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EPIDEMIOLOGY

European quality indicators developed by the European Commission Initiative on Breast Cancer: a first nationwide assessment for the Dutch setting

Kay Schreuder[1,2] · Tim J. Bult[2] · Babet Stroop[2] · Linetta B. Koppert[3] · Rhodé M. Bijlsma[4] · Enja J. Bantema-Joppe[5] · Marije J. Hoornweg[6] · Sabine Siesling[1,2]

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Abstract

Purpose This observational study aims to assess the feasibility of calculating indicators developed by the European Commission Initiative on Breast Cancer (ECIBC) for the Dutch breast cancer population.

Methods Patients diagnosed with invasive or in situ breast cancer between 2012 and 2018 were selected from the Netherlands Cancer Registry (NCR). Outcomes of the quality indicators (QI) were presented as mean scores and were compared to a stated norm. Variation between hospitals was assessed by standard deviations and funnel plots and trends over time were evaluated. The quality indicator calculator (QIC) was validated by comparing these outcomes with the outcomes of constructed algorithms in Stata.

Results In total, 133,527 patients were included. Data for 24 out of 26 QIs were available in the NCR. For 67% and 67% of the QIs, a mean score above the norm and low or medium hospital variation was observed, respectively. The proportion of patients undergoing a breast reconstruction or neoadjuvant systemic therapy increased over time. The proportion treated within 4 weeks from diagnosis, having >10 lymph nodes removed or estrogen negative breast cancer who underwent adjuvant chemotherapy decreased. The outcomes of the constructed algorithms in this study and the QIC showed 100% similarity.

Conclusion Data from the NCR could be used for the calculation of more than 92% of the ECIBC indicators. The quality of breast cancer care in the Netherlands is high, as more than half of the QIs already score above the norm and medium hospital variation was observed. The QIC can be easy and reliably applied.

Keywords Breast cancer · Quality of care · Benchmark · Privacy · Legal issue

Introduction

Recent studies demonstrated that treatment of breast cancer patients within an interdisciplinary breast cancer service was associated with benefits in terms of quality of life and survival [1]. In 2016, the European Parliament

Tim J. Bult and Babet Stroop have contributed equally to this work.

✉ Kay Schreuder
k.schreuder@iknl.nl

1 Department of Research and Development, Netherlands Comprehensive Cancer Organisation (IKNL), Enschede, The Netherlands

2 Department of Health Technology and Services Research (HTSR), Technical Medical Centre, University of Twente, Enschede, The Netherlands

3 Department of Surgery, Erasmus MC Cancer Institute, Rotterdam, The Netherlands

4 Department of Medical Oncology, University Medical Center Utrecht, Utrecht, The Netherlands

5 Department of Radiation Oncology, Radiotherapy Institute Friesland, Leeuwarden, The Netherlands

6 Department of Plastic and Reconstructive Surgery, The Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

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Resolution on Breast Cancer called member states to deliver a report on progress in quality of care within these (interdisciplinary) breast cancer services. To determine this, it was necessary to define a set of quality indicators (QIs) covering the complexity, interdisciplinarity, and variety of treatments [1]. QIs are standardized measures to determine health care outcomes and can be subdivided into three types of indicators using the Donabedian framework: structure, process, and outcome [2]. The QIs should be routinely measured and can be used for monitoring trends over time, comparisons to norms for certification purposes, and to benchmark between breast cancer services.

An European initiative to assess the quality of the delivered breast cancer care is the European Society of Breast Cancer Specialists (EUSOMA). EUSOMA is a non-profit society founded in 1986 by a group of breast cancer specialists, who started a voluntary certification to assess the clinical performance in breast cancer services [1, 3]. To confirm clinical outcomes were met, the EUSOMA developed QIs for breast cancer to create an agreed minimum standard of care and also to establish a benchmark [3]. In total, 17 QIs have been identified; seven on diagnosis, four on surgery and locoregional treatment, two on systemic treatment, and four on staging, counseling, follow-up, and rehabilitation. The QIs have been developed by taking into account the usability and feasibility, without increasing the registration burden [3].

To further improve the quality of breast cancer care, the European Commission initiated the European Commission Initiative on Breast Cancer (ECIBC) to develop evidence- and consensus-based requirements and a quality assurance (QA) scheme for the entire pathway of breast cancer care [4]. The Joint Research Centre (JRC) provides the European Commission with independent scientifically substantiated information and has been mandated with developing the QA scheme. This QA scheme, constructed within Quality Assurance Scheme Development Group (QASDG), aims to assess whether requirements are being met by using qualitative and quantitative QIs and site visits [5, 6]. The QASDG consists of medical doctors, researchers, and patients representatives and is building on EUSOMA initiatives. Consensus on requirements and reports was achieved by using the Delphi method and resulted in 55 QIs to measure the quality of care for patients with invasive and/or in situ breast cancer in hospitals across Europe. The breast cancer service will be able to assess their own outcomes of the QIs automatically from their own patient level data with use of the Quality Indicator Calculator (QIC). The QIC is an IT tool that can be installed locally on a computer at the breast cancer service. Moreover, for benchmark purposes, it is not necessary to transfer identifiable patient data outside the breast cancer service and information is exchanged only on indicator aggregated level, which complies the vision of the General Data Protection Regulation (GDPR).

Until now, the QIs have not been calculated based on real world data and no validation of the QIC has been performed. Therefore, the aim of the current study was to assess the feasibility of calculating the indicators for the Dutch breast cancer population, to determine the deviation from the norm, variation between Dutch hospitals, trends over time, and to validate the QIC.

Material and methods

Design

For this retrospective observational study, female patients aged over 18 years diagnosed with invasive or in situ breast cancer between 2012 and 2018 in the Netherlands were selected from the Netherlands Cancer Registry (NCR). The NCR is managed by the Netherlands Comprehensive Cancer Organisation (IKNL) and contains data on patient characteristic, diagnosis, treatment, and survival of all cancer patients diagnosed in the Netherlands [7]. Diagnosis of new malignancies is electronically notified to the NCR by the pathology database (PALGA) and medical registrations of hospitals. Additional information on diagnosis, treatment, and follow-up is registered by trained data managers directly from the patients files [7]. All patients with prior ipsilateral breast cancer (invasive and/or in situ) were excluded for this study. For each QI, different in- and exclusion criteria were defined and patients were selected accordingly. In total, 75 Dutch hospitals (97%) were included. Hospitals merged during the study period (2012–2018) were considered as one over all included years.

Definition of the indicators

The QASDG constructed 55 QIs of which only process and outcome indicators ($N = 26$) were included in this study. Each QI was assigned to a main subject; three on general (QIs 5, 6, 17), one on diagnosis (QI 20), ten on surgery (QIs 21, 22, 23, 24, 25, 26, 27, 28, 29, 30), nine on systemic treatment (QIs 31, 32, 33, 35, 36, 37, 38, 39, 40), and three on radiotherapy (QIs 42, 43, 44) (Online Appendix A, Table A1). The rationale of all QIs (with relevant scientific references) are listed in Online Appendix A (Table A2).

Statistical analyses

A data dictionary containing variable names, data formats, and codes for each variable necessary for computing QIs was provided by the QASDG. It also included references to the classification or standard that were used (e.g., ICD-O-3,

Table 1. Summary table of the results on all calculated quality indicators, constructed by the QASDG, for patients with primary invasive and/or in situ breast cancer diagnosed in the Netherlands from 2012 to 2018

Indicator	Name	Category	Norm%	2012		2014		2016		2018	
				Mean	St.dev.	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
5	Multidisciplinary team	General	≥90	85%	10%	86%	8%	87%	9%	86%	8%
6	Lead time (diagnosis to treatment)	General	≥90	61%	15%	60%	15%	58%	13%	50%	13%
17	Nurse referral	General	≥95	x	x	x	x	x	x	x	x
20	Biomarkers	Diagnosis	≥95	97%	4%	96%	5%	96%	7%	97%	5%
21	Sentinel lymph node biopsy	Surgery	≥90	97%	3%	97%	2%	97%	3%	96%	5%
22	Axillary lymph node dissection (invasive)	Surgery	≥80	98%	3%	99%	1%	99%	2%	99%	1%
23	Axillary lymph node dissection (DCIS)	Surgery	≥95	x	x	100%	2%	100%	0%	100%	1%
24	Axillary lymph node dissection (10-nodes)	Surgery	≥90	91%	8%	90%	8%	79%	20%	78%	24%
25	Breast-conserving surgery (DCIS)	Surgery	≥80	x	x	81%	15%	85%	12%	86%	12%
26	Breast-conserving surgery (invasive)	Surgery	≥70	71%	11%	72%	9%	75%	9%	78%	9%
27	Single breast operation (DCIS)	Surgery	≥70	85%	9%	90%	7%	89%	9%	91%	7%
28	Single breast operation (invasive)	Surgery	≥80	94%	3%	95%	3%	96%	2%	96%	2%
29	Breast reconstruction (immediate)	Surgery	M*	11%	8%	31%	17%	35%	17%	36%	17%
30	Breast reconstruction (delayed)	Surgery	M*	x	x	x	x	x	x	x	x
31	Lead time chemotherapy	Systemic	≥80	88%	10%	91%	10%	88%	17%	88%	15%
32	Estrogen negative adjuvant chemotherapy	Systemic	≥85	69%	12%	66%	19%	55%	22%	45%	26%
33	Neoadjuvant anti-HER2 therapy	Systemic	≥90	93%	15%	94%	14%	95%	15%	98%	7%
35	Hormone sensitive endocrine therapy	Systemic	≥85	68%	6%	67%	8%	65%	8%	62%	9%
36	Triple negative neoadjuvant chemotherapy	Systemic	M*	20%	15%	37%	25%	40%	23%	56%	21%
37	HER2+ neoadjuvant systemic therapy	Systemic	M*	26%	21%	34%	21%	46%	21%	63%	19%
38	Locally advanced	Systemic	≥90	27%	15%	39%	19%	42%	18%	46%	16%
39	ER+ HER2- metastatic breast cancer	Systemic	≥50	70%	24%	70%	22%	73%	21%	74%	20%
40	HER2+ anti-HER2 therapy	Systemic	≥90	90%	17%	90%	22%	93%	14%	96%	9%
42	Lead time radiotherapy	Radiotherapy	≥80	91%	7%	94%	4%	94%	4%	90%	9%
43	BCS adjuvant radiotherapy (whole or partial breast)	Radiotherapy	≥90	95%	7%	95%	6%	95%	7%	91%	7%
44	Mastectomy radiotherapy (local regional)	Radiotherapy	≥90	78%	20%	77%	21%	84%	20%	76%	24%

Structure indicators ($N = 29$) are excluded and only outcome and process indicators ($N = 26$) are included in this table

M * = This is a monitoring indicator without a norm

x = Data not available in the NCR

TNM8, etc.). Furthermore, also a manual was provided consisting of descriptions, definitions, eligible criteria, denominators, numerators, and a norm for all 55 QIs.

First, data from the NCR were renamed and recoded to comply with the data requirements listed in the data dictionary. Subsequently, the QI calculations (eligible criteria, numerators, and denominators), provided in descriptive text, were converted to algorithms. Indicators were calculated by dividing a numerator by the denominator and were expressed as scores between 0 and 100%. Each score was a percentage of registered patients in year 'X' at hospital 'A' in the Netherlands who fulfilled the description of the numerator

and met the eligible criteria of the specific indicator. Mean scores per indicator were presented in a summary table and were compared to the stated norm. The variation between Dutch hospitals per year was represented by the standard deviation (SD). Low variation was defined as an average SD ≤ 5%, medium variation was defined as an average SD between 5 and 15% over, and large variation was defined as an average SD>15% over all included years. In addition, these results were visualized by funnel plots for 2012 and 2018 to represent the variation over time between hospitals with 95% confidence intervals included. Hospitals displayed outside the 95% confidence intervals in the funnel plots were considered to be statistically significant deviating from the mean value (based on all hospitals). Mean scores per year (2012, 2014, 2016, and 2018) were assessed to reveal trends over time.

Finally, a validation was performed by comparing the outcomes of the constructed quality indicators in the current study and the outcomes of the indicators calculated by the QIC. The QIC was downloaded on a local server. As the number of patients that could be imported in the QIC was limited to a maximum of 900 patients, a subset of patients diagnosed with breast cancer in 2018 was generated. This selection was made by randomly assigning a number varying between 0 and "the total number of patients diagnosed in 2018" to every patient diagnosed in 2018. Only patients with a number assigned lower than 900 were included. All analyses were performed in STATA (version 13.1 2013, Texas).

Results

In total, 133,527 patients were diagnosed with primary invasive (n= 109,623) or in situ breast cancer (n = 23,904) in the Netherlands between 2012 and 2018 in one of the 75 included hospitals. Out of 26 QIs, 24 (92%) could be calculated based on the data from the NCR. The other two indicators, nurse care (QI 17) and delayed breast reconstruction (QI 30), could not be calculated due to lack of data. The mean score and (if applicable) a norm of the QIs are presented in Table 1.

Norm

A norm is set for 21 out of the 24 QIs that could be calculated. Out of the 21 QIs, 14 have a mean score above the norm. From these indicators, one is related to diagnosis (QI 20), seven related to surgery (QIs 21, 22, 23, 25, 26, 27, 28), four related to systemic treatment (QIs 31, 33, 39, 40), and two indicators are related to radiotherapy (QIs 42, 43) (Table 1). For example, the mean score of QI 20 (the collection of biomarkers) is 97% with a norm of 95%.

Seven out of the 21 QI show mean score below the norm. From these indicators, two are general indicators (QIs 5, 6), one is a surgery indicator (QI 24), three are systemic treatment indicators (QIs 32, 35, 38) and one is a radiotherapy indicator (QI 44). For example, the mean outcome of QI 5 (multidisciplinary team) is 86% with a norm of 90%. Three out of the 24 QIs are considered to be monitoring indicators as no norm have been defined by the QASDG. From these indicators, one is a surgery indicator (QI 29) and two are systemic treatment indicators (QIs 36, 37).

Variation between hospitals

Variation between hospitals for all indicators is visualized in Online Appendix A and corresponding SDs are listed in Table 1. Four out of the 24 indicators show little variation between hospitals (average SD ≤5%). All these indicators (QIs 21, 22, 23, 28) are surgical indicators. For example, QI 21 (the use of a sentinel lymph node biopsy) is characterized by a SD varying between 2 and 5% for all included years. Even smaller variation is found for QI 23 (the use of an axillary lymph node biopsy for DCIS) as the SD does not exceed the 2% for all years (Table 1). As a consequence, only a limited number of hospitals are visualized outside the 95% confidence interval in the funnel plots for both indicators (Online Appendix A, QIs 21, 23).

Medium variation between hospitals (average SD between 5 and 15%) is observed for 12 out of the 24 indicators. From these indicators, two are general indicators (QIs 5, 6), one is a diagnosis indicator (QI 20), four are surgical indicators (QIs 25, 26, 27, 29), three are systemic treatment indicators (QIs 31, 33, 35), and two are radiotherapy indicators (QIs 42, 43). For example, QI 5 (the existence of a multidisciplinary team meeting) and QI 33 (the use of neoadjuvant anti-HER2 therapy) are characterized with SDs varying between 8 and 10% and 7 and 15% for all years, respectively (Table 1). For indicator 29 (the use of breast reconstruction (immediate)), higher variation between hospitals is observed in 2018 (SD of 17%) compared to 2012 (SD of 8%) (Table 1; Fig. 1).

Finally, eight out of the 24 indicators show large variation between hospitals (average SD ≥15%). From these indicators, one is a surgery indicator (QI 24), six are systemic treatment indicators (QIs 32, 36, 37, 38, 39, 40), and one is a radiotherapy indicator (QIs 44). For example, QI 36 (the use of neoadjuvant chemotherapy for triple negative breast cancer) shows a SD of 15, 25, 23, and 21% for 2012, 2014, 2016, and 2018, respectively. Indicator 24 (the removal of ≥ 10 nodes during axillary lymph node dissection) and 32 (the use of estrogen negative adjuvant chemotherapy) both differ from the other indicators with large variation as these show increasing values on SD over time, respectively, 8, 8, 20, and 24% for indicator 24 and 12, 19, 22, and 26% for indicator 32 (Table 1; Figs. 2 and 3). For QI 40 (HER2+ breast cancer

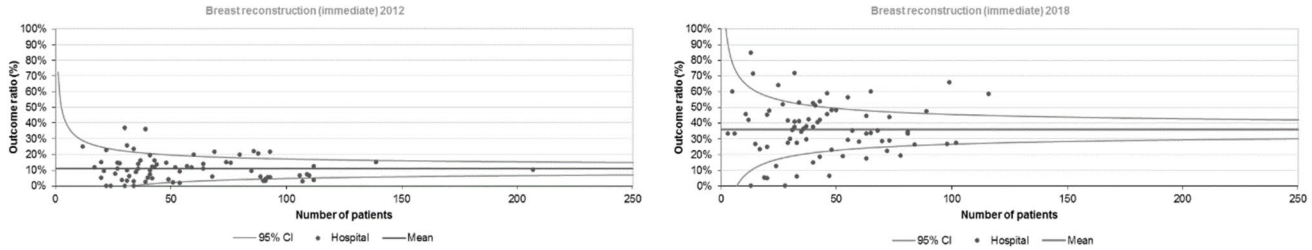

Fig. 1 Breast reconstruction (immediate; QI 29) in 2012 (left) and 2018 (right)

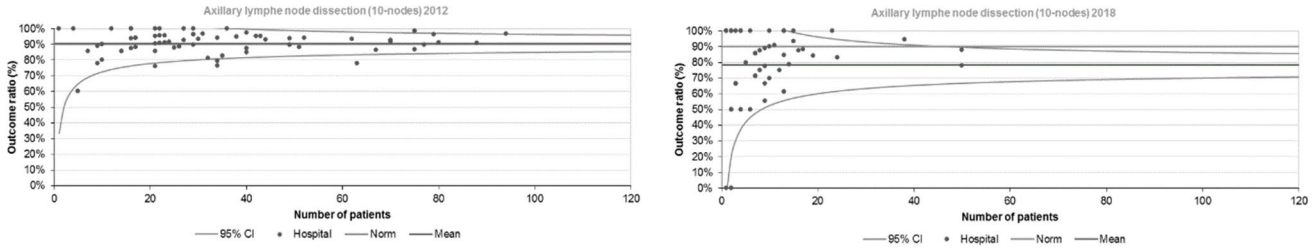

Fig. 2 Axillary lymph node dissection (10-nodes, QI 24) in 2012 (left) and 2018 (right)

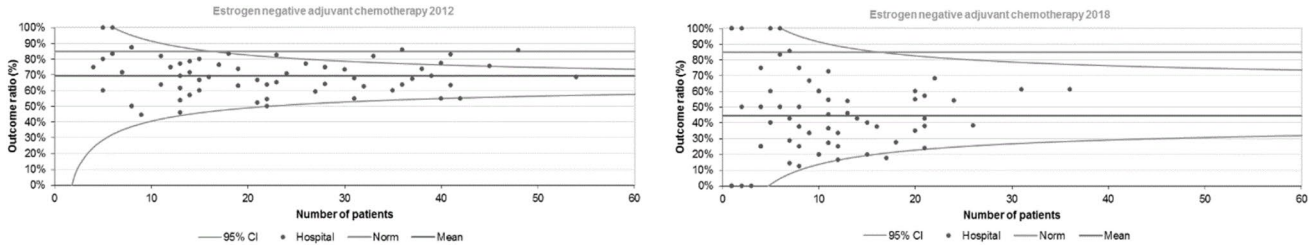

Fig. 3 Estrogen negative adjuvant chemotherapy (QI 32) in 2012 (left) and 2018 (right)

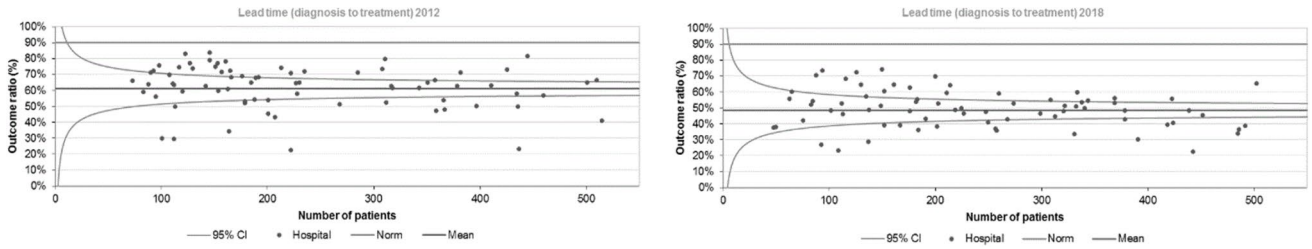

Fig. 4 Lead time (diagnosis to treatment, QI 6) in 2012 (left) and 2018 (right)

treated with neoadjuvant anti-HER2 therapy), a decrease in variation over time was observed reflected by a SD of 17% in 2012 to 9% in 2018.

Mean score over time

Indicators for surgery (QI 29) and systemic treatment (QIs 36, 37, 38) show a mean score that is increasing over the years 2012–2018 (Table 1). For example, an almost threefold increase of the mean score is found for indicator 29 (the use of breast reconstruction (immediate)) from 11% (2012) to 36% (2018) (Table 1; Fig. 1). Indicator 6 (the lead time between diagnosis and start of treatment) shows a mean score that is decreasing over the years from 61 to 50% (Table 1; Fig. 4). Indicator 24 (the removal of ≥10 nodes during axillary lymph node dissection) and 32 (the use of estrogen negative adjuvant chemotherapy) both show a decreasing mean score. For these indicators, the mean scores

decrease from 91 to 78% and 6% to 45% (Figs. 2 and 3) over the years 2012–2018, respectively.

Validation of the QIC

Based on a random selection, a subset is generated with 896 patients diagnosed in 2018 with primary invasive ($n = 778$) or in situ breast cancer ($n = 118$) and this set is used to validate the QIC. The numerator, denominator, and the outcome of all 24 indicators show 100% similarity between the results of the constructed algorithms in the current study and the outcomes of the validation provided using the QIC.

Discussion

This study shows the feasibility of data from the NCR to calculate 24 out of 26 recently developed QASDG breast cancer QIs. Moreover, this study provides insight in the outcomes of these QIs for all patients diagnosed with primary invasive and/or in situ breast cancer diagnosed in 75 Dutch hospitals. More than half of the QIs show a mean score above the norm and for most QIs medium hospital variation is observed, reflecting the high quality of breast cancer care in the Netherlands.

In general, it is assumed that indicators and guidelines could positively influence the outcomes of QIs and mean scores above the norm reflect hospitals lived up to the agreed minimum standard of care established [1, 8]. Moreover, feedback and benchmark of indicator outcomes at hospital level could also limit the variation between hospitals. Inconsistencies, or adjustments in indicators could possibly cause variation [8, 9]. It is important to interpret indicator scores and variation cautiously, especially if the assessed indicators have not been tested and/or adjusted for validity and reliability [10, 11]. Furthermore, inconsistencies or limited level of evidence of guideline recommendations can also increase variation, which has to be reduced in case this variation leads to inferior outcomes.

Quality of breast cancer care in the Netherlands is supported by the NABON Breast Cancer Audit (NBCA, initiated in 2011), which is an initiative to assess and, where necessary, to increase the quality of the delivered breast cancer care in Dutch hospitals [12]. Evidence- and consensus-based indicators were constructed and used to assess Dutch guideline adherence. The outcomes of the indicators were discussed within hospitals and regional tumor networks to discuss on possible improvements. Some overlap exists in the indicators included in the NBCA and the indicators constructed by the QASDG. A major difference between the NBCA and the QASDG indicator set lies in the inclusion criteria, wherein the NBCA only includes patients subjected to surgical procedures, whereas the QASDG includes both surgically and non-surgically treated patients. Furthermore, certain differences in inclusion criteria between NBCA and QASDG indicators increased the complexity in comparing outcomes.

The effect of already related existing NBCA QIs is well observable in the proportion of breast cancers for which the biomarkers are collected, as mean scores over the norm of 95% (set by the QASDG) and limited hospital variation are found in the current study. Scientific research shows that ER and PR receptors and HER2 status should be measured on all newly diagnosed breast cancer patients to optimize personalized treatment [13]. A comparable QI has been part of the NBCA indicator set for some years, which could explain the already high mean scores and limited variation for this QASDG indicator. However, a mean score below the norm was observed for the QI assessing the lead time between diagnosis and start of primary treatment. It is expected that this lower mean score is related to differences in indicator definitions. The already existing EUSOMA and NBCA indicator wields a maximum of six and five weeks from the first diagnostic examination to the date of primary treatment, respectively, whereas the new indicator in the current study states a stricter maximum of four weeks [3, 12]. As a consequence, less patients fulfill this stricter requirement explaining the lower mean score (far below the norm) found in this study.

In general, high mean scores above the norm and limited variation between hospitals are found for almost all surgical indicators. Most probably this could be explained by the fact that at start of the NBCA in 2011, most indicators were related to surgical procedures. However, an example of a surgical QI showing a decline in mean score and an increase in hospital variation over time is the removal of lymph nodes. It is expected that these findings could be related to recent adjustments in recommendations. Nowadays, removal of 10 or more lymph nodes may no longer be the minimum yield to be considered a good surgery in the Netherlands. Removing a lower number lymph nodes should result in fewer surgical side effects and ultimately improve the quality of life for the patient without compromising the oncological safety [14]. With regard to the QASDG indicator focusing on re-operation for DCIS, it is worth noting that these indicators encompass both patients who underwent breast-conserving surgery and mastectomy. Consequently, the percentage of patients who underwent only one operation appears higher compared to the percentage of resection-free margins observed based on NBCA data, where only patients who underwent breast-conserving surgery are included [12].

Compared to the outcomes of the surgical QIs, lower mean scores and higher variation between hospitals are found for indicators related to systemic treatments. Due to recent developments in systemic treatments and changed recommendation in Dutch guidelines accordingly, relevant

indicators have been constructed and included in the NBCA some years after the initial implementation of surgical indicators. As a consequence, the observed variation between hospitals for these indicators is larger. Though, as observed in this study, the variation decreases and mean scores increase over time for these indicators. As surgery is considered as standard treatment in curative breast cancer and systemic treatment is often complementary, for which personal choices, performance status, and shared decision making may be even more relevant in systemic therapy use, possibly causing the higher variation observed. Lower mean scores of systemic QIs could also be attributed to differences in indicator definitions. The proportion of patients with hormone sensitive breast cancer who were prescribed endocrine therapy, for example, scores below 70%, while the norm (set by the QASDG) is ≥85%. This deviation from the norm for Dutch patients could be explained by the fact in the Dutch guidelines endocrine therapy is recommended, but the corresponding eligible criteria are more specific than required by the QASDG. For example, based on the QASDG recommendation, all surgically treated women with hormone sensitive invasive M0 breast cancer are eligible for endocrine therapy. Whereas based on Dutch guidelines, this recommendation is further specified: tumor size should also be larger than 2cm (grade 1) or 1cm (grade 2/3) and/or the presence of lymph node involvement. Furthermore, no indicator on endocrine therapy has been included in the NBCA. Additionally, the outcome of the indicator associated with adjuvant chemotherapy for estrogen negative breast cancer was surprising, as a declining trend over time was observed. This could be attributed to the exclusion of patients treated with neoadjuvant chemotherapy in this indicator as there is an increasing use of neoadjuvant systemic therapy over time. Another indicator, the use of neoadjuvant systemic therapy for locally advanced breast cancer, demonstrated lower outcomes compared to the specified norm. This deviation from the norm can be attributed to the use of data up to 2018, as more recent data have revealed more favorable outcomes.

In general, the QIs focusing on radiotherapy score above the norm with only limited variation. The only exception is the proportion of locoregional radiotherapy after a mastectomy, where the stated norm set by the QASDG of 90% was not met. This finding is in line with a previous Dutch study where higher post-mastectomy radiotherapy rates were expected [15] as this resulted in significantly reduced recurrence rates, improved disease-specific and overall survival for intermediate and high risk patients and therefore it should be considered for these patients according to Dutch Guidelines [16–18].

Finally, for all indicators without a norm, an increasing mean scores (improved quality) over time is observed in this study. Although no specific quality target is set for either of these indicators, it is considered important to monitor them and gain insight in factors influencing them. For instance, patients desire immediate reconstruction of their body shape after mastectomy more often which increases their quality of life, but is influenced by hospital factors such as attendance of a plastic surgeon during the multidisciplinary team discussion [19]. The same holds true for the use of neoadjuvant systemic therapy, as an increase in mean score over time is observed. Research showed that disease-free and overall survival after neoadjuvant systemic therapy is equal to the use of adjuvant therapy [20]. However, neoadjuvant systemic therapy increases the rate of breast-conserving surgery, which improves quality of life [21]. Neoadjuvant systemic therapy can be used as a predictor of long-term outcomes and gives insight in prognostic information (for example response of a tumor to chemotherapy) in contrast to adjuvant trials, which do not show prognostic information until after 5 to 10 year follow-up [20].

The JRC has recently finished the QIC to calculate the indicators with predefined algorithms without transfer of data on patient level which is an important strength of the tool. In the current study, the tool has shown to be easily installed on a local server within the firewall protected environment of the Netherlands Comprehensive Cancer Organisation. Furthermore, it is demonstrated that the outcomes of the indicators calculated by the QIC are 100% similar with the calculated indicators based on constructed algorithms in Stata. Therefore, the QIC can be reliably used by hospitals all over Europe to assess and monitor their delivered quality of care.

Limitations

This study includes process and outcome indicators. Structure indicators ($N = 29$) are excluded because the data needed for these indicators are not collected in the NCR. Furthermore, also the indicators about nurse referral and delayed breast reconstruction could not be calculated for the same reason. Two hospitals are excluded in this study because their data were not collected by data managers of the NCR.

Moreover, the outcomes of the indicators reflect the practice in the Netherlands based on recommendations of the Dutch NABON guideline, which generally are more strict than recommendations in guidelines from other countries. This results in a stricter patient selection for some treatments which is seen in the QI outcomes. As a consequence, the results cannot be completely generalized to countries with more general guidelines than the Netherlands.

Conclusion

Data from the NCR could be used for the calculation of more than 92% of the indicators defined by the QASDG. The quality of breast cancer in the Netherlands is quite high, as

more than half of the QASDG indicators already showed a mean score above the norm and for most indicators little to medium hospital variation was observed. Changes over time were observed for different indicators and these changes could largely be attributed to the implemented guideline recommendations and existence of comparable NBCA quality indicators. Importantly, the QIC can be easy and reliably applied in breast cancer services.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10549-023-07158-w.

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Data availability The data that support the findings of this study are available from Netherlands Comprehensive Cancer. Organisation but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Netherlands Comprehensive Cancer Organisation.

Declarations

Conflict of interest None.

Ethics approval According to the Central Committee on Research involving Human Subjects (CCMO), this type of study does not require approval from an ethics committee in the Netherlands. This study was approved by the Privacy Review Board of the Netherlands Cancer Registry.

Consent to participate Not applicable.

Consent to publish Not applicable.

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