508 of additional costs.\(^2\)

The significant difference in savings between the two operations may in part be a product 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 $1,844. The elimination of technical recalls in 2007 for the Townsville mobile breast screen operation would have resulted in a savings of approximately $7,420. This greater savings is partly the result of the van visiting more distant locations (e.g. Mt. Isa) in 2007.

<table>
<thead>
<tr>
<th>Mobile Unit</th>
<th>Travel for Recalls, (kms)</th>
<th>Travel Costs (kms x .75)</th>
<th>Travel + Screening (Hours)</th>
<th>Total Indirect Costs</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Townsville</td>
<td>1277</td>
<td>958</td>
<td>41</td>
<td>609</td>
<td>1567</td>
</tr>
<tr>
<td>Toowoomba</td>
<td>17094</td>
<td>12,820</td>
<td>284</td>
<td>4260</td>
<td>17508</td>
</tr>
</tbody>
</table>

1. Average 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 wee and breast screening procedures have been averaged to 12 minutes per client, which may also be a slight under-estimation.

2. These 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.
Outcomes (II): The BSQ Workforce

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 is thought to lead to improved job satisfaction 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 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 was also queried 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.

The foregoing workforce results 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.

Conclusions

The virtual elimination of technical recalls in 2009 saved in the neighbourhood of $19,000 in the case of our two case study operations. As to why the savings are greater in one case than the other is the object of further investigation. However 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 reduction in technical recall rates in our study has been appreciably greater than what has been reported thus far in the literature. 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.

References


Queensland Health, 2009, ‘Business Case: Request to release funds to invest in the BreastScreen Queensland digital for the implementation of a picture archive and communication system’.
