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Breast cancer management and outcome according to surgeon's affiliation: a population-based comparison adjusted for patient's selection bias

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Background: Studies have reported that breast cancer (BC) units could increase the quality of care but none has evaluated the efficacy of alternative options such as private BC networks, which is our study objective.
Patients and methods: We included all 1404 BC patients operated in the public unit or the private network and recorded at the Geneva Cancer Registry between 2000 and 2005. We compared quality indicators of care between the

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public BC unit and the private BC network by logistic regression and evaluated the effect of surgeon's affiliation on BC-specific mortality by the Cox model adjusting for the propensity score.
Results: Both the groups had high care quality scores. For invasive cancer, histological assessment before surgery and axillary lymph node dissection when indicated were less frequent in the public sector (adjusted odds ratio (OR): 0.4, 95% confidence interval (CI) 0.3–0.7, and OR: 0.4, 95% CI 0.2–0.8, respectively), while radiation therapy after breast-conserving surgery was more frequent (OR: 2.5, 95% CI 1.4–4.8). Surgeon affiliation had no substantial effect on BC-specific mortality (adjusted hazard ratio (HR): 0.8, 95% CI 0.5–1.4).
Conclusions: This study suggests that private BC networks could be an alternative to public BC units with both structures presenting high quality indicators of BC care and similar BC-specific mortality.
Key words: breast cancer, network, prognosis, quality of care, unit

introduction

Breast cancer (BC) management has dramatically changed in the last two decades becoming increasingly complex. BC care requires a comprehensive assessment of multiple tasks needing a multidisciplinary approach. Professional organizations like the European Society of Breast Cancer Specialists (EUSOMA) have issued several recommendations to raise the quality of care of BC patients [1]. Among those, dedicated BC units with multidisciplinary pre-therapeutic meetings are proposed to stimulate professionals to collaborate, to increase their experience, and to continue professional training. Such units have been progressively implemented in Europe with the goal of ensuring high quality standards to all BC patients. In Switzerland, the Swiss Cancer League with the help of professional societies is currently developing guidelines for accreditation of future Swiss BC units [2].

However, the implementation and accreditation of protocols of such units are quite rigid in structure. Although the published literature tends to support the efficacy of such BC units, the level of evidence remains weak [3]. Putative alternative and more flexible options to BC units, such as BC networks of health care professionals, have been created but have never been evaluated in terms of efficacy.

The Swiss canton of Geneva has a particularly high incidence rate of BC, but survival rates are among the highest in Europe [4, 5]. The canton of Geneva presents also the best survival and quality indicators of BC care in Switzerland [6]. Geneva, with its ~450 000 inhabitants, is essentially urban and provides dense medical resources. The Swiss health care system is based on a federal law called LAMal (voted on 18 March 1994) that consists of a basic health insurance that each individual has to contract. This compulsory insurance covers for everybody universal access to preventive and therapeutic care as well as pharmaceuticals. The costs per person are about 350 Euros per month. The Swiss government covers the complete medical insurance fees for indigent individuals (~10% of the population) and part of the fees for people with low income (~17% of the population). Approximately 25% of the population contract supplementary health insurance to benefit of care not covered by the compulsory health insurance (i.e. free choice of hospital physicians and superior levels of hospital accommodation).

Approximately 50% of BC patients are treated in the private sector. Both the public and private sectors offer an exhaustive range of care covering screening mammography, diagnostic magnetic resonance imaging (MRI), positron emission tomography (PET scan), pathology laboratories to well-equipped operating rooms.

In the public sector, the public BC unit has established a systematic multidisciplinary consultation meeting weekly to discuss the best therapeutic approaches for all new BC cases referred to the Geneva University Hospitals since 2001. In addition, all cases are rediscussed after the first-line treatments for the proposition of adjuvant treatments and follow-up.

In the private sector, the BC network SONGe (Séno ONcologie Genevoise), found in 2000, regroups most of the private health professionals with particular interest in the field of BC care. This network meets every month to discuss new topics in BC management in order to reach the highest clinical standards.

Other private practitioners, who are not affiliated to the BC network, are mostly gynecologists and surgeons who also operate BC but are not specialized in BC surgery.

The objective of our study is to compare BC quality of care and outcome between patients operated by surgeons of the public BC unit and those operated by surgeons of the private BC network after accounting for the biases linked to patients' selection. This study was requested by the BC network to assess the quality of its BC management.

patients and methods

patient, tumor and treatment characteristics

We used data from the Geneva Cancer Registry, which records all incident cancers occurring in the population of the canton. All hospitals, pathology laboratories and practitioners are requested to report all cancer cases. Registrars abstract data from medical and laboratory records. Physicians regularly receive questionnaires to secure missing data. Recorded data include sociodemographic variables, tumor characteristics (coded according to the International Classification of Diseases for Oncology ICD-O), stage at diagnosis (coded according to the TNM Classification of Malignant Tumors), and treatment received within 6 months after diagnosis [7, 8].

The Registry regularly assesses survival. The index date refers to the date of confirmation of diagnosis or the date of hospitalization if it precedes the diagnosis and is related to the disease. In addition to passive follow-up (routine examination of death certificates and hospital records), active follow-up is carried out yearly by linking the files of the Cantonal Population Office in charge of the registration of the resident population with the Registry database, using a personal identity number.

The exact cause of death is established by systematically consulting clinical records and/or by inquiring the patient's physician. The cause of

death is coded according to the international statistical classification of diseases and health-related problems established by the World Health Organization [9].

Among the 2075 women diagnosed with a first primary BC in 2000–2005 who have undergone surgery for the first treatment, we excluded from the analysis patients operated outside Geneva ($N = 63$, 3.0%) or by other hospital services other than the public BC unit (i.e. thoracic surgery) ($N = 31$, 1.5%), and by private surgeon's not affiliated to the private BC network ($N = 577$, 28%). The study finally included 1404 BC patients. Patients were followed up for survival until 31 December 2009.

Variables of interest included: age (<50, 50–69, 70–79, ≥80 years); period of diagnosis (2000–2002, 2003–2005); social class coded according to the last occupation of the woman, and for unemployed, that of the spouse (high, medium, low, unknown); country of birth (Switzerland, Southern Europe, other); family history of breast or ovarian cancer (high: at least one first-degree relative diagnosed with breast or ovarian cancer before the age of 50 years, none: no affected first- or second-degree relative with breast or ovarian cancer, medium: all other known family histories, unknown); method of discovery (mammography screening, clinical screening, breast self-examination, other, unknown); stage coded according to the pathological tumor, node, metastasis (pTNM) classification of malignant tumors (*In situ*, I, II, III, IV, unknown); pathological surgical tumor size (in mm); tumor grade (well, moderately, poorly differentiated, unknown); histology (ductal, lobular, other); estrogen and progesterone receptor status (positive if ≥10% expressed, negative, unknown); human epidermal growth factor receptor 2 (HER2) (positive, negative, unknown); type of surgery (breast-conserving surgery, mastectomy); number of surgeries (1, >1); surgical margins (positive, negative, unknown); sentinel lymph node research (yes, no); axillary lymph node dissection (yes, no); number of lymph nodes removed (<10, ≥10); radiotherapy (yes, no); chemotherapy (yes, no); and hormonal therapy (yes, no).

surgeon groups

We divided BC patients into two groups according to the surgeon's affiliation: the public BC unit and the private BC network.

The public BC unit regroups university hospital professionals working in the field of BC care, i.e. gynecologists, medical oncologists, radio oncologists, plastic surgeons, pathologists, radiologists, social assistants, and specialized BC nurses. These specialists meet on a weekly basis to discuss the best therapeutic options for each newly diagnosed BC patient. For the majority of patients, one meeting is sufficient. If supplementary investigations are needed, the multidisciplinary team refers the final pre-therapeutic decision to a second meeting. When the patient has undergone the first-line treatments, her files are reviewed again to propose the best adjuvant treatment and follow-up.

The private BC network meets monthly to discuss advances in BC treatment and research. This private network regroups all professionals in the private sector with particular interest in BC care including gynecologists, medical oncologists, radio oncologists, plastic surgeons, pathologists, and radiologists. Affiliation to the private BC network has progressively been strengthened and membership criteria include experience in BC diagnosis and treatment, participation in international congresses and/or presentations in national or local congresses in their field. Every 2 years, the network organizes a symposium on the latest standards for BC guidelines and controversies. Contrary to the public BC unit, BC patients are not systematically presented to the other members of the network. Instead, the multidisciplinary work-up is tailored according to the situation of the patient and left to the appreciation of the first specialist who treated the patient.

indicators of quality of care

We a priori defined state of the art treatment according to the quality indicators set by the EUSOMA [10]. We selected indicators which could be determined from our Registry database.

For *in situ* cancer, we retained the following quality indicators: (i) reporting of tumor size and grade; (ii) histological assessment before surgery; (iii) a single operation for the primary tumor (excluding reconstruction); (iv) negative surgical margin; (v) lack of axillary lymph node dissection; (vi) breast-conserving surgery for tumor ≤2 cm; and (vii) radiotherapy after breast-conserving surgery. The last indicator does not appear in the EUSOMA guidelines but was built on the basis of the last Cochrane review on post-operative radiotherapy for ductal carcinoma *in situ* of the breast [11].

For invasive cancer, we considered the following indicators: (i) reporting of tumor size, grading, and estrogens receptor status; (ii), (iii), and (iv) the same as for *in situ* cancer; (v) sentinel lymph node biopsy for clinically negative axilla; (vi) axillary lymph node dissection when the lymp node is clinically (physically and/or by imaging) suspect of metastasis or positive lymph node sentinel biopsy; (vii) at least 10 lymph nodes removed when axillary dissection was carried out; (viii) breast-conserving surgery for tumor ≤3 cm; (ix) radiotherapy after breast-conserving surgery if no metastasis; (x) radiotherapy after mastectomy for pT3 or pT4 or positive margin or ≥pN2a; (xi) endocrine therapy for estrogen receptor-positive tumors; and (xii) chemotherapy for estrogen receptor-negative tumors >1 cm or *N* positive or age ≤35 years. Each indicator was scored 1 when correctly carried out, 0 otherwise. Indicators were scored only if the item was applicable to the patient.

We developed one overall score of good practice for *in situ* using the seven items and one for invasive cancer using the twelve items. The overall score obtained by dividing the sum of the values attained at the pertinent items by the total number of pertinent items multiplied by 100. For example, in the presence of a patient with a 5 cm *in situ* tumor with no mention of tumor grade in the pathological report, with histological assessment before surgery, with two operations for the primary tumor, with negative margins, without axillary lymph node dissection, and mastectomy, the score calculation is as follows: item 1 = 0, item 2 = 1, item 3 = 0, item 4 = 1, item 5 = 1, item 6 = not pertinent, and item 7 = not pertinent; the sum is 3, divided by 5 pertinent items = 60%.

statistical analysis

We compared patient and tumor characteristics between the two groups of surgeons by χ^2 test. We also evaluated the differences in the quality of diagnosis and treatment by logistic regression, considering as cases women operated by surgeons affiliated to the public BC unit, and as controls those operated by surgeons of the private BC network. We evaluated the effect of surgeon's affiliation on BC-specific mortality by Cox models. To account for the bias related to the selection of patients,, i.e. the nonrandom assignment to the surgeon's group, we adjusted all analyses by the propensity score [12]. To build the propensity score, we identified by logistic regression substantial sociodemographic differences between the surgeon groups and derived a continuous variable which predicted the individual probability to be treated by one of the two groups.

We considered differences to be statistically significant at P value <0.05 and used SPSS software (Version 14; SPSS Inc, Chicago, IL, USA).

results

patient, and tumor characteristics according to surgeon's affiliation

Of the 1404 patients, 166 had *in situ* and 1238 invasive BC. Surgeons of the public BC unit operated 50% ($N = 83$) of the

in situ cancer patients and 60.7% ($N = 752$) of the patients with invasive tumors. Patient and tumor characteristics are presented in Table 1 for *in situ* cancer and Table 2 for invasive cancer. For *in situ* cancer, when compared with women operated in the private BC network, women operated by a surgeon of the public BC unit were of lower social class, had less frequently tumor detected by mammography screening, had more often a report on tumor grade, and presented more frequently a tumor with non-ductal histology (Table 1). In the logistic regression model, two variables,, i.e. period of diagnosis and social class, were retained by the logistic regression model to build the propensity score.

For invasive cancer, patients treated by surgeons from the public BC unit were older, of lower social class, were more often born in Southern Europe, and had less often tumor detected by screening. For other remaining variables such as familial history, tumor characteristics (including stage, hormone receptor status, and grade), there were no differences among the surgeon groups. In fact, the only substantial difference was the lower proportion of unknown data for patients treated by public BC unit surgeons compared with those treated by surgeons of the private BC network (Table 2). In the logistic regression model, the propensity score was built on age, country of birth, and social class.

score of quality of care according to surgeon's affiliation

Tables 3 and 4 show the distribution of quality indicators between the two surgeon groups for *in situ* and invasive cancer, respectively. The tables also present the P values of the χ^2 tests and the odds ratios (OR) derived from the logistic regression adjusted for the propensity scores (right columns).

For *in situ* cancer, the mean score of care quality (based on the seven relevant items) was high in each group: 82% for the public BC unit and 78% for the private BC network ($P = 0.132$). Only two indicators were substantially different between the public BC unit and the private BC network. Higher report of *in situ* tumor size and grading was observed for women operated by the public BC unit surgeons [69% versus 42%, OR adjusted for the propensity score for the public BC unit versus private BC network: 3.0, 95% confidence interval (CI): 1.5–5.8, $P = 0.001$]. Conversely, the public BC unit surgeons carried out less frequently breast-conserving surgery when indicated than surgeons in the private BC network (65% versus 90%, OR: 0.3, 95% CI 0.1–0.9, $P = 0.030$). We observed no differences for other indicators.

For invasive cancer, the mean score of quality (based on twelve items) was high with a slight but significant difference in favor of patients treated by the surgeons of the private BC network (85% for the public BC unit and 87% for the private BC network; $P = 0.007$). Significant differences existed between the two groups concerning the histological assessment before surgery, which was not reported in 13% of the public BC unit patient files compared with only 6% in the private BC network (OR: 0.4, 95% CI 0.3–0.7, $P < 0.000$). The use of axillary lymph node dissection when indicated was lower in the public BC unit than in the private BC network (85% versus 94%, OR: 0.4, 95% CI 0.2–0.8, $P = 0.018$). Radiation therapy after breast-conserving surgery was more frequently carried out for patients operated by the public BC unit surgeons than those operated by the private BC network surgeons (96% versus 93%, OR: 2.5, 95% CI 1.3–4.8, $P = 0.004$). The use of tamoxifen, when indicated, tended to be more frequent in the public BC unit than in the private BC network. The opposite was observed for the use of chemotherapy. However, the last two results were not significant in adjusted analysis.

breast cancer BC-specific mortality according to surgeon's affiliation

The mean follow-up of patients with invasive cancer was 6.3 years and 67 women died from BC during the study follow-up.

Table 5 presents the effect of surgeon's affiliation on BC-specific mortality among patients with invasive BC. Hazard ratios (HRs) were adjusted for propensity scores. The surgeon's affiliation had no substantial effect on BC-specific mortality (adjusted HR for women operated by surgeons of the BC network when compared with those operated by surgeons of the public BC unit: 0.8, 95% CI 0.5–1.4). Additional adjustment for tumor characteristics (including stage, grade, and tumor receptors) did not modify the result.

discussion

Although there is some scientific evidence that dedicated BC units with multidisciplinary tumor boards increases the quality of care, we have no data evaluating the effectiveness of other approaches [13]. We evaluated whether the quality of care differed between patients treated by surgeons affiliated to the public BC unit and those treated by surgeon members of the private BC network, accounting for patient's selection bias to provide interpretable comparison. We found that the quality of care of the two approaches is high and very close. Furthermore, BC-specific mortality is similar between the two surgeon groups.

For *in situ* cancer, differences in quality indicators between the public BC unit and the private BC network were mainly linked to the higher report rate of *in situ* tumor size and grading for women operated in the public BC unit. This result is due to coding differences between pathologists at the Geneva University Hospitals and those of the private sector. The latter frequently describe cancer grade as 'low/medium' or 'medium/high', making it difficult for registrars to recode data according to the three levels (low, medium, and high) grading classification of disease in oncology used by cancer registries. On the contrary, for women with small tumors, the public BC unit surgeons tended to perform breast-conserving surgery less frequently than surgeons of the private BC network.

For invasive cancer, the histological assessment before surgery was less frequently carried out for patients operated by the public BC unit surgeons, with ~10% of women operated on the basis of cytological evaluation only. Axillary dissection, when indicated, was less frequently carried out by surgeons from the public BC unit, with approximately one-third of the patients not having dissection. On the contrary, radiation therapy after breast-conserving surgery was less frequently

Table 1. Patient, tumor, and treatment characteristics according to surgeon's affiliation among patients with *in situ* breast cancer

	Surgeon's affiliation		*P* value for heterogeneity test[a]
	Public BC unit [*N* (%); 83 (50.0)]	Private BC network [*N* (%); 83 (50.0)]	
Mean age at diagnosis (years)	57.5	57.3	0.942
Age			0.238
<50	21 (25.3)	15 (18.1)	
50–69	48 (57.8)	60 (72.3)	
70–79	11 (13.3)	7 (8.4)	
≥80	3 (3.6)	1 (1.2)	
Period of diagnosis			
2000–2002	44 (53.0)	32 (38.6)	0.086
2003–2005	39 (47.0)	51 (61.4)	
Social class			
High	16 (20.3)	23 (28.0)	0.004
Medium	47 (59.5)	56 (68.3)	
Low	16 (20.3)	3 (3.7)	
Unknown	4 (–)	1 (–)	
Country of birth			
Switzerland	42 (50.6)	47 (56.6)	0.059
Southern Europe	23 (27.7)	11 (13.3)	
Other	18 (21.7)	25 (30.1)	
Method of detection			
Mammography screening	57 (68.7)	67 (82.7)	0.005
Clinical screening	1 (1.2)	3 (3.7)	
Breast self-palpation	5 (6.0)	7 (8.6)	
Other	20 (24.1)	4 (4.9)	
Unknown	—	2 (–)	
Familial history of BC			
High	9 (10.8)	9 (11.5)	0.808
Medium	16 (19.3)	12 (15.4)	
None	58 (69.9)	57 (73.1)	
Unknown	—	5 (–)	
Grade			
Well differentiated	15 (20.5)	9 (22.0)	0.999
Other	58 (79.5)	32 (78.0)	
Unknown	10 (–)	42 (–)	
Histology			
Ductal	77 (92.8)	83 (100.0)	0.044
Lobular	5 (6.0)	—	
Other	1 (1.2)	—	
Estrogen receptor status			
Positive	66 (89.2)	59 (79.7)	0.173
Negative	8 (10.8)	15 (20.3)	
Unknown	9 (–)	9 (1–)	
Progesterone receptor status			
Positive	53 (71.6)	41 (55.4)	0.060
Negative	21 (28.4)	33 (44.6)	
Unknown	9 (–)	9 (–)	
Her2 receptor status[b]			
Positive	9 (64.3)	3 (42.9)	0.397
Negative	5 (35.7)	4 (57.1)	
Unknown	69 (–)	76 (–)	

[a]After exclusion of unknown data.

[b]Since 2001.

BC, breast cancer; HER2, human epidermal growth factor receptor 2.

Table 2. Patient, tumor, and treatment characteristics according to surgeon's affiliation among patients with invasive breast cancer

	Surgeon's affiliation		*P* value for heterogeneity test[a]
	Public BC unit [*N* (%); 752 (60.7)]	Private BC network [*N* (%); 486 (39.3)]	
Mean age at diagnosis (years)	61.8	58.8	<0.001
Age			
<50	141 (18.8)	101 (20.8)	<0.001
50–69	394 (52.4)	306 (63.0)	
70–79	150 (19.9)	61 (12.6)	
≥80	67 (8.9)	18 (3.7)	
Period of diagnosis			
2000–2002	350 (46.5)	237 (48.8)	0.449
2003–2005	402 (53.5)	249 (51.2)	
Social class			
High	90 (12.3)	137 (28.8)	<0.001
Medium	427 (58.3)	295 (62.1)	
Low	215 (29.4)	43 (9.1)	
Unknown	20 (–)	11 (–)	
Country of birth			
Switzerland	362 (48.1)	254 (52.3)	<0.001
Southern Europe	258 (34.3)	96 (19.8)	
Other	132 (17.6)	136 (28.0)	
Method of detection			
Mammography screening	290 (38.6)	201 (42.1)	0.016
Clinical screening	67 (8.9)	63 (13.2)	
Breast self-palpation	288 (38.3)	163 (34.2)	
Other	106 (14.1)	50 (10.5)	
Unknown	1 (–)	9 (–)	
Familial history of BC			
High	68 (9.1)	31 (6.8)	0.125
Medium	173 (23.2)	126 (27.5)	
None	505 (67.7)	302 (65.8)	
Unknown	6 (–)	27 (–)	
Stage			
I	389 (52.2)	236 (50.3)	0.475
II	301 (40.4)	206 (43.9)	
III	51 (6.8)	24 (5.1)	
IV	4 (0.5)	3 (0.6)	
Unknown	7 (–)	17 (–)	
Lymph node invasion			
No	517 (69.1)	317 (67.7)	0.612
Yes	231 (30.9)	151 (32.3)	
Unknown	4 (–)	18 (–)	
Grade			
Well differentiated	250 (34.1)	161 (33.8)	0.950
Other	404 (65.9)	220 (66.2)	
Unknown	18 (–)	9 (–)	
Histology			
Ductal	612 (81.4)	399 (82.1)	0.853
Lobular	109 (14.5)	70 (14.4)	
Other	31 (4.1)	17 (3.5)	
Estrogen receptor status			
Positive	652 (86.8)	429 (89.6)	0.179
Negative	99 (13.2)	50 (10.4)	
Unknown	1 (–)	7 (–)	
Progesterone receptor status			
Positive	552 (73.5)	354 (73.9)	0.895
Negative	199 (26.5)	125 (26.1)	
Unknown	1 (–)	7 (–)	

Continued

Table 2. *Continued*

	Surgeon's affiliation		*P* value for heterogeneity test[a]
	Public BC unit [*N* (%); 752 (60.7)]	Private BC network [*N* (%); 486 (39.3)]	
HER2 receptors[b]			
Positive	135 (24.8)	65 (25.4)	0.861
Negative	409 (75.2)	191 (74.6)	
Unknown	208 (–)	230 (–)	

[a]After exclusion of unknown data.
[b]Recorded since 2001.
BC, breast cancer; HER2, human epidermal growth factor receptor 2.

Table 3. Quality of diagnosis assessment and treatment according to surgeon's affiliation among patients with *in situ* breast cancer

Indicator of quality	Public BC unit [*N* (%); 83 (50.0)]	Private BC network [*N* (%); 83 (50.0)]	*P* value for heterogeneity	Propensity score adjusted odds ratio (OR) comparing public unit versus private network OR (95% CI)	*P* value of logistic regression
Reporting of tumor size and grading					
Yes	57 (68.7)	35 (42.2)	0.001	1 (reference)	0.001
No	26 (31.3)	48 (57.8)		3.0 (1.5–5.8)	
Histological assessment before surgery					
Yes	69 (83.1)	62 (74.7)	0.253	1 (reference)	0.170
No	14 (16.9)	21 (25.3)		1.8 (0.8–3.9)	
Number of interventions					
One	71 (85.5)	66 (79.5)	0.414	1 (reference)	0.607
More	12 (14.5)	17 (20.5)		1.3 (0.5–2.9)	
Surgical margins					
Negative	77 (93.9)	80 (96.4)	0.496	1 (reference)	0.359
Positive	5 (6.1)	3 (3.6)		0.5 (0.1–2.3)	
Unknown	1 (–)	—			
Axillary dissection					
No	73 (88.0)	75 (90.4)	0.804	1 (reference)	0.842
Yes	10 (12.0)	8 (9.6)		1.1 (0.4–3.3)	
Breast-conserving surgery for tumor ≤20 mm					
Yes	32 (65.3)	44 (89.8)	0.007	1 (reference)	0.030
No	17 (34.3)	5 (10.2)		0.3 (0.1–0.9)	
>20 mm or NOS not requested	34 (–)	34 (–)			
Radiotherapy after breast-conserving surgery					
Yes	41 (89.1)	54 (83.1)	0.423	1 (reference)	0.413
No	5 (10.9)	11 (16.9)		1.6 (0.5–5.2)	
Not pertinent (mastectomy)	37 (–)	18 (–)			
Score of care quality					
≤75%	60 (72.3)	46 (55.4)	0.035	1 (reference)	
>75%	23 (27.7)	37 (44.6)		2.3 (1.1–4.5)	0.021
Mean score of quality	81.7	77.8	0.132		

BC, breast cancer.

delivered to patients treated in the private BC network than in the public BC unit.

Reviews on the effect of multidisciplinary care on BC survival in particular, or more generally on all types of cancers conclude that although intrinsically multidisciplinary care should be associated with better survival, there is little evidence to support this [3, 14]. Great disparities exist in study designs and in the definition of multidisciplinary approaches. This also applies for studies on BC units. Some studies have considered the specialization, others the membership of a professional society (association), the affiliation to a specialized center, the hospital or the surgeon's caseload. One cohort study on almost 30 000 operated BC patients in the Los Angeles County has reported that treatment by a surgical oncologist compared with

Table 4. Quality of diagnosis assessment and treatment according to surgeon's affiliation among patients with invasive breast cancer

Indicator of quality	Public BC unit [*N* (%); 752 (60.7)]	Private BC network [*N* (%); 486 (39.3)]	*P* value for heterogeneity	Propensity score adjusted odds ratio (OR) comparing public unit versus private network OR (95% CI)	*P* value of logistic regression
Reporting of hormone receptor, tumor size, and grading					
Yes	719 (95.6)	470 (96.7)	0.373	1 (reference)	0.351
No	33 (4.4)	16 (3.3)		0.7 (0.4–1.4)	
Histological assessment before surgery					
Yes	652 (86.7)	456 (93.8)	<0.001	1 (reference)	<0.001
No	100 (13.3)	30 (6.2)		0.4 (0.3–0.7)	
Number of interventions					
One	651 (86.6)	401 (82.5)	0.061	1 (reference)	0.148
More	101 (13.4)	85 (17.5)		1.3 (0.9–1.8)	
Surgical margins					
Negative	679 (90.9)	455 (93.8)		1 (reference)	
Positive	68 (9.1)	30 (6.2)	0.068	0.7 (0.4–1.1)	0.080
Unknown	5 (–)	1 (–)		excluded	
Sentinel lymph node if indicated[a]					
Yes	368 (69.7)	254 (73.2)	0.286	1 (reference)	0.679
No	160 (30.3)	93 (26.8)		0.9 (0.7–1.3)	
Not pertinent	224 (–)	139 (–)		excluded	
Axillary dissection when indicated[a]					
Yes	187 (85.4)	127 (94.1)	0.015	1 (reference)	0.018
No	32 (14.6)	8 (5.9)		0.4 (0.2–0.8)	
Not pertinent	533 (–)	351 (–)		excluded	
Number of lymph nodes removed					
≥10	281 (75.9)	186 (75.0)	0.849	1 (reference)	0.798
<10	89 (24.1)	62 (25.0)		1.1 (0.7–1.6)	
Not pertinent	382 (–)	238 (–)		excluded	
Breast-conserving surgery when indicated[a]					
Yes	518 (79.2)	366 (84.3)	0.039	1 (reference)	0.105
No	136 (20.8)	68 (15.7)		0.8 (0.5–1.1)	
Not pertinent	98 (–)	52 (–)		excluded	
Breast-conserving surgery and radiotherapy					
Yes	534 (96.4)	353 (92.9)	0.022	1 (reference)	0.004
No	20 (3.6)	27 (7.1)		2.5 (1.4–4.8)	
Not pertinent	198 (–)	106 (–)		excluded	
Mastectomy and radiotherapy when indicated[a]					
Yes	11 (44.0)	7 (70.0)	0.264	1 (reference)	0.314
No	14 (56.0)	3 (30.0)		0.4 (0.1–2.2)	
Not pertinent	727 (–)	476 (–)		excluded	
Anti-estrogen use when indicated[a]					
Yes	611 (93.7)	390 (90.9)	0.096	1 (reference)	0.084
No	41 (6.3)	39 (9.1)		1.5 (0.9–2.5)	
Not pertinent	100 (–)	57 (–)		excluded	
Chemotherapy use when indicated[a]					
Yes	164 (56.0)	131 (72.0)	<0.001	1 (reference)	0.082
No	129 (44.0)	51 (28.0)		0.7 (0.5–1.1)	
Not pertinent	459 (–)	304 (–)		excluded	
Score of care quality					
<50%	24 (3.2)	15 (3.1)	0.030		
<75%	172 (22.9)	86 (17.7)			
<90%	291 (38.7)	176 (36.2)			
>90–100%	265 (35.2)	209 (43.0)			
Score of care quality					
≤75%	196 (26.1)	101 (20.8)	0.035	1 (reference)	0.220
>75%	556 (73.9)	385 (79.2)		0.8 (0.6–1.1)	
Mean score of care quality	85.0	87.3	0.007		

[a]See the patients and methods section.
BC, breast cancer.

Table 5. Effect of surgeon's affiliation on breast cancer specific mortality

Surgeon's affiliation	Crude hazard ratio (HR; 95% CI)	HR adjusted for propensity scores (95% CI)
Public BC unit	1 (reference)	1 (reference)
Private BC network	0.7 (0.4–1.2)	0.8 (0.5–1.4)

BC, breast cancer.

a non-specialist surgeon resulted in a 33% reduction in the risk of death at 5 years in multivariate analysis, while treatment at a specialist center did not affect survival [15]. A significant increase in survival was also observed in a population-based cohort of 2192 patients in Oklahoma city for patients operated by specialist surgeons versus non-specialists. This study also reported differences in the use of adjuvant therapy, type of surgery, and compliance to treatment between specialized and non-specialized surgeons [16]. In Scotland, a retrospective study of 3786 patients reported a 16% of decreased mortality after adjustment for age, tumor size, socioeconomic status, and nodal involvement in BC patients cared for by specialist surgeons [17]. Another study including 24 834 patients from the Florida Cancer Data System reported higher survival rates for patients treated at teaching hospitals compared with community or low-volume hospitals [18, 19]. The authors concluded that many of these differences were due to the decreased use of proven adjuvant therapies, underlining the need for an integrated treatment for this disease. In Norway, where nearly all BC patients are treated in public hospitals, breast units with multidisciplinary meetings have been introduced in a staggered fashion along with a screening program since 1996. A cohort study of 1131 patients with resectable BC reported that relapse-free survival and overall survival did not differ substantially between the hospital groups based on the surgical workload or between university and non-university hospitals [20].

As previously reported, the quality of BC care is high in Switzerland [21]. This study reported that multidisciplinary therapeutic discussion was associated with substantially higher average quality of care, higher surgical sub-score and higher nonsurgical sub-score. The article also shows that BC patients treated in the canton of Geneva had the highest mean and surgical quality of care scores. The high degree of compliance with BC care recommendations found in the canton of Geneva was remarkable. As possible explanation, the authors of the study evoked the fact that in Geneva, most of the predictors of high management score are present: high caseload and clinical research at the Geneva University Hospitals, together with a higher proportion of patients with tertiary education, income in the highest tertile, and living in an urban area with high accessibility to specialized care. Our study results showing high scores for both the public BC unit and the private BC network contribute to explain the overall good performance observed in Geneva.

In our study, we found few differences in the quality of care and no differences in survival between the public BC unit and the private BC network. This could be linked to the fact that sophisticated medical tools are widely available in the public as well as in the private sector. Such tools include mammography, ultrasound, MRI, PET scan, good operating theaters with experienced pathologists in BC in both sectors of care. As seen at the Geneva University Hospitals, numerous private oncologists and gynecologists in the canton working as breast surgeons attend international breast conferences, meet regularly to update their knowledge, and discuss patient's medical files. Another particularity of the medical system in Geneva is that nearly 50% of the cancer patients are treated in the private sector. A total of 1981 BC patients were operated in the canton during the study period. Among those, 1146 (58%) were operated by private surgeons (i.e. 569, 29% by those affiliated to the BC network and 577, 29% by other private surgeons), a situation very different from other parts in the world [22].

As expected, our study shows that the public BC unit, considered as the reference for the public sector in the canton, served more disadvantaged patients with higher proportions of elderly, low social class, and foreign patients. Despite that, the quality of care of the public BC unit remains high. On the other hand, the added value for a patient to remain within her doctor's caring referees, as it is probably more often the case in the private BC network. This, although not easily computable, could be important for many patients [23].

The main limitations of our study are linked to its observational nature, as it is the case of all previous studies because of the lack of clinical trials testing BC units or network efficacy. In our study, patients treated by the public BC unit and the private BC network are not similar in terms of age, social class, and nationality. These sociodemographic variables, in particular age and social class, can strongly affect BC quality of care and outcome [24, 25]. To minimize the selection bias of BC patients' recruitment between surgeons groups, we adjusted all analyses for the propensity score. This has never been carried out before. We cannot, however, exclude the residual selection effect from unrecorded variables, such as patient co-morbidities, or other factors linked to the patient's status, social context, or behavior. Analysis by age sub-groups (<50, 50–70, ≥71 years), to indirectly account for the increasing presence of co-morbidities with advancing age, did not change the results presented on the quality scores but only on the levels of significance due to the lowered power. Also, the results from survival analysis should be considered as preliminary because of the short follow-up and the few events (i.e. cancer deaths) linked to high BC survival. Also, the definitions we use for our BC unit and network correspond to specific daily practice of BC care in the canton of Geneva, the public BC unit has not yet been formally accredited as defined by the EUSOMA 'Requirements of a specialist breast unit 2010'. This unit responds to most, but not all, necessary criteria issued. It includes all BC specialists, an important caseload, a weekly multidisciplinary medical pre-therapeutic and post-operative discussion of nearly all newly diagnosed patients in the public sector, and centralized medical facilities including specific radio-diagnostic and radiotherapy. The private BC network's work is more informal with no pre-therapeutic systematic discussion and medical facilities are not centralized in one institution. Therefore, the results presented in our study could not be easily extrapolated in other contexts.

Also, the way of collecting data on treatments between the public and private sectors differed with direct access to hospital files for the public sector and through specific questionnaires for the private sector. However, this could influence the recording of later use of adjuvant treatments but not surgery or radiotherapy, as the registry recorded similarly and directly the data from pathological and radiotherapy reports from both the sectors. Finally, this study did not consider the costs or the patient's satisfaction which are important indicators of the care system evaluation.

The strength of our study is the use the quality indicators of care developed specifically for accreditation of BC units by EUSOMA, which will allow future comparisons with other studies [10]. We are, however, aware of the fact that these indicators are not all linked to prognosis (such as use of breast-conserving surgery for small tumors) but are more linked to the quality of life. We could not study all the recommended indicators, including those concerning the evaluation of over-treatment or breast reconstruction, because part of the information needed to construct such indicators was lacking during the time of this study. Another strength of our study is the determination of exact cause of death by trained registrars from medical files and inquiries to physicians which offer a unique opportunity to assess correctly true BC-specific mortality.

In conclusion, in Geneva, the quality of BC care is high in both the public BC unit and the private BC network. Similarly operating networks could be considered as a less stringent alternative of BC units after careful evaluation of their efficacy. Finally, despite high quality of care, there is still rule for both improvement and homogenization of BC treatment between the private and public sectors.

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disclosure

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