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Effect of profit status in facilities on the mortality of patients on long-term haemodialysis: a nationwide cohort study

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ABSTRACT

Objectives Over the past two decades, debates on whether the profit status of dialysis facilities influences patient prognosis have been popular in the USA. Taiwan is one of the regions with the highest rate per capita of kidney replacement therapy worldwide, but no similar research has been conducted to date. This is the first study to address this issue.

Design This was a nationwide retrospective cohort study based on the Taiwan Renal Registry Data System.

Setting Patients were categorised into two groups based on the profit status (for-profit, not-for-profit (NFP)) of dialysis facilities, with 31 350 patients in each group. The patients were followed up from 2005 to 2012.

Participants Patients with uraemia who underwent long-term haemodialysis in private dialysis facilities and public facilities were excluded.

Primary and secondary outcome measures Survival analyses were performed to compare prognosis between the two groups. Adjustments to patients' basic profile, and facilities' geographical distribution, level, and length of ownership were carried out to minimise possible confounding effects.

Results Analysis revealed that NFP dialysis facilities had better outcomes (HR=0.91, 95% CI (0.89 to 0.93)). A favourable effect remains with the adjustment of the facilities' level, geographical distribution (HR=0.89, 95% CI (0.86 to 0.93)) or length of ownership (HR=0.95, 95% CI (0.89 to 0.95)). Survival analysis based on the geographical distribution and level of facilities was also conducted, which showed better prognosis in medical centres in the six municipalities, whereas worse prognosis was found in local hospitals not located in these municipalities.

Conclusion Our findings suggest that in contemporary settings in Taiwan, treatment at NFP dialysis facilities was associated with a better prognosis. The results should be interpreted with caution since the possibility of residual confounding effects and uncertainty of casual relations exist due to the nature of observational studies.

Strengths and limitations of this study

- This study was based on a relatively large sample size from a nationwide database (Taiwan Renal Registry Data System).
- Potential confounding effects of the study were minimised by matching study groups, adjusting for facilities' geographical distribution, level and length of ownership.
- Uncontrolled/residual confounding factors may interfere with the association between the profit status of facilities and patient prognosis due to the observational study design.
- Missing data from facilities' length of ownership limited further adjustment of this study.
- The study results have limited generalisability to other countries on account of different healthcare landscapes and insurance systems.

INTRODUCTION

Taiwan remains one of the countries with the highest prevalence and incidence of kidney replacement therapy worldwide,[1] as they reached 3480 per million individuals and 504 per million individuals, respectively, in 2017.[2] The total amount of National Health Insurance (NHI) for patients with uremia who underwent dialysis therapy, including haemodialysis (HD) or peritoneal dialysis, is approximately 62 billion New Taiwanese dollar (or US$2179 million), with 8.7%–9.2% of the total health expenditure in Taiwan in 2019.[2] Therefore, it is vital to determine the factors predicting patients' survival. These factors not only influence patient outcomes, but also impact the cost-effectiveness of HD. Of all the factors, the profit status of a dialysis facility is an important concern.[3]

In the past two decades, there has been debate on whether the profit status of dialysis facilities has an influence on patient mortality. According to a meta-analysis published in 2002 by Devereaux *et al*,[4] the pooled estimation demonstrated that private for-profit (FP) dialysis facilities were associated with an increased risk of death (risk

ratio=1.08, 95% CI (1.04 to 1.13), p<0.001). Nevertheless, a retrospective analysis of the US Renal Data System (USRDS) by Brooks *et al*[5] indicated that no relationship exists between dialysis facilities' profit status and patient survival after adjusting for the two-stage least squares variant of instrumental variable estimation with the relative proximity of facilities to the patient's residence as the instrument. Additionally, a retrospective study comparing Foley *et al*'s study,[6] featuring more recent patient data from the Medicare database between 1998 and 2003, with that of Devereaux *et al*'s study, with patients enrolled between 1973 and 1997, showed no significant difference in patient mortality between FP and not-for-profit (NFP) facilities (adjusted HR=1.02, 95% CI (0.99 to 1.06), p=0.143). Finally, a retrospective analysis of the USRDS by Brunelli *et al*[7] concluded that no difference was observed in mortality and hospitalisation rates between FP and NFP dialysis facilities when appropriate statistical adjustments were made, which emphasised the 'provider-level' approach by adding potential confounders such as facility's geographical location, length of facility ownership, vascular access at first dialysis session and pre-dialysis nephrology care into their analysis.

Despite the abundance of HD patients in Taiwan, few studies are available on this topic. However, this study is largely influenced by the health policy,[8] insurance, structure and distribution of dialysis facilities. The NHI system of Taiwan covers nearly the entire population of Taiwan and a broad range of medical services, including HD. Patients only need to pay a registration fee of approximately US$3 for each dialysis course. The fee is similar across different levels of facilities, and no specific referral system restricts patients from directly seeking dialysis treatment in high-level facilities. Under a unified payment system in Taiwan, it is a good opportunity to uncover the actual effect of ownership that might be confounded by the complex setting of the healthcare market in the USA.[9] Our research aimed to evaluate whether the profit status of dialysis facilities affects patient mortality. We assume that the effect of profit status among HD centres on mortality or survival benefit in Taiwan is minimal. Further analysis should be performed to ensure that the possible confounding factors are taken into account.

METHODS

Setting and participants

Patients registered in the Taiwan Renal Registry Data System (TWRDS) from 2005 to 2012 were enrolled (N=115 535). In Taiwan, all dialysis facilities have been obligated to upload patient information quarterly since 1987.[10] Information included patients' biochemical profiles, history, dialysis location and timing. After excluding patients treated with peritoneal dialysis (N=9232), that shift between different dialysis modalities (N=4661), who underwent HD at public facilities (N=20 609) and with missing biochemical/comorbidity profile (N=2570), the remaining 76 483 patients were included in our study (figure 1). If the patient underwent dialysis in multiple facilities, we chose the facility where the patient visited most frequently.

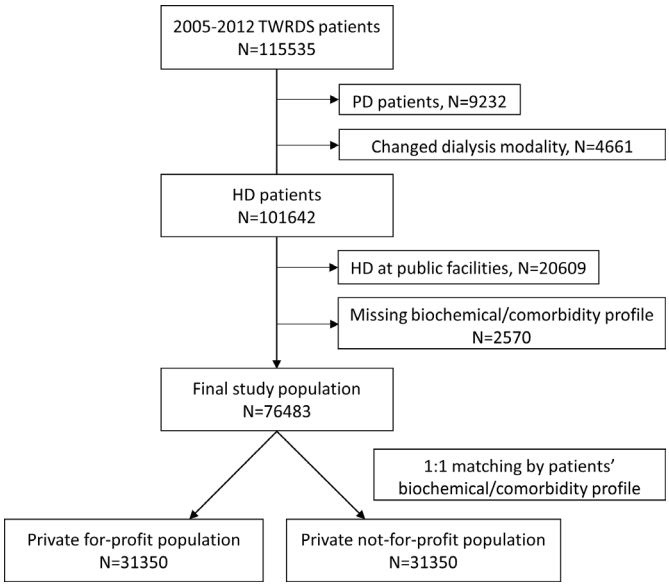

Figure 1 Flow chart of the patient selection process. HD, haemodialysis; PD, peritoneal dialysis; TWRDS, Taiwan Renal Registry Data System.

Patient and public involvement

No patient involved.

Grouping

By facilities' ownership and profit status

The profit status of dialysis facilities was divided into two groups, including 'private FP' and 'private NFP,' whereas public facilities were excluded. A facility was regarded as private when it is not established by government authorities, government-owned enterprises or public schools.[11] Furthermore, a facility was considered private NFP if it is established or operated by a medical foundation.[11] NFP facilities are required to contribute no less than 20% of revenue on research, training, health education, community service or charity. As compensation, NFP facilities are exempt from corporate tax, land and property taxes, and personal income tax. A reduction in the corporate tax is also offered.[9]

By facilities' level and geographical distribution

Facilities were divided into eight categories as a correction factor, according to four levels of medical facilities designated by the Taiwanese Ministry of Health and Welfare (medical centre, metropolitan hospital, local community hospital and clinic) and two types of geographical distribution in Taiwan (six special municipalities (SMC) or not). The Ministry of Health and Welfare of Taiwan holds hospital accreditation yearly and categorises medical facilities into four levels. A medical centre should be a teaching and research hospital with over 500 beds and 23 medical specialties. Metropolitan hospitals should be teaching hospitals with more than 300 beds and most

medical specialties (including pathology, anaesthesiology, radiology and rehabilitation). Local community hospitals should have no more than 100 beds and provide general/emergency healthcare services. Clinics are not subject to hospital accreditation, which are relatively small in size.[12] Special municipalities are defined as regions with populations of not less than 1 250 000 and have special requirements in their political, economic, cultural and metropolitan development.[13] Currently, there are six municipalities in Taiwan. Information concerning the level of the dialysis facility and its geographical distribution can be found in the TWRDS lists of dialysis facilities. The dialysis facility's length of ownership was also used as a correction factor. Information was collected through an online search of official websites or telephone interviews. The facilities were divided into four groups: group 1 (established for 0–5 years), group 2 (6–10 years), group 3 (11–20 years) and group 4 (≥20 years).

Statistical analysis

Descriptive statistics were expressed as mean±SD for continuous variables and proportions for categorical variables. One-way analysis of variance or the Kruskal-Wallis test was used for the analysis of differences between continuous variables, and the nominal variables were compared using the χ^2 test. Kaplan-Meier analysis was performed using the log-rank test. The level of significance was set at 0.05, two-tailed for all tests. A Cox regression model for survival analysis was used to estimate the HRs of all-cause mortality in HD patients. The primary endpoint of our study was all-cause mortality. If a patient switched to other dialysis modalities or received kidney transplant during follow-up period, the patient would be censored. An individual was considered deceased if he or she was lost to follow-up in the TWRDS based on the complete national coverage provided by the NHI policy for all kidney replacement therapy expenditures in Taiwan. All descriptive and multivariate analyses were performed using the SPSS software (V.17.0) for Windows V.XP (SPSS) and SAS V.9.1 (SAS Institute).

Survival analysis based on the profit status of the facilities

Survival analysis was performed to compare the HRs between the FP and NFP groups. Propensity score matching by patient age, sex and biochemical/comorbidity profile (table 1) was conducted before survival analysis, resulting in 31 350 patients in each group. With reference to the studies by Brunelli *et al*,[7] our research was carried out with four models, each correcting different parameters. Crude data compared the HR between FP and NFP without correction. Model 1 additionally corrects for age and sex. Models 2 and 3 further correct coronary artery disease (CAD), myocardial infarction (MI) and diabetes mellitus (DM) rates in the population. Furthermore, model 2 adds the geographical distribution and level of dialysis facilities as a correction factor, and model 3 adds the length of ownership as a correction factor.

Table 1 Baseline characteristics between the for-profit and not-for-profit groups after matching

Variable	Type of facilities by profit status		P value
	For-profit	Not-for-profit	
Number	31 350	31 350	
Age (years)	62.3±13.5	62.2±13.5	0.66
Male (%)	15 831 (50)	15 764 (50)	0.59
DM (%)	16 136 (51)	16 128 (51)	0.95
HTN (%)	13 799 (44)	13 459 (43)	<0.01
CHF (%)	4803 (15)	4585 (15)	<0.05
LVH (%)	4556 (15)	4328 (14)	<0.01
CVA (%)	2012 (6)	2038 (7)	0.67
CAD (%)	3815 (12)	3762 (12)	0.52
MI (%)	948 (3)	1027 (3)	0.07
HTN drugs (%)	18 475 (59)	18 274 (58)	0.1
HD duration (years)	3.55±2.61	3.55±2.61	0.99
Albumin (g/dL)	3.75±0.40	3.74±0.41	<0.01
Hct (%)	31.09±3.40	31.05±3.15	0.13
Ca (mg/dL)	9.18±0.71	9.18±0.69	0.33
P (mg/dL)	4.84±1.12	4.83±1.11	0.37
ALK-P (µ/L)	128.4±97.1	128.5±100.5	0.91
i-PTH (pg/mL)	226.9±184.0	225.5±175.6	0.32

ALK-P, alkaline phosphatase; Ca, calcium; CAD, coronary artery disease; CHF, chronic heart failure; CVA, cerebrovascular accident; DM, diabetes mellitus; Hct, haematocrit; HD, haemodialysis; HTN, hypertension; i-PTH, intact parathyroid hormone; LVH, left ventricular hypertrophy; MI, myocardial infarction; P, phosphate.

Survival analysis based on facilities' level and geographical distribution

Survival analysis was also performed based on the eight categories of facilities' level and geographical distribution without consideration of the profit status to evaluate the possible confounding effect of these categories.

RESULTS

Survival analysis based on profit status

Baseline characteristics between groups

After matching, there were 31 350 patients in each group (FP and NFP). Most baseline characteristics were not significantly different between the groups, except for the prevalence of hypertension, congestive heart failure, left ventricular hypertrophy and albumin level (table 1).

Model 1

The follow-up period was 96 months (2005–2012). Both crude data and model 1 showed significantly favourable outcomes (p<0.0001) for the NFP group, with HRs of 0.93 and 0.91, respectively. Figure 2 shows the Kaplan-Meier survival curve of the crude data (table 2).

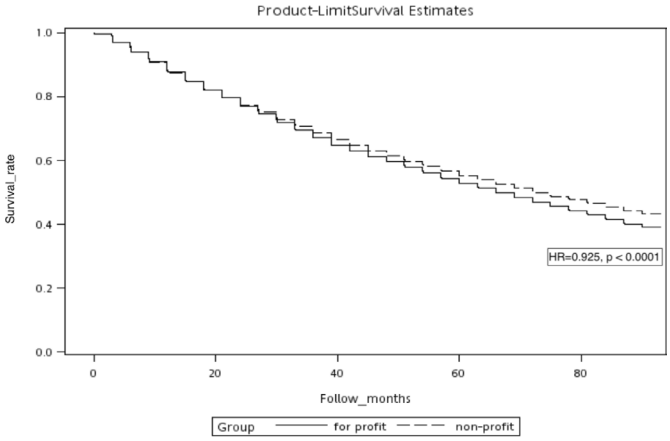

Figure 2 The Kaplan-Meier survival curve in HD patients. The survival rate in the for-profit group (approximately 8.75%) was decreased compared with that in the not-for-profit control group (p<0.0001). HD, haemodialysis.

Model 2

Data show significantly favourable outcomes (p<0.0001) for the NFP group with an HR of 0.89 (table 3).

Model 3

Data show a significantly favourable outcome (p<0.0001) for the NFP group with an HR of 0.95 (table 4).

Survival analysis based on facilities' level and geographical distribution

Baseline characteristics

Without matching, most parameters in the baseline characteristics showed significant differences between the eight groups. Of note, there were several patients in the SMC group at every level of the dialysis facility. The difference is most apparent in the medical centres (34 783 vs 2311) and clinics (10 0192 vs 31 450), and the influence of this difference on the FP and NFP outcomes will be discussed later in this article (table 5).

Survival analysis

Survival analyses with adjustments for age, sex, CAD, MI and DM were also performed to compare the impact of the facility level and geographical distribution on patient prognosis. The clinic SMC was designated as the reference group. Trends for better outcomes were observed at the medical centre level, whereas worse outcomes were observed in metropolitan hospitals and local hospitals. Non-significant p values were observed in the medical centre not SMC (NSMC) and clinic NSMC, indicating that the outcome is similar to that of clinic SMC (table 6).

DISCUSSION

In summary, our results revealed that private NFP dialysis facilities have better patient outcomes than private FP facilities. The favourable effect remains with the adjustment of the facilities' level, geographical distribution or length of ownership.

The possible reasons why NFP and FP facilities have different outcomes have been discussed extensively in previous studies.[4 14–16] By definition, FP facilities are owned by investors or shareholders. They usually distribute part of their profits directly to owners and focus on increasing shareholder wealth. In contrast, NFP facilities are owned by members (communities, religious organisations, non-governmental organisations, universities, etc) to fulfil certain missions (providing health services, teaching or research). Revenue should be used for their stated mission and cannot be distributed to the members of the organisation.[16] Theoretically, FP facilities result in greater efficiency if there are no barriers to entering the market and there is an observable and measurable outcome.[16–18] Nevertheless, numerous barriers exist (eg, high capital investment, technology, faculty training, regulation and certification), whereas the outcomes are hardly visible to customers (patients). The barriers to market, asymmetrical information, risk and the uncertain nature of the healthcare industry make it prone to market failure.[19] In a meta-analysis by Devereaux *et al*,[20] NFP hospitals are associated with higher payments for care, which indicates the shortcoming of FP facilities in terms of efficiency. To make matters worse, FP facilities are often faced with economic challenges. Shareholders expect 10%–15% returns on their investments,[14] and taxes may account for 5%–6% of the total expenses.[21] FP facilities must generate these profits and pay taxes while making an effort to provide the same quality of care as NFP facilities that are free of these excessive expenses.[4] In a healthcare system in which funding and resources are relatively fixed, as with the NHI in Taiwan, the FP facility may try to cut off other forms of spending to generate more profit. Although both business models ought to be confronted with costings on doing audit, ongoing training and purchasing medical supplies, there are several reasons that could result in the better efficiency of NFP facilities. First, due to the

Table 2 Adjustments for age and sex (model 1)

	Crude			Adjusted		
Group	HR	95% CI	P value	HR	95% CI	P value
For-profit	Reference			Reference		
Not-for-profit	0.93	0.9 to 0.95	<0.0001	0.91	0.89 to 0.93	<0.0001
Age (increase per year old)	1.04	1.04 to 1.05	<0.0001	1.05	1.04 to 1.05	<0.0001
Sex (male)	1.1	1.07 to 1.12	<0.0001	1.21	1.18 to 1.24	<0.0001

Table 3 Adjustments for age, sex, CAD, MI, DM, geographical distribution and facility level (model 2)

	Crude			Adjusted		
Group	HR	95% CI	P value	HR	95% CI	P value
For-profit	Reference			Reference		
Not-for-profit	0.93	0.9 to 0.95	<0.0001	0.89	0.86 to 0.93	<0.0001
Age (increase per year old)	1.04	1.04 to 1.05	<0.0001	1.04	1.04 to 1.05	<0.0001
Sex (male)	1.1	1.07 to 1.12	<0.0001	1.2	1.18 to 1.23	<0.0001
CAD (Y)	0.81	0.78 to 0.84	<0.0001	0.69	0.66 to 0.71	<0.0001
MI (Y)	1.02	0.96 to 1.09	0.56	1	0.94 to 1.07	0.97
DM (Y)	1.51	1.48 to 1.55	<0.0001	1.42	1.39 to 1.46	<0.0001
Geographical distribution and facility level						
Medical centre SMC	0.75	0.72 to 0.78	<0.0001	0.89	0.84 to 0.94	<0.0001
Medical centre NSMC	0.77	0.67 to 0.89	<0.001	0.9	0.78 to 1.05	0.17
Metropolitan hospital SMC	0.98	0.95 to 1.02	0.36	1.03	0.98 to 1.08	0.33
Metropolitan hospital NSMC	1.06	1.02 to 1.1	<0.01	1.14	1.08 to 1.2	<0.0001
Local hospital SMC	1.02	0.98 to 1.06	0.3	1.06	1.01 to 1.1	0.01
Local hospital NSMC	1.15	1.1 to 1.2	<0.0001	1.15	1.1 to 1.21	<0.0001
Clinic SMC	Reference			Reference		
Clinic NSMC	0.99	0.94 to 1.03	0.58	1	0.95 to 1.04	0.91

CAD, coronary artery disease; DM, diabetes mellitus; MI, myocardial infarction; NSMC, not six municipalities; SMC, six municipalities; Y, yes.

relatively larger scale of NFP facilities (table 7), economies of scale could be achieved. Facilities of larger scale could reduce the proportion on these expenditure by setting up standard operation procedures. Discounts may be provided by outsourcing training company or medical supply company. Second, according to the regulations in Taiwan,[11] NFP facilities are exempt from about 20% of costings on tax while no less than 20% of revenue on research, training, health education, community medical service or charity is required. The expenditure is roughly equal to the surplus from tax exemption. Additionally, NFP hospitals are entitled to receive charitable contributions. Several financial studies comparing NFP and FP hospitals also indicated that financial performance of NFP hospitals was better than FP hospitals.[9 22] Possible approaches for FP facilities to reducing expenses are

Table 4 Model 3 with adjustments for age, sex, CAD, MI, DM and establishment of facilities

	Crude			Adjusted		
Group	HR	95% CI	P value	HR	95% CI	P value
For-profit	Reference			Reference		
Not-for-profit	0.93	0.9 to 0.95	<0.0001	0.92	0.89 to 0.95	<0.0001
Age (increase per year old)	1.04	1.04 to 1.05	<0.0001	1.05	1.04 to 1.05	<0.0001
Sex (male)	1.1	1.07 to 1.12	<0.0001	1.12	1.16 to 1.23	<0.0001
CAD (Y)	0.8	0.78 to 0.84	<0.0001	0.69	0.66 to 0.72	<0.0001
MI (Y)	1.02	0.96 to 1.09	0.56	0.93	0.86 to 1.01	0.08
DM (Y)	1.51	1.48 to 1.55	<0.0001	1.45	1.4 to 1.49	<0.0001
Facilities' length of ownership						
Group 1	Reference			Reference		
Group 2	1	0.93 to 1.06	0.9	1.04	0.97 to 1.11	0.24
Group 3	1.07	1.01 to 1.13	<0.005	1.13	1.07 to 1.2	<0.0001
Group 4	0.96	0.91 to 1.02	0.21	1.07	1.01 to 1.13	0.02

Group 1 (established for 0–5 years), group 2 (6–10 years), group 3 (11–20 years), group 4 (≥20 years).
CAD, coronary artery disease; DM, diabetes mellitus; MI, myocardial infarction; Y, yes.

Table 5 Baseline characteristics of 76 483 HD patients based on facilities' level and geographical distribution

		Facilities' level and geographical distribution								
		Medical centre		Metropolitan hospital		Local community hospital		Clinic		
Variable	Total population	SMC	NSMC	SMC	NSMC	SMC	NSMC	SMC	NSMC	P value
Number	76 483	7559	510	10 286	9824	10 229	6040	24 327	7708	
Person-year	310 404	34 783	2311	40 047	38 421	40 236	22 964	10,0192	31 450	
Age (years)	62.4±13.6	60.9±13.9	60.1±14.5	63.0±13.5	63.4±13.3	63±13.7	64±13.2	61.8±13.5	62.3±13.4	<0.0001
Male (%)	38 529 (50)	3785 (50)	248 (49)	5179 (50)	4861 (49)	5149 (50)	3040 (50)	12 414 (51)	3853 (50)	0.2757
DM (%)	38 847 (51)	3158 (42)	250 (49)	5441 (53)	5277 (54)	5309 (52)	3209 (53)	12 384 (51)	3819 (50)	<0.0001
HTN (%)	30 728 (40)	2878 (38)	296 (58)	3499 (34)	4484 (46)	4339 (42)	2476 (41)	9367 (39)	3389 (44)	<0.0001
CHF (%)	9575 (13)	1144 (15)	83 (16)	964 (9)	1681 (17)	1575 (15)	938 (16)	2430 (10)	760 (10)	<0.0001
LVH (%)	8990 (12)	1142 (15)	85 (17)	844 (8)	1400 (14)	1342 (13)	710 (12)	2466 (10)	31 001 (13)	<0.0001
CVA (%)	5306 (7)	421 (6)	29 (6)	485 (5)	733 (7)	916 (9)	460 (8)	1695 (7)	567 (7)	<0.0001
CAD (%)	8789 (11)	572 (8)	79 (15)	1001 (10)	1444 (15)	1247 (12)	623 (10)	2813 (12)	1010 (13)	<0.0001
MI (%)	2219 (3)	286 (4)	32 (6)	226 (2)	294 (3)	316 (3)	166 (3)	715 (3)	184 (2)	<0.0001
HTN drugs (%)	38 957 (51)	4049 (54)	256 (50)	5088 (49)	5817 (59)	5093 (50)	2995 (50)	11 487 (47)	4172 (54)	<0.0001
HD duration (years)	3.42±2.67	4.01±2.84	3.93±2.66	3.24±2.61	3.25±2.59	3.28±2.65	3.14±2.59	3.48±2.66	3.46±2.67	<0.0001
Albumin (g/dL)	3.77±0.41	3.85±0.39	3.6±0.37	3.71±0.43	3.68±0.44	3.76±0.43	3.69±0.46	3.84±0.36	3.8±0.36	<0.0001
Hct (%)	31±3.3	31.1±3.5	30.9±2.7	30.8±3.2	31.0±3.1	30.9±3.4	30.6±3.4	31.0±3.2	31.5±3.2	<0.0001
Ca (mg/dL)	9.2±0.7	9.2±0.68	9.15±0.63	9.16±0.7	9.15±0.7	9.24±0.73	9.14±0.73	9.23±0.68	9.23±0.69	<0.0001
P (mg/dL)	4.79±1.13	4.94±1.09	4.75±1.11	4.82±1.12	4.81±1.17	4.71±1.15	4.63±1.18	4.81±1.11	4.73±1.09	<0.0001
ALK-P (μ/L)	124.8±97.3	107±76.1	215.2±147.1	135±113.2	130.7±103.8	138.8±113	153.4±116.7	110.9±80.5	118.0±74.3	<0.0001
i-PTH (pg/mL)	215.5±173.7	240±181	240.4±176.6	231.8±176.8	215.9±171.1	212.4±176.8	193.3±166.4	210.6±170.2	204.9±173.4	<0.0001

ALK-P, alkaline phosphatase; Ca, calcium; CAD, coronary artery disease; CHF, chronic heart failure; CVA, cerebrovascular accident; DM, diabetes mellitus; Hct, haematocrit; HD, haemodialysis; HTN, hypertension; i-PTH, intact parathyroid hormone; LVH, left ventricular hypertrophy; MI, myocardial infarction; NSMC, not six municipalities; P, phosphate; SMC, six municipalities.

Table 6 Survival analysis based on facilities' level and geographical distribution with adjustments

	Crude			Adjusted		
Group	HR	95% CI	P value	HR	95% CI	P value
Medical centre SMC	0.84	0.81 to 0.88	<0.0001	0.83	0.8 to 0.87	<0.0001
Medical centre NSMC	0.9	0.79 to 1.04	0.144	0.92	0.8 to 1.06	0.23
Metropolitan hospital SMC	1.15	1.11 to 1.19	<0.0001	1.08	1.04 to 1.11	<0.0001
Metropolitan hospital NSMC	1.18	1.14 to 1.22	<0.0001	1.1	1.06 to 1.14	<0.0001
Local hospital SMC	1.2	1.16 to 1.25	<0.0001	1.16	1.12 to 1.2	<0.0001
Local hospital NSMC	1.28	1.23 to 1.34	<0.0001	1.18	1.13 to 1.23	<0.0001
Clinic SMC	Reference			Reference		
Clinic NSMC	1.02	0.98 to 1.06	0.3361	1.02	0.98 to 1.06	0.44
Age (increase per year old)	1.04	1.04 to 1.04	<0.0001	1.04	1.04 to 1.04	<0.0001
Sex (male)	1.09	1.07 to 1.12	<0.0001	1.18	1.16 to 1.2	<0.0001
CAD (Y)	0.78	0.76 to 0.81	<0.0001	0.67	0.65 to 0.7	<0.0001
MI (Y)	1	0.94 to 1.06	1	1.02	0.96 to 1.08	0.57
DM (Y)	1.45	1.42 to 1.48	<0.0001	1.37	1.34 to 1.4	<0.0001

CAD, coronary artery disease; DM, diabetes mellitus; MI, myocardial infarction; NSMC, not six municipalities; SMC, six municipalities; Y, yes.

employing fewer personnel per run and less highly skilled personnel,[23 24] unwillingness to extend personal dialysis time and using low-performance dialysers.[24 25] These approaches may also be associated with higher mortality rates in the FP facilities.[25]

Although our study results are in concordance with those of previous studies,[1 4] some confounding factors specific to the setting in Taiwan may exist. Table 7 shows the distribution of the FP and NFP facilities at each level. All medical centres and most metropolitan hospitals are NFP facilities, whereas most clinics are FP facilities. Table 5 shows that the majority of person-year data in medical centres and clinics are contributed by the SMC. Table 6 illustrates that 'medical centre SMC' have the best outcome (HR=0.84, p<0.0001), whereas 'clinic SMC' and 'clinic NSMC' show no significant survival benefits (HR=reference and 1.02, respectively; p=0.3361). In conclusion, the NFP population may be affected by the good prognosis of the 'medical centre SMC'; the FP population is less affected by the neutral outcome of the 'clinic SMC'.

Our study had several limitations. First, as mentioned in previous studies,[4 6 7] it is impractical and highly unlikely that any randomised controlled trial will be conducted on this topic. Specifically, current studies unquestionably suffer from limitations inherent to observational designs. There may be residual confounding effects yet to be corrected, and the causal relationships between profit status and patient outcome cannot be directly derived from an observational study design. Second, due to the personal information protection law in Taiwan, we are unable to directly access the facilities' length of ownership data and have to conduct online searches and telephone interviews for the information needed. Approximately 30% of the facilities refused to report information on their length of ownership, resulting in missing data and insufficient correction in model 3. Correction with geographical distribution and length of ownership (model 2+model 3) was also not performed because of the problem in model 3. Similarly, due to limited access to more granular socioeconomic data of participants, more detailed geographical fixed effects of facilities and type of vascular access of each patient, adjustments regarding these factors could not be carried out. Third, most high-level medical facilities in Taiwan (table 7, medical centre and metropolitan hospital) are established as foundations and are deemed private NFP facilities. Nonetheless, some facilities were established as foundations for the sake of tax exemption and are de facto FP facilities. This finding cannot be properly addressed through statistical analysis. Lastly, immortal time bias is an important issue in the analysis of prevalence and patient survival, especially in our retrospective, long-term, nationwide population-based cohort study design. We could only decrease the impact of this bias using a time-dependent Cox regression model for the HR of mortality, and fortunately, a follow-up period of up to 7 years (figure 2) may alleviate the bias.

Our findings suggest that in contemporary HD settings in Taiwan, treatment at NFP dialysis facilities is associated with better outcomes. The result should be interpreted

Table 7 Level of dialysis facilities and profit status

Level	Private for-profit	Private not-for-profit
Medical centre	0	14
Metropolitan hospital	7	41
Local hospital	71	45
Clinic	207	2

with caution, since the possibility of residual confounding effects and uncertainty of causal relations exist in the setting of an observational study. However, the favourable effects of private NFP facilities have been demonstrated in a recent unpublished meta-analysis from the USA.[26] Studies also show shorter hospitalisation days or hospitalisation rates due to complications in NFP facilities.[27 28] The effect of the profit status of HD facilities on patient prognosis is a widespread and longstanding problem that needs to be corrected. Government regulations should be made for the welfare of dialysis patients, and more research with a robust study design is needed to investigate the problem more thoroughly.

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