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Original Article

Economic evaluation of centre haemodialysis and continuous ambulatory peritoneal dialysis in Ministry of Health hospitals, Malaysia

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SUMMARY:

Background: This is a multi-centre study to determine cost efficiency and cost effectiveness of the Ministry of Health centre haemodialysis and continuous ambulatory peritoneal dialysis (CAPD) programme.

Methods: Forty-four haemodialysis and 11 CAPD centres were enrolled in this study in 2001. Sixty patients, 30 from each modality, were evaluated. Micro-costing was used to determine costs.

Results: The number of haemodialyses conducted ranged from 402 to 23 000 procedures per year, while for CAPD, output ranged from 70 to 2300 patient months/year. Cost ranged from RM79.61 to RM475.79 per haemodialysis treatment, with a mean cost of RM169 per HD (USD 1 = RM 3.80). The cost of CAPD treatment ranged from RM1400 to RM3200 per patient month, with a mean of RM2186. Both modalities incurred similar outpatient costs. The cost of erythropoeitin per year is RM4500 and RM2500 for haemodialysis and CAPD, respectively. The number of life years saved is 10.96 years for haemodialysis and 5.21 years for CAPD. Cost per life year saved is RM33 642 for haemodialysis and RM31 635 for CAPD. The cost for land, building, equipment, overheads, and staff were higher for haemodialysis, while consumables and hospitalization cost more for CAPD. Sensitivity analysis was performed for two discount rates (3 and 5%), varying erythropoietin doses and maximum and minimum overheads. Relative cost effectiveness of haemodialysis and CAPD was unchanged in all sensitivity scenarios, except for overhead costs, which influenced the cost effectiveness of HD.

Conclusion: It is economically viable to promote the use of both CAPD and haemodialysis because the cost effectiveness of both are nearly equal.

KEY WORDS: **continuous ambulatory peritoneal dialysis, cost effectiveness, cost efficiency, economic evaluation, end-stage renal failure, haemodialysis.**

INTRODUCTION

Economic evaluation is a useful tool in the planning and operation of a health-care programme. Malaysia is a middle income country with a population of 23.7 million and a gross domestic product per capita of RM14 000 in year 2001.[1] Of 7539 patients on renal replacement therapy in 2000, 76% were on haemodialysis (HD), 8.5% were on continuous peritoneal dialysis (CAPD) and 15.5% had had a renal transplant (RT).[2] The number of patients benefiting from the dialysis programme is small and expenditure has to be justified. This study is an economic evaluation of the Ministry of Health (MOH) dialysis programme. The aim was to conduct a comprehensive and broadly applicable study in hospitals of various types and which are located in different areas.

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METHOD

This is a multicentre study to determine the cost efficiency and cost effectiveness of centre HD and CAPD provided by the MOH programme. Cost efficiency was measured by cost per unit output while

Table 1 Characteristics of participating hospitals

Characteristics	Haemodialysis (HD)	Continuous ambulatory peritoneal dialysis (CAPD)
No. units, *n* (%)		
Total no. units	44	11
Unit in state hospital	14 (31.8)	10 (90.9)
Unit in district hospitals	30 (68.2)	1 (9.1)
Hospitals with resident nephrologist, *n* (%)		
Yes	13 (30)	11 (100)
Duration of operation, *n* (%)		
≥10 years	19 (43.2)	4 (36.3)
5–9 years	7 (15.9)	2 (18.2)
3–4 years	15 (34.1)	3 (27.3)
≤ 2 years	3 (6.8)	2 (18.2)
Unit built-up area, square feet		
Mean (standard deviation SD)	3428 (2746)	790 (750)
HD machines in unit, *n* (%)		
≤5	19 (43.2)	–
6–9	13 (29.5)	–
≥10	12 (27.3)	–
No. staff in unit		
Mean (SD)	10 (6)	6 (5)
Service provision		
Mean chronic HD (SD)	6124 (4543)	–
Mean acute (temporary) HD (SD)	591 (1005)	–
Mean CAPD output, patient-month (SD)	–	645 (674)

cost effectiveness was measured by cost per life year saved on HD or CAPD. The viewpoint was that of the MOH. All costs borne by patients were excluded.

The output of a HD unit was the total number of HD procedures performed. The output of a CAPD unit was the number of patient months of treatment recorded in the National Renal Registry (NRR) database. Fifty-five sites were enrolled (44 HD and 11 CAPD centres), comprising all centres that commenced operations before 2001 (Table 1). Each site collected data on their inputs in 2001 and their outputs between 1997 and 2001. Costs were recorded from 2001 in RM (USD 1 = RM 3.80).

Cost categories measured were capital costs consisting of land, building and equipment, human resource costs including full and part-time staff, overhead costs such as administration, maintenance, pharmacy, security, waste and utilities, and dialysis consumable costs, which include medical and office supplies. Urban hospital land was priced at RM50 per square foot and rural land at RM10 per square foot. Land was not depreciated. Building costs were assumed to be RM200 per square foot, amortised over 30 years at a 3% discount rate. Equipment costs were annualized to the year of evaluation[3,4] and amortised over its estimated useful life at a 3% discount rate.[5] Staff costs were allocated to the dialysis service in proportion to the amount of time they spent on HD or CAPD related work. Part of the cost of consultant visits to satellite units was allocated from the providing to the receiving centre based on the total number of visit days. Overheads were allocated in proportion to the centre's relative floor area and staff numbers.

The quantity of resource used in each category was measured. Item cost was based on market price or published fee schedules. For the cost effectiveness component of the study, the unit of analysis was individual patients on dialysis. The target population were patients with ESRF who were on dialysis between 1980 and 2001, who had been on either HD or CAPD for at least 5 years and had not changed modality for the duration they were on dialysis. The NRR database, which included patients from all units, was used as the sampling frame. Subjects were randomly sampled with probability proportional to the number of patients in the dialysis unit. Thirty patients from each modality were enrolled. The sample size of 30 patients per modality was arrived at as follows: the parameter of interest is the cost effectiveness ratio (R). Based on previous studies, we assumed R to be approximately RM25 000 per life year saved,[6] and the standard error of R was 7–9%. We assumed a standard deviation (SD) of RM2000. To estimate R to within 3% of its anticipated value, the required sample size is 30.

Each subject's utilization of resources during clinic visits and hospitalization in the course of his/her life-long care was abstracted from medical records. Resources include laboratory tests during clinic visits, imaging investigations, pharmaceuticals consumed excluding erythropoeitin (EPO), vascular access surgeries and referrals to non-nephrology specialist services. Cost of EPO was based on the average EPO dose per patient.

The average number of clinic visits per patient per year and the costs of resource utilization per visit was calculated by dividing the total amount of outpatient resources by the duration the patient was in the programme for. Hospitalization costs were estimated from the costs of resource utilization per admission and the average admission rate per patient per month. Hospitalization cost per patient month was modelled over the lifetime of HD and CAPD patients separately, as an assumption of constant inpatient resource utilization was untenable. Outcome was survival on dialysis. The NRR database was used to estimate life expectancy or life year saved for each age group. All subjects who had been on dialysis between 1980 and 2001 were included. Life expectancy was estimated by using the method described by Hakama and Hakulinen[7] which is more accurate than other approximate methods.[8,9] Observed survival rates for centre HD and CAPD were related to expected survival rates in the general population of similar age and sex.[10] The relative survival ratio was used to estimate the excess risk caused by ESRF when patients were on dialysis. Relative survival

Table 2 Characteristics of haemodialysis (HD) and continuous ambulatory peritoneal dialysis (CAPD) subjects

Characteristics	HD patients ($n = 30$)	CAPD patients ($n = 30$)	P
Age profile at starting dialysis			
Mean age years (SD)	45.8 (10.2)	43.5 (16.2)	0.513
Sex, *n* (%)			
Female	20 (66.7)	10 (33.3)	0.0098
Duration on modality			
Mean duration years (SD)	9.5 (3.6)	7.2 (1.6)	0.002
Co-morbidities, *n* (%)			
Cardiovascular disease	1 (3.3)	5 (16.7)	0.0879
Diabetes mellitus	8 (26.7)	3 (10)	0.0984
Hypertension	22 (73.3)	22 (73.3)	1.000
Deaths, *n* (%)			
No. deaths	6 (20)	6 (20)	1.000
Cause of death (%)			
Cardiovascular disease	1 (3.3)	1 (3.3)	1.000
Sepsis	4 (13.3)	1 (3.3)	0.1611
Peritonitis	0	2 (6.7)	0.1503
Others	1 (3.3)	2 (6.6)	0.5536
Baseline lab tests, mean (SD)			
Serum calcium (mmol/L)	2.42 (0.22)	2.42 (0.28)	0.9417
Haemoglobin (g/dL)	10.1 (1.7)	10.4 (1.2)	0.6515
Serum albumin (g/L)	40.3 (3.9)	33.8 (5.2)	0.0003

and life expectancy were computed by using the programme from the Finnish Cancer Registry.[11] Sensitivity analyses were conducted by using a 5% discount rate, maximum and minimum overheads, and various doses and rates of EPO use. In all figures, we overlaid the scatter plots with a locally weighted linear regression (Lowess) line to better visualize the relationship between the variables plotted. As this was an observational study and no human subjects were involved, the protocol was not submitted to the Independent Ethics Committee for review and approval. Informed consent of study subjects was deemed unnecessary.

RESULTS

Of the 44 HD units 14 were in State hospitals and the rest in district hospitals. All State hospitals have nephrologists except for two. Haemodialysis is the more established dialysis modality in Malaysia compared to CAPD. Table 2 shows the characteristics of the 60 patients sampled for the study (30 on HD and 30 on CAPD). There was no statistically significant difference between the two groups, although serum albumin was lower in the CAPD group.

Cost per HD ranged from RM79.61 to RM475.79 per HD, with mean cost of RM169. Cost efficiency improved with increasing volume, demonstrating economy of scale (Fig. 1). The optimal point appears to be a volume of approximately 15 000 HD procedures per year at a cost of RM103 per procedure. Other factors that are related to cost efficiency include the duration the HD units have been in operation (>5 years = RM142, <5 years = RM199) and presence of resident nephrologists (present = RM125, absent = RM188). The units with

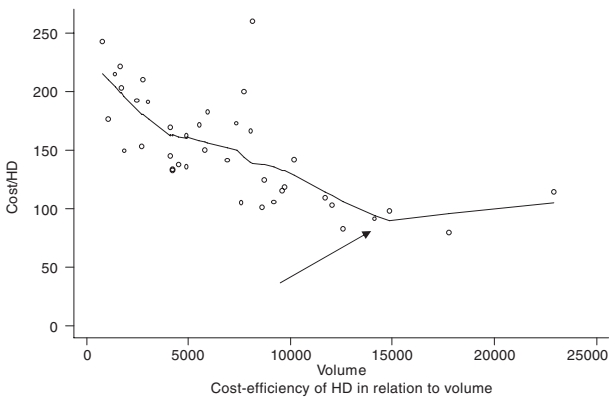

Fig. 1 Haemodialysis (HD) cost efficiency (RM) and output, 2001. (arrow) Optimal volume ~15 000 HD/year, cost RM103. Lowess smoother, bandwidth = 0.7.

nephrologists were mostly attached to State hospitals with very large outputs which have been functioning for a long time. Cost per patient month of CAPD for the 11 units was calculated. The range of costs is RM1400 to RM3200 per patient month, mean RM2084. Cost efficiency tends to improve with increasing output. It stabilized at a cost of RM1764 per patient month when the service volume reached 1245 patient months (Fig. 2).

Although both modalities incurred similar outpatient care costs, the cost profile differed. Haemodialysis patients utilized more radiology services while those on CAPD had more laboratory tests (Table 3). For the 60 patients analysed (30 on HD and 30 on CAPD), it was

Table 3 Costs of outpatient care, haemodialysis (HD) and continuous ambulatory peritoneal dialysis (CAPD)

No	Item	Mean cost per patient on HD (RM)		Mean cost per patient on CAPD (RM)	
		Per year	Per visit	Per year	Per visit
1	Drugs	808.95	180.17	827.61	125.21
2	Lab tests	892.15	198.70	981.33	148.46
3	Radiology	188.55	41.99	98.40	14.89
4	Procedures	177.26	39.48	164.34	24.86
5	Referrals	58.34	12.99	49.66	7.51
	TOTAL	2125.26	473.33	2121.33	320.93

Table 4 Costs of hospitalization and average length of hospitalization stay per month for patients on dialysis

No	Time on dialysis	Mean cost per patient-month on haemodialysis (RM)	Mean length of stay (LOS) per month on haemodialysis (days)	Mean cost per patient-month on continuous ambulatory peritoneal dialysis (RM)	Mean LOS per month on continuous ambulatory peritoneal dialysis (days)
A	Initial phase after starting dialysis	36.51	0.2147	135.21	0.897
B	Mid phase	23.31	0.1498	49.51	0.3705
C	End phase before death	208.74	1.059	243.42	0.979

LOS, length of stay.

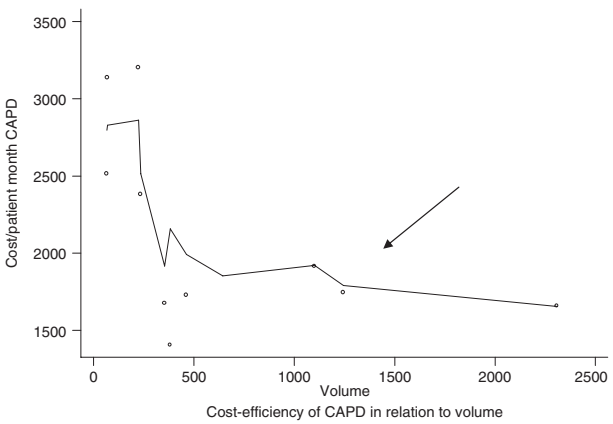

Fig. 2 Continurous ambulatory peritoneal dialysis (CAPD) cost efficiency (RM) and output, 2001. (arrow) Optimal volume ~1245 patient months per year, cost RM1764. Lowess smoother, bandwidth = 0.7.

found that they had a triphasic phase for hospitalization – a higher costing initial and end phase with a steady and low costing mid-phase. Hospitalization costs were higher for CAPD patients at every phase (Table 4). The highest cost per month was incurred by CAPD patients at the end-phase of which over 40% were attributable to drugs. At the initial phase, both modalities incurred high costs for procedures, for example, fashioning of arteriovenous fistulae for HD and insertion of Tenchkoff catheters for CAPD. The hospitalization rate of approximately 1.8 days/year for HD and 4.4 days/year for CAPD patients during the mid-phase was extremely low.

The rate of utilization for EPO is 63% for HD patients and 38% for CAPD patients, with average doses of 3361 U/week and 3374 U/week, respectively. The mean cost of EPO per patient per year is RM4500 for HD and RM2500 for CAPD. The five scenarios for EPO dosage and per cent utilization (Table 5) assumed that the optimal dose is 6000 U/week for both modalities and that 100% of patients require EPO. The scenario where no EPO was used applies to the small proportion of patients with normal haemoglobin, in spite of not being on EPO. These scenarios were used for sensitivity testing of the cost effectiveness analysis. The cost of EPO per year ranged from 0 to RM11 700 for the various scenarios presented.

The number of life years saved (life expectancy; LYS) is much lower for CAPD (5.21 years) than centre HD (10.96 years), although the difference in LYS between the two modalities narrowed in patients aged 55 years and above. Patients with diabetes had a markedly worse life expectancy for both HD and CAPD (Table 6). Continuous ambulatory peritoneal dialysis was marginally more cost effective than HD with a cost per life year saved of RM31 634.93 for CAPD and RM33 642 for HD. Cost for land, building, equipment, overheads and labour were higher for HD while dialysis consumable costs dominate in CAPD. Continuous ambulatory peritoneal dialysis patients incurred higher hospitalization costs,

Table 5 Costs of erythropoietin (EPO) utilization per patient-year

		Haemodialysis			Continuous ambulatory peritoneal dialysis		
		Mean EPO dose (Units per week)	% Utilization	Cost (RM)/ patient-year	Mean EPO dose (Units per week)	% Utilization	Cost (RM)/ patient-year
1	Actual dose and utilization	3661	62.9	4510.67	3374	38.4	2542.61
2	Actual dose and 100% utilization	3661	100	7171.18	3374	100	6621.39
3	Optimal dose and actual utilization	6000	62.9	7385.03	6000	38.4	4508.51
4	Optimal dose and 100% utilization	6000	100	11740.90	6000	100	11740.90
5	No utilization	0	0	0	0	0	0

Table 6 Life expectancies on haemodialysis (HD) and continuous ambulatory peritoneal dialysis (CAPD) by age and diabetic status

	HD			CAPD		
	No.	Life expectancy, years (SE)	% of Expected life lost	No.	Life expectancy, years (SE)	% of Expected life lost
Age group:						
All ages	4920	10.96 (0.4)	67	2067	5.21 (0.2)	84
<40 years	1899	17.34 (0.8)	62	671	9.04 (0.5)	82
40–54 years	1770	8.52 (0.3)	71	672	4.85 (0.3)	83
≥55 years	1251	5.05 (0.2)	72	724	3.30 (0.1)	81
Diabetes:						
Absent	3751	12.15 (0.4)	66	1340	6.46 (0.3)	83
Present	1169	5.23 (0.2)	78	727	2.97 (0.1)	87

Table 7 Cost per life-year saved on haemodialysis (HD) and continuous ambulatory peritoneal dialysis (CAPD) (at 3% discount on cost and life year saved)

		HD		CAPD	
		Cost per life year saved (RM)	%	Cost per life year saved (RM)	%
1	Land	490.91	1.5	312.20	1.0
2	Building	1056.58	3.1	285.81	0.9
3	Equipment	3109.52	9.2	681.32	2.2
4	Staff	6362.71	18.9	2095.84	6.6
5	Overheads	6390.28	19.0	2729.54	8.6
6	Dialysis unit consumables	8886.18	26.4	18906.20	59.8
7	EPO treatment (actual utilization)	4510.67	13.4	2542.61	8.0
8	Outpatient clinic care	2125.26	6.3	2121.33	6.7
9	Hospitalization	709.85	2.1	1960.08	6.2
	TOTAL	33641.96	100	31634.93	100

EPO, erythropoietin.

while HD patients consumed more EPO (Table 7). As age increases, cost effectiveness decreases for both modalities. Sensitivity analysis shows that the relative cost effectiveness of HD and CAPD does not change except in the scenario of minimum overheads when HD became more cost effective. Centre HD is dependant on the general overheads of the hospital and is sensitive to fluctuations in overhead costs. The conclusion that CAPD is slightly more cost effective than HD holds up in all the other scenarios (Table 8).

DISCUSSION

The cost analysis was conducted by microcosting, which is the major strength of the present study. It relied on

Table 8 Sensitivity analysis

Variable	Cost per life year saved (RM)	
	Haemodialysis	Continuous ambulatory peritoneal dialysis
Discount rate		
3%	33 641.96	31 634.93
5%	34 538.83	31 991.32
Overheads		
Maximum cost in sample	79 712.99	39 989.45
Minimum cost in sample	28 427.26	29 155.46
Erythropoeitin (EPO)		
Actual dose, 100% utilization rate	36 302.46	35 713.71
Optimal dose, actual utilization rate	36 516.32	33 600.82
Optimal dose, 100% utilization	40 872.19	40 833.21
No EPO	29 131.29	29 092.32

Table 9 Inter study comparisons of cost effectiveness

Study	Haemodialysis	Continuous ambulatory peritoneal dialysis
Ministry of Health (2001) no EPO (present study)	RM 29 131	RM 29 092
MOH (2001) with actual EPO usage	RM 33 642	RM 31 635
MOH (1996)[6]	RM 21 620	RM 30 469
Auckland, New Zealand (1988)[16]	$NZ 35 270	$NZ 25 395
Canada (1980)[6]	$CA 48 700	$CA 33 400
Japan (1986)[17]	USD 30 600	–

EPO, erythropoietin; MOH, Ministry of Health.

primary sources for resource utilization, and the valuation of resource use was based on market price with adjustments for inflation and time preference. Life year saved was the outcome. The NRR database was the primary source for outcome, not requiring modelling assumptions. Patient movement from HD to PD was negligible, from CAPD to HD it was 10% in 2000.[2] In the present study, change of modality was not taken into account because of the complexity of the calculations.

The mean cost per HD of RM169 compares favourably with the current average price of RM250 per HD at private hospitals operating in large cities in Malaysia (Lim TO, personal communication, 2001). The cost per HD was lower for large and older units with nephrologists, which suggests economy of scale. The relationship of cost per HD to output approximates a 'U' pattern cost curve with declining average costs as output increases and diseconomy of scale beyond the cost efficient level of service provision. A CAPD unit seems to be cost efficient when delivering an output of 1200 patient months a year. Centres with a volume smaller than this are less cost efficient. The cost per CAPD patient month to output relationship approximates the 'L' pattern cost curve. Cost data from larger CAPD centres compared to those presently in operation are required to confirm the absence of diseconomy of scale.

The sampling of patients who had had been on the modality for more than 5 years may have skewed the sample when it was compared with those patients in older centres with less comorbidities who lived longer. The cohort chosen is probably representative of HD patients starting treatment 5 years ago, but not presently as the number of patients with diabetes and old age have increased. The incidence for dialysis has risen from 28 per million population per year in 1996 to 71 per million in 2001.[2] In 1996, 27% of patients were older than 55 years of age and 27% of new dialysis patients were diabetic. By 2001, 35% were older than 55 years of age and 45% of new dialysis patients were diabetic. It was necessary to find patients with enough data to extract for resource use and the study was conducted on subjects who had been on the modality for some time.

There were fewer hospitalization days and lower hospitalization costs for the sampled patients compared with other studies. de Wit *et al.* reported initial average hospitalization of 10 days per year for CAPD patients and 7.8 days per year for centre HD patients in the Netherlands, with 10 days of hospitalization per year for all dialysis modalities in patients aged below 45 years.[12] As in the present study, patients on CAPD needed more days in hospital per year than those on centre HD.

The use of EPO is limited by funding and there is limited ability to raise the EPO dose to achieve the target haemoglobin level of 10–12 mg/dL. The proportion of patients on EPO is low compared to 83% of HD patients and 68% of PD patients who received EPO in the UK in 2002.[13] Patients on CAPD generally need less EPO than those on HD.[14,15] Erythropoeitin raises the quality of life,[14] reduces hospitalization and probably increases life expectancy.[15] The drug impacts on the total cost of patient care (approximately 10%), and is more than the cost of hospitalization and cost of outpatient follow up and medication.

Life years saved is less for CAPD compared to HD. Continuous ambulatory peritoneal dialysis patients in the programme are not comparable to HD patients, as CAPD was a scarce resource that was used in large units for patients who were older, lived far from a HD centre, and had vascular access problems or cardiovascular instability. It has become popular for ESRF patients in general in the last 5 years as results improved with disconnect and twin bag systems. Life years saved for HD and CAPD has dropped from 15.5 and 6.4 years to 10.96 and 5.2 years, respectively, in the last 5 years. The gap between HD and CAPD has closed for both cost and LYS. Compared to the last cost effectiveness study in the Ministry of Health in 1996,[6] the cost per life year saved now favours CAPD (Table 9). If the demographic shift towards older and more infirm patients persists, the cost of treatment will rise with a lesser return from LYS and a worsening of cost effectiveness for both modalities.

In a review of thousands of Medicare patients in the USA, Collins *et al*. noted that some countries had shown a higher risk for mortality for CAPD compared to HD; some had the opposite findings.[18] For the first 2 years, CAPD was associated with a superior outcome. Patients on the two modalities had different mortality patterns over time; this non-proportionality makes survival analysis vulnerable to the length of follow up. Continuous ambulatory peritoneal dialysis is probably effective initially when the patient has some residual renal function, but over time, the modality may be changed to haemodialysis. Most CAPD units in Malaysia are in hospitals with large haemodialysis units, and there is no difficulty in patients transferring modality when required. Most units keep one HD machine free for every 40 CAPD patients on treatment.

The value of RM decreased from USD 0.4 per RM to USD 0.26 per RM in 1997 and has been pegged at the latter value since. The drop in the value of RM may have had some impact on the total cost. Other studies have shown CAPD to be more cost effective than centre HD. de Wit *et al*. showed that the cost per life year gained from dialysis in the Netherlands in 2001 was DFL133 100, with the lowest cost being for CAPD and the highest being for centre HD;[12] the costs increased with patient age. In New Zealand in 1990[16] and in Sweden in 1992,[19] RT was the most cost effective, and this was followed by CAPD and centre HD. In Japan, RT costs one-third of haemodialysis, but there are few renal transplants and this is because of social factors.[17] In Hong Kong, the use of low volume CAPD was more cost-effective compared to HD.[20] In 1995 in the Philippines, RT was cheaper than HD or CAPD while HD was marginally more expensive than CAPD.[21] Gokal[22] and De Vecchi *et al*.[23] noted in 1999 that in the Western world, PD is more economical than centre HD.

Results from economic evaluation have little generalizability across borders of different countries. Professional staff costs predominates in studies from developed countries, however, this is low in Malaysia. Imported consumables and drugs are the most expensive component. These factors favour centre HD in Malaysia because it requires a large number of trained paramedics whereas CAPD involves the use of expensive consumables. Reuse of low flux synthetic dialysers (six to 12 times) using peracetic acid and automatic reuse machines decreased the disposables cost by up to 30%, which may explain the low cost of HD compared to other studies. Centre HD is well established and there are many large units running at maximal efficiency (Fig. 1), which brings down the average cost of the programme. Establishing new centres in deprived areas with a low population on the grounds of equity and universal access will increase the cost of HD in future. Continuous ambulatory peritoneal dialysis is just starting in some centres, with under-utilization of trained staff and space making the average cost high for the time being (Fig. 2). This will decrease as the existing units grow in size. Only two centres had more than 100 patients and the smallest had six. There is a need for more HD and CAPD centres and the use of both modalities is rising. The incidence of ESRF in Malaysia is in excess of 100 per million population per year, but the incidence of new dialysis patients per year was 71 per million[2] in 2000.

In conclusion, the results of the present study suggest that it is viable to promote the use of both CAPD and centre HD in Malaysia. Economic considerations may be removed, as this does not seem to have an impact if both are done in an efficient manner. For CAPD, the advantage is low fixed costs but high variable costs (dialysis consumables) and a low need for capital investment. The centre needs to serve approximately 100 patients/year to be cost efficient. For HD, a centre treating approximately 15 000 HD cases a year is cost efficient. Centre HD costs are relatively high for staff, building, and overheads. It may be more cost effective in future to start satellite HD units away from hospitals to dialyse stable patients as the cost of overheads may then be contained. Most analyses have cited renal transplantation as the most cost-effective modality in treating end-stage renal failure,[17,18] and this is usually limited by lack of cadaveric donor organs rather than by economics; because of its multidisciplinary nature, it would be difficult to do an economic assessment on this modality. The use of EPO would

increase the quality of life, but its use imposes a 10% rise in the cost per life year saved. Research is ongoing in terms of the cost utility of EPO in dialysis patients.

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