“Pattern comparison of Quality Indicators on a national and hospital level in the Netherlands and Norway”

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Master thesis in partial fulfillment of the requirements for the degree of the master(s) of Health Sciences, University of Twente. Commissioned by Comprehensive Cancer Organisation in the Netherlands and Cancer Registry of Norway.

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Date: 26 August 2018

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ABSTRACT

Introduction: In recent years, the quality of health care has become a subject of public debate. This has given rise to the need for hospitals to openly provide indicators of the quality of their diagnostics and treatment. Both the multidisciplinary NABON Breast cancer Audit in the Netherlands and the Norwegian Breast Cancer Quality Registry in Norway have established indicator sets.
Aim: This study aims to analyze six quality indicators, defined by the Dutch NABON Breast Cancer Audit, for both the Netherlands and Norway.
Material and Methods: All female patients diagnosed with ductal carcinoma in situ or Invasive breast cancer in the Netherlands and Norway between 2012 and 2016, were included. Six quality indicators were calculated and hospital performance of both countries was visualized with a funnel plot and given with a 95% confidence interval (CI). Case-mix correction for baseline characteristics of the patient (age and stage) were performed.
Results: Breast cancer care is given in 92 hospitals in the Netherlands. In Norway it is given in 65 hospitals, subdivided into 20 area hospitals. The Dutch data contains 78,126 breast tumors; 10,764 DCIS lesions and 67,362 invasive breast cancers. In Norway, the data contains 18,715 breast tumors; 1,753 DCIS lesions and 17,675 invasive breast cancers. The percentage of patients with unknown tumor resection margins in the first breast-conserving surgery (indicators 6 and 7) showed a higher average in Norway (DCIS 41.4% (95% CI 37-44), invasive breast cancer 14.2% (95% CI 14-15)) than in the Netherlands (DCIS 19.1% (95% CI 18-20), invasive breast cancer 1.5% (95% CI 1-2)). The percentage of patients who have conserved a breast contour after operative treatment for invasive M0 breast cancer showed a similar pattern for the Netherlands and Norway (indicator 8). Two sub-indicators showed a different pattern; patients who breast-saving treated after neo-adjuvant chemotherapy and the pattern of patients that have undergone a direct reconstruction following an ablative differ between the Netherlands and Norway. The remaining indicators (9,10 and 12) showed limited differences between the countries.
Conclusion: Case-mix adjustments reduce the variation in outcome of the four quality indicators in the Netherlands and Norway (indicator 8 till 12).

KEYWORDS: breast cancer; the Netherlands; Norway; quality improvement; quality indicators; pattern comparison; hospital variation

INTRODUCTION

In the Netherlands and most European Union countries, the measured incidence of breast cancer has increased on average from 145/100.000 cases in 2010 to 153/100.000 cases in 2015 [1]. This increase is the result of early diagnosis due to screening procedures, improvements in screening techniques, and improved self-diagnostics [2].

Data concerning the patient, tumor, diagnostics and treatment of all newly diagnosed malignancies in the Netherlands is prospectively registered in the Netherlands Cancer Registry (NRC). The NCR is hosted by the comprehensive cancer organization in the Netherlands (*Integraal Kankercentrum Nederland,* IKNL) and was established in 1989. IKNL is the quality institute for oncological and palliative research and practice. They collaborate with healthcare professionals, managers, and patients to ensure the continuous improvement of oncological and palliative care [3]. In Norway, information about every patient with cancer is gathered at the Cancer Registry of Norway (CRN). The CRN was established in 1951 [4]. The CRN is responsible for the national breast cancer screening program, which became a nationwide program in 2005. The purpose of the CRN is providing an empirical base for scientific studies concerning prognostic factors and treatment outcomes as well as evaluation of the quality of cancer care [4].

In recent years, the quality standards in healthcare have become a subject of public debate [5]. There is a growing demand for quality monitoring and subsequently improving of healthcare, which in the Netherlands is accompanied by the urge of health insurers to contract only hospitals with high-quality care. The need to provide information to hospitals, other healthcare institutions, professional groups, and patients is increasing.

To accommodate for the need to provide specific quality breast cancer care information, the multidisciplinary NABON Breast cancer Audit (NBCA) developed an indicator set with different types of quality indicators (process, outcome, and structure) providing insight in the given care for every hospital treating breast cancer patients [5-6]. In the NBCA scientific committee, all medical disciplines in breast cancer care are represented, i.e. surgeons, radiation therapists, medical oncologists, pathologists, and radiologists, together with the breast cancer patient coalition and the health insurers [5-6]. In the Netherlands, the NCR provides data for the NBCA for approximately 75% of the hospitals.

Furthermore, in 2013, the Norwegian Breast Cancer Quality Registry (NBCQ) was established by different clinicians and also developed an indicator set of quality indicators (process, outcome and structure).

This study will focus on the quality of breast cancer care in Dutch and Norwegian hospitals. Until recently, no studies have been performed to compare quality indicators on a national and hospital level between the Netherlands and Norway.

The Dutch population is about three and a half times larger than the Norwegian population. The incidence of new breast cancer cases among women in the Netherlands was 2,500 DCIS and 14,800 invasive cases in 2016 [7-8]. On average, 88.3% of women diagnosed with breast cancer survive the first five years in the Netherlands [7]. Breast cancer incidence in Norway among women was 3,371 women in 2016 and the survival of breast cancer has increased from 89% in five years [9]. Due to the

differences in hospital size and population density, it will be interesting to compare the quality of breast cancer care between both countries.

Insight into the outcomes of the quality indicators between the Netherlands and Norway could be input for a discussion about the continued development of medical treatments and guidelines.

The aim of this study is to analyse the quality of care of both countries with a selection of breast cancer quality indicators developed by the NBCA and determine the influence of case mix and the extent in differences between hospitals. Six quality indicators recommended by NBCA are analysed (Table 1).

METHODOLOGY

Study Design and participants

The design of this research is a retrospective cohort study. The data used in this study is derived from databases of the NRC and CRN.

In total 92 Dutch hospitals and 65 Norwegian hospitals were included. The 65 Norwegian hospitals were subdivided into 20 area hospitals. All female patients diagnosed with ductal in situ carcinoma (DCIS, a premalignant condition) or invasive breast cancer in the Netherlands and Norway between the 1st of January 2012 and December 31st 2016 were selected. Men with breast cancer and patients with metastasis were excluded.

Indicators

The quality indicators consist of information regarding diagnostic procedures, surgery, reconstructive surgery, radiotherapy, neo-adjuvant and adjuvant systemic therapy. All nineteen NBCA indicators (Appendix 1) have been reviewed and, based on the availability, the diversity and practicability of the indicators, a selection of six NBCA Indicators was made (Table 1). For each indicator, the databases of both countries were adjusted to allow us to perform the comparison between the NBCA indicators and the CRN available data items.

Table 1. Chosen NBCA quality indicators in breast cancer care for which data items were available in the CRN.

Number*	***Target***	***Indicator***
6	*<30*	Percentage of patients with unknown tumor resection margins in the first breast-conserving surgery for DCIS *A: Number of patients in whom DCIS is focal or more than focal in the resection area after a first local excision* B: *Number of patients for whom it is not known whether tumor suppression is present in the resection surface*
7	*<15*	Percentage of patients with unknown tumor resection margins in primary first breast-saving surgery for invasive breast cancer (without neo-adjuvant therapy) *A: Number of patients in whom tumor tissue (invasive component) is more than focal in the resection surface after a first local excision* *B: Number of patients for whom it is not known whether tumor tissue is present in the resection surface*
8		Percentage of patients who have maintained a breast contour after operative treatment for invasive M0 breast cancer *A: Number of patients that have maintained a breast contour after operative treatment for invasive M0 breast cancer (total indicator 8b, 8c, and 8d)* *B: Number of patients treated primarily breast-saving* *C: Number of patients breast-saving treated after neo-adjuvant chemotherapy*

	D: Number of patients that have undergone a direct reconstruction following an ablative procedure (primary or after neo-adjuvant chemotherapy)
9	Percentage of patients with an immediate breast reconstruction by a plastic surgeon for DCIS
	A: Number of patients for whom a direct reconstruction was performed
10	Percentage of patients with an immediate breast reconstruction by a plastic surgeon for invasive breast cancer
	A: Number of patients for whom a direct reconstruction was performed
12	Percentage of the patient receiving radiotherapy for locally advanced breast cancer (excluding T3N0) for which ablation mammae was performed

*Note * Numbers are corresponding to the quality indicators in the original NBCA indicator set (Table 5, Appendix). In the Netherlands and Norway, the data was available after the CRT privacy commission has agreed to the use of the data.*

Analyses

The Dutch and the Norwegian indicators were calculated separately. Patient and tumor characteristics were compared between the Netherlands and Norway (Table 2) by chi-square tests. Results of the quality indicators were calculated for all hospital institutions in both countries and case-mix correction was performed to adjust for age and tumor stage. The outcome of the indicators on a national level is the average percentage of patients fulfilling the indicator. Hospital performance of both countries was visualized with a funnel plot, with a 95% confidence interval (CI). Due to privacy reasons, hospitals for which data on less than ten patients was available were excluded from the Dutch and Norwegian dataset. The comparison is made using the calculated outcomes of the quality indicators and funnel plots (Figure 1). In this study a P-value <0.05 is considered statistically significant. All statistical analyses were performed in STATA (version 14.2, Texas).

RESULTS

Patient, Hospital, Treatment and Tumor Characteristics

In the Netherlands 78,126 (80.7%) breast tumors were included, consisting of DCIS (n=10,764) and invasive breast cancer (n=67,362). In Norway 18,715 (19.3%) breast tumors were included, consisting of DCIS (n=1,753) and invasive breast cancer (n=16,962). The average age in the Netherlands is 60.4 (Standard Deviation (SD): 12.3) and in Norway 61.7 (SD: 13.7). In the Netherlands and Norway, most patients diagnosed with breast cancer were aged between 50 and 69 years.

Patients with DCIS showed no differences in age, treatment and tumor stage, except for post-operative radiotherapy (p<0.01). All invasive variables are significant (p<0.01), except for the patient age below 50 years (p=0.15) and tumor stage number 3 (p=0.15).

Hospitals in the Netherlands treated more patients with postoperative radiotherapy for DCIS (13.5%) and Invasive breast cancer (10.3%). Furthermore, the hospitals in the Netherlands gave significantly (p<0.01) more neo-adjuvanted therapy for invasive breast cancer (Netherlands (NL)=15.8% versus Norway (NO)=8.1%) and performed 5.1% more breast-conserving surgeries than Norway. Furthermore, the hospitals in Norway perform 2.1% more immediate reconstructions after an ablation surgery for invasive breast cancer than the hospitals in the Netherlands. The immediate reconstructions in Norway consist of missing data for DCIS (29.1%) and invasive breast cancer (22.1%).

Table 2. The NABON Breast Cancer Audit (NBCA) and The Cancer Registry (CRN) characteristic of the indicators, stratified by DCIS, invasive, and the Netherlands and Norway (2012-2016).

	DCIS (n=12,517)					Invasive (n=84,324)				
	NL (n=10,764)		NO (n=1,753)		P-value (DCIS)	NL (n=67,362)		NO (n=16,962)		P-value (Invasive)
	N	%	N	%		N	%[1]	N	%	
Patient										
Age (Mean (SD) (t-test)))	*59.7*	*10.3*	*59.2*	*11.1*	*0.06*	*60.6*	*12.5*	*62*	*13.9*	*<0.01*
Below 50	*2,110*	*19.6*	*376*	*21.4*	*0.48*	*15,888*	*23.6*	*3,824*	*22.5*	*0.15*
50-69	*6,735*	*62.6*	*1,136*	*64.8*	*0.16*	*34,640*	*51.4*	*8,488*	*50*	*0.02*
70 or above	*1,919*	*17.8*	*241*	*13.7*	*0.11*	*16,834*	*25*	*4,650*	*27.4*	*<0.01*
Treatment										
Neo-adjuvant therapy										
Yes	*6*	*1.0*	*9*	*1*	*0.81*	*10,559*	*15.8*	*1,382*	*8.1*	*<0.01*
No	*10,758*	*99.9*	*1744*	*99*	*1.00*	*56,803*	*84.2*	*15,581*	*91.9*	
Type of first surgery										
Breast conserving surgery	*7,552*	*70.2*	*1,240*	*70.7*	*0.72*	*41,832*	*62.2*	*9,680*	*57.1*	*<0.01*
Ablative surgery	*3,044*	*28.3*	*466*	*26.6*	*0.45*	*25,245*	*37.5*	*6,089*	*35.9*	*0.02*
No reported surgery	*168*	*1.6*	*46*	*2.6*	*0.65*	*181*	*0.3*	*1,171*	*6.9*	*<0.01*
Immediate breast reconstruction										
Yes	*1,619*	*15*	*247*	*19.3*	*0.08*	*5,580*	*8.3*	*1,330*	*10.4*	*<0.01*
No	*9,144*	*85*	*1,030*	*58.8*		*61,782*	*91.7*	*11,442*	*67.5*	
Missing	*0*	*0*	*176*	*29.9*		*0*	*0*	*4,490*	*22.1*	
Postoperative radiotherapy										
Yes	*6,062*	*56.8*	*759*	*43.3*	*<0.01*	*48,183*	*71.6*	*10,390*	*61.3*	*<0.01*
No	*4,608*	*43.2*	*994*	*56.7*		*19,129*	*28.4*	*6,572*	*38.7*	
Tumor										
Stage										
1	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*35,126*	*52.1*	*7,438*	*43.9*	*<0.01*
2	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*24,931*	*37*	*5,968*	*35.2*	*0.01*
3	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*7,200*	*10.7*	*1,992*	*11.7*	*0.21*
Missing	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*98*	*0.2*	*1,564*	*9.2*	*<0.01*

Note. *N= Number*

SD = Standard deviation

% = Percentage

Mean = Mean

N.a = not applicable

[1] *= All percentages are rounded off*

Quality Indicators

The indicators in Table 3 are calculated on a national level. The funnel plots in Figure 1 demonstrate an overall result of the variation in quality indicators between the hospitals in the Netherlands and Norway.

Table 3. Quality Indicators for Breast Cancer Health Care in the Netherlands and Norway with the lower and upper percentages and outliers, between 2012 and 2016.

	The Netherlands				Norway			
	Pt (n)	*% (95% CI)*	*Lower- Upper (A%)*	*Outliers n^1- n^2 (n^3-n^4)*	*Pt (n)*	*% (95% CI)*	*Lower- Upper (A%)*	*Outliers (n^1- n^2) (n^3-n^4)*
Indicator 6								
Indicator 6a	*1,445*	*19.1 (18-20)*	*0-47 (19-18)*	*6-6 (6-6)*	*503*	*41.4 (37-44)*	*23-48 (41-41)*	*1-2 (1-2)*
Indicator 6b	*98*	*1.3 (1-2)*	*0-8 (1-1)*	*9-0 (9-0)*	*101*	*8.3 (7-10)*	*3-13 (8-8)*	*1-1 (1-1)*
Indicator 7								
Indicator 7a	*546*	*1.5 (1-2)*	*0-10 (1-3)*	*11-8 (11-8)*	*1,328*	*14.2 (14-15)*	*5-24 (14-15)*	*5-5 (5-5)*
Indicator 7b	*133*	*0.4 (0-1)*	*0-10 (1-1)*	*10-6 (10-6)*	*388*	*4.2 (4-4)*	*1-6 (4-4)*	*0-1 (0-1)*
Indicator 8								
Indicator 8a	*45,527*	*67.6 (67-68)*	14-93 (32-86)	*40-38 (38-35)*	*9,645*	*62.5 (62-63)*	*15-79 (23-64)*	*8-7 (7-6)*
Indicator 8b	*35,651*	*52.9 (53-53)*	*14-90 (46-60)*	*33-30 (32-27)*	*8,766*	*56.8 (56-58)*	*39-79 (15-71)*	*8-6 (0-6)*
Indicator 8c	*4,403*	*6.5 (6-7)*	*0-24 (1-18)*	*40-31 (37-29)*	*183*	*1.2 (1-1)*	*0-2 (1-2)*	*2-2 (3-2)*
Indicator 8d	*5,543*	*8.2 (8-8)*	*0-51 (6-11)*	*40-30 (42-27)*	*715*	*4.6 (4-5)*	*0-2 (0-11)*	*0-0 (8-0)*
Indicator 9								
Indicator 9a	*1,558*	*43.8 (42-45)*	*0-79 (26-57)*	*15-8 (18-8)*	*200*	*43.7 (39-48)*	*8-70 (34-49)*	*3-1 (4-2)*
Indicator 10								
Indicator 10a	*5,509*	*20.5 (20-21)*	*0-83 (10-30)*	*39-30 (42-28)*	*700*	*14.2 (13-15)*	*0-30 (5-16)*	*8-2 (11-2)*
Indicator 12								
Indicator 12a	*1,067*	*81.3 (79-83)*	*50-100 (72-87)*	*4-2 (3-2)*	*844*	*88.9 (87-91)*	*29-100 (70-79)*	*7-0 (4-1)*

Note. *Pt = Numerator*

CI= Confidence Interval

Lower - upper= lower and upper hospital score

A= Adjusted lower and upper hospital score

[1] = The number of hospitals outside the CI boundaries preforming worse, before case-mix

[2] = The number of hospital outside the CI boundaries preforming better, before case-mix

[3] = The number of hospitals outside the CI boundaries preforming worse, after case-mix

[4] = The number of hospitals outside the CI boundaries preforming better, after case-mix

Netherlands

Small variation between hospitals was observed in the percentages of patients with unknown tumor resection margins (indicator 6b). For invasive breast cancer patients with more than focal positive tumor resection margins an average of 1.5% (CI 95% 1-2; indicator 7a) and limited variation between hospitals was observed. For patients with unknown tumor resection margins an average of 0.4% (CI 95% 0-1; indicator 7b) was observed, with only limited variation between hospitals. All the other indicators (indicators 8 till 12) show a large variation between hospitals.

The percentage of patients who maintained a breast contour after operative treatment (BCS) for invasive M0 breast cancer (indicator 8a) is 67.6% (CI 95% 67-68). This indicator shows 40 negative and 38 positive significant hospital outliers (Table 3).

The number of patients that underwent a direct reconstruction (IBR) was 1,558 with an average of 43.8% (95% CI 42-45; indicator 9a). It is remarkable that there exist more significant negative outliers with a low hospital volume (<50), whereas the outliers with a higher hospital volume (>50) tend to be outliers in a positive direction.

Figure 1 demonstrates that case-mix adjustment for age and stage do affect the performance of the indicators 8, 9, 10, and 12, except for the performance regarding patients with unknown tumor resection margins in primary first breast-saving surgery for DCIS and invasive breast cancer (indicator 6 and 7).

Norway

The number of DCIS patients with focal or more than focal tumor resection margins was 1,445 with an average of 19% (CI 95% 18–20; indicator 6a) and the number of patients with unknown tumor resection margins was 98 with an average of 1.3% (CI 95% 1-2; indicator 6b). A large variation between hospitals was observed for indicator 6a and 6b and almost no significant hospital outliers were seen.

In total 9,645 patients underwent BCS for invasive M0 invasive breast cancer with an average of 62.5% (CI 95% 62-63; indicator 8a) and the number of patients treated primarily breast-saving was 8,766 with an average of 56.8% (CI 95% 55-58; indicator 8b). Large variation between hospitals was observed for both indicators.

A large variation between hospitals was observed for patients that underwent a IBR (indicator 9 and 10) and patients who receive radiotherapy for locally advanced breast cancer after mastectomy (indicator 12).

Besides, the percentage of patients treated breast-saving after neo-adjuvant chemotherapy (indicator 8c) and a percentage of patients who have undergone a direct reconstruction following an ablative (indicator 8d) shows a small variation between hospitals (0%-2%).

Figure 1 demonstrates that case-mix adjustment for age and stage do not affect the performance for indicator 6 and 7. Remarkable are the eight negative significant hospital outliers for the patients treated primarily. After the case-mix adjustment, the indicator regarding patients who have undergone a direct reconstruction following a mastectomy shows six positive adjusted significant

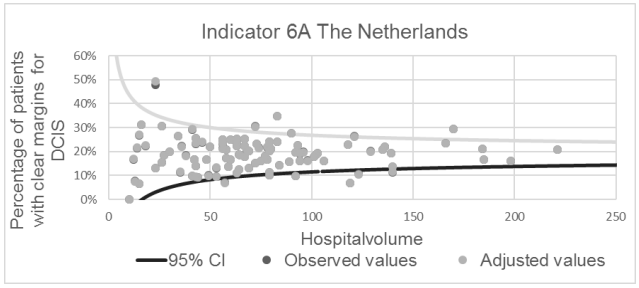
hospital outliers outside the 95% CI (indicator 8d). The indicator regarding patients who received radiotherapy for locally advanced breast cancer after mastectomy shows four negative hospital outliers after the case-mix adjustment (indicator 12).

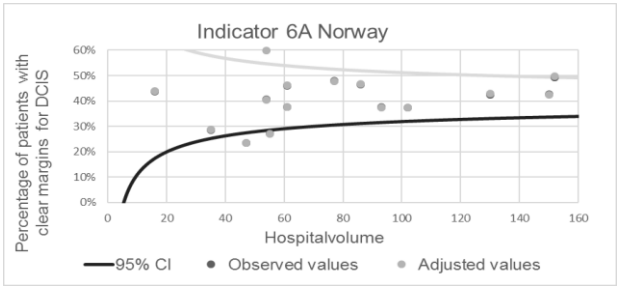
Similarities and Differences

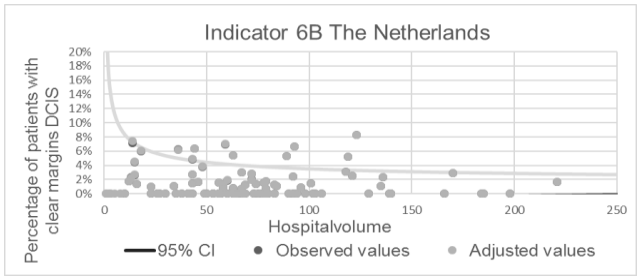
As Figure 1 shows, indicator 6 and 7 differ between the Netherlands and Norway. The average for Norway is higher with a wider confidence interval. However, the hospital outliers of these indicators show a comparable pattern.

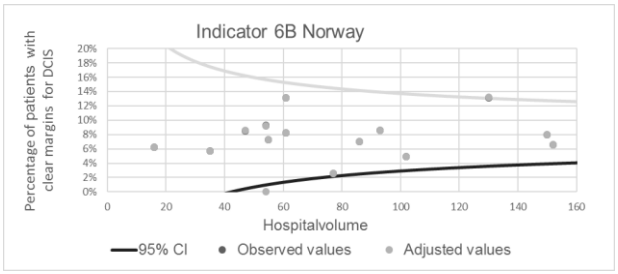
The variation of indicator 8a and 8b is similar between the Netherlands and Norway. These sub-indicators both have a lot of negative and positive hospital outliers. On the other hand, indicators 8c and 8d differ between the Netherlands and Norway in the hospital variation and outliers. The Netherlands has multiple negative and positive outliers with a wide variation, while Norway has hardly any outliers and only a small variation between hospitals.

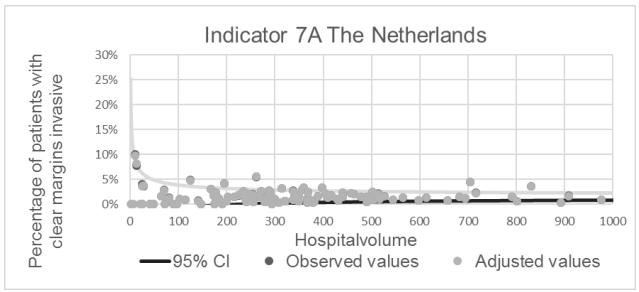
Indicators 9, 10, and 12 also show the same pattern (Figure 1). For these indicators variation between hospitals is similar. The differences in variation, ranging from 0%-83% for the Netherlands and 0-30% for Norway, of indicator 10 is due to one positive hospital outlier.

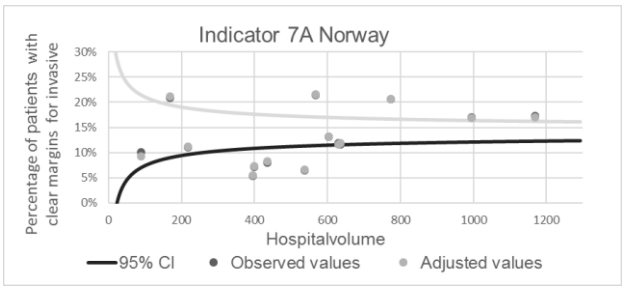

Indicator 6A The Netherlands
Percentage of patients with clear margins for DCIS
Hospitalvolume
95% CI
Observed values
Adjusted values

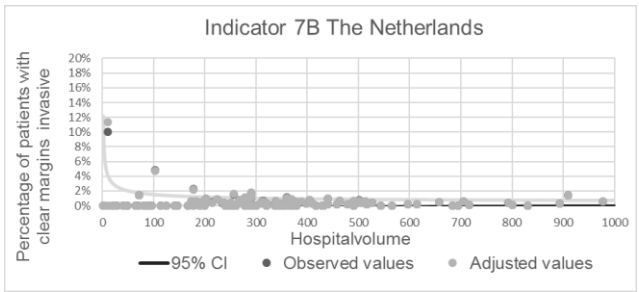

Indicator 6A Norway
Percentage of patients with clear margins for DCIS
Hospitalvolume
95% CI
Observed values
Adjusted values

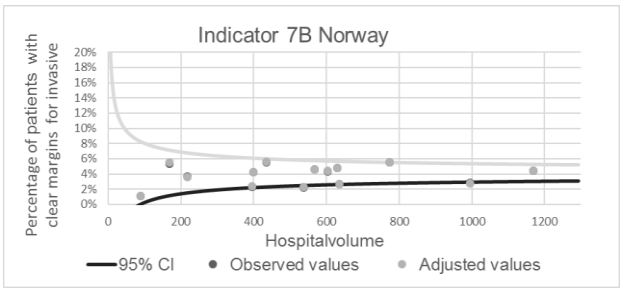

Indicator 6B The Netherlands
Percentage of patients with clear margins DCIS
Hospitalvolume
95% CI
Observed values
Adjusted values

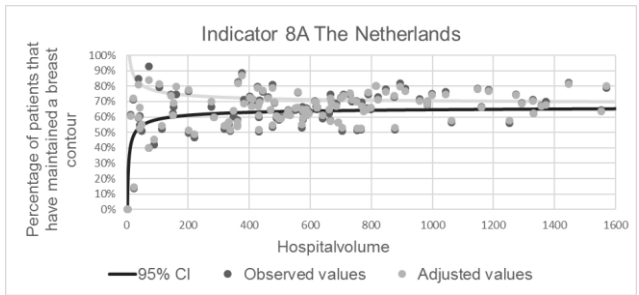

Indicator 6B Norway
Percentage of patients with clear margins for DCIS
Hospitalvolume
95% CI
Observed values
Adjusted values

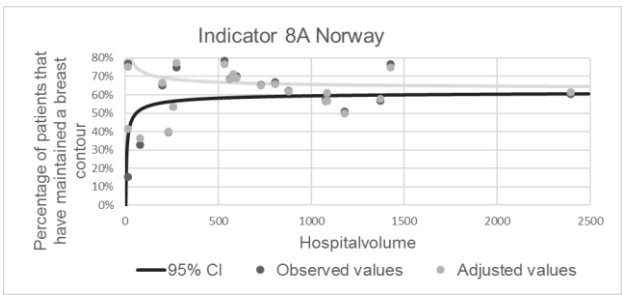

Indicator 7A The Netherlands
Percentage of patients with clear margins invasive
Hospitalvolume
95% CI
Observed values
Adjusted values

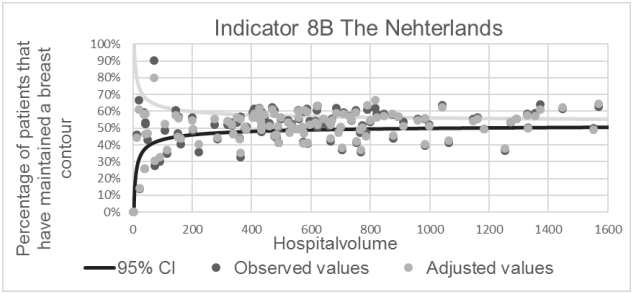

Indicator 7A Norway
Percentage of patients with clear margins for invasive
Hospitalvolume
95% CI
Observed values
Adjusted values

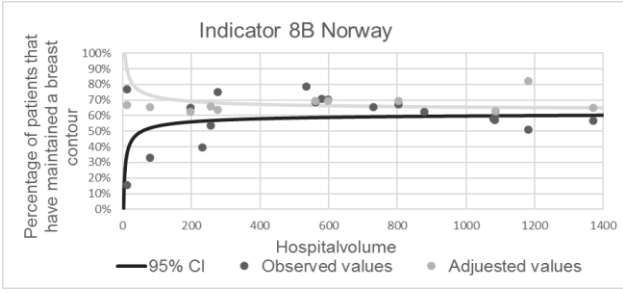

Indicator 7B The Netherlands
Percentage of patients with clear margins invasive
Hospitalvolume
95% CI
Observed values
Adjusted values


Indicator 7B Norway
Percentage of patients with clear margins for invasive
Hospitalvolume
95% CI
Observed values
Adjusted values


Indicator 8A The Netherlands
Percentage of patients that have maintained a breast contour
Hospitalvolume
95% CI
Observed values
Adjusted values


Indicator 8A Norway
Percentage of patients that have maintained a breast contour
Hospitalvolume
95% CI
Observed values
Adjusted values


Indicator 8B The Nehterlands
Percentage of patients that have maintained a breast contour
Hospitalvolume
95% CI
Observed values
Adjusted values


Indicator 8B Norway
Percentage of patients that have maintained a breast contour
Hospitalvolume
95% CI
Observed values
Adjuested values

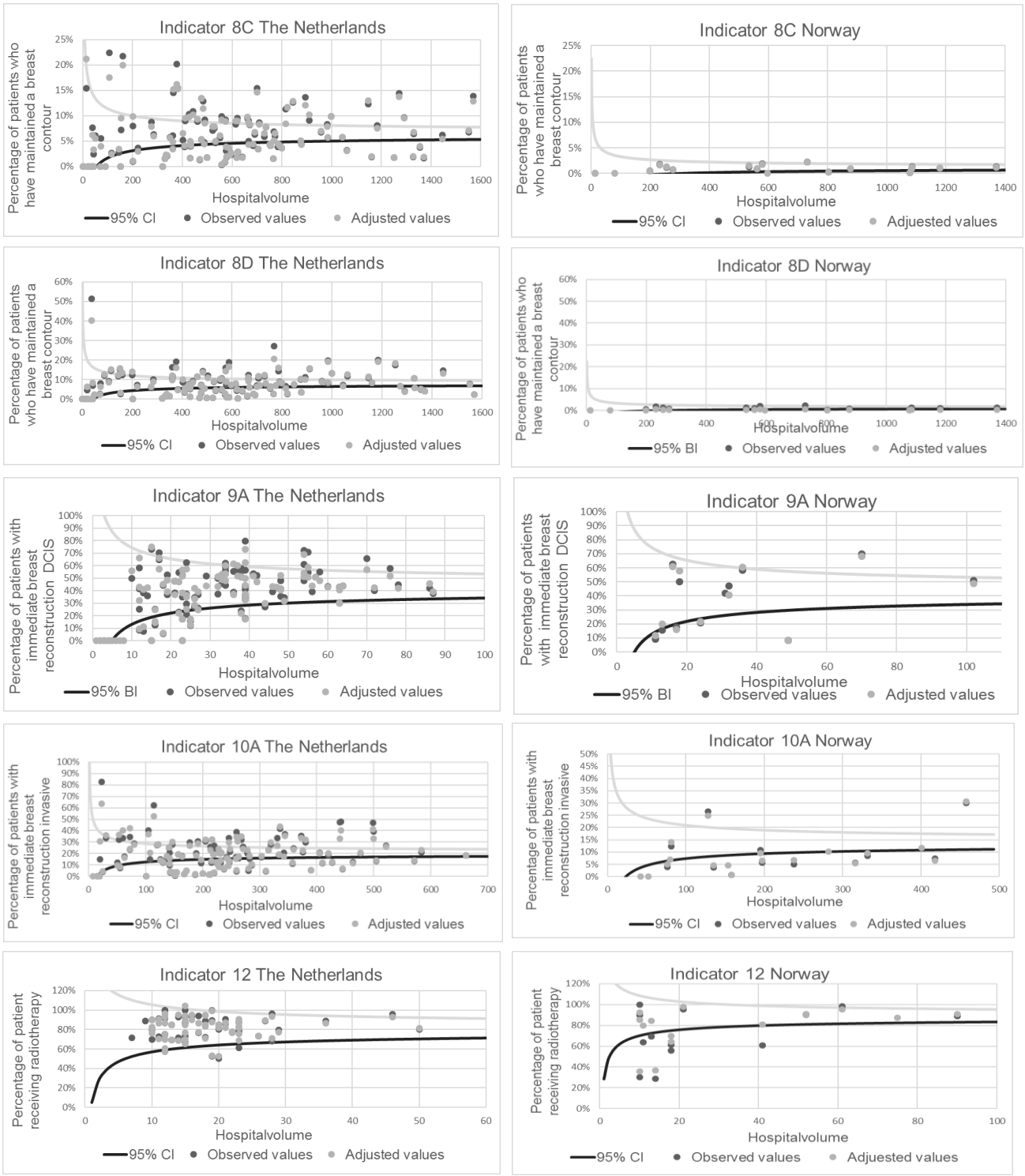


Figure 1. Funnel plots for all hospitals in the Netherlands and Norway, shown for every indicator between 2012 and 2016.

DISCUSSION

This study included in total 12,517 DCIS and 84,324 invasive breast cancer cases over the years 2012 till 2016 and compared six quality indicators defined by the NBCA between the Netherlands and Norway. To our best knowledge, this is the first study comparing quality indicators and quality of care between the Netherlands and Norway. For most quality indicators the pattern of variation between hospitals was similar between the two countries. The exceptions were indicator 6 and 7. No distinction has been made between academic and non-academic hospitals.

Within a single country, variation between the hospitals was observed, when case mix influence (age and stage) was taken into account. In the Netherlands, most indicators showed a large variation between hospitals, except for the indicators regarding patients with unknown tumor resection margins in primary first breast-saving surgery for invasive breast cancer (without neo-adjuvant therapy; indicator 7) and the number of patients in whom it is not known whether tumour suppression is present in the resection surface (indicator 6b). After the case-mix adjustment, significant hospital outliers were observed.

In Norway, the different quality indicators showed a wider variety in the variation between hospitals. After the case-mix adjustment, indicators 8, 9, and 10 were observed to have a high number of significant hospital outliers.

Quality Indicators

The National Institute for Health and Care Excellence (NICE) advises that patients with early invasive breast cancer, who underwent a BCS should have breast radiotherapy [10]. Also, Coelho et al. confirm that radiotherapy is an effective treatment for locally advanced breast cancer [11]. As the funnel plots show, hospitals follow the policy and guidelines of the Netherlands and Norway, which are in accordance with the advice of NICE. Following both guidelines, the chest will always be irradiated after a BCS. In the Netherlands, the policies are followed closely, as can be observed from the fact that al the hospitals are close together in the funnel plot (indicator 12).

In the Netherlands, a wide variety of variation between hospitals was observed for indicator 8. By contrast, in Norway, a wide variety of variation between hospitals was only observed for indicators 8a and 8b, whereas for indicators 8c and 8d only a limited variety of variation between hospitals was visible.

For indicator 8a, which is the total of indicator 8b, 8c, and 8d (number of patients that have maintained a breast contour after operative treatment for invasive M0 breast cancer), a similar degree of variation between hospitals, about the same average quality indicator outcome (differences of 5%) and a similar pattern of significant outliers could be observed when comparing the Netherlands and Norway. This indicator is strongly influenced by the percentage of immediate reconstructions.

Van Bommel et al. (2015) showed that the age of the patient affects the BCS with or without neoadjuvant therapy and the percentage of immediate reconstruction after mastectomy. This corresponds to the adjusted data of 8d in the Netherlands and 8c and 8d Norway [12]. Noticeably, the adjusted data of 8d in Norway is clearly significantly worse than the observed values. It is abundantly clear that the adjusted data is strikingly pulled down by age, with negative hospital outliers as a result.

In the Netherlands, indicator 8d had one remarkable significant better outlier (50%) with a small hospital volume (n=50). This outlier could be a specialized doctor in direct reconstructions.

Neo-adjuvant chemotherapy could be given either primary or after a direct reconstruction following an ablative procedure. The literature shows that neo-adjuvant chemotherapy is still under debate because the treatment can affect the direct reconstruction [13]. This explains the low average percentages for indicator 8d in the Netherlands (8.2%) and Norway (4.6%). However, Nestle-Kramling et al. (2016) emphasize that an immediate breast reconstruction could be a safe procedure equivalent to primary reconstruction after neo-adjuvant chemotherapy [13]. The funnel plots give a clear picture that the Netherlands follows this statement in the guideline.

This study identified that hospital volume (n=50) could affect the performance of an immediate breast reconstruction by plastic surgeons (indicator 9). The cause of this could be the less common presence of plastic surgeons in a smaller hospital. To check this conjecture, further research is recommended. For indicator 9, the funnel plots showed the same pattern for both countries. Literature shows a positively affected IBR outcome with a high number of plastic surgeons working in a hospital and also large variation between hospitals [14].

Finally, a large variation of immediate breast reconstruction by plastic surgeons for invasive breast cancer (indicator 10) was found, corresponding to the literature [14]. The difference between the Netherlands and Norway was 4% more direct breast reconstruction for DCIS and 2% more reconstructions for invasive breast cancer in Norway. Striking was the Norwegian missing immediate reconstruction data. The data is missing in 29.9% of DCIS and 22.1% of invasive breast cancer cases. This is probably caused because the NBCQ was only developed in 2013. Before that, the data registration was less specific. The missing data comes from the year 2012.

The effects of case-mix on the quality indicators show that in general, age and stage do affect the hospital performance. The only exceptions are indicator 6 and 7. Van Bommel et al. (2015) showed that the age of the patient affects the BCS with or without neoadjuvant therapy and the percentage of immediate reconstruction after mastectomy, which implies that indicator 8 could be affected by age [11]. Indicator 9 and 10 could be affected by age, Jeevan et al. (2017) revealed that increasing age is associated with the fall of the probability of a direct reconstruing [15]. Our observation that age affects hospital performance for these indicators implies that clinicians are generally following the guidelines for an IBR, taking into account the age of the patients. Indicator 12 could be affected by stage, as radiation treatment is based on the pathological report but should be based on the clinical report [16]. It could be affected by age as well, because the general belief is that aging is associated with the tolerance to radiation therapy. However, research shows that age is not associated with differences in tolerance to radiotherapy between older and younger patients [17].

Limitations

All invasive variables are significant (Table 2), this should be seen in the light of the large number of patients included of the dataset. Also, many Norwegian hospitals (on average 8 per indicator) were excluded since they had data for less than ten cases. As a result of the lower hospital numbers, the hospital variation of Norway is more difficult to estimate and compare to the Netherlands.

Due to privacy limitations, it was not possible for the author to make use of the Norwegian dataset. To circumvent this problem, a statistical research assistant of the Norwegian Cancer Registry provided the Norwegian indicators used in this study. This has the disadvantage that the coding of the variables in the databases could contain some differences. However, the calculation rules used to calculate the quality indicators were the same.

Some of the different outcomes observed in the indicators are probably due to coding in the dataset and difference in guidelines. Guidelines may differ between countries and therefore there will be differences in quality variables [12]. In the guidelines of Norway a more specific description of the variable "unknown tumor resection margins" is used. For DCIS, unknown tumor resection margins are defined as >0 mm for the front and back and >=2 mm on the sides. For invasive breast cancer they are defined as >0 mm on any side. In contrast, the Dutch breast cancer guidelines only define "unknown tumor resection margins" as >4mm from each side. The differences in outcome that were found between the Netherlands and Norway could be explained by this. We see a higher rate of radiotherapy in Norway, which is thought to take care of any “unknown tumor resection margins” that are remaining after surgery. Because of this, Norway scores higher for indicator 12.

Future challenges

A future challenge is the exchange of the anonymized datasets to compare the quality indicators between The Netherlands and Norway. With the exchange of the datasets, more reliable and extensive analyses and comparison could be done. Furthermore, a comparison between three countries (the Netherlands, Norway, and Denmark) would be interesting to force the boundaries and borders of Europe and eventually arrive at a uniform standard regarding breast cancer diagnosis, treatment, and guidelines. Finally, an important future challenge is to determine clear and similar definitions and uniform registrations. The European Society of Breast Cancer Specialists (EUSOMA) has identified that diagnosis and treatment of breast cancer, and in particular breast cancer care, vary widely ways across Europe [5]. The experts reviewed the literature and selected the main process and outcome indicators for quality assurance of breast cancer treatment [18]. To have a unified breast cancer treatment policy within Europe and confirm that the breast cancer treatment reaches the required standards, the EUSOMA has organized a workshop for experts in several disciplines related to breast cancer treatment.

CONCLUSION

This study revealed the influence of case mix and the extent of differences between hospitals in the Netherlands and Norway. The funnel plots showed a high quality of care for both countries. Both countries have a free choice of doctor and everyone can receive the necessary care. However, in Norway, the healthcare does not require personal contributions for the use of health care and medicines.

It was observed that the age and/or stage had an influence on the variation between hospitals and on the performance of hospitals. To wit, case-mix adjustment for age and stage reduce the variation in outcome of the four quality indicators in the Netherlands and in Norway (indicator 8 till 12). The funnel plots of the quality indicators showed some contrast in policy and guidelines between the Netherlands and Norway.

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APPENDIX

Table 4. NBCA Quality Indicators in breast cancer care.

Number	Indicator	Norm
1	Percentage of patients in whom a standardized mammary radiology report is immediately BI-RADS and category for a number of photos (mammography, ultrasound, MRI) in the diagnostic phase.	90%
2	Percentage of patients who have had an MRI before the start of the neoadjuvant chemotherapy	
3	Percentage of patients in which standard reporting of the following items were included: ER%, PR%, HER2 status, grading, tumor size, resection surface, number of positive lymph node	90%
4	Percentage of patients with a positive HER2 result	
5	Percentage of patients that were discussed in a preoperative and postoperative multidisciplinary consultation and for whom a digital report is available for a number of practitioners	90%
6	Percentage of patients with unknown tumor resection margins in the first breast-conserving surgery for DCIS	<30%
7	Percentage of patients with unknown tumor resection margins in primary first breast-saving surgery for invasive breast cancer (without neo-adjuvant therapy)	<15%
8	Percentage of patients who have maintained a breast contour after operative treatment for invasive M0 breast cancer	
9	Percentage of patients who have maintained a breast contour after operative treatment for invasive M0 breast cancer	
10	Percentage of patients with an immediate breast reconstruction by a plastic surgeon for DCIS	
11	Percentage of patients with neoadjuvant chemotherapy who are seen by the radiotherapist within 4 weeks after the start of this treatment	
12	Percentage of the patient receiving radiotherapy for locally advanced breast cancer (excluding T3N0) for which ablation mammae was performed	
13	Lead time and median time between diagnosis and starting neoadjuvant chemotherapy	
14	Lead time and median time between diagnosis and the first operation (exclusive direct reconstruction)	90%
15	Lead time and median time between diagnosis and first operation inclusive direct reconstruction	
16a	Lead time between the last surgical procedure and start of radiotherapy ≤5	
16b	Median time between the last surgical procedure and the start of radiotherapy	
17	Lead time and median time between the first day of chemotherapy and the start of radiotherapy	
18	Lead time and median time between the operation and the start of adjuvant chemotherapy	
19	Lead time and median time between the radiotherapy and the start of adjuvant chemotherapy	

Table 5. Numerator and Denominators of the calculated Quality Indicators.

Indicators	Numerators and Denominators
6. Percentage of patients with unknown tumor resection margins in the first breast-conserving surgery for DCIS (Target <30%)	Counter 6a Number of patients in whom DCIS is focal or more than focal in the resection area after a first local excision Counter 6b Number of patients in whom it is not known whether tumor suppression is present in the resection surface Denominator 6 Number of patients who have undergone a first breast-conserving surgery for DCIS Inclusion Primary DCIS, operated, first surgery sparing. Exclusion LCIS and invasive carcinoma, patients who did not had surgery
7. Percentage of patients with unknown tumor resection margins in primary first breast-saving surgery for invasive breast cancer (without neo-adjuvant therapy) (Target <15%)	Counter 7a Number of patients in whom tumor tissue (invasive component) is more than focal in the resection surface after a first local excision Counter 7b Number of patients in whom it is not known whether tumor tissue is present in the resection surface Denominator 7 Number of patients who have undergone initial breast-conserving surgery (without neo-adjuvant therapy) for an invasive M0 breast cancer (with or without DCIS) without distant metastases. Inclusion Primary invasive breast cancer (with or without DCIS), operated, first surgery sparing Exclusion M1, neo-adjuvant system therapy, patients who did not had surgery
8. Percentage of patients who have maintained a breast contour after operative treatment for invasive M0 breast cancer	Counter 8a Number of patients that have maintained a breast contour after operative treatment for invasive M0 breast carcinoma (total indicator 8b, 8c and 8d) Counter 8b Number of patients treated primarily sparingly Counter 8c Number of patients sparingly treated after neo-adjuvant chemotherapy Counter 8d Number of patients that have undergone a direct reconstruction following an ablative procedure (primary or after neo-adjuvant chemotherapy) Denominator 8 Number of operated patients with a primary M0 invasive breast carcinoma Inclusion Primarily invasive breast carcinoma Exclusion M1, patients who have not had surgery
9. Percentage of patients with an immediate breast reconstruction by a plastic surgeon for DCIS	Counter 9a Number of patients in whom a direct reconstruction was performed (total) Counter 9b Number of patients in whom a direct reconstruction has been performed (with prosthesis) Counter 9c Number of patients in whom a direct reconstruction has been performed (autologous)

	Counter 9d Number of patients in whom a direct reconstruction has been performed (combination prosthesis and autologous) Denominator 9 Number of patients with an ablative procedure for DCIS Inclusion Primary DCIS Exclusion M1, patients who have not had surgery
10. Percentage of patients with an immediate breast reconstruction by a plastic surgeon for invasive breast cancer	Counter 10a Number of patients in whom a direct reconstruction was performed (total) Counter 10b Number of patients in whom a direct reconstruction has been performed (with prosthesis) Counter 10c Number of patients in whom a direct reconstruction has been performed (autologous) Counter 10d Number of patients in whom a direct reconstruction has been performed (combination prosthesis and autologous) Denominator 10 Number of patients with an ablative procedure for invasive breast cancer
12. Percentage of the patient receiving radiotherapy for locally advanced breast cancer (excluding T3N0)	Inclusion Primarily invasive breast carcinoma Exclusion M1, patients who have not had surgery Counter 12 Number of patients receiving radiotherapy Denominator 12 Number of patients with a primary ivasive M0 locally extended breast cancer (NABON guideline: clinical T3, T4, any N, M0 and any T, N2-3, M0) operated by means of an ablatio breast (excluding T3N0) Inclusion Primary invasive locally extended breast cancer (NABON guideline: clinical T3, T4, any N, M0 and any T, N2-3, M0) Exclusion T3N0, M1, patients who have not been operated