CHAPTER 8: NUTRITIONAL STATUS ON DIALYSIS

Summary

- The mean serum albumin of both the haemodialysis and CAPD patients showed a decreasing trend over the years 1993 to 2002.
- The serum albumin level in the CAPD population was much lower than in the haemodialysis patients.
- The serum albumin concentration was lower in the older patients and in diabetic patients.
- Serum albumin level was not associated with gender.
- Adjusted one-year and five-year survival in haemodialysis patients was strongly correlated with serum albumin levels. However in CAPD patients, only the five-year survival showed association with serum albumin level. Serum albumin of >35g/L in both haemodialysis and CAPD patients conferred a better survival outcome.
- A higher body mass (BMI >25.0) conferred a survival benefit both in patients on haemodialysis and CAPD. In haemodialysis patients but not in CAPD population, a lower BMI (<18.5) also increased mortality risk.

Introduction

Protein energy malnutrition (PEM) is a common complication of chronic kidney disease [1], which if not intervened, progresses when the patient undergoes dialysis. Different authors had reported prevalence of protein energy malnutrition from about 18% to 70% of adult maintenance dialysis patients [2]. In adults, the presence of protein energy malnutrition is one of the strongest predictor of mortality and morbidity [3].

There is no single measure that provides a comprehensive indication of protein-energy nutritional status. Hence, there is a wide array of markers that are used to gauge the degree of malnutrition such as serum albumin, prealbumin, serum cholesterol, haematocrit, predialysis serum creatinine, creatinine index, body mass index and subjective global assessment. However, the most important indicator is serum albumin. Serum albumin has been shown to be associated with increased mortality together with protein nitrogen appearance (nPNA) and low predialysis serum concentration of cholesterol, urea and potassium. [4,5,6,7] The K/DOQI guidelines (2000 update) suggest that serum albumin level is a useful parameter for evaluating the nutritional status of dialysis patients.

A low body mass index (BMI) has been shown by several studies to be associated with increased mortality in patients on haemodialysis. Leavey et al [8], reported lower mortality risk in patients with higher BMI (overweight 25-29.9, mild obesity 30-34.9 or moderately obese 35-39.9. Hakim et al [9] reported that overweight and obese patients (BMI > 27.5) had a significantly better 12-month survival than underweight (BMI<20) and normal weight patients. Further analysis of the data, using Cox proportional hazard models, demonstrated that for every unit increase in BMI, the relative risk (RR) of mortality was reduced by 10%. However, Kaizu et al [10] found that a BMI of more than 23.0 was associated with a lower survival as compared to BMI of 17.0-18.9 and that survival on dialysis was

However the link between higher body mass and better survival is not as clear in patients on peritoneal dialysis (PD) at the present time. In a study by Johnson et al [11], overweight PD patients had a significantly better survival at three years compared to normal weight patients, possibly due to significantly higher nutrition among the overweight patients. However, in the study by Aslam et al [12], no survival advantage was observed in the overweight patients.

Hence, for this 10-year report, we analysed the nutritional status of our dialysis population and its association with patient survival.

Method

The National Renal Registry collects data on serum albumin and weight for dialysis patients at least 4 times annually.

Serum albumin can be measured by one of two methods, both of which utilize a colour change induced by a dye (bromocresol) binding to albumin.

i) BCG (bromocresol green) is the most commonly used reagent. However, it binds to a range of proteins other than albumin. At low albumin concentration, there may be a significant overestimation of the albumin concentration.
ii) BCP (bromocresol purple) is more expensive then BCG. It predominantly binds to albumin and thus gives a accurate measure of albumin concentration.

Serum albumin was most commonly measured utilizing the bromocresol green method in the private, government hospital or university hospital laboratories in Malaysia in the past ten years. However, differences in instrumentation, calibration and quality control between laboratories may lead to variations in albumin results.

Results and discussion

8.1.: HAEMODIALYSIS

Serum Albumin as Nutritional Marker

Serum albumin levels were decreasing over the last ten years of 1993 to 2002 in haemodialysis patients. (Table 8.1.1). However, the average serum albumin level each year was still acceptable at 39.3 to 42.1 g/L. The percentage of patients with serum albumin < 35 g/L was also increasing. This decreasing albumin trend may be attributed to larger proportions of older and diabetic patients.

Serum Albumin and Patient Characteristics

The serum albumin level decreased with age (Table 8.1.2). The elderly (>60 years) have the lowest serum albumin and this trend was consistently observed for the ten-year period. The female gender appears to have a slightly lower mean serum albumin (the difference ranged from 0.3 to 1.4 g/L) (Table 8.1.3). HD patients with diabetes mellitus tended to have lower serum albumin level as compared to patients without diabetes. (Table 8.1.4).

Serum albumin and Mortality

There was a significant correlation between serum albumin and the short term and long term survival on haemodialysis. The one-year patient survival analysis was based on incident patients only. The risk of death (adjusted for age, gender, primary diagnosis and time on RRT) was 98% higher in the HD patients with serum albumin < 30 g/l compared to the reference group taken as patients with serum albumin 35 to < 40 g/l; and 43% higher in those with serum albumin 30 to <35 g/l compared to the reference group.(Table 8.1.5). However, serum albumin higher than 40g/L was not associated with increased survival. The effect of hypoalbuminemia is seen even at 12-month on dialysis, and this data is in-keeping with another study [7]. It emphasizes that predialysis nutrition is an integral part of management to improve survival during dialysis. Nutritional indices should also be used as an independent indication for initiation of dialysis.

Adjusted 5-year survival for prevalent HD patients shows that the higher the serum albumin level, the better the survival. There was a more than 5-fold increase in mortality in those with serum albumin < 30 g/l compared to those with serum albumin 35 g/l or more. At 5 years, only 25% of haemodialysis patients with serum albumin <25g/L were alive (Figure 8.1.6). This finding is consistent with the predictive mortality of a lower serum albumin in patients on maintenance dialysis.

Table 8.1.1 Distribution of Albumin (g/L), HD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <30g/L	% patients 30-<35g/L	% patients 35-<40g/L	% patients ≥40g/L
1993	696	42.1	5.9	41.8	38.5	45.4	1	7	25	66
1994	932	42.4	5.8	42.3	39	45.7	1	6	24	68
1995	997	40.7	6.9	41	38	44	3	9	29	59
1996	1139	41.1	6.4	41.5	38	44.5	2	8	27	63
1997	1646	40.9	6.2	41	37.7	44.3	3	8	30	59
1998	2076	41.2	6.5	41	37.5	44.7	3	9	28	59
1999	2757	39.7	6.1	39.7	36.3	43	4	13	35	49
2000	3737	38.6	7	39	36	42	5	11	41	43
2001	4668	39	5.6	38.5	36	41.8	3	15	44	38
2002	5194	39.3	5.4	39.3	36.5	42	3	11	42	44

Figure 8.1.1 Distribution of Albumin (g/L), HD patients 1993-2002

Table 8.1.2 Distribution of Albumin in relation to Age, HD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		≥60	
1993	Mean ± SD	47.5	10.3	42.6	5.3	41.5	5.6	40.5	7.3
	Median ± IQR	46.5	11	42.3	7	41.5	6.3	41	8
1994	Mean ± SD	44.3	6.5	42.9	5.6	41.9	5.9	41.4	6.1
	Median ± IQR	43.3	7.3	43	7.3	41.5	6.3	41.3	8.5
1995	Mean ± SD	42.4	6.3	41.5	7.8	40.2	6.2	39.1	4.4
	Median ± IQR	43.3	4.5	41.8	7	40.3	5.7	39.3	5.8
1996	Mean ± SD	43.3	5.3	41.9	6.6	40.4	6.4	39.7	4.6
	Median ± IQR	43.8	4.5	42.3	6.3	40.9	6.3	40.3	5.8
1997	Mean ± SD	43.3	7.5	42.1	6.1	40.3	5.9	38.8	6.3
	Median ± IQR	42.8	6.9	42	7	40.5	6.5	39.7	7
1998	Mean ± SD	42.8	5.4	42.2	6.6	40.8	6.6	39.1	5.4
	Median ± IQR	43.3	5.5	41.8	7.2	40.7	6.9	39.3	6.5
1999	Mean ± SD	41.8	4.9	40.8	6	39.4	5.8	37.4	6.8
	Median ± IQR	42	5.8	40.5	6.5	39.3	6.7	37.5	6.6
2000	Mean ± SD	39.8	7.7	39.5	7.3	38.6	6.8	37.1	6.3
	Median ± IQR	40.8	6.3	40	6	38.8	6	37	5
2001	Mean ± SD	41.9	5.5	40.3	5.5	38.8	5.6	37.2	5.1
	Median ± IQR	41.8	5.5	39.8	6	38.3	5.7	37	5
2002	Mean ± SD	41.4	5.5	40.3	5.3	39.3	5.4	37.9	5.1
	Median ± IQR	41.8	5.8	40.1	5.3	39.3	5.3	38	4.7

Table 8.1.3 Distribution of Albumin in relation to Gender, HD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	42.2	5.6	41.9	6.3
	Median ± IQR	41.8	7	41.8	6.5
1994	Mean ± SD	42.7	5.9	41.7	5.6
	Median ± IQR	42.5	6.8	41.5	7
1995	Mean ± SD	40.9	7.1	40.4	6.4
	Median ± IQR	41.3	6.3	40.3	6
1996	Mean ± SD	41.3	6.3	40.5	6.4
	Median ± IQR	41.8	6.8	41	6.2
1997	Mean ± SD	41.3	5.9	40.2	6.5
	Median ± IQR	41.3	6.4	40.3	6.5
1998	Mean ± SD	41.7	6.4	40.4	6.7
	Median ± IQR	41.5	7	40	6.9
1999	Mean ± SD	40	6.2	39.1	5.9
	Median ± IQR	40	6.6	39	6.5
2000	Mean ± SD	39.1	7.1	38	6.7
	Median ± IQR	39.6	6.2	38.3	5.3
2001	Mean ± SD	39.6	5.7	38.2	5.3
	Median ± IQR	39.2	6.2	38	6
2002	Mean ± SD	39.7	5.5	38.8	5.2
	Median ± IQR	39.8	5.5	38.7	5.1

Table 8.1.4 Distribution of Albumin in relation to Diabetes mellitus, HD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	42.3	5.9	40.3	5.3
	Median ± IQR	42	7	41	6
1994	Mean ± SD	42.6	5.4	41	7.7
	Median ± IQR	42.3	6.8	41.3	8
1995	Mean ± SD	41.1	6.9	38.8	6.3
	Median ± IQR	41.3	6.1	39.3	5.7
1996	Mean ± SD	41.4	6.5	39.2	5.4
	Median ± IQR	42	6.3	39.5	7
1997	Mean ± SD	41.3	6.2	39	5.7
	Median ± IQR	41.3	6.3	39.3	7.1
1998	Mean ± SD	41.6	6.3	39.6	7
	Median ± IQR	41.3	7	39.7	7.3
1999	Mean ± SD	40.1	5.8	38.3	6.8
	Median ± IQR	40	6.3	38.5	7.3
2000	Mean ± SD	39.1	7	37.4	6.8
	Median ± IQR	39.5	6	37.6	5.7
2001	Mean ± SD	39.6	5.4	37.6	5.6
	Median ± IQR	39	6	37.3	5.3
2002	Mean ± SD	39.8	5.3	38.2	5.4
	Median ± IQR	39.7	5.3	38.3	5.5

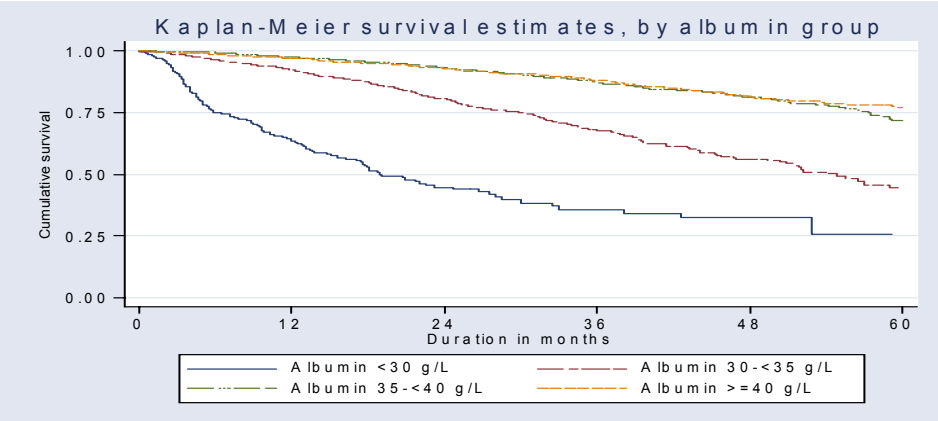
Table 8.1.5 Adjusted one-year patient survival in relation to Albumin, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Sr. albumin	n	Hazard ratio	95% CI	p-value
<30 g/L	157	1.98	(1.44,2.72)	0.000
30-<35 g/L	234	1.43	(0.99,2.08)	0.056
35-<40 g/L	451	1.00		
≥40 g/L	345	0.98	(0.68,1.42)	0.924

Table 8.1.6 Adjusted five-year patient survival in relation to Albumin, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Sr. albumin	n	Hazard ratio	95% CI	p-value
<30 g/L	263	5.44	(4.43, 6.69)	0.000
30-<35 g/L	845	2.13	(1.82, 2.49)	0.000
35-<40 g/L	2471	1.00	-	-
≥40 g/L	2038	0.70	(0.59, 0.83)	0.000

Figure 8.1.6 Adjusted five-year patient survival in relation to Albumin, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



Body Mass Index

Most haemodialysis patients (60-63%) had body mass index (BMI) between 18.5-25.0 (Table 8.1.7). The mean BMI from the 1993-2002 cohorts ranged from 21.3 to 22.5. There was an increasing trend in mean BMI during the 10-year observation. The proportion of patients with BMI >25 was also increasing over the ten years. Older patients (>40 years of age) had higher BMI (Table 8.1.8). There was no difference in BMI between gender (Table 8.1.9). BMI in diabetics was higher than the non-diabetic patients (Table 8.1.10), most probably because type II diabetes which is associated with obesity is common.

BMI and mortality

Table 8.1.12 shows that the higher the BMI, the lower the risk of mortality. Those with low BMI of <18.5 had a 50% higher risk of dying compared to those with normal BMI of 18.5-25. Conversely, those with BMI >25 had a 28% less risk of death. These results are consistent with other studies mentioned earlier [8,9]. A lower BMI probably reflects protein energy malnutrition, which is associated with higher mortality.

Table 8.1.7 Distribution of BMI, HD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <18.5	% patients 18.5-25	% patients >25
1993	598	21.3	3.6	21.1	18.6	23.5	24	61	15
1994	830	21.6	3.7	21.4	18.8	23.7	22	61	17
1995	915	21.8	3.8	21.5	19	24	19	63	18
1996	1139	21.9	3.9	21.6	19.2	24.1	19	62	19
1997	1517	21.9	4	21.5	19.1	24.1	19	61	20
1998	1938	22	4.2	21.5	19.1	24.1	19	61	20
1999	2655	22	4.1	21.4	19.1	24.3	18	62	20
2000	3777	22.1	4.2	21.6	19.2	24.4	19	60	21
2001	4435	22.3	4.3	21.8	19.3	24.6	18	60	23
2002	4691	22.5	4.3	22	19.5	24.8	16	60	24

Figure 8.1.7 Distribution of BMI, HD patients 1993-2002

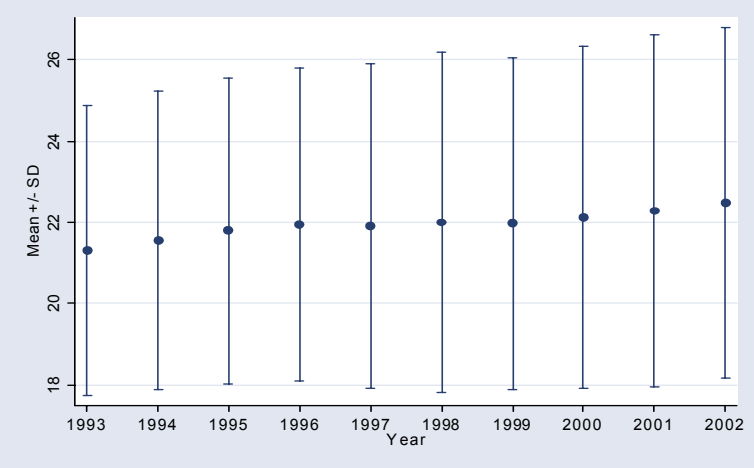


Table 8.1.8 Distribution of BMI in relation to Age, HD patients 1997-2002

Year		Age group (years)							
		<20		20-39		40-59		≥60	
1993	Mean ± SD	18.3	4.3	20.7	3.5	21.9	3.3	23	3.8
	Median ± IQR	17.1	3.1	20.1	4.3	21.8	4.6	23	5.4
1994	Mean ± SD	18.9	4	20.8	3.5	22.1	3.6	22.9	3.6
	Median ± IQR	18.6	4.5	20.5	4.3	21.9	4.9	23.1	5.1
1995	Mean ± SD	18.7	3.7	21.1	3.7	22.4	3.7	22.5	3.4
	Median ± IQR	18.2	4.1	20.6	4.4	22.1	4.8	22.6	4.7
1996	Mean ± SD	19.4	3.4	21.3	3.9	22.5	3.8	23	3.6
	Median ± IQR	19	3.4	20.7	5	22.3	4.8	23	4.3
1997	Mean ± SD	19.2	3.5	21.2	3.9	22.4	4	22.8	3.8
	Median ± IQR	18.5	3.6	20.6	4.6	22.2	5.1	22.4	5
1998	Mean ± SD	19.2	4.3	21.1	3.9	22.6	4.3	22.7	3.9
	Median ± IQR	18.2	5.2	20.5	4.5	22.1	5	22.4	5
1999	Mean ± SD	18.5	3.5	21	3.9	22.6	4.1	22.5	3.8
	Median ± IQR	18.2	3.6	20.4	4.6	22.1	5.1	22	4.9
2000	Mean ± SD	18.8	4.3	21.1	4	22.8	4.2	22.5	4.1
	Median ± IQR	18.1	4.2	20.3	4.6	22.4	5.1	22	4.7
2001	Mean ± SD	18.8	4.1	21.2	4.1	22.9	4.4	22.7	4.1
	Median ± IQR	18.3	3.7	20.6	4.9	22.5	5.3	22.2	4.8
2002	Mean ± SD	19.2	4	21.4	4.2	23.1	4.3	22.7	4.1
	Median ± IQR	18.6	4.1	20.7	4.9	22.7	5.3	22.1	4.7

Table 8.1.9 Distribution of BMI in relation to Gender, HD patients 1997-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	21.5	3.3	20.9	3.9
	Median ± IQR	21.4	4.5	20.4	5.7
1994	Mean ± SD	21.8	3.5	21.1	3.9
	Median ± IQR	21.6	4.6	20.7	5.3
1995	Mean ± SD	22	3.6	21.4	4
	Median ± IQR	21.6	4.4	21	5.5
1996	Mean ± SD	22.3	3.7	21.3	4
	Median ± IQR	22	4.6	20.7	5.6
1997	Mean ± SD	22.3	3.9	21.3	4
	Median ± IQR	21.7	4.9	20.7	5.5
1998	Mean ± SD	22.3	4.1	21.5	4.4
	Median ± IQR	21.7	4.8	20.9	5.4
1999	Mean ± SD	22.2	3.9	21.7	4.3
	Median ± IQR	21.6	4.9	21	5.6
2000	Mean ± SD	22.4	4	21.7	4.4
	Median ± IQR	21.9	4.9	21.1	5.5
2001	Mean ± SD	22.6	4.2	21.9	4.5
	Median ± IQR	22.1	4.9	21.4	5.8
2002	Mean ± SD	22.7	4.1	22.2	4.5
	Median ± IQR	22.2	5	21.7	5.7

Table 8.1.10 Distribution of BMI in relation to Diabetes mellitus, HD patients 1997-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	21.1	3.5	22.7	3.5
	Median ± IQR	20.8	4.7	22.6	5.7
1994	Mean ± SD	21.3	3.7	23	3.5
	Median ± IQR	21	4.7	23.1	5.3
1995	Mean ± SD	21.5	3.7	23.3	3.6
	Median ± IQR	21.1	4.8	23	4.6
1996	Mean ± SD	21.7	3.8	23.4	3.6
	Median ± IQR	21.2	4.9	23.3	4.7
1997	Mean ± SD	21.5	4	23.5	3.8
	Median ± IQR	21	4.9	23.3	4.6
1998	Mean ± SD	21.6	4.1	23.5	4.2
	Median ± IQR	20.9	5	23	4.7
1999	Mean ± SD	21.5	4	23.5	3.9
	Median ± IQR	20.9	4.9	23	5.1
2000	Mean ± SD	21.6	4.1	23.5	4.1
	Median ± IQR	20.9	5	23.1	4.9
2001	Mean ± SD	21.7	4.3	23.6	4.3
	Median ± IQR	21.2	5.2	23.1	5.2
2002	Mean ± SD	21.9	4.2	23.7	4.3
	Median ± IQR	21.4	5.2	23.2	5.1

Table 8.1.11 Unadjusted five-year patient survival in relation to BMI, HD patients 1997-2002

BMI	<18.5		18.5-25		>25	
Interval (months)	% survival	SE	% survival	SE	% survival	SE
6	96	1	97	0	98	0
12	93	1	94	0	95	1
24	84	1	87	1	89	1
36	76	2	79	1	82	1
48	72	2	72	1	74	2
60	67	3	66	1	67	2

SE = standard error

Figure 8.1.11 Unadjusted five-year patient survival in relation to BMI, HD patients 1997-2002

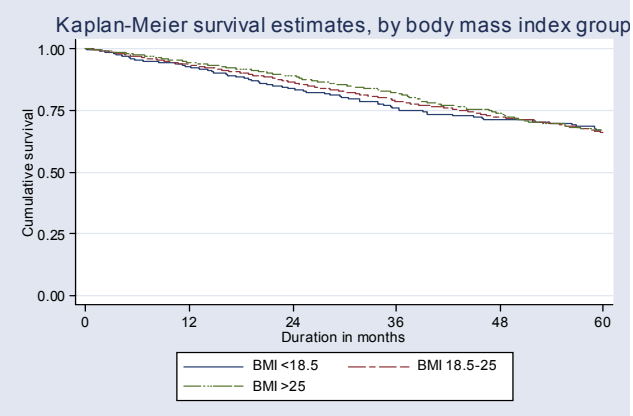
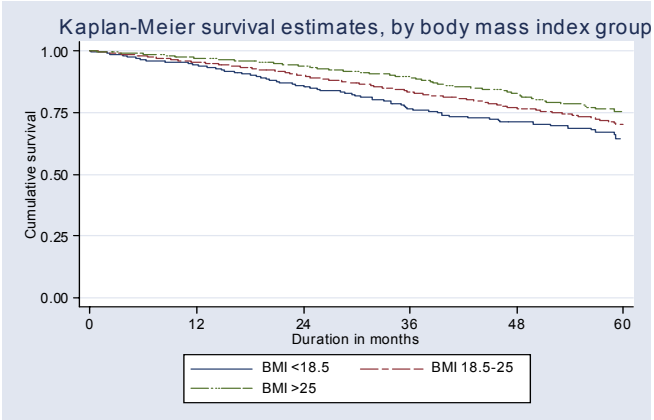


Table 8.1.12 Adjusted five-year patient survival in relation to BMI, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

BMI	n	Hazard ratio	95% CI	p-value
<18.5	789	1.50	(1.25, 1.80)	0.000
18.5-25	3097	1.00	-	-
>25	1176	0.82	(0.70, 0.96)	0.015

Figure 8.1.12 Adjusted five-year patient survival in relation to BMI, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



8.2: CAPD

Serum albumin as a nutritional marker

Serum albumin levels showed a decreasing trend over the last ten years of 1993 to 2002 in patients on CAPD in common with haemodialysis patients. However in contrast to HD patients, the mean serum albumin lately had fallen below the normal range with the proportion with serum albumin below 35 g/l increasing from 20% in 1993 to 56% in 2002. (Table 8.2.1, Figure 8.2.1) As expected, the mean serum albumin level has been consistently lower than that for haemodialysis

Serum Albumin and Patient Characteristics

The serum albumin showed a decreasing trend with age as in haemodialysis (Table 8.2.2). The elderly (>60 years) had the lowest serum albumin and this trend was consistently observed in the ten-years. The serum albumin was similar between gender in the CAPD patients (Table 8.2.3) Again, CAPD patients with diabetes mellitus tended to have a serum albumin compared to patients without diabetes (Table 8.2.4). The mean difference between the two groups was between 1.2 to 3.5g/L.

Serum albumin and mortality

The was no significant difference between serum albumin level and the short term (one-year) survival of incident patients on CAPD (Table 8.2.5, Figure 8.2.5) unlike in haemodialysis. This may be because of the relatively small number of patients on CAPD. In contrast, the long term survival on CAPD was significantly associated with serum albumin concentration. There was a 1.5-fold and 2.7–fold increase in risk of death with serum albumin of 30 to <35g/L and below 30g/L respectively (Table 8.2.6, Figure 8.2.6). The above findings shows that in CAPD patients, as in haemodialysis, lower serum albumin <35g/L conferred a poorer prognosis.

Table 8.2.1 Distribution of Albumin (g/L), CAPD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <30 g/L	% patients 30-<35 g/L	% patients 35-<40 g/L	% patients ≥40 g/L
1993	98	38.5	5.3	39.1	35.5	41.5	5	15	37	43
1994	118	39	5.6	39.4	35.8	43	6	14	34	47
1995	252	35.5	5.5	36	32	39.3	15	25	41	19
1996	360	34.8	6.3	35	31	38.5	20	27	35	17
1997	472	35.7	6.8	35.6	31.5	39.5	16	28	34	22
1998	536	35.8	6.7	36	32	39.7	16	25	35	24
1999	597	34.1	6.6	34	30.8	38	21	33	32	14
2000	640	34.3	6.1	35	31	38.3	20	28	37	14
2001	750	33.3	6.2	33.6	29.3	37	27	33	28	12
2002	860	33.9	5.9	34.3	30.8	37.5	21	35	33	12

Figure 8.2.1 Distribution of Albumin (g/L), CAPD patients 1993-2002

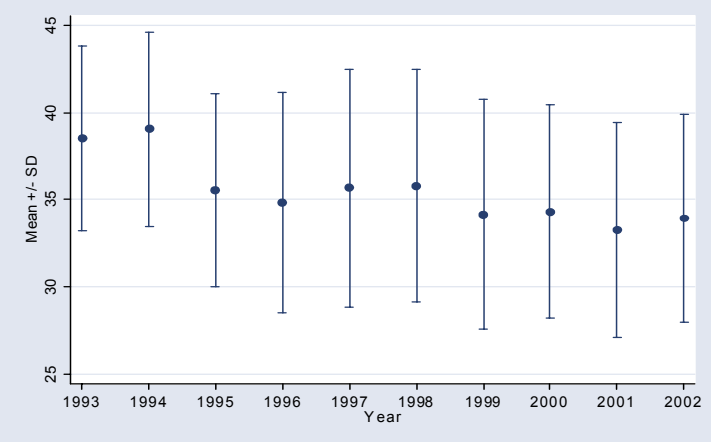


Table 8.2.2 Distribution of Albumin in relation to Age, CAPD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		³60	
1993	Mean ± SD	37.9	5	39.9	6	38.6	4.7	36.9	6.5
	Median ± IQR	37	9	41	4.5	39.5	5.7	37.3	6.1
1994	Mean ± SD	38.5	7	40.8	6.2	38.6	5	39	5.5
	Median ± IQR	37.4	8	42.5	7.7	38.5	6.3	40	8.8
1995	Mean ± SD	36.9	4.6	37.3	5.4	35	5.9	35	4.9
	Median ± IQR	37	3.5	37.4	8	35.8	7.6	35.3	5.5
1996	Mean ± SD	35.9	5.1	35.5	6.9	34.4	5.9	34.5	7.3
	Median ± IQR	36.5	6.4	35.5	10	35	7.5	35	7.5
1997	Mean ± SD	36.9	6.5	37.6	7.9	35.1	6.6	33.9	5.3
	Median ± IQR	37.3	7.3	37.3	7	35	7.8	34	7
1998	Mean ± SD	37.2	4.8	36.8	5.3	35.5	6.6	34	9.2
	Median ± IQR	37.7	6	37.3	7.4	35.8	7.3	34	11.1
1999	Mean ± SD	35	6.8	34.8	6	33.7	6.8	33.6	6.5
	Median ± IQR	34.8	6.8	34.6	6.5	33.6	8	34	7
2000	Mean ± SD	33.8	6.1	35	5.5	34.4	6.3	33.5	6.4
	Median ± IQR	34.8	6.8	35.7	6.8	35	8.1	33.8	8.5
2001	Mean ± SD	33.5	6.7	33.4	5.8	33.4	6.4	32.6	5.5
	Median ± IQR	33.9	8.5	33.5	7.5	33.8	7.3	32.3	7.4
2002	Mean ± SD	35	5.5	34	5.4	33.5	5.8	33.7	7.3
	Median ± IQR	35.8	7.4	34.3	6.8	33.8	5.8	33.7	7.6

Table 8.2.3 Distribution of Albumin in relation to Gender, CAPD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	39.2	5.5	38	5.2
	Median ± IQR	39.4	6.5	39	6
1994	Mean ± SD	39	5.6	39	5.5
	Median ± IQR	38	8	40	8
1995	Mean ± SD	35.8	5.3	35.2	5.8
	Median ± IQR	36.3	6.3	35.3	7.3
1996	Mean ± SD	35.3	6.7	34.3	5.8
	Median ± IQR	35.3	7.4	34.5	7.5
1997	Mean ± SD	35.7	7.4	35.6	6.2
	Median ± IQR	36	8.5	35.5	7.1
1998	Mean ± SD	36.3	6.7	35.3	6.6
	Median ± IQR	37	8	35.8	7.8
1999	Mean ± SD	34.5	7	33.8	6.2
	Median ± IQR	34.8	7.3	33.7	6.8
2000	Mean ± SD	34.6	5.7	34.1	6.5
	Median ± IQR	35.3	7.4	34.5	7.8
2001	Mean ± SD	33.7	6.4	32.9	5.9
	Median ± IQR	34	8.4	33.3	7.3
2002	Mean ± SD	34.1	5.6	33.8	6.2
	Median ± IQR	34.5	6.8	33.5	6.5

Table 8.2.4 Distribution of Albumin in relation to Diabetes mellitus, CAPD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	39.4	4.9	36.6	5.7
	Median ± IQR	40.3	6	38	6.7
1994	Mean ± SD	39.6	5.5	37.6	5.5
	Median ± IQR	40	8	37.8	6.8
1995	Mean ± SD	36.7	4.9	33.2	5.9
	Median ± IQR	37	5.8	32.7	8
1996	Mean ± SD	35.2	5.4	34	7.9
	Median ± IQR	35.7	7.3	33.3	7.8
1997	Mean ± SD	36.7	6.9	33.5	6
	Median ± IQR	36.6	7.3	33.5	7.3
1998	Mean ± SD	36.6	5.6	34.1	8.2
	Median ± IQR	37	7.8	34	9.3
1999	Mean ± SD	34.8	5.9	32.7	7.7
	Median ± IQR	34.8	6.3	32.7	8
2000	Mean ± SD	34.9	5.9	32.8	6.5
	Median ± IQR	35.5	6.9	33	8.5
2001	Mean ± SD	33.8	6	32.3	6.4
	Median ± IQR	34	7.5	32.3	7.8
2002	Mean ± SD	34.6	5.5	32.6	6.5
	Median ± IQR	35	6.7	32.9	6

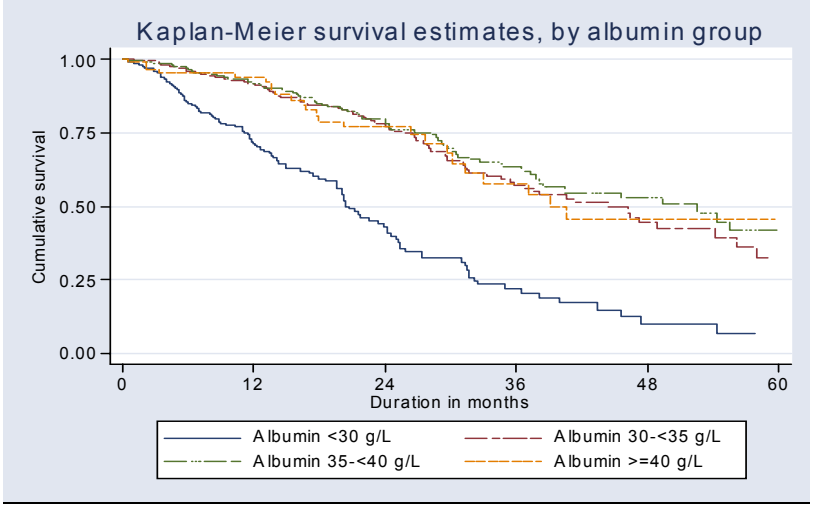
Table 8.2.5 Adjusted one-year patient survival in relation to Albumin, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Sr. albumin	n	Hazard ratio	95% CI	p-value
<30 g/L	140	1.63	(0.92,0.90)	0.093
30-<35 g/L	144	1.26	(0.68,2.33)	0.459
35-<40 g/L	112	1.00		
≥40 g/L	51	1.38	(0.52,3.62)	0.517

Table 8.2.6 Adjusted five-year patient survival in relation to Albumin, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Sr. albumin	n	Hazard ratio	95% CI	p-value
<30 g/L	294	2.76	(2.03, 3.75)	0.000
30-<35 g/L	404	1.52	(1.12, 2.06)	0.007
35-<40 g/L	386	1.00	-	-
≥40 g/L	145	1.04	(0.66, 1.66)	0.856

Figure 8.2.6 Adjusted five-year patient survival in relation to Albumin, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



Body Mass Index

CAPD patients had mean BMI between 21.7 to 22.4 from the years 1993-2002. Almost 50% of patients had BMI between 18.5 to 25.0 (Table 8.2.7). Older patients had higher BMI (Table 8.2.8.). There was no difference noted between gender (Table 8.2.9). BMI in CAPD patients with diabetes mellitus was higher than the non-diabetic patients (Table 8.2.10).

BMI and mortality

The unadjusted five-year patient survival showed that those with BMI <18.5 had the best five year survival. (Table 8.2.11 and Figure 8.2.11) However once this was adjusted for age, gender, primary diagnosis and time on RRT, the CAPD patients with BMI of <18.5 had a 35% higher risk of death compared to those with BMI 18.5-25, while those with BMI >25 had a 47% less risk of death compared to the group with BMI of 18.5-24. (Table 8.2.12, Figure 8.2.12)

This result emphasizes the fact that the mortality risk is reduced with higher BMI (>25.0) with any mode of dialysis.

Table 8.2.7 Distribution of BMI, CAPD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <18.5	% patients 18.5-25	% patients >25
1993	55	22.1	4.8	22.3	20	25.1	24	51	25
1994	72	22.4	5.1	22.5	18.9	25.6	21	49	31
1995	174	22.3	4.5	22.1	19.2	24.6	17	60	22
1996	281	22.1	4.6	22.1	19.2	25.1	21	52	26
1997	419	22.1	4.6	21.9	18.9	24.7	21	56	23
1998	489	21.7	4.6	21.3	18.7	24	22	57	20
1999	550	21.8	4.4	21.5	18.9	24.5	22	56	22
2000	599	21.8	4.3	21.5	18.6	24.6	25	53	22
2001	655	22.2	4.8	21.8	18.7	25.2	23	51	26
2002	738	22.4	4.8	22.1	18.8	25.5	22	48	29

Figure 8.2.7 Distribution of BMI, CAPD patients 1993-2002

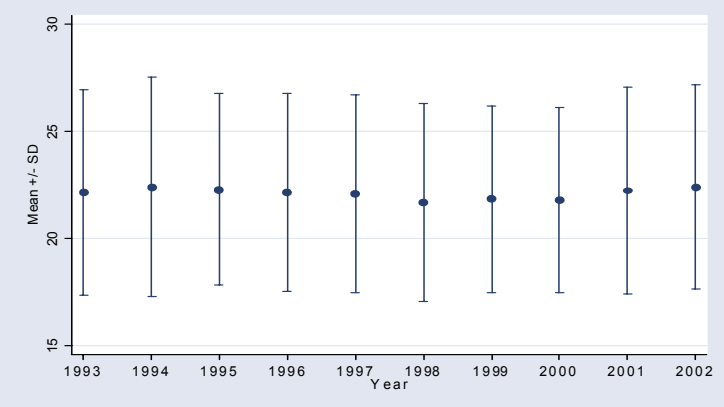


Table 8.2.8 Distribution of BMI in relation to Age, CAPD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		≥60	
1993	Mean ± SD	16.4	3.5	24.1	5.2	23.1	3.3	25.9	4.4
	Median ± IQR	15.4	6.3	23.5	6.8	23.3	3.8	25.4	8.7
1994	Mean ± SD	15.3	3.1	25.5	4.8	23.2	3.7	24.2	5
	Median ± IQR	15.6	2.6	24.9	5.9	23.2	5.1	23.7	6.2
1995	Mean ± SD	16	3.9	23.4	5.1	23	3.5	22.9	3.7
	Median ± IQR	15.2	4.7	22.3	6.7	22.9	4.1	22.2	3.5
1996	Mean ± SD	15.6	3.6	22.9	4.4	23.4	3.9	22.6	3.6
	Median ± IQR	15.1	4.6	21.8	5.8	22.8	5.4	22.2	4.9
1997	Mean ± SD	16.2	3.5	21.8	4.1	23.4	4.1	23.5	3.6
	Median ± IQR	15.4	4.3	21.2	4.5	23.4	5	23.2	4.5
1998	Mean ± SD	16.3	2.9	21.6	4.2	23	4.2	23.2	4
	Median ± IQR	16	4.3	20.8	4.3	22.8	5	22.6	5.2
1999	Mean ± SD	17	3	21.9	4.5	23.2	3.6	22.3	3.9
	Median ± IQR	16.9	4.2	20.9	5.4	23.2	4.9	21.6	4
2000	Mean ± SD	17.5	3.3	21.4	4.1	23.3	3.8	22.8	3.9
	Median ± IQR	17	3.5	20.7	5.5	23.3	5.1	22.2	5
2001	Mean ± SD	18.5	5.3	21.7	4.2	23.7	4.4	23.1	4
	Median ± IQR	17.2	3.8	20.8	5.5	23.5	5.6	22.6	5.1
2002	Mean ± SD	18.3	4.1	21.4	4.2	24.1	4.4	23.9	4
	Median ± IQR	17.5	4.2	20.6	6	23.6	6.1	23.2	5.2

Table 8.2.9 Distribution of BMI in relation to Gender, CAPD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	21.8	5.5	22.3	4.3
	Median ± IQR	22.3	8.2	22.3	4.6
1994	Mean ± SD	21.7	5.3	23	5
	Median ± IQR	21.6	7.3	23.4	5.6
1995	Mean ± SD	22.1	4.4	22.4	4.6
	Median ± IQR	22.1	4.4	21.6	5.7
1996	Mean ± SD	21.9	4.6	22.4	4.6
	Median ± IQR	22.4	5.4	21.7	6.9
1997	Mean ± SD	22	4.7	22.2	4.5
	Median ± IQR	22.6	5.8	21.6	5.5
1998	Mean ± SD	21.7	4.7	21.6	4.6
	Median ± IQR	21.6	5.5	21	5
1999	Mean ± SD	21.8	4.5	21.8	4.3
	Median ± IQR	21.8	5.8	21.2	5.4
2000	Mean ± SD	21.9	4.4	21.7	4.3
	Median ± IQR	21.7	6	21.4	6.1
2001	Mean ± SD	22.1	4.8	22.3	4.8
	Median ± IQR	22.1	6.5	21.7	6.5
2002	Mean ± SD	22.2	4.6	22.6	4.9
	Median ± IQR	22.2	6.7	22	7

Table 8.2.10 Distribution of BMI in relation to Diabetes mellitus, CAPD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	21.8	5	23.9	3.1
	Median ± IQR	21.8	6.2	24.2	3.4
1994	Mean ± SD	22	5.4	24.8	1.8
	Median ± IQR	21.5	6.7	25.1	2.6
1995	Mean ± SD	21.9	4.9	23.4	2.9
	Median ± IQR	21.3	5.7	23.1	3.9
1996	Mean ± SD	21.7	5	23.3	3.3
	Median ± IQR	21.4	6.3	23.3	4.2
1997	Mean ± SD	21.4	4.9	23.5	3.5
	Median ± IQR	20.8	5.5	23.7	4.1
1998	Mean ± SD	20.9	4.8	23.4	3.7
	Median ± IQR	20.3	5	23.4	4.4
1999	Mean ± SD	21.2	4.5	23.3	3.5
	Median ± IQR	20.6	5.5	22.8	4.5
2000	Mean ± SD	21.1	4.4	23.4	3.8
	Median ± IQR	20.5	6.4	23.4	4.6
2001	Mean ± SD	21.4	4.8	24.1	4.2
	Median ± IQR	20.6	6.7	23.8	5
2002	Mean ± SD	21.6	4.8	24.3	4.2
	Median ± IQR	20.8	6.7	23.9	5.6

Table 8.2.11 Unadjusted five-year patient survival in relation to BMI, CAPD patients 1997-2002

BMI	<18.5		18.5-25		>25	
Interval (months)	% survival	SE	% survival	SE	% survival	SE
6	96	1	95	1	99	1
12	91	2	89	1	97	1
24	82	3	74	2	82	3
36	74	4	57	3	64	5
48	65	6	48	3	56	5
60	65	6	40	4	48	7

SE=standard error

Figure 8.2.11 Unadjusted five-year patient survival in relation to BMI, CAPD patients 1997-2002

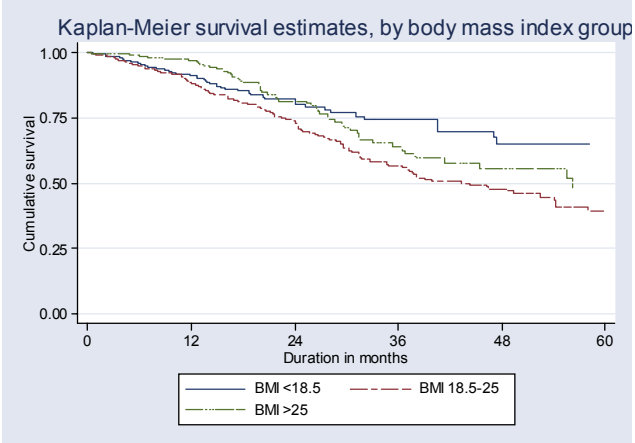
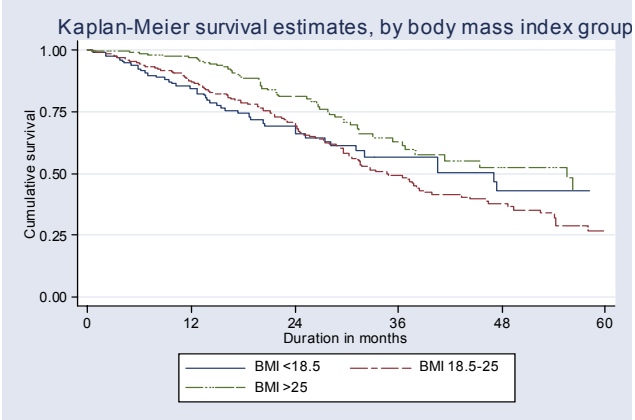


Table 8.2.12 Adjusted five-year patient survival in relation to BMI, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

BMI	n	Hazard ratio	95% CI	p-value
<18.5	267	1.35	(0.95, 1.92)	0.089
18.5-25	582	1.00	-	-
>25	250	0.53	(0.39, 0.73)	0.000

Figure 8.2.12 Adjusted five-year patient survival in relation to BMI, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



References

1. Kopple JD, Greene T, Chumlea WC, Hollinger D, Maroni BJ, Merrill D, Scherch LK, Schulman G, Wang S-R, Zimmer GS. Relationship between nutritional status and glomerular filtration rate: results from the MDRD study. Kidney Int. 2000; 57: 1688-1703

2. Ahmed KR, Kopple JD: Nutrition in maintenance haemodialysis patients, in Kopple JD, Massry SG (eds): Nutritional Management of Renal Disease. Baltimore, MD, Williams and Wilkins, 1998, pp 563-600

3. Lowrie EG, Huang WH, Lew NL: Death risk predictors among peritoneal dialysis and haemodialysis patients: A preliminary comparison. Am J Kidney Dis 26:220-228, 1995

4. Teehan BP, Schleifer CR, Brown JM, et al. Urea Kinetic analysis and clinical outcome on CAPD. A five-year longitudinal study. Adv Perit Dial 1990; 6: 181-185

5. Davis SJ, Russell L, Bryan J, Phillips L, and Russell GI. Comorbidity, urea kinetics and appetite in continuous ambulatory peritoneal dialysis patients: their inter-relationship and prediction of survival. Am J Kidney Dis 1995; 26: 353-361

6. Chertow GM, Lazarus JM. Malnutrition as a risk factor for morbidity and mortality in maintenance dialysis patients. In: Kopple JD, Massry SG eds. Nutritional Management of Renal Disease, 1997; Chapter 10. Williams & Wilkins, Baltimore

7. Lowrie EG, Lew NL. Death risk in haemodialysis patients. The predictive value of commonly measured variables and an evaluation of death rate differences between facilities. Am J Kidney Dis 1990; 15: 458-482

8. Leavey SF, Strawderman RL, Jones CA, Port FK, Held PJ. Simple nutritional indicators as independent predictors of mortality in haemodialysis patients. Am J Kidney Dis 1998; 31: 997-1006

9. Hakim RM, Lowrie E. Obesity and mortality in ESRD: is it good to be fat? Kidney Int 1999; 55

10. Kaizu Y, Tsunega Y, Yoneyama T et al. Overweight as another nutritional risk factor for the long term survival of non-diabetic haemodialysis patients. Clin Nephrol 1998; 50: 44-50

11. Johnson DW, Herzig KA, Purdie DM et al. Is obesity a favourable prognostic factor in peritoneal dialysis patients? Perit Dial Int 2002; 20: 715-721

12. Aslam N, Bernardini J, Fried L, Piraino B. Large body mass index does not predict short-term survival in peritoneal dialysis patients. Perit Dial Int 2002; 22: 191-196

13. Paniagua R, Amato D, Vonesh E et al. Effects of increased peritoneal clearances on mortality rates in peritoneal dialysis: ADEMEX, a prospective, randomized, controlled trial. J Am Soc Nephrol 2002; 13: 1307-1320

14. Nutrition In Chronic Kidney Disease: Clinical Practice Guidelines. Am J Kidney Dis June 2000,supp l 2 ; Volume 35 : Number 6