Original Research

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

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ABSTRACT

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.

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.

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 ($p < 0.001$).

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.

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.

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
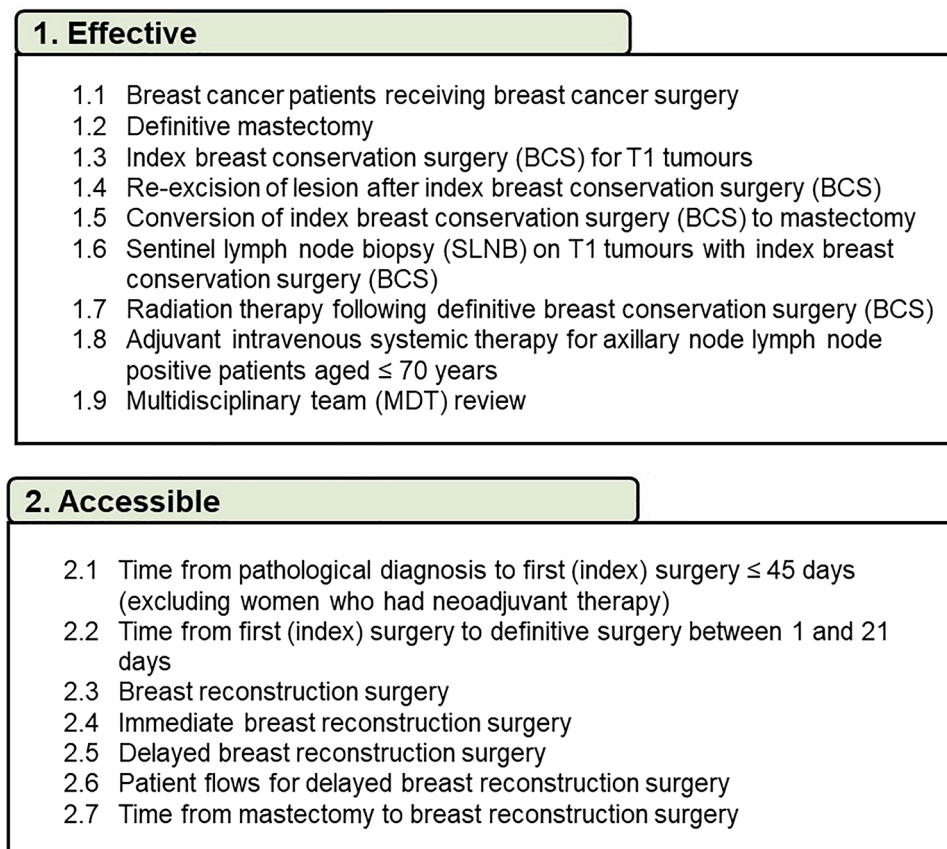
1. Effective

1.1 Breast cancer patients receiving breast cancer surgery
1.2 Definitive mastectomy
1.3 Index breast conservation surgery (BCS) for T1 tumours
1.4 Re-excision of lesion after index breast conservation surgery (BCS)
1.5 Conversion of index breast conservation surgery (BCS) to mastectomy
1.6 Sentinel lymph node biopsy (SLNB) on T1 tumours with index breast conservation surgery (BCS)
1.7 Radiation therapy following definitive breast conservation surgery (BCS)
1.8 Adjuvant intravenous systemic therapy for axillary node lymph node positive patients aged ≤ 70 years
1.9 Multidisciplinary team (MDT) review

2. Accessible

2.1 Time from pathological diagnosis to first (index) surgery ≤ 45 days (excluding women who had neoadjuvant therapy)
2.2 Time from first (index) surgery to definitive surgery between 1 and 21 days
2.3 Breast reconstruction surgery
2.4 Immediate breast reconstruction surgery
2.5 Delayed breast reconstruction surgery
2.6 Patient flows for delayed breast reconstruction surgery
2.7 Time from mastectomy to breast reconstruction surgery

Fig. 1. Breast Cancer Quality Index.

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 indictors 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 the earliest breast cancer diagnosis, used to define "index" and "definitive" breast cancer surgeries.

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 ($\geq$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 ($\leq$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 ($\leq$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
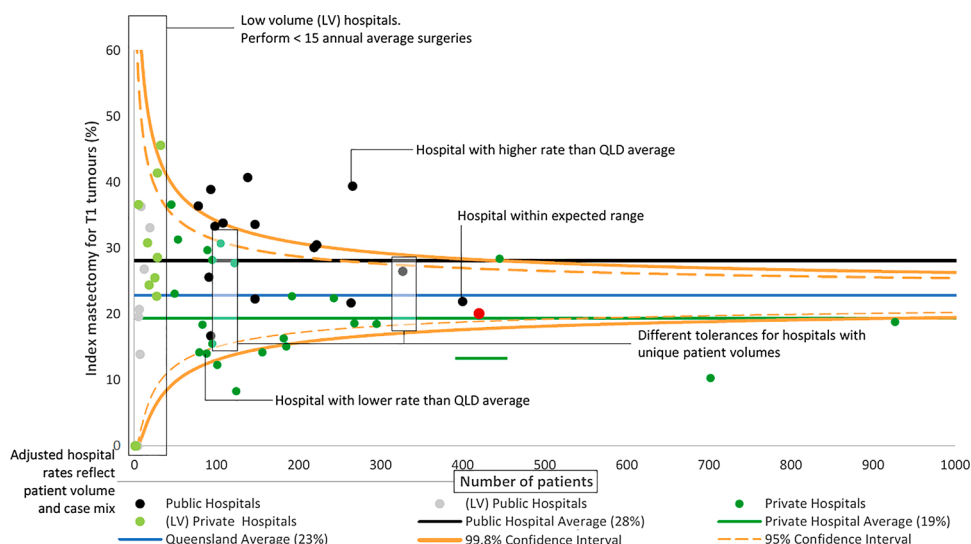

Fig. 2. Example of funnel plot used in the Breast Cancer Quality Index report.

Table 1

Sociodemographic and clinical characteristics of 27,571 women who received surgery for invasive breast cancer.

Variable	2007−2011 N = 12,598 N (%)	2012−2016 N = 14,943 N (%)	p-value
Age group			
<40	720 (5.7)	681 (4.6)	
40−49	2,382 (18.9)	2,756 (18.4)	<0.001
50−69	6,776 (53.8)	7,965 (53.3)	
70−79	1,856 (14.7)	2,538 (17.0)	
80+	864 (6.9)	1,003 (6.7)	
Indigenous status[†]			
Indigenous	280 (2.2)	330 (2.2)	0.94
Non-Indigenous	12,315 (97.8)	14,604 (97.8)	
Residential location			
Major city	8,338 (66.2)	9,987 (66.8)	
Inner regional	2,803 (22.2)	3,252 (21.8)	0.52
Rural[‡]	1,457 (11.6)	1,704 (11.4)	
Socioeconomic status			
Affluent	2,112 (16.8)	2,570 (17.2)	
Middle	8,192 (65.0)	9,646 (64.6)	0.61
Disadvantaged	2,294 (18.2)	2,727 (18.2)	
Charlson comorbidity			
0	11,145 (88.5)	12,511 (83.7)	
1	1,061 (8.4)	1,727 (11.6)	<0.001
2 or more	392 (3.1)	705 (4.7)	
Tumour size			
0−10mm	3,119 (24.8)	3,492 (22.9)	
11−20mm	4,548 (36.1)	5,074 (34.0)	
21−50 mm	3,875 (30.8)	4,806 (32.2)	<0.001
>50 mm	755 (6.0)	902 (6.0)	
Unknown	301 (2.4)	732 (4.9)	
Axillary lymph nodes			
Positive	4,313 (34.2)	4,649 (31.1)	
Negative	7,368 (58.5)	9,208 (61.6)	<0.001
Unknown	917 (7.3)	1,086 (7.3)	
Overall stage			
Localised	7,333 (58.2)	9,167 (61.4)	
Regional	4,204 (33.4)	4,533 (30.3)	<0.001
Distant	176 (1.4)	194 (1.3)	
Unknown	885 (7.0)	1,049 (7.0)	

Notes: † Indigenous status was unknown for 12 cases; ‡ Rural includes outer regional, remote and very remote.

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); had two or more comorbidities (p < 0.001) and were 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

Table 2

Trends over time across selected indicators for Effective and Accessible Dimension for women who received surgery.

Dimensions	2007−2011 N (%)	2012−2016 N (%)	p-value
Effective dimension			
1.1 Breast cancer patients receiving breast cancer surgery	12,598 (91.1)	14,943 (90.6)	0.15
1.2 Definitive mastectomy	5,502 (43.7)	6,496 (43.5)	0.74
1.3 Index[†] BCS[‡] for T1 (≤20mm) tumours	5,952 (77.6)	6,616 (77.8)	0.79
1.4 Re-excision of lesion after index BCS	1,739 (20.5)	1,814 (18.3)	<0.001
1.5 Conversion of index BCS to mastectomy	1,282 (15.1)	1,394 (14.1)	0.005
1.6 SLNB§ on T1 tumours with index BCS	N/A	5,702 (86.2)	N/A
1.7 Radiation therapy following definitive BCS	6,404 (90.3)	7,671 (90.8)	0.23
1.8 Adjuvant intravenous systemic therapy for axillary lymph node positive patients aged (≤70 years)	2,980 (85.8)	3,249 (89.1)	<0.001
1.9 Multidisciplinary Team Review¶	2,730 (21.7)	6,016 (40.3)	<0.001
Accessible dimension			
2.1 Time from pathological diagnosis to first (index) surgery ≤45 days	11,227 (92.2)	12,790 (90.3)	<0.001
2.2 Time from first (index) surgery to definitive surgery between 1 and 21 days	1,837 (64.0)	1,767 (57.8)	<0.001
2.3 Breast reconstruction surgery	1,145 (20.8)	1,195 (18.4)	0.001
2.4 Immediate breast reconstruction surgery	441 (8.0)	617 (9.5)	0.004
2.5 Delayed breast reconstruction surgery	704 (12.8)	578 (8.9)	<0.001

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

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. While information on recurrence is not yet available on a population basis, our group are currently testing methods to obtain data on recurrence.

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 3
Factors associated with the likelihood a woman with a T1 ($\leq 20\,mm$) breast tumour received breast conserving surgery.

	Odd ratio (95%CI)	p-value
Age group		
<40	0.63 (0.53−0.76)	
40−49	0.82 (0.74−0.91)	
50−69	Ref	<0.001
70−79	0.68 (0.61−0.76)	
80+	0.32 (0.27−0.37)	
Indigenous status		
Non-Indigenous	Ref	0.34
Indigenous	0.88 (0.67−1.15)	
Socioeconomic status		
Affluent	Ref	
Middle	0.88 (0.78−0.99)	0.09
Disadvantaged	0.91 (0.78−1.05)	
Residential location		
Major city	Ref	
Inner regional	0.63 (0.57−0.69)	<0.001
Outer regional/remote/very remote	0.62 (0.55−0.70)	
Charlson comorbidity		
0−1	Ref	<0.001
2+	0.62 (0.51−0.75)	
Overall stage		
Localised	Ref	
Regional	0.47 (0.43−0.52)	<0.001
Distant	0.56 (0.35−0.90)	
Unknown	1.55 (1.29−1.86)	
Type of hospital		
Private	Ref	<0.001
Public	0.63 (0.58−0.68)	
Hospital volume		
High (≥ 15/year)	Ref	<0.001
Low (<15/year)	0.66 (0.55−0.79)	
Diagnosis period		
2007−2011	Ref	0.88
2012−2016	1.01 (0.93−1.09)	

Notes: Model additionally adjusted for within hospital clustering.

results [23,24]. While the exact reason for this differential are unclear, it has been suggested the higher rates of MDT meetings in high-volume hospitals likely results in greater discussion of the best options for surgical management [25]. However, in Queensland, MDT meetings are usually held after initial surgery so would not necessarily influence BCS or mastectomy rates in this study. Several studies have found increased BCS rates for surgeons who perform more than 10 BCS procedures per year [19,26], however, we were unable to measure individual surgeon characteristics with our data.

Overall, 19% of women who had BCS required a re-excision with a small but significant reduction in this rate over time. These results are similar to a US study which found a reduction in re-excision rates post introduction of a "no tumour on ink" consensus guideline [27]. We also observed a small, but again significant reduction in rates of BCS conversion to mastectomy. Again, the reductions we observed are similar to those observed in other studies [28,29]. Changes in surgical practice (such as definition of adequate margins) likely explain the reductions in re-excision rates and conversion to mastectomy. While it could be argued the changes may reflect variation in patient population over time, we did not observe any change in BCS rate nor in the distribution of clinical factors over time.

We observed an increase in the use of adjuvant intravenous systemic therapy for women 70 years or less with positive lymph nodes, similar to others [30,31]. A significant increase in the number of patients being discussed at MDTs over time was also observed. There is good evidence that MDTs result in improved decision-making, effective coordination of patient care, and better treatment [32]. The development of a web-based system (QOOL), by our group to support MDT activity is increasingly being used by clinicians primarily in the public sector. While MDT meetings

occur in the private sector, currently we are unable to capture all activity and we are continuing to work towards greater capture of that data.

For women whose first treatment was surgery, we did observe a reduction over time in the number who received their surgery within 45 days (QI 2.1). While this reduction was only small (approximately 2%), and over 96% of both cohorts received their first surgery within 60 days, any delay in beginning treatment can cause increasing anxiety in patients. While we are unable to identify the exact reasons for this finding, issues around timely access to specialist care, lack of social support, and/ or other factors likely play a role. A French population-based study found difficulties in accessing social support for women contributed to surgical delays [33].

4.1. Using the BCQI to inform clinical practice

In Queensland, BCQI reports are distributed to each hospital as well as a broad cross-section of health professionals, professional bodies and national cancer organisations. Hospital reports are individualised, and each hospital can compare their results with the aggregated state results as well as hospital peer groups. For example, large referral hospitals are able to compare their results with other referral hospitals and hospitals with similar patient capacity and infrastructure are able to compare results with their peers. Clinicians and administrators are encouraged to discuss information contained within the report with colleagues in the context of the services that their hospital delivers. It is intended that the practice indicators provide useful information to assist with identifying services which are performing well as well as those that may benefit from improvement.

Work is ongoing to include new indicators as suggested by clinician groups including those relating to complications. For example, in consultation with breast and plastic and reconstructive surgeons, we are currently exploring options to develop new indicators for complications following breast reconstruction.

In a broader context the BCQI is underpinned by the availability of a comprehensive set 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].

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 from a variety of sources. As cancer is a notifiable disease in each Australian State and Territory, ascertainment is high. Approximately 91% of all cancer notifications had histological verification. While cancer stage is not routinely included in most Australian cancer registries, breast cancer stage has been routinely collected for several years. A further strength of BCQI is the use of population-based data which is not dependent on voluntary reporting.

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 we were 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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References

[1] International Agency for Research on Cancer (IARC), Globocan: Cancer Today, 2018. Available from: https://gco.iarc.fr/today/home. (Accessed 24 October 2020).

[2] M.R. Del Turco, A. Ponti, U. Bick, L. Biganzoli, G. Cserni, B. Cutuli, et al., Quality indicators in breast cancer care, Eur. J. Cancer 46 (13) (2010) 2344–2356.

[3] S. Stordeur, F. Vrijens, S. Devriese, K. Beirens, E. Van Eycken, J. Vlayen, Developing and measuring a set of process and outcome indicators for breast cancer, Breast 21 (3) (2012) 253–260.

[4] H. Mukai, T. Higashi, M. Sasaki, T. Sobue, Quality evaluation of medical care for breast cancer in Japan, Int. J. Qual. Health Care 28 (1) (2016) 110–113.

[5] Cancer Australia, Clinical practice guidelines. Available from: https://canceraustralia.gov.au/publications-and-resources/clinical-practice-guidelines. (Accessed 24 October 2020).

[6] E.T. Walpole, D.E. Theile, S. Philpot, P.H. Youl, Q. for Cancer Alliance, Development and implementation of a cancer quality index in Queensland, Australia: a tool for monitoring cancer care, J. Oncol. Pract. 15 (7) (2019) e636–e643.

[7] Cancer Quality Council of Ontario, Cancer System Quality Index (CSQI), 2017. Available at: http://www.csqi.on.ca/ Accessed 24 October 2020.

[8] K.M. Duvalko, M. Sherar, C. Sawka, Creating a system for performance improvement in cancer care: cancer care Ontario's clinical governance framework, Cancer Control 16 (4) (2009) 293–302.

[9] A. Greenberg, H. Angus, T. Sullivan, A.D. Brown, Development of a set of strategy-based system-level cancer care performance indicators in Ontario, Canada, Int. J. Qual. Health Care 17 (2) (2005) 107–114.

[10] Queensland Government, Queensland breast cancer quality index: practice indicators of safe, quality cancer care. Public and Private Hospitals 2007–2016, Queensland Health, Brisbane, 2019.

[11] Queensland Government, Queensland cancer quality index: indicators of safe, quality cancer care. Cancer Care in Public and Private Hospitals 2005–2014, Queensland Health, Brisbane, 2017. Available from, https://qccat.health.qld.gov.au/reports-publications/.

[12] Australian Institute of Health & Welfare, Australian Classification of Health Interventions eleventh ed., https://meteor.aihw.gov.au/content/index.phtml/itemId/699613. (Accessed 24 October 2020).

[13] Australian Bureau of Statistics, Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure 2011, ABS, Canberra, 2013.

[14] Australian Bureau of Statistics, Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia, ABS, Canberra, 2011. Available from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2033.0.55.001~2011~Main%20Features~Main%20Page~1, (Accessed 24 October 2020).

[15] Breast Surgeons of Australia and New Zealand Inc, Breast SurgANZ quality audit. Available from https://www.bqa.org.au/ (Accessed 22 October 2020).

[16] S.Y. Brucker, C. Schumacher, C. Sohn, M. Rezai, M. Bamberg, D. Wallwiener, et al., Benchmarking the quality of breast cancer care in a nationwide voluntary system: the first five-year results (2003–2007) from Germany as a proof of concept, BMC Cancer 8 (2008) 358.

[17] M. McCarthy, A. Gonzalez-Izquierdo, C. Sherlaw-Johnson, A. Khachatryan, M.P. Coleman, B. Rachet, Comparative indicators for cancer network management in England: availability, characteristics and presentation, BMC Health Serv. Res. 8 (2008) 45.

[18] E.C. Schneider, J.L. Malin, K.L. Kahn, E.J. Emanuel, A.M. Epstein, Developing a system to assess the quality of cancer care: ASCO's national initiative on cancer care quality, J. Clin. Oncol. 22 (15) (2004) 2985–2991.

[19] D. Roder, H. Zorbas, J. Kollias, C. Pyke, D. Walters, I. Campbell, et al., Factors predictive of treatment by Australian breast surgeons of invasive female breast cancer by mastectomy rather than breast conserving surgery, Asian Pac. J. Cancer Prev. 14 (1) (2013) 539–545.

[20] M. Lautner, H. Lin, Y. Shen, C. Parker, H. Kuerer, S. Shaitelman, et al., Disparities in the use of breast-conserving therapy among patients with early-stage breast cancer, JAMA Surg. 150 (8) (2015) 778–786.

[21] M.O. Celaya, J.R. Rees, J.J. Gibson, B.L. Riddle, E.R. Greenberg, Travel distance and season of diagnosis affect treatment choices for women with early-stage breast cancer in a predominantly rural population (United States), Cancer Causes Control 17 (6) (2006) 851–856.

[22] J. Gu, G. Groot, C. Boden, A. Busch, L. Holtslander, H. Lim, Review of factors influencing women's choice of mastectomy versus breast conserving therapy in early stage breast cancer: a systematic review, Clin. Breast Cancer 18 (4) (2018) e539–e554.

[23] C.S. Chen, T.C. Liu, H.C. Lin, Y.C. Lien, Does high surgeon and hospital surgical volume raise the five-year survival rate for breast cancer? A population-based study, Breast Cancer Res. Treat. 110 (2) (2008) 349–356.

[24] P. Peltoniemi, M. Peltola, T. Hakulinen, U. Hakkinen, L. Pylkkanen, K. Holli, The effect of hospital volume on the outcome of breast cancer surgery, Ann. Surg. Oncol. 18 (6) (2011) 1684–1690.

[25] J.H. Chang, E. Vines, H. Bertsch, D.L. Fraker, B.J. Czerniecki, E.F. Rosato, et al., The impact of a multidisciplinary breast cancer center on recommendations for patient management: the University of Pennsylvania experience, Cancer 91 (7) (2001) 1231–1237.

[26] D.L. Hershman, D. Buono, J.S. Jacobson, R.B. McBride, W.Y. Tsai, K.A. Joseph, et al., Surgeon characteristics and use of breast conservation surgery in women with early stage breast cancer, Ann. Surg. 249 (5) (2009) 828–833.

[27] K. Kaczmarski, P. Wang, R. Gilmore, H.N. Overton, D.M. Euhus, L.K. Jacobs, et al., Surgeon Re-excision rates after breast-conserving surgery: a measure of low-value care, J. Am. Coll. Surg. 228 (4) (2019) 504–512, e2.

[28] M.T. van Leeuwen, M.O. Falster, C.M. Vajdic, P.J. Crowe, S. Lujic, E. Klaes, et al., Reoperation after breast-conserving surgery for cancer in Australia: statewide cohort study of linked hospital data, BMJ Open 8 (4) (2018), e020858.

[29] M. Morrow, P. Abrahamse, T.P. Hofer, K.C. Ward, A.S. Hamilton, A.W. Kurian, et al., Trends in reoperation after initial lumpectomy for breast cancer: addressing overtreatment in surgical management, JAMA Oncol. 3 (10) (2017) 1352–1357.

[30] C.A. Puig, T.L. Hoskin, C.N. Day, E.B. Habermann, J.C. Boughey, National trends in the use of neoadjuvant chemotherapy for hormone receptor-negative breast cancer: a national cancer data base study, Ann. Surg. Oncol. 24 (5) (2017) 1242–1250.

[31] A.K. Imkampe, T. Bates, Improvements in breast cancer survival over time, related to adjuvant treatment and node status, Eur. J. Surg. Oncol. 35 (2) (2009) 151–155.

[32] C. Dubois, H. De Schutter, R. Leroy, S. Stordeur, C. De Gendt, V. Schillemans, et al., Multidisciplinary work in oncology: population-based analysis for seven invasive tumours, Eur. J. Cancer Care (Engl) 27 (2) (2018), e12822.

[33] S. Ayrault-Piault, P. Grosclaude, L. Daubisse-Marliac, J. Pascal, C. Leux, E. Fournier, et al., Are disparities of waiting times for breast cancer care related to socio-economic factors? A regional population-based study (France), Int. J. Cancer 139 (9) (2016) 1983–1993.

[34] C.E. Desch, K.K. McNiff, E.C. Schneider, D. Schrag, J. McClure, E. Lepisto, et al., American society of clinical oncology/national comprehensive cancer network quality measures, J. Clin. Oncol. 26 (21) (2008) 3631–3637.

[35] L. Biganzoli, L. Marotti, C.D. Hart, L. Cataliotti, B. Cutuli, T. Kuhn, et al., Quality indicators in breast cancer care: an update from the EUSOMA working group, Eur. J. Cancer 86 (2017) 59–81.

[36] P.A. van Dam, M. Tomatis, L. Marotti, J. Heil, R.E. Mansel, M. Rosselli Del Turco, et al., Time trends (2006–2015) of quality indicators in EUSOMA-certified breast centres, Eur. J. Cancer 85 (2017) 15–22.

[37] H. Bao, F. Yang, X. Wang, S. Su, D. Liu, R. Fu, et al., Developing a set of quality indicators for breast cancer care in China, Int. J. Qual. Health Care 27 (4) (2015) 291–296.

[38] S. Nietz, P. Ruff, W.C. Chen, D.S. O'Neil, S.A. Norris, Quality indicators for the diagnosis and surgical management of breast cancer in South Africa, Breast 54 (2020) 187–196.