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Original article

Hospital organizational factors affect the use of immediate breast reconstruction after mastectomy for breast cancer in the Netherlands

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ABSTRACT

Objectives: Significant hospital variation in the use of immediate breast reconstruction (IBR) after mastectomy exists in the Netherlands. Aims of this study were to identify hospital organizational factors affecting the use of IBR after mastectomy for ductal carcinoma in situ (DCIS) or invasive breast cancer (BC) and to analyze whether these factors explain the variation.
Materials and methods: Patients with DCIS or primary invasive BC treated with mastectomy between 2011 and 2013 were selected from the national NABON Breast Cancer Audit. Hospital and organizational factors were collected with an online web-based survey. Regression analyses were performed to determine whether these factors accounted for the hospital variation.
Results: In total, 78% (n = 72) of all Dutch hospitals participated in the survey. In these hospitals 16,471 female patients underwent a mastectomy for DCIS (n = 1,980) or invasive BC (n = 14,491) between 2011 and 2014. IBR was performed in 41% of patients with DCIS (hospital range 0–80%) and in 17% of patients with invasive BC (hospital range 0–62%). Hospital type, number of plastic surgeons available and attendance of a plastic surgeon at the MDT meeting increased IBR rates. For invasive BC, higher percentage of mastectomies and more weekly MDT meetings also significantly increased IBR rates. Adjusted data demonstrated decreased IBR rates for DCIS (average 35%, hospital range 0–49%) and invasive BC (average 15%, hospital range 0–18%).
Conclusion: Hospital organizational factors affect the use of IBR in the Netherlands. Although only partly explaining hospital variation, optimization of these factors could lead to less variation in IBR rates.

1. Introduction

Current surgical treatment of breast cancer patients consists of either breast conserving surgery or mastectomy. A mastectomy is performed in about 40% of invasive breast cancer patients and in approximately 33% of patients with a ductal carcinoma in situ [1–3]. An increasing number of patients desire restoration of their breast contour following mastectomy and consequently breast reconstruction has become an integral part of breast cancer treatment [4]. The breast can be reconstructed during the initial operation following mastectomy (immediate breast reconstruction (IBR)) or at a later time (delayed breast reconstruction) [2].

IBR has proven to be safe in terms of local recurrence and long-term survival rates compared to mastectomy only [5,6]. Moreover, IBR offers women psychological benefits in terms of recovery and improved quality of life and is associated with superior aesthetic results compared to delayed breast reconstruction [5–7]. Guidelines emphasize the importance of reconstruction after mastectomy and recommend clinicians to discuss the possibility of IBR

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Abbreviations

MDT	multidisciplinary team
IBR	immediate breast reconstruction
NBCA	Nabon Breast Cancer Audit
BC	breast cancer

with every patient undergoing mastectomy [2,8,9].

Despite the benefits of IBR, the percentage of patients with DCIS or invasive breast cancer actually undergoing IBR after mastectomy is approximately 20% in the Netherlands. Large hospital variation in the use of IBR was found previously, ranging from 0 to 64% for invasive breast cancer and 0–83% for DCIS [10]. Comparable IBR rates were shown in other international studies; IBR was performed in 21% of the postmastectomy patients in the United Kingdom and 24% in the United States [2,11,12]. Literature has demonstrated that patient and tumor factors such as age, social economic status, multifocality, tumor type, clinical tumor stage, clinical lymph node stage, grade and previous breast surgery are predictors of the use of IBR [10,11,13–17]. However, these patient and tumor factors do not fully explain the large variation between hospitals in the Netherlands [10].

The aim of the present study was to investigate which hospital and hospital organizational factors affect the use of IBR after mastectomy for DCIS and invasive breast cancer in the Netherlands and whether these factors account for the variation seen.

2. Material and methods

2.1. Data source

Data of the NABON Breast Cancer Audit (NBCA) was used to obtain information on breast cancer patients in the Netherlands. The NBCA is a national multidisciplinary quality improvement register in which all 92 hospitals in the Netherlands participate and is supported by the Dutch Institute of Clinical Auditing (DICA) and the Netherlands Comprehensive Cancer Organization (IKNL) [18]. Information concerning patient, tumor, diagnostics and treatment is continuously collected prospectively either by the hospitals themselves or by data managers of the Netherlands Cancer Registry (NCR).

2.2. Study population

All female patients diagnosed with DCIS or invasive breast cancer between January 1st, 2011 and December 31st, 2013 who underwent a mastectomy were selected.

2.3. Hospital organizational factors based on data from the NBCA

Hospitals were categorized as district hospitals, teaching hospital (despite educational activities, not affiliated with a medical faculty), university hospitals (hospitals having a medical faculty) and cancer specific hospitals (hospitals only treating cancer patients). According to the number of new breast cancer patients annually diagnosed in a hospital, three groups were identified (group 1: 1–150, group 2: 150–300, group 3: >300 patients per year). The percentage of mastectomies (related to all surgical excisions) were categorized in three groups (group 1: 0–30%, group 2: 30–50% and group 3: >50%).

2.4. Survey

All 92 hospitals were invited to complete a web-based survey regarding hospital organization factors. Questions encompassed the number of weekly MDT meetings (1, 2, >2 times per week), the presence of the various disciplines involved in breast cancer care participating the MDT meeting (e.g., nurse practitioners, pathologists, radiation oncologists, radiologists and medical oncologists), number of plastic surgeons available at institution per 100 new diagnoses of breast cancer (0–0.5, 0.5–2.5 and > 2.5), number of breast surgeons available at institution per 100 new diagnoses of breast cancer (0–1.5, 1.5–2.5 and > 2.5) and the presence of a plastic surgeon at weekly MDT meeting (never/incidental, structural). “Never” refers to hospitals where no plastic surgeon was attending the weekly MDT meetings and “incidental” only incidentally on request. Only patients of hospitals that responded to the survey were included for analyses. In case data were missing, we categorized them as unknown.

2.5. Statistical analyses

DCIS and invasive breast cancer were analyzed separately. Factors tested for confounding were age, social economic state (SES), multifocality, clinical tumor stage, clinical lymph node stage, grade and radiation therapy. With use of logistic regression models hospital organizational factors were related to the prevalence of IBR and were presented as odds ratio's with 95% confidence intervals (95%CIs). Factors that demonstrated to significantly affect IBR rates in univariable analyses ($p < 0.10$) were included in the multivariable analyses.

Hospital performance of IBR was visualized with the use of a funnel plot. In the funnel plots the volume is based on the number of mastectomies (and not the total number of breast cancer diagnosis treated per hospital) over 3 years. Actually, in the Netherlands, 60% of the patients are treated with breast conserving surgery, so the actual hospital volume of breast cancer patients is much higher. Data were analyzed unadjusted and adjusted for patient, tumor and hospital organizational factors significantly affecting the use of IBR. Since the data is organized at more than one level and is clustered for the individual hospitals, multilevel analysis was performed. Not all organizational characteristics of the hospitals were known, but with use of a multilevel analysis, all hospital depending factors were taken into account in the adjusted data. All statistical analyses were performed in STATA (version 13.1 2013, Texas).

3. Results

3.1. Study population

Seventy-two hospitals (78.3%) responded to the survey leading to inclusion of 16,471 patients with a mastectomy for DCIS ($n = 1{,}980$) and invasive breast cancer ($n = 14{,}491$) (Table 1). Almost 90% of the responding hospitals were categorized as a district or teaching hospital and most (85%) of the hospitals had 0-300 diagnosis annually. In most hospitals, one MDT meeting per week was organized and one hospital reported to have a daily MDT meeting (Table 1). All disciplines related to breast cancer care (e.g., surgeons, medical oncologists, radiation oncologists, radiologists, pathologists, nurse practitioners) structurally attended the MDT meetings. In 71% of the hospitals a plastic surgeon was structurally attending the MDT meeting. In most hospitals the geneticist, psychologist and palliative care expert were incidentally present. Eighty percent of the hospitals reported to offer plastic surgical care for breast cancer patients. In 83% of the responding hospitals,

Table 1
Hospital characteristics of the 72 responding hospitals in the Netherlands.

		Dutch hospitals (n = 72)		Number of patients	
		Number	%	DCIS	Invasive
Response	Non-Responding hospitals	20	21.7		
	Responding hospitals	72	78.3	1,980	14,491
Hospital Type	District Hospital	27	37.5	499	4,044
	Teaching Hospital	37	51.4	1,106	8,624
	University Hospital	7	9.7	243	1,299
	Cancer specific hospital	1	1.4	132	524
Volume (# diagnosis annually)	Group 1 (1/150)	24	33.3	420	2,920
	Group 2 (150/300)	37	51.4	1,109	8,023
	Group 3 (>300) ub = 436	11	15.3	451	3,548
% mastectomies (of all surgical excisions)	Group 1 (0/30)	4	5.6	90	612
	Group 2 (30/50)	49	68.1	1,275	9,505
	Group 3 (50/90)	19	26.4	615	4,374
% referrals for mastectomy	Group 1 (0/2.5)	17	23.6	691	4,532
	Group 2 (2.5/5.0)	26	36.1	628	5,054
	Group 3 (>5) ub = 31	29	40.3	661	4,905
% referrals mastectomy + reconstruction	Group 1 (0/2.5)	46	63.9	1,419	10,162
	Group 2 (2.5/5.0)	17	23.6	409	3,119
	Group 3 (> 5.0) ub = 21	9	12.5	152	1,210
# of weekly MDT	Group 1 (1)	24	33.3	535	4,214
	Group 2 (2)	14	19.4	374	2,661
	Group 3 (>2) ub = 7	9	12.5	265	2,217
	Group 4 (unknown)	25	34.7	806	5,399
# of plastic surgeons/100 diagnoses	Group 1 (0/0.5)	4	5.6	43	453
	Group 2 (0.5/2.5)	60	83.3	1,713	12,791
	Group 3 (>2.5) ub = 23	7	9.7	215	1,136
	Group 4 (unknown)	1	1.4	9	111
# of breast-surgeons/100 diagnoses	Group 1 (0/1.5)	28	38.9	932	7,181
	Group 2 (1.5/2.5)	35	48.6	908	6,320
	Group 3 (>2.5) ub = 17	9	12.5	140	990
Attendance plastic surgeon at weekly MDT	Never or incidental	13	18.1	294	2,404
	Yes, structural	51	70.8	1,381	10,145
	Unknown	8	11.1	305	1,942

ub = upper boundary MDT = multidisciplinary team meetings.

0.5–2.5 plastic surgeons per 100 new diagnoses of breast cancer were available. For breast surgeons, most hospitals (49%) reported to have 1.5–2.5 breast surgeons per 100 new diagnoses of breast cancer (Table 1).

On average, 41% (n = 809) of the patients underwent IBR after a mastectomy for DCIS. The hospital variation in performing IBR for DCIS varied between 0 and 80%. The average rate of IBR for invasive breast cancer was 17% (n = 2,435) with a hospital variation ranging from 0 to 62%.

3.2. DCIS

Hospital organizational factors such as hospital type, hospital volume, number of weekly MDT meetings, number of plastic surgeons per 100 new diagnoses and the attendance of plastic surgeon at weekly MDT meetings significantly affected IBR rates in univariable analyses. Consequently, these variables were included in the multivariable model (Table 2). The percentage of mastectomies (related to all surgical excisions), and the number of breast surgeons available at institution per 100 new diagnoses did not affect IBR rates significantly in univariable analyses and were therefore not included in multivariable analyses.

Because age, SES and grade significantly affected IBR rates (data not shown) [10], these factors were included in the multivariable model to correct for confounding (Table 2). The multivariable model demonstrated that patients who underwent a mastectomy for DCIS at the cancer specific hospital had a higher chance of receiving IBR (OR = 6.10 95%CI: 3.34–11.13) compared to patients receiving a mastectomy at a district hospital. Patients treated at a teaching (OR = 1.33, 95%CI: 0.97–1.83) or university hospital (OR = 0.97, 95%CI: 0.47–1.99) did not have a significant higher chance of receiving IBR compared to patients treated at a district hospital. The percentage of patients receiving IBR increased with an increasing number of plastic surgeons practicing in that specific hospital. Hospitals with more than 2.5 plastic surgeons per 100 diagnoses had a more than 3 fold higher IBR rate in comparison to hospitals with no or limited plastic surgeons available (OR = 3.26, 95%CI: 1.11–9.59). The structural attendance of a plastic surgeon at the weekly MDT meeting was significantly associated with a higher IBR rate compared to MDTs with no or incidental plastic surgeon attendance (OR = 1.52, 95%CI: 1.10–2.10) (Table 2).

In Fig. 1, the variation between hospitals in the use of IBR after mastectomy for DCIS in the Netherlands is demonstrated. Case-mix adjustments for patient and tumor factors significantly affecting the use of IBR were performed. Also adjustments for hospital organizational factors were performed, due to the characteristics of a multilevel analysis. Adjusted data demonstrated a decrease in hospital variation in the use of IBR from 0-80% to 0–49%.

3.3. Invasive breast cancer

The hospital organizational factors (hospital type, hospital volume, percentage of mastectomies, number of weekly MDT meetings, number of plastic surgeons per 100 new diagnoses, number of breast surgeons per 100 new diagnoses and the attendance of plastic surgeon at weekly MDT meeting) demonstrated to significantly affect IBR rates in univariable analyses and were included in the multivariable model (Table 3).

Because patient (age, SES) and tumor factors (tumor and nodal stage, multifocality, grade) significantly affected IBR rates (data not shown) [10], these factors were included in the multivariable model to correct for confounding (Table 3). The multivariable

Table 2
Univariable and multivariable analyses of hospital organization factors affecting the use of IBR after mastectomy for 1,980 patients with DCIS.

		Immediate breast reconstruction (DCIS) (n = 1,980)								
		No	%	Yes	%	Total	Univariable		Multivariable[a]	
							OR	95% CI	OR	95% CI
Hospital Type	District Hospital	355	71.14	144	28.86	499	ref		ref	
	Teaching Hospital	663	59.95	443	40.05	1,106	1.65	1.31–2.07	1.33	0.97–1.83
	University Hospital	127	52.26	116	47.74	243	2.25	1.64–3.09	0.97	0.47–1.99
	Cancer specific hospital	26	19.70	106	80.30	132	10.05	6.28–16.09	6.10	3.34–11.13
Volume (# diagnosis annually)	Group 1 (1/150)	278	66.19	142	33.81	420	ref		ref	
	Group 2 (150/300)	627	56.54	482	43.46	1,109	1.50	1.19–1.90	1.25	0.88–1.78
	Group 3 (>300) ub = 436	266	58.98	185	41.02	451	1.36	1.03–1.79	1.19	0.78–1.82
% mastectomies (of all surgical excisions)	Group 1 (0/30)	52	57.78	38	42.22	90	ref			
	Group 2 (30/50))	731	57.33	544	42.67	1,275	1.02	0.66–1.57		
	Group 3 (50/90)	388	63.09	227	36.91	615	0.80	0.51–1.25		
# of weekly MDT	Group 1 (1)	361	67.84	174	32.52	535	0.59	0.44–0.80	0.69	0.47–1.02
	Group 2 (2)	237	63.37	137	36.63	374	0.71	0.51–0.98	0.67	0.45–0.99
	Group 3 (>2) ub = 7	146	55.09	119	44.91	265	ref		ref	
	Group 4 (unknown)	427	52.98	379	47.02	806	1.09	0.82–1.44	0.71	0.48–1.04
# of plastic surgeons/100 diagnoses	Group 1 (0/0,5)	33	76.74	10	23.26	43	ref		ref	
	Group 2 (0,5/2,5)	1,021	59.60	692	40.40	1,713	2.24	1.10–4.57	1.56	0.70–3.47
	Group 3 (>2,5) ub = 23	108	50.23	107	49.77	215	3.27	1.53–6.97	3.26	1.11–9.59
	Group 4 (unknown)	9	100.00	0	0.00	9	omitted		omitted	
# of breast-surgeons/100 diagnoses	Group 1 (0/1,5)	532	57.08	400	42.92	932	ref			
	Group 2 (1,5/2,5)	552	60.79	356	39.21	908	0.86	0.71–1.03		
	Group 3 (>2,5) ub = 17	87	62.14	53	37.86	140	0.81	0.56–1.17		
Attendance plastic surgeon in weekly MDT	Never or incidental	209	71.09	85	28.91	294	ref		ref	
	Yes, structural	798	57.78	583	42.22	1,381	1.80	1.37–2.36	1.52	1.10–2.10
	Unknown	164	53.77	141	46.23	305	2.11	1.51–2.96	2.15	1.39–3.34
Radiation therapy	No	1,152	59.20	794	40.80	1,946	Ref			
	Yes	19	55.88	15	44.12	34	1.15	0.58–2.27		

ub = upper bound MDT = multidisciplinary team meetings.
[a] Corrected for age, grade, social economic state, hospital type, hospital volume, % referrals for mastectomy, number of weekly MDT, number of plastic surgeons and attendance of plastic surgeon at weekly MDT.

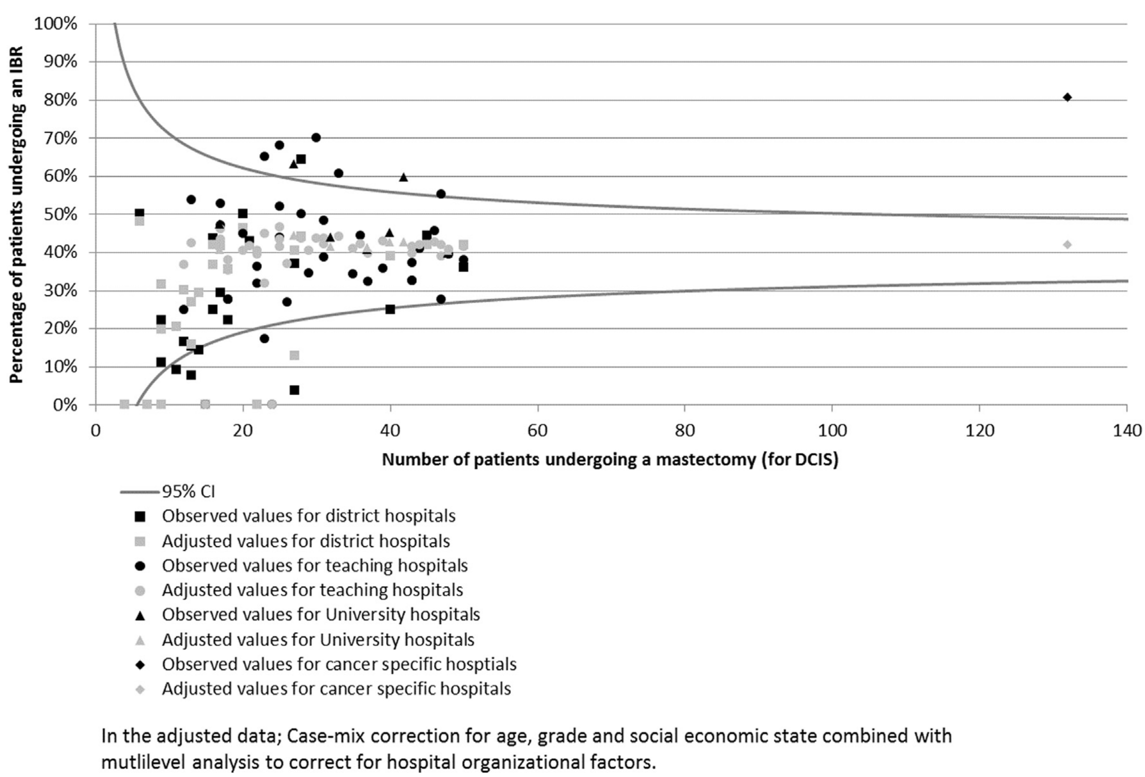

Fig. 1. Funnel plot demonstrating the variation in the use of IBR for DCIS between hospitals in the Netherlands with and without case-mix correction for patient and tumor factors, combined with multilevel analyses to adjust for hospital factors.

Table 3
Univariable and multivariable analyses of hospital organization factors affecting the use of IBR after mastectomy for 14,491 invasive breast cancer patients.

		Immediate breast reconstruction (invasive breast cancer) (n = 14,491)								
		No	%	Yes	%	Total	Univariable		Multivariable[a]	
							OR	95% CI	OR	95% CI
Hospital Type	District Hospital	3,582	88.58	462	11.42	4,044	ref		ref	
	Teaching Hospital	7,232	83.86	1,392	16.14	8,624	1.49	1.33–1.67	0.97	0.83–1.14
	University Hospital	1,042	80.22	257	19.78	1,299	1.91	1.62–2.26	0.65	0.45–0.95
	Cancer specific hospital	200	38.17	324	61.83	524	12.56	10.27–15.36	13.39	9.76–18.38
Volume (# diagnosis annually)	Group 1 (1/150)	2,579	88.32	341	11.68	2,920	ref		ref	
	Group 2 (150/300)	6,596	82.21	1,427	17.79	8,023	1.64	1.44–1.86	1.20	0.97–1.48
	Group 3 (>300) ub = 436	2,881	81.20	667	18.80	3,548	1.75	1.52–2.02	1.29	1.00–1.65
% mastectomies (of all surgical excisions)	Group 1 (0/30)	537	87.75	75	12.25	612	ref		ref	
	Group 2 (30/50))	7,861	82.70	1,644	17.30	9,505	1.50	1.17–1.92	1.15	0.87–1.54
	Group 3 (50/90)	3,658	83.63	716	16.37	4,374	1.40	1.09–1.81	1.50	1.11–2.02
# of weekly MDT	Group 1 (1)	3,550	84.24	664	15.76	4,214	0.65	0.57–0.74	0.74	0.61–0.89
	Group 2 (2)	2,340	87.94	321	12.06	2,661	0.48	0.41–0.56	0.66	0.54–0.82
	Group 3 (>2) ub = 7	1,722	77.67	495	22.33	2,217	ref		ref	
	Group 4 (unknown)	4,444	82.31	955	17.69	5,399	0.75	0.66–0.84	0.48	0.39–0.59
# of plastic surgeons/100 diagnoses	Group 1 (0/0,5)	441	97.35	12	2.65	453	ref		ref	
	Group 2 (0,5/2,5)	10,606	82.92	2,185	17.08	12,791	7.57	4.26–13.46	5.55	3.04–10.11
	Group 3 (>2,5) ub = 23	898	79.05	238	20.95	1,136	9.74	5.39–17.59	12.33	6.03–25.21
	Group 4 (unknown)	111	100.00	0	0	111	omitted		omitted	
# of breast-surgeons/100 diagnoses	Group 1 (0/1,5)	5,793	80.67	1,388	19.33	7,181	ref			
	Group 2 (1,5/2,5)	5,394	85.35	926	14.65	6,320	0.72	0.65–0.78	0.76	0.65–0.88
	Group 3 (>2,5) ub = 17	869	87.78	121	12.22	990	0.58	0.48–0.71	0.64	0.47–0.87
Attendance plastic surgeon in weekly MDT	Never or incidental	2,227	92.64	177	7.36	2,404	ref			
	Yes, structural	8,144	80.28	2,001	19.72	10,145	3.09	2.63–3.63	2.91	2.39–3.54
	Unknown	1,685	86.77	257	13.23	1,942	1.92	1.57–2.35	2.49	1.91–3.24
Radiation therapy	No	8,162	79.96	2,046	20.04	10,208	Ref			0.39–0.53
	Yes	3,894	90.92	389	9.08	4,283	0.40	0.36–0.45	0.45	

Table 1-letter:
ub = upper boundary MDT = multidisciplinary team meetings.
[a] Corrected for age, tumor type, clinical tumor stage, clinical lymph node stage, grade, multifocality, social economic state, hospital type, hospital volume % mastectomies (of all surgical excisions), % referrals for mastectomy, number of plastic surgeons,# of breast-surgeons/100 diagnoses, attendance of plastic surgeon at weekly MDT and radiation therapy.

model demonstrated that patients who underwent a mastectomy at a cancer specific hospital had a higher chance of receiving IBR (OR = 13.39, 95%CI: 9.76–18.38) compared to patients who received a mastectomy at a district hospital. As for DCIS, invasive breast cancer patients who were treated at a teaching hospital did not have a significantly higher chance of receiving IBR (OR = 0.97, 95%CI: 0.83–1.14) compared to patients treated at a district hospital. University hospitals demonstrated to perform significantly less IBRs compared to district hospitals, (OR = 0.65, 95% CI:0.45–0.95).

Also the number of weekly MDT meetings positively affected the rate of IBR. Hospitals having one or two MDT meetings per week (OR = 0.74, 95%CI: 0.61–0.89 and OR = 0.66, 95%CI: 0.54–0.82, respectively) performed significantly less IBRs compared to hospitals that organized more than two MDT meetings per week. The percentage of patients receiving IBR increased with an increasing number of plastic surgeons practicing in that specific hospital. Hospitals with 0.5–2.5 plastic surgeons per 100 new diagnoses of breast cancer performed 5-fold more IBRs (OR = 5.55, 95%CI: 3.04–10.11) and hospitals with more than 2.5 plastic surgeons performed almost twelve-fold more IBRs (OR = 12.33, 95%CI: 6.03–25.21) compared to hospitals with less than 0.5 plastic surgeons per 100 diagnoses of breast cancer. The number of breast surgeons did not affect IBR rates. The structural attendance of a plastic surgeon at the weekly MDT meeting was strongly associated with performing more IBRs compared to MDT meetings with no or incidental plastic surgeon attendance (OR = 2.91 95%CI: 2.39–3.54).

In Fig. 2, the variation between hospitals in the use of IBR after mastectomy for invasive breast cancer in the Netherlands is demonstrated. Case-mix adjustments for patient and tumor factors, significantly affecting the use of IBR were performed. Also adjustments for hospital organizational factors were performed, due to the characteristics of a multilevel analysis. Adjusted data demonstrated a decrease in hospital variation in the use of IBR from 0-62% to 0–18%.

4. Discussion

It is known that various patient and tumor characteristics significantly affect IBR rates [10]. However, these characteristics were not fully responsible for the observed large hospital variation in the use of IBR following mastectomy in the current cohort [10]. Like other studies, we were able to show that hospital organizational factors such as hospital type, patient volume or presence and availability of a plastic surgery facility may additionally explain part of the hospital variation [8–12]. In previous research, Jagsi et al., demonstrated the influence of radiation therapy on the chance of receiving a reconstruction [16]. Although the focus of the current study was hospital characteristic, we performed an analysis to determine the possible influence of radiation therapy. This revealed similar results as demonstrated by Jagsi et al. Moreover, radiation therapy does not influence the effects of the hospital organizational factors in multivariable analysis.

The current population based study shows that multiple hospital organizational factors affect the use of IBR after mastectomy for DCIS and breast cancer in the Netherlands. Hospital type (cancer specific centre), the number of plastic surgeons and the structural attendance of a plastic surgeon at the MDT meeting increased IBR rates significantly for both DCIS and non-metastatic invasive breast cancer. For invasive breast cancer, also the percentage of mastectomies related to all surgical excisions (>50%), >2 weekly MDTs and

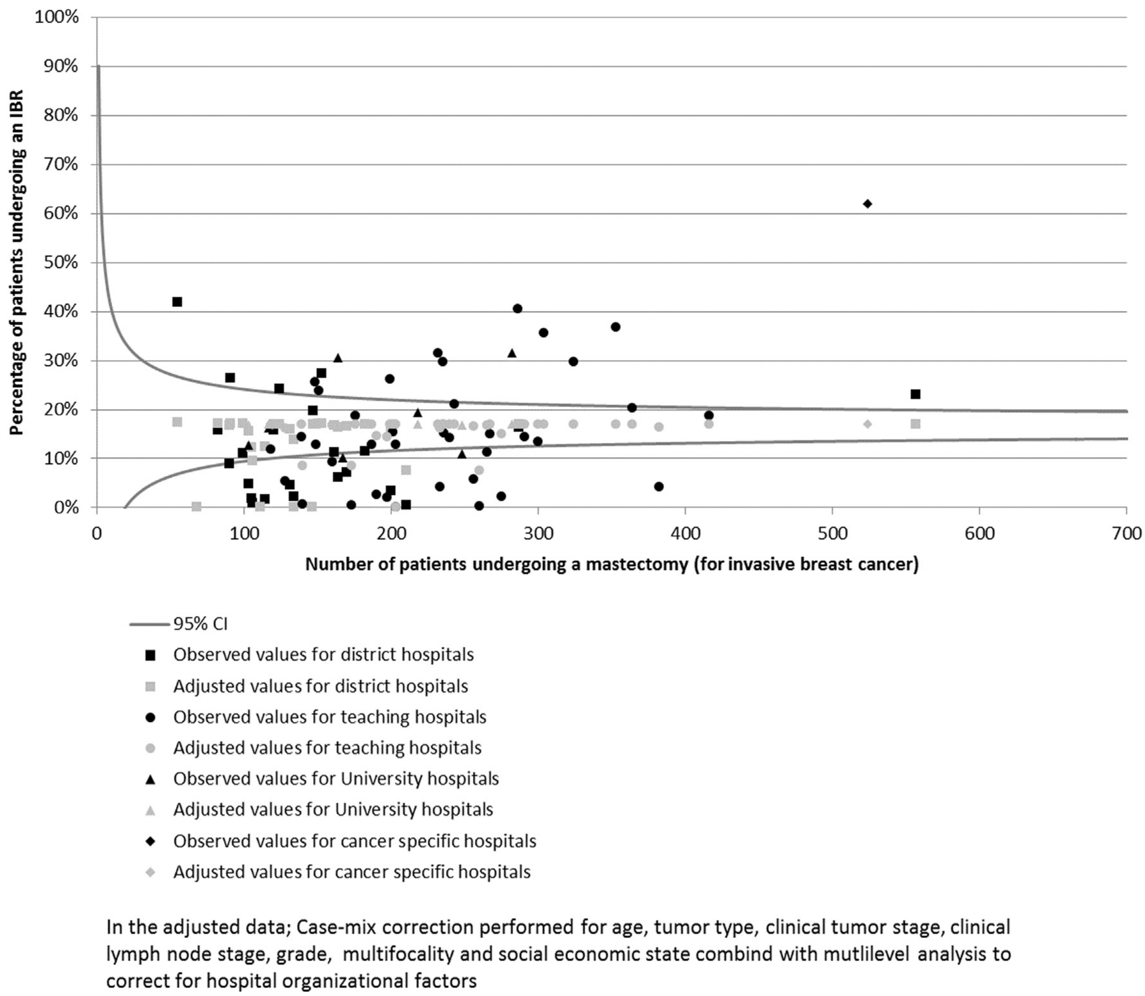

Fig. 2. Funnel plot demonstrating the variation in the use of IBR for invasive breast cancer between hospitals in the Netherlands with and without case-mix correction for patient and tumor factors, combined with multilevel analyses to adjust for hospital factors.

number of plastic surgeons available at institution (>0.5 per 100 new diagnoses) significantly increased IBR rates.

Therefore, the use of IBR in breast cancer patients could be improved by optimization of these hospital organizational factors. Although the aim of the present study was not to stimulate performing more IBRs in clinical practice, we feel that the availability of IBR for eligible patients should be more or less comparable between hospitals and unrelated to hospital organizational factors. However, hospital variation could only be partially explained by hospital organizational factors in the present study.

A large variation was found in the use of IBR for DCIS or invasive breast cancer between hospitals that were included in the current study. The large variation is comparable with other studies; IBR was performed in 21% of the mastectomy patients in the United Kingdom and 24% in the United States [2,11]. Our data demonstrated that some hospitals tended not to perform IBR, however, the referral rates for IBR revealed that there were collaborations between hospitals. Therefore, it is possible that hospitals referred their patients to other hospitals in case IBR was preferred. Like others, we demonstrated that collaboration between hospitals does not significantly affect IBR rates in the hospital of referral. An English national study also reported similar hospital variation in performing IBR after statistically correcting for hospital collaborations [2].

Different hospital organizational factors were investigated and appeared to be related to the use of IBR in the present study. For example, hospital type (cancer specific hospital) significantly affected IBR rates. Other nationwide studies also demonstrated the relationship between hospital type and IBR rates [11,17]. Alderman et al. demonstrated that IBR rates were most probably higher in specialized cancer centers, because of high referrals to plastic surgeons [19].

Others revealed that high volume clinical breast hospitals extensively collaborate with plastic surgery departments, which could result in higher IBR rates [13,19]. We were not able to demonstrate a significant association between higher volume hospital (>150 diagnoses) and higher IBR rates for invasive breast cancer.

In our study a higher number of plastic surgeons working in a hospital positively affected IBR rates. However, the number of breast surgeons working in a hospital did not. Breast Surgeons in the Netherlands differ from the Breast Surgeons in other countries, since Dutch oncologic breast surgeons only perform breast ablative surgery or breast conserving surgery and do not carry out breast reconstructions, which is exclusively performed by plastic surgeons. In addition, the presence of a plastic surgeon at the MDT meeting positively affected the use of IBR. Alderman et al. demonstrated that a large proportion of surgeons did not refer breast cancer patients to a plastic surgeon at the time of surgical decision-making [19]. This implicates the relevance of the attendance of a plastic surgeon at the weekly MDT meeting to timely discuss the possibility of IBR. However, in Dutch clinical practice, it is quite common for patients to visit the plastic surgeon before surgery. Interestingly, Alderman et al. also concluded that surgeons who have a high referral propensity are more likely to be women [19]. Unfortunately we did not have information on gender of the (plastic) surgeon.

4.1. Limitations

In total, 72 of the 92 of the Dutch hospitals (78.3%) participated in this study, despite repeated invitations to the non-responding hospitals. However, the included hospitals are a good reflection of all Dutch hospitals, since representative proportions of hospital type and hospital volume were included.

Although we were able to demonstrate a significant effect of hospital type on IBR rates, it is important to realize that even *within* three out of four hospital categories variation in performing IBR existed.

DCIS and invasive breast cancer were analyzed separately, to make testing for confounding (tumor factors such as tumor and nodal stage) possible. However, due to low numbers of DCIS patients we were not able to demonstrate the same significant effect of hospital organizational factors on IBR rates as for invasive breast cancer.

To investigate the effect of hospital factors explaining variation in performing IBR, a multilevel analysis was performed to obtain the adjusted data for the funnel plot. The demonstrated reduction in variation after case-mix correction for patient and tumor factors was mainly caused by hospital factors. Other undefined hospital related factors could have contributed to this reduction, such as surgeons' attitude towards IBR, gender of surgeon, geographical location, waiting times for plastic surgery, patient preferences and loss of control of patient's management [11,15]. Jeevan et al. demonstrated that 50% of the patients were very satisfied with the options they received about breast reconstruction but preferred no IBR [2]. Further research should identify patient preferences and surgeon's attitudes towards IBR and whether or not these factors can explain the variation in performing IBR completely; such a study is on its way.

5. Conclusion

Large hospital variation in IBR rates was observed between hospitals in the Netherlands. The current study demonstrated that the observed variation in performing IBR was significantly affected by hospital type, but also by organizational factors that could be subject for change and improvement. Although hospital variation could only be partially explained by these factors, optimization of these factors could lead to an increased use of IBR in breast cancer patients and less variation in IBR rates between hospitals.

Ethical 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.

Disclaimers

Nothing to declare.

Conflict of interest statement

The authors declare that they have no conflict of interest.

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