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The effects of pay-for-performance on tuberculosis treatment in Taiwan

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Objectives In order to make tuberculosis (TB) treatment more effective and to lower the transmission rate of the disease, the Bureau of National Health Insurance (BNHI) in Taiwan implemented the 'Pay-for-Performance on Tuberculosis' programme (P4P on TB) in 2004. This study investigates the effectiveness of the P4P system in terms of cure rate and length of treatment.

Methods This retrospective study obtained information on all TB cases in the national data sets of Taiwan for the years 2002 to 2005. The number of cases in pre-P4P years (2002 and 2003) was 25 754, compared with 33 536 in the post-P4P implementation years (2004 and 2005). The effectiveness of the programme was evaluated by comparing the TB cure rate and length of treatment before and after the implementation of the P4P programme, and between participating and non-participating hospitals. Logistic regression analysis was conducted to explore the factors affecting TB patients' cure rate within a 12-month treatment period.

Findings The cure rate and the average length of treatment before the implementation of P4P were 46.9% and 256.24 days, respectively, compared with 63.0% and 249.74 days after implementation of P4P. The cure rate and length of treatment in P4P hospitals were 68.1% and 249.13 days, respectively, compared with 42.4% and 53.71 days in non-P4P hospitals.

Conclusions This study found that both the cure rate and average length of treatment for cured cases improved significantly after the implementation of the P4P on TB programme in Taiwan. Compared with non-P4P hospitals, P4P hospitals had significantly better treatment outcomes. Patients' age, income level, the physician density of a patient's place of residence, and whether the hospital has joined the P4P on TB programme are factors affecting the treatment outcomes of TB patients in Taiwan.

Keywords Pay-for-performance, tuberculosis, cure rate, length of treatment

KEY MESSAGES

- The implementation of a pay-for-performance programme for TB treatment in Taiwan was found to significantly improve both the TB cure rate and average length of treatment for cured cases.
- Factors affecting the treatment outcomes of TB patients in Taiwan are the patient's age, income level, the physician density of a patient's place of residence, and whether the hospital has joined the pay-for-performance programme.

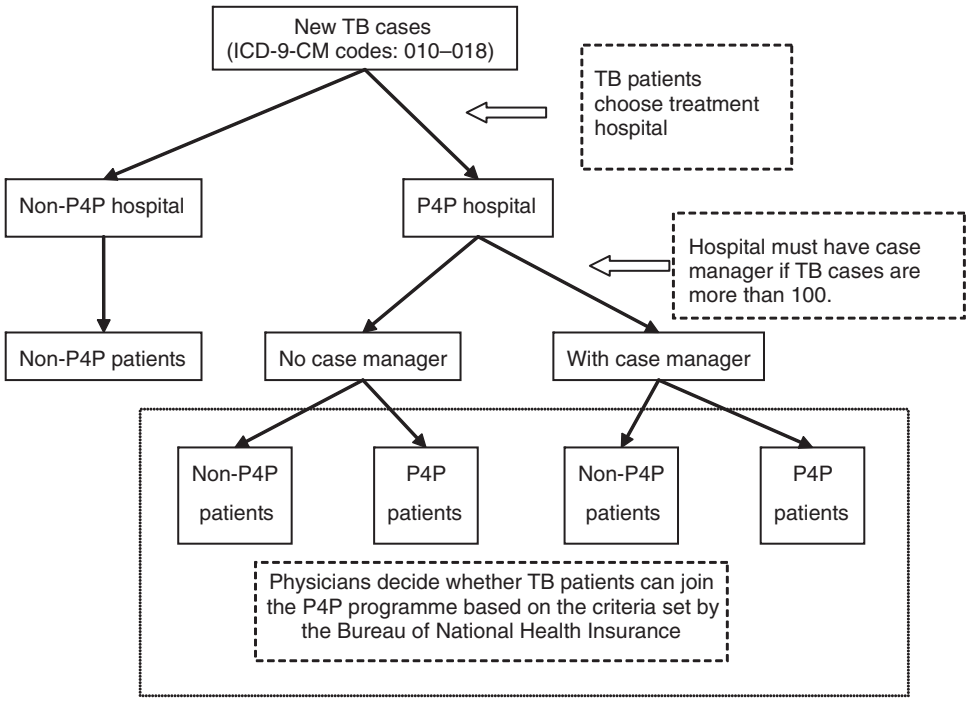

Figure 1 Flow chart showing the treatment approach followed in Taiwan for treating TB patients in the post-P4P period

Background

For thousands of years tuberculosis (TB) has remained one of the major killers worldwide (WHO 1994; WHO 2004; WHO 2006). During 1967 to 1977, the annual number of new tuberculosis cases reached 2.8 million, around 400 000 of whom died from the disease (WHO 2000). The incidence of tuberculosis has been increasing at a rapid rate since 1980, from 2.8 million in the 1970s to about 8.9 million in 2004, implying an incidence of 140 per 10 000 population (WHO 2006). The mortality rate also increased from 25 per 10 000 population in 1995 to 27 in 2004 (WHO 2006). One-third of all new TB cases occurred in Southeast Asia (WHO 2006).

In Taiwan, TB has the highest incidence of any infectious disease (Wang 2002), with the number of new TB cases stable at around 1500 per month (TCDC 2008). The data from the Department of Health (DOH) indicate that the incidence of TB in 2004 was about 74.1 per 100 000 population but other studies put the rate much higher, as high as two times the incidence reported by the DOH (Wang and Lin 2000; Department of Health 2006). Taiwanese TB incidence is much higher than the incidence in other more developed countries. For example, in recent years the incidence of TB in the USA and Canada was about 5 per 100 000 population, while it was about 12 per 100 000 in the United Kingdom and 23 per 10 000 in Japan (WHO 2006). The case mortality rate is also significantly higher in Taiwan than in the USA and Canada. It appears that Taiwan has not been very successful in implementing TB control and management strategies to achieve the international standard in case fatality rates. More rigorous TB control, treatment and management are required to achieve a better outcome in Taiwan.

In order to make TB treatment more effective and to avoid the continuing spread of the disease, the Bureau of National Health Insurance (BNHI) in Taiwan initiated the pay-for-performance payment demonstration project in October 2001. Later in January 2004, the demonstration project had been scaled up as a national programme. The programme was officially named 'Pay-for-Performance on Tuberculosis' (P4P on TB). Cases with ICD-9-CM code 010–018 were included in this programme, but multi-drug resistant tuberculosis (MDR-TB) cases, extrapulmonary TB (EPTB) cases and atypical mycobacterium tuberculosis cases were excluded. The hospitals in Taiwan could choose to participate in the P4P on TB programme if they satisfied four eligibility criteria: (1) the BNHI has a contract with the hospital for the provision of services; (2) it is approved by the Centers for Disease Control of Taiwan (TCDC); (3) the participating physicians have specialist licensing in infectious disease, tuberculosis, or have related training/certification; and (4) the hospital has more than 100 new cases under treatment (at any point in time), it has a full-time TB case manager in the hospital. The new system of treating TB patients in Taiwan after the implementation of P4P is summarized schematically in Figure 1.

One of the most important aspects of the P4P on TB is the implementation of incentive payments for physicians and hospitals based on the outcomes of TB treatment. The incentives vary by the stages of treatment as defined by the P4P on TB programme. Four stages were defined and each stage consists of at least 3 months of treatment and management. The payments for hospitals, physicians and case managers for each of the stages are summarized in Table 1.

The pay-for-performance concept is based on the idea that the quality of diagnosis, management and treatment can

Table 1 Medical payment for TB treatment as adopted by the P4P programme

Treatment categories	P4P on TB payment (points-value)		
	Hospitals	Physicians	Case managers
First (1–3 months)	4900	500	1500
		250	
		(cases identified)	
Second (4–6 months)	2900	1000	1500
		if case is cured	
Third (7–9 months)	5250	1000	500 per
	1950	if case is cured	month
	(if case cured)		
Fourth (9–12 months)	–	1000 if case is cured	500 per month
Total	13 050 maximum		3000 plus

be improved by rewarding health care providers. In theory, the reward could be financial or non-financial (Gosfield 2005; Henley 2005; Cognetti and Reiter 2006; Goldman 2006). Several studies have shown the positive effects of pay-for-performance on the health care system. For instance, it could improve patients' compliance behaviour (Cutler *et al*. 2007) and clinical treatment quality (Rosenthal *et al*. 2005; Casale *et al*. 2007; Coleman *et al*. 2007; Lindenauer *et al.* 2007).

Taiwan's pay-for-performance system is based on monetary incentives for providers. A number of recent studies have found that P4P on TB in Taiwan has improved health outcomes of patients (with ICD 010–018) significantly (Tsai *et al*. 2002; Tsai and Kung 2003). According to the TCDC report, the number of hospitals taking part in P4P on TB reached 250 as of June 2006, and about 70% of TB patients are covered by this programme (TCDC 2008). The goal of P4P on TB is to increase patients' cure rate within the recommended length of treatment. The BNHI estimates that the P4P on TB and directly observed treatment together will be able to decrease the number of TB patients by 50% in 10 years time.

Although P4P on TB has been implemented in Taiwan for several years, only a few studies have investigated the effectiveness of the programme and programme components (Tsai *et al*. 2002; Tsai and Kung 2003; Hsu *et al*. 2004; Weng 2004). Most studies have focused on the epidemiology or public health aspects of the disease. Unlike other studies, this study will focus on the outcomes likely to be associated with the incentive structure of the P4P on TB programme. The national level data set obtained from the TCDC was used for the analysis. More specifically, the study compared the outcome of TB treatment before and after the implementation of P4P on TB and the outcomes between hospitals by participation status in the P4P programme.

Methods

Study samples and data sources

The study population consists of new TB cases detected in different health facilities in Taiwan from January 2002 to December 2005. Detailed information on all cases in the national data set was obtained from the TCDC. Since P4P was officially implemented on 1 January 2004, TB cases identified during 2002 and 2003 ($n = 25\,754$) constitute the pre-programme group cases and TB cases identified after 1 January 2004 ($n = 33\,536$) are defined as the post-programme group. Since the P4P demonstration project was implemented in 2001, all the cases in the demonstration project areas were excluded from the pre-programme group. The sample size in the pre-programme group after the exclusion of cases from the demonstration project is 24 754. For the analysis of patient treatment outcomes for these two groups, additional data were obtained from the TCDC. These additional variables include patient gender and age, physician and the health facility reporting the case, date of registration of the patient, treatment outcomes, etc.

Definition of cured cases

According to the definition by the World Health Organization (WHO), the cured cases in this study were those initially smear-positive patients who had a negative sputum smear in the last month of treatment, and on at least one previous occasion.

Statistical methods used

For comparative analysis of treatment outcomes of TB patients, mean values of the variables were calculated. T-test and other relevant statistical tests were conducted to examine differences between the average values of TB patients' cure rate (including cured and treatment success rate) and length of treatment. Similar tests were also used to compare patients' cure rate and length of treatment between hospitals participating in P4P and those not participating.

To identify the factors affecting the treatment outcomes of TB patients in Taiwan, multivariate analysis was also conducted. Since the treatment outcome variables are dichotomous, the appropriate empirical model would be the logistic regression equations. Since the hospitals choose to participate in the programme, self-selection bias may influence the estimates of the models. To correct for potential self-selection bias, two-stage logistic regression equations were estimated. The first logistic regression estimated the probability of hospitals participating in the 'P4P on TB' programme. Given the probability of participation in P4P, the next model estimated the probability of treatment cure rate within 12 months of treatment after diagnosis.

Results

The number of new TB cases identified in Taiwan was 13 255 in 2002, 12 499 in 2003, 18 188 in 2004 and 15 348 in 2005 (Table 2). It appears that the identification of new TB cases jumped by about 30% in the immediate post-P4P era compared with the pre-P4P years. Since the increase in reported TB cases happened immediately after the implementation of P4P, the programme clearly encouraged identification of new cases. Early detection of undiagnosed cases of TB is an important positive outcome of the P4P programme. Early identification of

Table 2 Cure rate, death rate and length of treatment of TB patients in Taiwan, 2002–2005

	2002	2003	2004	2005
Total new TB cases	13 255	12 499	18 188	15 348
Number of cases cured, *n* (%)[a]	5755 (43.4)	6305 (50.4)	11 396 (62.7)	9741 (63.5)
Average length of treatment for cured cases (days)	257.62	255.35	250.13	249.29

[a]Cases were followed for 12 months after the detection of TB.

Table 3 Comparison of TB treatment outcomes: before and after the implementation of pay-for-performance (P4P)

	Before implementation of P4P *n* (%)	**After implementation of P4P** *n* (%)	***P***
N	25 754 (42.20)	33 536 (57.80)	
Gender			0.301
Male	17 632 (68,5)	22 826 (68.1)	
Female	8122 (31.5)	10 710 (31.9)	
Age (years)			0.623
<45	5617 (21.8)	7345 (21.9)	
45–64	5939 (23.1)	7612 (22.7)	
≥65	14 198 (55.1)	18 543 (55.4)	
Cases cured within 9 months[a]	12 060 (46.9)	21 137 (63.0)	<0.01
Average length of treatment in days for cases cured in 9 months	256.24 (58.3)	249.74 (55.4)	<0.01

[a]Table summarizes the outcomes for cases at the end of a 12-month follow-up period after detection.

cases provides significant external social benefits by reducing the transmission risk.

The P4P programme not only increased the number of cases identified; the 12-month cure rate of new TB cases also increased significantly from 43.4% in 2002 to 63.5% in 2005. The average length of treatment decreased from 257 days in 2002 to 249 days in 2005 for cases cured within 12 months (see Table 2).

Table 3 compares the demographics and treatment outcomes of new TB cases between pre- and post-P4P periods. The incidence of TB was found to be higher for males than that for females. Two-thirds of all new patients were male in both pre- and post-P4P periods. Most of the TB patients (over half) were 65 years of age or over while another 23% were in the age group 45–64 years. Again, the age distribution of new cases remained almost identical between pre- and post-P4P periods. The cure rate of TB within 12 months of treatment improved significantly from 46.9% before the P4P years to 63.0% after the P4P years ($P < 0.01$). The average length of treatment for TB patients cured within 12 months was 256 days before the implementation of P4P, decreasing to 250 days after the implementation of P4P ($P < 0.01$).

Table 4 Comparison of TB treatment outcomes between P4P hospitals and non-P4P hospitals

	P4P hospitals *n* (%)	**Non-P4P hospitals** *n* (%)	***P***
N	26 977 (80.4)	6559 (19.6)	
Gender			0.0002
Male	18 266 (67.7)	4560 (69.6)	
Female	8711 (32.3)	1999 (30.5)	
Age (years)			<0.01
<45	6161 (22.9)	1184 (18.1)	
45–64	6291 (23.3)	1321 (20.2)	
≥65	14 494 (53.8)	4049 (61.8)	
Number of cases			
Medical centres	10 810	626	
Regional hospitals	9285	833	
Local hospitals	5265	1645	
Number cured (cure rate)[a]	18 377 (68.1)	2778 (42.4)	<0.01
Medical centres	7210 (66.7)	410 (65.5)	0.282
Regional hospitals	6477 (69.8)	577 (69.3)	0.401
Local hospitals	3649 (69.3)	1065 (64.7)	<0.01
Average treatment days [days (SD)]	249.13 (62.73)	250.56 (53.71)	0.225
Medical centres	251.78 (73.12)	251.40 (51.47)	0.708
Regional hospitals	246.31 (54.44)	251.82 (51.87)	0.020
Local hospitals	248.22 (55.06)	248.30 (53.58)	0.967

[a]Cases were followed for 12 months after detection.

Following the implementation of P4P on TB in 2004, all hospitals in Taiwan can be categorized as P4P hospitals or non-P4P hospitals. In Taiwan, 143 hospitals out of 583 decided to join the P4P on TB programme by 2005. During 2004–5, 6559 new TB cases were reported from the non-P4P hospitals, whereas 26 977 new cases were reported from the P4P hospitals. The distributions of patient gender and age in these hospital categories were very similar to the national averages. More than 67% of new patients were males, more than 50% of new patients were ≥65 years old and 20% were in the age group 45–64 years.

As indicated in Table 4, some of the important outcome indicators regarding the cure rate and average length of treatment for cured cases demonstrated significant improvements in P4P hospitals compared with the outcomes in non-participating hospitals ($P < 0.01$). The TB cure rate in 12 months was around 68.1% in P4P hospitals and 42.4% in non-P4P hospitals ($P < 0.01$). The average length of treatment for cured cases in P4P hospitals was 249 days, just slightly shorter than 251 days in non-participating hospitals. The average number of treatment days for cured cases in P4P regional hospitals was fewer than in non-P4P regional hospitals ($P = 0.02$). Other levels of hospitals did not show statistically significant differences.

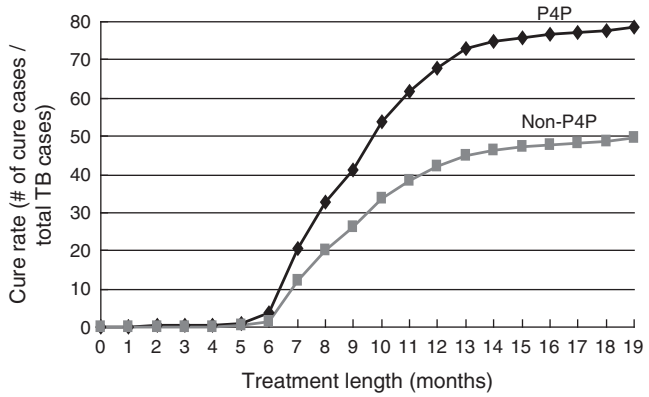

Figure 2 Comparison of cure rate by length of treatment between P4P and non-P4P hospitals

Figure 2 presents the cumulative cure rate by length of treatment for P4P and non-P4P hospitals. The cumulative cure rate for P4P hospitals is higher than for non-P4P hospitals and the vertical gap between the two continues to increase until about 13–14 months after the initiation of TB treatment.

Table 5 reports the results of the logistic regression model with participation of hospitals in P4P as the dependent variable. In this model, the dependent variable indicates the probability of hospitals participating in the P4P on TB programme. The estimated parameters indicate that the hospitals located in median and low physician density areas (median physician density of median ±1 SD and less than median −1 SD) are more likely to participate in the P4P on TB programme (OR = 6.012, 3.358; 95% CI = 5.450–6.631, 2.862–3.941). Hospitals located in cities with a median income level (mean of all cities in Taiwan ± 1 SD) were less likely to participate in the programme (OR = 0.594; 95% CI = 0.538–0.656). However, hospitals located in cities with lower income levels (lower than the mean of all cities in Taiwan minus 1 SD) are more likely to participate (OR = 4.534; 95% CI = 2.870–7.162). As expected, regional hospitals and local hospitals were less likely to participate in the P4P on TB programme than medical centres (OR = 0.448, 0.077; 95% CI = 0.401–0.500, 0.069–0.087), and private hospitals and veterans hospitals were less likely to participate than public hospitals (OR = 0.637, 0.314; 95% CI = 0.564–0.720, 0.281–0.351).

Table 6 reports the result of the logistic regression model with TB cases cured within 12 months of treatment as the dependent variable, corrected for the participation of hospitals in the programme. In this model, the dichotomous dependent variable indicates whether the patient was cured within the first 12 months of treatment or not. Note from the parameters estimated that older patients are less likely to be cured within 12 months of treatment than younger patients (odds ratio for elderly patients ≥65 years old of 0.554 compared with patients <45 years of age). Patients in P4P hospitals are more likely to be cured within 12 months of treatment than patients in non-P4P hospitals (OR = 1.338; 95% CI = 1.159 ~ 1.544). A number of hospital characteristics also affect the TB treatment cure rate. For example, patients treated in regional hospitals were more likely to be cured (OR = 1.102; 95% CI = 1.048 ~ 1.160) than patients treated in medical centres. It is interesting that patients in private hospitals show a lower likelihood of being cured within 12 months than those treated in public hospitals (OR = 0.880; 95% CI = 0.830 ~ 0.933). A number of city characteristics also affect the cure rate. For example, patients living in median income level cities are more likely to be cured than the patients living in high income cities (OR = 1.424; 95% CI = 1.345 ~ 1.507). Patients living in cities with lower physician density are less likely to be cured than patients living in cities with high physician density (OR = 0.854; 95% CI = 0.791–0.922). Surprisingly, the presence of full-time case managers in a hospital does not show any positive effect on the TB cure rate.

Table 5 Results of logistic regression analysis with hospital participating in pay-for-performance on TB as the dependent variable

Criteria	Estimate	Odds ratio	*P*
Intercept	3.3159		<0.0001
Physician density			
High (ref)			
Median	1.7937	6.012 (5.450–6.631)	<0.0001
Low	1.2114	3.358 (2.862–3.941)	<0.0001
City income			
High (ref)			
Median	−0.5214	0.594 (0.538–0.656)	<0.0001
Low	1.5115	4.534 (2.870–7.162)	<0.0001
Hospital type			
Medical centres (ref)			
Regional hospitals	−0.8039	0.448 (0.401–0.500)	<0.0001
Local hospitals	−2.5578	0.077 (0.069–0.087)	<0.0001
Hospital ownership			
Public hospitals (ref)			
Private hospitals	−0.4509	0.637 (0.564–0.720)	<0.0001
Military/veterans hospitals	−1.1592	0.314 (0.281–0.351)	<0.0001

Discussion

The incidence and prevalence of TB were higher for males than for females in Taiwan, consistent with the observations of a number of previous studies (Chen *et al*. 1991; Tsai *et al*. 2002; Tsai and Kung 2003; WHO 2004). The differences between the genders in terms of their health behaviour, work pattern, social role and biological differences may explain the differential TB incidence and prevalence (WHO 2004). More than 50% of newly diagnosed patients were aged ≥65 years. Increasing TB incidence with age has also been observed by other studies in Taiwan (Chen *et al*. 1991; Tsai and Kung 2003). It is possible that higher incidence among the elderly, to some extent, is affected by their higher frequency of hospital visits and higher likelihood of having microbiological tests due to symptoms like fever, night sweats, cough, etc. These symptoms are more frequent in older patients with TB, although such symptoms are non-specific and not uncommon in other diseases like heart failure, pulmonary embolism, endocarditis, cancer and pneumonia (Fullerton and Dyer 1965; Morris and Nell 1988; Korzeniewska-Kosela *et al*. 1994).

Table 6 Results of logistic regression analysis with TB case cured within 12 months of treatment as the dependent variable[a]

Criterion	Estimate	Odds ratio	*P*
Intercept	−0.1279		0.1116
Gender			
Male (ref)			
Female	−0.0311	0.969 (0.928–1.012)	0.1592
Age (years)			
<45 (ref)			
45–64	−0.2881	0.750 (0.706–0.797)	<0.0001
≥65	−0.5913	0.554 (0.525–0.583)	<0.0001
P4P hospital			
Non-P4P (ref)			
P4P hospital	0.2911	1.338 (1.159–1.544)	<0.0001
Case manager			
With no case manager (ref)			
With case manager	0.0176	1.108 (0.956–1.084)	0.5835
Hospital type			
Medical centres (ref)			
Regional hospitals	0.0976	1.102 (1.048–1.160)	0.0002
Local hospitals	0.0494	1.051 (0.983–1.122)	0.1428
Hospital ownership			
Public hospitals (ref)			
Private hospitals[b]	−0.1277	0.880 (0.830–0.933)	<0.0001
Military/veterans hospitals	0.0181	1.018 (0.962–1.078)	0.5321
Physician density			
High (ref)			
Median	−0.0156	0.985 (0.926–1.047)	0.6199
Low	−0.1579	0.854 (−0.791–0.922)	<0.0001
City income			
High (ref)			
Median	0.3532	1.424 (1.345–1.507)	<0.0001
Low	0.0004	1.000 (0.893–1.119)	0.995
Residual	−0.0338	0.967 (0.932–1.003)	0.0736

$N = 45\,398$; cured cases: 12 849; non-cured cases: 32 549.
[a]Event: cured cases.
[b]Including proprietary hospitals.

Similar to the results of other studies (Humphries *et al*. 1984; Van den Brande *et al*. 1991; Teale *et al*. 1993), this study found that older TB patients in Taiwan have much a lower cure rate compared with younger patients. Except for the high fatality rate due to TB or other comorbid disease, Teale *et al*. (1993) found a highly significant difference in the frequency of reported side-effects between elderly and younger patients. Their report implied that side-effects of anti-tubercular drugs were more frequent or more severe in elderly patients. This may explain the relatively low success rate among elderly TB patients.

This study found a significantly higher cure rate for TB treatment after the implementation of the P4P on TB programme (Table 3). In addition, P4P hospitals had a higher cure rate than non-P4P hospitals (Table 6). The results are consistent with the hypothesis that the P4P hospitals provide more effective treatment to their TB patients in order to receive the financial incentive from the BNHI.

The analysis found that the medical centres had the lowest cure rate compared with regional and local hospitals. This finding is consistent with that of another study on TB patients in Taiwan (Tsai *et al*. 2002). Although the result is quite surprising, it may be due to the higher severity of TB patients at the medical centre level. Since medical centres are the most advanced tertiary hospitals, most of the serious cases, such as cases with significant comorbidities, are transferred from regional and local hospitals to medical centres. The higher proportion of more complicated TB cases in the TB patient pool of the medical centres may explain the lower cure rate and higher death rate. Another possible explanation identified by TB physicians or other related experts was that perhaps medical centres did improve their patients' treatment outcomes after P4P on TB was implemented, but the improvement was not as high as for regional or local hospitals.

Multivariate analysis indicated that patients in private hospitals were less likely to be cured than patients in public hospitals. Some previous studies hypothesized that public hospitals will have better treatment outcomes due to the government subsidy (Chang *et al*. 2004) and direct control of the hospitals by the local DOH. Moreover, some public hospitals, such as the Chest Hospital in southern Taiwan and Taichung Hospital in mid-Taiwan, have specialized units for treating TB patients. These hospitals have been the principal facilities providing care to TB patients since 1960 and many TB patients may prefer to come to these hospitals for treatment because of their long experience in treating TB. The experience of public hospitals with TB patients in general and the DOH's emphasis on treatment and management of TB patients make the public hospitals relatively better than private hospitals in terms of disease management and treatment outcomes.

Another interesting result of the analysis is that the cities with higher income levels had lower TB cure rates within 12 months of treatment. A number of previous studies have found similar patterns (Nagpaul 1988; Jesani and Anantharam 1990; Chakraborty 1993; Chakraborty *et al*. 1995; WHO 2001). One reason for this could be that the TB control and treatment programmes have lower impact in urban areas compared with rural areas (Nagpaul 1988; Chakraborty 1993). Another possible explanation could be migration of poorer sections of the population from rural to urban areas in search of employment, and rural–urban migration may increase the risk of disease transmission.

If we examine the slope of the cumulative cure rate function shown in Table 1, it is apparent that the slopes for P4P and non-P4P hospitals reach a plateau after 12 months of treatment. This probably indicates that the length of treatment defined by the P4P incentive structure is appropriate and almost all who can be cured are cured within the 12 months of treatment. When we analyse the number of cases cured by length of treatment in P4P hospitals and non-P4P hospitals, we find that the numbers of cured cases increase sharply after 6 months of treatment and the numbers of cured cases peak during the 7–10 month period (Table 1). Therefore, the

government may consider rewarding hospitals at a higher rate for successful cure within a shorter timeframe than 12 months.

One of the objectives of P4P on TB was to establish a treatment team in the hospital, as well as to cooperate with the community. Treating TB became the work of a team, including physicians, nurses in the hospital, case managers, public nurses and pastoral care assistants in communities. Case managers act as a bridge to connect the hospital and the community. If the patient does not return to hospital to follow-up, the case manager will contact a public nurse, and a home visit by a public nurse or pastoral care assistant will be made. The government also asks public nurses to make at least 10 home visits during the first 6 months of treatment. Treating TB is not only physicians' and patients' work, it has become a cooperative work between hospital and community.

Conclusion

This study found that both the cure rate and average length of treatment for cured cases improved significantly after the implementation of the P4P on TB programme in Taiwan. Compared with non-P4P hospitals, P4P hospitals had significantly better treatment outcomes. These results confirm that P4P on TB is an effective incentive structure for the treatment of TB in Taiwan.

A number of limitations should also be mentioned here. This study is based on the analysis of a limited number of variables available in the national data sets. The study could not get access to hospital records of individual patients to understand the factors affecting the severity of the illness. Similarly, the study did not have any information on microbiological data, drug susceptibility test results and resistance pattern, presence of adverse reactions to anti-tubercular therapy and the comorbid illness of patients.

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