Continuity of Care, Follow-Up Care, and Outcomes among Breast Cancer Survivors

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Abstract: This retrospective cohort study examined the effects of care continuity on the utilization of follow-up services and outcome of breast cancer patients (stages I–III) in the post-treatment phase of care. Propensity score matching and generalized estimation equations were used in the analysis of data obtained from national longitudinal databases. The continuity of care index (COCI) was calculated separately for primary care physicians (PCP) and oncologists. Our results revealed that breast cancer survivors with a higher oncology COCI were more likely than those with a lower oncology COCI to use mammography or breast ultrasound during the follow-up period (OR = 1.26, 95% CI: 1.19–1.32; OR = 1.12, 95% CI: 1.06–1.18; respectively). In terms of health outcomes, a higher oncology COCI was associated with a lower likelihood of hospitalization (OR = 0.78, 95% CI: 0.71–0.85) and emergency department use (OR = 0.88, 95% CI: 0.82–0.95). A higher PCP COCI was also associated with a lower likelihood of hospitalization (OR = 0.77, 95% CI: 0.70–0.85) and emergency department use (OR = 0.75, 95% CI: 0.68–0.82). Overall, this study determined that ambulatory care continuity is positively associated with the likelihood of using recommended follow-up care services and negatively associated with adverse health events among breast cancer survivors.

Keywords: breast cancer; survivors; continuity of care; care continuity; follow-up care; surveillance; health outcome; hospitalization; emergency department use

1. Introduction

Early diagnosis and improvements in cancer treatment have greatly enhanced the likelihood of cancer survival, and the number of cancer survivors is expected to reach 20 million by 2026 [1]. Since the National Institute of Medicine (IOM) reported on the importance of survivorship care [2], this issue has gradually attracted attention. Survivorship care has even been described as a paradigm shift in the cancer care continuum [3]. The follow-up period after cancer treatment is a distinct phase of care, involving psychosocial, community and supportive care, health promotion, regular monitoring, and long-term follow-up as well as interventions for late-effects [4–6].

Cancer care is a worldwide problem of considerable complexity and fragmentation [7,8]. The fact that treatment can have a major impact on the long-term health and quality of life of survivors greatly complicates disease management, and the disease burden of survivors is often underestimated. Many patients with limited resources must deal with intermittent healthcare and compromised adherence to treatment regimes. In some cases, regular surveillance care in accordance with established guidelines is underused [9,10]. In other cases, advanced imaging diagnostics (widely regarded as low-value care),
are overused [9,11–13]. The American Society of Clinical Oncology (ASCO) has listed the overuse of advanced imaging methods for breast cancer as one of the top five issues that must be addressed in efforts to improve the quality of cancer care and reduce the associated costs [14].

Continuity of care is concerned with the quality of care over time as well as fairness and efficiency [15–23]. Some empirical studies have surveyed care continuity from the perspective of cancer patients [23–25]. Previous research has indicated that higher care continuity is associated with a stronger sense of satisfaction, higher quality of life, and better mental health [19,22]. Poor care continuity is associated with excessive consumption of medical resources, primarily through the consumption of unnecessary services [26].

One population-based study linked a lower oncology care continuity to a higher likelihood that breast cancer survivors would exceed the recommended number of visits to their oncologist [27]; however, there has been little research on the relationship between care continuity and health outcomes among cancer survivors empirically by using claims-based measurements. In addition, Taiwan has a unique medical environment which might undermine the care continuity [28]. The implementation of universal health insurance has greatly improved access to medical treatment in Taiwan; however, the family physician arrangement has not been formally implemented. This means that under the current scheme, patients may visit specialists without a referral [29].

Breast cancer is the most common form of cancer among women; however, the survival rate is relatively high [30]. Breast cancer survivors face multiple medical and psychosocial needs as they progress from treatment to survival [31]. Nonetheless, it has been shown that many breast cancer survivors do not receive adequate care [32–35]. Therefore, we employed a nationally representative longitudinal database from the universal health insurance program in Taiwan to evaluate the effects of post-treatment care continuity on follow-up care utilization and health outcomes among breast cancer survivors in this study.

2. Methods

2.1. Study Design, Data Resource, Participants

This retrospective cohort study was based on the long-form databases of the Taiwan Cancer Registry, comprising a nationally representative cohort of patients diagnosed with cancer [36,37]. Patients newly diagnosed with breast cancer between January 1, 2002 and December 31, 2007 were included. Follow-up information extending until December 31, 2012 was obtained via data linkage using profiles from the National Healthcare Insurance Database (NHIIRD) and the National Register of Deaths. Data resources were collected, organized, and managed by the Health and Welfare Data Science Center (HWDC) of the Ministry of Health and Welfare (MOHW). The index date for each patient in this study was set at 366 days post-diagnosis. The follow-up period was defined as the period from one year after the index date to four years after the index date (or sooner if censored), as this covers the period in which survivors are followed-up most intensively [27]. The recurrence or death during the follow-up period was considered as censored. This study was approved by the Institutional Review Board at the National Taiwan University Hospital (IRB approval number 201405054w), which waived the requirement for informed consent.

In accordance with previous studies [38–41], patients were selected for inclusion based on the following criteria: (1) newly diagnosed with breast cancer, (2) confirmed diagnosis of cancer between 2002 and 2007, (3) diagnosis of Stage I–III breast cancer, (4) >20 years old at the time of diagnosis, and (5) survived at least two years after diagnosis. Exclusion criteria included (1) missing information including age, gender, and date of cancer diagnosis date, and (2) receiving chemotherapy or radiation therapy during the follow-up period. Additionally, our focus in this study was on care continuity in the outpatient setting, and particularly in the second year after diagnosis during which survivors switch from treatment to follow-up care. Thus, cases without any outpatient records beyond the second year after diagnosis were also excluded. In order to avoid the problem of reverse causality,
the care continuity was measured for one-year period and the measurement of follow-up care and health outcome was measured for a subsequent period (Figure 1).

**Follow-up period 1**
- Continuity measure
- Outcome measure

**Follow-up period 2**
- Continuity measure
- Outcome measure

**Follow-up period 3**
- Continuity measure
- Outcome measure

The index date

![Study design](image)

**Figure 1.** Study design.

### 2.2. Variables

#### 2.2.1. Independent Variables

The independent variable was continuity of care between patients and their physician (solely for outpatient services) during the follow-up period. We adopted the continuity of care index (COCI) to calculate care continuity due to the larger number of physician visits typical of the Taiwanese healthcare system. The COCI derived from the number of different physicians visited and the number of visits made to each physician [42]. Note that this index is less sensitive to the number of visits to physicians [43].

The equation used to derive the index is as follows:

\[
COCI = \frac{\sum_{j=1}^{M} n_j^2 - N}{N(N - 1)}
\]

, where \(N\) represents the total number of primary care physician visits for a given patient, \(n_j\) is the number of visits to the same physician \(j\), and \(M\) is the total number of physicians for a given patient. COCI was calculated separately for primary care physicians (PCP) and oncology specialists. PCPs were physicians dealing with general medicine, internal medicine, family medicine, and obstetrics/gynecology [44–46]. Oncology specialists included subspecialists in medical oncology, hematology oncology, surgeons, or radiation oncologists.

COCI was calculated only for patients who made at least three visits, due to the fact that continuity of care would be meaningless if based a small number of visits [47–49]. COCI is bounded between 0 and 1, where a higher value indicates greater continuity of care. The value assigned for continuity of care has no inherent clinical meaning; therefore, we divided the sample into two groups (high and low continuity) based on the median COCI and distribution of scores across the entire study population. COCI was treated as time-varying variable for each year.

#### 2.2.2. Dependent Variables

Measurements of follow-up care included the use of annual surveillance mammograms, breast ultrasounds, and advanced imaging tests for metastatic disease, which included chest X-rays, bone
scans, liver ultrasound, computed tomography (CT) scans, positron emission tomography (PET) scans, and breast magnetic resonance imaging (MRI). The health outcomes included instances of hospital admission or emergency department visit in a given year. All outcome measures were coded as dichotomous variables.

2.2.3. Covariates

Patient characteristics included the year of diagnosis, age at the time of diagnosis, tumor stage, hormone receptor status, type of surgery, health status, occupation, and the level of insurance premiums. We used the modified Charlson Comorbidity Index (CCI) [50], the number of visits to physicians, and the likelihood of hospitalization for any reason in the year prior to breast cancer diagnosis as proxy variables for a patient health status. Modified CCI values were used to recalculate the score excluding cancer-related diagnoses. Regional characteristics included the level of urbanization and the number of physicians per square kilometer in the area of residence. The characteristics of the medical provider most frequently visited by the patient each year included the age of the physician and the average annual breast cancer volume of the physician. The characteristics of the medical institution most frequently visited by the patient each year included the accreditation level, ownership, and average annual breast cancer volume of the facility.

2.3. Statistical Analysis

In cases of bivariate analysis, the chi-square test was used for the analysis of categorical variables. The continuous variable was first checked using the Kolmogorov–Smirnov test for normality. If the data presented normal distribution, then the Student’s t-test was used; otherwise, the Mann–Whitney U Test was used. Additionally, we used propensity score matching (PSM) to minimize confounding effects [51]. In estimating propensity scores for oncology care continuity and PCP care continuity, the variables used in the logistic regression models included patient characteristics (year of diagnosis, age, tumor stage, hormone receptor status, type of surgical procedure, health status, and socioeconomic variables), regional characteristics (urbanization and number of physicians per square kilometer in area of patient residence), physician characteristics (age, average annual breast cancer volume), and the hospital characteristics (accreditation level, ownership, and average annual breast cancer volume).

Data were randomized using nearest neighbor matching, matching without replacement, and the tolerable caliper width was set at 0.001. After matching, the sample was analyzed in terms of standardized difference to determine whether the distribution of data was balanced. Generalized estimating equations (GEEs) were used for data analysis in order to control for subject characteristics that were not observed during the study, such as healthcare-seeking behavior. Note that GEE methods are commonly used for the analysis of correlated data to obtain unbiased estimates of coefficients despite possible misspecification of the correlation structure [52]. To avoid over-adjustment, we opted not to include in our analysis any variables that had been used in propensity score matching and had been balanced after matching.

3. Results

3.1. Patient Characteristics

This study included patients newly diagnosed with breast cancer (Stage I, II, or III) between 2002 and 2007. A total of 18,031 patients were included in the analysis. Table 1 presents the distribution of baseline characteristics of the sample grouped according to the continuity of oncology care. Among breast cancer survivors with higher continuity of oncology care, the average age at the time of diagnosis was 51.7 years with the age distribution peaking at 45–54 years (37%), followed by 35–44 years old (22%), and 55–64 years (21%). In terms of clinical characteristics, most of the tumors were in Stage II (48%), followed by Stage I (34%). The estrogen receptor (ER)-positive rate was 52%, and progesterone receptor (PR)-positive rate was 47%. Approximately 25% of the patients underwent breast conserving
surgery (BCS). In terms of basic health status, the CCI score of most of the patients was 0 (80%) or 1 (13%), and 16% were hospitalized one year prior to diagnosis. The occupation of most of the patients fell within the category of labor (31%). It was observed that 2% of the patients were physicians or family members of physicians. Most of the patients resided in urban areas (69%). The facilities most frequently visited by patients in the second year after diagnosis were medical centers (55%), most of which were non-public hospitals (80%). The physicians most frequently visited by patients were 40–59 years old (74%). Following PSM, the distributions of the variables were balanced.

| Characteristics                  | Pre-PSM Sample | Post-PSM Sample | p Value | Standardized Difference |
|----------------------------------|----------------|-----------------|---------|-------------------------|
|                                  | Low COCI       | High COCI       |         |                         |
|                                  | (n = 7113, 50%)| (n = 7129, 50%) |         |                         |
|                                  | n   | %   | n   | %   | n   | %   | n   | %   |                         |
| Year of diagnosis                |         |       | 2002 | 3.84 | 219 | 3.07 | 202  | 3.64 | 194 | 3.50 |
|                                  |         |       | 2003 | 5.31 | 334 | 4.69 | 281  | 5.07 | 274 | 4.94 |
|                                  |         |       | 2004 | 18.28 | 1363 | 19.12 | 1035 | 18.67 | 1034 | 18.65 |
|                                  |         |       | 2005 | 20.29 | 1568 | 21.99 | 1185 | 21.37 | 1189 | 21.44 |
|                                  |         |       | 2006 | 23.92 | 1680 | 23.57 | 1316 | 23.73 | 1340 | 24.17 |
|                                  |         |       | 2007 | 28.36 | 1965 | 27.56 | 1526 | 27.52 | 1514 | 27.30 |
| Age of diagnosis                 | <0.0001   |       | 2002 | 4.57 | 310 | 4.35 | 244  | 4.40 | 254 | 4.58 |
|                                  |         |       | 2003 | 24.74 | 1597 | 22.40 | 1293 | 23.32 | 1306 | 23.55 |
|                                  |         |       | 2004 | 38.05 | 2662 | 37.34 | 2115 | 38.14 | 2081 | 37.53 |
|                                  |         |       | 2005 | 5.31 | 334 | 4.69 | 1131 | 20.4 | 1139 | 20.54 |
|                                  |         |       | 2006 | 9.17 | 790 | 11.08 | 563  | 10.15 | 581 | 10.48 |
|                                  |         |       | 2007 | 3.11 | 262 | 3.68 | 199  | 3.59 | 184 | 3.32 |
| Stage                            | 0.0010    |       | I    | 34.61 | 2446 | 34.31 | 1925 | 34.72 | 1918 | 34.59 |
|                                  |         |       | II   | 45.17 | 3398 | 47.66 | 2552 | 46.02 | 2562 | 46.20 |
|                                  |         |       | III  | 20.22 | 1285 | 18.02 | 1068 | 19.26 | 1065 | 19.21 |
| ER                               | 0.0219    |       | Negative | 19.87 | 1307 | 18.33 | 1058 | 19.08 | 1073 | 19.35 |
|                                  |         |       | Positive | 49.64 | 3685 | 51.69 | 2835 | 51.13 | 2827 | 50.98 |
|                                  |         |       | Unknown  | 30.49 | 2137 | 29.98 | 1652 | 29.79 | 1645 | 29.67 |
| PR                              | 0.004     |       | Negative | 25.26 | 1625 | 22.79 | 1343 | 24.22 | 1326 | 23.91 |
|                                  |         |       | Positive | 44.25 | 3362 | 47.16 | 2549 | 45.97 | 2575 | 46.44 |
|                                  |         |       | Unknown  | 30.49 | 2142 | 30.05 | 1653 | 29.81 | 1644 | 29.65 |
| Type of surgery                  | <0.0001   |       | BCS   | 36.31 | 1784 | 25.02 | 1680 | 30.3 | 1651 | 29.77 |
|                                  |         |       | Else   | 63.69 | 5345 | 74.98 | 3865 | 69.7 | 3894 | 70.23 |
| CCI score                        | 0.1164    |       | 0     | 79.36 | 5730 | 80.38 | 4418 | 79.68 | 4429 | 79.87 |
|                                  |         |       | 1     | 13.57 | 955 | 13.40 | 749  | 13.51 | 757 | 13.65 |
|                                  |         |       | 2+    | 7.07 | 444 | 6.23 | 378  | 6.62 | 359 | 6.47 |
| Prior hospitalization            | 0.1088    |       | Yes   | 15.18 | 1152 | 16.16 | 872  | 15.73 | 890 | 16.05 |
|                                  |         |       | No    | 84.82 | 5977 | 83.84 | 4673 | 84.27 | 4655 | 83.95 |
| Number of outpatient visits      | <0.0001   |       | Low   | 25.35 | 2077 | 29.13 | 1521 | 27.43 | 1518 | 27.38 |
|                                  |         |       | Median | 34.92 | 2620 | 36.75 | 1964 | 35.42 | 1971 | 35.55 |
|                                  |         |       | High   | 39.73 | 2432 | 34.11 | 2060 | 37.15 | 2056 | 37.08 |
| Level of insurance premiums      | <0.0001   |       | Low   | 21.35 | 1552 | 21.77 | 1205 | 21.73 | 1212 | 21.86 |
|                                  |         |       | Mid-Low | 26.78 | 2120 | 29.74 | 1544 | 27.84 | 1560 | 28.13 |
|                                  |         |       | Mid-High | 20.87 | 1493 | 20.94 | 1153 | 20.79 | 1156 | 20.85 |
|                                  |         |       | High   | 31.00 | 1964 | 27.55 | 1643 | 29.63 | 1617 | 29.16 |
Table 1. Cont.

| Characteristics | Pre-PSM Sample | Post-PSM Sample | p Value | Low COCI (n = 7133, 50%) | High COCI (n = 7129, 50%) | Low COCI (n = 5545, 50%) | High COCI (n = 5545, 50%) | p Value | Standardized Difference |
|-----------------|----------------|-----------------|---------|--------------------------|---------------------------|--------------------------|--------------------------|---------|-------------------------|
| Occupation status |                |                 |         |                          |                           |                          |                           |         |                         |
| Labor           | 2362           | 33.11           | 2187    | 30.68                    | 1727                      | 31.15                    | 1768                      | 31.88   |                         |
| Public servant  | 1868           | 26.19           | 1905    | 26.72                    | 1510                      | 27.23                    | 1474                      | 26.58   |                         |
| Farmer or fishermen | 861          | 12.07           | 1018    | 14.28                    | 714                       | 12.88                    | 723                       | 13.04   |                         |
| Low-income households b | 64         | 0.90            | 48      | 0.67                     | 57                        | 1.03                     | 43                        | 0.78    |                         |
| Unemployed      | 1978           | 27.73           | 1971    | 27.65                    | 1537                      | 27.72                    | 1537                      | 27.72   |                         |
| Whether physicians/family members of physicians | 151         | 2.12            | 147     | 2.06                     | 126                       | 2.27                     | 121                       | 2.18    | 0.7476 -0.006           |
| Yes             | 151            | 2.12            | 147     | 2.06                     | 126                       | 2.27                     | 121                       | 2.18    |                         |
| No              | 6982           | 97.88           | 6982    | 97.94                    | 5419                      | 97.73                    | 5424                      | 97.82   |                         |
| Occupation status |                |                 |         |                          |                           |                          |                           |         |                         |
| Number of physicians per square kilometer | <0.0001 |                         |         |                          |                           |                          |                           |         |                         |
| Low             | 3357           | 47.07           | 3612    | 50.67                    | 2717                      | 49.00                    | 2754                      | 49.67   | 0.8113 -0.008           |
| High            | 3767           | 52.94           | 3517    | 49.33                    | 2828                      | 51.00                    | 2791                      | 50.33   |                         |
| Age of physician |                |                 |         |                          |                           |                          |                           |         |                         |
| <40             | 1553           | 21.77           | 1439    | 20.19                    | 1162                      | 20.96                    | 1137                      | 20.87   | 0.9917 0.001            |
| 40–59           | 5132           | 71.95           | 5251    | 73.66                    | 4056                      | 73.15                    | 4062                      | 73.26   |                         |
| 60+             | 448            | 6.28            | 439     | 6.16                     | 327                       | 5.90                     | 326                       | 5.88    |                         |
| Average annual breast cancer volume of the physician | <0.0001 |                         |         |                          |                           |                          |                           |         |                         |
| Low             | 3972           | 55.68           | 3145    | 44.12                    | 2789                      | 50.30                    | 2801                      | 50.51   | 0.8578 -0.008           |
| High            | 1383           | 19.39           | 2198    | 30.83                    | 1299                      | 23.43                    | 1312                      | 23.66   |                         |
| Age of physician |                |                 |         |                          |                           |                          |                           |         |                         |
| <40             | 1778           | 24.93           | 1786    | 25.05                    | 1457                      | 26.28                    | 1432                      | 25.83   | 0.8045 0.005            |
| 40–59           | 3799           | 53.26           | 3909    | 54.83                    | 2962                      | 53.42                    | 2975                      | 53.65   |                         |
| 60+             | 3334           | 46.74           | 3220    | 45.17                    | 2583                      | 46.58                    | 2570                      | 46.35   |                         |
| Accreditation level |        |                 |         |                          |                           |                          |                           |         |                         |
| Medical center  | 7990           | 37.26           | 3909    | 54.83                    | 2962                      | 53.42                    | 2975                      | 53.65   |                         |
| Non-medical center | 3334        | 62.74           | 3220    | 45.17                    | 2583                      | 46.58                    | 2570                      | 46.35   |                         |
| Ownership       |                |                 |         |                          |                           |                          |                           |         |                         |
| Public hospital | 2192           | 30.73           | 1423    | 19.96                    | 1372                      | 24.74                    | 1344                      | 24.24   | 0.5364 -0.012           |
| Non-public hospital | 4941     | 69.27           | 5706    | 80.04                    | 4173                      | 75.26                    | 4201                      | 75.76   |                         |
| Average annual breast cancer volume of the facility | <0.0001 |                         |         |                          |                           |                          |                           |         |                         |
| Low             | 3179           | 44.57           | 3506    | 49.18                    | 2618                      | 47.21                    | 2638                      | 47.57   | 0.7972 -0.012           |
| Median          | 2065           | 28.95           | 2231    | 31.29                    | 1669                      | 30.10                    | 1680                      | 30.30   |                         |
| High            | 1889           | 26.48           | 1392    | 19.53                    | 1258                      | 22.69                    | 1227                      | 22.13   |                         |

PSM: propensity score matching; COCI: continuity of care index; ER: estrogen receptor; PR: progesterone receptor; CCI: Charlson comorbidity index; BCS: breast cancer surgery. a The analytic sample included only the patients who made at least 3 visits for oncologists in the second year after diagnosis. b Insured income is lower than the level required for charging premium.

Table 2 presents the distribution of baseline characteristics of the sample grouped according to continuity of care by primary physicians (PCP). At the time of diagnosis, the average age of breast cancer survivors experiencing high continuity of primary care was 54.9 years with the age distribution peaking at 45–54 years (34%) followed by 55–64 years (26%). In terms of clinical characteristics, most of the tumors were in Stage II (47%) followed by Stage I (34%). The proportion of ER-positive results was 47%, and the proportion of PR-positive results was 42%. BCS accounted for 28% of the surgical procedures. In terms of basic health status, most of the patients had CCI scores of 0 (72%) or 1 (20%), and 16% were hospitalized during the year prior to diagnosis. Most of the patients were unemployed (28%) or categorized as labor (27%). It was observed that 1.6% of the patients were physicians or family members of physicians. Most of the patients resided in urban areas (65%). The hospitals most frequently visited in the second year after diagnosis were medical centers (66%), most of which were non-public hospitals (81%). The physicians most frequently visited by patients were between 40–59 years (74%). Following PSM, the distributions of the variables were balanced.
Table 2. Baseline characteristics of patients grouped according to the PCP continuity of care.

| Characteristics | Pre-PSM Sample | Post-PSM Sample | p Value | Standardized Difference |
|-----------------|----------------|-----------------|---------|-------------------------|
|                 | Low COCI (n = 3058, 49%) | High COCI (n = 3143, 51%) |
|                 | n % | n % | n % | n % |
| Year of diagnosis | 0.0025 | | 0.9954 | 0.006 |
| 2002 | 122 | 3.99 | 123 | 3.91 |
| 2003 | 212 | 6.93 | 196 | 6.24 |
| 2004 | 652 | 21.32 | 625 | 19.89 |
| 2005 | 728 | 23.81 | 662 | 21.06 |
| 2006 | 624 | 20.41 | 670 | 21.32 |
| 2007 | 720 | 23.54 | 867 | 27.59 |
| Age of diagnosis | 0.0683 | | 0.9942 | 0.001 |
| <35 | 85 | 2.78 | 70 | 2.33 |
| 35–44 | 507 | 16.58 | 507 | 16.13 |
| 45–54 | 1016 | 33.22 | 1065 | 33.88 |
| 55–64 | 727 | 23.77 | 830 | 26.41 |
| 65–74 | 514 | 16.81 | 473 | 15.05 |
| 75+ | 209 | 6.83 | 198 | 6.30 |
| Stage | 0.0961 | | 0.737 | 0.019 |
| I | 1114 | 36.43 | 1075 | 34.20 |
| II | 1421 | 46.47 | 1478 | 47.03 |
| III | 523 | 17.10 | 590 | 18.77 |
| Type of surgery | 0.7421 | | 0.9007 | 0.003 |
| BCS | 855 | 27.96 | 867 | 27.59 |
| CCI score | 0.0009 | | 0.973 | 0.007 |
| 0 | 2107 | 68.90 | 2261 | 71.94 |
| 1 | 629 | 20.57 | 629 | 20.01 |
| 2+ | 322 | 10.53 | 253 | 8.05 |
| Prior hospitalization | 0.0755 | | 0.5019 | 0.019 |
| Yes | 537 | 17.56 | 499 | 15.88 |
| No | 2521 | 82.44 | 2644 | 84.12 |
| Level of insurance premiums | 0.0009 | | 0.909 | 0.008 |
| Low | 768 | 25.11 | 777 | 24.72 |
| Mid-Low | 749 | 24.69 | 693 | 21.99 |
| Mid-High | 823 | 26.91 | 803 | 25.55 |
| High | 718 | 23.48 | 872 | 27.74 |
| Occupation status | 0.0018 | | 0.9864 | 0.010 |
| Labor | 719 | 23.51 | 850 | 27.04 |
| Public servant | 775 | 25.34 | 799 | 25.42 |
| Farmer or fishermen | 664 | 21.71 | 575 | 18.29 |
| Low-income households | 35 | 1.14 | 41 | 1.30 |
| Unemployed | 829 | 27.94 | 914 | 28.26 |
| Whether physicians/family members of physicians | 0.1581 | | 0.8071 | 0.007 |
| Yes | 35 | 1.14 | 49 | 1.56 |
| No | 3023 | 98.86 | 3094 | 98.44 |
| Urbanization | 0.0610 | | 0.7276 | 0.010 |
| Low | 1151 | 37.64 | 1111 | 35.35 |
| High | 1907 | 62.36 | 2032 | 64.65 |
| Number of physicians per square kilometer | 0.2812 | | 0.8736 | 0.014 |
| Low | 1554 | 50.82 | 1529 | 48.65 |
| High | 1504 | 49.18 | 1614 | 51.35 |
Table 2. Cont.

| Characteristics | Pre-PSM Sample | Post-PSM Sample | p Value | Standardized Difference |
|-----------------|----------------|-----------------|---------|-------------------------|
|                 | Low COCI (n = 3058, 49%) | High COCI (n = 3143, 51%) |         | Low COCI (n = 2565, 50%) | High COCI (n = 2565, 50%) |         |
| Age of physician | <40 | 645 | 21.09 | 550 | 17.50 | <0.0001 | 0.899 | 0.012 |
|                 | 40–59 | 2202 | 72.01 | 2313 | 73.59 | | |
|                 | 60+ | 211 | 6.90 | 280 | 8.91 | | | |
| Average annual breast cancer volume of the physician | Low | 1370 | 44.80 | 1731 | 55.07 | <0.0001 | 0.8736 | 0.014 |
|                 | Median | 746 | 24.40 | 799 | 25.42 | | |
|                 | High | 942 | 30.80 | 613 | 19.50 | | |
| Accreditation level | Medical center | 1255 | 41.04 | 1069 | 34.01 | <0.0001 | 0.9082 | 0.003 |
|                 | Ownership | 1803 | 58.96 | 2074 | 65.99 | | |
|                 | Public hospital | 730 | 23.87 | 608 | 19.34 | <0.0001 | 0.6116 | 0.014 |
|                 | Non-public hospital | 2528 | 76.13 | 2074 | 80.66 | | |
| Average annual breast cancer volume of the facility | Low | 1399 | 45.75 | 1692 | 53.83 | <0.0001 | 0.9726 | 0.003 |
|                 | Median | 851 | 27.83 | 766 | 24.37 | | |
|                 | High | 808 | 26.42 | 685 | 21.79 | | |

PCP: primary care physician; PSM: propensity score matching; COCI: continuity of care index; ER: estrogen receptor; PR: progesterone receptor; CCI: Charlson Comorbidity Index; BCS: breast cancer surgery. 

* The analytic sample included only the patients who made at least three visits for primary care physicians in the second year after diagnosis. 

3.2. Distribution of Care Continuity, Follow-Up Care, and Health Outcome

Table 3 presents the values of ambulatory care continuity, the percentage of follow-up service utilization, and negative health outcomes in the various follow-up periods. The average continuity of oncology care value was 0.70–0.72, and the average continuity of PCP care value was 0.52–0.54. In terms of follow-up services, 56–57% of the breast cancer survivors underwent mammography and 73–75% underwent breast ultrasound. Advanced imaging tests were administered to 82–85% of the patients. In terms of health outcomes, 11–13% of the patients were hospitalized and 12–15% visited the emergency department in each of the years (Table 3).

Table 3. Summary statistics for main interest variables according to follow-up period.

| Variable | Follow-Up Period 1 (n = 18031) | Follow-Up Period 2 (n = 16904) | Follow-Up Period 3 (n = 15990) | Follow-Up Period 4 (n = 15237) |
|----------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Continuity of care | mean (SD) | mean (SD) | mean (SD) | mean (SD) |
| Oncology COCI | 0.71 (0.28) | 0.72 (0.29) | 0.71 (0.29) | 0.70 (0.30) |
| PCP COCI | 0.52 (0.31) | 0.54 (0.31) | 0.54 (0.31) | 0.54 (0.30) |
| Follow-up service | % | % | % | % |
| Mammography # | 56.63 | 55.54 | 56.77 | 56.96 |
| Breast Ultrasound # | 74.63 | 74.26 | 73.13 | 73.73 |
| Mammography or Breast Ultrasound # | 79.89 | 78.49 | 77.55 | 75.28 |
| Advanced Imaging Taking | 84.75 | 83.62 | 82.99 | 82.18 |
| Health Outcome | % | % | % | % |
| Hospitalization | 13.06 | 10.59 | 10.57 | 10.92 |
| Emergency Department Use | 12.03 | 13.36 | 14.13 | 14.67 |

COCI: continuity of care index; PCP: primary care physician. # Excludes women with a history of bilateral mastectomy.

3.3. Effect of Oncology Care Continuity and PCP Care Continuity

Table 4 lists sample analysis after PSM. The distribution of each variable was balanced; therefore, we did not include the covariates used for adjustment; i.e., the table presents crude odds ratios). In terms of follow-up care utilization, breast cancer survivors with a higher oncology COCI was more likely to use mammography (OR = 1.26, 95% CI: 1.19–1.32), breast ultrasound (OR = 1.12, 95%
CI: 1.06–1.18), or advanced imaging tests (OR = 1.47, 95% CI: 1.36–1.60). Primary care COCI was not associated with the use of these services. In terms of health outcomes, a higher oncology COCI was associated with a lower likelihood of hospitalization (OR = 0.78, 95% CI: 0.71–0.85) and lower likelihood of emergency department use (OR = 0.88, 95% CI: 0.82–0.95). Similarly, a higher primary care COCI was associated with lower likelihood of hospitalization (OR = 0.77, 95% CI: 0.70–0.85) and lower likelihood of emergency department use (OR = 0.75, 95% CI: 0.68–0.82). In addition, we used subgroup analysis to explore the potential effects of other variables on the association between continuity of care and the likelihood of adverse health events. The results are presented in Appendix A, Figure A1.

Table 4. Generalized estimating equation models for the effect of continuity of care.

| Variable              | Mammography | Breast Ultrasound | Advanced Imaging Test | Hospitalization | Emergency Department Use |
|-----------------------|-------------|-------------------|-----------------------|-----------------|--------------------------|
|                       | OR 95% CI   | OR 95% CI         | OR 95% CI             | OR 95% CI       | OR 95% CI                |
| Oncology COCI *       | 1.26 1.19   | 1.32 1.12         | 1.06 1.18             | 1.47 1.36       | 1.60 0.78 0.71 0.85 0.88 0.82 0.95 |
| PCP COCI *            | 1.02 0.95   | 1.09 0.95         | 0.95 0.88             | 1.03 1.01       | 0.93 1.10 0.77 0.70 0.85 0.75 0.68 0.82 |

COCI: Continuity of Care Index; PCP: Primary care physician; OR: Odds ratio; CI: Confidence interval. * Reference group is lower continuity of care. Using a generalized estimating equation model with binomial distribution with logit link. To avoid over-adjustment, we opted not to include in our analysis any variables that had been used in propensity score matching and had been balanced after matching.

4. Discussion

This study examined the correlations between ambulatory continuity of care (by oncologists and primary care physicians) and the utilization of follow-up care by breast cancer survivors and their health outcomes.

Existing guidelines suggest that breast cancer survivors regularly undergo mammography in the first five years of the follow-up period; however, only 56%–57% of breast cancer survivors in this study actually undergo annual mammography during that period. The use of mammography by breast cancer survivors was estimated at 41% in South Korea [53], 54% in the UK [34], and 47%–82% in the US [9,44,46,54,55]. Considering the fear of pain caused by mammography and the higher density of breast tissue in Asian women, it is not uncommon for clinicians to opt for breast ultrasound as an alternative for follow-up monitoring. We discovered that 80% of the breast cancer survivors underwent mammography or breast ultrasonography in each year of the follow-up period.

On the other hand, we observed that 80% of breast cancer survivors used advanced imaging tests that were not recommended in current guidelines. Based on a review of medical records, Hahn et al. reported that 55% of breast cancer survivors in the US underwent at least one imaging examination that was not recommended for the monitoring of cancer status [22]. Note that we were unable to confirm the purpose of using the various examinations with administrative datasets; therefore, the relevant proportion may be overestimated. This type of imaging test exposes the patient to unnecessary high doses of radiation and many imaging tests are prone to false positive results, which can lead to anxiety and in some cases unnecessary invasive treatment [14]. In one study, it was surmised that the use of unnecessary imaging tests can be attributed to requests from patients for more aggressive examinations [56].

In the current study, the average ambulatory COCI values were as follows: oncology specialists (0.71) and primary care physicians (0.54). In relevant empirical studies on chronic diseases in the past, the mean COCI of outpatient care provided by physicians was 0.66 for asthma patients [57], 0.55–0.79 for patients with chronic obstructive pulmonary disease [57–59], 0.33–0.55 for patients with chronic heart failure [60], 0.50–0.71 for patients with diabetes [58], and 0.74 for patients with hypertension [57]. Continuity of care is related to disease characteristics; therefore, patients requiring long-term treatment and follow-up tend to have better ambulatory continuity of care [59]. The higher COCI values observed in this study may correlate with the risk of recurrence and the requirements of health management.
(e.g., dealing with late-effect symptoms). Anxiety about recurrence often prompts breast cancer survivors to seek follow-up support from oncologists [61].

Our results revealed that patients who continued to receive care from their oncologist were more likely to use mammography and/or breast ultrasonography, whereas patients who received follow-up care from their primary care physician were not likely to do so. Additionally, our results indicate that continuity of care, no matter for oncologists or for PCP, is negatively associated with hospitalization and emergency department visits. This result is consistent with the influence direction reported in previous studies [20,62–66]. Continuity of care can promote a willingness on the part of patients to communicate disease-related information. It also makes it easier for patients and their families to deal with the disease. It appears that continuity of care can alter the health behavior of patients [67]. A good physician–patient relationship may increase the likelihood that the patient will seek medical help before the condition becomes urgent, thereby reducing the possibility of hospital admission or emergency department use. Long-term physician–patient relationships also make it easier for the physician to understand changes in the health status and needs of the patient. Patients who feel trust and satisfaction with their physician are more likely to comply with disease management instructions, such as compliance in taking medication [68]. At the provider level, regular care is highly conducive to information continuity. Lack of care continuity has been associated with a higher number of medical errors, such as duplicate medication and inappropriate medication [49,69,70].

This study has several limitations. First, the secondary database used in this study did not include clinical test values or data pertaining to comprehensive health status (e.g., awareness and physiological functions), socio-economic status (e.g., education level and actual income), health literacy, social network, psychological support resources, diet or exercise, or the life style choices of breast cancer survivors. We were also unable to confirm the care decision-making process, which made it impossible to determine whether the use of care services was related to the attitudes of health care providers or patient preferences. Furthermore, our use of the National Health Insurance Research Database made it impossible to obtain relevant information on self-paid health examinations from other archives. We were unable to confirm the reasons for using the various imaging tests; i.e., it is difficult to distinguish between surveillance and diagnostic procedures. This increases the likelihood that we overestimated the use of low-value (non-recommended) imaging diagnostics. Third, the indicators of continuity of care adopted in this study reflect only the degree to which patients sought medical care from regular medical providers. Thus, it was not possible for us to examine the variables related to physician–patient relationships, communication, and trust. Our analysis was also limited to physicians, such that the characteristics of the entire medical team could not be taken into consideration. Finally, it is possible that the influence of continuity of care may vary over time. This issue could be addressed in future studies.

5. Conclusions

This study provides evidence that breast cancer survivors receiving ambulatory care continuity are more likely to use recommended surveillance care services and less likely to experience negative health events. Maintaining regular source of care should be adequately addressed in the post-treatment phase of cancer care.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Figure A1. Cont.
Figure A1. Subgroup analysis of odds ratio between the high COCI and low COCI groups for health events of (A) all-cause hospitalization and (B) all-cause emergency department use.

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CCI: Charlson Comorbidity Index; COCI: Continuity of Care Index; PCP: Primary care physician.
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