MAINTENANCE HAEMODIALYSIS IN SINGAPORE

H L Choong, H S Pwee, K T Woo, C H Lim

ABSTRACT

The chronic haemodialysis programme of the Singapore General Hospital started in 1968 as a hospital-based fully nurse-assisted programme. This has since expanded to include Self Dialysis and Home Dialysis programmes. Data of 425 patients who entered the dialysis programmes was analysed retrospectively. The major cause of end stage renal failure was chronic glomerulonephritis (52%). Almost half of the patients in the haemodialysis programme were patients on self-dialysis (49%). There were 157 withdrawals and 116 deaths. Survival has improved tremendously with the use of treated water for dialysis from 1981. The 5 year survival in an earlier group of patients dialysed with untreated water was 48% compared with 81% in a late group dialysed with treated water ($p < 0.001$). The pattern of complications has also changed with a lower incidence of dialysis osteomalacia, hypertension, hepatitis and eradication of dialysis dementia.

Keywords : End stage renal disease, dialysis modality, survival, complication

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INTRODUCTION

Haemodialysis in Singapore first began in September 1961 when a patient with acute renal failure was dialysed using the twin coil artificial kidney. Only patients with acute renal failure were treated in those days and it was not until 1968 that the chronic haemodialysis programme was initiated. Initially, patients were dialysed in a fully nurse-assisted hospital based unit in the old Singapore General Hospital (SGH) in a converted attic. Dialysate was prepared in a large stainless tank and pumped out to Watson Marlow monitors. Ultrafiltration was achieved by dropping the dialysate outflow line two stories down from the attic. The Unit shifted to its present location in 1981 when the Hospital was rebuilt(1). Here, a 10-bedded Drake Willock machine was used to run two shifts of 10 patients per day. This in-hospital fully nurse-assisted programme was termed the Centre Dialysis programme and is heavily subsided. This Centre had to cope with patients on temporary haemodialysis as well as those awaiting further plans such as living related donor transplantation or continuous ambulatory peritoneal dialysis. The new SGH has, in addition, four single-bedded stations available for training patients for Home Dialysis or for Self-Dependency dialysis at a satellite centre.

The Home Dialysis programme started in 1970. Patients were trained for three months at the Singapore General Hospital along with a helper who would normally be the spouse or some other close relative. This programme was not subsidised and patients had to bear the full cost of dialysis themselves.

The Self-Dependency Dialysis programme started in 1975 with a centre built by the National Kidney Foundation in Alexandra Hospital. The concept was to have a minimum of staff and patients had to be self-reliant. In a hospital where staff salaries could form half of the total cost of dialysis, the savings from the Self-Dependency programme were obvious(2). The Alexandra Hospital Self-Dependency Dialysis Unit (SDDU) has a capacity for 44 patients. In 1983, another such centre was started in Tan Tock Seng Hospital in one of the converted wards. This centre can take up to 80 patients. Both self-dialysis centres are heavily subsidised as patients pay only S$10 per dialysis. Patients would be selected for this programme based on medical and socio-economic considerations.

We would now like to report on the survival, causes of mortality and some complications occurring in these three groups of patients (Centre Dialysis, Home Dialysis and Self-Dependency Dialysis) while on maintenance haemodialysis from 1968 to 1989.

PATIENTS AND METHODS

Patients

All patients who started maintenance haemodialysis since the inception of the programmes were included in this study. The records of these 425 patients were reviewed to establish the cause of chronic renal failure, time spent on maintenance haemodialysis, cause of death, incidence of complications including anaemia, hepatitis, renal osteodystrophy, and hypertension as well as the degree of rehabilitation and reasons for withdrawal from the programme.

A patient who had a renal transplant that allowed him to be free from dialysis was considered a withdrawal. When failure of the graft occurred and the patient had to return to dialysis, he was considered a new entry. If a patient received a transplant but never ceased dialysis because of early graft failure he was not considered a withdrawal.

Dialysis

Before 1981, haemodialysis was performed using standard Kiil dialysers and later the Meltec Multipoint plate dialysers; each session lasting 6 to 8 hours three times a week (3). With the change to hollow-fibre dialysers, dialysis time was reduced to an average of 4 hours per session. Treated water was not available

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until the SGH Dialysis Centre shifted to its new premises at the new SGH in 1981 which had reverse osmosis facilities. The units at Alexandra Hospital installed a deioniser in 1979, while that at Tan Tock Seng Hospital was built with a deioniser unit. Acetate buffered dialysate was used throughout in all three centres.

Investigations

These were performed routinely every two months. Haemoglobin and biochemistry which included predialysis serum creatinine, potassium, calcium, phosphate, alkaline phosphatase and transaminases were estimated.

Hepatitis B antigen and antibody screening were also performed every 6 months. In 1980, the method used was counter immunoelectrophoresis. In 1988, this was done with the enzyme immunoassay method using AUSZYME for HBsAg and AUSAB for anti HBs (Abott Laboratories, Chicago).

Skeletal surveys for renal bone disease were done yearly.

Statistics

Results were analysed using chi-square, Students' t test and survival rates by the method of Peto and colleagues(4).

If the patient had an unsuccesful transplant with no discontinuation of dialysis treatment, his time on dialysis is considered to be continuous. Any patient who left the programme alive was considered a withdrawal. A patient who restarted haemodialysis after a failed transplant is considered a new entry into the programme.

RESULTS

Patients

Until 1989, a total of 425 patients have been accepted into the three programmes. Their causes of end stage renal failure included: 51.8% chronic glomerulonephritis, 2.1% diabetic nephropathy, 1.9% polycystic kidney disease and 1.4% vesico-ureteric reflux. In 41.6%, the cause of end stage renal failure was unknown though secondary renal disease was excluded (Table I).

One hundred and thirteen patients have been accepted into the Centre Dialysis programme compared to 103 for Home Dialysis and 209 on Self-Dependency Dialysis programmes. Most of the patients taken on to the Centre Dialysis programme were in the earlier years before the increase in availability of Self Dialysis places (Fig 1). Thirteen of the 425 patients restarted regular haemodialysis after rejection of a previously functioning graft.

There was a definite male predominanace in all the three programmes with the male to female ratio being highest in the Centre Dialysis programme. This bias resulted from selection of patients, one of the criteria being employment status. This has since been corrected and house duties are now deemed as employment. Home Dialysis patients were significantly older (39 ± 12 years, mean $\pm$ SD) than the other two groups (Centre Dialysis 33 ± 9 years ($p < 0.005$), and Self-dependency dialysis 36 ± 6 years ($p < 0.005$)) (Table II).

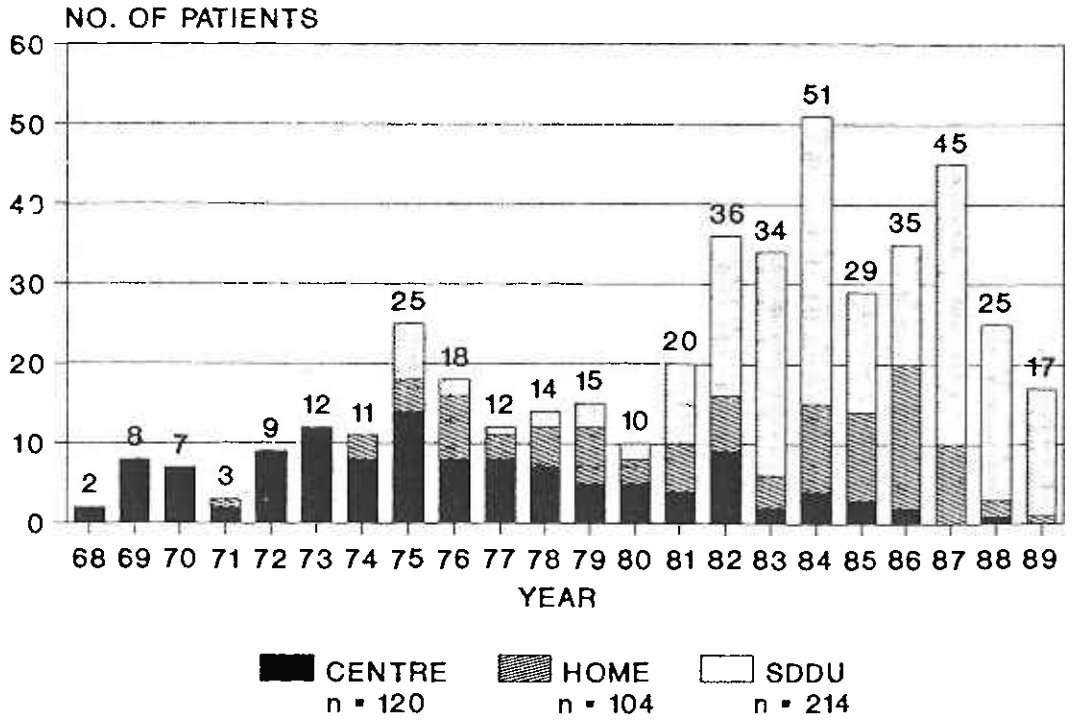
Table I
Causes of end-stage renal disease In patients starting haemodiaysis between 1968 and 1989

Cause	No. of Patients	Percentage
Chronic Glomerulonephritis	220	51.8
Diabetic Nephropathy	9	2.1
Polycystic Kidney Disease	8	1.9
Vescico-ureteric Reflux	6	1.4
Lupus Nephritis	2	0.5
Interstitial Nephritis	2	0.5
TB Kidney	1	0.2
Unknown	177	41.6
TOTAL	425	100.0

Survival

Patient survival in two groups was compared : patients who started haemodialysis before 1981 and those after and including 1981. It was in 1981 that measures had been taken to use treated water for dialysis in SGH although Alexandra Hospital had

Fig. 1 – Intake of patients into Centre Dialysis, Home Dialysis and Self-Dependency Dialysis Programmes



treated water from 1979. It was obvious that just two years after commencement of dialysis, survival was significantly better in the later group: 92.6% compared to 85.3% ($p < 0.05$) (Fig 2).

Table II
Patient Characteristics

PROGRAMME	No. of Patients	M : F	Age started dialysis (years)
Centre	113	3.2 : 1	33 ± 9*
Home	103	1.9 : 1	39 ± 12
Self-dependency	209	1.5 : 1	36 ± 6*
TOTAL	425	1.9 : 1	36 ± 9

* $p < 0.005$ compared to Home Dialysis patients

Comparing survival by centre, the survival of the Self-dialysis group is significantly higher than that compared to Home ($p < 0.001$) or Centre Dialysis patients ($p<0.001$). Significance was apparent just two years after commencement of dialysis in both Home Dialysis patients (81.3% compared with 95.0%) the Centre Dialysis patients (89.1%) (Fig 3).

There was no difference in survival between the three groups for patients starting haemodialysis in the earlier period 1968-80. However, although survival was generally better in the group starting dialysis after 1980, the Self-dialysis patients had a significantly better survival rate compared to Home Dialysis patients ($p < 0.005$) and Centre Dialysis patients ($p < 0.01$). At one year this was 97.1% for Self-dialysis patients compared to 86.7% for Centre and two years survival was 96.4% compared with 85.2% for Home patients (Fig 4).

Fig 2.
Survival of patients starting regular haemodialysis between 1968-80 and 1981-89.

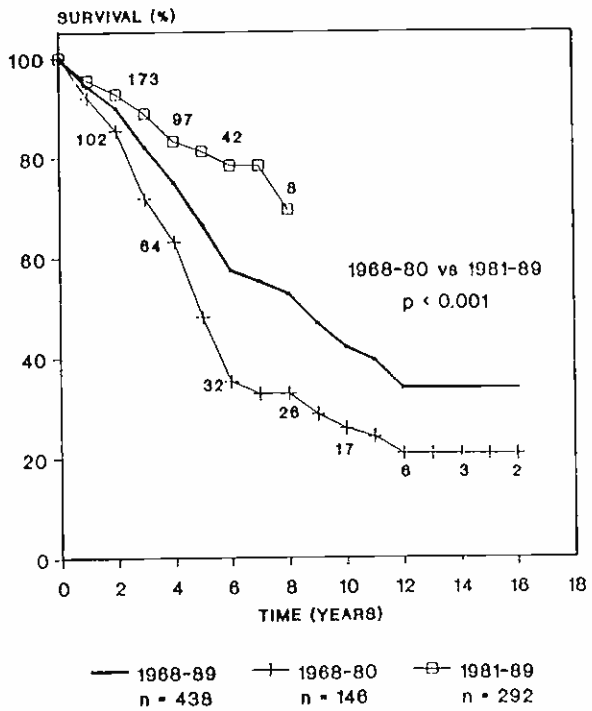
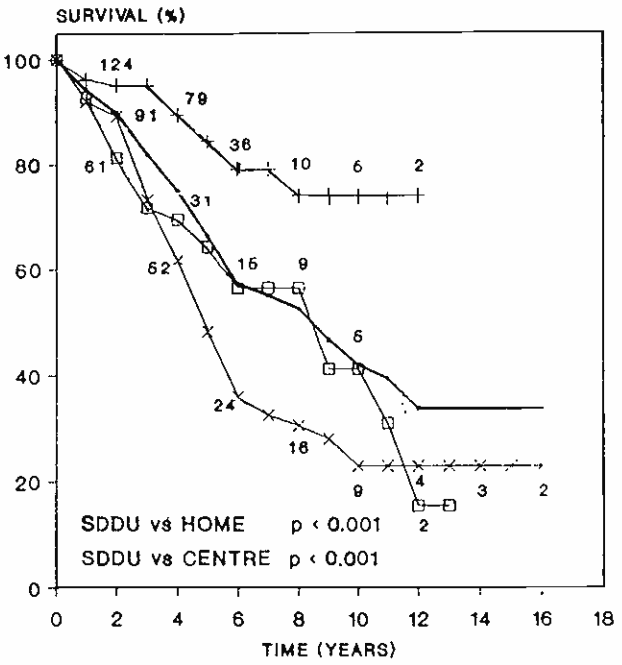


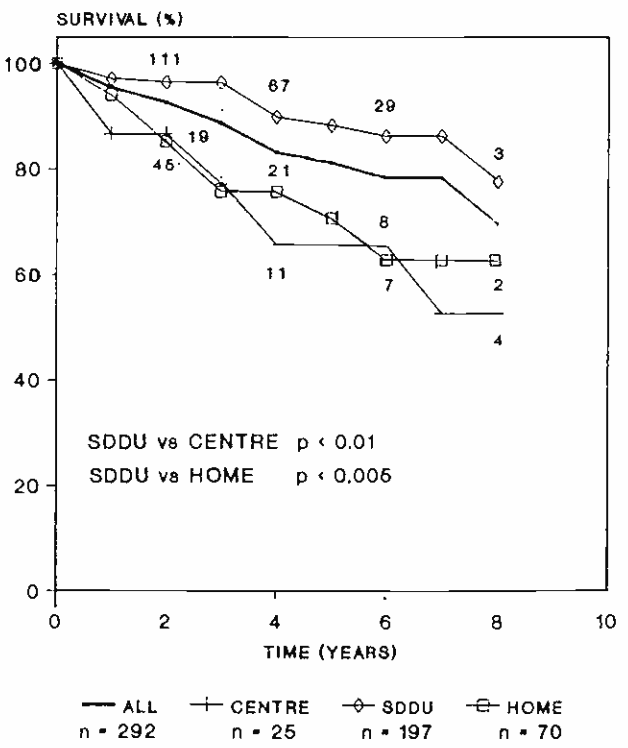
Fig 3.
Survival of patients in the 3 programmes (Centre, Home and Self-Dependency Dialysis)



Deaths

Patient mortality was also compared in two groups; those occurring before 1981 and those during or after 1981. Dialysis dementia was responsible for 44% of deaths (26/59) in the earlier period (1968-80), significantly higher ($p< 0.001$) when compared to 5% (3/57) in the later period. Of the later deaths (1981-89), these were all in patients who had started haemodialysis without

Fig 4.
Survival of patients in the three programmes (Centre, Home and Self-Dialysis) who started haemodialysis after 1980.



the benefit of treated water. Cardiovascular events and sepsis in the later period (1981-89) became the major cause of death accounting for 37% (21/57) and 23% (13/57) as compared to 22% (13/59) and 7% (4/59) respectively in the earlier years (1968-80). The proportion of patients with mortality due directly to poor compliance has not increased (4/59 vs 5/57). However all these cases occured in the Home Dialysis patients. Other causes of mortality included gastro-intestinal haemorrhage, hepatic failure, malignancy, suicide and a road traffic accident. The exact cause of death was unknown in a few patients who died at home (Table III).

Table III
Causes of death in haemodialysis patients

Cause of death	1968-80 n = 59	1981-89 n = 57
Dialysis Dementia	44 %	5 %*
Cardiovascular Events	22 %	37 %
G I Haemorrhage	8 %	2 %
Sepsis	7 %	23 %**
Poor Compliance	7 %	10 %
Others		
Suicide	2 %	2 %
Hepatic Failure	2 %	4 %
Road Traffic Accident	2 %	—
Malignancy	—	4 %
Unknown	6 %	13 %
TOTAL	100 %	100 %

* p = <0.001
** p = <0.01

Withdrawals

There were 157 withdrawals from the haemodialysis programme out of 438 entries. 73.3% received local (70.1% cadaveric and 3.2% live) transplants and 15.3% obtained foreign kidneys. 7.6% sought treatment elsewhere. 3.2% had to go onto continuous ambulatory peritoneal dialysis because of vascular access problems (Table IV).

Complications

This was compared in two groups of patients who had been on a chronic haemodialysis program for at least two years. The first group comprised patients starting haemodialysis between 1972 and 1978 (n = 30) and the second group between 1981-86 (n = 101). The more recent patient group is significantly older, 40 ± 7 years compared with the earlier group 36 ± 7 years (p < 0.01). The mean period of time they had been on regular dialysis therapy was not significant, 51 ± 5 months compared with 50 ± 20 months in the earlier group.

Serum creatinine, haemoglobin, hepatitis B antigen status and radiological surveys in 1980 for the earlier group (starting haemodialysis between 1972 and 78) and 1988 for the later group (starting haemodialysis between 1981 and 86) were compared. The later group also appeared to be better dialysed, the predialysis serum creatinine being significantly lower (p < 0.02) (Table V).

Table IV
Reasons for withdrawal from chronic haemodialysis

Reason	No. of patients	Percentage
Local Transplants – Cadaveric	110	70.1
– Live	5	3.2
Foreign Transplants	24	15.3
Treatment elsewhere	12	7.6
CAPD	5	3.2
Defaulted	1	0.6
TOTAL	157	100.0

a) *Anaemia*

Mean Haemoglobin was higher in the later group, 8.7 ± 2.2 (range 4.2 to 15.4) g/dl compared to the earlier group 7.5 ± 2.2 (range 4.6 to 13.6) g/dl. A haemoglobin of less than 7 g/dl was found in only 20% of the later group in 1988 compared with 37% of the earlier group in 1980.

Table V
Characteristics of 2 patient groups starting chronic haemodialysis between 1972-78 and 1981-86 at Dec 80 and Dec 88 respectively.

	1972-78 n = 30	1981-86 n = 101	Significance
Age (years)	36 ± 7	40 ± 7	p < 0.01
Time on Dialysis (months)	50 ± 20	51 ± 5	N.S.
Predialysis S Creatinine (mg/dl)	14.9 ± 3.2	13.6 ± 2.3	p < 0.02

b) *Hypertension*

The prevalence of hypertension, defined as a blood pressure of 160/90mm Hg or more, has fallen significantly (p < 0.005). 77% of patients were hypertensive in 1980 compared with 41% in 1988.

c) *Hepatitis*

63% of patients in the earlier group has had evidence of symptomatic hepatitis or asymptomatic elevation of transaminase levels above normal. This was significantly higher than in the later group where the incidence was only 28% (p < 0.001)

d) *Hepatitis B*

The hepatitis B carrier rate in 1980 was 13% compared with 9% in 1988. Although this figure is not significant, it must be taken into account that the less sensitive counterimmunofluorescence (CIE) method was used in 1980 compared with radioimmunoassay (RIA) in 1988.

e) *Renal Osteodystrophy*

The pattern of renal osteodytrophy was compared with regards

to prevalence of erosions (typically found at the phalanges, lateral end of the clavicles and along the sacro-iliac joints), sclerosis, osteopenia and spontaneous fractures. The prevalence of radiological bone disease has diminished with a rate of 80% in the early group compared with 50% in the later group ($p < 0.01$). There was a definite predominance in the earlier group of osteopaenia (47% compared with 13%, $p < 0.0005$) and spontaneous fractures (57% compared with 1%, $p < 0.0005$). Other features were not significantly different (Table VI).

Rehabilitation

81.9% of our male patients were gainfully employed in 1988 compared with 36.1% of the female patients. However, these figures do not take into account the fact that a number of the female patients though not employed are fully responsible for the dosmetic duties in their respective households. Of the three groups, the Home Dialysis patients have the highest rate of employment (Table VII).

Table VI
Complications of 2 groups of patients starting chronic haemodialysis between 1972-78 and 1980-86

COMPLICATION	1972-78 n = 30	1981-86 n = 119	Significance
Anaemia of Hb < 7 G/dl	37%	20%	$p < 0.1$
Hypertension	77%	41%	$p < 0.005$
Hepatitis	63%	28%	$p < 0.001$
HepBsAg Positive	13%	9%	N.S.
Radiological Bone Disease	80%	50%	$p < 0.01$
Osteopaenia	47%	13%	$p < 0.0005$
Erosions	27%	42%	N.S.
Sclerosis	10%	4%	N.S.
Pseudofractures	0%	1%	N.S.
Spontaneous fractures	57%	0%	$p < 0.0005$
Metastatic calcification	3%	2%	N.S.
Degenerative changes	3%	9%	N.S.

Table VII
Patients employed while on haemodialysis in 1988

	CENTRE (21)	SDDU (70)	HOME (28)	TOTAL (119)
Males (83)	78.6% (11/14)	80.0% (40/50)	89.5% (17/19)	81.9% (68/83)
Females (36)	42.8% (3/7)	20.0% (6/20)	55.5% (5/9)	36.1% (14/36)
TOTAL (119)	66.7% (14/21)	65.7% (46/70)	78.6% (22/28)	68.9% (82/119)

DISCUSSION

The history of maintenance haemodialysis in Singapore is just over 20 years old. Over this period of time the pattern of mortality and morbidity has changed.

Because of the scarcity of donor kidneys for renal transplantation and the expense involved in maintenance dialysis therapy, only patients with primary renal disease were accepted into the subsidised programmes. It was therefore not suprising that renal disease secondary to systemic disorders such as diabetes mellitus and systemic lupus erythematosus only accounted for 2.6% of patients with end-stage renal failure on our haemodialysis programme (Table I). This group was taken on mainly to the Home Haemodialysis programme which is fully self-supporting. There is a large group of patients (41.6%) in whom systemic causes were excluded but the original renal disease could not be elucidated as they presented to our Department in end-stage renal failure already requiring dialysis. Other than this group, the pattern of the causes of renal failure is consistent with other reports in this region(5).

In the early years, most of the patients taken on for chronic haemodialysis went on to the Centre Dialysis programme. However in later years with the opening of satellite centres in Alexandra Hospital and Tan Tock Seng Hospital, patients were trained for the Self-Dialysis programme instead (Fig 1).

More males have been accepted into the programmes reflecting the Department's policy of selecting patients on socio-economic grounds. It was more likely to find the main provider of the family being the father or the husband. Furthermore, as employment status was a consideration, female patients tended to lose out even though many of them were housewives actively occupied with domestic work. This bias has since been corrected with house duties being considered a full-time occupation since 1987.

Home Dialysis patients were significantly older. This is one of the reasons for this group of patients being unable to find a place on the subsidised programmes when competing with a younger person.

Survival rate on maintenance haemodialysis in the early years was quite dismal with a 5-year survival of about 48% compared with 81% for those who started haemodialysis after 1980. The improvement was due to the institution of treated water for haemodialysis. As early as 1972, there were reports of a debilitating dementia(6). This was later linked to aluminium toxicity from exposure to untreated water used for dialysis(7,8). Dialysis dementia caused 44% of our patients' deaths occurring prior to 1981. Subsequently cardiovascular events and sepsis became the main causes of death in our dialysis population. This pattern is similar to other reports(9,10). Deaths from under-dialysis were seen mainly in the Home Dialysis population. There is a tendency for Home Dialysis patients to cut costs as they have to bear the full expense of dialysis. There is also poorer compliance because there is no supervision at home. Patients who are not motivated therefore are less likely to do well.

There were 157 withdrawals from our programme. The majority (73.3%) left because they received cadaveric or living related transplants locally. 15.3% sought transplants in other countries.

Patients characteristics and the pattern of complications have changed over the years. Patients appear to be better dialysed. With the introduction of better dialysis machines, dialysers and newer membranes, the efficiency of haemodialysis has improved. Nowadays patients dialyse 4 hours each session instead of 6 to 8 hours. This later group of patients are older. Another important event was the introduction of treated water around 1980. With this, dialysis dementia virtually disappeared.

Although later patients (after 1980) are less anaemic than the earlier ones (before 1980) the difference was not significant. Aluminium toxicity has been shown to cause microcytic anaemia(11). Dialysers now have smaller blood compartment

volume. In the event of a dialyser clotting blood loss is less. Hypertension is less of a problem now though still prevalent. Better dialysers with higher ultrafiltration coefficient are able to remove more fluid in a shorter time. Patients having better understanding of their condition through intensive education during their training period in preparation for Home or Self-Dialysis and motivation may be more compliant with antihypertensive theraphy, fluid and salt restriction.

There was a higher incidence of hepatitis in the early years. This complication of haemodialysis resulting from cross-infection is well known(12). 63% of our patients on dialysis in 1980 have experienced hepatitis compared to 28% in 1988. The congested surroundings in the old SGH converted attic probably contributed to the spread of bloodborne hepatitis (B as well as non-A non-B). A vaccination programme for hepatitis B was started in 1981. Patients were also encouraged to be vaccinated if they had not previously been exposed. It is still current practice to segregate hepatitis B antigen-positive patients from antigen-negative ones. Although the prevalence of hepatitis B antigenaemia is lower, this is statistically not significant. However the assay used in 1980 was the much less sensitive counterimmunoelectrophoresis. If a similar test had been applied, we expect that the difference would be significant. A recent survey of our chronic haemodialysis patients shows 30% positivity for hepatitis C antibody using the Ortho Diagnostics Systems Enzyme Immunoassay(13).

The prevalence of radiologically evident renal osteodystrophy has decreased. Moreover, the pattern of disease is different. There were much more patients with spontaneous fractures and osteopaenia in the group dialysing in 1980. This is consistent with dialysis osteomalacia caused by aluminium toxicity(14,15). With the use of treated water haemodialysis, this radiological picture has disappeared. However, there has been reports of aluminium toxicity due to the use of aluminium hydroxide as a phosphate binder(16-18). The first choice of a phosphate binder is now calcium carbonate. With its use, there has been reports of reversal of aluminium related bone disease after discontinuing aluminium hydroxide(19).

Erosions were radiologically more prevalent though statistically not significant in the later group. This is consistent with secondary hyperparathyroidism. Although there are vitamin D analogues in the market currently, they are not freely available to our patients because of the expense invloved. Hence the high rate of radiological abnormality from renal osteodystrophy in the later group.

Rehabilitation is successful in most cases with 81.9% of our male patients being employed.

CONCLUSION

The outlook for a patient today, going on regular maintenance haemodialysis, is better in terms of survival and morbidity than before 1980. This is especially important in our context where the scarcity of cadaveric kidneys for transplantation lead patients to turn to maintenance haemodialysis as an alternative treatment for end stage renal failure.

Dialysis dementia and dialysis osteomalacia appear to have been eradicated with the use of treated water. Aluminium toxicity may now be from the oral route with use of aluminium hydroxide as phosphate binder. There seems to be less cross-infection as evidence by a lower incidence of hepatitis. The prevalence of hepatitis B antigen is also lower. Under-dialysis in the Home Dialysis patients remains a problem due to difficulty in adequate supervision at home and the costs involved.

There is still scope for improvement as we look towards using bicarbonate thereby reducing some of the side effects of acetate dialysis and even better dialysers in an attempt to shorten dialysis hours without compromising the adequacy of dialysis.

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