

CHAPTER 5: COST-EFFECTIVENESS OF DIALYSIS AND RESOURCE UTILISATION

Summary

- 44 Ministry of Health (MOH) haemodialysis (HD) and 11 MOH continuous ambulatory peritoneal dialysis (CAPD) centres were enrolled in 2001. 30 patients from each modality were evaluated.
- Mean cost of centre haemodialysis is RM169 per HD. Optimal cost efficiency is achieved at 15,000 haemodialysis per year.
- Mean cost of CAPD is RM2,186 per patient month. Optimal cost efficiency is achieved at a service level of 1,200 patient months
- Mean out-patient care costs were RM2,125 for HD and RM2,121 for CAPD per patient year.
- Mean in-patient care costs were RM710 for HD and 1,960 for CAPD per patient year.
- The average cost of erythropoietin is RM4,500 for HD and RM2,500 for CAPD per patient year.
- The number of life years saved is 10.96 years for HD and 5.21 for CAPD
- Cost per life year saved is RM33,642 for HD and RM31,635 for CAPD
- Sensitivity analysis was performed on the discount rate on costs, erythropoietin doses, overhead costs and cost of estimated hospitalisation investigations. Relative cost effectiveness of haemodialysis and continuous ambulatory peritoneal dialysis was unchanged in all the sensitivity scenarios except for overhead costs.

Introduction

In this chapter, we present the results of a multi-centre study by Hooi, Lim, Sharmini & Goh[1] on the cost efficiency and cost effectiveness of the Ministry of Health (MOH) centre haemodialysis (HD) and continuous ambulatory peritoneal dialysis (CAPD) programme in 2001.

Methodology

This is a multi-centre study to determine the cost efficiency and cost-effectiveness of the centre HD and CAPD services provided under the MOH dialysis programme. Cost-efficiency was measured by cost per unit of output while cost-effectiveness was measured by the cost per life-year saved on HD or CAPD. The viewpoint taken was that of the MOH. Only costs borne by the MOH in providing dialysis care was included. All costs borne by patients were excluded be they direct non-treatment costs (e.g. transport to hospital), indirect costs (e.g. lost work time) or intangible costs (e.g. pain and anxiety).

The output of a HD unit was measured by the total number of HD procedures (chronic and acute), which were performed by the unit for the year. Other procedures performed by HD units such as continuous renal replacement therapy (CRRT) and plasmapheresis were excluded from the study. The output of a CAPD unit was measured by the total number of patient-months of treatment as recorded in the National Renal Registry (NRR) database.

For the cost efficiency part of the study, the unit of analysis was the dialysis centre (both HD and CAPD). A total of 55 such MOH sites were enrolled (44 HD and 11 CAPD centres)^{*}, comprising all HD

and CAPD dialysis centres that were attached to a MOH hospital, and had commenced operations before 2001 (Table 5.1 and Appendix). Each site collected data on their inputs in year 2001 as well as their outputs from 1997 and 2001. Costs in the study are in year 2001 ringgit Malaysia (RM).

The cost categories identified and measured for cost efficiency were:

1. Capital costs, consisting of land, building and equipment
2. Human resource costs including full-time and part time staff.
3. Overhead costs (indirect cost centres) such as administration, maintenance, pharmacy security, and utilities.
4. Dialysis consumable costs, which include medical supplies and office consumables

For the cost-effectiveness component of the study, the unit of analysis was individual patients on dialysis in the MOH programme while the treatment alternatives compared were centre HD and CAPD.

In addition to the cost categories from cost efficiency, the cost components in cost effectiveness analysis included patient care cost components, namely:

1. Out-patient care, consisting of drugs, investigations, procedures and referrals to non-nephrology services
2. In-patient care, consisting of drugs, hospital stays, procedures & investigations
3. Erythropoietin (EPO) cost

Patient costs were modelled from data obtained from a sample of 30 patients from each treatment modality, subject to inclusion and exclusion criteria

^{*} One HD centre had incomplete hospital level data

(Table 5.2). The NRR database was used as the sampling frame. Data on each sampled subject's utilisation of resources in the course of his/her life long care was abstracted from medical records.

The outcome of interest was survival on dialysis. The time horizon for this study was the lifetime of dialysis patients in the MOH programme. The event pathway encompassed all significant medical events for a typical cohort of dialysis patients in the MOH programme from inception of dialysis to termination of dialysis for whatever reasons (death, transplantation etc). For quantifying life expectancy on HD and CAPD, all subjects must have been on HD or CAPD treatment in the MOH programme between 1980 and 2001. The NRR database was used to estimate the life expectancy for each age group. All patients on dialysis were included in the calculation. The life expectancy without RRT for ESRF is assumed to be zero. Therefore, life expectancy on treatment is the same as the number of life years saved (LYS).

Life expectancy or life years saved on dialysis was estimated from NRR data. Data of MOH patients commencing dialysis between 1980 and 2001 was used to compute survival rates. Observed survival rates in the patient groups (centre HD and

CAPD) is related to the expected survival rates in a group of the general population similar with respect to age, sex and calendar time in order to obtain the relative survival ratio. Expected survival rates are obtained from official data. [2] The relative survival ratio was used to estimate the constant persistent excess risk due to ESRD on dialysis. This constant was then used to estimate life expectancy, using the method described by Hakama and Hakulinen[3].

The average cost effectiveness ratio for a treatment (CERT) is estimated by:

$$\text{CERT} = \frac{C_T}{E_T} \quad \text{Where } C_T \text{ and } E_T \text{ are the sample estimates of the cost and treatment effect respectively}$$

To ensure that the results are robust, sensitivity analyses were carried out using 5% discount rate, maximum and minimum overheads, various doses and rates of EPO use and estimated cost of laboratory investigations conducted during hospitalisation of patients (41.98% and 46.26% of annual out-patient costs for HD and CAPD respectively).

Table 5.1 Characteristics of participating centres

Characteristics	HD	CAPD
Number of units, n (%)		
• Total HD units	44	11
• Unit in State Hospital	14 (31.82)	10 (90.9)
• Unit in District Hospitals	30 (68.18)	1 (9.1)
Hospitals with Resident Nephrologist, n (%)		
• Yes	13 (29.5)	11 (100)
• No	31 (70.5)	-
Duration of operation of Unit up to end-2001, n (%)		
• ≥ 10 years	19 (43.2)	4 (36.3)
• 5-9 years	7 (15.9)	2 (1.82)
• 3-4 years	15 (34.1)	3 (2.73)
• ≤ 2 years	3 (6.8)	2 (1.82)
Unit build-up area, square feet		
• Mean (SD)	3,427.67 (2,745.60)	790.11 (750.24)
• Median (IQR)	2,858 (1991)	444 (752.25)
HD machines in Unit, n(%)		
• ≤ 5	19 (43.18)	-
• 6-9	13 (29.55)	-
• ≥ 10	12 (27.27)	-
Number of staff in unit		
• Mean (SD)	10 (6)	6 (5)
• Median (IQR)	10 (7)	4 (3)
Service provision		
• Mean Chronic Haemodialysis (SD)	6,124.11 (4,542.92)	-
• Mean Acute (temporary) Haemodialysis (SD)	590.93 (1,005.18)	-
• Mean Continuous renal replacement therapy (SD)	21.77 (29.90)	-
• Mean Haemoperfusion (SD)	-	-
• Mean Others (SD)	13.67 (16.95)	-
• Mean CAPD output, pt-month (SD)		645.18 (673.53)

Table 5.2 Characteristics of sample HD and CAPD subjects

Characteristics	HD Patients, n=30	CAPD Patients, n=30
Age profile at starting dialysis		
• Mean Age (SD)	45.8 (10.24)	43.5 (16.16)
Age Group, n (%)		
• <40	7 (23.33)	10 (33.33)
• 40-54	18 (60.0)	11 (36.67)
• ≥55	5 (16.67)	9 (30.00)
Sex, n (%)		
• Female	20 (66.67)	10 (33.33)
• Male	10 (33.33)	20 (66.67)
Duration on Modality		
• Mean Duration (SD)	9.51 (3.57)	7.20 (1.62)
Duration, Grouped, n (%)		
• <7 years	6 (20)	16 (53.33)
• 7-10 years	16 (53.33)	11 (36.67)
• >10 years	8 (26.67)	3 (10)
Co-morbidities, n (%)		
• Cardiovascular disease	1 (3.33)	5 (16.67)
• Diabetes Mellitus	8 (26.67)	3 (10)
• Hypertension	22 (73.33)	22 (73.33)
• HbsAg+	3 (10.0)	1 (3.33)
• Anti-HCV+	3 (10.0)	1 (3.33)
Deaths, n (%)		
• Number of Deaths	6 (20%)	6 (20%)
Cause of death		
• Cardiovascular disease	1 (3.3%)	1 (3.3%)
• Sepsis	4 (13.3%)	1 (3.3%)
• Peritonitis		2 (6.7%)
• Dialysis dementia	1 (3.3%)	1 (3.3%)
• Death at home		1 (3.3%)
Baseline Lab, mean (SD)		
• Sr. Calcium (mmol/l)	2.42 (0.22)	2.42 (0.28)
• Haemoglobin (g/dL)	10.12 (1.73)	10.38 (1.21)
• Sr. Albumin (g/L)	40.34 (3.86)	33.78 (5.19)

Results

The mean cost per haemodialysis (HD) in 2001 at the 41 non-IT hospital-based centres studied was RM167.99 (Table 5.3). However there are significant variations in cost. State hospital-based HD centres tend to be more cost efficient than centres at district hospitals (mean cost of RM121.18/HD to RM191.75/HD) and older centres were more cost efficient than newly established centres (RM142.47/HD to RM199.03/HD). Figure 5.1 plots the relationship between the number of HD procedures performed by a centre in a year and the cost per HD. The plot shows a negative relationship between average cost and output with minimum cost achieved of about RM100 per HD procedure when a centre performs about 15,000 HD per year.

The major cost components for HD were consumables (40%), staff (25%), overheads (20%) and equipment (13%), consistent with the HD being a hospital-based, equipment and staff intensive treatment.

For CAPD, the mean cost per patient month in 2001 at the 10 non-IT Hospital based centres studied was RM2,084.24 (Table 5.4). Figure 5.2

plots the relationship between the number of CAPD patient months provided and the cost per patient month. The plot suggests a negative relationship between average cost and output with minimum cost achieved of about RM1,764 per patient month when a centre provides about 1,245 patient months per year.

The main cost component in CAPD was consumables, making-up 78.5% of the cost of providing one patient month of CAPD service.

Both modalities incurred similar outpatient costs of over RM2,120 per year (Table 5.5). HD patients tended to have higher radiology costs while CAPD patient had higher drug and laboratory investigation costs. However, CAPD patients had longer lengths of stay in hospital (table 5.6) and incurred higher in-patient care costs (Table 5.7) than HD patients (RM1,960 to RM710 per year).

More HD patients were given EPO than CAPD patients (63% to 38%). HD patients also received marginally higher average doses of EPO than CAPD patients (3,660U to 3,380U per week). At current dosage and utilisation, the annual cost of

erythropoietin (EPO) in 2001 was RM4,500 and RM2,500 per HD and CAPD patient respectively. (Table 5.8).

The number of life years saved is 10.96 years for haemodialysis and 5.21 years for continuous ambulatory peritoneal dialysis. (Table 5.9)

Cost per life year saved is RM33,642 for haemodialysis and RM31,635 for continuous ambulatory peritoneal dialysis (Table 5.10), with

CAPD marginally more cost effective than centre HD across all age groups (Table 5.11). Sensitivity analysis did not alter the relative cost effectiveness of haemodialysis and continuous ambulatory peritoneal dialysis in all the sensitivity scenarios, except for overhead costs, which as expected influenced the cost effectiveness of HD given the centre based nature of this treatment modality (Table 5.12).

Table 5.3 Cost per HD procedure with cost component breakdown

	Land	%	Building	%	Equip	%	Staff	%	Overhead	%	C'mable	%	Total
All Hospitals (n=43)													
• Mean cost	3.08	1.4	6.99	4.1	20.99	13.1	40.79	25.0	40.68	20.0	56.25	36.4	168.78
• Median cost	1.24	0.9	4.96	3.5	17.72	13.2	34.01	23.4	23.11	17.3	50.13	37.5	149.75
State Hospitals (n=14)													
• Mean	2.84	2.0	4.44	3.6	15.73	13.7	27.02	23.1	23.99	17.7	47.16	39.9	121.18
• Median	1.48	1.4	3.80	3.5	15.17	13.6	27.77	21.8	17.16	14.8	46.61	41.3	115.08
District Hospitals (n=29)													
• Mean	3.20	1.1	8.22	4.3	23.53	12.9	47.43	25.9	48.73	21.1	60.64	34.6	191.75
• Median	1.13	0.8	6.89	4.2	19.94	13.1	42.46	25.4	26.19	17.3	53.39	34.8	169.67
IT Hospitals (n=2)													
• Mean	1.98	1.1	11.88	6.5	44.05	23.6	43.64	23.5	37.66	20.8	45.70	24.6	184.90
Non-IT hospitals (n=41)													
• Mean	3.14	1.4	6.75	4.0	19.86	12.6	40.65	25.1	40.82	20.0	56.77	36.9	167.99
• Median	1.24	0.9	4.86	3.5	17.48	13.1	33.57	23.4	23.11	17.3	50.13	37.6	145.09
Resident Nephrologist (13)													
• Mean	2.89	2.0	5.05	3.8	17.01	14.3	28.37	23.4	26.14	18.3	45.86	38.2	125.30
• Median	1.41	1.4	3.81	3.5	15.32	14.0	30.66	21.6	16.56	14.6	46.11	38.0	115.62
Without Resident (n=29)													
• Mean	3.16	1.2	7.83	4.2	22.72	12.6	46.17	25.7	46.98	20.8	60.76	35.6	187.61
• Median	1.18	0.8	6.27	3.9	19.55	13.0	42.44	25.2	25.38	17.7	55.78	35.8	164.77
Established centre# (n=23)													
• Mean	2.50	1.5	4.81	3.5	17.05	13.0	28.99	22.4	37.29	19.7	51.82	39.8	142.47
• Median	0.97	0.8	3.90	3.4	15.90	13.4	30.66	21.3	19.04	14.7	47.10	41.1	119.16
New centre# (n=20)													
• Mean	3.75	1.3	9.50	4.7	25.52	13.3	54.35	28.0	44.57	20.4	61.35	32.4	199.03
• Median	1.65	0.9	8.13	4.5	23.99	13.2	51.12	28.2	36.62	18.8	58.74	30.4	177.26
Large Centre* (n=15)													
• Mean	1.71	1.4	4.19	3.5	16.10	14.3	26.54	23.2	22.21	17.9	44.71	39.6	115.47
• Median	1.24	1.3	3.79	3.5	15.01	14.0	24.67	21.6	17.75	14.9	45.01	41.1	109.29
Medium Centre* (n=19)													
• Mean	2.43	1.2	6.33	3.9	19.38	11.5	39.60	24.7	46.83	21.3	59.40	37.3	173.97
• Median	0.97	0.7	5.95	3.5	17.72	11.5	39.10	26.7	24.57	17.3	58.17	36.6	153.32
Small Centre* (n=9)													
• Mean	6.76	1.9	13.04	5.4	32.52	14.6	67.04	28.5	58.47	20.8	68.84	28.8	246.67
• Median	2.15	1.0	12.06	4.7	26.65	13.5	64.46	25.4	43.50	17.3	65.94	26.8	215.30

Established centre: in operation before 1997, New centre: in operation after 1997

* Large centre: more than 8,000 HD procedures p.a.,

Medium centre: 2,500 to 8,000 HD procedures p.a.,

Small centre: less than 2,500 HD procedures p.a.

C'mable = consumables

Table 5.4 Cost per patient-month of CAPD treatment with cost component breakdown

	Land	%	Building	%	Equip	%	Staff	%	Overhead	%	C'mable	%	Total
IT Hospital (1)													
• Mean	1.50	0.0	49.99	1.6	344.85	10.8	263.47	8.2	426.51	13.3	2,117.44	66.1	3,203.76
Non-IT hospitals (10)													
• Mean	26.02	1.0	23.82	1.1	56.78	2.6	174.65	7.6	227.46	9.2	1,575.52	78.5	2,084.24
• Median	5.24	0.3	16.44	0.8	45.76	2.3	97.87	6.2	99.97	5.1	1,575.81	82.0	1,828.85

Table 5.5 Costs of Outpatient care

No	Item	Mean cost per patient on HD		Mean cost per patient on CAPD	
		per year	per visit	per year	per visit
1	Drugs	808.95	180.17	827.61	125.21
2	Labs	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	2,125.26	473.33	2,121.33	320.93

Table 5.6 Average length of Hospitalisation (LOS) per month on Dialysis

Chronological time on Dialysis		Mean LOS per month on HD	Mean LOS per month on CAPD
A	Initial phase after starting dialysis	0.2147	0.897
B	Mid phase	0.1498	0.3705
C	End phase before death	1.059	0.979

Table 5.7 Costs of Hospitalisation care

No	Item	Mean cost per patient-month on HD	Mean cost per patient-month on CAPD
A Initial phase after starting dialysis			
1.	Drugs	0.99	9.29
2.	Procedures & Investigations	24.59	65.76
3.	Per diem	10.94	60.16
	TOTAL	36.51	135.21
B Mid phase			
1.	Drugs	0.63	3.40
2.	Procedures & Investigations	15.70	24.08
3.	Per diem	6.98	22.03
	TOTAL	23.31	49.51
C End phase before death			
1.	Drugs	47.17	103.64
2.	Procedures & Investigations	71.57	80.18
3.	Per diem	90.01	59.60
	TOTAL	208.74	243.42

Table 5.8 Costs of EPO utilisation per patient-year

		HD			CAPD		
		Mean EPO Dose	% Utilisation	Cost / patient -year	Mean EPO Dose	% Utilisation	Cost / patient -year
1	Actual dose and utilisation	3,661	62.9%	4,510.67	3374	38.4%	2,542.61
2	Actual dose and 100% utilisation	3,661	100%	7,171.18	3374	100%	6,621.39
3	Optimal dose and Actual utilisation	6,000	62.9%	7,385.03	6000	38.4%	4,508.51
4	Optimal dose and 100% utilisation	6,000	100%	11,740.90	6000	100%	11,740.90
5	No utilisation	0	0%	0	0	0%	0

Table 5.9 Life expectancies on HD and CAPD by Age

	Haemodialysis			CAPD		
	N	Life Expectancy, Years (SE)	% of Expected Life Lost	N	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	1899	17.34 (0.8)	62%	671	9.04 (0.5)	82%
40-54	1770	8.52 (0.3)	71%	672	4.85 (0.3)	83%
>=55	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 5.10 Cost per Life-year saved on HD and CAPD (at 3% discount on cost and life year saved)

	Haemodialysis		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	1,056.58	3.1	285.81	0.9
3 Equipment	3,109.52	9.2	681.32	2.2
4 Staff	6,362.71	18.9	2,095.84	6.6
5 Overhead	6,390.28	19.0	2,729.54	8.6
6 Dialysis unit consumables	8,886.18	26.4	18,906.20	59.8
7 EPO treatment (actual utilisation)	4,510.67	13.4	2,542.61	8.0
8 Outpatient clinic care	2,125.26	6.3	2,121.33	6.7
9 Hospitalisation	709.85	2.1	1,960.08	6.2
TOTAL	33,641.96	100	31,634.93	100

Table 5.11 Cost per Life-year saved on HD and CAPD by Age (3% discount)

Age group	HD Cost per Life-year saved	CAPD Cost per Life-year saved
All age groups	33,641.96	31,634.93
<40 years	33,483.72	31,056.21
40-54 years	33,765.13	31,736.32
>=55 years	34,145.27	32,444.57

Table 5.12 Cost Effectiveness under different scenarios

Variable	Cost per Life Year Saved HD	Cost per Life Year Saved CAPD
Discount rate		
• 3%	33,641.96	31,634.93
• 5%	34,538.83	31,991.32
Overhead		
• Maximum cost in sample	79,712.99	39,989.45
• Minimum cost in sample	28,427.26	29,155.46
EPO		
• Actual dose, 100% utilisation rate	36,302.46	35,713.71
• Optimal dose, actual utilisation rate	36,516.32	33,600.82
• Optimal dose, 100% utilisation	40,872.19	40,833.21
• No EPO	29,131.29	29,092.32
Hospitalisation		
• In-patient lab cost	33,939.96	32,541.67

Figure 5.1: Cost-efficiency of HD in relation to Volume

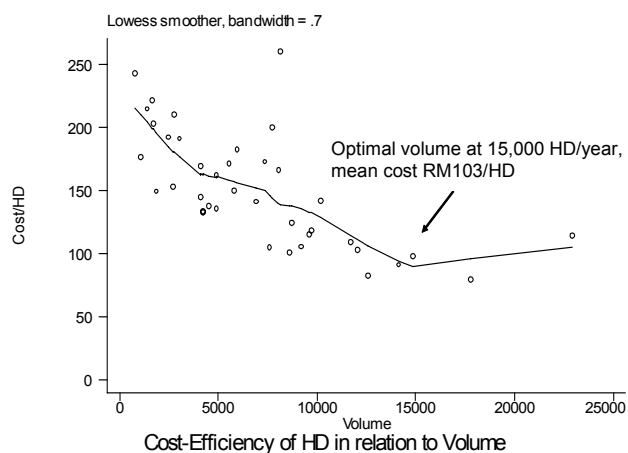
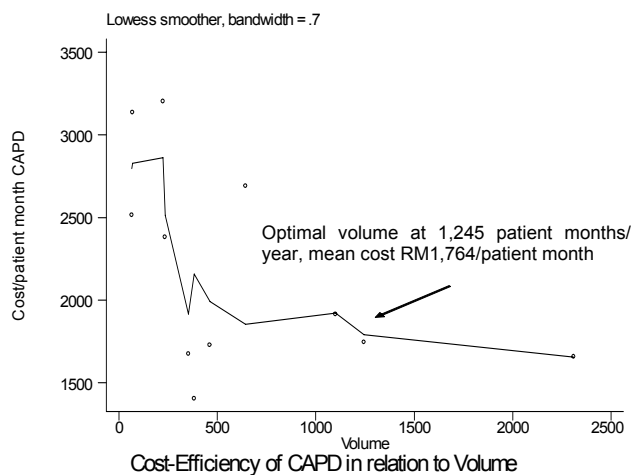


Figure 5.2: Cost-efficiency of CAPD in relation to Volume



Appendix: Participating sites

Alor Setar Hospital	Langkawi Hospital
Baling Hospital	Melaka Hospital
Batu Pahat Hospital	Mentakab Hospital
Besut Hospital	Miri Hospital
Bintulu Hospital	Muar Hospital
Bukit Mertajam Hospital	Penang Hospital
Duchess of Kent Hospital	Putrajaya Hospital [‡]
Ipoh Hospital	Queen Elizabeth Hospital
Kajang Hospital	Raub Hospital
Kangar Hospital	Segamat Hospital
Kemaman Hospital	Selayang Hospital [‡]
Keningau Hospital	Seremban Hospital
Kluang Hospital	Sibu Hospital,
Kota Bahru Hospital	Sik Hospital
Kuala Krai Hospital [†]	Sultanah Aminah Hospital, Johor Baru
Kuala Lumpur Hospital	Sungai Petani Hospital
Kuala Nerang Hospital	Taiping Hospital
Kuala Pilah Hospital	Tawau Hospital
Kuala Trengganu Hospital	Teluk Intan Hospital
Kuching Hospital, Sarawak	Tengku Ampuan Afzan Hospital, Kuantan
Kulim Hospital	Tengku Ampuan Rahimah Hospital
Labuan Hospital	Yan Hospital

[†]missing data

[‡]Information Technology (IT) hospital

References

1. Hooi LS, Lim TO, Sharmini S, Goh A. Economic Evaluation Of The Ministry Of Health Nephrology Services: Efficiency And Cost Effectiveness Of Centre Haemodialysis And Continuous Ambulatory Peritoneal Dialysis In Ministry Of Health Hospitals. Clinical Research Centre, Ministry of Health, 2003
2. Abridged Life Tables 1981-1996, Malaysia. Department of Statistics, Malaysia
3. Hakama M, Hakulinen T. Estimating the expectation of life in cancer survival studies with incomplete follow-up information. *J Chron Dis* 1977; 30:585-597