# Effect of the Pay-for-Performance Program for Breast Cancer Care in Taiwan

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## Abstract

**Purpose:** To evaluate the impact of the nationwide pay-for-performance (P4P) program for breast cancer care (BC-P4P) in Taiwan on care quality, patient survival, and recurrence.

**Study Design:** A population-based observational study with cross-sectional design.

**Methods:** Retrospective analysis of population-based cancer registration and claims data was used in this study. A total of 4,528 patients with stage I or II breast cancer diagnosed in 2002 or 2003 who received curative surgery were observed until the end of 2008. This study applied multivariate linear regression to explore the association between BC-P4P enrollment and quality of care. Cox regression was applied to examine the effect of BC-P4P enrollment on 5-year recurrence and overall survival among patients with breast cancer.

**Results:** After controlling for age, stage, type of surgery, and other factors, BC-P4P enrollees were found to have received better quality care than nonenrollees ($P = .001$). Cox regression models also indicated that after controlling for patient characteristics, quality of care was related to better 5-year overall survival (odds ratio [OR], 0.212; $P = .001$) and recurrence (OR, 0.289; $P < .001$). Even when controlled by quality of care provided to patients and its interaction with status of BC-P4P enrollment, BC-P4P enrollment remained statistically significant regarding 5-year overall survival (OR, 0.167; $P < .001$) and recurrence (OR, 0.370; $P = .002$).

**Conclusion:** Patients with breast cancer enrolled in the BC-P4P program received better quality care and had better outcome than nonenrolled patients. Evidence from this study indicates that financial incentives in the payment design had a positive impact on outcome of breast cancer care.

## Introduction

Pay for performance (P4P), a modification of the traditional payment scheme to reward health care providers for better performance, has been widely discussed in recent literature.[1] The theoretical basis for designing an incentive mechanism within a payment scheme originated from the agent theory, which posits that incentive contracting occurs when an individual or organization induces and rewards another individual or organization for specific behaviors.[2,3] Traditional payment designs, such as fee for service, capitation, and salary, are based on a piece-rate system and can result in problems of overuse, underuse, and low productivity.[2,4] Reports from the Institute of Medicine on issues concerning quality of health care[5,6] have led to research on payment reform and implementation of the pay-for-performance scheme.

P4P has been implemented in health care systems of many countries. In the United States, P4P has been widely implemented in both private and public sectors.[7-9] Since the report and consequent actions announced by Leapfrog, a joint organization for health care purchasers, implementation of P4P has become popular in health care settings.[10] The United Kingdom implemented P4P in its New General Medical Service in 2004 and introduced a revision in 2006.[11-13] Other countries such as Australia, New Zealand, Costa Rica, Haiti, and Nicaragua also have P4P-like programs for reimbursement.[14-18] Although P4P is increasingly being implemented, there remains insufficient evidence to support the belief that the incentive design of P4P improves outcome of care.[19] Some studies have found that P4P has a positive impact on outcome of care,[12,19-21] whereas others have found unintended consequences or no significant effect.[19,22]

Taiwan launched a nationwide breast cancer P4P (BC-P4P) initiative in November 2001 to provide financial incentives to encourage guideline-adhering therapy and reward better patient survival. Unlike most P4P programs in other countries, the Bureau of National Health Insurance (BNHI) in Taiwan implemented disease-specific P4P programs for diabetes mellitus, tuberculosis, breast cancer, cervical cancer, and asthma.[23,24] These programs are designed to reform the original payment scheme, in which most services were paid for on a fee-for-service or case-base basis. The financial incentives within these P4P programs are expected to improve continuity, timeliness, and comprehensiveness of care delivered to patients.

BC-P4P is a disease-specific program focused on breast cancer care. It covers medical costs and drug fees for both outpatient and inpatient services. Hospitals with more than 100 cases of breast cancer annually, a multidisciplinary team for breast cancer care, and an in-hospital database that routinely collects recurrence and survival information on patients with breast cancer are eligible to participate in the program. Patients who are newly diagnosed with breast cancer are eligible and must be claimed as BC-P4P enrollees. Only patients receiving palliative or hospice care without any other curative therapy are excluded. There are two financial incentives for hospitals in the BC-P4P program. First, unlike in the original case-based payment scheme for breast cancer surgery and fee-for-service scheme for other inpatient and outpatient claims for breast cancer care, payment for caring for BC-P4P enrollees is a bundled payment, called the treatment mix. It groups treatment options (ie, surgery, radiotherapy, chemotherapy, and so on) based on guideline-recommended treatment for a specific stage of breast cancer. Payments for those treatment mixes are set higher than

in the original case-based payment scheme for breast cancer surgery and fee-for-service scheme for other related uses. However, the BC-P4P program also reduces total payment for a treatment mix if the patient does not complete the full care package per the treatment plan (eg, did not receive adjuvant therapy after surgery). Therefore, hospitals participating in the BC-P4P share financial risk under the payment scheme and must improve patients' compliance with treatment plans in addition to minimizing any complications within the course of treatment. Second, BC-P4P–enrolled hospitals earn an annual bonus if they meet the goals for a set of stage-specific survival rates (Appendix Table A1, online only, lists complete target survival rates for annual bonus). Participating hospitals are also required to report results of process-based performance to the BNHI, although performance is not directly linked to financial incentives.

The purpose of this study was to compare quality of care provided by enrolled and nonenrolled hospitals and evaluate the effects of the BC-P4P program on patient survival and recurrence.

## Methods

Retrospective analyses of population-based cancer registration and claims data were used in this study. The 2003 to 2004 Taiwan Cancer Database (TCDB), which was collected and released by the Bureau of Health Promotion, Department of Health in Taiwan, was used to identify patients with breast cancer in this study. Women with stage I or II breast cancer who were diagnosed in 2003 to 2004 and reported to the TCDB were included. However, those patients who did not receive curative surgery were excluded for analysis. Major cancer care providers in Taiwan are eligible to report to the TCDB. At present, the database covers more than 80% of patients with newly diagnosed breast cancer in Taiwan. To avoid errors in coding and maximize data quality, each record was checked by computerized verification software issued by the Bureau of Health Promotion. Medical record reabstraction for random selected cases and onsite surveys were conducted annually to ensure data validity.

The TCDB records of selected patients were linked to the 2002 to 2008 National Health Insurance Database (NHID), a population-based claims database released by the Department of Health, to identify BC-P4P enrollment status. Patients who did not appear in the NHID were assumed to be National Health Insurance nonenrollees or patients who paid out of pocket and were thus excluded. These data were also used to measure quality as well as patient comorbidity. The 2003 to 2008 National Death Registry was then linked to the previous two data sets to identify survival time. Recurrence, along with related information (eg, type of recurrence, recurrence date), was reported directly to the TCDB. A patient was also defined as presenting with recurrence if that patient received treatment, including surgery, chemotherapy, radiotherapy, and palliative care, after the last follow-up date recorded in the database. Chemotherapy data were excluded if the regimen was the same as that used in the 2 months before the last day of follow-up. Personal and hospital identification derived from those data were encrypted for privacy protection.

Quality of care measured in this study was based on core measure indicators developed by Chung et al.[25] These indicators were derived from an original pool of 150 indicators and selected using the modified Delphi technique to build consensus within an expert panel group. By linking the TCDB and NHID data, the selected measurement indicators for quality of breast cancer care in this study were coded as binary variables at the patient level. They were then aggregated as patient-level quality scores (ie, number of patient-level quality indicators applied to a patient, divided by total number of indicators applicable to that patient). Although some studies have questioned the validity of cancer registries for measurement quality,[26-28] in this study we used cancer registry data combined with claims data to enhance data completeness.

The comorbidity score for each patient was estimated following the method first published by Klabunde et al[29-31] in 2000 and modified in 2006. This scale is also known as the National Cancer Institute comorbidity index. In this estimation, different comorbidities (International Classification of Diseases, Ninth Revision, Clinical Modification diagnosis codes) listed in insurance claims 1 year before first diagnosis are assigned specific scores and summed for each patient. Comorbidities appearing fewer than three times or within the same month were excluded.

Multivariate linear regression was used in this study to explore the association of P4P enrollment and quality of care, while controlling for age, stage, comorbidity, and type of surgery. Cox proportional hazard models were fitted to examine the effect of P4P enrollment on 5-year recurrence and overall survival in patients with breast cancer. To control selection bias and properly identify the effect of BC-P4P enrollment on quality of care as well as on patient outcome, this study applied a propensity score method to obtain an unbiased estimation of the effect of BC-P4P enrollment in multivariate linear regres-

### Take-Away Points

A retrospective analysis of population-based cancer registration and claims data was used to evaluate effects of the nationwide pay-for-performance program for breast cancer care (BC-P4P) in Taiwan. The association between BC-P4P enrollment and quality of care and effect of BC-P4P enrollment on 5-year recurrence and overall survival among patients with breast cancer were examined.

- BC-P4P enrollees received higher-quality care than nonenrollees ($P = .001$).
- BC-P4P enrollees had better 5-year overall survival (odds ratio, 0.167; $P < .001$) and less recurrence (odds ratio, 0.370; $P = .002$).
- Financial incentives in the payment design had a positive impact on outcome of breast cancer.

sion and Cox proportional hazard models. Variables included in the propensity score estimation to account for the systematic difference between BC-P4P enrollees and nonenrollees are listed in Appendix Table A2, online only.

## Results

Patient demographics are listed in Table 1. A total of 4,528 patients with stage I or II breast cancer were included in this study. Of these patients, 1,393 were P4P enrollees (30.8%). Patients in the BC-P4P group were younger and had fewer comorbidities than those in the non–BC-P4P group, but the difference in age was minor. There were no statistical differences between the two groups in disease stage or type of surgery. Quality of care provided to BC-P4P enrollees was better than that provided to nonenrollees (0.70 *v* 0.63; $P < .001$). BC-P4P enrollees also tended to be documented as having a higher proportion of negative surgical margins (97.5% *v* 93.6%; $P < .001$), which is another factor related to quality of care received. In the bivariate analysis, 5-year mortality and recurrence rates also indicated that outcome in BC-P4P patients was better than that among nonenrollees. A higher proportion of BC-P4P patients were also cared for by public hospitals, and a lower proportion were cared for by medical school–affiliated hospitals.

The baseline model (model 1) listed in Table 2 shows that age, cancer stage, type of surgery, and type of hospital were related to quality of care received by patients with breast cancer. However, comorbidity was shown to have no statistical impact on quality of care. Surgical volume was positively related to quality of care, although the nonstandardized coefficient is small. Model 2 shows that after controlling for all other factors, patients enrolled in the BC-P4P program received better quality of care than nonenrollees ($P = .001$). The final model shows that even after controlling for the propensity score estimated for potential selection bias within the study sample, patients enrolled in the BC-P4P program still received better quality of care than nonenrollees ($P = .001$). The magnitude of the effect of BC-P4P enrollment also increased after controlling for propensity score.

Table 3 lists results of four Cox proportional hazard models for 5-year overall survival (models 1 and 2) and recurrence (models 3 and 4) compared with process quality and BC-P4P enrollment. Model 1 shows that after controlling for age, stage of cancer, and surgical margin, type of surgery was not related to 5-year overall survival. Model 2 indicates that after controlling for propensity score and other factors, quality of care was positively related to 5-year overall survival (hazard ratio, 0.212; $P < .001$), but surgical volume had no statistical impact on patient survival. Table 2 shows that both BC-P4P enrollment and surgeons' surgical volume were related to quality of care delivered to patients. For that reason, we added two interactions to quality of care in model 2: surgeons' surgical volume and BC-P4P enrollment. Results demonstrate that surgeons' surgical volume and its interaction with quality of care had no impact on patient survival when quality of care is controlled for in the model. After controlling for other factors, BC-P4P enrollment significantly increased 5-year overall survival (odds ratio [OR], 0.167; $P = .003$).

**Table 1.** Characteristics of BC-P4P and Non–BC-P4P Patients in 2003 and 2004

| | BC-P4P Patients (n = 1,393) | | Non–BC-P4P Patients (n = 3,135) | | |
|---|---|---|---|---|---|
| **Characteristic** | **No.** | **%** | **No.** | **%** | ***P*** |
| Age, years | | | | | .022 |
| Mean | 50.0 | | 50.8 | | |
| SD | 11.4 | | 11.6 | | |
| Comorbidity* | | | | | .004 |
| Mean | 0.185 | | 0.225 | | |
| SD | 0.412 | | 0.448 | | |
| Quality of care† | | | | | < .001 |
| Mean | 0.706 | | 0.623 | | |
| SD | 0.200 | | 0.210 | | |
| Stage | | | | | |
| I | 567 | 40.7 | 1,208 | 38.5 | .167 |
| II | 826 | 59.3 | 1,927 | 61.5 | |
| Breast-conserving surgery | 456 | 32.7 | 1,047 | 33.4 | .682 |
| Margin free | 1,358 | 97.5 | 2,935 | 93.6 | < .001 |
| Recurrence (5 year) | 189 | 13.6 | 539 | 17.3 | .002 |
| Death (5 year) | 74 | 5.3 | 266 | 8.5 | < .001 |
| Type of hospital | | | | | |
| Public | 628 | 45.1 | 689 | 22.0 | < .001 |
| Medical school affiliated | 319 | 22.9 | 2,011 | 64.1 | < .001 |

Abbreviations: BC-P4P, pay-for-performance program for breast cancer care; SD, standard deviation.
* Measured by the National Cancer Institute comorbidity index.
† Measured by the breast cancer core measure indicators.

Models 3 and 4 show results similar to those of the models fitted for 5-year survival. Model 1 shows that after controlling for age and stage of cancer, surgical margin was related to 5-year recurrence. However, surgical margin was not related to patient survival in the results of models 1 and 2. Model 4 shows that patients who received breast-conserving surgery also had a higher probability of recurrence in 5 years (OR, 1.89; $P = .021$). After controlling for propensity score and other factors, BC-P4P enrollment (OR, 0.370; $P = .002$) significantly decreased probability of 5-year cancer recurrence. Results listed in Table 3 also show that patients with breast cancer who received treatment at medical school–affiliated hospitals had better outcomes than those who were cared for in nonaffiliated hospitals.

## Discussion

Although there is still debate on the effect of implementing P4P programs in health plans,[12,19,20,22] this study shows that the BC-P4P program in Taiwan had a positive effect on outcome of breast cancer care. Patients enrolled in the BC-P4P program seemed to receive better quality care and tended to have increased survival and lower recurrence. Although previous studies have reported on cancer care as part of the aspects monitored by P4P programs,[32-34] to the best of our knowledge, this is the

**Table 2.** Regression Models for BC-P4P Enrollment and Other Factors Related to Quality of Care

| | Model 1 | | | Model 2 | | | Model 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Characteristic** | **(B)*** | **95% CI** | ***P*** | **(B)*** | **95% CI** | ***P*** | **(B)*** | **95% CI** | ***P*** |
| Age | −0.001 | −0.002 to −0.001 | .001 | −0.001 | −0.002 to −0.001 | .001 | −0.001 | −0.002 to −0.001 | .001 |
| Stage II (stage I, reference) | −0.051 | −0.061 to −0.041 | .001 | −0.049 | −0.059 to −0.039 | .001 | −0.052 | −0.062 to −0.042 | .001 |
| Comorbidity | −0.004 | −0.017 to 0.009 | .519 | −0.002 | −0.015 to 0.011 | .722 | −0.007 | −0.019 to 0.007 | .297 |
| Margin free | 0.108 | 0.079 to 0.138 | .001 | 0.105 | 0.077 to 0.135 | .001 | 0.105 | 0.077 to 0.135 | .001 |
| Breast-conserving surgery | 0.221 | 0.211 to 0.232 | .001 | 0.221 | 0.210 to 0.231 | .001 | 0.220 | 0.209 to 0.231 | .001 |
| Public hospital | 0.049 | 0.038 to 0.061 | .001 | 0.033 | 0.021 to 0.044 | .001 | 0.034 | 0.021 to 0.045 | .001 |
| Medical school–affiliated hospital | −0.039 | −0.050 to −0.029 | .001 | −0.013 | −0.025 to −0.001 | .026 | −0.010 | −0.022 to 0.001 | .082 |
| Surgeon volume | $1.666^{-04}$ | $1.188^{-04}$ to $2.188^{-04}$ | .001 | $1.230^{-04}$ | $7.701^{-05}$ to $1.733^{-04}$ | .001 | $1.148^{-04}$ | $6.785^{-05}$ to $1.653^{-04}$ | .001 |
| BC-P4P enrollment | | | | 0.062 | 0.050 to 0.074 | .001 | 0.079 | 0.067 to 0.091 | .001 |
| Propensity score | | | | | | | −0.145 | −0.174 to −0.112 | .001 |

Abbreviation: BC-P4P, pay-for-performance program for breast cancer care.
* Coefficients are based on 1,000 bootstrap samples, stratified by stage, type of surgery, and BC-P4P enrollment.

**Table 3.** Cox Models for BC-P4P Enrollment and Other Factors Related to Survival and Recurrence

| | 5-Year Overall Survival | | | | | | 5-Year Recurrence | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | |
| Characteristic | Exp (β) | 95% CI | P | Exp (β) | 95% CI | P | Exp (β) | 95% CI | P | Exp (β) | 95% CI | P |
| Age | 1.012 | 1.002 to 1.021 | .019 | 1.010 | 1.000 to 1.019 | .045 | 0.983 | 0.976 to 0.990 | < .001 | 0.982 | 0.975 to 0.989 | < .001 |
| Stage II (stage I, reference) | 2.562 | 1.947 to 3.371 | < .001 | 2.354 | 1.783 to 3.108 | < .001 | 1.801 | 1.522 to 2.130 | < .001 | 1.697 | 1.432 to 2.012 | < .001 |
| Comorbidity | 1.885 | 1.608 to 2.211 | < .001 | 1.856 | 1.579 to 2.182 | < .001 | 1.478 | 1.266 to 1.724 | < .001 | 1.436 | 1.229 to 1.677 | < .001 |
| Margin free | 0.719 | 0.465 to 1.114 | .140 | 0.820 | 0.525 to 1.279 | .382 | 0.652 | 0.494 to 0.861 | .003 | 0.717 | 0.540 to 0.952 | .021 |
| Breast-conserving surgery | 0.903 | 0.698 to 1.168 | .437 | 1.106 | 0.829 to 1.474 | .495 | 1.087 | 0.924 to 1.280 | .314 | 1.289 | 1.067 to 1.557 | .008 |
| Public hospital | 0.990 | 0.781 to 1.254 | .931 | 1.282 | 0.995 to 1.653 | .055 | 0.862 | 0.729 to 1.020 | .084 | 1.010 | 0.843 to 1.210 | .912 |
| Medical school–affiliated hospital | 0.896 | 0.722 to 1.112 | .320 | 0.711 | 0.561 to 0.901 | .005 | 0.956 | 0.824 to 1.108 | .548 | 0.831 | 0.704 to 0.982 | .030 |
| Surgeon volume | | | | 0.999 | 0.996 to 1.003 | .737 | | | | 1.000 | 0.997 to 1.002 | .658 |
| Quality of care | | | | 0.212 | 0.089 to 0.502 | < .001 | | | | 0.289 | 0.162 to 0.516 | < .001 |
| BC-P4P enrollment | | | | 0.167 | 0.064 to 0.432 | < .001 | | | | 0.370 | 0.200 to 0.685 | .002 |
| Interaction of surgeon volume and quality of care | | | | 1.001 | 0.996 to 1.006 | .727 | | | | 1.001 | 0.998 to 1.004 | .480 |
| Interaction of BC-P4P and quality of care | | | | 7.016 | 1.855 to 26.530 | .004 | | | | 3.183 | 1.393 to 7.274 | .006 |
| Propensity score | | | | 0.989 | 0.474 to 2.064 | .976 | | | | 0.716 | 0.428 to 1.199 | .204 |

Abbreviation: BC-P4P, pay-for-performance program for breast cancer care.

first study to investigate the results of a P4P program specifically targeting outcome of breast cancer care. Tisnado et al[35] used a population-based cohort of patients with breast cancer in Los Angeles, CA. They found that only 15% of medical oncologists, radiation oncologists, and surgeons caring for patients with breast cancer in the study area were offered financial incentives for guideline adherence. They also pointed out the need for new approaches to guide financial incentives for quality of care provided by specialists. Attending physicians in Taiwan are all employed by hospitals, and fewer than 1% of hospitals have physicians contracted from outside the hospital (ie, self-employed physicians). Financial incentives target hospitals, because the BNHI compensates hospitals, not physicians directly, and as such, they can impact physician behavior. This might not be the case in other countries. Therefore, it is expedient to evaluate the effect of P4P programs linking financial incentives to quality of care. Although this might be difficult to do in a more complex health care delivery system with a multipayer mix and various payment schemes set for different provider systems, it is an appropriate method in the case of Taiwan.

This study provides empirical evidence of the positive effect of P4P programs in hospitals that provide quality care based on disease-specific performance. People in Taiwan have open access to any health care provider, without a referral from a gatekeeper (eg, general practitioner or family physician). Because the capitation payment scheme is not applied in Taiwan, a design to reward hospitals achieving a specific performance measure covering different diseases and services does not fit the health care system in Taiwan. Therefore, the BNHI decided to implement disease-oriented P4P programs. This meant that compared with a scheme that rewards a comprehensive scope of clinical performance covering different diseases and services, disease-oriented P4P programs could design incentives so as to directly influence provider behavior, improving both quality of care and treatment outcome in the target population. Mehrotra et al[36] proposed several design features that could improve the effects of P4P programs, including dividing the lump-sum incentive into a series of smaller incentive payments, considering bonus payments, using deposit contracts rather than withholding payment, and using tiered absolute thresholds instead of relative thresholds. The financial incentives of the BC-P4P program in Taiwain are similar to these. Unlike the approach adopted in other P4P programs, in which providers can be rewarded with a bonus after meeting a preset threshold, hospitals that join the BC-P4P program are rewarded for each patient with breast cancer who completes planned treatments (ie, better payment than that for a nonenrolled patient). The scaled bonus rate for different survival years—rather than just rewards for top performers—encourages hospitals to pursue better treatment outcome. The design of financial incentives in the BC-P4P program not only encourages hospitals to do the right thing every time they provide care for a patient with breast cancer (ie, better payment for treatment mixes) but also provides an incentive to achieve and maintain performance at the target level (ie, annual bonus rate for stage-specific survival rate).[37] These features of the BC-P4P program motivate both hospitals as well as physicians to provide better quality care, resulting in better treatment outcome.

The results of this study show that the BC-P4P program has had a positive effect on outcome of breast cancer care. However, the number of hospitals participating the program remains limited. There are several reasons for this; to determine these reasons, we conducted informal interviews with leaders of breast cancer care teams at several cancer centers. Results of these interviews indicate that in Taiwan, cooperation between professionals in multidisciplinary teams tends to vary widely across hospitals. Treatment of breast cancer relies greatly on multidisciplinary teamwork, and therefore, some hospitals, especially those in which multidisciplinary teams are not well coordinated, are concerned that the BC-P4P program could reduce total payment for an enrolled patient if the patient does not complete the full care package per the treatment plan. As a result, some hospitals prefer to retain the original payment scheme so as to reduce financial risk in the case of incomplete treatment or overuse of resources because of complications. In addition, the bonus based on patient survival lacks control by health care providers with regard to both process and outcome. This raises the concern that rewards might largely depend on patient adherence to treatment plans as well as patient lifestyle.[38] Because patient lifestyle cannot be identified through claims data, it was not controlled for in this study.

In this study, OR for the interaction of BC-P4P enrollment and quality of care in the Cox models indicates that for those patients undergoing treatment with a provider who already delivers better quality of care, the effect of BC-P4P enrollment on patient survival may decrease. On the other hand, hospitals participating in the BC-P4P program tended to provide better quality care, so the total effect of BC-P4P enrollment and quality of care is less than the sum of the effects of the two factors considered independently. The design of financial incentives within the BC-P4P program may be cause for some concern. All eligible hospitals must reach the same goal to receive a bonus payment. Although results shows that BC-P4P enrollment still had a positive effect when controlling for the interaction between quality of care and BC-P4P enrollment, the BC-P4P program may reward hospitals for performance even though they had already performed better before joining the BC-P4P program.[39] The goal of the incentives is to encourage providers to improve the quality of care they provide, not to reward hospitals that already have a good level of care.[40] Thus, financial incentives for hospitals already doing well need to be redesigned such that these hospitals are rewarded for degree of improvement. This issue needs to be addressed if the BC-P4P program is to attract more participants.

There are several limitations in this study that need to be addressed. The BNHI allowed hospitals to join the program on a voluntary basis. This nonrandom selection of participating hospitals may have biased the results of our study. The data used in this study reflect only hospitals eligible to report to the TCDB, which means they must have a high volume of patients with cancer (at least 500 cases annually, including all sites of cancer), and this may therefore limit generalizability of the re-

sults. Although the sample of patients with newly diagnosed breast cancer reported to the TCDB represents more than 80% of total incident cases in Taiwan, the remaining patients received care from other hospitals with relatively lower case volumes. Because the TCDB started to collect data close to the time that the BC-P4P was initiated, the data used in this study do not include patients with breast cancer who were diagnosed and treated before the start of the BC-P4P program. A before and after comparison of each hospital that joined would be nearly impossible. This prevents evaluation of any direct changes in quality of care and outcome as a result of the program. Patient lifestyle could not be identified from the claims data and thus was not taken into account in this study, although it might have affected treatment outcome.

This study provides additional empirical support for the incentive design of P4P programs to improve both process and outcome of care. It is also strongly suggested that the BNHI, hospital administrators, and medical professionals of multidisciplinary breast cancer care teams arrive at a method for working together as a cohesive team so that they can maximize hospital participation in the BC-P4P program.

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*The authors indicated no conflicts of interest.*

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## Appendix

**Table A1.** Stage-Specific Survival Rates for Annual Bonus

| Pathology Staging | Year (%) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 0 (disease free) | 97 | 94 | 93 | 93 | 93 |
| I (disease free) | 97 | 93 | 89 | 88 | 86 |
| II (disease free) | 95 | 86 | 80 | 78 | 75 |
| III (disease free) | 85 | 70 | 50 | 45 | 40 |
| IV (overall) | 64 | 33 | 23 | 18 | 10 |
| Bonus* | 2 | 3 | 4 | 6 | 7 |

* Percentage of total fee claimed for patients meeting bonus criteria and receiving a complete treatment mix as first course of treatment.

**Table A2.** Estimation of Propensity Scores

| Variable List |
|---|
| Age |
| Breast cancer stage (stage I or II) |
| Diagnosis-based comorbidities, measured by Elixhauser index (31 comorbidities) |
| Medication-based comorbidities, measured by revised chronic disease score (32 classes of prescribed medications) |