Development and implementation of a population-based breast cancer quality index in Queensland, Australia

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\textbf{ABSTRACT}

\textbf{Background:} While quality indicators (QI) are relatively commonplace, QIs focusing on breast cancer treatment and outcomes have not been previously developed in Australia. We describe the development and implementation of the Queensland Breast Cancer Quality Index (BCQI) and report on trends in performance indicators over time.

\textbf{Methods:} Development of the BCQI was overseen by a clinician-led quality assurance committee covering several clinical disciplines. Using a population-based dataset of female patients diagnosed with breast cancer from 2007 to 2016 (n = 27,541) we examined trends in indicators over time.

\textbf{Results:} The BCQI includes two quality dimensions (Effective and Accessible) and 14 indicators for public and private cancer services. Rates of re-excision following breast conservation surgery (BCS) and conversion of BCS to mastectomy reduced over time (p < 0.001 and p = 0.005, respectively). BCS was less common for women living outside a major city (p < 0.001), who had their surgery in a public (p < 0.001) or low volume hospital (p < 0.001).

\textbf{Conclusions:} Application of the BCQI at a population-level demonstrated our results are comparable to, and in some cases superior to other jurisdictions. We identified some areas where improvement over time has occurred, while also identifying some outcomes requiring further investigation.

\textbf{Policy summary:} The BCQI is a well-established and valuable tool for measuring and monitoring breast cancer care. Practice indicators provide useful information to assist with identifying services performing well as well as those that may benefit from improvement.

1. Introduction

Breast cancer is the most common cancer diagnosed among women worldwide with over two million incident cases in 2018 [1].

Given the high rates of breast cancer and thus the high volume of surgery required, several groups have developed breast cancer quality measures to monitor treatments, identify areas where a renewed effort or new approaches may be required, and to inform health service planning [2–4]. While clinical practice guidelines covering several aspects of the care and management of breast cancer exist in Australia [5], quality indicators (QIs) focusing on breast cancer treatment and outcomes have not been available at a population-wide level. In Queensland, a Cancer Quality Index (CQI) tool for reviewing, comparing and sharing information on the safety and quality of cancer treatments and outcomes for public and private cancer services has been previously developed and implemented [6].

We describe here the development and implementation of Australia’s first breast cancer quality index (the Queensland Breast Cancer Quality Index). Further, we used a series of indicators to track progress in the surgical treatment of breast cancer over time.

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2. Methods

2.1. Setting

Queensland, the third most populous Australian State has a population of approximately 5 million with 40% living outside a major city.

2.2. Development of the Queensland Breast Cancer Quality Index (BCQI)

Several steps were undertaken to develop the Queensland Breast Cancer Quality Index (BCQI), led by Cancer Alliance Queensland’s Cancer Control Safety and Quality Partnership Committee (The Partnership), a Quality Assurance Committee inclusive of hospital administrators, consumers, clinicians and data experts. Several sub-committees are part of The Partnership, including The Breast Cancer sub-committee. This sub-committee is clinician-led and includes breast cancer surgeons, medical and radiation oncologists, a breast care nurse and pathologist with representation from public and private sectors and urban, regional and remote areas of Queensland.

Overall, a modified Delphi process was undertaken in developing the index, which began with an extensive search of the scientific and grey literature to identify other breast cancer indices and clinical practice guidelines [7–9]. The Breast Cancer sub-committee consulted with relevant professional bodies representing a broad range of clinical disciplines during the development and review phase. In selecting the final indicators, the committee considered the availability of population-wide data and capability to link data from multiple sources. Extensive review and consultation with clinician groups was undertaken to discuss reliability of data from chart reviews and relevant clinical hospital databases.

The BCQI provides population-wide information on treatments received for women diagnosed with invasive breast cancer in Queensland and includes two quality dimensions (Effective and Accessible) and 14 indicators (Fig. 1). The ‘Effective’ dimension describes current treatment practices and the ‘Accessible’ dimension is focused on measuring the availability of health services for all population groups. The focus is on surgery, radiation therapy and intravenous (IV) systemic therapy. The 14 indicators were developed through consultation with breast surgeons and other clinical experts in breast cancer treatment and aim to inform clinicians and hospital administrators of the variation in practice and process that exists among public and private hospitals in Queensland. Key to the indicator selection was the availability of population-wide data.

Population-wide patient-level data are obtained through the Queensland Oncology Repository (QOR). QOR links and consolidates information on cancer diagnoses (pathological characteristics) and deaths (including cause) from the Queensland Cancer Register (QCR), Queensland Hospital Admitted Data Collection, and on surgery, radiation therapy and IV systemic therapy. Information collected from multidisciplinary team meetings (MDT) in public facilities is also included.

2.3. Reporting results

Individual (confidential) and state-based aggregated data and reports are regularly disseminated to each hospital. The state-based report is also disseminated more widely to other professional bodies and can be freely accessed on the Cancer Alliance Queensland website [10]. The report includes a summary table by hospital peer grouping. These define groups of similar hospitals based on shared characteristics. Peer grouping hospitals allows comparisons that reflect the purpose, resources, and role of individual hospitals. Confidential reports are provided to clinicians, administrators, and each individual hospital quality assurance committees for review and to act on as necessary. Individual hospital reports include funnel plots for each indicator which help to

![Fig. 1. Breast Cancer Quality Index.](image-url)
identify where variation in hospital performance lies outside the range of results we would expect to see through natural variation. Hospital results sitting outside the funnel are considered to be significantly different (outliers) to the state-wide average and public and private hospital averages are also displayed (Fig. 2).

Those receiving the reports are encouraged to provide feedback in relation to the individual reports. Hospitals are able to request a more detailed audit where a result has been identified as a cause for concern. The report is presented and discussed as part of regular clinical discussion forums.

2.4. Using the BCQI in practice

Three annual state-wide reports have now been published using the BCQI and the most recent is available on the CAQ website [11]. Each year additional indicators are included with the latest relating to breast reconstruction. To illustrate the use of the BCQI in practice, we present here results using selected indicators from the “Effective” and “Accessible” quality dimensions.

2.4.1. Selection of the breast cancer cohort

The study population included all women diagnosed with invasive breast cancer in Queensland between 2007 and 2016. Breast cancer-related surgical procedures were identified from the Australian Classification of Health Interventions [12] and The International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM). To assign a surgery record to a woman with invasive breast cancer, each cancer diagnosis in a calendar year was matched and linked to one or many surgery records. This produced a record of all breast cancer related surgeries performed for breast cancer in Queensland between 2007 and 2016. Breast cancer-surgical procedures included breast conservation surgery (BCS), mastectomy (unilateral or bilateral), re-excision, axillary sentinel lymph node biopsy (SLNB), axillary lymph node dissection (ALND) and breast reconstruction (BR) surgery. From the population of 30,279 women with invasive breast cancer, 27,541 (91%) received breast cancer surgery, representing our study cohort.

2.4.2. Variables included

Residence at the time of diagnosis was categorised into three groups, major city, inner regional and outer regional/remote very remote on the basis of the Australian Geographical Classification [13]. Socioeconomic status (SES) was assigned according to the Australian Bureau of Statistics Socio-Economic Indexes for Areas (SEIFA) [14]. Stage and lymph node status recorded in histology reports was assigned for 93% of cases. Hospital volume was categorised as high (>15 breast cancer surgeries/year) or low (<15 breast cancer surgeries/year). Type of hospital (public or private) and number of comorbidities was also included.

2.4.3. Statistical analysis

The absolute percentage change in rates between two time periods (i.e. 2007–2011 and 2012–2016) was calculated. A multivariate models was constructed to identify factors associated with the likelihood a woman with a T1 (<20 mm) tumour received BCS. The model was adjusted for age, SES, residential location, comorbidities, stage at diagnosis, type of hospital, hospital volume and period of diagnosis.

This study was conducted under the auspices of Cancer Alliance Queensland’s ‘The Partnership’, a gazetted quality assurance committee under section 82 of Queensland’s Hospital and Health Boards Act (2011).

3. Results

Of 27,571 women who received surgery for invasive breast cancer, median age at diagnosis was 60 years (range 17–102 years). Overall median tumour size was 17 mm and was similar between the two diagnosis periods. A total of 84 Queensland public and private hospitals performed between one and 345 definitive surgeries annually. Table 1 summarises the sociodemographic and clinical characteristics of the cohort across the two time periods (2007–2011 and 2012–2016) with some modest differences observed. For example, in the more recent period (2012–2016) compared to the earlier period (2007–2011), fewer women had positive lymph nodes (p < 0.001). A higher proportion of women had a comorbidity (p < 0.001) in the more recent period and there was an increase in the number of women diagnosed with localised disease (58.2% and 61.4% for 2007–2011 and 2012–2016, respectively).

3.1. Effective dimension over time

For both cohorts combined, 43.6% had a definitive mastectomy and 47.1% of women with a T1 (<20 mm) tumour had BCS with no change in either indicator over time (Table 2). A reduction in the frequency of re-excision of tumours following BCS (20.5% in 2007–2011 and 18.3% for 2012–2016, p < 0.001) was observed over

Fig. 2. Example of funnel plot used in the Breast Cancer Quality Index report.
time. Rates of multidisciplinary team review almost doubled from 21.7% to 40.3% (p < 0.001).

Table 3 shows the results of the multivariate model examining the likelihood of receiving BCS for a T1 tumour. The likelihood of receiving BCS was lower for women who lived outside a major city (p < 0.001) and those diagnosed with regional or distant metastasis (p < 0.001). Additionally, women whose surgery was in a public, compared to private hospital and for those treated in a low versus high volume hospital were significantly less likely to have had BCS (OR = 0.63, 95%CI = 0.58–0.68 and OR = 0.66, 95%CI = 0.55–0.79, respectively).

3.2. Accessible dimension over time

A slight reduction over time in the number of women having their first surgery within 45 days of pathological diagnosis (92.2% from 2007 to 2011 and 90.3% from 2012 to 2016, p < 0.001) was observed (Table 2). Additionally, 64.0% of women received definitive surgery within 1–21 days following their initial surgery in the first time period compared to 57.8% in the most recent period (2012–2016). Of women who had a mastectomy, 20.8% had BR in the earlier compared to 18.4% in the later time period (p < 0.001).

4. Discussion

The BCQI is a published set of indicators for measuring and monitoring breast cancer care. Key to the development of the index has been the involvement of clinicians from several disciplines who care for women diagnosed with breast cancer, and the availability of a comprehensive suite of linked population-level data.

The use of QIs for measuring clinical performance in relation to breast cancer has been increasing over time. In 2003 the European Society of Breast Cancer Specialists (EUSOMA) developed a set of QIs and began a voluntary certification system for dedicated European breast cancer centres with a focus on monitoring and feedback processes [2]. The Breast Surgeons of Australia and New Zealand have also developed a voluntary quality audit database [15]. Other breast cancer QIs have been developed and implemented in several European countries [3,16], as well as the United Kingdom [17], Japan [4] and the USA [18]. The BCQI is the first Australian QI to be implemented and used in practice.

While the aim of QIs are to monitor and provide feedback on outcomes and processes, linkage to a centralised population-based cancer repository where data on stage at diagnosis, recurrence and survival adds to their value. The BCQI is linked to data in the Queensland Oncology Repository which includes stage, date and cause of death. The BCQI is the first Australian QI to be implemented and used in practice.

In relation to the individual QIs included in this study, BCS rates for women with tumours ≤20 mm were around 78% with virtually no change over time. While these rates compare favourably with European guidelines suggesting a BCS rate of 70–80% [2], we did observe several factors that impacted the likelihood of receiving BCS. For example, women living outside major cities were significantly less likely to have BCS. Studies have consistently shown rural women are less likely to have BCS compared to their urban counterparts [19,20]. The reasons for this continuing disparity likely include the need for rural women to travel for post-operative radiation therapy [20,21] and potentially surgeon choice [22]. We also observed women were less likely to have BCS if they had surgery in a public or a low volume hospital. Others have found similar

Table 2

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<tr>
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<tbody>
<tr>
<td>Effective dimension</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.1 Breast cancer patients receiving breast cancer surgery</td>
<td>12,598</td>
<td>14,943</td>
<td>0.15</td>
</tr>
<tr>
<td>1.2 Definitive mastectomy</td>
<td>5,952 (43.7)</td>
<td>6,496 (43.5)</td>
<td>0.74</td>
</tr>
<tr>
<td>1.3 Index(\text{BCSI}) for T1 (&lt;20mm) tumours</td>
<td>5,952 (77.6)</td>
<td>6,616 (77.8)</td>
<td>0.79</td>
</tr>
<tr>
<td>1.4 Excision of lesion after index BCS</td>
<td>1,739 (20.5)</td>
<td>1,814 (18.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1.5 Conversion of index BCS to mastectomy</td>
<td>1,282 (15.1)</td>
<td>1,394 (14.1)</td>
<td>0.005</td>
</tr>
<tr>
<td>1.6 SLNB(\text{B}) on T1 tumours with index BCS</td>
<td>N/A</td>
<td>5,702 (86.2)</td>
<td>N/A</td>
</tr>
<tr>
<td>1.7 Radiation therapy following definitive BCS</td>
<td>6,404 (90.3)</td>
<td>7,671 (90.8)</td>
<td>0.23</td>
</tr>
<tr>
<td>1.8 Adjunct intravenous systemic therapy for axillary lymph node positive patients aged (&lt;70 years)</td>
<td>2,980 (85.8)</td>
<td>3,249 (89.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1.9 Multidisciplinary Team Review(\text{B})</td>
<td>2,730 (21.7)</td>
<td>6,016 (40.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Accessible dimension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Time from pathological diagnosis to first (index) surgery ≤45 days</td>
<td>11,227</td>
<td>12,790</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2.2 Time from first (index) surgery to definitive surgery between 1 and 21 days</td>
<td>1,837 (64.0)</td>
<td>1,767 (57.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2.3 Breast reconstruction surgery</td>
<td>1,145 (20.8)</td>
<td>1,195 (18.4)</td>
<td>0.001</td>
</tr>
<tr>
<td>2.4 Immediate breast reconstruction surgery</td>
<td>441 (8.0)</td>
<td>617 (9.5)</td>
<td>0.004</td>
</tr>
<tr>
<td>2.5 Delayed breast reconstruction surgery</td>
<td>704 (12.8)</td>
<td>578 (8.9)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Notes: | Index refers to first surgical procedure; † Sentinel lymph node biopsy; ‡ Multidisciplinary team review data available primarily in the public sector; N/A data not available for the period 2007–2011.

The BCQI is the first Australian QI to be implemented and used in practice.
While the exact reason for this differential are unclear, it has been suggested that the higher rates of MDT meetings in high-volume hospitals likely results in greater discussion of the best options for surgery in each Australian State and Territory, ascertainment is high. APPROXIMATELY 91% OF ALL AUSTRALIAN CANCER REGISTRIES FOR LOW AND MIDDLE INCOME COUNTRIES (LMIC) CAN BE PROBLEMATIC. DIFFERENCES IN CLINICAL PRACTICE, CULTURE AND HEALTH CARE SYSTEMS ACROSS COUNTRIES PRECLUDE THE DIRECT TRANSFER OF EXISTING QIS. HOWEVER, SOME LMIC CAN, AND HAVE RECENTLY DEVELOPED BREAST CANCER QIS USING MODIFIED DELPHI APPROACHES ALONG WITH CONSENSUS AT A LOCAL LEVEL [37, 38].

5. Strengths and limitations

A strength of the BCQI has been the involvement of clinicians at every stage of development and ongoing implementation. Further, the BCQI is underpinned by a comprehensive suite of linked population-based data. A strength of the BCQI has been the involvement of clinicians at every stage of development and ongoing implementation. Further, the BCQI is underpinned by a comprehensive suite of linked population-based data. Similar QIs have been developed and applied in other high income countries [2, 34, 35]. Studies have shown quality of care improves over time where QIs have been implemented [6, 36]. Using QIs developed in high income countries for low and middle income countries (LMIC) can be problematic. Differences in clinical practice, culture and health care systems across countries preclude the direct transfer of existing QIs. However, some LMIC can, and have recently developed breast cancer QIs using modified Delphi approaches along with consensus at a local level [37, 38]. A further limitation is that it primarily focuses on outcomes and not process. This then limits our ability to identify factors that may influence clinician practices. A strength of the BCQI has been the involvement of clinicians at every stage of development and ongoing implementation. Further, the BCQI is underpinned by a comprehensive suite of linked population-based data. Similar QIs have been developed and applied in other high income countries [2, 34, 35]. Studies have shown quality of care improves over time where QIs have been implemented [6, 36]. Using QIs developed in high income countries for low and middle income countries (LMIC) can be problematic. Differences in clinical practice, culture and health care systems across countries preclude the direct transfer of existing QIs. However, some LMIC can, and have recently developed breast cancer QIs using modified Delphi approaches along with consensus at a local level [37, 38].

A limitation of using the BCQI as a tool for measuring and monitoring trends over time, is that it primarily focuses on outcomes and not process. This then limits our ability to identify factors that may influence outcomes. That said, our clinician-led Breast Cancer subcommittee, meet regularly to discuss the need to add to, or refine QIs based on feedback from hospitals and current best practice. A further limitation is that we are unable to account for patient or surgeon choice as neither are routinely recorded in electronic data sources.
6. Conclusions

The BCQI is a well-established and valuable tool for measuring and monitoring breast cancer care in Queensland public and private health services. This study has applied the BCQI at a population-level using a series of indicators which demonstrate our results are comparable to, and in some cases superior to other jurisdictions. We identified some areas where improvement over time has occurred, while also identifying some outcomes requiring further investigation.

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Declaration of Competing Interest

The authors report no declarations of interest.

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