Original Article

Quality Assessment and Trend for Breast Cancer Treatment Practice across South Korea Based on Nationwide Analysis of Korean Health Insurance Data during 2013-2017

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Purpose Quality assessment of breast cancer treatment in South Korea showed the upward standardization of the grade since 2013, but treatment disparities still have existed. This study analyzed the 5-year trend between 2013 and 2017 in the assessment of breast cancer treatment practice using the Korean health insurance data.

Materials and Methods All the medical records including surgery, chemotherapy, and radiotherapy for 7,354 patients a year on average were evaluated. Twenty indices consisted of one structural, 17 process-related, and two result-related factors. We calculated the coefficient of variation (CV) annually to determine the variation in adherence rate of evaluation indices according to the type of institution (advanced vs. general hospital vs. clinic).

Results Based on the initial assessment in 2013, 10 out of 20 indicators showed significant variation among the types of institutions with a CV of less than 0.1%. Six of them had a CV decline of less than 0.1%. The CV was still 0.1% or higher in the four indicators, including the composition of professional staff, the implementation of target therapy, the average length of hospital stay, and the hospitalization cost. Regarding the first grade of assessment, there was a statistically significant relationship between the institution type (p=0.029) and region (metropolitan vs. province, p < 0.001).

Conclusion There were disparities in the structural and systemic treatment factors depending on the institutional type. The quality improvement of the regional institutions and multidisciplinary experts for breast cancer is necessary.

Key words South Korea, Breast neoplasms, Quality assessment, Health insurance

Introduction

In South Korea, the number of breast cancer patients has dramatically increased due to the westernization of life style and the use of hormonal therapy [1]. Between 2006 and 2014, the number of newly diagnosed patients with invasive breast cancer increased by about 60%, according to the National Health Insurance Service and the Korea National Cancer Incidence Database [2,3]. Since the interest in diagnosis and treatment has emerged in South Korea, the Health Insurance Review and Assessment (HIRA) Service conducted annual quality assessment to improve the breast cancer treatment since 2013 [4]. The purpose of the evaluation is to ensure the quality of treatment by minimizing the variation in management according to the type of institution.

Despite years of evaluation efforts, disparities in the breast cancer treatment are still being reported. According to the data released by the Korean Society for Health Equity in 2018, life expectancy in the southeast area outside the metropolitan area in South Korea was 2.4 years shorter than in the metropolitan area, and the number of tertiary general hospitals that can offer the qualified treatment is only half that of the metropolitan area [5]. However, in the actual world, there are still variations in the quality of health care service between regions and types of institutions [6]. Therefore, it is necessary to analyze the improvement trend by detailed indicators and to find out the main factors that are still unresolved and cause the imbalance.

Materials and Methods

1. Study population

Korean HIRA analyzed the survey based on health insurance medical benefit claims and medical records of the previous year, and compiled the total score of all indicators at each

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medical institution. The subjects of the survey were female patients aged 18 years or older who underwent surgery for primary breast cancer. Exclusion criteria were as follows: (1) patients with American Joint Committee on Cancer stage 4, (2) bilateral breast cancer, (3) other primary cancerous diseases, diagnosed within 5 years, (4) inflammatory or occult breast cancer, (5) patients who received surgery or treatment in other hospitals, (6) patients who were diagnosed with sarcoma or lymphoma, and (7) pregnant patients. Institutions reporting fewer than 150 breast cancer surgeries were evaluated by census, and those with more than 150 by sampling. Medical records were surveyed annually from 2012 to 2016, and the trends were analyzed based on the data reported the following year.

2. Definition of evaluation indices

The evaluation indices comprising a total of 20 indicators were divided into three categories: structure, process, and results. All factors are known to influence the prognosis or to be associated with the treatment decision. A total of 302 indicators from the worldwide quality assessment programs and medical guidelines were compiled into the quality evaluation indicators [7-11]. The National Quality Forum was applied as the criterion for selection, and in order to choose appropriate indices, it was reviewed using the modified Delphi survey, the hospital medical record survey, and the opinion of the experts, which included medical oncologists, breast surgeons, pathologists, and radiation oncologists [12,13].

As a structural component, the composition of professional personnel was investigated. The process category included six diagnostic or reporting-related indicators as follows: breast cancer family history taking, record of patient's performance status, explanation and permission taking of adjuvant therapy from patient, detailed chemotherapy-related report, radiotherapy dose and field charts, and cancer stage and hormone status related reports by board-certified physicians. Three indicators based on surgery were the faithfulness of surgical pathology report, fulfilling of sentinel or regional lymph node dissection, and clearly negative resected surgical margin rate. Six indicators of systemic adjuvant therapy were commencing adjuvant therapy within 8 weeks after surgery, prescription of adjuvant endocrine therapy in hormone receptor-positive patient and adjuvant chemotherapy recommended by the National Comprehensive Cancer Network (NCCN) guidelines, proportion of patients receiving prophylactic antiemetics in chemotherapy, prescription of target therapy in human epidermal growth factor receptor 2 (HER2)–positive patient, and fulfilling bone mineral density (BMD) before administration of aromatase inhibitors (AI). Two indicators of radiation therapy were the time to start radiotherapy within 6 weeks after surgery or adjuvant chem-

otherapy, and the proportion of radiotherapy in high-risk patient after mastectomy. The result-related indicators were consisted of the average number of hospitalization days and the average hospitalization cost. The detailed formulae are presented in Fig. 1.

3. Analytical method

The coefficient of variation (CV) was calculated, and the variation among types of medical institution in the first 2013 survey was evaluated. The CV was defined as the standard deviation of the adherence rate divided by the mean value, and the greater the value, the larger the variation among institution types [14]. A CV ≥ 0.1% reflected large variation among institutional types. The Jonckheere test was conducted to analyze the CV trend every year to evaluate the trends in improvement [15].

Each indicator was summarized and graded into five categories (the first to fifth grade). We analyzed factors affecting the first grade, and the factors used in analyses were the evaluation year, the region to which the institution belongs, and the type of institution. Independent-group t test was used for a comparison between grades and factors. A p-value less than 0.05 was considered statistically significant. Approval of an Institutional Review Board and informed consent was waived because the anonymized patient data were collected from administrative data of HIRA which were open to the public.

Results

1. Demographic and clinical features

The number of survey subjects increased from 4,574 in 2013 to 8,624 in 2017, and the number of institutions also increased from 160 in 2013 to 193 in 2017. The subjects evaluated each year are listed in Table 1. The number of people aged 50 and over has been increased across the board, and the relative increment is particularly notable in the elderly over 80 years of age. The increase in the number of cases undergoing breast-conserving surgery was higher than that of total mastectomy.

2. Indicators at first evaluation in 2013

The CVs of evaluation indices were extracted and compared to analyze the variations among institutional types that were investigated during the first survey in 2013. Variations were found among with CV value of 0.1% or more in eight structural and process-related indicators (Table 2). Among them, indicators with a relatively larger value of CV (> 0.5%) were the composition of professional personnel, the rates of explanation and permission taking of adjuvant ther-

Evaluation index	Definition or formula
Structure category	
Composition of professional personnel	Professionals affiliated with departments of surgery, medical oncology, pathology, and radiation oncology
Process category	
Breast cancer family history taking	$\dfrac{\text{No. of patients with confirmed family history of breast cancer}}{\text{No. of patients who underwent breast cancer surgery}} \times 100$
Record of patient's performance status	$\dfrac{\text{No. of patients with performance evaluation reports before chemotherapy}}{\text{No. of patients who underwent chemotherapy}} \times 100$
Explanation and permission taking of adjuvant therapy from patient	$\dfrac{\text{No. of patients who received permission for adjuvant therapy}}{\text{No. of patients who actually underwent adjuvant therapy}} \times 100$
Detailed chemotherapy –related report	$\dfrac{\text{No. of patients with chemotherapy reports faithfully recorded}}{\text{No. of patients who underwent chemotherapy}} \times 100$
Detailed radiotherapy –related report	$\dfrac{\text{No. of patients with radiotherapy reports faithfully recorded}}{\text{No. of patients who underwent radiotherapy}} \times 100$
Cancer-related records by board-certified physicians	$\dfrac{\text{No. of patients with cancer–related reports recorded by board–certified physicians}}{\text{No. of patients who underwent breast cancer surgery}} \times 100$
Faithfulness of surgical pathology report	$\dfrac{\text{No. of patients with pathology reports faithfully recorded}}{\text{No. of patients who underwent breast cancer surgery}} \times 100$
Fulfilling of sentinel or regional lymph node dissection	$\dfrac{\text{No. of patients who underwent sentinel or regional lymph node dissection}}{\text{No. of patients who underwent breast cancer surgery}} \times 100$
Clearly negative resected surgical margin	$\dfrac{\text{No. of patients with negative resection margin}}{\text{No. of patients who underwent breast-conserving surgery}} \times 100$
Commencing adjuvant therapy within 8 weeks after surgery	$\dfrac{\text{No. of patients who received adjuvant therapy within 8 weeks after surgery}}{\text{No. of patients with mass} > 1 \text{ cm or positive regional node(s)}} \times 100$
Prescription of adjuvant endocrine therapy in hormone receptor–positive patient	$\dfrac{\text{No. of patients who received adjuvant endocrine therapy}}{\text{No. of patients with positive hormonal receptor}}$
Prescription of adjuvant chemotherapy recommended as NCCN guidelines	$\dfrac{\text{No. of patients who received adjuvant chemotherapy according to recommendation}}{\text{No. of patients who received adjuvant chemotherapy}} \times 100$
Administration of prophylactic antiemetics in chemotherapy	$\dfrac{\text{No. of patients who received a prescription for serotonin antagonist}}{\text{No. of patients treated with chemotherapy with more than moderate vomiting}} \times 100$
Prescription of target therapy in HER2-positive patient	$\dfrac{\text{No. of patients treated with targeted therapy}}{\text{No. of patients with HER2–positive based on immunohistochemistry, FISH or SISH test}} \times 100$
Fulfilling bone mineral density before AI	$\dfrac{\text{No. of patients who underwent bone mineral density evaluation before AI}}{\text{No. of patients who received AI}} \times 100$
Radiotherapy within 6 weeks after surgery or adjuvant chemotherapy	$\dfrac{\text{No. of patients who received radiotherapy within 6 weeks of surgery or adjuvant chemotherapy}}{\text{No. of patients who underwent breast–conserving surgery}} \times 100$
Radiotherapy in high-risk patient after mastectomy	$\dfrac{\text{No. of patients who received radiotherapy}}{\text{No. of patients who underwent mastectomy based on the following criteria}} \times 100$ ① Positive resection margin ② Mass size > 5 cm ③ Invasion of chest wall or skin ④ Nodal stage ≥ N2

Fig. 1. Definition of 20 evaluation indices. AI, aromatase inhibitors; DRG, diagnosis-related group; FISH, fluorescence *in situ* hybridization; HER2, human epidermal growth factore receptor 2; NCCN, National Comprehensive Cancer Network; SISH, silver-enhanced *in situ* hybridization. *(Continued to the next page)*

Evaluation index	Definition or formula	
Result category		
Average hospitalization stay	h=Surveyed medical institutions g=Group based on DRG according to disease diagnosis n_{hg}=No. by DRG of surveyed medical institutions L_g=Hospitalization days by DRG L_{hg}=Hospitalization days by DRG of surveyed medical institutions LI_h=Lengthiness index of surveyed medical institutions	$LI_h = \dfrac{\sum\limits_{g=1}^{n}(L_{hg} \times n_{hg})}{\sum\limits_{g=1}^{n}(L_g \times n_{hg})}$
Average hospitalization cost	h=Surveyed medical institutions g=DRG according to disease diagnosis n_{hg}=No. based on DRGs of surveyed medical institutions C_g=Average medical expenses by DRG C_{hg}=Average medical expenses by DRG of surveyed medical institutions CI_h=Cost-line index of surveyed medical institutions	$CI_h = \dfrac{\sum\limits_{g=1}^{n}(C_{hg} \times n_{hg})}{\sum\limits_{g=1}^{n}(C_g \times n_{hg})}$

Fig. 1. *(Continued from the previous page)*

Table 1. Study population

Characteristic	Cases per year					
	2017	2016	2015	2014	2013	Average
No. of institutions						
Advanced general hospital	43	43	43	43	44	43.2
General hospital	118	114	113	116	95	111.2
Hospital	21	22	19	18	15	19.0
Clinic	11	8	10	8	6	8.6
Age (yr)						
18-29	68	46	57	64	-	58.8
30-39	703	668	714	739	-	706.0
40-49	2,784	2,765	2,677	2,676	-	2,725.5
50-59	2,710	2,510	2,396	2,404	-	2,505.0
60-69	1,449	1,325	1,192	1,111	-	1,269.3
70-79	720	640	639	621	-	655.0
≥ 80	190	124	107	95	-	129.0
Surgery type						
Breast-conserving surgery	5,661	5,323	5,052	4,967	2,976	4,795.8
Mastectomy	2,963	2,755	2,730	2,743	1,598	2,557.8
Pathologic stage[a]						
I	3,882	3,649	-	3,557	2,110	3,299.5
II	3,488	3,254	-	3,031	1,843	2,904.0
III	1,254	1,174	-	1,122	621	1,042.8

[a]American Joint Committee on Cancer eighth edition.

apy from patient, and the prescription of target therapy in HER2-positive patient. The composition of professional personnel showed the largest CV of 0.631%. In the result categories, the CVs for average hospitalized days and costs were 0.528% and 0.292%, respectively, indicating a large variation among institution types.

3. CV trend by year

Each indicator's changes were evaluated annually, and Fig. 2 shows the annual trends for each indicator. Among ten indicators with high CVs, the proportion of patients receiving antiemetic drugs, the rate of breast cancer family history taking, record of patient's performance status, explanation and permission taking of adjuvant therapy from

Table 2. Coefficient variation among types of institutions at initial evaluation

	Evaluation index	Coefficient variation (%)
Structure	Composition of professional personnel (surgery, medical oncology, pathology, radiation oncology)	0.631
Process		
Diagnosis and report	Breast cancer family history taking	0.233
	Record of patient's performance status	0.226
	Explanation and permission taking of adjuvant therapy from patient	0.535
	Detailed chemotherapy–related report	0.030
	Detailed radiotherapy–related report	0.005
	Cancer-related records by board-certified physicians	0.098
Surgery–related	Faithfulness of surgical pathology report	0.003
	Fulfilling of sentinel or regional lymph node dissection	0.027
	Clearly negative resected surgical margin	0.007
Systemic therapy–related	Commencing adjuvant therapy within 8 weeks after surgery	0.014
	Prescription of adjuvant endocrine therapy in hormone receptor–positive patient	0.370
	Prescription of adjuvant chemotherapy as recommended	0.013
	Administration of prophylactic antiemetics in chemotherapy	0.197
	Prescription of target therapy in HER2-positive patient	0.506
	Fulfilling bone mineral density before AI	0.250
Radiotherapy–related	Radiotherapy within 6 weeks after surgery or adjuvant chemotherapy	0.037
	Radiotherapy in high-risk patient after mastectomy	0.060

AI, aromatase inhibitors; HER2, human epidermal growth factore receptor 2.

patient, prescription of adjuvant endocrine therapy in hormone receptor-positive patient, and fulfilling BMD before AI administration were six indicators with decreases in CVs of less than 0.1%, indicating that institutional type differences were reduced. However, the four indicators (professional personnel composition, target therapy adherence rate, average number of hospital days, and average hospitalization cost) exhibited CVs with high values of 0.1% or more, showing that the variations were not lowered.

The Jonckheere test was used to assess the 5-year trends of each indicator, and the findings are shown in Table 3. The adherence rate of adjuvant endocrine therapy in hormone receptor-positive patient, prescription of adjuvant chemotherapy recommended by NCCN guidelines, prophylactic antiemetic drug prescriptions in chemotherapy, and fulfilling BMD before AI were indicators that were statistically significant for CV reduction.

4. Factors related to the first grade

The adherence rates of each evaluation index were summarized and graded by institution. Fig. 3 shows the distribution by grade according to year, region, and type of institution. The average ratio of the first grade was 78.6%, the second grade 9.3%, the third grade 7.5%, the fourth grade 1.9%, and the fifth grade 2.7%. The proportion of the

first grade increased in 2017 (81.5%) compared with 2013 (72.7%). In the metropolitan area, the ratio of the first grade was higher than that of the provinces (81.8% vs. 74.6%), and the advanced general hospitals presented a markedly higher ratio of the first grade compared with general hospitals (99.4% vs. 76.5%). Factors statistically related to the proportion of the first grade were institution type and region (Table 4). According to the evaluation year, no significant difference was observed.

Discussion

The purpose of the present study was to evaluate the quality assessment of breast cancer treatment by HIRA in Korea according to indicators and institutional types, and to analyze the factors that require further improvement. This study revealed significant differences in some systemic treatment–related indicators (such as target therapy). Adjuvant treatment after breast cancer surgery depends on the hormone receptor and HER2 type, and various studies are currently in progress on systemic adjuvant therapy [16,17]. The different treatment approaches vary on the physicians' experience, the institutions, or a multidisciplinary principle, which would have contributed to the high CV [18,19].
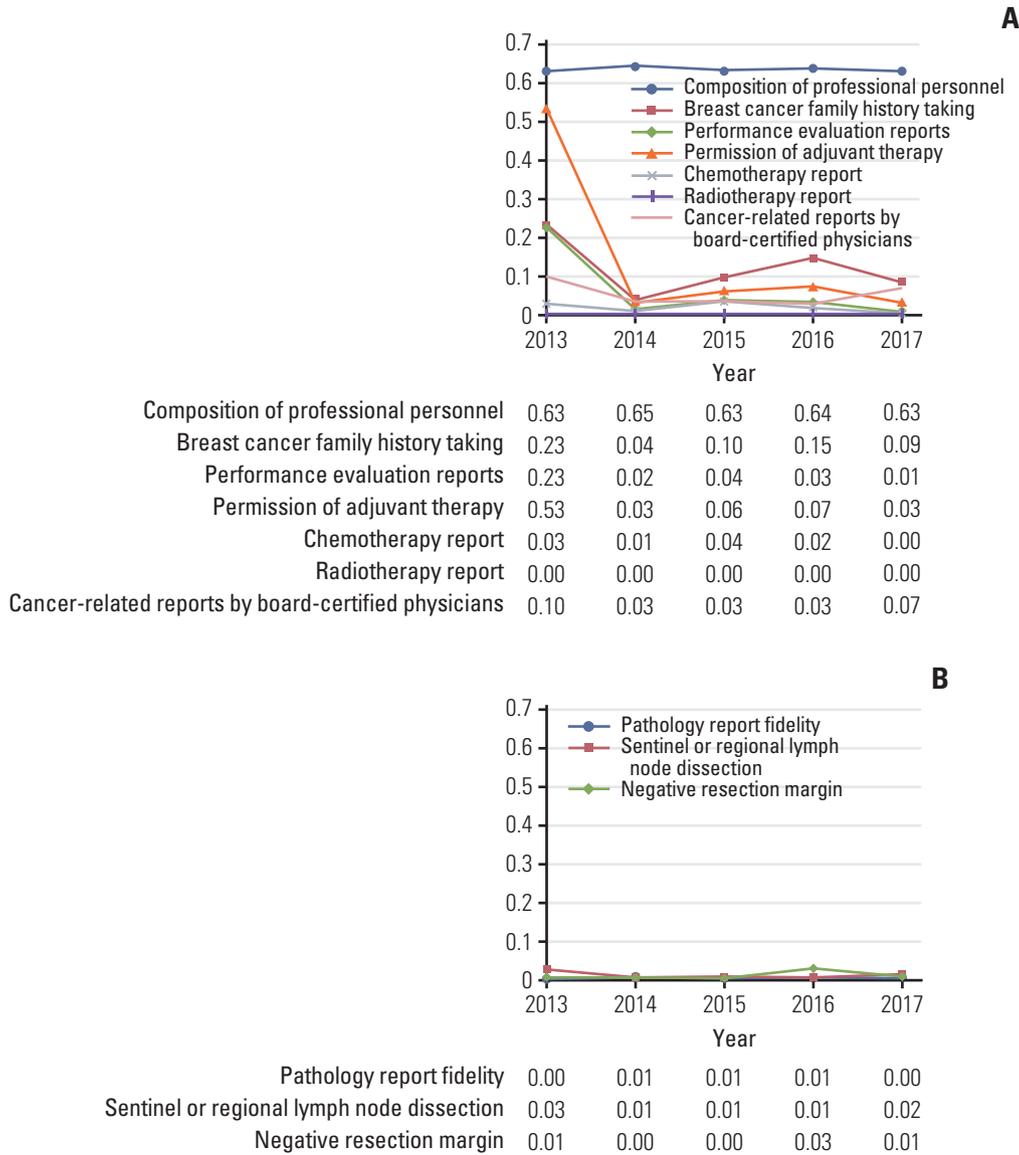
A

	2013	2014	2015	2016	2017
Composition of professional personnel	0.63	0.65	0.63	0.64	0.63
Breast cancer family history taking	0.23	0.04	0.10	0.15	0.09
Performance evaluation reports	0.23	0.02	0.04	0.03	0.01
Permission of adjuvant therapy	0.53	0.03	0.06	0.07	0.03
Chemotherapy report	0.03	0.01	0.04	0.02	0.00
Radiotherapy report	0.00	0.00	0.00	0.00	0.00
Cancer-related reports by board-certified physicians	0.10	0.03	0.03	0.03	0.07

B

	2013	2014	2015	2016	2017
Pathology report fidelity	0.00	0.01	0.01	0.01	0.00
Sentinel or regional lymph node dissection	0.03	0.01	0.01	0.01	0.02
Negative resection margin	0.01	0.00	0.00	0.03	0.01

Fig. 2. Coefficient of variation by institution type from 2013 to 2017. (A) Structural indicator and report fidelity. (B) Surgery-related indicators. *(Continued to the next page)*

According to the annual trend analyses, there was also no statistically significant improvement in structural indicators. In East Asia including South Korea, there have been still structural problems. The fundamental budget for radiation therapy instruments is very high and the number of radiation oncologists are less than surgeons and medical oncologists. The one of reasons for high CV in structure is that the most of specialized doctors including radiation oncologists are affiliated with advanced general hospitals. Interestingly, it was found that there was also no improvement of CV in the systemic chemotherapy field rather than the radiation therapy. The diversity and inconsistency of treatment according

to hormone or HER2 status shows that not only in East Asia but also in Europe, recommendations are still being updated [20]. It indicates the need for not only quality assessment but also the development of consensus among multidisciplinary experts.

Similar patterns were seen in studies about breast cancer quality assessment conducted in other East Asian countries [21-23]. In Taiwan, the breast cancer quality evaluation tool consisting of 10 indicators has been implemented since 2007, and during the 5-year evaluation period, high-volume hospitals reported higher adherence rates for pathologic confirmation before surgery and sentinel node sampling in
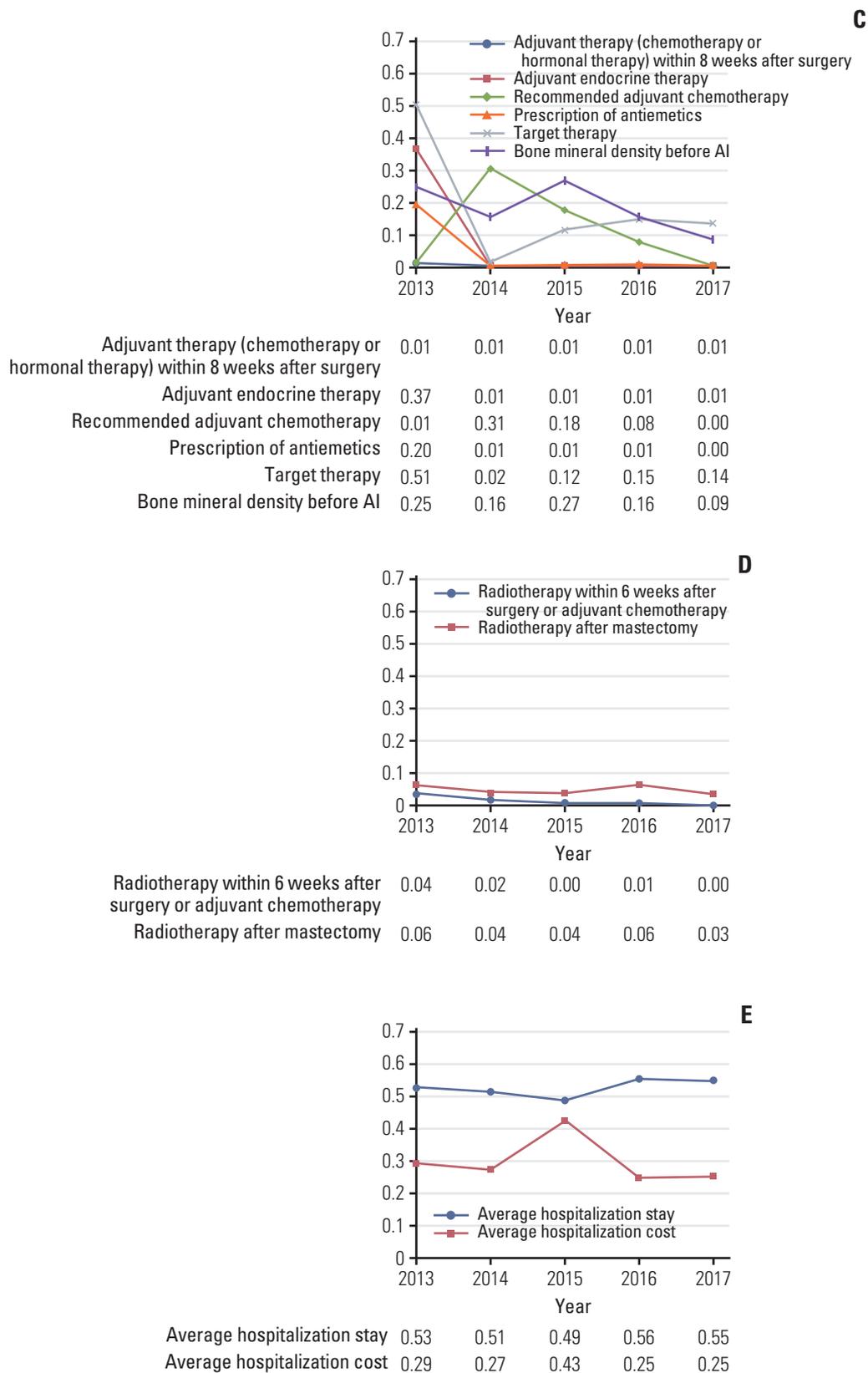
C

	2013	2014	2015	2016	2017
Adjuvant therapy (chemotherapy or hormonal therapy) within 8 weeks after surgery	0.01	0.01	0.01	0.01	0.01
Adjuvant endocrine therapy	0.37	0.01	0.01	0.01	0.01
Recommended adjuvant chemotherapy	0.01	0.31	0.18	0.08	0.00
Prescription of antiemetics	0.20	0.01	0.01	0.01	0.00
Target therapy	0.51	0.02	0.12	0.15	0.14
Bone mineral density before AI	0.25	0.16	0.27	0.16	0.09

D

	2013	2014	2015	2016	2017
Radiotherapy within 6 weeks after surgery or adjuvant chemotherapy	0.04	0.02	0.00	0.01	0.00
Radiotherapy after mastectomy	0.06	0.04	0.04	0.06	0.03

E

	2013	2014	2015	2016	2017
Average hospitalization stay	0.53	0.51	0.49	0.56	0.55
Average hospitalization cost	0.29	0.27	0.43	0.25	0.25

Fig. 2. *(Continued from the previous page)* (C) Systemic therapy–related indicators. (D) Radiotherapy-related indicators. (E) Result indicators. AI, aromatase inhibitors.

Table 3. Jonckheere test for analyzing trend of variation coefficient for 5 years

	Evaluation index	p-value
Structure	Composition of professional personnel (surgery, medical oncology, pathology, radiation oncology)	0.838
Process		
Diagnosis and report	Breast cancer family history taking	0.242
	Record of patient's performance status	0.256
	Explanation and permission taking of adjuvant therapy from patient	0.477
	Detailed chemotherapy–related report	0.134
	Detailed radiotherapy–related report	0.246
	Cancer-related records by board-certified physicians	0.877
Surgery-related	Faithfulness of surgical pathology report	0.141
	Fulfilling of sentinel or regional lymph node dissection	0.685
	Clearly negative resected surgical margin	0.645
Systemic therapy-related	Commencing adjuvant therapy within 8 weeks after surgery	0.412
	Prescription of adjuvant endocrine therapy in hormone receptor–positive patient	0.029
	Prescription of adjuvant chemotherapy as recommended	0.010
	Administration of prophylactic antiemetics in chemotherapy	0.009
	Prescription of target therapy in HER2-positive patient	0.529
	Fulfilling bone mineral density before AI	0.015
Radiotherapy-related	Radiotherapy within 6 weeks after surgery or adjuvant chemotherapy	0.200
	Radiotherapy in high-risk patient after mastectomy	0.100

AI, aromatase inhibitors; HER2, human epidermal growth factore receptor 2.
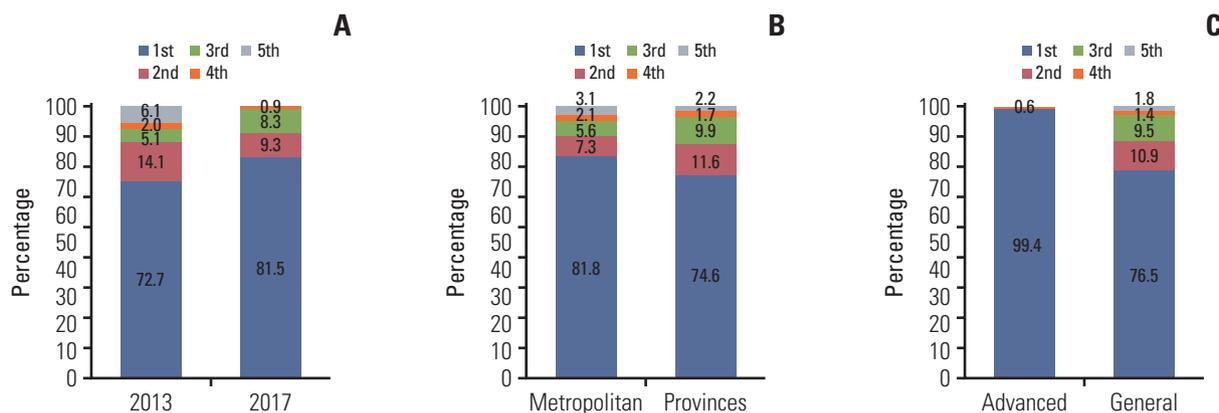

Fig. 3. Distribution of grades according to evaluation year in 2013 vs. 2017 (A), metropolitan area vs. provinces (B), and advanced general hospital vs. general hospital (C).

Table 4. Factors associated with the first grade

	Factor	Mean±SD	p-value
Year	2013 (Initial)	72.44±3.73	0.081
	2017 (Latest)	82.04±3.04	
Region	Metropolitan area	82.23±1.55	0.029
	Provinces	75.42±2.46	
Type of institution	Advanced general hospital	99.40±0.60	< 0.001
	General hospital	76.48±1.79	

SD, standard deviation.

stages 1 and 2 [24]. In Japan, the variation among facilities was analyzed based on seven indicators in 2005; however, no longitudinal studies were conducted [25]. In the present study, Korea showed a high degree of consistency in the area of surgical oncology compared to other East Asian countries. This is considered the result of careful surgical quality control, and it will be used as an international assessment framework.

In the quality evaluation analysis of colorectal cancer conducted by HIRA in Korea, there were also differences in structural elements among the institutional types [26]. During the 6-year evaluation period, there was no significant improvement in the preoperative work-up or postoperative radiotherapy if indicated. The quality evaluations of major carcinomas in Korea, which were conducted since 2011, have continuously been revised and reviewed through additional analysis like previous studies. The present study of breast cancer quality evaluation is also expected to be used as a tool to improve evaluation system.

Because only patients who have had breast cancer surgically resected were eligible for quality assessment of breast cancer treatment by Korean HIRA, this assessment had limited ability to represent the quality of comprehensive breast cancer treatment. Since the initial assessment, there has been less diversity between institutions in the surgical field, which has served to the significant variation in systemic treatments. Additionally, the significance of preventive cancer management emerged as the number of elderly patients increased; nevertheless, this evaluation system did not reflect preventive and generic medicine [27,28].

In conclusion, there was a difference in grades of the treatment quality assessment in breast cancer by region or type of institution, rather than an improvement in grades by year. It is warranted to use the analytical tool of this study on subgroup components rather than just enhancing grades by summarization to validate its applicability as an international evaluation framework.

Ethical Statement

Approval of an Institute Review Board was waived because the patient data were collected from administrative data without identifiable personal information.

Author Contributions

Conceived and designed the analysis: Choi KH, Lee JH.
Collected the data: Choi KH, Sung SY, Lee SW, Kim SH, Lee JH.
Contributed data or analysis tools: Lee JH.
Performed the analysis: Sung SY, Lee SW, Kim SH, Lee JH.
Wrote the paper: Choi KH, Jeon YW, Lee JH.

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Conflicts of Interest

Conflict of interest relevant to this article was not reported.

Acknowledgments

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