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# Effects of pay-for-performance system on tuberculosis default cases control and treatment in Taiwan

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## KEYWORDS

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**Summary Objectives:** In order to make tuberculosis (TB) treatment more effective and to lower the default rate of the disease, the Bureau of National Health Insurance (BNHI) in Taiwan implemented the “pay-for-performance on Tuberculosis” program (P4P on TB) in 2004. The purpose of this study is to investigate the effectiveness of the P4P system in terms of default rate.

**Methods:** This is a retrospective study. National Health Insurance Research Datasets in Taiwan from 2002 to 2005 has been used for the study. The study compared the differences of TB default rate before and after the implementation of P4P program, between participating and non-participating hospitals, and between P4P hospitals with and without case managers. Furthermore, logistic regression analysis was conducted to explore the related factors influencing TB patients default treatment after TB detected.

**Results:** The treatment default rate after “P4P on TB” was 11.37% compared with the 15.56% before “P4P on TB” implementation. The treatment default rate in P4P hospitals was 10.67% compared to 12.7% in non-P4P hospitals. In addition, the default rate was 10.4% in hospitals with case managers compared with 12.68% in hospitals without case managers.

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*Conclusions:* The results of the study showed that "P4P on TB" program improved the treatment default rate for TB patients. In addition, case managers improved the treatment outcome in controlling patients' default rate.

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## Background

TB has been a serious problem in Taiwan for years. The Department of Health (DOH) data indicates that the incidence rate is around 70 per 100,000 population in Taiwan and the fatality rate is around 4 per 100,000 population in year 2005. It appears that Taiwan has not been very successful in implementing effective TB control and management to achieve the international standard in case fatality rate. More rigorous TB control, treatment and management are required for achieving a better outcome in Taiwan.

In order to make TB treatment more effective and to avoid rapid spread of the disease, the Bureau of National Health Insurance (BNHI) in Taiwan started the implementation of a pay-for-performance payment demonstration project in October of 2001. Later in January 2004 the demonstration project was scaled-up as a national program. The program was officially named as "pay-for-performance on Tuberculosis" (P4P on TB). All diagnosis of "tuberculosis" (ICD-9-CM codes 010.0–018.9) in Taiwan was included in this program, but multi-drug resistant tuberculosis (MDR-TB) cases, extrapulmonary TB (EPTB) cases, and atypical mycobacterium tuberculosis cases were excluded. The BNHI set the objectives of pay-for-performance demonstration programs for TB to include: 1) improving the case management model; 2) decreasing the death rate from tuberculosis; 3) increasing the cure rate of tuberculosis; 4) improving the payment system to encourage health care providers to provide high quality treatment, and give them more responsibilities.

The idea of pay-for-performance payment system derives from the concept of "case management". Case management has been defined as "a collaborative process of assessment, planning, facilitation and advocacy for options and services to meet an individual's health needs through communication and available resources to promote quality cost-effective outcomes."<sup>1</sup> Case management was developed for coordinating care so that continuous discovery and conformity can take place. Therefore, the P4P on TB program integrate the case managers into the system to provide continuous health care services to TB patients.

The most serious problem hampering tuberculosis treatment and control is patients' non-compliance with treatment or therapy.<sup>2–7</sup> Defaulting or lack of adherence with the treatment regime increase the transmission of disease within the community, increase the morbidity rate and increase the cost of TB control efforts.<sup>3,6</sup>

Several countries have implemented many incentives activities on Tuberculosis control and treatment in recent years in which the ideas were consistent with pay-for-performance. The incentives can be to patients or to providers. For patients, most countries provide food or other living supports as incentives to encourage patients. In Russian, some cities provided food, travel support or

clothing to patients if they did not interrupt treatment. The default rates dropped from 15–20% to 2–6%. In Tajikistan, vulnerable patients were given food, conditional on their adherence to treatment. The treatment success rate was 89.5% compared to 59.4% in non-incentive patients.<sup>8</sup> From the provider incentive side, several countries also showed positive results. In China, providers would receive financial payment or monetary incentives when diagnosis or treatments have been completed. However, no related results are showed. Bangladesh provided travel, food and doctor handbag to TB treatment doctors, and the cure rate increased significantly to 88%.<sup>9</sup>

The first study which examined the effectiveness of pay-for-performance demonstration project on TB in Taiwan was conducted in 2003.<sup>10</sup> The results suggested that the project can shorten the period of tuberculosis treatment for the patients cured. Same group<sup>11</sup> did further study and indicated that TB cure rate and length of treatment for cured cases improved significantly after P4P on TB implemented. Hospitals participating in the program showed significant better cure rate and length of treatment for cured cases comparing with non-participating hospitals.

Although the pay-for-performance has been implemented in Taiwan over several years, only a few studies discussed the effectiveness of the policy.<sup>10–18</sup> Most studies on tuberculosis focused on the epidemiology or public health aspects of the disease. No related studies were focused on the TB interrupt problems. This study will focus on the outcomes of the incentive structure of the P4P on TB program by analyzing the data set obtained from the national insurance agency. More specifically, the study will compare the default rate of TB treatment before and after the implementation of P4P on TB, between hospitals by participation status in the P4P program. Another related comparison will be to see if participating hospitals with case managers perform better on patients' interruption than the hospitals without case managers.

## Research methods

### Data sources

National Health Insurance Research Dataset in Taiwan from 2002 to 2005 has been used for the study. Total study samples are 13,191 patients in the years 2002 and 2003, and 27,142 patients in the years 2004 and 2005. For the analysis of pay-for-performance program on TB default rate, additional data were also obtained from the National Health Insurance Research Dataset. These additional variables include patients' gender, age, area of residence, patients' ICD-9-CM codes, levels of comorbidity, notification physician, date of medical visits, date of inpatient/discharge, duration of drug therapy, notification hospital/institution, etc.

## Inclusion and exclusion criteria

The Department of Health and WHO<sup>19</sup> defined the “default rate” as the percent of patients who interrupt the treatment regime for 2 months or longer. The duration of default is calculated by taking the difference between a medical visit and the next visit when the gap is 2 months or more. The date of medical visits and duration of medication days provide information to understand the patients’ compliance behavior. Patient with as long as 4 months of treatment from start of treatment was included in the study since diagnosis errors are common in the beginning of TB treatment.

The P4P on TB demonstration program was implemented in the central branch of TCDC (Center for Disease Control, Taiwan) in October, 2001. For the purpose of this analysis, the cases from the central branch of TCDC were excluded from the list of pre-P4P cases. Another 20,167 patients were excluded from the study because of diagnosis error in the early stage of treatment.

## Data analysis

Descriptive statistics were obtained for the number of default cases and default rate for TB patients for the years 2002–2005. Besides descriptive analysis, bivariate analysis

was performed to understand the effects of “P4P on TB” program on the default rate or treatment interruption. Chi-square test and fisher’s exact test were used to compare patients’ default rates between pre-P4P and post-P4P, between P4P hospital and non-P4P hospital, and between P4P hospitals with and without case managers.

To identify the factors affecting interruption from treatment in Taiwan, multivariate analysis was conducted. Since the outcome variable is dichotomous, the appropriate empirical model would be to use logistic regression equations. Logistic regression analyses were performed to estimate the probability of interruption from treatment. The independent variables included in the analysis were gender, age, migration status, hospital characteristics, comorbidity level, levels of city development, city income, and physician resources.

Level of comorbidity was followed by the Charlson comorbidity index (CCI) which was developed by Charlson et al. in 1987.<sup>20</sup> Deyo et al. adapted the CCI for use with ICD-9-CM administrative data by identifying specific ICD-9-CM code to represent each of the individual comorbid conditions in the original Charlson index. This study used this index to identify the levels of patients’ comorbidity. The higher the CCI points the more serious is the patients’ comorbid condition. Three CCI classes (no, mild, and severe) were defined as 0, 1, and  $\geq 2$ .

**Table 1** Comparison of TB patients’ default rate: before and after the implementation of P4P.

	Before P4P				<i>P</i>	After P4P				<i>P</i>	<i>P</i> <sup>a</sup>	
	No default		Default			No default		Default				
	<i>N</i>	(%)	<i>N</i>	(%)		<i>N</i>	(%)	<i>N</i>	(%)			
<i>N</i>	11,138	84.44	2053	15.56		24,057	88.63	3085	11.37		<0.05	
Gender					0.01						<0.05	0.31
Male	7465	83.85	1438	16.15		16,148	87.92	2218	12.08			
Female	3555	85.62	597	14.38		7872	90.11	864	9.89			
Age (years)					<0.05						<0.05	0.60
<45	3089	86.53	481	13.47		6610	89.72	757	10.28			
45–65	3136	83.67	612	16.33		6869	88.53	890	11.47			
>65	4913	83.65	960	16.35		10,578	88.03	1438	11.97			
Migration					<0.05						<0.05	0.26
No	10,906	85.16	1900	14.84		23,701	89.34	2828	10.66			
Yes	232	60.26	153	39.74		356	58.08	257	41.92			
Comorbidity levels					<0.05						<0.05	0.00
No	10,548	85.00	1862	15.00		22,947	88.99	2839	11.01			
Mild	561	74.90	188	25.10		1021	81.81	227	18.19			
Severe	29	90.63	3	9.38		89	82.41	19	17.59			
City income levels					<0.05						<0.05	0.01
High	2673	82.42	570	17.58		5777	88.55	747	11.45			
Median	8004	85.47	1361	14.53		17,361	88.83	2182	11.17			
Low	447	79.68	114	20.32		897	85.51	152	14.49			
Physician density levels					<0.05						<0.05	0.04
High	2559	82.07	559	17.93		5573	88.21	745	11.79			
Median	7282	85.68	1217	14.32		15,511	89.07	1903	10.93			
Low	1283	82.67	269	17.33		2951	87.20	433	12.80			

<sup>a</sup> The relationship of default rate between before and after “P4P on TB” implementation.

## Result

From the data sets of Bureau of National Health Insurance, the number of new TB cases was 13,191 in 2002 and 2003 (pre-P4P period), and 27,142 in 2004 and 2005 (post-P4P period). The data set implies that 15.56% ( $N = 2053$ ) of patients interrupted treatment schedule for more than 2 months during the pre-P4P study period while treatment default rate was 11.37% ( $N = 3085$ ) during post-P4P years. The default rate decreased significantly after "P4P on TB" program was implemented ( $P < 0.05$ ). Table 1 indicates that after "P4P on TB" implemented, the default rates significantly decreased among patients after controlling for comorbidity levels, levels of city income, and physician resources as compared with the default rate before ( $P < 0.05$ ).

The default rates based on patient characteristics and city characteristics were almost identical between pre and post-P4P scenarios. As indicated by Table 1, treatment defaults were significantly different by patients' gender, age groups, migration status, comorbidity levels, levels of city income, and levels of physician resources ( $P < 0.05$ ). Male had significantly higher default rate than females and younger patients had significantly lower default rate than older patients. Migrating patients had significantly higher default rate than patients who are not migrants ( $P < 0.05$ ). Patients

in cities with the lowest income (lower than mean of income in all cities in Taiwan minus one S.D) levels show the highest default rate (20.32%, 14.49%) while cities with median income level (mean of income in all cities in Taiwan  $\pm$  one S.D) had the lowest default rate (14.53%, 11.17%). Patients from cities with median levels of physician resources (physician resource of median in Taiwan  $\pm$  one S.D) show the lowest default rate (14.32%, 10.93%).

To compare the default rates between P4P and non-P4P hospitals, the study focused on the medical centers and regional hospitals in Taiwan after the implementation of "P4P on TB". Seventeen out of 24 medical centers and 57 out of 78 regional hospitals joined the "P4P on TB" program in the year 2004. In the years 2004 and 2005, a total 638 TB cases were found in non-P4P hospitals whereas 16,423 TB cases were found in P4P hospitals.

As indicated in Table 2, the default rate was lower in hospitals participating in P4P compared to non-participating hospitals ( $P < 0.05$ ). The default rate was 10.67% in hospitals participating in P4P compared to 12.7% in non-participating hospitals. The default rates were significantly lower in P4P hospitals than non-P4P hospitals after controlling for gender, age, migration status, comorbidity level, levels of city income, and physician resources compared with non-P4P hospitals ( $P < 0.05$ ).

**Table 2** Comparison of TB patients' default rate between P4P hospitals and non-P4P hospitals.

	P4P hospitals				<i>P</i>	Non-P4P hospitals				<i>P</i>	<i>P</i> <sup>a</sup>
	No default		Default			No default		Default			
	<i>N</i>	(%)	<i>N</i>	(%)		<i>N</i>	(%)	<i>N</i>	(%)		
<i>N</i>	14,671	89.93	1752	10.67		557	87.30	81	12.70		<0.05
Gender					0.01					0.03	<0.05
Male	9765	88.91	1218	11.09		352	85.23	61	14.77		
Female	4892	90.21	531	9.79		204	91.07	20	8.93		
Age (years)					0.20					0.39	0.04
<45	4039	89.84	457	10.16		172	88.66	22	11.34		
45–65	4158	89.59	483	10.41		171	84.65	31	15.35		
>65	6474	88.86	812	11.14		214	88.43	28	11.57		
Migration					<0.05					0.02	<0.05
No	14,630	89.62	1694	10.38		546	87.78	76	12.22		
Yes	41	41.41	58	58.59		11	68.75	5	31.25		
Comorbidity levels					<0.05					0.42	<0.05
No	13,854	89.76	1580	10.24		520	87.54	74	12.46		
Mild	747	82.91	154	17.09		32	82.05	7	17.95		
Severe	70	79.55	18	20.45		5	100.00	0	0.00		
City income levels					<0.05					0.46	<0.05
High	3851	87.82	534	12.18		53	82.81	11	17.19		
Median	10,482	89.92	1175	10.08		482	87.96	66	12.04		
Low	324	89.26	39	10.74		22	84.62	4	15.38		
Physician number levels					<0.05					0.78	<0.05
High	3661	87.35	530	12.65		337	87.99	46	12.01		
Median	8849	90.89	887	9.11		204	86.44	32	13.56		
Low	2147	86.64	331	13.36		16	84.21	3	15.79		

<sup>a</sup> The relationship of default rate between P4P hospitals and non-P4P hospitals.

In respective of the participation in P4P, males had higher default rate than females, patients migrating from one place to another had much higher default rate than the non-migrant patients ( $P < 0.05$ ). In P4P hospitals, patients with no comorbidity (CCI = 0) had the lowest default rate (10.24%) whereas patients with severe comorbidity levels (CCI  $\geq 2$ ) had the highest default rate (20.45%) ( $P < 0.05$ ). For P4P hospitals, patients from cities with highest income level had the highest default rate (12.18%) while patients from cities with median levels of income had the lowest rate (10.08%). If we examine the default rates by physician resources, cities with the lowest physician resources showed the highest default rates for both the P4P and non-P4P hospitals (see Table 2).

The study also examined the difference in rates by hospitals with case managers and hospitals without case managers. The study had 1900 new TB cases from hospitals without case managers and 14,523 new cases from hospitals with case managers. Table 3 summarizes the descriptive statistics for default rate by hospitals with or without case managers. The table shows that the default rate in hospitals with case managers was 10.4%, which is significantly lower than the rate in hospitals without case managers (12.68%) ( $P < 0.05$ ). The default rates in hospitals with case managers were also lower for each of the

population categories defined by controlling for patients' gender, migration status, comorbidity levels, levels of city income, and of physician resources ( $P < 0.05$ ) (see Table 3).

Therefore, since the default rates are lower for each of the patient and city characteristics for hospitals with case managers, presence of case managers clearly had a positive impact on treatment contribution. Patients with no comorbidity level (CCI = 0) had lower default rates than patients with median (CCI = 1) or severe comorbidity (CCI  $\geq 2$ ) level. Patients having moved to other places had significantly higher default rates than patients without migration history ( $P < 0.05$ ). Patients living in cities with the highest physician resources had the lowest default rates while patients live in cities with median level of physician resources had the lowest default rates.

In the hospitals with case managers, male patients had significantly higher default rates (10.86%) than the female patients (9.46%) ( $P < 0.05$ ), and younger patients had lower default rates (9.74%) than the older patients ( $P < 0.05$ ). Patients living in the cities with the highest income level had the highest default rates (12.13%), followed by cities with the lowest income levels (10.43%) and cities with median levels of income (9.75%) (Table 3).

Table 4 reports the results of the logistic regression model with treatment interruption probability for TB

**Table 3** Comparison of TB patients' default rate between P4P hospitals with case managers and P4P hospitals without case managers.

	P4P hospitals with case managers				<i>P</i>	P4P Hospitals without case managers				<i>P</i>	<i>P</i> <sup>a</sup>
	No default		Default			No default		Default			
	<i>N</i>	(%)	<i>N</i>	(%)		<i>N</i>	(%)	<i>N</i>	(%)		
<i>N</i>	13,012	89.60	1511	10.40		1659	87.32	241	12.68		<0.05
Gender					0.01						0.84 0.01
Male	8635	89.14	1052	10.86		1130	87.19	166	12.81		
Female	4366	90.54	456	9.46		526	87.52	75	12.48		
Age (years)					0.17						0.67 0.69
<45	3522	90.26	380	9.74		517	87.04	77	12.96		
45–65	3735	89.72	428	10.28		423	88.49	55	11.51		
>65	5755	89.11	703	10.89		719	86.84	109	13.61		
Migration					<0.05						<0.05 <0.05
No	12,979	89.86	1464	10.14		1651	87.77	230	12.23		
Yes	33	41.25	47	58.75		8	42.11	11	57.89		
Comorbidity level					<0.05						0.03 <0.05
No	12,312	90.01	1367	9.99		1542	87.86	213	12.14		
Mild	638	83.40	127	16.60		109	80.15	27	19.85		
Severe	62	78.48	17	21.52		8	88.89	1	11.11		
Levels of city income					<0.05						0.87 <0.05
High	3348	87.87	462	12.13		503	87.48	72	12.52		
Median	9342	90.25	1009	9.75		1140	87.29	166	12.71		
Low	309	89.57	36	10.43		15	83.33	3	16.67		
Levels of physician resources					<0.05						<0.05 <0.05
High	3123	88.12	421	11.88		538	83.15	109	16.85		
Median	7938	90.88	797	9.12		911	91.01	90	8.99		
Low	1938	87.02	289	12.98		209	83.27	42	16.73		

<sup>a</sup> The relationship of default rate between hospital with or without case managers.

**Table 4** Results of logistic regression analysis with TB cases default from treatment more than 2 months as the dependent variable.

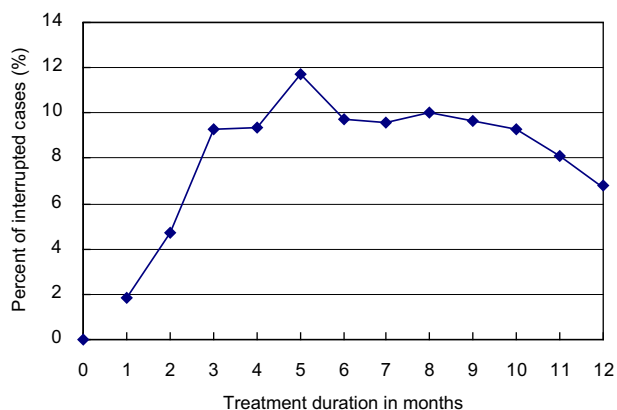
Criteria	Estimate	OR (95% CI)	P-value
Intercept	-1.8806		<.0001
Gender			
Male (reference)			
Female	-0.1303	0.878 (0.788–0.978)	0.0183
Age (years)			
<45 (reference)			
45-65	0.0458	1.047 (0.915–1.198)	0.5048
>65	0.0951	1.100 (0.972–1.244)	0.1305
Migration			
No (reference)			
Yes	2.2853	9.829 (6.757–14.298)	<.0001
Comorbidity level			
No (reference)			
Mild	0.4716	1.603 (1.335–1.924)	<.0001
Severe	0.6905	1.995 (1.187–3.353)	0.0092
P4P Hospital			
No (reference)			
Yes	-0.1011	0.904 (0.702–0.973)	0.0241
Case manager			
No (reference)			
Yes	-0.1849	0.831 (0.717–0.964)	0.0142
Levels of city income			
Low (reference)			
Median	-0.1267	0.881 (0.768–1.011)	0.0710
High	0.1060	1.112 (0.784–1.576)	0.5518
Physician resources			
Low (reference)			
Median	-0.2785	0.757 (0.658–0.871)	0.0001
High	0.1257	1.134 (0.954–1.347)	0.1529

Model events: patients default from treatment;  $N = 17,061$ .

patients as the dependent variable. The independent variables included in the model are gender, age, migration status, hospital participating in P4P program, hospital with/without case managers, comorbidity level, levels of city income, and physician resources. Note from the parameters estimated (Table 4) that the probability of default is lower for female compared to male patients (OR = 0.878). Patients migrating to other cities were more likely to interrupt their treatment than patients not migrating during the treatment phase (OR = 9.829). As expected, patients with more serious comorbidity status are more likely to interrupt from treatment than patients with no comorbidity. Patients with mild comorbidity level (CCI = 1) had around 1.6 times more likely to default from treatment while patients with severe comorbidity level (CCI  $\geq$  2) had around 2 times more likely to default compared to patients with no comorbidity. Patients in P4P hospitals were less likely to default than patients in non-P4P hospitals (OR = 0.904), and patients in hospitals with case manager were less likely to default than patients in hospitals without case manager (OR = 0.831). A number of city characteristics also influenced the default rate. Patients living in cities

with median level of income were less likely to default from treatment than patients living in cities with high income level (OR = 0.881). Patients in cities with median level of physician resources were less likely to default than patients living in cities with high income levels (OR = 0.757) (see Table 4).

After "P4P on TB" program was implemented, the study found total 3085 patients with 6022 times of default from treatment. There was 15.84% ( $N = 954$ ) of the defaults within the first 3 months of treatment, and 30.78% ( $N = 1854$ ) defaulted between the fourth and sixth month of treatment, and 29.26% ( $N = 1762$ ) defaulted between the seventh and ninth month of treatment, and 24.12% ( $N = 1452$ ) defaulted after the tenth month of treatment. The number of default cases dramatically increased from the first month to the 3rd month of treatment, and peaked at the 5th month from the start of treatment (Fig. 1). After the 5th month, the trend of number of default cases decreased slightly. Furthermore, the study analyzed the relationship between time from start of treatment to default and patients' medication days per medical visits. Patients receiving medication days between 15 to 28 days had the



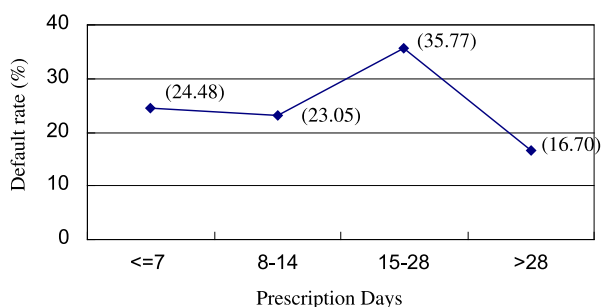
**Figure 1** Percent of cases interrupting treatment by treatment duration.

highest default rate which was 35.77%, following by the patients receiving medication days less than 7 days (24.48%). The lowest default rate was in the group of patients with medication days more than 28 days (Fig. 2).

### Discussions

The study concluded that P4P on TB program could decrease the default rate significantly in Taiwan. Although some other countries implemented related incentive programs on TB control, the related outcomes are still not available. However, comparing with basic report from Russian, the incentive program significantly decreased the default rate.<sup>8</sup> Russian focused on the patients' incentive, which provided patients some food or living supports to increase patients' compliance.<sup>9</sup> Government in Taiwan can consider the patients' incentive activities. For poor patients, food or traveling support may be needed. For non-poor patients, some extra monetary incentives may encourage patients' compliance and decrease the default rate.

From this study, male had lower compliance (higher default rate) than women. Some previous studies had same conclusions.<sup>3,10,21-23</sup> Previous study found that once the symptoms were gone, men and the elderly were easily defaulted from treatment.<sup>2</sup> Men and elderly do not understand the importance of compliance and completing the full treatment. Same findings were in the Philippines because men were too hard to give up alcohol. Drinking plays



**Figure 2** The relationship between default rate and prescription days.

an important role makes a man as seriously ill.<sup>24</sup> Therefore, the patients' education especially for man is important for improving their compliance behaviors.

Age had effects on univariate analysis. However, after controlling for other variables, age became a non-significant factor. The study conducted the relationship between age and comorbidity level, and found that elderly patients had severe comorbidity than non-elderly ( $P < 0.001$ ). In the age group of older than 65 years old, 91% of patients without any comorbidity compared with 94.5% and 97.2% in aged 45–65 years old and less than 45 years old. Therefore, the age factor becoming insignificant may be due to influence of comorbidity level in elderly patients.

Stigma of TB was the other main reason for patients default from treatment.<sup>2</sup> Previous studies also concluded same results that stigma is the main reason for patient interrupting treatment.<sup>4,25,26</sup> Because of the stigma attached to TB, patients usually hide their condition from their employers or friends.<sup>2,4</sup> From clinical experience, the TB treatment team in Taiwan found that non-compliance due to stigma may be described as more common among men in Taiwan because men were often the only earning member in a family. Several previous studies also mentioned that lacking of social support was the main problem of patient default from treatment, especially when they felt better soon after starting treatment.<sup>27,28</sup> Health education for patients and society is the only way to improve the problem of stigma.

The study indicates that older patients had tendency of higher default rate than younger patients although it is not significant. Some studies had similar outcome with our study.<sup>22,24</sup> This may be due to the fact that the side-effects of many drugs are more frequent or more severe in elderly patients.<sup>24</sup> In addition, older patients who live in rural areas may have traveling problems when they seek for medical services. Since the directly observed treatment, short-course (DOTS) program has been implemented in Taiwan in 2006, the traveling problems for these patients might be improved.

Another interesting part for the result showed the default rate for migrants in 2002 and 2003 (39.74%) was lower than default rate for migration patients in 2004 and 2005 (41.92%). That might be the severe acute respiratory syndrome (SARS) outbreak in Taiwan rapidly in 2003. In order to control the infectious of SARS efficiently, the migrants decreased rapidly. In addition, since SARS explored in the society rapidly, patients' compliance behaviors might be improved because of the awareness of disease control. Therefore, that might decrease the default problems during this period.

Consistent with the findings in previous studies,<sup>5,29,30</sup> migrants had the worst outcomes in terms of completion of treatment. Europe and USA have been aware of this problem for several years.<sup>29-33</sup> Changes of domicile will affect patients' behaviors.<sup>34,35</sup> Lack of fixed address is the main problem for migrants. As the results of comparing the default rate in 2004 and 2005, P4P hospitals or hospitals with case managers did not show lower default rate for migration of individuals. However, when the study only focused on the default cases, the migration cases were 3.31% and 3.11% of P4P hospitals and with case managers, respectively. These numbers were lower than non-P4P

hospital and without case managers (6.17% and 4.56%, respectively). This revealed the function of case managers who monitor and update patients' information should be more strengthened. Once patients move to other cities, the case managers should transfer patients' information to next charged case managers. Therefore, the training of case managers should be improved and the communications between hospital and community should be also enhanced.

The multivariate analysis presents the default rate in the hospitals participating in "P4P on TB" is significantly lower than non-participating hospitals. In addition, participating hospitals with case managers had significantly lower default rate than hospital without case managers. The results confirmed that presence of case managers clearly had a positive impact on TB treatment contribution. In addition, the results also achieve one of the objects of "P4P on TB" program which improving case management system in TB treatment.

In the respect of levels of physician resources, the study found that patients living in the highest level of physician resources did not have the lowest default rate. Serious patients might be transferred from hospitals in rural areas to hospitals in urban cities which have more health care resources in cities.<sup>36</sup> Traveling time was also one of the determined factors associated with default.<sup>23</sup> Patients might default from routine outpatient visits due to the long duration of transportation. Since the DOTS program in Taiwan has been implemented in 2006, the problem of transportation might be decreased rapidly.

The finding in this study suggested that default could be associated with the time from start of treatment. As our studies' results, at the 5th month from start of treatment was the month with the highest default rate. The study from Singapore had similar findings in year 2000.<sup>37</sup> Many studies concluded that higher compliance of TB treatment could be attributed to the presence of disease symptoms, because compliance is usually lower with treatment for asymptomatic conditions.<sup>38,39</sup> For the treatment of tuberculosis, the disease symptoms were usually resolved within the first 3 months of treatment. Thus patients may discontinue the treatment when they feel markedly better after the first 3 months of treatment.<sup>28,40</sup> This underscores the importance of TB patients' education on the need to complete the full course of treatment so as to prevent subsequent relapse. In addition, the ultimate responsibility for this can only lie on the treating physicians and case managers, whose role was not only to treat disease, but also to ensure that the patients adhere to and complete the treatment. Previous study suggested that reminding patients by clinics or hospitals are required to ensure the rate of complete treatment.<sup>41</sup> Telephone reminders, use of incentives are effective methods.

No related studies discussed about the relationship between medication days and default rate. According to the present study's results, patients with no medication days or patients with medication days between 15 and 28 days had the highest default rate. According to the treatment guidelines for TB treatment, patients will get longer medication days when the disease symptoms declared and became stable. Patients might think they fully recovered from an illness and stopped the medication.

Again, case managers and physicians have the responsibility to educate patients' behaviors. The studies' results also found that the medication days would be associated with the time from start of treatment to default. The case managers should refer to the default time under different patients' medication days, and remind patients for medication visits following by the schedules.

There are some limitations for this study, the study just had limited variables for analysis from the data set which obtained from BNHI of Taiwan. The study also could not get sufficient hospital records to review other influencing factors such as the microbiologic data, drug susceptibility tests results and resistance pattern, presence of adverse reactions of anti-tubercular therapy and the comorbid illness of the patients.

## Conclusions

In short, from the comparisons of "P4P hospitals" and "non-P4P hospitals", the study found that the default rate was improved significantly. These results confirmed that P4P on TB is a good payment policy for TB controlling and treatment on patients' default rate. The study also found the default rate in the hospitals with case managers was significantly lower than hospitals without case managers. The results showed that the case managers improved the problem of interruption.

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