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11TH REPORT OF THE MALAYSIAN DIALYSIS & TRANSPLANT REGISTRY 2003

Review of Dialysis Provision 1980 to 2003
Survey of Dialysis Practices 1993-2002
Analysis of RRT Outcomes 1997 - 2002

Edited by

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The Dialysis Association of
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FOREWORD

This special 11th Report reviews the progress made and looks at the trends in renal replacement therapy (RRT) over the years from 1980 to 2003, dialysis practices from 1993 to 2002 and analysis of RRT outcomes from 1997 to 2002. It has been a remarkable two decades. Starting from near the bottom of the league table of renal replacement program we have now moved to a more respectable position. While a lot more needs to be done, the achievements to date have been considerable. Everyone involved in the provision and management of RRT can be justifiably proud of the progress made. The National Renal Registry started with modest aspirations and even less resources. It has now consolidated its management, acquired new resources especially in IT and has reached out to all providers of RRT. Its single most important achievement in this period under review has been to garner the trust and cooperation of all providers who willingly submitted data regularly. Its management approach of keeping in regular contact with the providers, being responsive to their needs, meeting all deadlines goes a long way in ensuring success. Two key individuals, Dr Lim Teck Onn and Ms Lee Day Guat, played key roles in the success of the National Renal Registry thus far. Their drive, enthusiasm, management skills, obsessive attention to details are the critical success factors of the registry.

The number of new patients taken in for dialysis increased by more than 6.5 times over the last 10 year period. A truism shown in all countries is consistently seen in this report i.e. you can only treat that many you can afford. As the country's Gross domestic product increases so does the number of new patients taken in for dialysis. However for a country with an income and status of a developing nation, we see a pattern in our dialysis patients that is more commonly seen in the rich industrialized countries. Nearly half of the new patients taken in for dialysis were diabetics and the dialysis acceptance rates were highest amongst the older age groups. In these groups the acceptance rates continue to increase sharply.

A number of interesting features are seen in this report. The survival of dialysis patients in recent cohorts is lower than the earlier ones. Whether this is a reflection of the rapid proliferation of dialysis centers in recent years with the attendant problems of lack of experienced staff and supervising nephrologists is left to be seen in more detailed studies. Nonetheless it is a cause for concern. An economic evaluation of the cost of dialysis was included in this report. This was a study done on the Ministry of Health's dialysis program. The cost per life year saved on haemodialysis was quite similar to that for CAPD. This has important implications for the planning of future RRT program. For this 10 year review expert panels were formed to look into selected clinical areas in greater detail than the usual annual reports. While most of the findings are in keeping with reports in the literature and other registry publications, there are a few that warrants further study as they showed differing trends.

It would appear that taking in more patients for treatment will not pose a major hurdle given the trend seen in the last ten years and provided the country's economy continue to grow. A major challenge now confronts all RRT providers; where do we go from here and how can we build on this success. We now have to focus more on improving outcomes through improvements in the quality of treatment that we provide. The NRR can play an important role in this respect. Given the network it has established, the database it accumulated and the goodwill it has generated it would not be too difficult a task for the NRR to take on this new responsibility of promoting quality initiatives through regular monitoring and analysis of outcomes.

DR ZAKI MORAD
Chairman,
National Renal Registry.

ACKNOWLEDGEMENTS

We owe grateful thanks to a multitude of people to get this - the Eleventh Report of the Malaysian Dialysis and Transplant Registry 2003 to fruition.

We would especially like to thank the following (in no particular order):

Our source data providers :

The nephrologists, physicians and staff of dialysis and transplant centres from the various government, university, non-government and private centres, without whose commitment, toil and tears, and timely data submission there will be no report.

The members of the various panels for their expertise and of course for devoting their valuable time and effort in preparing and writing the various chapters.

Director of the National Registration Department (Jabatan Pendaftaran Negara), for allowing us to verify the status of those patient lost to follow-up.

And of course not forgetting our supporters from the industry and other well-wishers:
Fresenius Medical Care

Baxter Healthcare (Asia)
Gambro
MX Services

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And all others who have in one way or another contributed towards the success and the publication of this report.

Dr. Zaki Morad
Chairman
National Renal Registry

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205 Seberang Perai Haemodialysis Centre, Bagan Specialist Centre
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215 Sik Hospital
216 SJAM-KPS Haemodialysis Centre, Kampar
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245 Traktif Specialist Dialysis Centre
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250 University Malaya Medical Centre
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253 Yayasan Dialisis Pertubohan Pendidikan Akhlak-NKF, Taiping
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ABOUT THE NATIONAL RENAL REGISTRY

The National Renal Registry (NRR) collects information about patients on renal replacement therapy (RRT) in Malaysia. This information is needed for the estimation of treatment rates in the country, as well as to assist the Ministry of Health (MOH), Non-Governmental Organization, private providers and industry in the planning and evaluation of RRT services.

The National Renal Registry (NRR) has its origin in the Dialysis and Transplant Registry established by the Department of Nephrology in 1992 to collect data from patients on renal replacement therapy within the MOH. In order to expand coverage to include all patients on RRT in the country so that the registry may truly claim to be a national one, the Malaysian Society of Nephrology (MSN) was invited to co-sponsor the registry in 1995. In 2001, the Clinical Research Centre of the MOH was designated as NRR collaborating unit to provide clinical operational, biostatistical and data management capabilities to support the operations of the NRR. The Dialysis Association of Medical Assistant and Nurses (DAMAN), a key professional counterpart to MSN, also agrees to co-own the NRR in 2002.

The objectives of NRR are to:

1. Determine the frequency and distribution of dialysis and transplantation in Malaysia. These are useful measures of the health burden arising of end stage renal failure and its treatment provision in the country
2. Determine the outcomes, and factors influencing outcomes of dialysis and renal transplantation. This serves the needs of outcome assessment.
3. Evaluate RRT program. This serves the need of accountability.
4. Stimulate and facilitate research on RRT and ESRD.
5. Maintain the national renal transplant waiting list.

The NRR receives data on RRT from 2 main sources:

1. The National Vital Registration system (Jabatan Pendaftaran Negara). These data are useful for determining or verifying mortality outcomes of patients on RRT.
2. The most important data sources are the individual doctors, medical assistants and nurses who care for patients on RRT, and voluntarily report data to the NRR.

NRR SPONSORS

Malaysian Society of Nephrology

Dialysis Association of Medical Assistant and Nurses

Clinical Research Centre, Kuala Lumpur Hospital.

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Ms. Lee Day Guat	
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Ms. Asma Abdullah	

EXPERT PANEL

For each chapter of this report, the NRR established an expert panel comprising nephrologists and allied health professionals where relevant with expert knowledge in the area concerned.

The tasks of the Expert Panel were:
1. To undertake Quality Control of the reported data
2. To undertake literature review in the area relevant to the panel
3. To interpret the results presented in the NRR report
4. To write the chapter of the report relevant to the panel's expertise

Hence the contributors of the various chapters in this Report are:

Chapter Title	Expert Panel Members	Institution/company
Chapter 1: All RRT in Malaysia	Lim Yam Ngo *(Chairperson)*	Kuala Lumpur Hospital
	Lim Teck Onn	Clinical Research Centre
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	Lim Teck Onn	Clinical Research Centre
Chapter 3: Dialysis Survival	Wan Shaariah Bt Md Yusuf *(Chairperson)*	Seremban Hospital
	Wong Hin Seng	Kuala Lumpur Hospital
	Ong Loke Meng	Pulau Pinang Hospital
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	Rafidah Abdullah	Selayang Hospital

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	Tharmaratnam A/L Rasanayagam	Tg. Ampuan Rahimah Hospital
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	Foo Sui Mei	Ipoh Hospital
	Indralingam Vaithiligam	Taiping Hospital
Chapter 12: Vascular Access Infection	Teo Sue Mei *(Chairperson)*	Ipoh Hospital
	Claire Tan Hui Hong	Sarawak Hospital
	Foo Sui Mei	Ipoh Hospital
	Indralingam Vaithiligam	Taiping Hospital
Chapter 13: Dialysis Adequacy	Tan Si Yen *(Chairperson)*	University Malaya Medical Centre
	Chang Sean Haw	University Malaya Medical Centre
	Sukeri Mohamad	Kota Bharu Hospital
Chapter 14: Paediatric RRT	Lee Ming Lee *(Chairperson)*	Seremban Hospital
	Susan Pee	Sultanah Aminah Hospital
	Lynster Liaw	Pulau Pinang Hospital
	Wan Jazilah Wan Ismail	Selayang Hospital

CLINICAL RESEARCH CENTRE

The Clinical Research Centre (CRC) is the designated collaborating unit to the NRR. It provides the functional capacity to support the operations of the NRR.

The CRC is the clinical research arm of the Ministry of Health. Apart from the NRR, CRC currently also supports the National Cancer Registry, National Cataract Surgery Registry, National Neonatal Registry, National Mental Health Registry, National HIV/AIDS Treatment Registry and National Transplant Registry.

In recent years, CRC has emerged to become the preferred collaborating partner for medical professional groups to establish disease and treatment registers in the country. This is because CRC possesses sophisticated facility and equipment, state of the art technology, and most importantly the trained human resources such as registry managers, clinical epidemiologists, biostatisticians, information technology professionals and other supporting staff skilled in registry operations. These resources are consolidated in the Disease and Treatment Registry Unit in the CRC. This unit specializes in assisting medical professionals to establish and operate their registries.

Staff of the Clinical Research Centre (CRC) and Renal Registry Unit (RRU) of Disease & Treatment Registry Unit (DTRU)

Director	Dr. Zaki Morad B Mohamad Zaher
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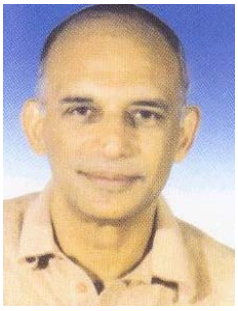
NEPHROLOGY IN MALAYSIA: THEN AND NOW

Introduction

Nephrology as a separate clinical specialty developed in Malaysia only in the early 1970s. Before this time the general physicians took the burden of looking after patients with renal problems (as they did with all other medical conditions). Often there was only one physician in each state (the state physician) and he was kept busy with malaria, tuberculosis, typhoid and other infectious diseases. In the annual reports of the Federation of Malaya in the mid 1940s there was little mention of renal diseases apart from acute and chronic nephritis.

The early pioneers

Dr . G. Sreenevasan



Dr. S. S . Gill

Dr. Florence Wang

Dr . Abu Bakar Suleiman

In 1964 the Ministry of Health purchased the first Haemodialysis machine, a Kolff haemodialysis machine, in the country at the request of Dr.G Sreenevasan (now Dato' Dr. G Sreenevasan) who had just returned from the U.K. after training in Urology. This machine was placed in Hospital Kuala Lumpur and used for the treatment of acute renal failure particularly due to urinary tract obstruction. Between 1964 and 1968, 85 haemodialysis treatments were performed. Patients with end stage renal failure (ESRF) at this time did not receive any definitive treatment. It was not until 1966 that an attempt was made to treat end stage renal failure on a more long-term basis. In that year the plight of a young man by the name of Harry Kydd caught the public's attention and a dialysis machine was bought through public donations and placed in Assunta Hospital. He survived on chronic haemodialysis for a few months. Dr. S.S. Gill who looked after him had just returned from training in Haemodialysis and Nephrology at Seattle, USA under Professor Scribner. Dr Gill was the first to develop a private haemodialysis centre. He later became involved in the National Kidney Foundation and presently is its chairman.

teacher artificial kidney

TEACHERS and former pupils of the Methodist Boys Primary School in Jalan Davidson are rallying to the aid of Mr. Harry Kydd, a teacher and an old boy of the school, whose life depends on a $30,000 artificial kidney.

Mr. Kydd, 25, who is married with two small children, is suffering from nephritis, a chronic kidney disease.

Donations

Doctors at the Assunta Hospital, where he has been since early this month, have given him six months to live at the most unless an artificial kidney machine is available to purify his blood.

Following the publication of his plight in the Straits Times today, the headmaster of his school, Mr. Gan Cheong Chiah, said that he had launched a fund-raising campaign to buy an artificial kidney.

Mr Gan said: "I want to do all I can for him."

Mr. Gan said that he started the ball rolling for the fund with promised donations totalling $1,000 from the teachers and old boys of the school.

Mr. Gan said that the Methodist Boys School Old Boys Association was also rallying to help Mr. Kydd.

Meanwhile, a spokesman of the Assunta Hospital said that though an artificial kidney machine was available in Singapore, it was not the type required to keep Mr. Kydd alive.

He said that he had also written to the Ministry of Health to help supply the machine his patient required but he had been informed that the Government was not in a position to help.

KUALA LUMPUR, Wed.

The only way

"The only way we can save his life now is for us to raise enough money to buy the right machine," he added.

Donations may be sent to the Headmaster, Methodists Boys Primary School, Jalan Davidson, Kuala Lumpur.

In SINGAPORE, the Lions Club today, presented a cheque for $9,210 for the purchase of a second artificial kidney for use in the Department of Clinical Medicine at the General Hospital.

The cheque was presented to the Vice-Chancellor of the University of Singapore, Dr...

Left: Newspaper reports on the appeal for help to purchase a Haemodialysis machine for Mr Harry Kydd.

Dr. Florence Wang joined the University of Malaya as an Associate Professor in Medicine. She had received training in nephrology in the USA. However the policies and priorities of the Faculty of Medicine and the teaching Hospital then did not allow the development of any subspecialty. Dr. Florence Wang took a keen interest in many aspects of nephrology and was particularly known for her work in SLE nephritis.

Nephrology in Malaysia developed rapidly only from 1975 through the initiatives and efforts of the Ministry of Health. In 1974 the Ministry sent a young physician Dr. Abu Bakar bin Dato' Suleiman for training in Nephrology in Washington, USA and Melbourne, Australia. On his return in 1975, he headed the Nephrology unit at Hospital Kuala Lumpur (HKL). The unit was part of the Department of Urology which was headed by Dr. Hussein Awang who had just taken over from Dr. Sreenevasan following the latter's retirement. Dr. Hussein Awang (now Dato' Hussein Awang) and Dr. Abu Bakar Suleiman are cousins. The close working relationship between the urologists and the nephrologists in the Ministry of Health stemmed from this very beginning. It was facilitated in no small way by the physical structure of the Institute of Urology and Nephrology in which they share many common facilities, not the least important being a common tea room! This was indeed a great foresight by Dato' G Sreenevasan who was instrumental in planning the Institute of Urology and Nephrology at Hospital Kuala Lumpur. He proposed then that there should be recruitment and training of renal physicians (and indeed suggested that the Department should have at least three such physicians), a renal pathologist and a radiologist in addition to dialysis nurses and technicians. Much of what has been achieved to date in both fields came from the work of doctors in the Institute.

In 1976 the Nephrology unit was upgraded to a full department of the hospital and Dr. Abu Bakar Suleiman became its first head. He took on the job with zest and became the principal architect of the subsequent development of nephrology services in the country. For most of the time he worked alone until 1981 when others joined to train in nephrology or returned form overseas after completing their training. The very early ones included Dr Izham Cheong, Dr Zaki Morad and Dr Norella Kong. Dr Zaki Morad subsequently took over the job of head of the Department of Nephrology from Dr Abu Bakar Suleiman in 1987; while Dr Izham Cheong went on to establish the Nephrology unit in the Department of Medicine, National University of Malaysia. He was soon joined by Dr Norella Kong. Both later became Professors of Medicine in the University. In the University of Malaya, Professor Florence Wang was joined by Dr Chua Chin Teong who also became a Professor of Medicine later. Dr Abu Bakar Suleiman went on to assume the post of Director of Medical Services in the Ministry of Health and subsequently became its Director General. During his tenure he made a great impact on the delivery of healthcare in the country emphasizing the need for quality and ethical practice.

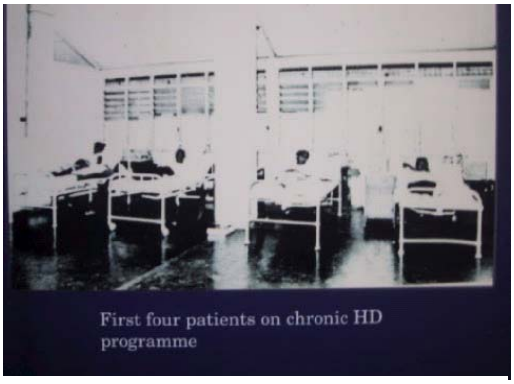
Paediatric Nephrology had its beginnings in University of Malaya in the 1970s where Professor Lam Khuan Leng took an interest in the specialty and provided renal biopsy services for the whole country. Dr Fabiola de Cruz became the second paediatrician to train in the field. In the Ministry of Health Pediatric Nephrology developed later when Dr. Indon Lajim returned in 1983 following training in UK. She was later joined by Dr Lim Yam Ngo who is the current head of Paediatric Nephrology services in the Ministry.

Renal pathology services were not readily available then and now. The late Professor K Prathap of the Department of Pathology, University of Malaya provided such service in the early years. Subsequently a number of pathologists took an interest in renal pathology and went for training. They include Dr Chong Siew Meng (who later left to work in Singapore), Dr. Looi Lai Meng, Dr Phang Koon Seng and Dr Cheah Phaik Leng.

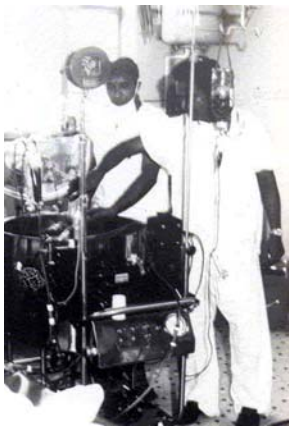
The long-term Haemodialysis treatment programme – the beginnings

The first long-term haemodialysis programme was initiated by Assunta Hospital with a machine donated by the public. In the Ministry of Health it was started by a Urologist. When Dr G Sreenevasan proposed the building of the Institute of Urology and Nephrology at hospital Kuala Lumpur, he also proposed the setting up of a haemodialysis unit that could dialyse six patients. The first haemodialysis unit was set-up in the old Ward 4 of Hospital Kuala Lumpur in 1969. The first patient to be taken in for long term Haemodialysis treatment, Mohamad Sabawi bin Mat Jidin, survived for more than three years. Few of the remaining eighteen patients taken in during the first year survived more than a few months. A two tank dialysis system was used and this was replaced by the Biosystem multiple dialysis unit in October 1970. Two medical assistants Mr. Hanip Che Man and Mr. Tan Teck Khiam underwent training in the United States and were responsible for the operations and maintenance of the dialysis machines. The unit produced its own dialysate with the help of the Hospital Pharmacist Mr Lee Sze Peng at a cost of 50 cents per litre. The commercially available solution, which was imported, was $2.88 per litre. The dialyser used after the first few years was the Kiil dialyser which took time to assemble. As there were no Nephrologists at that time the care of the medical problems of this pioneer batch of dialysis patients were undertaken by the general physicians. They included Dr K Sarvanathan, Dr Lloyd Thuraisingham and Dr Rahim Omar.

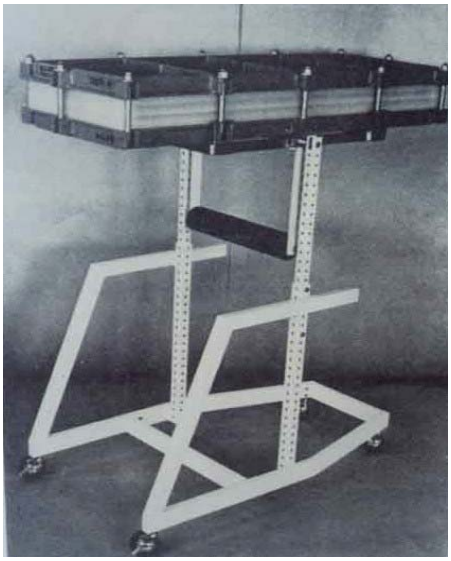
The first Haemodialysis unit with six beds was set up in the old ward 4 of Hospital Kuala Lumpur.



Above: The first Haemodialysis unit in the Ministry of Health



Right: The first Haemodialysis machine in Malaysia



The Kiil Dialysis machine was the standard dialysis machine in the late 70's

As often happens in any new venture fortuitous intervention sometimes plays an important role. Mr. G Sreenevasan received help from none other than the Prime Minister himself. The late Tunku Abdul Rahman had a close friend who had end stage renal failure and had to travel from Alor Star to Kuala Lumpur for dialysis. The Tunku wrote to the Minister of Health requesting the Urology unit to be set up. There was also an unknown British gentleman who donated to the Minister of Finance (the late Tun Tan Siew Sin) a sum of four thousand pounds to set up the Urology and Dialysis unit.

In the early days vascular access was via a Scribner shunt. Two Teflon catheters, one in the artery and one in the vein were connected by a Silastic tube. The shunt frequently clotted and one of the major duties of the Medical officer on call was to de-clot the shunt. It was only in 1977 that Dr Prohoeman, another Urologist working with Mr. Sreenevasan started doing the Brescio-Cimino arteriovenous fistula which became the standard vascular access even to this day.

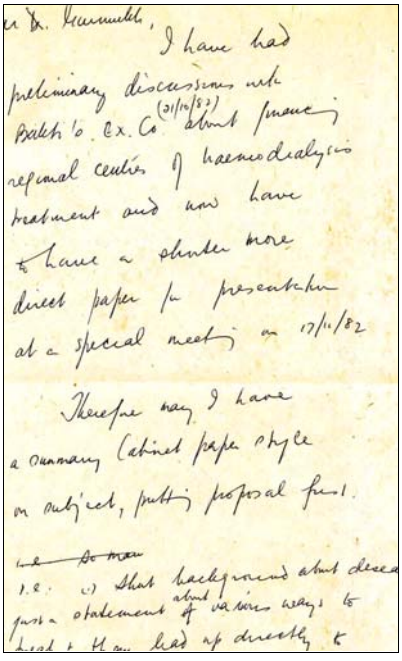
Long-term Haemodialysis programme – the subsequent years.

From the late 1960s to the beginning of the 1980s haemodialysis facilities was available only in Kuala Lumpur in both the private and public sectors. Patients requiring haemodialysis treatment especially those with acute renal failure had to be transported to Hospital Kuala Lumpur. Those few who were accepted for long-term haemodialysis treatment had to relocate themselves and their families to Kuala Lumpur.

As the haemodialysis facilities in HKL were limited, prioritisation was necessary and the department of Nephrology developed guidelines on the use of government haemodialysis facilities. Patients with acute renal failure received priority in the use of such facilities, followed by patients who were being prepared for renal transplantation. Patients who had their transplants done in Hospital Kuala Lumpur and whose grafts subsequently failed also received priority on the use of the haemodialysis facilities. Government servants and their dependants were also taken into the long-term dialysis programme.

The inconveniences that patients and their families had to suffer in order to receive long term haemodialysis treatment at Hospital Kuala Lumpur led Dr. Abu Bakar Suleiman to develop the Home Haemodialysis programme in 1979. Patients purchased their own haemodialysis machines and disposable and performed haemodialysis treatment in their own homes. They received three months of training on the procedure at Hospital Kuala Lumpur. These patients returned to the hospital at three monthly intervals for follow up. In between these clinic visits they were managed by the local physicians or General Practitioners if they had intercurrent medical problems. This programme was highly successful as it provided opportunities for patients who did not wish to relocate themselves to Kuala Lumpur to receive treatment. At its height there were more than 350 patients doing dialysis at home, which might even be as far away as Sabah or Sarawak. The very first patient on the Home Haemodialysis programme in 1979, a nurse, continued to do dialysis at her home in Sibu, Sarawak till her death in April 2000.

At its height there were more than 350 Home Hemodialysis patients . Home HD was carried out in the most unlikely places. The above photograph showed a well used to supply water for Home HD



The above letter from the secretary of BAKTI initiated a series of actions that culminated in the opening of six haemodialysis centres outside Kuala Lumpur in 1984

In 1984 with the financial assistance of BAKTI (Association of Wives of Cabinet Ministers) which contributed $800,000, the Department of Nephrology with the support of the Ministry started six haemodialysis units- one each in Hospital Alor Star, Hospital Penang, Hospital Ipoh, Hospital Johor Bahru, Hospital Lau King Howe, Sibu and Hospital Queen Elizabeth, Kota Kinabalu, Sabah.

Realising the crucial role played by nurses in Haemodialysis treatment Dr Abu Bakar started a post basic renal nursing course in 1984 in conjunction with the nursing division of the Ministry of Health. The course proved to be popular and to date has produced more than 1200 renal-trained nurses and medical assistants. Two nursing tutors who played important roles in developing and running the course were Mr. Pasupathy and Ms Chong Kwai Fong. The course was initially for three months but was extended to six months soon after starting.

In the early 1980s a number of very capable nurses and medical assistants played important roles in assisting Dr Abu Bakar in consolidating and expanding the long-term haemodialysis programme. They not only looked after the patients but supervised the home haemodialysis programme, managed the unit including the supplies of disposables and consumables and even did maintenance and repair works on the machines. They include Mr. Hanip Che Man, Mr. T Satkunasingam, Mr. Ngatiman Tular, Ms Mok Yoke Lan, Ms Choo Soke Har, Ms Lee Day Guat, Ms Jeyarani and Ms Samporanam. Most continued to work in the haemodialysis field till today, each accumulating almost three decades of experience in haemodialysis nursing.

When Dr Abu Bakar left for the Ministry of Health in 1987, Dr Zaki Morad took over the running of the Department and with it the responsibility of developing the service nationwide. Dr Zaki Morad expanded the Haemodialysis programme in a phased development. It began with developing dialysis units in the remaining general hospitals and later in large district hospitals like Hospital Muar, Taiping and Teluk Intan. Subsequently Haemodialysis units were built in all district hospitals. In the last ten years CAPD units were opened in similar fashion although they are currently limited to all general and large district hospitals. By the end of 2004 all of the 130 hospitals in the Ministry of Health will have a haemodialysis unit. Dr Zaki Morad introduced a number quality initiative efforts including a document on Standards and Quality in Haemodialysis which became the standard for Haemodialysis treatment in the Ministry. In 1996 he initiated the development of Practice Guidelines in Renal Replacement Therapy for the Ministry of Health. This guideline is now undergoing a revision.

He intensified the training programme for Nephrologists and structured it by introducing a syllabus, a log book, and more recently an exit evaluation where trainees are assessed by local and external examiners. When he was appointed the Director of Clinical Research Centre (CRC) of the Ministry of Health, he involved the nephrologists in research and it is no mere coincidence that the main research work of the CRC is nephrology centred.

The early period of rapid growth of Haemodialysis facilities and Nephrology services outside the Klang Valley was not matched by the number of available nephrologists. The burden of providing nephrology services countrywide fell on the Department of Nephrology Hospital Kuala Lumpur. Drs Abu Bakar and Zaki Morad and later joined S. Prasad Menon and Fan Kin Sing criss-crossed the country to run clinics, perform renal biopsies and conduct Continuing Medical Education for the doctors. They travelled by road to nearby state capitals or by air to more distant hospitals including those in Sabah and Sarawak; in one location in Sarawak they crossed a river in a ferry to reach the dialysis centre. Those were hectic but nonetheless most rewarding times.

Despite the rapid growth of Haemodialysis units in the Ministry, the demand for the treatment far exceeded the available facilities. In the late 1980s, Government departments purchased Haemodialysis machines and placed them in their premises for the use of staff that had ESRD.

As the county's economy improved, more and more patients with ESRD could afford haemodialysis treatment and this led to the rapid development of haemodialysis centres in the private sector. There are now an estimated 74 centres in the private hospitals and clinics, many of which are small sized units and located in the west coast of peninsular Malaysia particularly the Klang Valley.

A development unique to Malaysia is the establishment of the Non-governmental, not for profit dialysis centres. These centres provide haemodialysis treatment for those who are unable to afford the private haemodialysis treatment and were not accepted for the MOH Haemodialysis programme. These NGO Haemodialysis centres as they are known are of varied background. Many are started by service clubs such as Rotary or Lions while others are funded and run by Religious bodies. The largest group of NGO Haemodialysis centres is run by the National Kidney Foundation which started the very first of such centres in Jalan Hang Lekiu, Kuala Lumpur in 1993 with the assistance of the Ministry of Social Welfare. As of December 2003 there are 72 such centres. In 2001 the then Minister of Finance Tun Zaim Zainuddin announced in the budget speech that the government would provide subsidy to all these NGO Haemodialysis centres that provide treatment to deserving patients. These centres receive RM50 for each haemodialysis treatment they do on deserving patients and they are not allowed to charge these patients more than RM60. This gesture by the government helped boost the number of NGO dialysis centres as well as allow them to focus on providing quality treatment and not be distracted by the need to raise funds all the time. The government also subsidises the purchase of Haemodialysis machines and related hardware by these NGOs. The Ministry of Finance channelled this subsidy through the Ministry of Health, which appointed the National Kidney Foundation to manage the subsidy programme.

Renal Transplantation

Dr. Hussein Awang performed the first renal transplantation in Malaysia on 15th December 1975. The patient, Mr. Martin Rinyeb form Sarawak continues to enjoy normal renal function today, twenty-eight years after the surgery. More than a thousand renal transplantation has been done until now and in the vast majority the kidneys were obtained from live related donors. Cadaveric transplantation although started early in 1976 did not take off until more recently.

Mr Martin Rinyeb (right) became the first person to undergo a renal transplant surgery in Malaysia after he received a kidney from his brother Augustine

The immunosuppression protocol evolved over the years from high dose steroids and Azathioprine to Steroids and Azathioprine with donor specific transfusion to the current one of triple immunosuppression consisting of Prednisolone, Mycophenolate mofetil and Cyclosporine/Tacrolimus. Cyclosporin was used routinely in all new patients receiving a kidney transplant from 1991 onwards. It was first used in 1988 in children and those adult recipients who were not able to receive donor specific blood transfusion.

Apart from Hospital Kuala Lumpur, the University Malaya Medical Centre, and Selayang Hospital do renal transplantation on a regular basis. A few private hospitals do renal transplantation occasionally. The demand for kidney transplantation is high and patients desirous of such surgery but did not have a live related donor had resorted to getting kidneys from live unrelated donors mainly from India or commercial cadaveric donors from China. Such forms of transplantation exceeded the number of live related kidney transplantation done locally. The lack of suitable live related donors led to the use of emotionally related donors. University of Malaya Medical Centre performed the first spousal transplantation in Malaysia. This form of transplantation is also now carried out in Hospital Kuala Lumpur and Hospital Selayang.

Peritoneal dialysis

Peritoneal dialysis as a treatment for acute renal failure as well as a temporary treatment for ESRF was available in the country as early as the late 1960s. Dr. G Sreenevasan introduced the treatment in 1966 in patients with acute renal failure. With the development of permanent indwelling catheters, it became possible to do peritoneal dialysis on a long term basis and in 1978, Popovich, Moncrief and Nolph described a technique called Continuous Ambulatory Peritoneal Dialysis or CAPD for short. This was introduced in Hospital Kuala Lumpur in 1984 and increased the treatment options for ESRD patients. The system used then was from Travenol (which is now known as Baxter). University Hospital, Kuala Lumpur had offered the treatment earlier with a couple of patients in 1981. This treatment modality is now available in all major MOH and University hospitals but not in the private sector. The success of CAPD is very much dependant on capable nurses and in the Ministry of Health, two such nurses Rajakumari a/p Arunasalam and Tan Poh Choo were the pioneers who contributed greatly to the success of the programme. Tan Poh Choo continues to work in CAPD till today. In the early months they received considerable help from Ms Margaret Jones who worked with Baxter as a CAPD nurse specialist. The very first patient on CAPD was a policeman Encik Hussin Abdul Rahman who continued to work as a policeman while on treatment. He started on 28th May 1984 and died four years later from a cerebrovascular accident.

The 10th Anniversary of the start of CAPD in the Ministry of Health was held in 1994. Seen above are the three nurses who initiated the program: Margaret Jones from Baxter, Tan Poh Choo and Rajeswari from the Dept of Nephrology of HKL. Also in the photograph are Dr Abu Bakar Suleiman, Dr Zaki Morad and Mr T.S. Singam

General nephrology

Haemodialysis and transplantation appear to be the most visible part of nephrology practice. Nonetheless over the years since the formal establishment of the Department of Nephrology, many advances have been made in the management of nephrological conditions including glomerulonephritis, pyelonephritis, and renal stone diseases. Renal biopsies was utilised frequently in the diagnosis of glomerular diseases since the early 1970s. At the beginning it was done only at General Hospital Kuala Lumpur and University Hospital Kuala Lumpur but subsequently the procedure could be done at many of the other hospitals where nephrologists are stationed. A few pathologists such as Professor Looi Lai Meng (University of Malaya), Dr. Chong Siew Meng (now in Singapore) and Dr. K.S. Phang (University Kebangsaan Malaysia) developed special interest in renal pathology and contributed greatly to the improved quality of diagnosis of glomerular diseases.

There are also others who contributed over the years to the improved diagnostic services for nephrological conditions with the introduction of radionuclear techniques which enabled better assessment of renal function; and interventional radiology which enabled some patients to have certain lesions corrected without open surgery.

Training of nephrologists

The Department of Nephrology at Hospital Kuala Lumpur has as one of its main functions the training of nephrologists to meet the country's needs. Soon after organising the Department, Dr. Abu Bakar Suleiman started recruiting physicians to train in the field. To date more than fifty have been trained. Approximately half have left to join the private sector while the rest continue to serve in the Ministry. Training has also been more organised and structured now and as part of the training the trainees are sent for clinical attachment in centres of excellence overseas. Nephrology services were upgraded in a number of hospitals where trained nephrologists were posted. Apart from the Department of Nephrology, University Hospitals also had training programmes. The majority of the nephrologists in the country however were trained in Hospital Kuala Lumpur.

National Renal Registry

In 1992 the Department of Nephrology initiated the establishment of the National Renal Registry. The Malaysian Society of Nephrology was invited to be a co-sponsor of the registry and contributed to its running and funding. The Registry which collects data on treated ESRD patients is highly successful and proved to be an invaluable source of information to healthcare planners, clinicians and also the industry. In 2002 the Society and the Department agreed to transfer the operations of the Registry to the Disease and Treatment Registry unit of the Clinical Research Center of the Ministry of Health. Two individuals played critical roles in the success of the registry; Dr Lim Teck Onn and Staff Nurse Lee day Guat. Dr Lim Teck Onn, a consultant nephrologist at the Department of Nephrology Hospital Kuala Lumpur took a Masters degree in Statistics and later moved to the Clinical Research Centre, Ministry of Health where he spearheaded its rapid development.

The Malaysian Society of Nephrology

The Malaysian Society of Nephrology was started in 1984 by Dr Abu Bakar Suleiman who became its first President. The Secretary was Dr Zaki Morad. The first major task of the Society was organising the 6th Asian Colloquium in Nephrology in 1985, which it did with considerable success. Many eminent nephrologists from USA, Europe and Australia and Asia were invited as guest speakers. The Society organised annual scientific meetings, seminars and workshops on various aspects of nephrology and represented the profession in government organized meetings that looked into training of nephrologists, accreditation and credentialing as well as standards of care. In conjunction with the Department of Nephrology Hospital Kuala Lumpur it helped initiate the National Renal Registry and the Malaysian Organ Sharing System (MOSS).

The National Kidney Foundation

The National Kidney Foundation was established in 1975 with the assistance of the Petaling Jaya Rotary club. Its main objectives are to increase awareness of kidney diseases amongst the Malaysian public, assist in the training of healthcare workers in the field of kidney diseases and promote research on kidney diseases in the country. Dr G Sreenevasan, Dr SS Gill, Dr Abu Bakar, Dr S Ganesan and Dr Hussein Awang were amongst the early members that guided the foundation in its early years. In 1993 the foundation, taking cognizance of the public demands for more haemodialysis treatment facilities decided to set up Haemodialysis centers to help the poor patients. It now has sixteen centers all over the country.

Conclusion

Nephrology is still a developing specialty in this country. Although much progress has been made in the last twenty years, more needs to be done. More nephrologists need to be trained so that the level of care will continue to improve. The major challenge to present and future nephrologists in the country is the management of end stage renal diseases (ESRD). With improved socio-economic status and the general health standards, the incidence of certain diseases such as glomerulonephritis, pyelonephritis and obstructive uropathy which leads to ESRD can be expected to decline. However as shown by the experience in developed countries the incidence of ESRD continues to rise chiefly from the elderly and diabetics. The nephrology community must look at the most cost effective ways of treating ESRD. An even greater challenge is to stem the rise in chronic renal disease through various strategies that are now being shown to be effective.

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References

1. Zaki Morad. Medicine in Malaysia: Nephrology. Medical Journal of Malaysia, May 1995
2. TO Lim. First Report of the Malaysian Dialysis and Transplant Registry 1993
3. Malaysian Urological Association: Urology in Malaysia- The Biography of Malaysian Urological Association 1974-2002
4. Department of Nephrology, Hospital Kuala Lumpur, Bulletin, 1995: 25th Anniversary of Haemodialysis
5. Department of Nephrology, Hospital Kuala Lumpur, Bulletin, 1994: 10th Anniversary of CAPD
6. Department of Nephrology, Hospital Kuala Lumpur, Bulletin, 2000: 25th Anniversary of Renal Transplantation.

CHAPTER 1: ALL RENAL REPLACEMENT THERAPY IN MALAYSIA

Summary

- Intake of new dialysis patients increased from 43 in 1980 to 2223 in 2002 and prevalent dialysis patients increased from 59 in 1980 to almost 10,000 at year end 2003.
- The number of new transplant patients increased from 30 in 1980 to 163 in 2002 and patients with functioning renal transplants increased from 55 to 1419 over the same period.
- Overall dialysis acceptance rates increased rapidly from 3 per million population in 1980 to 91 per million population in 2002.
- New transplant rates have remained low over the last 23 years, fluctuating between 2-3 per million in the 1980's and 6-10 per million since 1990.
- Dialysis prevalence rate increased from 4 per million population in 1980 to 365 in 2002; over the same period, the transplant prevalence rates were 4 and 58 per million population respectively.

1.1 Stock and Flow

Dialysis therapy in Malaysia was introduced on a rudimentary basis in 1964 mainly to support patients with acute renal failure. Chronic haemodialysis (HD) was introduced in 1969 and the first renal transplantation was performed in Malaysia in 1975.

In this 10 year report, the acceptance and prevalence of all patients on renal replacement therapy (RRT) in Malaysia are shown from 1980 to 2003. Prior to 1980, < 20 patients were accepted for chronic HD therapy or underwent renal transplantation. It should be noted that data for 2003 are preliminary since at the time of going to press (March 2004) there were still many new cases yet to be notified to registry.

In 1980, only 43 patients were accepted for chronic dialysis and this intake remained around 100 patients in the 1980's. This number increased to 223 in 1990 and subsequently increased by leaps and bounds to achieve a total acceptance of >2000 per year since 2001 and 2223 in 2002 (Table 1.01, Figure 1.01a). The total number of patients dialyzing each year has similarly shown an almost exponential increase, from 59 in 1980 to almost 10,000 in 2003 (Figure 1.01b).

New renal transplants however, showed only modest increase (Figure 1.01b) from about 40 new transplants per year in the early 80's to between 100 to 160 per year since 1990. The initial increase in the number of transplants were mainly due to overseas live unrelated renal transplantation in India starting from the mid 1980's until 1995 when such transplant activities were proscribed. Since then however, so called commercial cadaveric transplantation performed in China has provided an alternative source of organ transplantation. Such transplants were first registered in 1992 and have since made significant contribution to the number of transplantations seen each year.

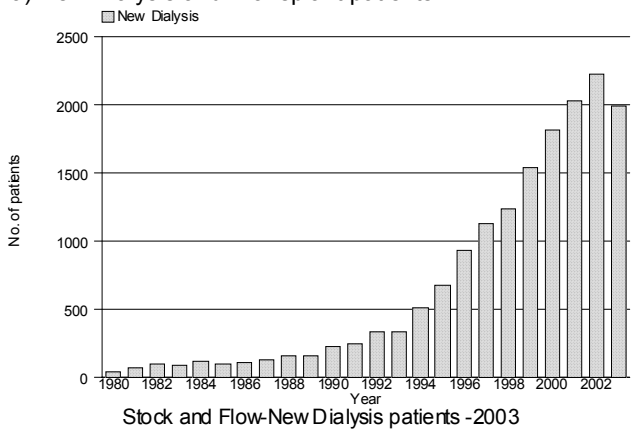
By 2003, the number of functioning renal transplants has increased steadily from 55 in 1980 to 1419 in 2002 (Figure 1.01b).

Table 1.01 Stock and Flow of RRT, Malaysia 1980 – 2003

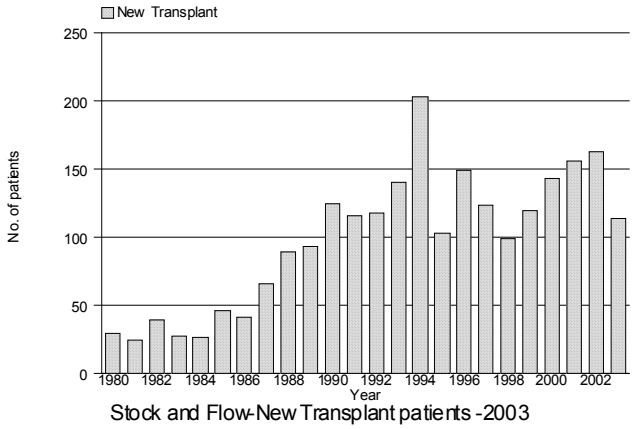
Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New Dialysis patients	43	73	104	93	118	106	108	131	162	161	233	247
New Transplants	30	25	40	28	27	46	42	66	90	94	125	116
Dialysis deaths	6	3	14	22	27	26	47	31	38	65	70	87
Transplant deaths	5	4	3	14	6	7	8	8	9	10	19	13
Dialysing at 31st December	59	124	195	252	334	406	467	543	634	704	838	972
Functioning transplant at 31st December	55	66	97	103	119	150	177	227	296	372	461	545
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New Dialysis patients	333	339	514	680	939	1130	1237	1538	1811	2036	2223	1992
New Transplants	118	140	203	103	149	124	99	120	143	156	163	114
Dialysis deaths	95	102	146	178	222	314	373	486	581	786	874	993
Transplant deaths	16	20	28	16	31	29	23	25	27	33	27	27
Dialysing at 31st December	1178	1399	1743	2230	2914	3689	4519	5522	6663	7775	8954	9795
Functioning transplant at 31st December	625	721	872	928	1017	1074	1101	1159	1240	1322	1419	1466

Figure 1.01 Stock and Flow of RRT, Malaysia 1980 – 2003

a) New Dialysis and Transplant patients

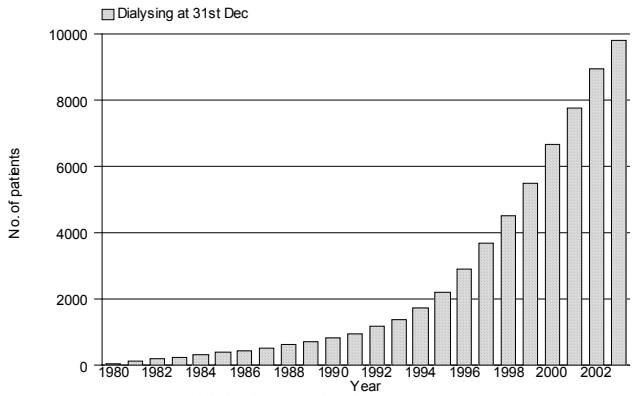


Stock and Flow-New Dialysis patients -2003

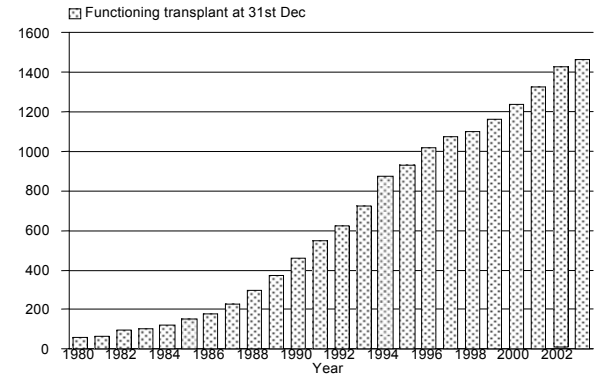


Stock and Flow-New Transplant patients -2003

b) Patients Dialysing and with Functioning Transplant at 31st December 1980 – 2003



Dialysing at 31st Dec -2003



1.2 Treatment Provision Rate

The new dialysis acceptance rates increased slightly from 3 per million population in 1980 to 9 per million in 1989. The rates then showed an exponential increase from 13 per million from 1990 onwards to reach 91 per million population in 2002 (Table 1.02 and Figure 1.02). With rising acceptance rates (and constant mortality rates), the dialysis prevalence rates has similarly increased exponentially from 4 per million in 1980 to 391 per million in 2003

The reasons for the rapid increase in dialysis provision and prevalence rates are many. Firstly, there has been rapid economic growth in Malaysia with the gross domestic product (GDP) more than doubling over this period from USD1845 in 1980 to USD4114 in 1997 paralleling the increase in the dialysis provision rate.(see Figures 1.03b and c). With the advent of the Asian financial crisis in 1998, the ringgit which was trading at about RM2.50 to USD1.00 was pegged to the US dollar at RM3.80 to USD1.00, partly accounting for the dip in per capita GDP in 1998. Without the pegging of the ringgit to USD the GDP in Malaysia would have increased more than 3 fold from 1980 to 2003. Secondly, the Minister of Health too had been given a challenge in 1994 during the silver anniversary celebration of HD treatment in Malaysia to increase the dialysis provision to 50 per million by the year 2000 from 17 per million in 1993. Malaysia hit the target dialysis provision of 50 per million by 1997.

Thirdly, with increased awareness among the public and politicians, charitable organizations with subsidies from the government started providing dialysis in the 1990's and now accounts for about a third of all dialysis provision in Malaysia. More public funds became available for dialysis treatment resulting in the setting up of dialysis centres. Affluence in Malaysia too has led to a rapid growth in private dialysis centres.

Incident rates for renal transplantation up till 1986 remained at 2-3 per million population consisting of mainly live related transplantations. After 1986 the transplant rate increased steadily to 10 per million in 1994 contributed mainly by live unrelated transplants done overseas but has since decreased to about 5 to 7 per million when this source of kidneys became unavailable after 1995 to be replaced at a slower rate by overseas cadaveric renal transplantation. These overseas transplantations were mainly self-funded or funded by private or public donations. The Asian financial crisis in 1998 resulted in the lowest renal transplantation rate in the 1990's at 4 per million population in 1998.

The rate of increase of renal transplant prevalence rates has almost plateaued off from 1996 to 1999 because of the Asian financial crisis in 1998 and the proscription of live unrelated transplantation in India. The transplant prevalence rates have started to show an increase again since 2000 contributed in part by more cadaveric renal transplantation done in China.

Table 1.02 New Dialysis Acceptance Rate and New Transplant Rate per million population 1980 – 2003

Acceptance rate	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New Dialysis	3	5	7	6	8	7	7	8	9	9	13	13
New Transplant	2	2	3	2	2	3	3	4	5	5	7	6

Acceptance rate	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New Dialysis	17	17	26	33	44	52	56	68	77	85	91	80
New Transplant	6	7	10	5	7	6	4	5	6	6	7	5

Figure 1.02 New Dialysis Acceptance and New Transplant Rate 1980 - 2003

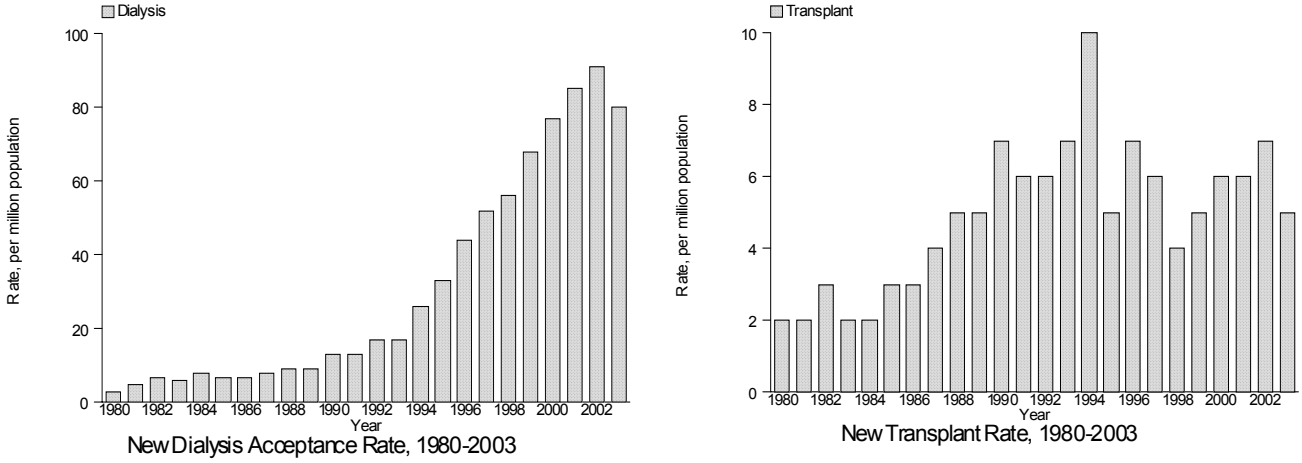


Table 1.03 RRT Prevalence Rate per million population 1980 – 2003

Prevalence rate	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Dialysis	4	9	13	17	22	26	29	32	37	40	46	52
Transplant	4	5	7	7	8	9	11	14	17	21	25	29

Prevalence rate	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Dialysis	62	72	87	108	138	170	204	243	284	324	365	391
Transplant	33	37	43	45	48	50	50	51	53	55	58	59

Figure 1.03(a) Dialysis and Transplant Prevalence Rate per million population 1980 - 2003

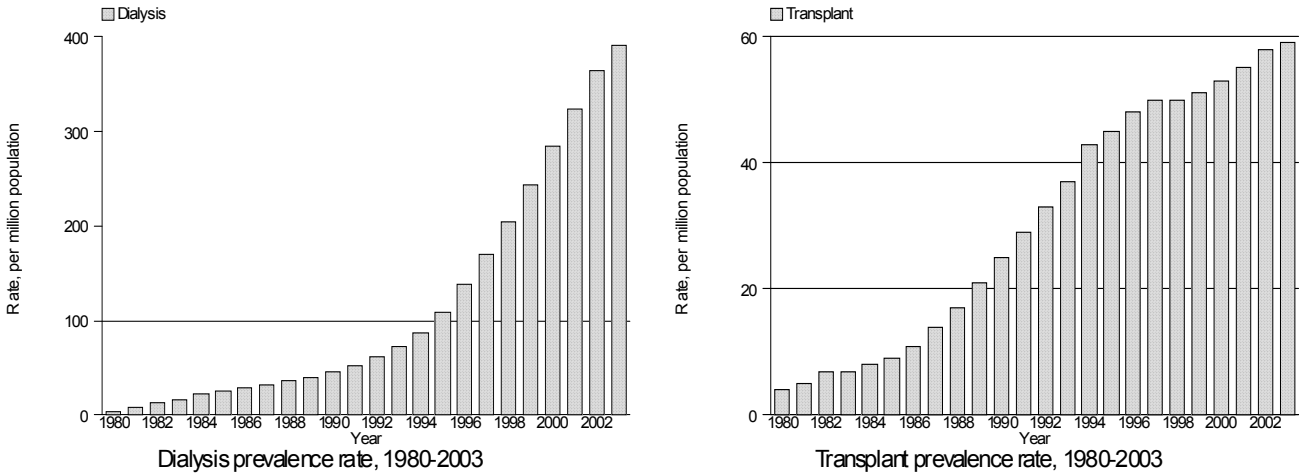


Figure 1.03(b) New Dialysis Treatment Rate per million population and Gross Domestic Product (USD) 1980-2003

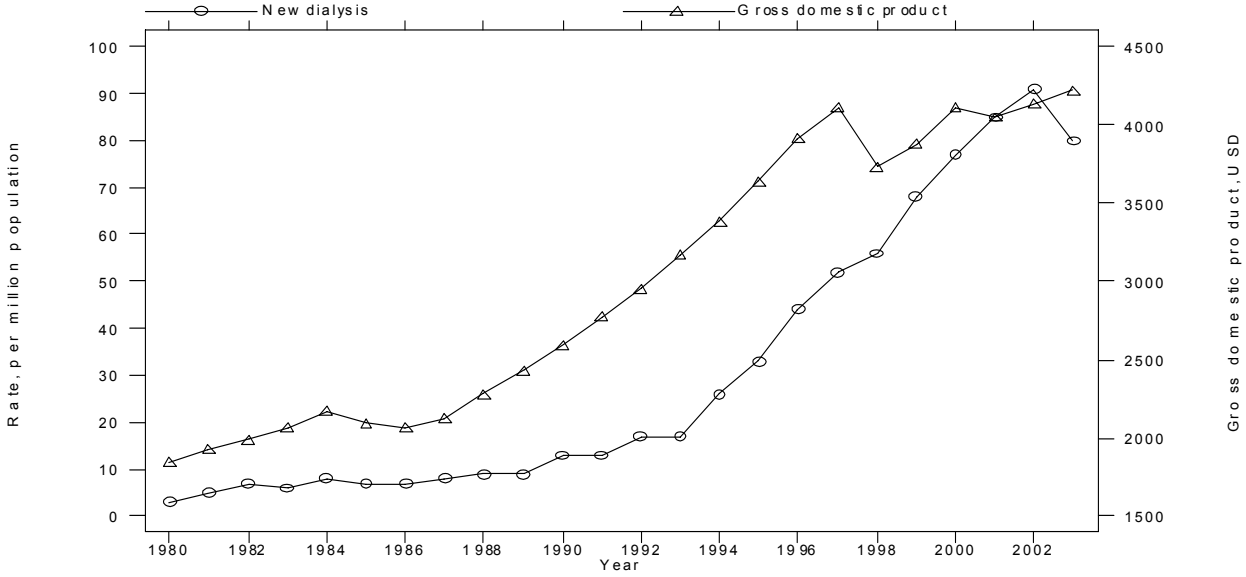
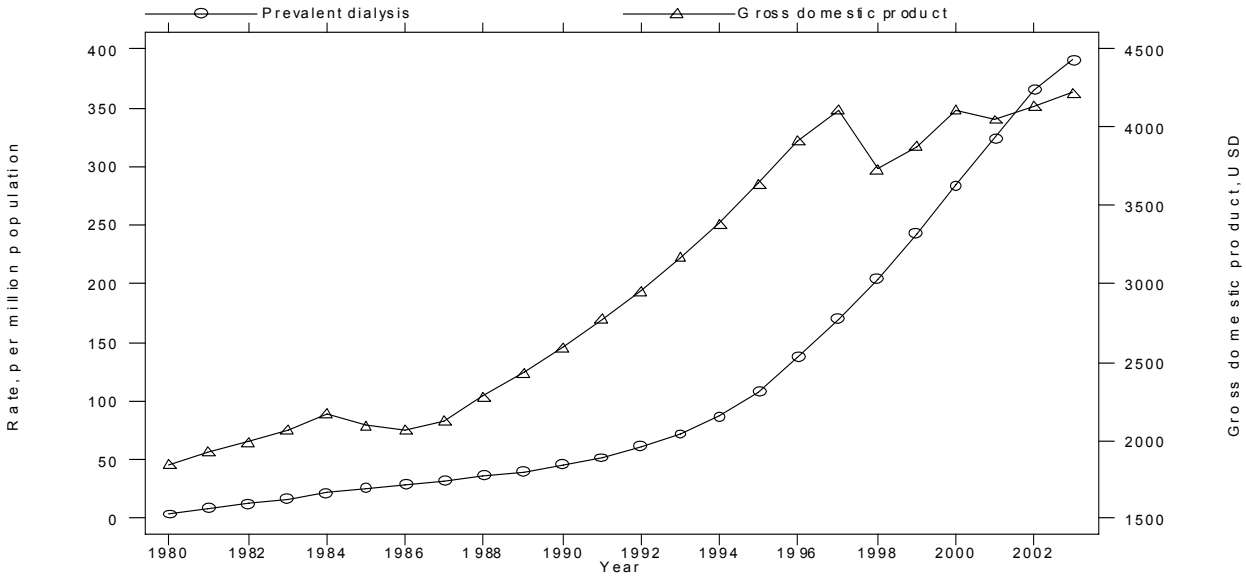


Figure 1.03(c) RRT Prevalence Rate per million population and Gross Domestic Product (USD) 1980-2003



CHAPTER 2: DIALYSIS IN MALAYSIA

Summary

- By year end 2002, a total of 2223 patients were accepted for dialysis compared to 43 patients in 1980
- Prevalent dialysis patients increased rapidly from a total 59 in 1980 to 8954 in 2002.
- Acceptance rate for dialysis increased very rapidly from 3 per million population to 91 per million in 2002.
- The dialysis prevalence rate increased from 4 per million population in 1980 to 365 per million in 2002 and 391 per million in 2003.
- The average dialysis acceptance rate had increased by 12-fold in the new millennium compared to the period of the 1980's.
- The average dialysis prevalence rate increased by 14-fold between time periods of 2000-2002 and the 1980's.
- The most economically developed, west coast states of Peninsular Malaysia registered the highest level of provision of new dialysis treatment at more than 100 per million state population since 2000. The less developed states of Terengganu, Kedah & Perlis and Sarawak registered provision rates of 59 and 72 per million state population and the 3 economically least developed states of Malaysia – Pahang, Kelantan and Sabah had the lowest dialysis provision at 32 to 50 per million state population.
- All the states showed remarkable increase in dialysis treatment rate but the disparity between states in provision of dialysis remained throughout this whole period.
- There was an initial bias against females being accepted into dialysis programmes but this bias was not seen after the early 1990's.
- The modal age group for dialysis treatment increased from 35-44 years in the 1980's to 55-64 years after 1992.
- Treatment rates for those above 55 years rose rapidly and accounted for the largest proportion of new intake of patients each year in the last 10 years.
- There was rapid growth of centre haemodialysis and disappearance of home/office haemodialysis since the mid 1990's. CAPD contributed to about 10-20% of new dialysis treatment.
- There was progressively increased funding for dialysis by charitable organizations noted from the 1990's.
- By 2002, 40% of patients were dialysed in government centres, 35% in NGO centres and 25% in private dialysis centres compared to the 1980's when more than 90% received treatment from government centres.
- Diabetes mellitus accounted for 50% of new ESRD patients and the proportion of patients with unknown cause decreased from 81% in 1980 to 30% in 2003.
- Death rates on haemodialysis have remained at 10% or lower per year throughout the years 1980 to 2003; CAPD death rates were higher at 10 to 20%.
- Cardiovascular cause of death, death at home and sepsis were the 3 commonest causes of death in the dialysis population.

2.1 Dialysis Treatment Provision Overall

The stock and flow of all dialysis patients between 1980 and 2003 is shown in Table 2.1.1. In the year 2002, a total of 2223 patients were accepted for dialysis compared to only 43 patients in 1980. The total number of patients dialyzing at the end of each year has increased exponentially from 59 in 1980 to 8954 in 2002 and 9795 in 2003.

As shown in Table 2.12a, the acceptance rate for dialysis has increased rapidly from 3 per million in 1980 to 91 per million population in 2003. The prevalence rates of all dialysis patients have similarly shown this tremendous increase from 4 per million in 1980 to 365 per million in 2002 and at least 391 in 2003.

For ease of comparison and from the increase noted in the dialysis acceptance rates per year, the dialysis acceptance rates were divided into 4 periods of 1980-1989, 1990-1994, 1995-1999 and 2000-2002 as shown in Table 2.1.2b and Figures 2.1.2 b & c. The new dialysis acceptance rate increased by two and a half times from the period 1980-1989 to the period 1990-1995; by three fold over the next five years, and 1.6 fold after 2000 compared to the period 1995-1999. The dialysis acceptance rate had increased by 12-fold in the new millennium compared to the period of the 1980's. Comparison of prevalence rates over the same time periods showed an almost 3 fold increase between periods 1990-1994 compared to the ten-year period of the 1980's; and between the later half of the 1990's compared to the earlier half of the 1990's; and an almost 2-fold increase between 2000-2003 compared to the period just before 2000. The prevalence rates increased by 14-fold between time periods of 2000-2002 and the 1980's.

Table 2.1.1 Stock and flow – Dialysis Patients 1980 – 2003

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New Dialysis patients	43	73	104	93	118	106	108	131	162	161	233	247
Died	6	3	14	22	27	26	47	31	38	65	70	87
Transplanted	21	21	31	21	26	14	6	35	50	38	43	45
Lost to Follow-up	0	0	0	0	1	1	1	2	0	1	1	2
Dialysing at 31st Dec	59	124	195	252	334	406	467	543	634	704	838	972

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New Dialysis patients	333	339	514	680	939	1130	1237	1538	1811	2036	2223	1992
Died	95	102	146	178	222	314	373	486	581	786	874	993
Transplanted	47	36	45	36	56	59	61	69	106	134	141	103
Lost to Follow-up	3	2	2	5	5	6	9	7	12	26	43	63
Dialysing at 31st Dec	1178	1399	1743	2230	2914	3689	4519	5522	6663	7775	8954	9795

Table 2.1.2a Dialysis Treatment Rate per million population 1980 – 2003

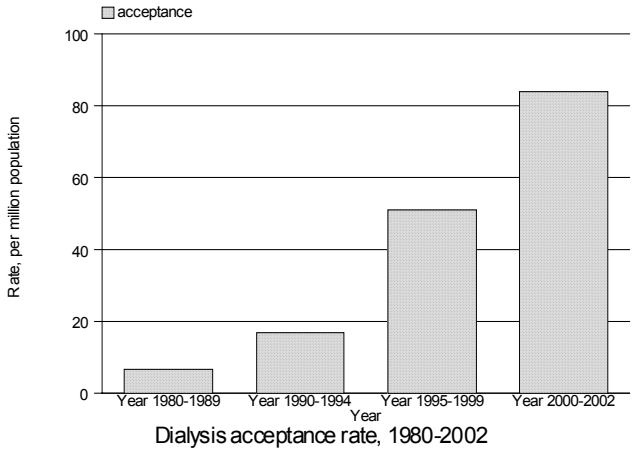
Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Acceptance rate	3	5	7	6	8	7	7	8	9	9	13	13
Prevalence rate	4	9	13	17	22	26	29	32	37	40	46	52

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Acceptance rate	17	17	26	33	44	52	56	68	77	85	91	80
Prevalence rate	62	72	87	108	138	170	204	243	284	324	365	391

Table 2.1.2b Average Treatment Rate per million population: Comparing 4 time periods

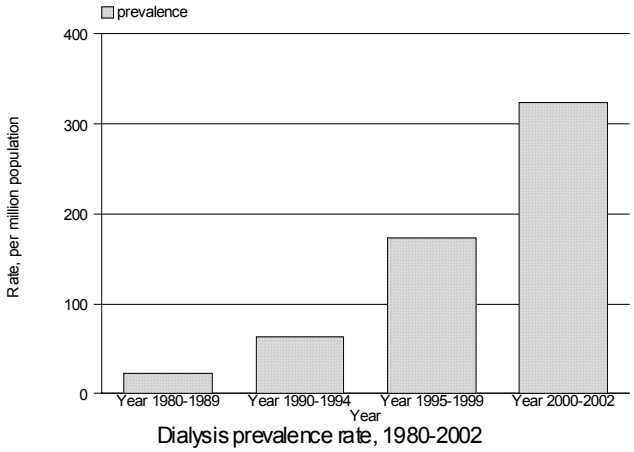
	1980-1989	1990-1994	1995-1999	2000-2002
New Dialysis Acceptance rate	7	17	51	84
Dialysis Prevalence rate	23	64	173	324

Figure 2.1.2b New Dialysis Treatment Rate per million population, Comparing 4 periods



Dialysis acceptance rate, 1980-2002

Figure 2.1.2c Dialysis Prevalence Rate per million population, Comparing 4 periods



Dialysis prevalence rate, 1980-2002

2.2 Geographic Distribution of Dialysis Treatment Provision

Historically, dialysis treatment started in Kuala Lumpur hospital located in the states of Selangor & Wilayah Persekutuan, hence it is not surprising that this state showed the highest dialysis treatment rate in the first 10-years of dialysis treatment. The subsequent spread of dialysis treatment throughout the rest of the country was uneven, resulting in considerable variation in dialysis provision among the various states of Malaysia (Table 2.2.1). In the period 2000-2002, 7 states have registered dialysis treatment rate in excess of 100 per million state population (pmp) (referred to as high provision states in Table 2.2.2), 3 states in the range 50 to 100 pmp (mid provision states), and 4 with treatment rates below 50 pmp (low provision states).

We have no reason to believe that the incidence of end stage renal disease (ESRD) would vary so markedly among the various states to account for the uneven distribution in treatment rates. On the other hand, it is no coincidence that the high provision states are also the most economically developed states in Malaysia located mainly along the west coast of Peninsular Malaysia, while the 4 economically least developed states of Malaysia – Pahang, Kelantan, Sarawak and Sabah had the lowest dialysis provision. And this has always been so since the 1980s. While all states have increased dialysis treatment rates since the 1980s, the best provided states have experienced the largest increase, and the least provided states the least (Table 2.2.2, Figure 2.2.2). Understandably, private dialysis providers would preferentially locate their dialysis facilities in economically more advanced states, however providers from the NGO and public sectors, which together account for 70% of total dialysis provision in the country, have less reason to do the same. We can find no justification for such persistent geographic inequity in dialysis provision.

Table 2.2.1 Dialysis Treatment Rate by State, per million state population, 1980-2003

State	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Negeri Melaka	6	4	4	6	8	10	2	10	4	13	22	20
Johor Darul Takzim	2	5	7	3	4	5	3	4	9	10	15	17
Negeri Sembilan	2	3	12	8	8	2	12	15	6	3	7	17
Pulau Pinang	5	5	9	3	7	10	5	12	7	15	17	11
Selangor & W.Persekutuan	21	32	38	33	40	31	33	36	46	68	28	32
Perak Darul Redzuan	2	5	6	5	8	8	8	7	8	12	14	16
Terengganu Darul Iman	0	2	5	0	0	0	1	3	4	4	6	4
Kedah & Perlis	2	2	2	3	9	4	4	5	6	2	3	5
Kelantan Darul Naim	0	0	0	4	3	2	3	3	4	4	5	2
Sarawak	1	2	3	6	5	7	8	7	9	13	12	11
Pahang Darul Makmur	4	4	1	3	5	3	5	10	5	4	10	8
Sabah	0	3	2	2	3	2	3	2	3	1	8	11

State	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Negeri Melaka	40	32	69	74	82	95	111	91	147	151	145	95
Johor Darul Takzim	18	27	45	42	57	79	71	104	131	136	145	125
Negeri Sembilan	19	30	39	48	74	73	90	94	116	113	133	123
Pulau Pinang	14	16	30	73	70	85	109	124	102	120	130	86
Selangor & W.Persekutuan	39	32	40	63	82	76	90	102	121	116	122	105
Perak Darul Redzuan	19	24	28	28	57	62	64	75	106	101	110	91
Terengganu Darul Iman	4	16	15	18	27	37	34	36	37	76	87	66
Kedah & Perlis	18	12	19	18	26	54	47	59	68	64	85	72
Kelantan Darul Naim	2	5	7	10	6	11	15	26	31	59	60	65
Sarawak	16	13	21	20	36	46	33	44	51	67	58	55
Pahang Darul Makmur	14	12	13	20	17	44	36	47	48	52	51	60
Sabah	7	4	11	12	18	16	24	32	25	36	35	39

Table 2.2.2 Dialysis Treatment Rate by State, per million state population over 4 periods

State	1980-89	1990-94	1995-99	2000-02
Negeri Melaka	7	41	91	148
Johor Darul Takzim	5	25	71	137
Negeri Sembilan	7	23	76	121
Pulau Pinang	8	18	92	117
Selangor & W.Persekutuan	38	36	83	120
Perak Darul Redzuan	7	21	57	106
Terengganu Darul Iman	2	9	30	67
Kedah & Perlis	4	14	41	72
Kelantan Darul Naim	2	4	14	50
Sarawak	6	16	36	59
Pahang Darul Makmur	4	13	33	50
Sabah	2	7	20	32

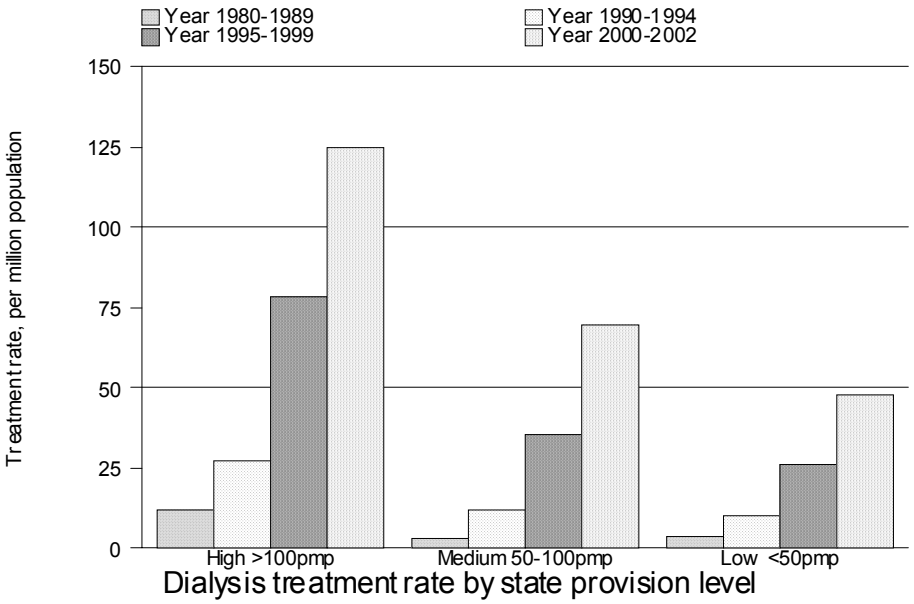
Table 2.2.3 Classification of level of provision

State	2000-02	Level of provision 2000 -2002
Negeri Melaka	148	High (>100 pmp)
Johor Darul Takzim	137	
Negeri Sembilan	121	
Selangor & W.Persekutuan	120	
Pulau Pinang	117	
Perak Darul Redzuan	106	
Kedah & Perlis	72	Mid (>50-100 pmp)
Terengganu Darul Iman	67	
Sarawak	59	
Kelantan Darul Naim	50	Low (<=50 pmp)
Pahang Darul Makmur	50	
Sabah	32	

Table 2.2.4 Average Dialysis Treatment Rate per million state population (pmp) over 4 periods in Low, Mid and High provision states, 1980-2002

	1980-1989	1990-1994	1995-1999	2000-2002
High provision states (>100 pmp)	12	27	78	125
Mid provision states (>50-100 pmp)	4	13	36	66
Low provision states (<=50 pmp)	3	8	22	44

Figure 2.2.4 Average Dialysis Treatment Rate per million state population (pmp) over 4 periods in Low (<=50 pmp), Mid (50-100 pmp) and High (>100 pmp) provision states, 1980-2002



2.3 Dialysis Treatment in Relation to Gender

Table 2.3.1 and Figure 2.3.1 show the dialysis treatment rate by gender. Dialysis treatment rate for males increased from 6 per million male population in 1980 to 105 per million in 2002 compared to the rates of 2 and 90 per million female population for females in 1980 and 2002 respectively.

In the 1980s new dialysis patients were disproportionately male. Since then, as treatment provision has increased markedly, the proportion of female patients have steadily improved (Table and Figure 2.3.2). This convergence in male and female treatment rates implies that there has always been a gender bias in dialysis provision in the early years of chronic dialysis treatment in Malaysia when dialysis provision was scarce and males were preferentially treated. We believe this reflects a cultural bias which placed a greater value on male life, rather than a conscious decision on the part of nephrologists or policy makers.

Table 2.3.1 Dialysis Treatment Rate by Gender, per million male or female population 1980– 2003

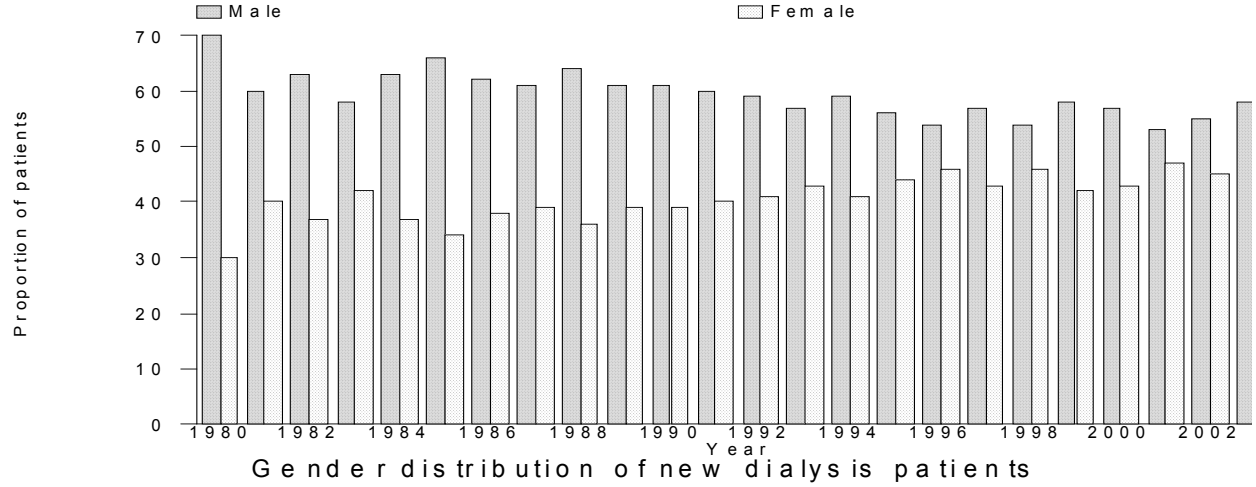
Gender	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Male	6	8	10	8	12	10	10	12	14	13	18	18
Female	2	5	6	6	7	5	6	7	8	9	11	13
Gender	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Male	22	23	34	39	51	62	62	81	91	95	105	95
Female	17	17	24	32	45	50	56	61	72	87	90	74

Figure 2.3.1 Dialysis Treatment by Gender 1980 – 2003

Table 2.3.2 Gender distribution of Dialysis Patients 1980-2003

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New Dialysis patients	43	73	104	93	118	106	108	131	162	161	233	247
% Male	70	60	63	58	63	66	62	61	64	61	61	60
% Female	30	40	37	42	37	34	38	39	36	39	39	40
Dialysing at 31st December	59	124	195	252	334	406	467	543	634	704	838	972
% Male	73	67	66	63	62	62	63	61	62	63	63	62
% Female	27	33	34	37	38	38	37	39	38	37	37	38
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New Dialysis patients	333	339	514	680	939	1130	1237	1538	1811	2036	2223	1992
% Male	59	57	59	56	54	57	54	58	57	53	55	58
% Female	41	43	41	44	46	43	46	42	43	47	45	42
Dialysing at 31st December	1178	1399	1743	2230	2914	3689	4519	5522	6663	7775	8954	9795
% Male	61	60	60	59	57	57	56	56	56	55	55	55
% Female	39	40	40	41	43	43	44	44	44	45	45	45

Figure 2.3.2 Gender Distribution of New Dialysis patients 1980 – 2003



2.4 Dialysis Treatment in Relation to Age

In the 1980's, patients in the working age groups (age 25-54 years) have the highest treatment rates, perhaps as expected. In subsequent years with increasing availability of dialysis treatment, the older age groups with higher incidence of ESRD have benefited the most. Treatment rates increased most rapidly for patients over the age of 55 years and are still rising for those 65 years and older. In contrast, intake rates for those 25-44 years of age have almost leveled off, suggesting perhaps that in recent years no ESRD patients in this age group are denied treatment. The intake rate for children less than 15 years of age were almost nil until the early 1990's and has remained at bout 4 per million child population since 1999. (Table 2.4.1 and Figure 2.4.1.) With these population treatment rates, new patients in the young adult age groups (ages of 25 to 44 years) accounted for the largest proportion of patients on dialysis in the 1980s. In subsequent years, older patients accounted for an increasingly larger proportion of the dialysis population in this country. By the years 2002-2003, patients age ≥55 years accounted for half the new intakes, though a smaller proportion of prevalent patients on account of higher mortality in this age group (Table and Figures 2.4.2).

Table 2.4.1 Dialysis Treatment Rate by Age Group, per million age group population 1980 – 2003

Age groups (years)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1-14	0	1	0	0	0	0	0	1	0	0	0	0
15-24	2	4	5	4	3	3	2	5	5	6	7	7
25-34	9	11	15	13	20	12	10	14	18	13	18	22
35-44	10	22	26	18	24	20	21	26	31	27	27	32
45-54	7	13	21	21	24	19	29	31	18	33	59	55
55-64	10	6	8	18	19	27	30	20	39	30	40	45
>=65	2	4	6	0	5	14	7	5	8	12	21	19

Age groups (years)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1-14	1	1	1	2	3	3	3	4	4	4	4	4
15-24	6	5	9	10	13	15	15	16	18	22	28	21
25-34	22	23	19	31	39	39	40	43	46	46	50	41
35-44	35	37	51	58	67	80	81	85	98	100	98	78
45-54	66	59	88	121	154	166	172	225	245	244	258	223
55-64	90	67	141	156	226	289	306	370	429	502	511	440
>=65	25	58	81	111	167	214	230	299	343	428	479	436

Figure 2.4.1 Dialysis Treatment Rate by Age Group 1980 - 2003

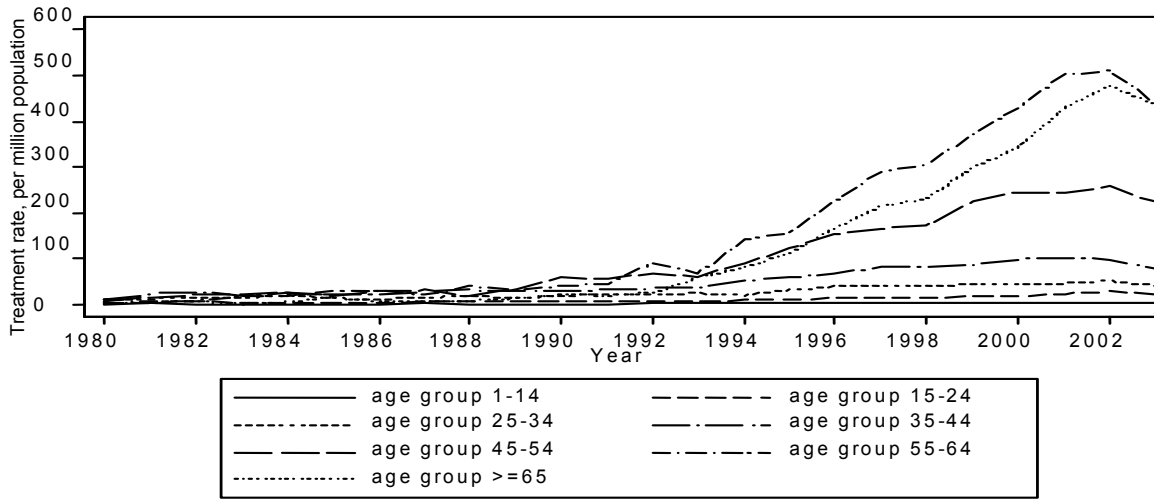


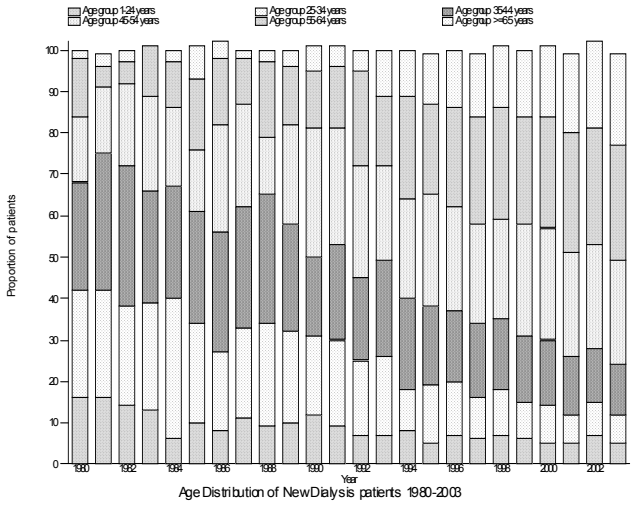
Table 2.4.2 Percentage Age Distribution of Dialysis Patients 1980 – 2003

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New dialysis patients	43	73	104	93	118	106	108	131	162	161	233	247
% 1-14 years	2	5	0	0	1	2	2	2	2	1	1	0
% 15-24 years	14	11	14	13	5	8	6	9	7	9	11	9
% 25-34 years	26	26	24	26	34	24	19	22	25	22	19	21
% 35-44 years	26	33	34	27	27	27	29	29	31	26	19	23
% 45-54 years	16	16	20	23	19	15	26	25	14	24	31	28
% 55-64 years	14	5	5	12	11	17	16	11	18	14	14	15
% ≥ 65 years	2	3	3	0	3	8	4	2	3	4	6	5
Dialysing at 31st December	59	124	195	252	334	406	467	543	634	704	838	972
% 1-14 years	2	4	2	1	1	1	1	1	1	1	1	1
% 15-24 years	22	14	12	12	10	9	9	9	7	8	8	8
% 25-34 years	22	23	23	22	27	26	25	24	25	24	23	24
% 35-44 years	25	33	36	35	31	32	31	31	33	32	30	30
% 45-54 years	17	17	19	20	20	18	20	21	20	20	23	23
% 55-64 years	10	7	6	9	9	11	12	11	12	12	12	12
% ≥65 years	2	2	2	1	2	3	3	2	2	2	3	3

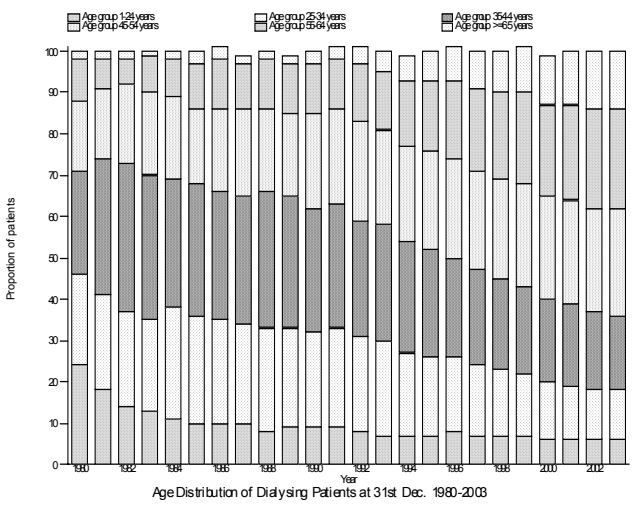
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New dialysis patients	333	339	514	680	939	1130	1237	1538	1811	2036	2223	1992
% 1-14 years	2	2	2	1	2	1	2	2	1	1	2	1
% 15-24 years	5	5	6	4	5	5	5	4	4	4	5	4
% 25-34 years	18	19	10	14	13	10	11	9	9	7	8	7
% 35-44 years	20	23	22	19	17	18	17	16	16	14	13	12
% 45-54 years	27	23	24	27	25	24	24	27	27	25	25	25
% 55-64 years	23	17	25	22	24	26	27	26	27	29	28	28
% ≥ 65 years	5	11	11	12	14	15	15	16	17	19	21	22
Dialysing at 31st December	1178	1399	1743	2230	2914	3689	4519	5522	6663	7775	8954	9795
% 1-14 years	1	1	1	1	2	2	2	2	1	1	1	1
% 15-24 years	7	6	6	6	6	5	5	5	5	5	5	5
% 25-34 years	23	23	20	19	18	17	16	15	14	13	12	12
% 35-44 years	28	28	27	26	24	23	22	21	20	20	19	18
% 45-54 years	24	23	23	24	24	24	24	25	25	25	25	26
% 55-64 years	14	14	16	17	19	20	21	22	22	23	24	24
% ≥65 years	4	5	6	7	8	9	10	11	12	13	14	14

Figure 2.4.2 Age Distribution of Dialysis patients 1980 – 2003

a) New Dialysis patients



b) Dialysing patients at 31st December



2.5 Method and Location

Trends in the method and location of dialysis therapy reflect the prevailing conditions and funding of the ESRD programme.

Home or office HD is dialysis carried out at the patient's own home or in the work-place where a HD machine may be shared by several patients belonging to the same institution or company.

From Table and Figure 2.5.1 in the 1980's so-called home or office HD made up a third to half of new dialysis treatment. Since the mid 1990's the proportion of new patients started on home HD has been almost negligible and 80-90% of new patients were accepted into centre HD. The proportion of patients accepted into the CAPD programme increased in the early 1990's to about 22-24%, plateaued in the mid 1990's; decreased in the late 1990's to 11% on account of the Asian financial crisis, and increased slightly again in the new millennium. The percentage of prevalent patients on center HD increased at the expense of both the home HD and CAPD patients and has remained at 87% of total prevalent dialysis patients since 2000. Several reasons could account for this trend in method and location of dialysis. Firstly, in the early years of dialysis provision, when funds were scarce and there were very few HD centers (which were mainly located in the big towns), those who could afford but were not situated within commuting distance of HD centres were provided with home/ office HD throughout the country. Secondly, increase in public funding resulted in rapid expansion of HD centers providing center HD in the public and private sectors as well as the centers run by charitable organizations. Thirdly, it was perceived that there were more profits to be made from center HD than CAPD – a modality of treatment provided mainly by public sector dialysis facilities with nephrologists.

Table 2.5.1 Method and Location of Dialysis 1980 - 2003

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New Dialysis patients	43	73	104	93	118	106	108	131	162	161	233	247
% Centre HD	53	65	55	42	31	26	40	50	51	58	52	57
% Home and office HD	44	31	42	49	43	57	47	33	35	32	29	20
% CAPD	2	4	3	9	26	17	13	17	14	10	19	23
Dialysing at 31st Dec	59	124	195	252	334	406	467	543	634	704	838	972
% Centre HD	55	59	52	50	44	42	44	47	48	54	55	57
% Home and office HD	45	39	45	46	45	48	47	44	42	39	36	32
% CAPD	0	2	3	4	11	10	9	9	9	7	9	12
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New Dialysis patients	333	339	514	680	939	1130	1237	1538	1811	2036	2223	1992
% Centre HD	60	70	68	72	74	81	86	85	87	84	85	81
% Home and office HD	16	12	10	5	4	2	2	2	1	1	1	1
% CAPD	24	18	22	23	22	16	12	13	11	14	14	19
Dialysing at 31st Dec	1178	1399	1743	2230	2914	3689	4519	5522	6663	7775	8954	9795
% Centre HD	60	65	68	72	75	79	82	85	87	87	87	87
% Home and office HD	27	21	18	13	10	8	6	5	4	3	3	2
% CAPD	14	14	14	15	15	14	12	11	10	10	10	11

Figure 2.5.1 Method and Location of New Dialysis Patients 1980 - 2003

2.6 Funding for Dialysis Treatment

Dialysis provision is closely linked with economics. With the rapid development of dialysis provision in this country, it would be important to know the source of funding for dialysis therapy.

The government directly funded three quarters of dialysis treatment when chronic dialysis was first started. Over the years however, the proportion of dialysis treatment directly funded by the government had declined to about 50% in the last 5 years since 1998. The proportion of new and existing patients providing their own funds for dialysis treatment fluctuated from 18 to 46% but has remained at about 30% over the last 5 years. The most obvious change in the trend of funding was the contribution by charitable organizations – so called non-governmental organizations (NGO), which accounted for 16% of the total funding in 2002 compared to only 3% in 1990 and about 0-3% in the 1980's. (Table 2.6.1 & Figure 2.6.1) This increase in funding by NGOs for dialysis treatment came about as a result of increased public awareness and support, increasing affluence of society, and dialysis subsidies from the government for dialysis treatment provided to very poor patients by NGO centres.

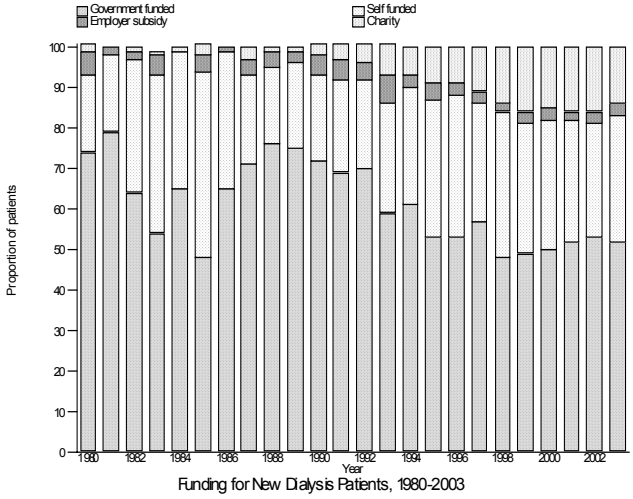
Table 2.6.1 Funding for Dialysis Treatment 1980 – 2003

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New Dialysis patients	43	73	104	93	118	106	108	131	162	161	233	247
% by Government	74	79	64	54	65	48	65	71	76	75	72	69
% self funded	19	19	33	39	34	46	34	22	19	21	21	23
% subsidized by Employer	6	2	2	5	0	4	1	4	4	3	5	5
% by Charity	2	0	1	1	1	3	0	3	1	1	3	4
Dialysing at 31st December	59	124	195	252	334	406	467	543	634	704	838	972
% by Government	62	68	62	59	59	56	58	59	62	65	67	66
% self funded	29	27	34	35	37	39	37	35	32	28	26	25
% subsidized by Employer	5	3	3	5	3	3	3	4	4	4	5	5
% by Charity	3	2	2	2	2	2	2	3	2	2	3	3

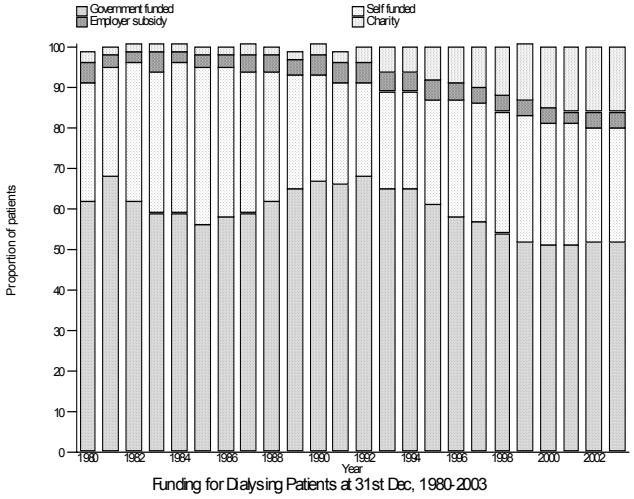
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New Dialysis patients	333	339	514	680	939	1130	1237	1538	1811	2036	2223	1992
% by Government	70	59	61	53	53	57	48	49	50	52	53	52
% self funded	22	27	29	34	35	29	36	32	32	30	28	31
% subsidized by Employer	4	7	3	4	3	3	2	3	3	2	3	3
% by Charity	5	8	7	9	9	11	14	16	15	16	16	14
Dialysing at 31st December	1178	1399	1743	2230	2914	3689	4519	5522	6663	7775	8954	9795
% by Government	68	65	65	61	58	57	54	52	51	51	52	52
% self funded	23	24	24	26	29	29	30	31	30	30	28	28
% subsidized by Employer	5	5	5	5	4	4	4	4	4	3	4	4
% by Charity	4	6	6	8	9	10	12	14	15	16	16	16

Figure 2.6.1 Funding for Dialysis Treatment 1980 – 2003

(a) New Dialysis Patients at 31st December 2003



(b) Dialysing patients at 31st December 2003



2.7 Distribution of Dialysis Treatment by Sector

The percentage of new patients dialysed in government centres has decreased from more than 90% in the 1980's to about 40% in 2000's. The proportion of new patients dialysed in NGO centres increased rapidly from 6% in 1990 to about 30% since 1998 and those in private centres from 7% to 30% over the same period. The same trend is seen for prevalent patients (Table 2.7.1 and Figures 2.7.1 a & b).

The 3 sectors – government, NGOs, and private dialysis provided about 40%, 35% and 25% respectively of all dialysis treatment in the last few years. However, as noted in the previous section, half the funds for dialysis treatment were still provided directly by government agencies. This discrepancy arose not because the cost per dialysis was higher in government centres but because a fair proportion of government pensioners and serving government servants received dialysis treatment in NGO and private centres but whose dialysis therapy were paid for by their respective government agencies. The proportion of government funding for dialysis therapy would be even higher if we were to include the subsidies provided to NGO centres for dialysis treatment to the very low-income group.

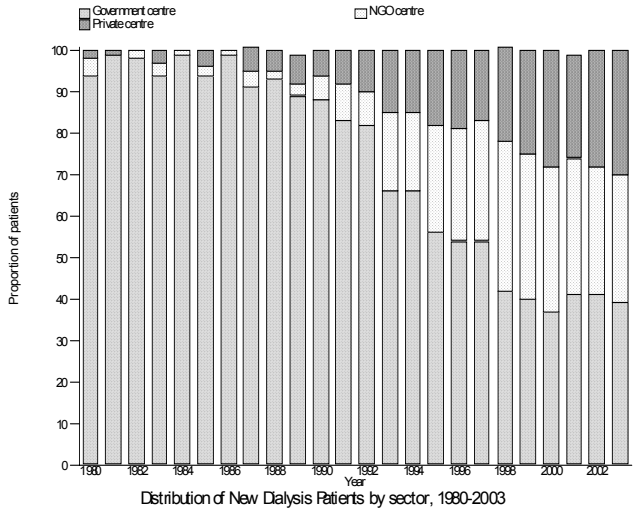
Table 2.7.1 Distribution of Dialysis Patients by Sector 1980 - 2003

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New Dialysis patients	43	73	104	93	118	106	108	131	162	161	233	247
% Government centre	94	99	98	94	99	94	99	91	93	89	88	83
% NGO centre	4	0	2	3	1	2	1	4	2	3	6	9
% Private centre	2	1	0	3	0	4	0	6	5	7	6	8
Dialysing at 31st Dec	59	124	195	252	334	406	467	543	634	704	838	972
% Government centre	92	95	96	94	95	94	95	93	92	90	88	85
% NGO centre	5	2	3	3	3	3	3	4	4	4	5	7
% Private centre	3	2	2	2	2	3	2	4	5	6	7	8

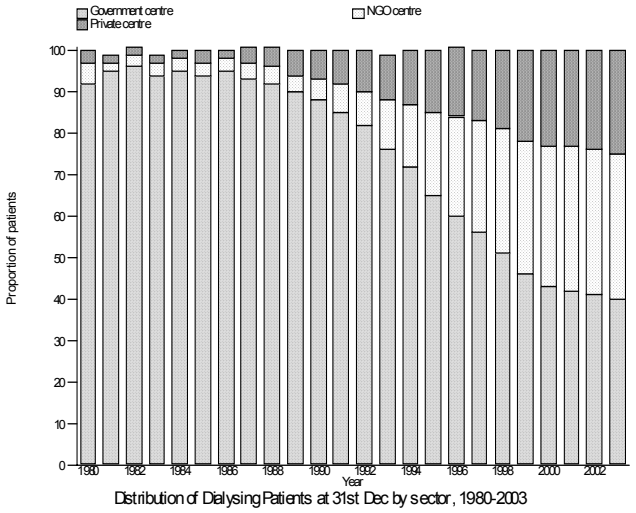
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New Dialysis patients	333	339	514	680	939	1130	1237	1538	1811	2036	2223	1992
% Government centre	82	66	66	56	54	54	42	40	37	41	41	39
% NGO centre	8	19	19	26	27	29	36	35	35	33	31	31
% Private centre	10	15	15	18	19	17	23	25	28	25	28	30
Dialysing at 31st Dec	1178	1399	1743	2230	2914	3689	4519	5522	6663	7775	8954	9795
% Government centre	82	76	72	65	60	56	51	46	43	42	41	40
% NGO centre	8	12	15	20	24	27	30	32	34	35	35	35
% Private centre	10	11	13	15	17	17	19	22	23	23	24	25

Figure 2.7.1 Distribution of Dialysis Patients by Sector 1980 – 2003

(a) New Dialysis Patients



(b) Dialysing Patients at 31st December



2.8 Primary Renal Disease

Patient selection for ESRD treatment is one of the main reasons for the trends in the primary renal disease shown in Table 2.8.1. In the initial years of dialysis therapy, younger patients without diabetes were selected for chronic dialysis or renal transplantation. However with increased dialysis provision and acceptance of older patients for RRT, diabetes mellitus has become the main cause of ESRD accounting for 50% of new ESRD patients. The rising prevalence of diabetes mellitus associated with increasing affluence over the last 10 to 15 years no doubt account in part for the rising incidence of diabetic nephropathy. This has grave implications for the programme of chronic kidney disease prevention and also on the outcome of patients on dialysis.

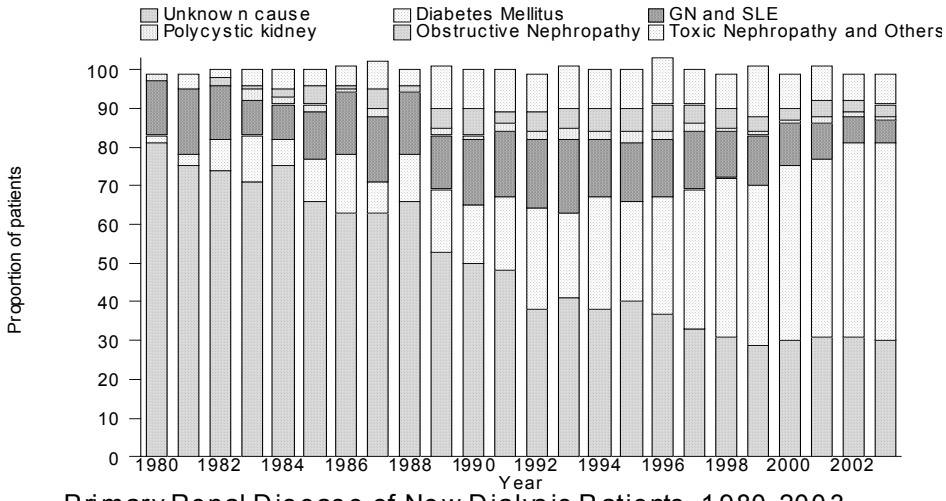
The proportion of patients with unknown primary renal disease has decreased over the years from 81% in 1980 to about 30% since 1998 presumably because of better and easier access to health care resulting in earlier detection of renal disease. A decreasing proportion of patients had chronic glomerulonephritis as the cause of the ESRD. However, a significant proportion of the ESRD of unknown cause may be due to chronic glomerulonephritis. Obstructive nephropathy still remained a significant cause of ESRD. Systemic lupus erythematosus (SLE) too contributed to about 1 to 2% of new ESRD patients each year.

Table 2.8.1 Primary Renal Disease 1980– 2003

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
New Dialysis patients	43	73	104	93	118	106	108	131	162	161	233	247
% Unknown cause	81	75	74	71	75	66	63	63	66	53	50	48
% Diabetes Mellitus	2	3	8	12	7	11	15	8	12	16	15	19
% GN	14	16	14	9	9	11	14	16	15	13	16	16
% SLE	0	1	0	0	0	1	2	1	1	1	1	1
% Polycystic kidney	2	0	0	3	2	2	1	2	0	2	1	2
% Obstructive Nephropathy	0	0	2	1	2	5	1	5	2	5	7	3
% Toxic Nephropathy	0	0	0	1	0	0	0	1	0	1	0	0
% Others	0	4	2	3	5	4	5	6	4	10	10	11

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
New Dialysis patients	333	339	514	680	939	1130	1237	1538	1811	2036	2223	1992
% Unknown cause	38	41	38	40	37	33	31	29	30	31	31	30
% Diabetes Mellitus	26	22	29	26	30	36	41	41	45	46	50	51
% GN	17	17	13	13	13	13	11	11	9	7	6	5
% SLE	1	2	2	2	2	2	1	2	2	2	1	1
% Polycystic kidney	2	3	2	3	2	2	1	1	1	2	1	1
% Obstructive Nephropathy	5	5	6	6	7	5	5	4	3	4	3	3
% Toxic Nephropathy	0	1	0	0	1	0	0	1	0	1	0	0
% Others	10	10	10	10	11	9	9	12	9	8	7	8

Figure 2.8.1 Primary Renal Disease for New Dialysis Patients 1980– 2003



Primary Renal Disease of New Dialysis Patients, 1980-2003

2.9 Death on Dialysis

From Table 2.9.1 death rates on HD have consistently been 10% or lower per year from 1980's when mainly young patients were selected for chronic dialysis to 2000's when a much higher proportion of older and diabetic patients were accepted into the programme. There may possibly be a trend towards higher mortality in HD patients over the last 3 years as shown in Figure 2.7.1. CAPD patients showed a consistently higher mortality compared with HD with large fluctuations in the early years but averaging between 14 to 18% per year in the last 10 years.

The data on causes of death is not as reliable. Cardiovascular mortality and death at home still remain the two commonest causes of death with sepsis either as the second or third commonest cause of death. CAPD peritonitis accounted for less than 4% of the total causes of death (Table 2.9.2).

Table 2.9.1 Deaths on Dialysis 1980 – 2003

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
No. of dialysis patients at risk	59	92	160	224	293	370	437	505	589	669	771	905
Dialysis deaths	6	3	14	22	27	26	47	31	38	65	70	87
Dialysis death rate %	10	3	9	10	9	7	11	6	6	10	9	10
No. of HD patients at risk	59	90	155	216	270	332	396	460	535	616	708	810
HD deaths	5	3	14	22	24	19	38	26	28	52	62	69
HD death rate %	8	3	9	10	9	6	10	6	5	8	9	9
No. of CAPD patients at risk	0	2	5	8	24	39	41	45	54	54	64	95
CAPD deaths	1	0	0	0	3	7	9	5	10	13	8	18
CAPD death rate %	0	0	0	0	13	18	22	11	19	24	13	19

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
No. of dialysis patients at risk	1075	1289	1571	1987	2572	3302	4104	5021	6093	7219	8365	9375
Dialysis deaths	95	102	146	178	222	314	373	486	581	786	874	993
Dialysis death rate %	9	8	9	9	9	10	9	10	10	11	10	11
No. of HD patients at risk	938	1112	1353	1700	2189	2831	3584	4454	5466	6506	7523	8393
HD deaths	72	79	104	120	160	241	299	386	491	658	759	826
HD death rate %	8	7	8	7	7	9	8	9	9	10	10	10
No. of CAPD patients at risk	137	177	218	287	384	471	521	567	627	713	842	982
CAPD deaths	23	23	42	58	62	73	74	100	90	128	115	167
CAPD death rate %	17	13	19	20	16	15	14	18	14	18	14	17

Figure 2.9.1 Death Rates on Dialysis 1980 – 2003

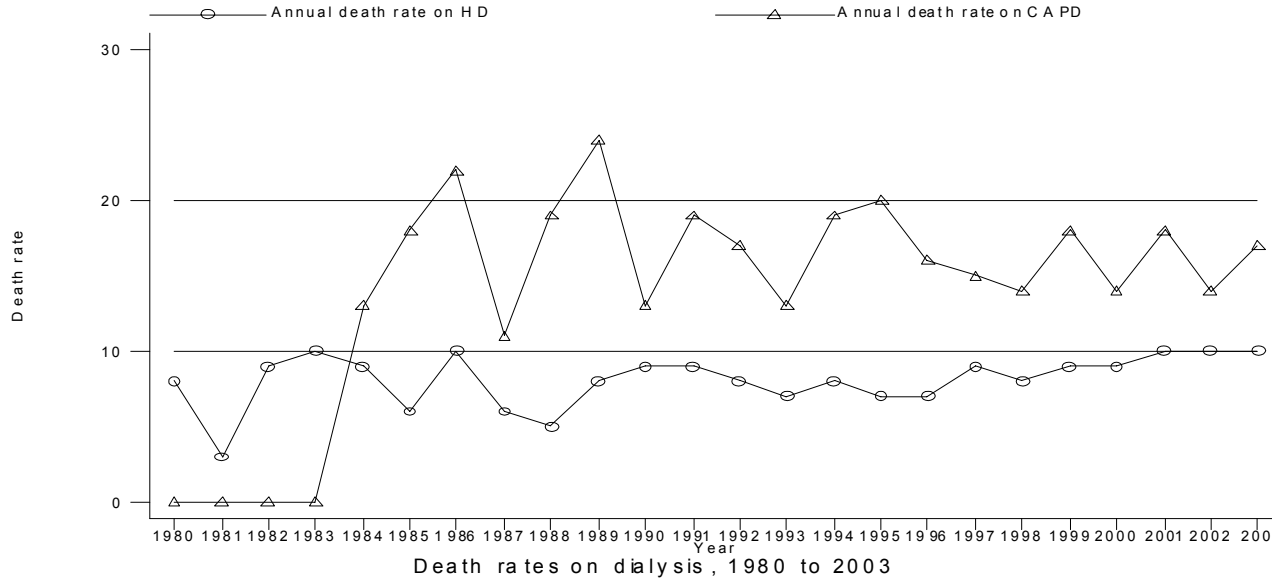


Table 2.9.2 Causes of Death on Dialysis 1980 - 2003

Year	1980		1981		1982		1983		1984		1985		1986		1987	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Cardiovascular	1	17	0	0	0	0	3	14	5	19	2	8	13	28	6	19
Died at home	0	0	0	0	0	0	2	9	0	0	1	4	3	6	0	0
Sepsis	0	0	0	0	4	29	2	9	3	11	1	4	5	11	2	6
CAPD peritonitis	0	0	0	0	0	0	0	0	0	0	2	8	0	0	1	3
GIT bleed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cancer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liver disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	5	83	3	100	10	71	15	68	19	70	19	73	26	55	20	65
Unknown	0	0	0	0	0	0	0	0	0	0	1	4	0	0	2	6
total	6	100	3	100	14	100	22	100	27	100	26	100	47	100	31	100

Year	1988		1989		1990		1991		1992		1993		1994		1995	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Cardiovascular	13	34	20	31	18	26	27	31	31	33	30	29	34	23	47	26
Died at home	4	11	8	12	12	17	11	13	9	9	9	9	21	14	23	13
Sepsis	1	3	6	9	12	17	12	14	14	15	20	20	17	12	35	20
CAPD peritonitis	1	3	2	3	2	3	1	1	1	1	0	0	7	5	0	0
GIT bleed	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2	1
Cancer	0	0	0	0	0	0	0	0	0	0	2	2	6	4	5	3
Liver disease	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
Others	18	47	25	38	24	34	26	30	36	38	34	33	42	29	55	31
Unknown	1	3	4	6	2	3	7	8	3	3	6	6	18	12	10	6
total	38	100	65	100	70	100	87	100	95	100	102	100	146	100	178	100

Year	1996		1997		1998		1999		2000		2001		2002		2003	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Cardiovascular	53	24	87	28	123	33	157	32	208	36	267	34	335	38	335	34
Died at home	39	18	53	17	64	17	107	22	132	23	210	27	202	23	261	26
Sepsis	46	21	55	18	61	16	74	15	87	15	120	15	128	15	160	16
CAPD peritonitis	1	0	4	1	1	0	8	2	15	3	21	3	11	1	7	1
GIT bleed	2	1	2	1	8	2	13	3	10	2	15	2	18	2	20	2
Cancer	2	1	9	3	8	2	6	1	10	2	14	2	18	2	18	2
Liver disease	1	0	3	1	2	1	8	2	6	1	6	1	8	1	12	1
Others	55	25	69	22	75	20	92	19	89	15	105	13	131	15	150	15
Unknown	23	10	32	10	31	8	21	4	24	4	28	4	23	3	30	3
total	222	100	314	100	373	100	486	100	581	100	786	100	874	100	993	100

CHAPTER 3: DIALYSIS SURVIVAL

Summary

- The survival of all dialysis patients starting dialysis in 1993 to 2002 was 90%, 73%, 60% and 39% at one year, 3 years, 5 years and 10 years respectively.
- CAPD patients had a 74% higher risk of death compared to haemodialysis patients
- Survival of dialysis patients in recent vintage was lower than in earlier vintage. Compared to the 1997-1998 cohort the mortality risk of 1999-2000 and 2001-2002 cohorts were increased by 21% and 27% respectively.
- Diabetics on dialysis had 2.1 times higher risk of death compared to non-diabetics.
- Low serum albumin concentration, low body mass index and low serum cholesterol level were independent risk factors for mortality.
- There was a U-shaped relationship between diastolic blood pressure and risk of mortality.
- The haemoglobin level associated with the lowest risk of mortality was 11-12 g/dl.
- Hyperphosphataemia, hypercalcaemia and low calcium phosphate product were associated with increased risk of death.
- Hepatitis B or Hepatitis C status did not affect patient survival.

Introduction

Despite recent advances, patients on dialysis have higher mortality compared to the normal population. The survival trend and factors affecting the survival of dialysis patients need to be evaluated to assess the effectiveness of this expensive therapy and to allow us to formulate and implement measures to improve the outcome.

3.1 Overall Dialysis Patient Survival

All patients starting dialysis in 1993 to 2002 were included in the analysis for probability of survival. The overall survival of dialysis patients was 90% at one year, 73% at 3-years, 60% at 5-years and 39% at 10-years. (Table 3.2) The 5-year patient survival is similar to those reported from Japan and the UK but higher than those reported by the USRDS and the Netherlands. [1][2] (Table 3.1)

3.2 Patient Survival by Dialysis Modality

Patient survival on haemodialysis (HD) was better compared to CAPD. Haemodialysis patients had a survival probability of 90% at one-year, 63% at 5-years and 41% at 10-years while that for CAPD patients were 88%, 43% and 20% respectively. (Table 3.2 & Figure 3.2) The survival difference between the two modalities was seen after one year on dialysis.

Table 3.1 Unadjusted survival of dialysis patients by country

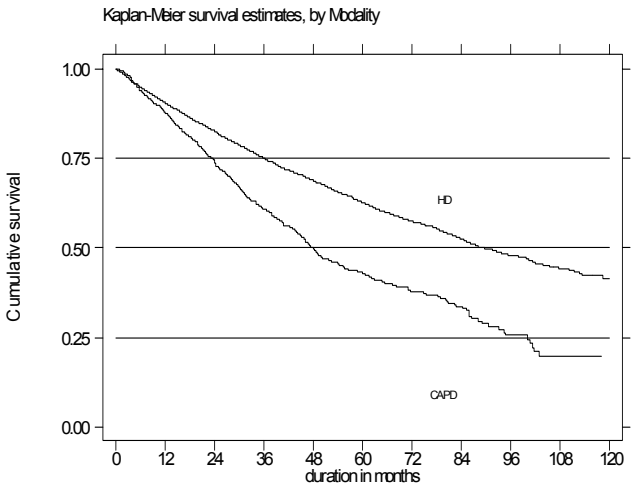
Interval (years)	Malaysia (1993 cohort) (%)	US (1991 cohort) (%)	Japan (%)	UK (%)	Netherlands (%)
1	92	78			
2	85	61			67
5	68	29	61	59	35
10	47	9			11

Table 3.2 Unadjusted ten-year patient survival by Dialysis modality (1993-2002 cohort)

Dialysis modality	CAPD		HD		ALL DIALYSIS	
Interval (months)	% Survival	SE*	% Survival	SE*	% Survival	SE*
6	94	1	95	0	95	0
12	88	1	90	0	90	0
24	74	1	82	0	81	0
36	61	1	75	0	73	0
48	50	2	69	1	66	0
60	43	2	63	1	60	1
72	38	2	57	1	55	1
84	34	2	53	1	50	1
96	26	3	48	1	45	1
108	20	3	44	1	41	1
120	20	3	41	1	39	1

* SE=standard error

Figure 3.2 Unadjusted ten-year patient survival by Dialysis Modality (1993-2002)



3.3 Patient Survival by Year Commencing Dialysis

The survival of haemodialysis and CAPD patients by year of entry into the dialysis programme is shown in Table 3.3. There was no apparent trend in the crude survival of HD patients over the last 10 years despite the increasing intake of older and diabetic patients. In CAPD, long-term survival has gradually improved, perhaps reflecting the improvement in connectology in CAPD treatment resulting in reduced peritonitis rate – the Achilles heel of the peritoneal dialysis programme. The survival at 5 years was 37% and 49% in 1993 and 1997 respectively. (Table 3.3).

3.4 Patient Survival by Age

Not surprisingly, younger patients on dialysis had better survival compared to older patients. The one-year, 5-year and 10-year survival for patients less than 15 years old was 97%, 85% and 56% respectively compared to 84%, 34% and 14% for patients 65 years or older. (Table 3.4 & Figure 3.4)

Table 3.3 Unadjusted ten -year survival of haemodialysis and CAPD patients by year of entry (1993-2002 cohort)

Year	1993		1994		1995		1996	
Interval (months)	HD % (SE)	CAPD % (SE)	HD % (SE)	CAPD % (SE)	HD % (SE)	CAPD % (SE)	HD % (SE)	CAPD % (SE)
6	96 (1)	94 (3)	94 (1)	91 (3)	95 (1)	93 (2)	95 (1)	94 (1)
12	93 (1)	85 (5)	89 (2)	82 (4)	92 (1)	87(3)	92 (1)	88 (2)
24	87 (2)	74 (6)	84 (2)	65 (5)	86 (2)	71 (4)	86 (1)	77 (3)
36	81 (2)	58 (7)	77 (2)	50 (5)	79 (2)	59 (4)	76 (2)	66 (4)
48	77 (2)	44 (7)	72 (2)	43 (6)	75 (2)	46 (4)	70 (2)	52 (4)
60	73 (3)	37 (7)	64 (2)	37 (6)	69 (2)	37 (4)	63 (2)	48 (4)
72	68 (3)	37 (7)	60 (2)	33 (6)	64 (2)	33 (4)	57 (2)	39 (4)
84	63 (3)	37 (7)	53 (3)	31 (6)	60 (2)	29 (4)	52 (2)	35 (4)
96	58 (3)	24 (7)	47 (3)	28 (6)	54 (2)	23 (4)		
108	54 (3)	19 (7)	42 (2)	17 (7)				
120	51 (3)	19 (7)						

Year	1997		1998		1999		2000	
Interval (months)	HD % (SE)	CAPD %(SE)	HD % (SE)	CAPD % (SE)	HD % (SE)	CAPD % (SE)	HD % (SE)	CAPD % (SE)
6	94 (1)	96 (1)	95 (1)	94 (2)	95 (1)	94 (2)	95 (1)	94 (2)
12	90 (1)	92 (2)	92(1)	86 (3)	90 (1)	90 (2)	90 (1)	88 (2)
24	83 (1)	79 (3)	84(1)	73 (4)	83 (1)	73 (3)	81 (1)	77 (3)
36	76 (1)	65 (4)	77(1)	62 (4)	75 (1)	55 (4)	74 (1)	64 (4)
48	70 (1)	56 (4)	70(1)	54 (4)	67 (1)	46 (4)		
60	63 (2)	49 (4)	63(1)	44 (5)				
72	57 (2)	42 (4)						

Year	2001		2002	
Interval (months)	HD % (SE)	CAPD % (SE)	HD % (SE)	CAPD % (SE)
6	94 (1)	93 (1)	96 (1)	94 (1)
12	89 (1)	88 (2)	91 (2)	87 (2)
24	79 (1)	74 (3)		

* SE=standard error

Figure 3.4 Unadjusted ten-year survival of dialysis patients by age (1993-2002 cohort)

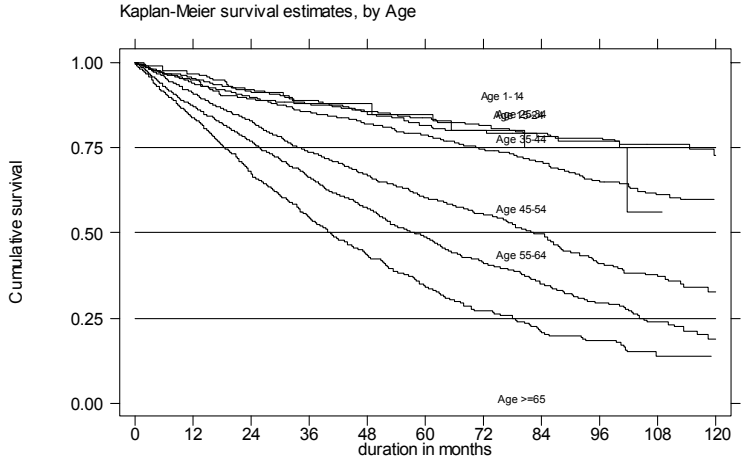


Table 3.4 Unadjusted ten-year survival of dialysis patients by age (1993-2002 cohort)

Age group	≤14		15 - ≤24		25 - ≤ 34		35—≤ 44	
Interval (months)	% Survival	SE*	% Survival	SE*	% Survival	SE*	% Survival	SE*
6	98	1	97	1	97	1	97	0
12	97	1	95	1	95	1	94	1
24	92	2	89	1	92	1	90	1
36	88	3	88	1	89	1	85	1
48	88	3	85	2	86	1	82	1
60	85	3	82	2	84	1	78	1
72	80	4	80	2	81	1	74	1
84	75	6	78	3	79	2	71	1
96	75	6	77	3	78	2	65	2
108	56	17	75	3	76	2	61	2
120	56	17	75	3	73	3	60	2

Age group	45 - ≤ 54		55—≤ 64		≥ 65	
Interval (months)	% Survival	SE*	% Survival	SE*	% Survival	SE*
6	96	0	93	0	91	1
12	91	1	87	1	84	1
24	83	1	78	1	68	1
36	74	1	66	1	54	1
48	67	1	57	1	44	1
60	60	1	49	1	34	1
72	55	1	41	1	27	2
84	49	1	35	1	21	2
96	41	2	29	2	18	2
108	37	2	24	2	14	2
120	33	3	19	3	14	2

* SE=standard error

3.5 Patient Survival by Diabetic Status

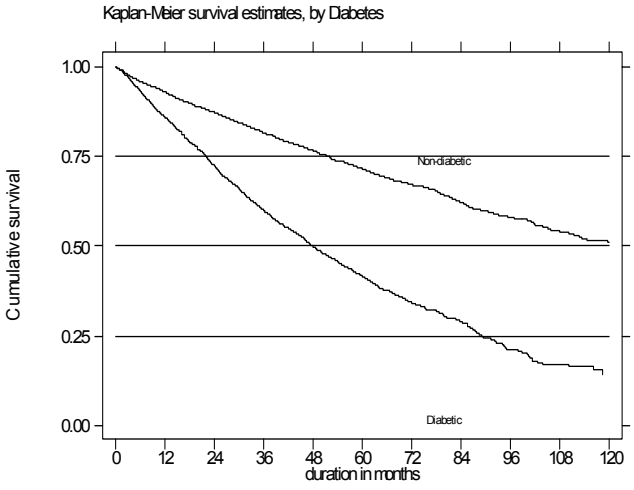
The presence of diabetes mellitus has a major impact on survival. The one-year, 5-year and 10-year survival for non-diabetics were 93%, 71% and 51%, while that for diabetics were 86%, 41% and 14% respectively. The divergence in survival was noted 6 months after commencement of dialysis. The median time of survival for diabetics was 48 months compared to at least 120 months for non-diabetics. (Table 3.5. & Figure 3.5)

Table 3.5 Unadjusted ten-year survival of dialysis patients by diabetic status (1993-2002)

Diabetes status	Non-Diabetic		Diabetic	
Interval (months)	% Survival	SE*	% Survival	SE*
6	96	0	93	0
12	93	0	86	0
24	87	0	73	1
36	82	0	60	1
48	77	1	50	1
60	71	1	41	1
72	67	1	34	1
84	62	1	29	1
96	58	1	21	1
108	54	1	17	2
120	51	1	14	2

* SE=standard error

Figure 3.5 Unadjusted ten-year survival of dialysis patients by diabetic status (1993-2002 cohort)



3.6 Adjusted Mortality of Dialysis Patients

The 1997-2002 dialysis cohort was examined for independent risk factors for death by Cox proportional hazard regression model. The clinical and biochemical data for patients commencing dialysis before 1997 were incomplete and unsuitable for analysis and hence were not included in the analysis. Furthermore the earlier data was only available for patients on dialysis in the Ministry of Health facilities and therefore not representative of the whole dialysis population where about 60% of patients received dialysis therapy in non-Ministry of Health facilities.. The risk of death was adjusted for age, gender, primary diagnosis, time on renal replacement therapy (RRT), modality of dialysis, presence of cardiovascular disease, diabetic status, body mass index (BMI), serum concentrations of albumin, cholesterol, calcium, phosphate, calcium-phosphate product and haemoglobin; blood pressure, and hepatitis status. Time averaged values of biochemical data were used.

Patient characteristics that had significant impact on the hazard of death were age, gender, body mass index, year commencing dialysis, dialysis modality, diastolic blood pressure and presence of diabetes or cardiovascular disease. The significant biochemical risk factors for death were serum albumin, haemoglobin, cholesterol, calcium and calcium-phosphate product. (Table 3.6)

As expected age was an independent risk factor for death. The risk rose progressively with each decade of life. The hazard of death for an elderly patient (more than 65 years of age) was 5.8 times higher compared to a patient less than 15 years of age. This is consistent with the ERA- EDTA registry data. In their report the relative risk of death increased by 5% for each one year increment in age.[3] Female patients had a 14% lower risk of death compared to their male counterparts. This is consistent with the USRDS data.[1] However, the ERA-EDTA registry reported that females had a 5% higher risk of death compared to males.[3]

Diabetic patients on dialysis had about 2 times higher risk of death compared to the non-diabetics. This is comparable with the ERA-EDTA Registry report where the risk of death in diabetics was 2.46 times higher the than non-diabetics.[3] As reported by other authors, dialysis patients with underlying cardiovascular disease had a higher risk of mortality (49%) when compared to patients with no reported history of cardiovascular disease.[4]

CAPD patients had a 74% higher risk of death compared to haemodialysis patients. The ERA-EDTA showed a 25% higher risk of death for those who started renal replacement therapy with peritoneal dialysis.[3] In contrast two other studies did not find any difference in survival between CAPD and haemodialysis patients.[5][6]. The reasons for the lower survival in our CAPD patients are unclear and needs further studies.

The US and European registries have reported improved survival of patients starting dialysis in later vintage. ERA-EDTA data showed that after adjustment for age, gender and diabetes, patient survival for the 1990-1994 (relative risk (RR) 0.94) and the 1995-1999 cohorts (RR 0.88) were better compared to the 1980-1984 cohort.[2] Their improved survival on RRT was attributed to the improved efficiency and safety of dialysis. However our study indicates the reverse - a higher risk of death in patients commencing dialysis from 1999-2002 compared to patients starting dialysis before 1999. Compared to the 1997-1998 cohort the mortality risks of the 1999-2000 and the 2001-2002 cohorts were increased by 21% and 27% respectively. The higher mortality may be due to increased intake of high risk patients into dialysis centres with limited medical care. However, this trend is worrying and more analysis is urgently needed to examine for possible centre-treatment interaction and other as yet unidentified reasons for this trend.

Three nutritional markers (serum albumin concentration, body mass index and serum cholesterol concentration) were identified as independent risk factors for death. Serum albumin concentration was inversely related to the risk of death. Compared to a serum albumin of 40g/l or more, the risk of death was 4.37, 2.24 and 1.38 times higher in patients with serum albumin less than 30g/l, 30-34g/l and 35-39g/l respectively. This relationship has been well described in the literature.[7]

Low body mass index (BMI) and low serum cholesterol concentration were also associated with increased risk of death. Compared to a BMI of 25 kg/m^2 or higher, a BMI of less than 18.5 kg/m^2 was associated with a 41% increased risk of death. The USRDS data also showed higher death rate in haemodialysis patients with lower body mass index. [8][9] Similarly, a serum cholesterol of less than 3.2 mmol/l was associated with a 47% increased risk of death compared to patients with serum cholesterol of more than 5.2 mmol/l. The USRDS data showed similar findings.[1] This inverse relationship in dialysis patients is at variance with the evidence from the normal population. This discrepancy is probably due to the association of low cholesterol with malnutrition and inflammation.[10] Further studies are needed to establish the relationship between higher serum cholesterol and the risk of death from cardiovascular disease.

A prescribed Kt/V_{urea} of less than 1.0 was associated with a 73% higher risk of death compared to a Kt/V_{urea} of 1.2 to 1.4. There was a trend of better survival in patients with $Kt/V_{urea} > 1.4$, but this was not statistically significant.

In the general population high blood pressure is associated with increased mortality. Even borderline high blood pressure has been associated with increased cardiovascular events.[11] Evidence now shows that there is no J-curve relationship between blood pressure and mortality in the general population. In the dialysis population however, several studies have shown a higher risk of death in patients with low blood pressure.[12][13] In our cohort, there is a U-shaped or J-shaped relationship between blood pressure and risk of death. (Figure 3.6a) Compared to the reference range of 80-

90 mmHg, a diastolic blood pressure of less than 70 mmHg was associated with a 28% higher risk of death while a diastolic blood pressure of 90-99 mmHg and 100 mmHg or more was associated with a 1.3 and 2.2 times higher mortality risk respectively. The U-shaped relationship has also been reported in other series. [14][15] After adjustment for diastolic blood pressure and other risk factors, systolic blood pressure and pulse pressure did not independently affect mortality.

Anaemia was associated with increased mortality and poorer quality of life.[16] A haemoglobin level of less than 8g/dl was associated with a 2.2 times higher risk of death compared to a haemoglobin level of 10-12g/dl; while a haemoglobin level of 8-10g/dl was associated with a 31% increase in mortality. The lowest risk of death was recorded in patients with haemoglobin of 11-12g/dl but this was not statistically significant compared to the reference group (haemoglobin 10-11g/dl). There was no significant improvement in survival with haemoglobin level of more than 11g/dl.

The USRDS data showed that serum phosphate of more than 2.08 mmol/l was associated with a 27% increase risk of death.[17] Using a timed average phosphate concentration over 2 years in more than 12,000 patients, Ganesh et al showed that hyperphosphataemia (serum phosphate > 2.08 mmol/l) was associated with a 41% risk of death from cardiovascular disease and a 20% risk of sudden death.[18] Our data showed that hyperphosphataemia had a significant impact on death only when serum phosphate was 2.4 mmol/l or higher - a serum phosphate level of 2.4 to 2.6 mol/l resulted in a 71% increase risk of mortality compared to the reference range of 1.6 to <2.0 mmol/l. Hypercalcaemia (serum calcium 2.6 mmol/l or more) was associated with a 24% increased risk of death compared to the reference range of 2.2 to <2.6 mmol/l in our dialysis population . Foley et al reported that chronic hypocalcaemia was associated with more than two times increased risk of mortality in contrast to our results which did not show any significant increased risk of mortality.[19] The reasons for the discrepancy are unclear.

Patients with a low calcium phosphate product (less than 3.5 $mmol^2/l^2$) was associated with a 31% higher risk of mortality when compared to those with normal calcium phosphate product (3.5-4.5 $mmol^2/l^2$). High calcium phosphate product did not adversely affect survival. This differs from other series where high calcium phosphate product was also associated with increased mortality.[20]

Hepatitis B antigenaemia had no effect on patient survival and this is consistent with other reports.[21] [22] A positive hepatitis C virus (HCV) antibody also did not confer an increase in risk of mortality. However this differs from experience from other centres where a positive HCV antibody was associated with a higher relative risk of death compared to patients negative for HCV antibody. [23-26]

Conclusion

In conclusion survival of our dialysis patients over the last 10 years is comparable to those reported from other centres/registries. The reasons for poorer survival in recent years need to be identified and corrective measures implemented.

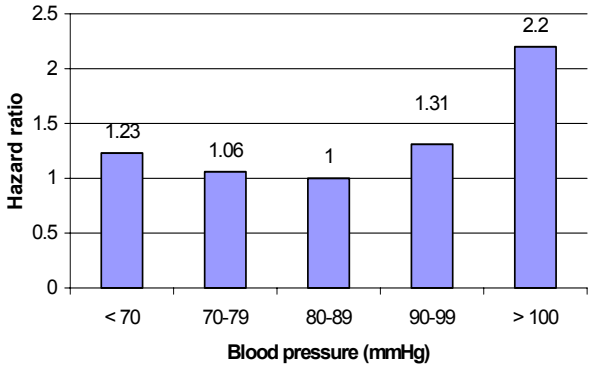
Table 3.6 Adjusted hazard ratio for mortality of dialysis patients (1997-2002 cohort)

Factors	N	Hazard ratio	95% CI	P value
Age (years):				
0-≤14(ref.*)	157	1.00		
15-≤24	417	1.82	(0.89,3.71)	0.100
25-≤34	727	1.58	(0.79,3.16)	0.198
35-≤44	1223	1.97	(1.00,3.89)	0.049
45-≤54	1885	3.12	(1.60,6.09)	0.001
55-≤64	1907	4.03	(2.06,7.89)	0.000
≥65	1094	5.76	(2.92,11.33)	0.000
Gender:				
Male (ref.*)	4113	1.00		
Female	3297	0.86	(0.75, 0.97)	0.015
Primary diagnosis:				
Unknown/Uncertain (ref.*)	2168	1.00		
Diabetes mellitus	2915	2.14	(1.81,2.52)	0.000
GN/ SLE	908	1.04	(0.79,1.35)	0.777
Polycystic kidney	119	1.61	(0.99,2.63)	0.057
Obstructive Nephropathy	361	1.39	(1.05,1.85)	0.023
Others	939	1.23	(0.98,1.53)	0.073
Year start dialysis				
1997-8 (ref.*)	1915	1.00		
1999-2000	2652	1.21	(1.05,1.39)	0.009
2001-2002	2843	1.27	(1.06,1.53)	0.010
Modality:				
CAPD (ref.*)	1243	1.74	(1.51,2.00)	0.000
HD	6167	1.00		
BMI:				
<18.5	1080	1.41	(1.15,1.74)	0.001
18.5-<25	3635	1.27	(1.10,1.46)	0.001
≥25(ref.*)	1444	1.00		

Table 3.6 Adjusted hazard ratio for mortality of dialysis patients (1997-2002 cohort)

Factors	N	Hazard ratio	95% CI	P value
Serum albumin (g/L)				
<30	558	4.36	(3.41,5.56)	0.000
30-<35	1255	2.31	(1.91,2.81)	0.000
35-<40	2861	1.39	(1.17,1.64)	0.000
≥ 40(ref.*)	2170	1.00		
Serum cholesterol (mmol/l):				
<3.2	197	1.45	(1.10,1.92)	0.010
3.2-<5.2	2987	1.00	(0.88,1.13)	0.996
≥5.2(ref.*)	2537	1.00		
KT/V				
<1	274	1.73	(1.23,2.43)	0.002
1.0-1.2	898	1.21	(0.96,1.51)	0.106
1.2-1.4(ref.*)	1439	1.00		
1.4-1.6	1422	0.97	(0.80,1.18)	0.763
≥ 1.6	1823	0.84	(0.67,1.05)	0.126
Diastolic BP:				
<70	824	1.23	(1.01,1.49)	0.036
70-<80	2193	1.06	(0.92,1.22)	0.450
80-<90(ref.*)	2800	1.00		
90-<100	1186	1.31	(1.09,1.58)	0.004
≥100	270	2.20	(1.63,2.98)	0.000
Haemoglobin (g/dl):				
<8	1610	2.17	(1.78,2.64)	0.000
8-<9	1783	1.31	(1.09,1.60)	0.005
9-<10	1803	1.26	(1.04,1.51)	0.016
10-<11(ref.*)	1112	1.00		
11-<12	504	0.89	(0.68,1.20)	0.453
≥ 12	234	1.14	(0.79,1.63)	0.487
Serum Calcium (mmol/l):				
<2.2	1683	1.04	(0.88,1.24)	0.636
2.2-<2.6(ref.*)	4423	1.00		
≥ 2.6	673	1.24	(1.03,1.50)	0.022
Calcium Phosphate product				
<3.5	2130	1.31	(1.08,1.59)	0.006
3.5-<4.5(ref.*)	2335	1.00		
4.5-<5.5	1460	0.84	(0.67,1.05)	0.128
≥ 5.5	813	0.96	(0.64,1.43)	0.824
Serum Phosphate (mmol/l)				
<1.6	2645	1.01	(0.82,1.25)	0.923
1.6-<2.0(ref.*)	2218	1.00		
2.0-<2.2	788	1.17	(0.91,1.50)	0.213
2.2-<2.4	577	1.07	(0.77,1.49)	0.670
2.4-<2.6	329	1.71	(1.11,2.61)	0.014
≥ 2.6	414	1.55	(0.98,2.45)	0.061
HbAsg:				
Negative(ref)	6943	1.00		
Positive	467	1.11	(0.87,1.40)	0.407
Anti-HCV:				
Negative(ref)	6276	1.00		
Positive	1134	0.89	(0.76,1.05)	0.163
Cardiovascular disease (CVD)				
No CVD(ref)	5938	1.00		
CVD	1472	1.49	(1.30,1.70)	0.000

Figure 3.6(a) Adjusted hazard ratio for mortality of dialysis patients by diastolic blood pressure (1997-2002 cohort)



References

1. Outcome: Hospitalisation and mortality in US Renal Data System, USRDS 2003 Annual Data Report: Atlas of End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Disease, Bethesda, MD, 2003;103-114

2. van Dijk PCW, Jager KJ, de Charro F et al. Renal replacement therapy in Europe: the results of a collaborative effort by the ERA-EDTA registry and six national or regional registries. Nephrol Dial Transplant 2001;16:1120-1129

3. Elinder CG, Jones E, Briggs JD et al. Improved survival in renal replacement therapy in Europe between 1975 and 1992. An ERA – EDTA Registry study. Nephrol Dial Transplant 1999;14: 2351-2356

4. Ganesh SA, Hulbert-Shearon T, Port FK, Eagle K et al. Mortality differences by dialysis modality among incident ESRD patients with and without coronary artery disease. J Am Soc Nephrol 2003;14(2):415-424

5. Fenton SA, Schuabel DE, Desmueles M et al Haemodialysis versus peritoneal dialysis: a comparison of adjusted mortality rates. Am J Kidney Dis 1997;30:334-342

6. Maiorca R, Brunori G, Zubani R et al. Predictive value of dialysis adequacy and nutritional indices for mortality and morbidity in CAPD and HD. A longitudinal study. Nephro Dial Transplant 1995;10:2295-2305

7. Owen WF, Lew NL, Liu Y, Lowrie EG et al. The urea reduction ratio and serum albumin concentration as predictors of mortality in patients undergoing haemodialysis. N Engl J Med 1993;329:1001-1006

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(6):997-1006.

9. Abbott KC, Glanton CW, Trespalacios FC, Oliver DK, Ortiz MI, Agodoa LY, Cruess DF, Kimmel PL. Body mass index, dialysis modality, and survival: analysis of the United States Renal Data System Dialysis Morbidity and Mortality Wave II Study. Kidney Int. 2004;65(2):597-605.

10. Liu Y, Coresh J, Eustace JA, Longenecker JC, Jaar B, Fink NE, Tracy RP, Powe NR, Klag MJ. Association between cholesterol level and mortality in dialysis patients: role of inflammation and malnutrition. JAMA 2004;291(4):451-9.

11. Vasan RS. Larson MG, Leip EP et al. Impact of high-normal blood pressure on the risk of cardiovascular disease. N Engl J Med 2001;345:1291-7

12. Port FK, Hulbert-Shearon TE, Wolfe RA, Bloembergen WE et al. Predialysis blood pressure and mortality risk in a national sample of maintenance haemodialysis patients. Am J Kidney Dis 1999;33(3):507-517

13. Foley RN, Herzog CA, Collins AJ. Blood pressure and long-term mortality in United States haemodialysis patients: USRDS Waves 3 and 4 study. Kidney Int 2002;62:1784-1790

14. Zager PC, Nikolic J, Brown RH et al. U curve association of blood pressure and mortality in haemodialysis patients. Kidney Int 1998;54:561-9

15. Mazzuchi N, Carbonell E, Fernandez-Cean J. Importance of blood pressure control in haemodialysis patient survival. Kidney Int. 2000;58(5):2147-54

16. Foley RN, Parfrey PS, Harnett JD et al. The impact of anemia on cardiomyopathy, morbidity, and mortality in end stage renal disease. Am J Kidney Dis 1996;28:53-61

17. Block GA, Hulbert-Shearon TE, Levin NW, Port FK. Association of serum phosphate and calcium X phosphate product with mortality risk in chronic haemodialysis patients: a national study. Am J Kidney Dis. 1998;31(4):607-617

18. Ganesh SK, Stack AG, Levin NW, Hulbert-Shearon T, Port FK. Association of elevated serum PO(4), Ca x PO(4) product, and parathyroid hormone with cardiac mortality risk in chronic haemodialysis patients. J Am Soc Nephrol 2001;12(10):2131-2138

19. Foley RN, Parfrey PS, Harnett JD, Kent GM et al. Hypocalcaemia, morbidity, and mortality in end-stage renal disease. Am J Nephrol. 1996;16(5):386-393

20. Block GA. Prevalence and clinical consequences of elevated Ca X P product in haemodialysis patients. Clin Nephrol 2000;54(4):318-324

21. Josselson J, Kyser BA, Weir MR, Sadler JH. Hepatitis B surface antigenaemia in a chronic haemodialysis program: lack of influence on morbidity and mortality. Am J Kidney Dis. 1987;(6):456-461

22. Harnett JD, Parfrey PS, Kennedy M, Zeldis JB, Steinman TI, Guttmann RD. The long term outcome of hepatitis B infection in haemodialysis patients. Am J Kidney Dis 1988;(3):210-213

23. Nakayama E, Akiba T, Marumo F, Sato C. Prognosis of anti-hepatitis C virus antibody positive patients on regular haemodialysis. J Am Soc Nephrol. 2000;11 (10):1896-1902

24. Pereira BJ, NAtov SN, Bouthot BA, Murthy BV et al. Effects of hepatitis C infection and renal transplantation on survival in end stage renal disease. The New England Organ Bank Hepatitis C study group. Kidney Int. 1998;53 (5): 1374-1381

25. Stehman-Breen CO, Emerson S, Gretch D, Johnson RJ. Risk of death among chronic dialysis patients infected with hepatitis C virus. Am J Kidney Dis. 1998;32(4):629-634

26. Espinosa M, Martin-Malo A, Alvarez de lara MA, Aljama P. Risk of death and liver cirrhosis in anti HCV positive long term haemodialysis patients. Nephrol Dial Transplant. 2001;16(8):1669-1674

CHAPTER 4: QUALITY OF LIFE AND REHABILITATION OUTCOMES OF DIALYSIS PATIENTS IN MALAYSIA

Summary of the report

- The aims of this analysis are (i) to examine the trends of and (ii) to identify the risk factors for quality of life scores and work related rehabilitation among 6908 dialysis patients entering dialysis in year 1997-2002.
- In both HD and CAPD patients commencing dialysis from 1997 to 2002, the median QoL-index score ranged between 9 and 10
- Amongst dialysis patients the quality of life outcome was positively influenced by various factors including male gender, younger age, starting of dialysis in 2001-2002, CAPD, BMI > 25 kg/m^2, albumin of at least 30 g/L, serum cholesterol of >3.2 mmol/L, haemoglobin at least >10 g/dL, and intact PTH of 100-250 ng/L.
- The work rehabilitation outcome was enhanced by male gender, younger age, starting of dialysis in 2001-2002, CAPD, BMI > 25 kg/m^2, albumin of at least 30 g/L, haemoglobin at least >10 g/dL and intact PTH of >100 ng/L.
- Diabetes and haemodialysis modality, which constituted 40% and 90% of our dialysis population respectively, negatively influenced both the patients' quality of life and work rehabilitation outcome.
- Future research to ascertain and to minimize the impact of these risk factors will be beneficial.

Introduction

The provision of dialysis treatment in any country is historically driven by its life saving capability. This remains the fundamental reason for providing dialysis even today. It is increasingly realized that such large investments in resources that benefits relatively few patients should show not just gross outcomes such as survival but also the quality of life (QoL) and rehabilitation potential of these individuals. The vocational and functional rehabilitation of these patients are important to the patient and his family, the healthcare provider and also the community at large. Dialysis treatment does have considerable impact on patients' lifestyle. The treatment is time consuming and is not without adverse effects. The fluid and dietary restrictions required of patients on dialysis further impact on their QoL.

There is increasing interest in the determinants of QoL and work related rehabilitation on dialysis. Outcome of such studies, especially of treatment modifiable factors, has obvious potential to change clinical and dialysis practices to improve patients' QoL and rehabilitation.

A number of factors have been associated with QoL and rehabilitation outcomes. Increasing age [1-4], anaemia [1, 5-7] , nutritional status as evaluated by its markers like BMI, serum albumin [1, 6, 8-10] and cholesterol have strong and predictable adverse effect on patients' QoL and rehabilitation, while the effect of gender was not consistent [6, 8, 11-13]. Whether treatment modality i.e. HD or CAPD has differing effect on QOL and rehabilitation however remains controversial [4, 14].

The National Renal Registry (NRR) has been collecting data on patients' QoL and work rehabilitation status since 1994. The instrument used for measuring QoL, the Spitzer QL index, contains five items. Each item measures a different dimension of quality of life. The 5 dimensions covered are activity level, activities of daily living, feeling of healthiness, social support and psychological outlook. Each dimension is scored on a scale from 0 (worst health) to 2 (best health). The 5 scores are summed to give a total ranging between 0 and 10. The instrument was administered by a staff of each dialysis centre. All staff has received prior training and instruction on how to use the instrument. The instrument has previously been validated in the same dialysis population [15]. A staff also interviews patients to determine whether patients have been able to return to part or full time paid employment, and if not whether this is due to ill health.

In this chapter, we describe the QoL and work related rehabilitation outcomes of patients on HD and CAPD in this country. We also examine the influence of various patient and treatment characteristics on these outcomes. Analysis is confined to the inception cohort consisting of 6908 HD and CAPD patients who commenced dialysis between 1997 and 2002.

Part A shall focus on QoL outcome while Part B is on work related rehabilitation.

Results and Discussion

Part A: Quality of Life Outcome on Dialysis

In both HD and CAPD patients commencing dialysis from 1997 to 2002, the median QL-index score ranged between 9 and 10 (Table 4.1 and 4.2, Figure 4.1 and 4.2). There is an obvious age trend in QOL outcome as expected, with older patients having poorer QoL (Table 4.3 and Figure 4.3). Male patients appeared to do better on dialysis than their female counterparts (Table 4.4 and figure 4.4), and predictably, diabetic subjects did worse (Table 4.5 and figure 4.5). Table 4.6 (Figure 4.6) shows the differences in QOL outcomes between HD and CAPD, with apparent superior outcome for CAPD.

We examine the effects of all these factors and more on QoL outcome using an ordinal regression model. As shown in Table 4.7, adjusted for all other covariates in the model, the analysis confirmed that female patients did have poorer QoL outcome, they were 23% less likely to have a better QoL outcome than men, which is in keeping with other reports [8, 11-13]. Similar findings were also shown in Mittal's [1] group of HD patients who had lower physical component score (SF-36 QoL questionnaire) among females than males. Kalantar-Zadeh et al [6] using a similar instrument but only on 65 patients, did not detect a QoL difference between gender. The reasons for differences between gender seen in this report remained speculative and include biological factors or cultural conditioning or biases in the provision of care according to sex.

The analysis also confirmed the predictable relationship between age and QoL (Table 4.7, Figure 4.7a) [3, 4]. If the cumulative odds ratio is taken as 1 for the age group 20-39 years, there is a consistent decline for the age groups 40-54 years and that greater than 55 years. However, the age group (age <20) had an apparent worse QoL than the reference age group (age 20-39 years) but this difference did not reach statistical significance. It is possible that the impact of end stage renal failure on QoL is less in elderly patients who were more satisfied with their life on dialysis and accepted the limitations better than younger patients [2]. Patients who are less than twenty years old are relatively less equipped with coping skills than older adults and may therefore find dialysis a struggle.

Amongst different primary renal diseases, diabetics had the lowest chance of achieving better QoL scores, having a 69% reduced chance compared to those with unknown aetiology. Mittal et al found diabetics obtained poorer QoL than non-diabetics in all age groups and in all health dimensions [1]. Similarly, the USRDS Annual Report 2003 showed diabetics have lower QoL score in the general health domains than non-diabetics.

Patients starting on dialysis in 2001-2002 (Figure 4.7b) performed better than those in 1997-1998 a 23% higher chance of reporting better QoL scores. Such benefit can be attributed to continuing improvement of technology in dialysis and nursing care or the lack of dialysis related complications in the later cohort.

Being on HD was associated with a 50% lower probability of achieving a higher QoL score as compared to CAPD. Bairardi et al [4] found CAPD patients enjoyed a greater well being in four components of the SF-36 (physical functioning, bodily pain, general health and vitality) than HD patients. Diaz-Buxo et al using the same instrument on 18,015 dialysis patients however found no difference between the two groups [16]. CAPD being a home based therapy offers less disruption to individual's lifestyle. In addition, pain during needling, intradialytic symptoms and stringent fluid and dietary restrictions were common issues affecting HD patients.

There is a consistent trend of worsening QoL outcome with decreasing BMI (Table 4.7), serum albumin (Table 4.7, Figure 4.7c), cholesterol (Table 4.7) and haemoglobin (Table 4.7, Figure 4.7d). These are markers of nutritional status, which can influence QoL. A number of studies have shown both haemoglobin [1, 6, 7] and albumin [1, 6, 8,9,10] correlated well with QoL. However, a study using SF-36 QoL questionnaire [6], showed that the level of cholesterol was not related to the QoL score.

Diastolic blood pressure of greater than 90mmHg (Table 4.7) conferred a reduction of 31% probability in achieving a better QoL scores compared to 70-90mmHg. This may indicate underlying poorly controlled blood pressure with its associated end organ damage and adverse effects of polypharmacy which can lower QoL.

Intact parathyroid hormone (iPTH) levels of 100-250 ng/L was associated with a 34% increased chance of a better QoL outcome compared to those of <100 ng/L. Those with >250 ng/L did not show significant advantage presumably due to the associated bone pain in high bone turnover state. Other authors did not find correlation between iPTH and QoL [6].

The measure of dialysis adequacy Kt/V did not have an impact on QoL scores among HD patients (Figure 4.7e). Moreno et al [13], Morton et al [17] and Kalantar-Zadeh et al [6] all reported similar findings. Spitzer's QoL total score has been reported to be skewed to the right, indicating poor discrimination among well outpatient HD patients [15], especially those with Kt/V >1.2. In addition, in this report those with a Kt/V <1 group (n= 331) involved a relatively small number of patients compared to the other subgroups (n >900). Such biases may confound the impact of Kt/V. Whether Asian haemodialysis patients tolerate a lower threshold of Kt/V remains uncertain and will need further investigations.

Table 4.1 Cumulative distribution of QL-Index score in relation to Year of entry, HD patients 1997-2002

Year of Entry	1997	1998	1999	2000	2001	2002
Number of patients	714	778	976	1143	1188	1000
Centile						
0	0	0	0	0	0	0
0.05	4.6	5	4.5	4.5	5	4
0.10	5.8	6	5.5	5.7	5	5
0.25 (LQ)	8	7.8	7.3	7.3	7	7
0.5 (median)	9.5	9.4	9.3	9	9	9
0.75 (UQ)	10	10	10	10	10	10
0.90	10	10	10	10	10	10
0.95	10	10	10	10	10	10
1	10	10	10	10	10	10

Figure 4.1 Cumulative distribution of QL-Index score in relation to Year of entry, HD patients 1997-2002

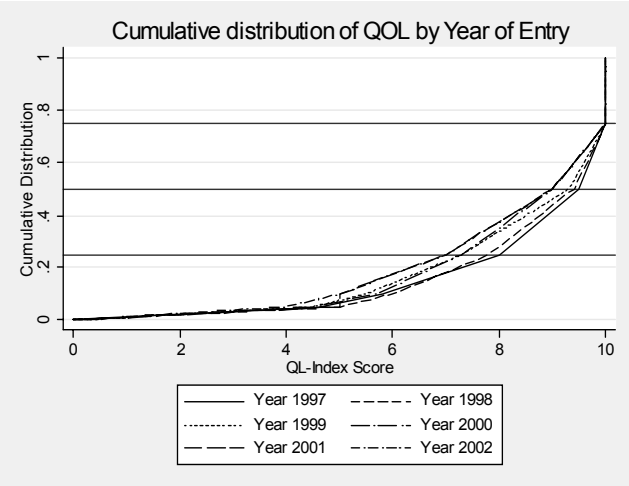


Table 4.2 Cumulative distribution of QL-Index score in relation to Year of entry, CAPD patients 1997-2002

Year of Entry	1997	1998	1999	2000	2001	2002
Number of patients	156	113	159	177	251	253
Centile						
0	0	0	0	0	0	0
0.05	5	5	4.5	5	5	5
0.10	6	6	5	6	6	6
0.25 (LQ)	7.5	8	7	8.5	8	8
0.5 (median)	9.5	9.8	9.3	10	10	10
0.75 (UQ)	10	10	10	10	10	10
0.90	10	10	10	10	10	10
0.95	10	10	10	10	10	10
1	10	10	10	10	10	10

Figure 4.2 Cumulative distribution of QL-Index score in relation to Year of entry, CAPD patients 1997-2002

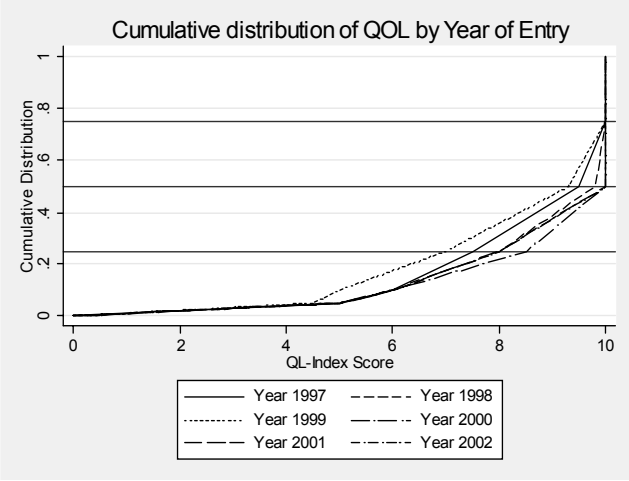


Table 4.3 Cumulative distribution of QL-Index score in relation to Age, All dialysis patients 1997-2002

Age group	<20	20-39	40-59	>=60
Number of patients	313	1397	3413	1785
Centile				
0	0	0	0	0
0.05	7	7	5	4
0.10	8	8	6	5
0.25 (LQ)	9	9	8	6
0.5 (median)	10	10	10	8
0.75 (UQ)	10	10	10	9
0.90	10	10	10	10
0.95	10	10	10	10
1	10	10	10	10

Figure 4.3 Cumulative distribution of QL-Index score in relation to Age, All Dialysis patients 1997-2002

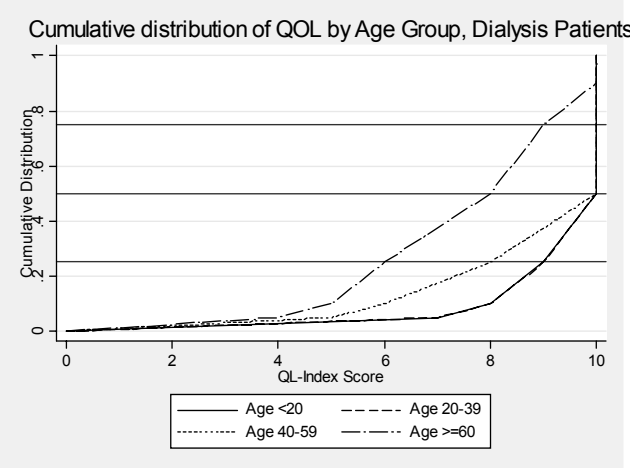


Table 4.4 Cumulative distribution of QL-Index score in relation to Gender, All Dialysis patients 1997-2002

Gender	Male	Female
Number of patients	3836	3072
Centile		
0	0	0
0.05	5	4
0.10	6	5
0.25 (LQ)	8	7
0.5 (median)	10	9
0.75 (UQ)	10	10
0.90	10	10
0.95	10	10
1	10	10

Figure 4.4 Cumulative distribution of QL-Index score in relation to Gender, All Dialysis patients 1997-2002

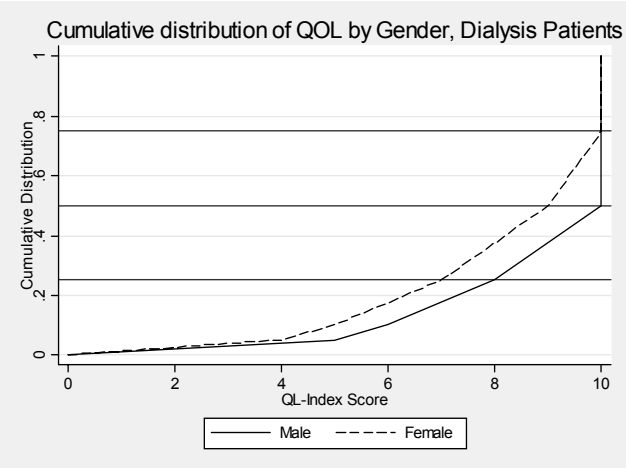


Table 4.5 Cumulative distribution of QL-Index score in relation to Diabetes mellitus, All Dialysis patients 1997-2002

Diabetes mellitus	No	Yes
Number of patients	4159	2749
Centile		
0	0	0
0.05	6	4
0.10	7	5
0.25 (LQ)	9	6
0.5 (median)	10	8
0.75 (UQ)	10	10
0.90	10	10
0.95	10	10
1	10	10

Figure 4.5 Cumulative distribution of QL-Index score in relation to Diabetes mellitus, All Dialysis patients 1997-2002

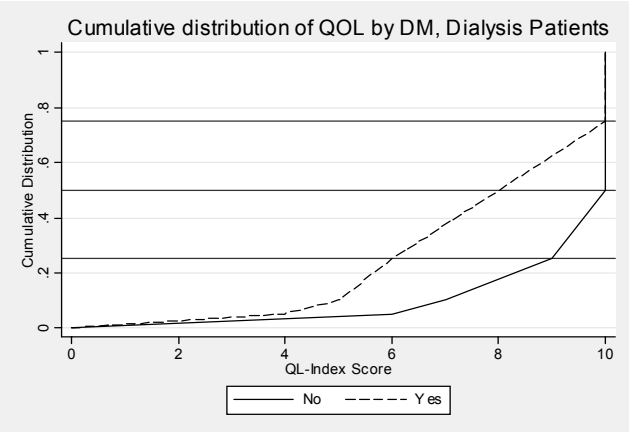


Table 4.6 Cumulative distribution of QL-Index score in relation to Dialysis modality, All Dialysis patients 1997-2002

Dialysis modality	CAPD	HD
Number of patients	1109	5799
Centile		
0	0	0
0.05	5	5
0.10	6	6
0.25 (LQ)	8	7
0.5 (median)	10	9
0.75 (UQ)	10	10
0.90	10	10
0.95	10	10
1	10	10

Figure 4.6 Cumulative distribution of QL-Index score in relation to Dialysis modality, All Dialysis patients 1997-2002

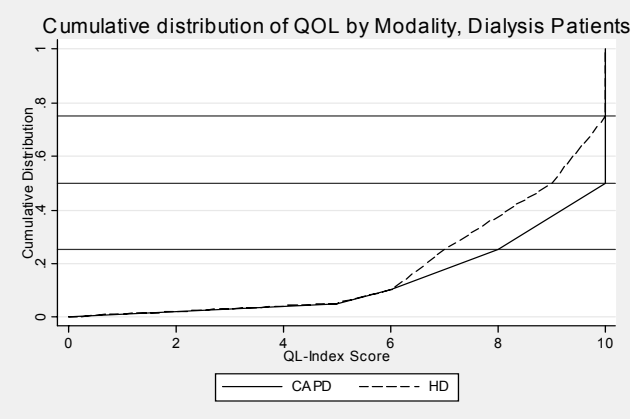


Table 4.7 Risk factors for QOL outcome, All dialysis patients 1997-2002

Factors	N	Cumulative OR	95% CI	P value
Gender:				
Male (ref.*)	3836	1.00		
Female	3072	0.77	(0.67,0.89)	0.000
Age:				
<20	313	0.72	(0.49,1.05)	0.088
20-39 (ref.*)	1397	1.00		
40-54	3413	0.61	(0.50,0.75)	0.000
>=55	1785	0.22	(0.18,0.28)	0.000
Primary diagnosis:				
Unknown (ref.*)	2104	1.00		
Diabetes Mellitus	2685	0.31	(0.26,0.37)	0.000
GN / SLE	840	1.35	(1.07,1.71)	0.013
Polycystic kidney	111	1.33	(0.72,2.45)	0.357
Obstructive nephropathy	316	1.13	(0.82,1.55)	0.460
Others	850	1.01	(0.81,1.26)	0.953
Year start dialysis				
1997-8 (ref.*)	1761	1.00		
1999-2000	2455	0.96	(0.82,1.13)	0.631
2001-2002	2692	1.23	(1.03,1.46)	0.021
Modality:				
CAPD (ref.*)	1109	1.00		
HD	5799	0.50	(0.41,0.62)	0.000
BMI:				
<18.5(ref.*)	997	1.00		
18.5-<25	3366	1.29	(1.06,1.57)	0.010
≥25	1400	1.84	(1.46,2.31)	0.000
Sr. albumin				
<30(ref.*)	461	1.00		
30-<35	1175	1.81	(1.37,2.57)	0.000
35-<40	2762	3.11	(2.29,4.23)	0.000
≥40	2084	5.05	(3.64,7.00)	0.000
Serum cholesterol:				
<3.2(ref.*)	178	1.00		
3.2-<5.2	2899	1.67	(1.12,2.48)	0.012
≥5.2	2444	1.96	(1.31,2.95)	0.001
Diastolic BP:				
<70	745	0.88	(0.71,1.09)	0.243
70-90(ref.*)	4655	1.00		
>=90	1324	0.69	(0.57,0.83)	0.000
Hemoglobin:				
<8	1441	0.53	(0.43,0.65)	0.000
8-<10	3371	0.75	(0.63,0.88)	0.001
10-<12(ref.*)	1558	1.00		
≥12	218	1.03	(0.67,1.58)	0.900
Intact PTH:				
<100(ref.*)	2849	1.00		
100-250	864	1.34	(1.13,1.60)	0.001
>=250	498	1.10	(0.88,1.38)	0.388
KT/V (HD patients only):				
<1	331	1.15	(0.76,1.74)	0.511
1-1.2	913	1.22	(0.94,1.58)	0.144
1.2-1.4(ref.*)	1198	1.00		
1.4-1.6	999	0.99	(0.77,1.28)	0.946
>=1.6	1162	1.08	(0.81,1.43)	0.597

ref: Reference group

Figure 4.7a. Cumulative probability of better QoL outcome in different age groups (years) of dialysis patients, entering in 1997-2002.

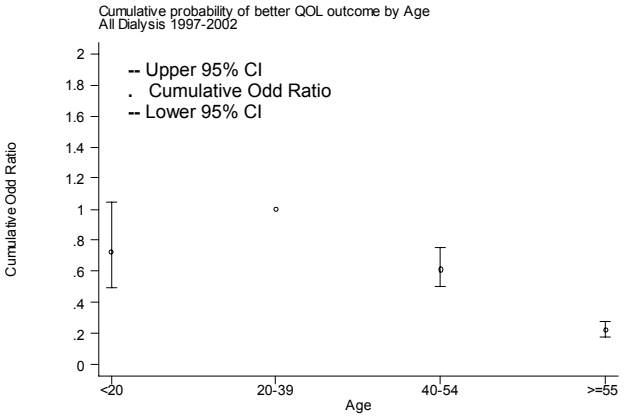


Figure 4.7b. Cumulative probability of better QoL outcome in dialysis patients entering in different year.

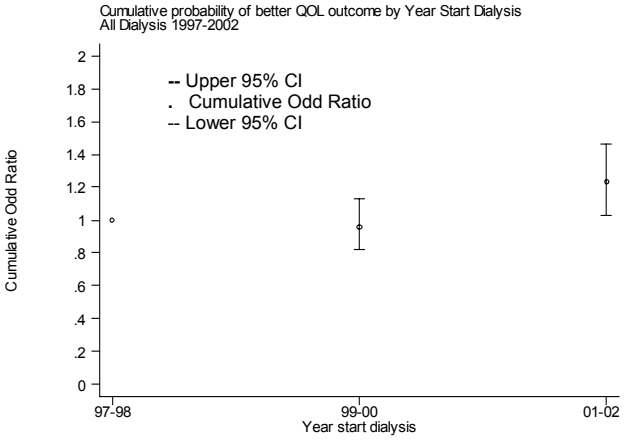


Figure 4.7c. Cumulative probability of better QoL outcome according to different albumin (g/L) levels in dialysis patients, entering in 1997-2002.

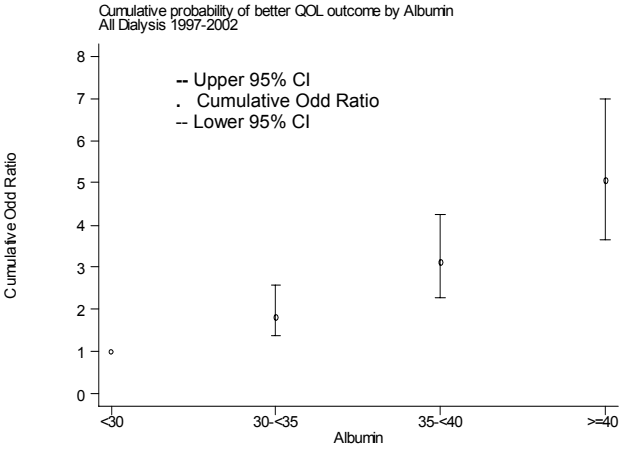


Figure 4.7d. Cumulative probability of better QoL outcome according to different haemoglobin (g/dL) levels in dialysis patients, entering in 1997-2002.

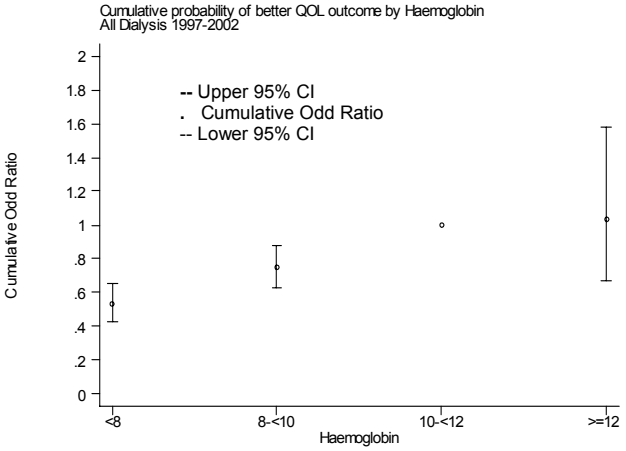
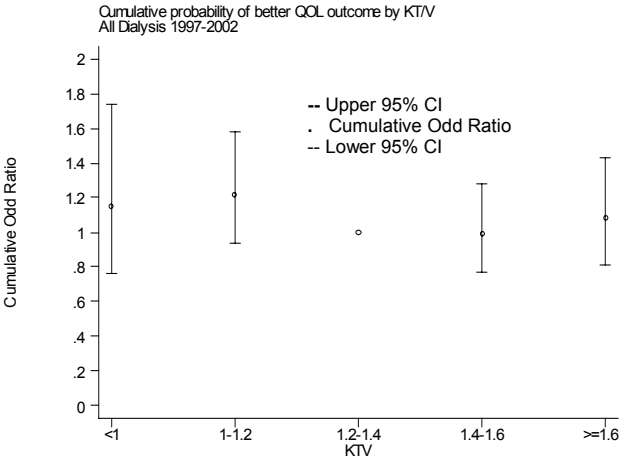


Figure 4.7e. Cumulative probability of better QoL outcome according to different Kt/V levels in dialysis patients, entering in 1997-2002.



Part B: Work related Rehabilitation Outcome on Dialysis

All dialysis patients (HD: n=2183, CAPD: n=294) of the age 21-55 years old inclusive who entered dialysis between 1997-2002, were included for analysis. For the purpose of our analysis, students, housewives, and retirees were excluded. Patients who reported to be able to work but not working due to non-health reasons were not considered in view of ambiguity of their potential vocational status. Proportion of those being employed ranged from 75-81%(HD) (Table 4.8) and 71-94%(CAPD) (Table 4.9) respectively, with no specific trend over the six year period.

An analysis looking at seven variables including age, gender, diabetic status, modality of RRT, haemoglobin, albumin and Kt/V (only HD patients) was done on all working or unemployed individuals because of ill health. They were 2477 patients, between the ages 21-55 years old inclusive who entered dialysis between 1997 to 2002. With increasing age, the proportion of patients employed decreased from 90% amongst 21-35 age-group to 64% amongst 46-55 age group. (Table 4.10) Less females (72%) compared to males (80%) were employed. (Table 4.11) Poor physical function which is usually related to advancing age [18] and female gender [1], has been shown to predict unemployment.

More diabetics (45%) than non-diabetics (11%) were not employed because of ill health. (Table 4.12) The USRDS 2003 reported a similar trend: of dialysis patients aged 18-54 years old, 20% diabetics compared to 36% non-diabetics claimed to be able to work. There was no difference in terms of proportion of patients working between HD (78%) and CAPD (81%) (Table 4.13).

Higher haemoglobin (Table 4.14) and higher albumin (Table 4.15) concentrations were consistently associated with a higher proportion of patients on employment. Correction of haemoglobin with erythropoeitin has been shown to improve cognitive function, physical symptoms, exercise tolerance and socialization, all of which can facilitate employment [5]. Kt/V at different levels did not show an impact on employment.(Table 4.16)

Using logistic regression analysis we studied the effects of 12 covariables of gender, age, primary renal disease, year of starting dialysis, modality of RRT, BMI, albumin, haemoglobin, intact PTH, Kt/V (only for HD patients) on the rehabilitation outcome of 2477 dialysis patients (Table 4.17) between 1997-2002.

Female patients were 40% less likely to return to employment compared to male patients. One possible explanation is that the female role as homemaker is still prominent in our society. Patients who were 40-55 years old had a 54% lower probability to return to work than those who were 21-35 years old (Figure 4.17a).

Diabetics had the least prospect of gaining employment: 86% lower chance than those with unknown aetiology of primary renal disease. The USRDS 2003 reported similar trend: of dialysis patients aged 18-54 years old, 20% diabetics compared to 36% non-diabetics claimed to be able to work. Multiple diabetic complications e.g. visual impairment and peripheral vascular diseases with limb amputations are potential limitations jeopardizing employment.

Those patients starting dialysis in year 2001-2002 had 63% higher chance of gaining employment than those starting in 1997-1998. (Figure 4.17b). Holley [19] reported that those patients who worked were on shorter duration of dialysis compared to nonworking patients. Better nursing care and dialysis technology, less development of dialysis related complications for the cohort starting in 2001-2002 era may improve employment opportunities.

Haemodialysis modality conferred a disadvantage of 70% lower chance of returning to work compared to CAPD. Haemodialysis schedule of three times a week is a genuine problem if the employer does not allow flexibility in working hours. In addition, those who are receiving invalidity pension from Social Security Organisation (SOCSO) are not allowed to work even though they are healthy enough to do so. Policy makers do need to evaluate such restriction which is against the rehabilitative goals of renal replacement therapy.

There is an increasing chance of gaining employment for patients with BMI of >25 (24% increase above those with BMI of <18.5). Similarly higher albumin concentration of >40 g/L (Figure 4.17c) led to at least an 11 fold increase in the chance of gaining employment compared to the level <30 g/L). Patients with haemoglobin < 8 g/dL (Figure 4.17d) had 47% less chance of working compared to those at 10-12 g/dL. These three nutritional markers reflect health status, stamina for work as well as energy levels. Those with iPTH of <100 ng/L had the least chance of working compared to others with iPTH >100 ng/L. It is not clear why such association existed. The number of patients in each iPTH subgroup are skewed to the <100ng/L group and may confound the analysis. As with the QoL outcome analysis, Kt/V levels among HD patients, did not have an influence on employment outcome. (Figure 4.17e)

Table 4.8 Work related rehabilitation in relation to Year of entry, HD patients 1997-2002

Year of Entry	1997		1998		1999		2000		2001		2002	
Number of patients	336		356		427		436		365		263	
	N	%	N	%	N	%	N	%	N	%	N	%
Able to return to Full or Part time for pay*	272	81	281	79	338	79	337	77	273	75	198	75
Unable to work for pay	64	19	75	21	89	21	99	23	92	25	65	25

* Exclude patients unable to find employment for non-health related reasons

Table 4.9 Work related rehabilitation in relation to Year of entry, CAPD patients 1997-2002

Year of Entry	1997		1998		1999		2000		2001		2002	
Number of patients	59		34		44		45		56		56	
	N	%		%	N	%	N	%	N	%	N	%
Able to return to Full or Part time for pay*	46	78	32	94	33	75	32	71	49	88	45	80
Unable to work for pay	13	22	2	6	11	25	13	29	7	13	11	20

* Exclude patients unable to find employment for non-health related reasons

Table 4.10 Work related rehabilitation in relation to Age, Dialysis patients 1997-2002

Age Group	21-35		36-45		46-55	
Number of patients	607		835		1035	
	N	%	N	%	N	%
Able to return to Full or Part time for pay*	545	90	726	87	665	64
Unable to work for pay	62	10	109	13	370	36

* Exclude patients unable to find employment for non-health related reasons

Table 4.11 Work related rehabilitation in relation to Gender, Dialysis patients 1997-2002

Gender	Male		Female	
Number of patients	1814		663	
	N	%	N	%
Able to return to Full or Part time for pay*	1458	80	478	72
Unable to work for pay	356	20	185	28

* Exclude patients unable to find employment for non-health related reasons

Table 4.12 Work related rehabilitation in relation to Diabetes Mellitus, Dialysis patients 1997-2002

Diabetes mellitus	No		Yes	
Number of patients	1671		806	
	N	%	N	%
Able to return to Full or Part time for pay*	1489	89	447	55
Unable to work for pay (%)	182	11	359	45

* Exclude patients unable to find employment for non-health related reasons

Table 4.13 Work related rehabilitation in relation to Modality, Dialysis patients 1997-2002

Modality	CAPD		HD	
Number of patients	294		2183	
	N	%	N	%
Able to return to Full or Part time for pay*	237	81	1699	78
Unable to work for pay	57	19	484	22

* Exclude patients unable to find employment for non-health related reasons

Table 4.14 Work related rehabilitation in relation to haemoglobin, Dialysis patients 1997-2002

Haemoglobin (g/dl)	<8		8-<10		10-<12		>=12	
Number of patients	503		1186		605		89	
	N	%	N	%	N	%	N	%
Able to return to Full or Part time for pay*	364	72	926	78	504	83	77	87
Unable to work for pay	139	28	260	22	101	17	12	13

* Exclude patients unable to find employment for non-health related reasons

Table 4.15 Work related rehabilitation in relation to Albumin, Dialysis patients 1997-2002

Albumin (g/L)	<30		30-<35		35-<40		>=40	
Number of patients	125		304		957		976	
	N	%	N	%	N	%	N	%
Able to return to Full or Part time for pay*	57	46	190	63	743	78	864	89
Unable to work for pay	68	54	114	38	214	22	112	11

* Exclude patients unable to find employment for non-health related reasons

Table 4.16 Work related rehabilitation in relation to KT/V, HD patients only 1997-2002

KT/V	<1		1-<1.2		1.2-<1.4		1.4-<1.6		>=1.6	
Number of patients	148		382		430		353		358	
	N	%	N	%	N	%	N	%	N	%
Able to return to Full or Part time for pay*	122	82	292	76	332	77	282	80	274	77
Unable to work for pay	26	18	90	24	98	23	71	20	84	23

* Exclude patients unable to find employment for non-health related reasons

Table 4.17 Risk factors for Rehabilitation outcome, All dialysis patients 1997-2002

Factors	**N**	**Odd Ratio**	**95% CI**	**P value**
Gender:				
Male (ref.*)	1814	1.00		
Female	663	0.60	(0.42,0.85)	0.004
Age (years):				
21-35(ref.*)	607	1.00		
36-44	835	1.04	(0.63,1.72)	0.889
45-55	1035	0.46	(0.29,0.73)	0.001
Primary diagnosis:				
Unknown (ref.*)	799	1.00		
Diabetes Mellitus	783	0.14	(0.09,0.22)	0.000
GN / SLE	379	1.22	(0.66,2.23)	0.528
Polycystic kidney	47	2.77	(0.35,21.9)	0.335
Obstructive nephropathy	116	0.46	(0.22,0.96)	0.038
Others	353	0.74	(0.42,1.30)	0.294
Year start dialysis				
1997-8 (ref.*)	785	1.00		
1999-2000	952	1.28	(0.90,1.82)	0.170
2001-2002	740	1.63	(1.07,2.47)	0.022
Modality:				
CAPD (ref.*)	294	1.00		
HD	2183	0.30	(0.18,0.52)	0.000
BMI (kg/m^2):				
<18.5(ref.*)	303	1.00		
18.5-<25	1284	1.42	(0.88,2.28)	0.146
≥25	548	2.24	(1.31,3.84)	0.003
Sr. albumin (g/L)				
<30(ref.*)	125	1.00		
30-<35	304	3.61	(1.71,7.65)	0.001
35-<40	957	6.21	(2.98,12.93)	0.000
≥40	976	11.72	(5.40,25.42)	0.000
Haemoglobin (g/dL):				
<8	503	0.53	(0.33,0.85)	0.009
8-<10	1186	0.69	(0.47,1.03)	0.072
10-<12(ref.*)	605	1.00		
≥12	89	0.80	(0.30,2.15)	0.656
Intact PTH (ng/L):				
<100(ref.*)	1097	1.00		
100-250	389	1.94	(1.29,2.92)	0.002
>=250	194	1.99	(1.10,3.59)	0.022
KT/V (HD patients only):				
<1	148	1.09	(0.49,2.43)	0.826
1-1.2	382	1.49	(0.86,2.60)	0.156
1.2-1.4(ref.*)	430	1.00		
1.4-1.6	353	1.52	(0.85,2.70)	0.158
>=1.6	358	1.15	(0.59,2.22)	0.688

ref: Reference group

Figure 4.17a. Probability of returning to work according to different age groups (years) in dialysis patients, entering in 1997-2002

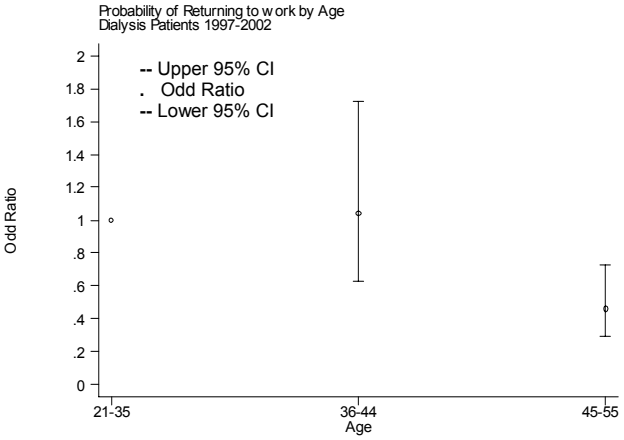


Figure 4.17b. Probability of returning to work according to year of entering dialysis between 1997-2002

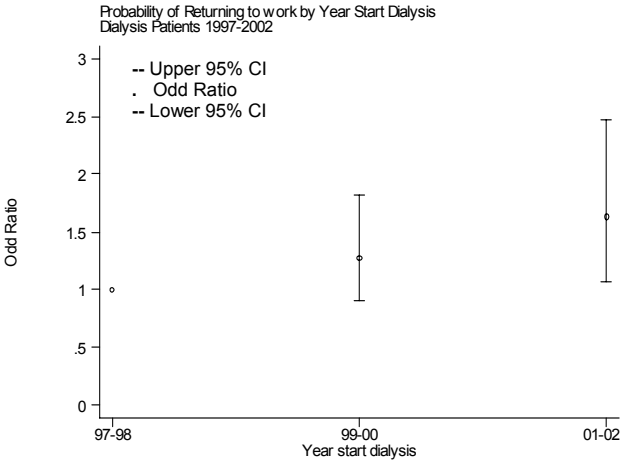


Figure 4.17c. Probability of returning to work according to albumin (g/L) levels in dialysis patients, entering in 1997-2002

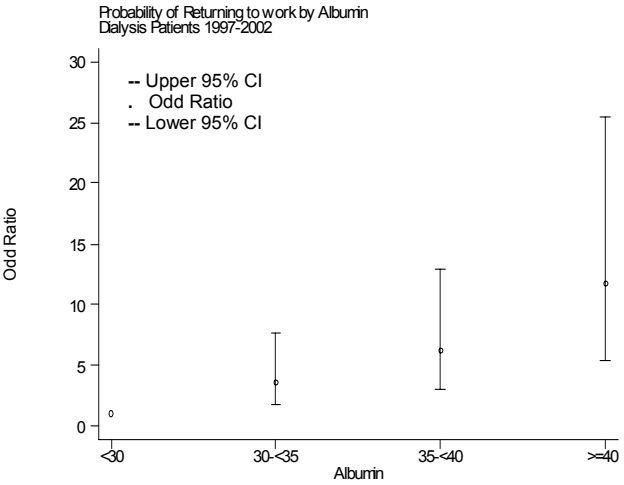


Figure 4.17d. Probability of returning to work according to haemoglobin (g/dL) levels in dialysis patients, entering in 1997-2002

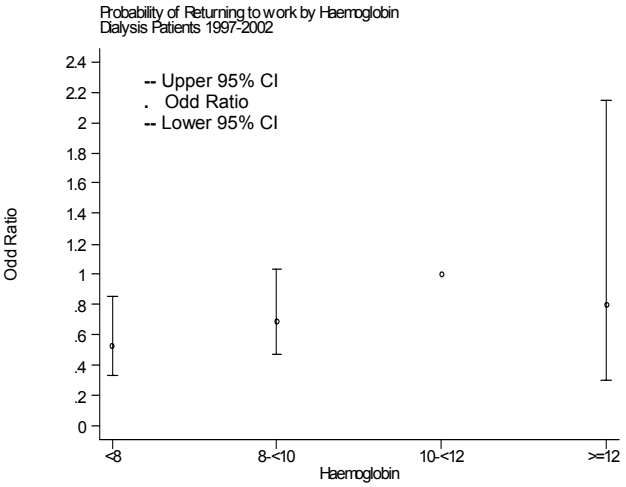
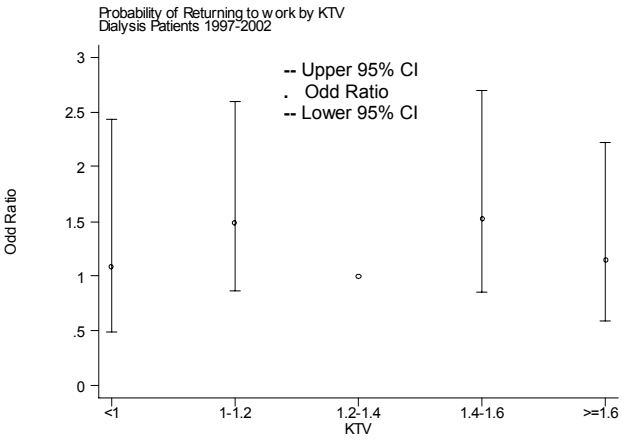


Figure 4.17e. Probability of returning to work according to Kt/V levels in dialysis patients, entering in 1997-2002.



Conclusion

Amongst dialysis patients the QoL outcome was positively influenced by various factors including male gender, younger age, starting dialysis in 2001-2002, CAPD, BMI>25, albumin of at least 30 g/L, serum cholesterol of >3.2 mmol/L, haemoglobin at least >10 g/dL, and an iPTH of 100-250 ng/L. The work rehabilitation outcome was enhanced by male gender, younger age, starting of dialysis in 2001-2002, CAPD, BMI>25, albumin of at least 30 g/L, haemoglobin at least >10 g/dL, iPTH of >100 ng/L. Diabetes which was present in 40% of our patients has a negative influence on QoL and work rehabilitation. Similarly HD, the modality by which 90% of our dialysis population were treated negatively influenced both the patients' QoL and work rehabilitation outcome.

In a resource intensive treatment such as dialysis, optimal rehabilitation of the patient becomes important from many perspectives. Competing demands for limited resources will force funding authorities to look beyond patient survival and a successful rehabilitation program will stand dialysis in good stead. It is important also from the patient's viewpoint. A long term repetitive treatment schedule which restricts successful rehabilitation particularly vocational rehabilitation may further add psychosocial problems to the patient. Further research to ascertain and minimize the impact of these risk factors on QoL and rehabilitation can lead to the development of strategies that will promote optimal rehabilitation.

References

1. Mittal SK, Ahern L, Flaster E, Maesaka JK, Fishbane S. Self-assessed physical and mental function of haemodialysis patients. Nephrol Dial Transplant 2001;16 (7):1387-94.

2. Valderrabano F, Jofre R, Lopez-Gomez JM. Quality of life in end-stage renal disease patients. Am J Kidney Dis. 2001;38(3):443-64.

3. Mozes B, Shabtai E, Zucker D. Differences in quality of life among patients receiving dialysis replacement therapy at seven medical centers. J Clin Epidemiol 1997;50(9):1035-43.

4. Baiardi F, Degli Esposti E, Cocchi R, Fabbri A, Sturani A, Valpiani G, et al. Effects of clinical and individual variables on quality of life in chronic renal failure patients. J Nephrol 2002;15(1):61-7.

5.. Association between recombinant human erythropoietin and quality of life and exercise capacity of patients receiving haemodialysis. Canadian Erythropoietin Study Group. BMJ 1990;300(6724):573-8.

6. Kalantar-Zadeh K, Kopple JD, Block G, Humphreys MH. Association among SF36 quality of life measures and nutrition, hospitalization, and mortality in hemodialysis. J Am Soc Nephrol 2001;12(12):2797-806.

7. Beusterien KM, Nissenson AR, Port FK, Kelly M, Steinwald B, Ware JE, Jr. The effects of recombinant human erythropoietin on functional health and well-being in chronic dialysis patients. J Am Soc Nephrol 1996;7 (5):763-73.

8. Mingardi G, Cornalba L, Cortinovis E, Ruggiata R, Mosconi P, Apolone G. Health-related quality of life in dialysis patients. A report from an Italian study using the SF-36 Health Survey. DIA-QOL Group. Nephrol Dial Transplant 1999;14(6):1503-10.

9. Kimmel PL, Peterson RA, Weihs KL, Simmens SJ, Boyle DH, Cruz I, et al. Aspects of quality of life in hemodialysis patients. J Am Soc Nephrol 1995;6(5):1418-26.

10. Kimmel PL, Peterson RA, Weihs KL, Simmens SJ, Boyle DH, Umana WO, et al. Psychologic functioning, quality of life, and behavioral compliance in patients beginning hemodialysis. J Am Soc Nephrol 1996;7 (10):2152-9.

11. Rettig RA, Sadler JH. Measuring and improving the health status of end stage renal disease patients. Health Care Financing Review. 1997;18(4):77-82.

12. Kutner NG, Lin LS, Fielding B, Brogan D, Hall WD. Continued survival of older hemodialysis patients: investigation of psychosocial predictors. Am J Kidney Dis 1994;24(1):42-9.

13. Moreno F, Lopez Gomez JM, Sanz-Guajardo D, Jofre R, Valderrabano F. Quality of life in dialysis patients. A spanish multicentre study. Spanish Cooperative Renal Patients Quality of Life Study Group. Nephrol Dial Transplant 1996;11(Suppl 2):125-9.

14. Cameron JI, Whiteside C, Katz J, Devins GM. Differences in quality of life across renal replacement therapies: a meta-analytic comparison. Am J Kidney Dis 2000;35(4):629-37.

15. Lim TO, Morad Z. Reliability, validity and discriminatory ability of Spitzer's QL-index in dialysis patients. Med J Malaysia. 1998;53(4):392-400.

16. Diaz-Buxo JA, Lowrie EG, Lew NL, Zhang H, Lazarus JM. Quality-of-life evaluation using Short Form 36: comparison in hemodialysis and peritoneal dialysis patients. Am J Kidney Dis 2000;35(2):293-300.

17. Morton AR, Meers C, Singer MA, Toffelmire EB, Hopman W, McComb J, et al. Quantity of dialysis: quality of life--what is the relationship? Asaio J 1996;42(5):M713-7.

18. Blake C, Codd MB, Cassidy A, O'Meara YM. Physical function, employment and quality of life in end-stage renal disease. J Nephrol 2000;13(2):142-9.

19. Holley JL, Nespor S. An analysis of factors affecting employment of chronic dialysis patients. Am J Kidney Dis 1994;23(5):681-5

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 erythropoeitin 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, erythropoeitin 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. Erythropoeitin (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:

$$\text{CERT} = \frac{C_T}{E_T}$$

Where C_T and E_T 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

erythropoeitin (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

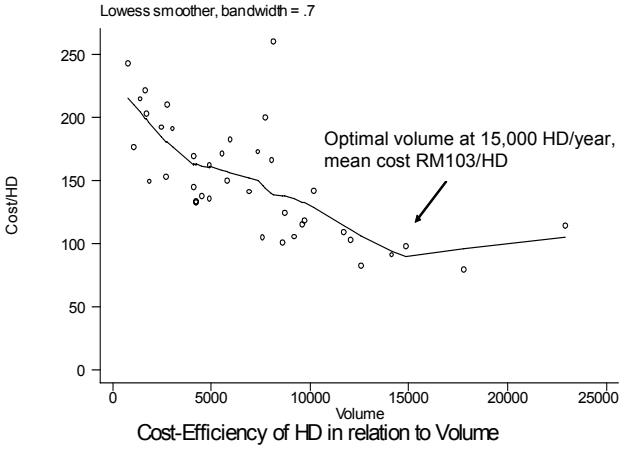
Table 5.11 Cost per Life-year saved on HD and CAPD by Age (3% discount)

	HD	*CAPD*
Age group	**Cost per Life-year saved**	**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

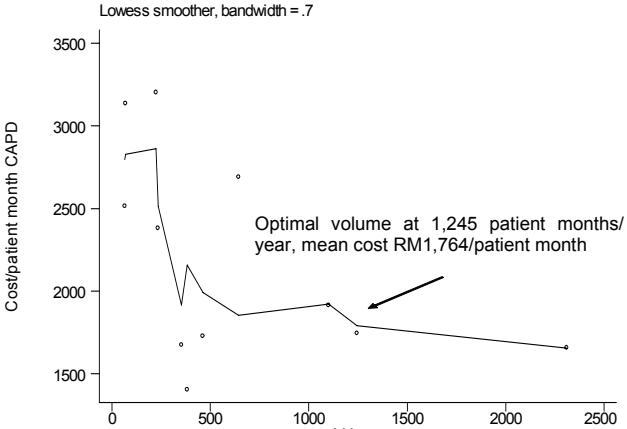
Variable	**Cost per Life Year Saved**	
	HD	**CAPD**
Discount rate		
• 3%	33,641.96	31,634.93
• 5%	34,538.83	31,991.32
Overhead		
• Maximum cost in sample	79,712.99	39,989.45
• Minimum cost in sample	28,427.26	29,155.46
EPO		
• Actual dose, 100% utilisation rate	36,302.46	35,713.71
• Optimal dose, actual 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



Cost-Efficiency of HD in relation to Volume

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



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

CHAPTER 6: RENAL TRANSPLANTATION IN MALAYSIA

Influence of Non Immunological Factors on Long-term Survival

Summary

- There were a total of 1400 renal transplantation reported to National Renal Registry between 1993-2002
- The risk of graft failure in all transplants decreased by 25%, and the risk of patient death fell by 39% for patients transplanted in 1998 to 2002 compared to those transplanted in 1993 to 1997.
- A number of recipient and transplant characteristics were independently associated with graft failure. Recipients aged 55 years or older had a 63% higher risk of graft failure; diabetics – a 44% higher risk; polycystic kidney disease – a 2.4 fold increase in risk, cadaveric renal transplants – 2.3-fold and anti-HCV positivity a 2.1-fold increase in risk of graft failure.
- Recipient characteristics associated with poorer patient survival were recipients aged 40 to 54 years - relative risk of 2.03; 55 years or older -relative risk 3.90; received cadaver donor graft - relative risk 3.94; and with HBsAg seropositivity - relative risk 1.88.
- Very preliminary analysis suggests that there might be a slight graft survival advantage associated with the use of tacrolimus and mycophenolate mofetil.

Introduction

Organ transplantation is an established form of treatment for various end stage organ failures. The success of organ transplantation over the last 2 decades has been widely attributed to the introduction of cyclosporine A (CsA). Since the introduction of CsA into clinical practice by Calne and Starzl in the late 1970's and early 1980's [1-4], many transplant centres around the world have reported at least 80-85% one-year renal allograft survival [5]. These impressive results with CsA were also extended into the field of other organ transplantation [4,6,7]. However, despite the short-term success of renal allograft with CsA, the UCLA multicentre data demonstrated that the half-life of primary cadaver renal allograft was 7.7 years in pre-CsA as well as post-CsA era [8]. Eurotransplant data also revealed somewhat similar observations (half-life of 9.7 vs 11.6 years for pre-CsA and post-CsA era respectively) [9]. Thus, while CsA has clearly improved the survival of renal allograft in the short-term, the long-term outcome is less certain. Chronic allograft failure in kidney transplantation is always conveniently attributed to allograft rejection. However, there are increasing data to suggest that the non-immunologic factors may play a significant contribution to chronic renal allograft dysfunction.

The first successful renal transplantation was carried out in Hospital Kuala Lumpur (HKL) on the 15th of December 1975. The transplant programme in Malaysia was almost exclusively living related programme until 1987 when many patients sought commercial living unrelated transplantation in India. It was only in 1996 when such activities were proscribed that the number of commercial living unrelated transplants dropped. However, this was taken over by commercial cadaver transplant activity in China. (Table 6.1)

In the early years, the immunosuppressive protocol used was azathioprine and corticosteroids until 1992 when cyclosporine A (CsA) based triple therapy was introduced for all new transplant recipients. Despite the improvement in the short-term results of renal transplantation during the past decade, the rate of attrition of kidney grafts after the first year has remained constant. According to large registry data, the half-life of kidney grafts has not changed very much.

When analyzing our data, the overall unadjusted patient and graft survival rates appears to have improved for those transplanted in 1998-2002 compared to those done in 1993-1997 (Figure 6.2 and 6.3). The 5-year patient survival rates for the cohorts of 1998-2002 and 1993-1997 were 92% and 88%, respectively, while rates for 5-year graft survival were 82% and 76%, respectively (Table 6.2 and 6.3), despite the increasing proportions of older and diabetic transplant recipients. (Table 6.4)

Table 6.5 shows that rejection as the cause of graft failure in our kidney transplantation patients has remained stable particularly since CsA based triple therapy was introduced in 1992.

As we have made no major policy changes in our kidney transplantation protocol over the last decade, the evident lengthening of graft half-life prompted us to evaluate potential patient and transplant characteristics (non immunological factors) as predictors of long-term graft survival.

Table 6.1 Place of Renal Transplantation 1993-2002

Year	1993		1994		1995		1996		1997	
	No	%	No	%	No	%	No	%	No	%
HKL	36	26	33	16	36	35	33	22	29	23
UH	3	2	5	2	10	10	6	4	6	5
Other local	0	0	0	0	0	0	0	0	0	0
India	86	61	143	70	21	20	5	3	7	6
China	13	9	21	10	35	34	104	70	80	65
Other overseas	2	1	1	0	1	1	1	1	2	2
TOTAL	140	100	203	100	103	100	149	100	124	100

Year	1998		1999		2000		2001		2002	
	No	%	No	%	No	%	No	%	No	%
HKL	33	33	36	30	28	20	33	21	29	18
UH	7	7	16	13	19	13	22	14	14	9
Other local	0	0	1	1	1	1	2	1	0	0
India	6	6	5	4	9	6	8	5	11	7
China	50	51	60	50	80	56	78	50	97	60
Other overseas	3	3	2	2	0	0	6	4	2	1
TOTAL	99	100	120	100	143	100	156	100	163	100

Table 6.2 Unadjusted Transplant Patient Survival related to Year of transplant 1993-2002

Year	1993-1997		1998-2002	
Interval (months)	% survival	SE	% survival	SE
6	96	1	96	1
12	95	1	95	1
24	94	1	93	1
36	92	1	92	1
48	90	1	92	1
60	88	1	92	1

SE = standard error

Table 6.3 Unadjusted Graft Survival related to Year of transplant 1993-2002

Year	1993-1997		1998-2002	
Interval (months)	% survival	SE	% survival	SE
6	93	1	93	1
12	92	1	91	1
24	89	1	88	1
36	84	1	86	1
48	80	2	84	2
60	76	2	82	2

SE = standard error

Figure 6.2 Unadjusted Transplant Patient Survival related to Year of transplant 1993-2002

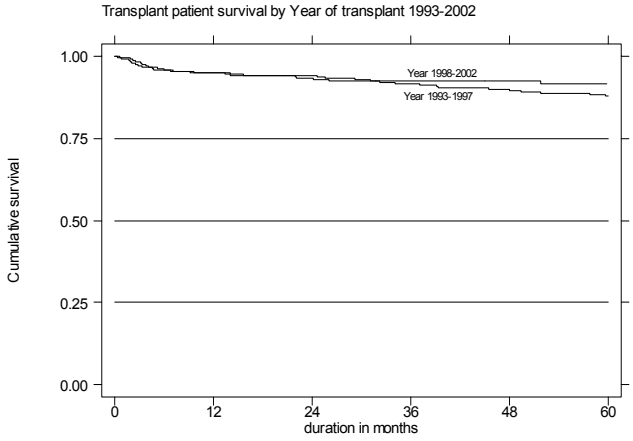


Figure 6.3 Unadjusted Graft Survival related to Year of transplant 1993-2002

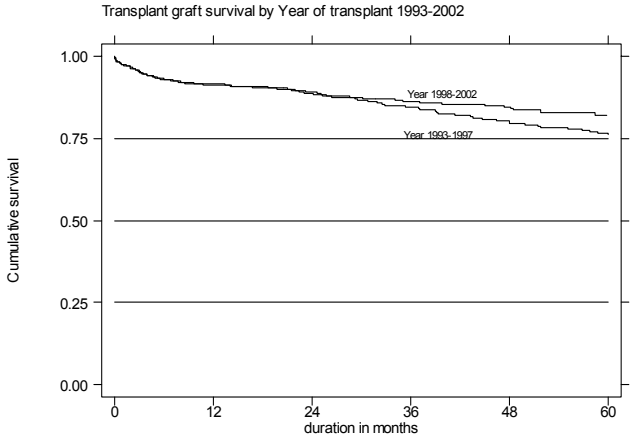


Table 6.4 Renal Transplant Recipients' Characteristics 1993-2002

Year	1993	1994	1995	1996	1997
New Transplant patients	140	203	103	149	124
Mean age ±sd	38±13	38±12	35±12	38±11	35±12
% Male	60	67	57	56	65
% Diabetic	10	10	12	9	11
% HBsAg	8	8	6	11	5
% Anti-HCV+	16	8	12	15	6

Year	1998	1999	2000	2001	2002
New Transplant patients	99	120	143	156	163
Mean age ±sd	37±11	37±13	39±13	40±13	40±13
% Male	60	62	64	62	56
% Diabetic	9	11	13	16	14
% HBsAg	5	4	4	4	6
% Anti-HCV+	15	8	6	13	7

Table 6.5 Causes of Graft Failure 1993-2002

Year	1993		1994		1995		1996		1997	
	No	%	No	%	No	%	No	%	No	%
Rejection	1	25	1	14	5	45	4	40	11	58
CsA or drug toxicity	1	25	0	0	0	0	0	0	0	0
Ureteric obstruction	0	0	1	14	1	9	0	0	0	0
Vascular causes; RAS/ thrombosis	1	25	1	14	1	9	1	10	4	21
Renal disease; recurrent/de novo	0	0	0	0	0	0	2	20	0	0
Technical complication	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	1	9	0	0	1	5
Unknown	1	25	4	57	3	27	3	30	3	16
TOTAL	4	100	7	100	11	100	10	100	19	100

Year	1998		1999		2000		2001		2002	
	No	%	No	%	No	%	No	%	No	%
Rejection	18	60	12	60	13	57	7	41	12	48
CsA or drug toxicity	0	0	0	0	0	0	0	0	1	4
Ureteric obstruction	0	0	0	0	0	0	0	0	0	0
Vascular causes; RAS or thrombosis	1	3	0	0	3	13	1	6	0	0
Renal disease; recurrent or de novo	1	3	0	0	0	0	1	6	1	4
Technical complication	0	0	0	0	3	13	1	6	0	0
Others	2	7	0	0	2	9	1	6	1	4
Unknown	8	27	8	40	2	9	6	35	10	40
TOTAL	30	100	20	100	23	100	17	100	25	100

Methods

The data of all renal transplantation done in the years 1993 to 2002 that were reported to the National Renal Registry (NRR) were analysed and reviewed without exclusion. Until 31st December 2002 there were a total of 1400 of renal transplantations reported to NRR (Table 6.6). The data was stratified to reflect differences in 1) recipient demography: race, gender, age, body mass index (BMI); 2) medical factors: primary disease, co-morbid conditions (diabetes mellitus, cardiovascular diseases, hepatitis B and C status), duration of dialysis; 3) social factors: smoker or non smoker; and 4) transplant factors: type of transplant and the immunosuppressants used. Using Cox proportional hazard modeling, we studied the association of these variables with graft and patient survival. Covariates of interest were: year of transplant, age, gender, ethnic, primary diagnosis, smoking status, type of transplant, BMI, diabetes, whether they were ever Hepatitis B surface Antigen (HBsAg) or anti- Hepatitis C (HCV) antibody positive, HLA matching, cardiovascular disease and prior dialysis time.

Results and Discussion

The overall transplant patient survival rate from 1993 to 2002 was 95%, 92% and 89% at one year, three years and five years respectively, while the overall graft survival rate was 91%, 85% and 78% respectively (Table 6.7). These survival rates are comparable to the USRDS data [10].

I. Factors Affecting Outcome

Demography

Age

Patient survival rates decreased with increasing age. Recipients aged 55 years or older had the lowest patient survival rate at 5 years (74%), followed by recipients aged 40-54 (86%), aged 20-39 (93%), while recipients under age 20 had the highest patient survival rate (97%) (Table 6.8). The lowest 5-year graft survival rate (67%) was noted among older recipients over 55 years of age. There was no significant difference in 5-year graft survival rates among recipients in the other age groups (Table 6.9). This observation is consistent with other published data where older recipients despite lower rejection rate had poorer graft and patient survival rates [11-13]. This is attributed to a higher incidence of atherosclerotic diseases in the older age group. A higher proportion of older patients died with functioning graft.

Ethnicity

The recipients' ethnicity seemed to influence both 5-year graft and patient survival rates. Chinese recipients had the highest graft and patient survival rates at 80% and 90%, respectively. (Tables and Figures 6.10 & 6.11). However this observed advantage disappeared with adjustments for other covariates (age, gender, smoking status, BMI, type of transplant, diabetes, hepatitis status, HLA match, cardiovascular disease and prior dialysis time).

Table 6.6 Renal Transplant performed between 1993-2002

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
New transplant patients	140	203	103	149	124	99	120	143	156	163
Died	3	12	5	14	20	11	14	20	23	19
Returned to dialysis	4	7	11	10	19	30	20	23	17	25
Lost to F/U	0	1	0	1	0	1	2	1	2	1
Functioning graft at 31st December	133	316	403	527	612	669	753	852	966	1084

Table 6.7 Unadjusted Transplant Patient and Graft Survival 1993-2002

	Patient Survival		Graft Survival	
Interval (months)	% survival	SE	% survival	SE
6	96	1	93	1
12	95	1	91	1
24	94	1	89	1
36	92	1	85	1
48	91	1	81	1
60	89	1	78	1

SE=standard error

Figure 6.7 Unadjusted Transplant Patient and Graft Survival 1993-2002

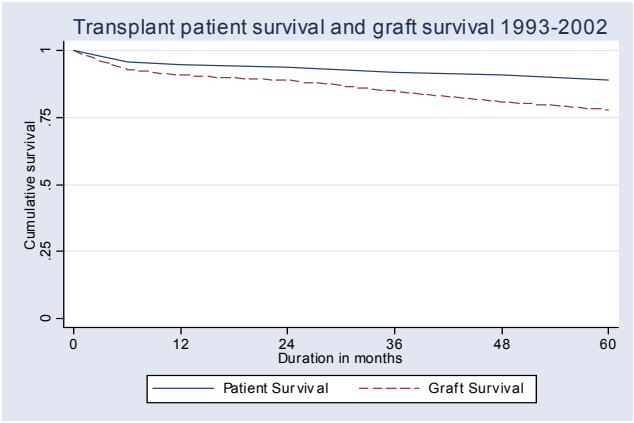


Table 6.8 Unadjusted Transplant Patient Survival related to Age 1993-2002

Age	<20		20-39		40-54		>=55	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	98	1	97	1	94	1	95	2
12	98	1	96	1	93	1	93	2
24	98	1	96	1	91	1	89	3
36	97	2	95	1	90	1	83	4
48	97	2	93	1	89	1	81	4
60	97	2	93	1	86	2	74	5

SE = standard error

Table 6.9 Unadjusted Graft Survival related to Age 1993-2002

Age	<20		20-39		40-54		>=55	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	90	3	93	1	93	1	95	2
12	89	3	91	1	92	1	93	2
24	88	3	89	1	89	1	88	3
36	83	4	86	1	85	2	81	4
48	77	5	82	2	82	2	78	4
60	77	5	79	2	78	2	67	5

SE = standard error

Figure 6.8 Unadjusted Transplant Patient Survival related to Age 1993-2002

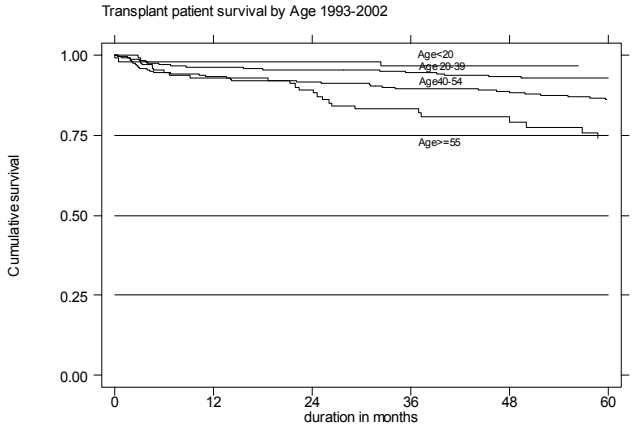


Figure 6.9 Unadjusted Graft Survival related to Age 1993-2002

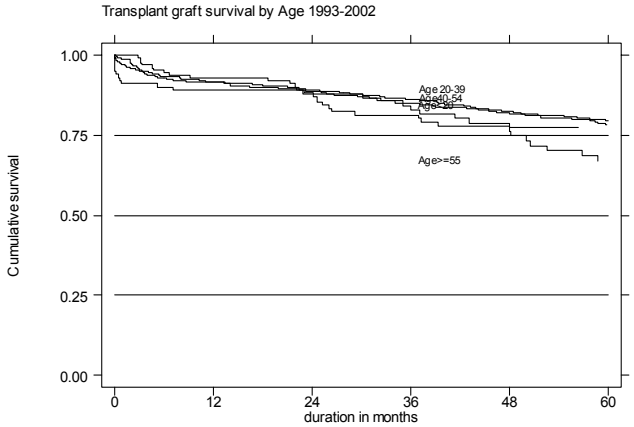


Table 6.10 Unadjusted Patient Survival related to Ethnicity 1993-2002

Ethnic	Malay		Chinese		Indian		Others	
Interval (months)	% Survival	SE	% Survival	SE	% Survival	SE	% Survival	SE
6	94	2	97	1	93	2	95	2
12	92	2	96	1	93	2	92	3
24	90	2	95	1	92	3	90	3
36	88	2	93	1	87	3	89	3
48	86	3	92	1	86	4	88	4
60	85	3	90	1	86	4	88	4

SE=standard error

Table 6.11 Unadjusted Graft Survival related to Ethnicity 1993-2002

Ethnic	Malay		Chinese		Indian		Others	
Interval (months)	% Survival	SE	% Survival	SE	% Survival	SE	% Survival	SE
6	88	2	94	1	93	2	90	3
12	85	2	93	1	91	3	87	4
24	80	3	91	1	86	3	86	4
36	76	3	88	1	75	4	82	4
48	74	3	84	1	70	5	80	4
60	72	3	80	1	66	5	79	5

SE=standard error

Figure 6.10 Unadjusted Transplant Patient Survival related to Ethnicity 1993-2002

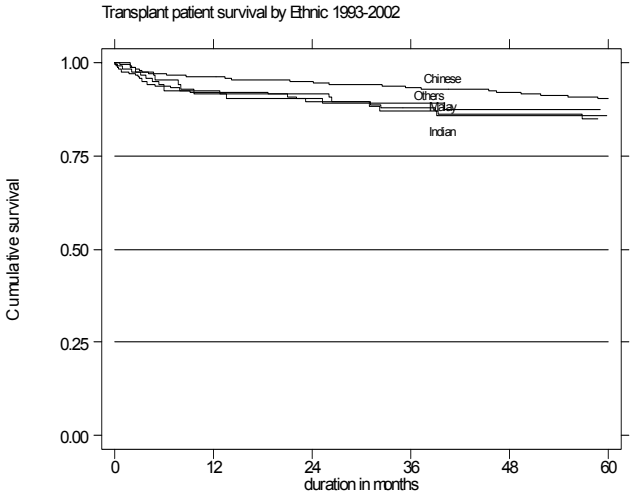
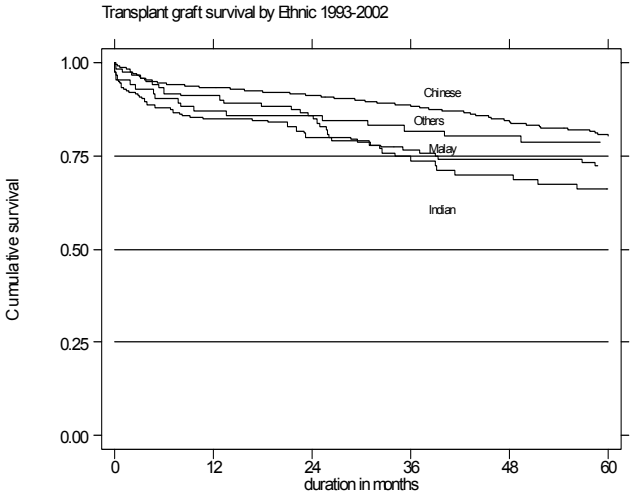


Figure 6.11 Unadjusted Graft Survival related to Ethnicity 1993-2002



Gender

Recipients' gender had no significant impact on both the graft and patient survival rates in our group of patients.

Body Mass Index

Graft survival rate improved with increasing BMI. Recipients with BMI less than 18.5 had the poorest 5 year graft survival rate (73%) compared with recipients with BMI 18.5-25 (77%) and BMI more than 25 (82%) (Table and Figure 6.12). In contrast, Paul Terasaki et al [14] and Chertow et al [16] reported that large size recipients were found to have poorer outcome. This discrepancy may be because BMI in our patients was probably more of a nutritional marker. [15].

Primary Renal Disease and Co-morbid Conditions

Diabetes mellitus

One-year patient survival was similar in diabetics and non-diabetics; however 5-year patient survival was 90% and 83% respectively for diabetics and non-diabetics. The graft survival rate between diabetics and non-diabetics were almost similar. (Tables and Figures 6.13 & 6.14). Kim et al [17] reported similar findings while Nampoory et al [18] observed lower patient and graft survival in diabetics. However, after adjustment for other risk factors, there was no significant difference in patient survival but graft survival in diabetic recipients was poorer compared to non-diabetics (Tables 6.24 & 6.24).

Hepatitis B

The data were stratified according to the presence or absence of HBsAg. HBsAg seronegative recipients had better graft and patient survival than HBsAg positive recipients. The 5-year patient survival rate for recipients positive and negative for HBsAg was 81% and 90%, respectively, while the 5 year graft survival rate was 69% and 79%, respectively (Tables and Figures 6.15 & 6.16). This observation is similar to reports from other workers.

The 5-year patient survival for transplant recipients with positive HBsAg was 78%, while that for haemodialysis patients with seropositive for HBsAg was 66%. However, this data has to be interpreted with caution as there might be selection bias where only healthy HBsAg positive patients were transplanted. Furthermore this direct comparison does not take into account other potential confounding factors.

Hepatitis C

The data were stratified according to the presence or absence of anti-HCV. Anti-HCV seronegative recipients had better graft outcome than anti-HCV positive recipients. The 5- year graft survival rate for recipients positive and negative for anti-HCV were 62% and 81%, respectively (Table and Figure 6.17). However, unlike graft survival, there was no significant difference in 5-year patient survival rate for those positive or negative for anti-HCV. Reports in literature were mixed. While Batty et al [19] observed poorer patient survival among recipients with positive anti-HCV, Hassan et al [20] reported similar patient and graft survival among anti-HCV positive and negative recipients.

Table 6.12 Unadjusted Graft Survival related to BMI 1993-2002

BMI	<18.5		18.5-25		>25	
Interval (months)	% Survival	SE	% Survival	SE	% Survival	SE
6	89	2	93	1	96	1
12	89	2	91	1	95	1
24	87	3	88	1	93	2
36	82	3	84	1	89	2
48	73	4	81	1	87	2
60	73	4	77	2	82	3

SE=standard error

Figure 6.12 Unadjusted Graft Survival related to BMI 1993-2002

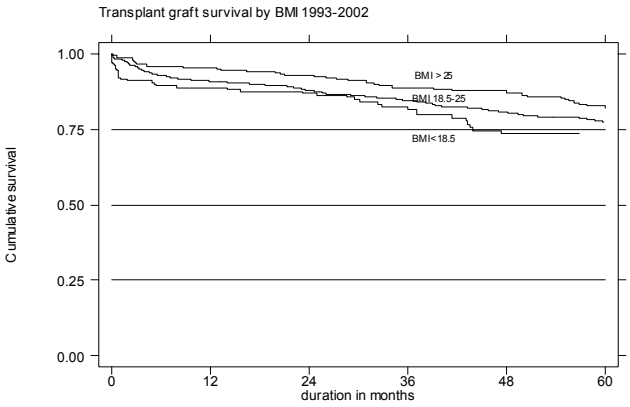


Table 6.14 Unadjusted Graft Survival related to Diabetes Mellitus 1993-2002

Diabetes Mellitus	Non-diabetic		Diabetic	
Interval (months)	% Survival	SE	% Survival	SE
6	92	1	96	1
12	91	1	93	2
24	88	1	91	2
36	85	1	87	3
48	81	1	83	3
60	78	1	76	4

SE=standard error

Table 6.13 Unadjusted Patient Survival related to Diabetes Mellitus 1993-2002

Diabetes Mellitus	Non-diabetic		Diabetic	
Interval (months)	% Survival	SE	% Survival	SE
6	96	1	96	1
12	95	1	93	2
24	94	1	92	2
36	92	1	89	3
48	91	1	88	3
60	90	1	83	4

SE=standard error

Figure 6.13 Unadjusted Patient Survival related to Diabetes Mellitus 1993-2002

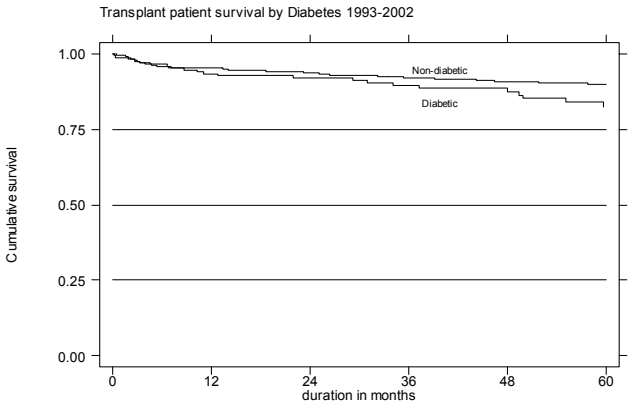


Figure 6.14 Unadjusted Graft Survival related to Diabetes Mellitus 1993-2002

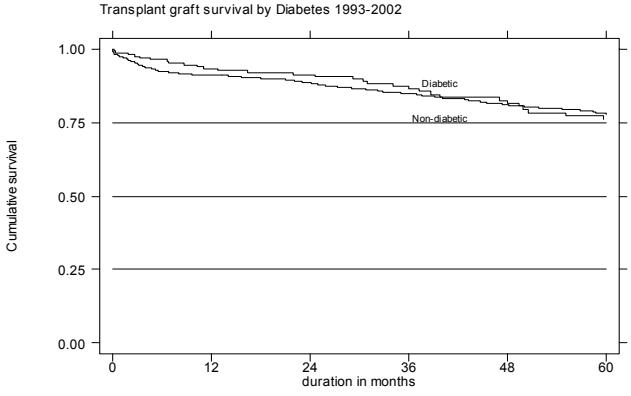


Table 6.15 Unadjusted Patient Survival related to HbsAg status 1993-2002

Ever HbsAg	Negative		Positive	
Interval (months)	% Survival	SE	% Survival	SE
6	96	1	93	2
12	95	1	90	3
24	94	1	89	3
36	92	1	85	4
48	91	1	84	4
60	90	1	81	4

SE=standard error

Figure 6.15 Unadjusted Patient Survival related to HbsAg status 1993-2002

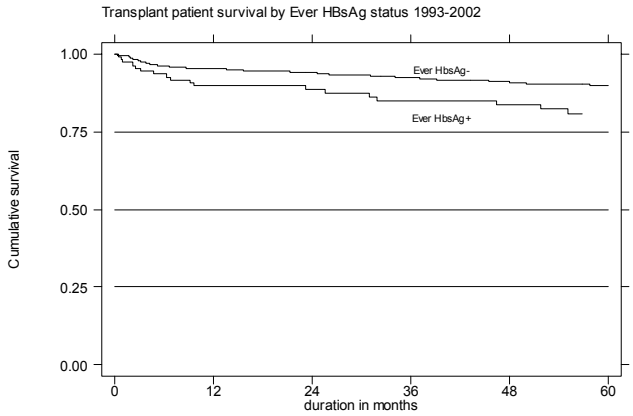


Table 6.16 Unadjusted Graft Survival related to HBsAg status 1993-2002

Ever HbsAg	Negative		Positive	
Interval (months)	% Survival	SE	% Survival	SE
6	93	1	88	3
12	92	1	84	3
24	89	1	82	4
36	86	1	76	4
48	82	1	73	4
60	79	1	69	5

SE=standard error

Figure 6.16 Unadjusted Graft Survival related to HBsAg status 1993-2002

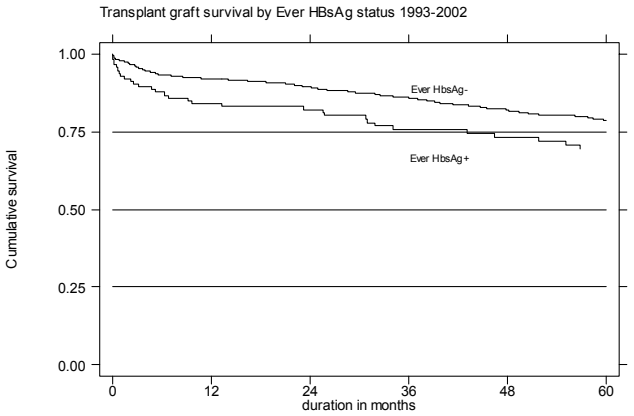
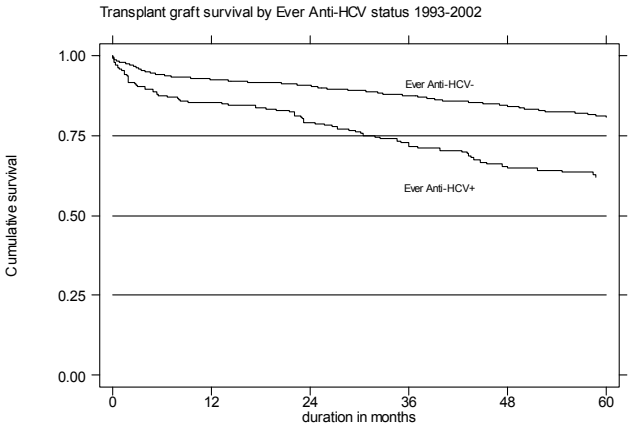


Table 6.17 Unadjusted Graft Survival related to Anti-HCV status 1993-2002

Ever Anti-HCV	Negative		Positive	
Interval (months)	% Survival	SE	% Survival	SE
6	94	1	88	2
12	93	1	85	2
24	91	1	79	3
36	87	1	72	3
48	84	1	65	3
60	81	1	62	4

SE=standard error

Figure 6.17 Unadjusted Graft Survival related to Anti-HCV status 1993-2002



Cardiovascular Disease

Cardiovascular disease (CVD) in this report is defined as anyone with any of one or more of the following disorders at initial notification to the Registry: cardiac failure, ischaemic heart disease, cerebrovascular accident, peripheral vascular disease and non accidental amputation. Patients with CVD had poorer outcome. The 5-year patient survival rates for recipients with CVD and without CVD were 77% and 90% respectively, while the 5 year graft survival rates were 65% and 79% for those with and without CVD (Tables and Figures 6.18 & 6.19). Woo et al [21] also reported similar observation. However, it would be interesting to compare the graft survival after deaths with functioning graft were censored.

Duration of Dialysis

The 3-year patient survival rates for recipients who underwent dialysis less than one year, one to three years and more than three years before transplantation were 94%, 91% and 88% respectively, while the graft survival rates were 88%, 84% and 80% for the same durations of dialysis prior to transplantation. (Tables and Figures 6.20 & 6.21). Casio et al [22] reported that increased time on dialysis before transplant was associated with decreased patient survival and they attributed this to higher prevalence of left ventricular hypertrophy and greater infection risk.. Mange and Caciarelli [23-24] had reported independently that increased duration of dialysis prior to transplant was associated with higher risk of acute rejection post transplant.

Table 6.18 Unadjusted Transplant Patient Survival related to Cardiovascular Disease 1993-2002

Anti-HCV	No		Yes	
Interval (months)	% Survival	SE	% Survival	SE
6	96	1	95	2
12	95	1	93	3
24	94	1	89	3
36	92	1	86	4
48	91	1	83	4
60	90	1	77	4

SE=standard error

Table 6.19 Unadjusted Graft Survival related to Cardiovascular Disease 1993-2002

Anti-HCV	No		Yes	
Interval (months)	% Survival	SE	% Survival	SE
6	93	1	93	3
12	92	1	91	3
24	89	1	87	3
36	85	1	79	4
48	82	1	72	5
60	79	1	65	5

SE=standard error

Figure 6.18 Unadjusted Transplant Patient Survival related to Cardiovascular Disease 1993-2002

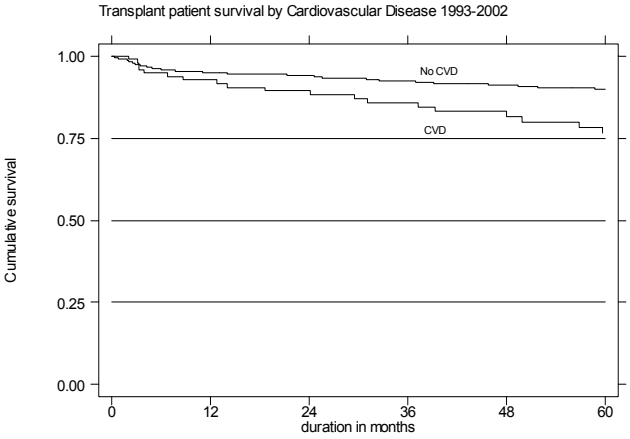


Figure 6.19 Unadjusted Graft Survival related to Cardiovascular Disease 1993-2002

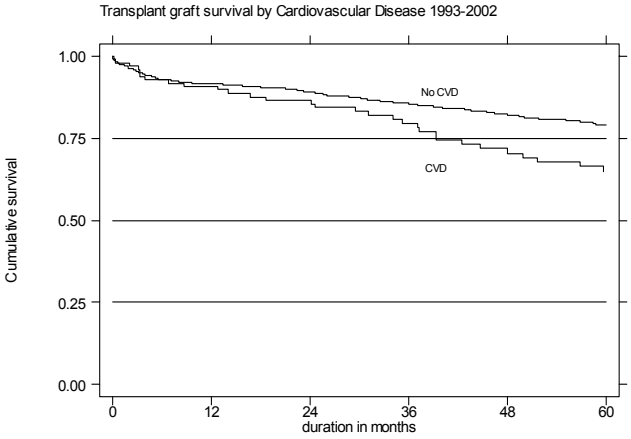


Table 6.20 Unadjusted Transplant Patient Survival related to Prior Dialysis Duration 1993-2002

Prior dialysis time	<1 years		1-<3 years		>=3 years	
Interval (months)	% Survival	SE	% Survival	SE	% Survival	SE
6	97	1	96	1	92	2
12	97	1	94	1	91	2
24	96	1	93	1	89	2
36	94	1	91	1	88	2
48	92	1	90	2	87	2
60	90	1	90	2	87	2

SE=standard error

Table 6.21 Unadjusted Graft Survival related to Prior Dialysis Duration 1993-2002

Prior dialysis time	<1 years		1-<3 years		>=3 years	
Interval (months)	% Survival	SE	% Survival	SE	% Survival	SE
6	95	1	93	1	88	2
12	94	1	91	1	86	2
24	92	1	88	2	83	2
36	88	1	84	2	80	3
48	84	1	79	2	79	3
60	80	2	76	2	77	3

SE=standard error

Figure 6.20 Unadjusted Transplant Patient Survival related to Prior Dialysis Duration 1993-2002

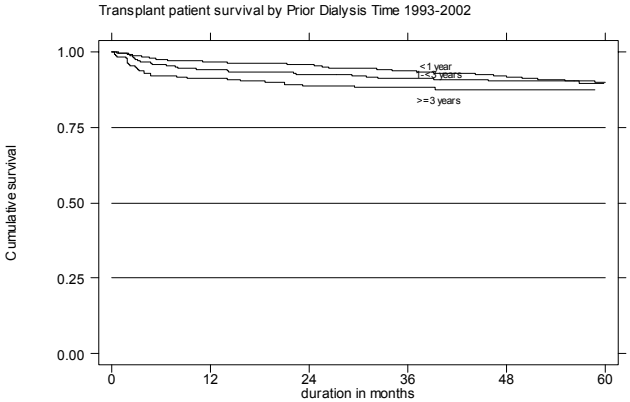
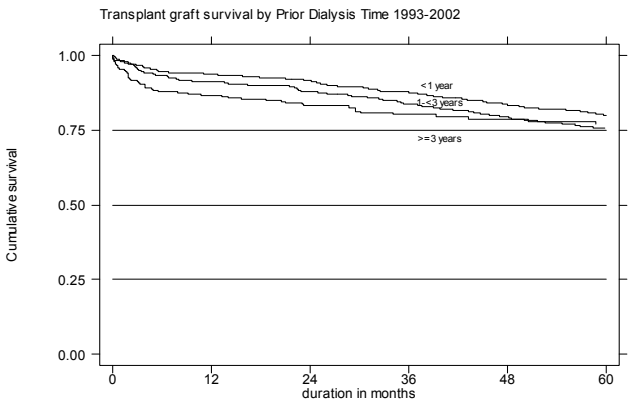


Figure 6.21 Unadjusted Graft Survival related to Prior Dialysis Duration 1993-2002



Transplant Factors

Type of Transplant

The outcome of transplantation for kidneys from four different donor sources are shown in Figures 6.22 & 6.23 and demonstrated substantial difference in patient and graft survival rates. Cadaver donor grafts had the poorest patient and graft survival rates. The 5-year graft survival for recipients of cadaver donor grafts was 72%, commercial living donor grafts was 74%, while commercial cadaver donor grafts and living donor grafts were 81%. The 5-year patient survival rates also differed in these 4 groups at 83% for cadaver transplantation, 87% for commercial living transplantation, 89% for commercial cadaver transplantation and 94% for live related transplantation.

The differences in graft survival rates among these 4 donor sources were significant even after adjustment for other risk factors such as age, gender, ethnic, year of transplant, smoking status, BMI, diabetes, hepatitis B and C, HLA match, cardiovascular disease and prior dialysis time (Table 6.25). Hence other immunological and non immunological factors such as acute rejection, panel reactive activity, cold ischaemic time, number of previous transplants, donor factors and the effect of immunosuppressive regime may contribute to these observed difference in outcome.

Table 6.22 Unadjusted Transplant Patient Survival related to Type of Transplant 1993-2002

Type of Transplant	Commercial Cadaver		Commercial Live Donor		Live Donor		Cadaver	
Interval (months)	% Survival	SE	% Survival	SE	% Survival	SE	% Survival	SE
6	97	1	96	1	98	1	88	3
12	96	1	95	1	97	1	86	3
24	94	1	94	1	97	1	84	3
36	92	1	91	2	96	1	83	3
48	91	1	90	2	95	1	83	3
60	89	1	87	2	94	1	83	3

SE=standard error

Table 6.23 Unadjusted Graft Survival related to Type of Transplant 1993-2002

Type of Transplant	Commercial Cadaver		Commercial Live Donor		Live Donor		Cadaver	
Interval (months)	% Survival	SE	% Survival	SE	% Survival	SE	% Survival	SE
6	95	1	94	1	93	1	82	3
12	94	1	93	1	92	2	79	3
24	91	1	90	2	90	2	74	4
36	89	1	84	2	86	2	72	4
48	85	2	78	3	83	2	72	4
60	81	2	74	3	81	2	72	4

SE=standard error

Figure 6.22 Unadjusted Transplant Patient Survival related to Type of Transplant 1993-2002

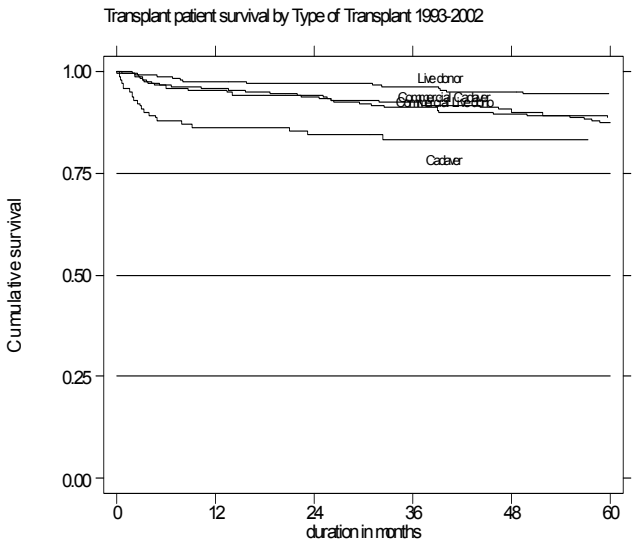


Figure 6.23 Unadjusted Graft Survival related to Type of Transplant 1993-2002

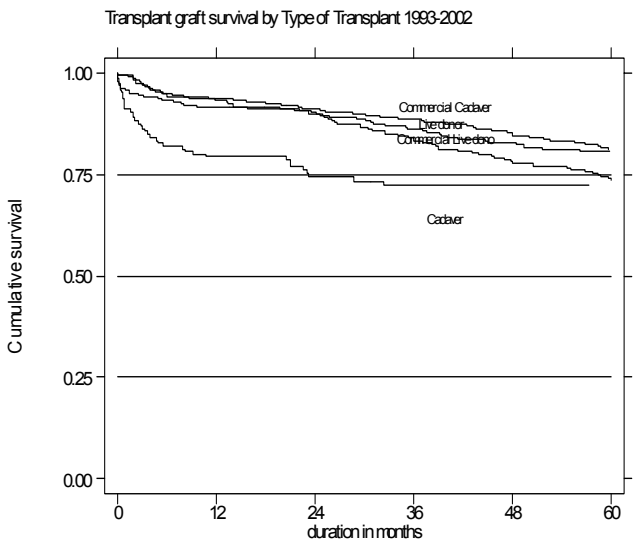


Table 6.24 Risk factors for Transplant Patient Survival 1993-2002

Factors	N	Hazard ratio	95% CI	P value
Year of transplant:				
1993-1997 (ref.*)	719	1.00		
1998-2002	681	0.61	(0.40,0.94)	0.024
Age at transplant:				
<20	100	0.44	(0.13,1.44)	0.175
20-39 (ref.*)	652	1.00		
40-54	524	2.03	(1.36,3.02)	0.001
>=55	124	3.90	(2.35,6.46)	0.000
Gender:				
Male (ref.*)	856	1.00		
Female	544	0.87	(0.62,1.22)	0.415
Primary diagnosis:				
Unknown (ref.*)	618	1.00		
Diabetes Mellitus	151	1.52	(0.95,2.43)	0.077
GN / SLE	433	0.77	(0.49,1.19)	0.238
Polycystic kidney	21	2.37	(0.94,5.60)	0.069
Obstructive nephropathy	57	1.86	(0.97,3.57)	0.061
Others	120	1.14	(0.63,2.06)	0.657
Type of Transplant:				
Commercial cadaver (ref.*)	603	1.00		
Commercial live donor	290	1.26	(0.84,1.89)	0.268
Living donor	341	1.05	(0.61,1.80)	0.872
Cadaver	145	3.94	(2.11,7.39)	0.000
HbsAg:				
Negative (ref.*)	1287	1.00		
Positive	113	1.88	(1.16,3.02)	0.009
Anti-HCV:				
Negative (ref.*)	1183	1.00		
Positive	217	0.90	(0.56,1.44)	0.664
Prior dialysis time:				
<1 years	717	1.00		
1-<3 years	417	1.41	(0.97,2.06)	0.074
>=3 years	266	1.13	(0.66,1.94)	0.646

* ref: Reference group

Figure 6.24 Adjusted Transplant Patient Survival related to Year of Transplant 1993-2002
(Adjusted for age, gender, primary diagnosis, type of transplant, HBsAg and Anti-HCV status)

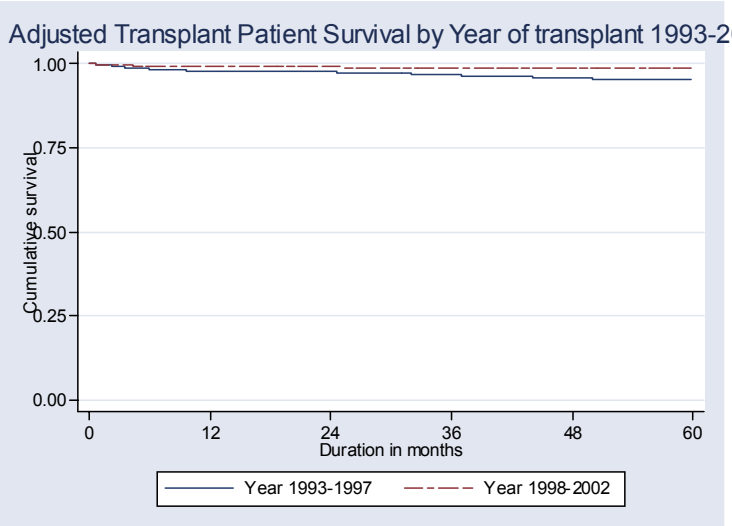
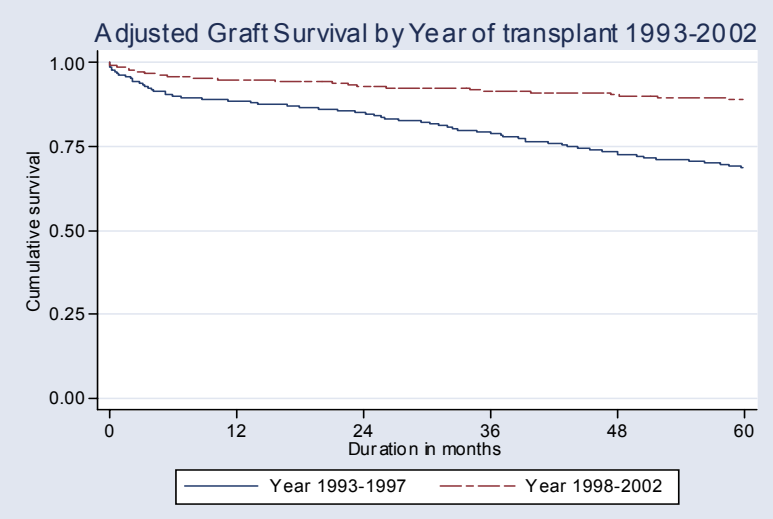


Table 6.25 Risk factors for Graft Survival 1993-2002

Factors	N	Hazard ratio	95% CI	P value
Year of transplant:				
1993-1997 (ref.*)	719	1.00		
1998-2002	681	0.75	(056,1.01)	0.060
Gender:				
Male (ref.*)	856	1.00		
Female	544	0.88	(0.70,1.10)	0.270
Age at transplant:				
<20	100	0.91	(0.57,1.46)	0.706
20-39 (ref.*)	652	1.00		
40-54	524	1.08	(0.84,1.39)	0.546
>=55	124	1.63	(1.11,2.38)	0.011
Primary diagnosis:				
Unknown (ref.*)	618	1.00		
Diabetes Mellitus	151	1.44	(1.00,2.08)	0.049
GN / SLE	433	1.02	(0.78,1.34)	0.864
Polycystic kidney	21	2.38	(1.15,4.90)	0.019
Obstructive nephropathy	57	1.33	(0.81,2.19)	0.259
Others	120	1.32	(0.88,1.98)	0.178
Type of Transplant:				
Commercial cadaver(ref.*)	603	1.00		
Commercial live donor	290	1.43	(1.08,1.90)	0.014
Living donor	341	1.15	(0.84,1.60)	0.384
Cadaver	145	2.26	(1.45,3.50)	0.000
HbsAg:				
Negative (ref.*)	1287	1.00		
Positive	113	1.60	(1.15,2.22)	0.005
Anti-HCV:				
Negative (ref.*)	1183	1.00		
Positive	217	2.10	(1.62,2.72)	0.000
BMI:				
<18.5 (ref.*)	178	1.00		
18.5-25	949	0.66	(0.47,0.92)	0.013
>25	273	0.49	(0.33,0.74)	0.000
Prior Dialysis Time				
<1 year	717	1.00		
1-<3 years	417	1.24	(0.96,1.60)	0.093
≥3 years	266	0.87	(0.60,1.25)	0.453

* ref: Reference group

Figure 6.25 Adjusted Graft Survival related to Year of Transplant 1993-2002
(Adjusted for age, gender, primary diagnosis, type of transplant, BMI, HBsAg and Anti-HCV status)



Risk Factors for Patient and Graft Survival 1993-2002

Results obtained from Cox proportional hazards model adjusted for multiple covariates are shown in Tables 6.24 and 6.25. Hazard ratios should be compared to the reference risk of 1.00, arbitrarily assigned to one group for each characteristic.

The risk of graft failure in all transplants had decreased by 25% while the risk of patient death decreased by 39% for those transplanted in 1998 to 2002 compared to those transplanted in 1993 to 1997 (Tables 6.24 & 6.24 and Figures 6.24 and 6.25). The risk of graft failure was also higher for recipients aged 55 years or older, diabetics, recipients with HBsAg seropositivity, and anti-HCV seropositivity, those with polycystic kidney disease as primary diagnosis, cadaver transplantation, and commercial live donor graft , while the risk of graft failure was reduced by 34% for recipients with normal BMI (Table 6.25).

The risk of patient mortality was increased for recipients aged 40 years and older, cadaver renal transplant recipients, and those with HBsAg seropositivity (Table 6.24).

It is interesting to note that in this cohort of patients, the risk of graft failure was increased by 44% for recipients with diabetes compared with non-diabetics. However, there was no significant difference in patient mortality. The 3- and 5-year unadjusted patient survival for diabetics compared to non diabetics were 89% & 83% versus 92% & 90%, respectively. The 3- and 5-year unadjusted HD patient survival rates for diabetics were 64% and 46%, respectively (Table 6.26 and 6.27). Hence, ESRD patients with diabetes mellitus who underwent renal transplantation appear to have better outcome compared to those continuing on haemodialysis. However, this data has to be interpreted with caution as there might be selection bias where only healthy diabetic patients were transplanted. Furthermore this direct comparison did not take into account other potential confounding factors. Nevertheless, it may be concluded that diabetic transplant recipients were at least not worse off compared to their counterparts on haemodialysis.

Effect of Newer Immunosuppressive Agents on Graft Survival

Results from the previous section showed that the risk of graft failure had decreased by 25% for the 1998-2002 cohort compared to the 1993-1997 cohort. One possible explanation for this result could be the increasing use of newer immunosuppression agents such as mycophenolate mofetil (MMF) and tacrolimus (FK506) in recent years. The table below shows the exposure of 1400 recipients between 1993 and 2002 to the various immunosuppressive agents:

Year of transplant	1993-1997	1998-2002
Ever on CsA, No. (%)	683 (95%)	53 (79%)
Ever on AZA, No. (%)	626 (87%)	254 (37%)
Ever on MMF, No. (%)	18 (3%)	332 (49%)
Ever on tacrolimus, No. (%)	2 (0%)	109 (16%)
TOTAL	719 (100%)	681 (100%)

We therefore determined the effect of exposure to the newer immunosuppressive agents on graft survival. We compared the effect of Azathioprine versus MMF, and that of CsA versus FK506.

Azathioprine versus MMF

Figure 6.28 shows the slight advantage in graft survival in patients on MMF versus azathioprine on crude analysis which became more obvious after adjustment for known confounding factors (Figure 6.29) On crude analysis there appeared to be slight advantage associated with the use of MMF as shown in Figure 6.28. However, there were more patients who were older and had diabetes among more recent transplants. Hence the adjusted graft survival as shown in Figure 6.29 which showed better graft survival with the use of MMF. This result is consistent with reports from large trials such as the Tri-continental trial [27].

Table 6.26 Unadjusted Transplant Patient Survival related to Diabetes Mellitus 1993-2002

Diabetes Mellitus	Non-diabetic		Diabetic	
Interval (months)	% Survival	SE	% Survival	SE
6	96	1	96	1
12	95	1	93	2
24	94	1	92	2
36	92	1	89	3
48	91	1	88	3
60	90	1	83	4

SE=standard error

Table 6.27 Unadjusted HD Patient Survival related to Diabetes Mellitus 1993-2002

Diabetes Mellitus	Non-diabetic		Diabetic	
Interval (months)	% Survival	SE	% Survival	SE
6	95	0.2	93	0.3
12	92	0.3	87	1
24	86	0.4	74	1
36	81	1	64	1
48	76	1	54	1
60	72	1	46	1

SE=standard error

Cyclosporine versus Tacrolimus

This analysis was confined only to subjects who were exclusively on either CsA or tacrolimus. Patients exposed to both CsA and tacrolimus were excluded from analysis as they might possibly be given tacrolimus as rescue therapy for steroid resistant rejection. There appears to be a slight advantage associated with the use of tacrolimus as shown in Figure 6.30 which again is more obvious once adjustments were made for age and diabetes mellitus status as shown in Figure 6.31.

Vincenti et al [28] in their US Multicenter Trial comparing tacrolimus and cyclosporine based immunosuppressive therapy reported that tacrolimus based therapy resulted in significant reduction in graft failure risk. It is also interesting to note that in our analysis, the better graft survival with the use of tacrolimus based therapy appears to be enhanced after adjusting for risk factors such as age and diabetes. This may be explained by preferential use of tacrolimus based therapy in higher risk patients as per Ministry of Health protocol.

Although the preliminary results suggest that the use of tacrolimus and MMF might be the explanation for the observed superior graft and patient survival rates for the 1998-2002 cohort compared with the 1993-1997 cohort, this analysis is limited by the small number of patients, missing data on details of drug utilization and treatment indication. Hence, a properly conducted study would be necessary to further clarify this observation.

Figure 6.28 Transplant graft survival: AZA vs MMF 1993-2002

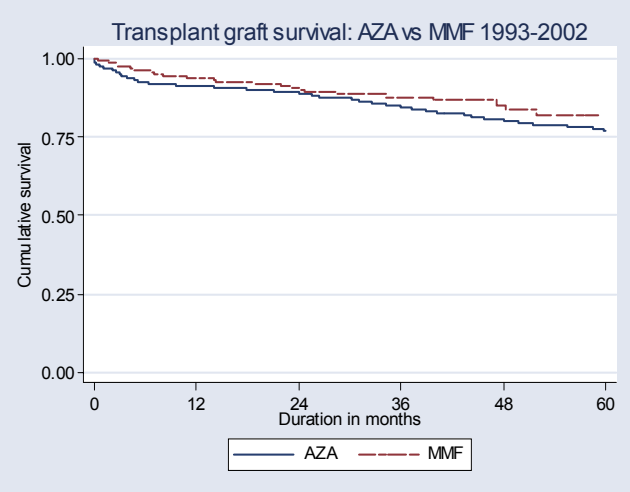


Figure 6.29 Adjusted transplant graft survival: AZA vs MMF 1993-2002

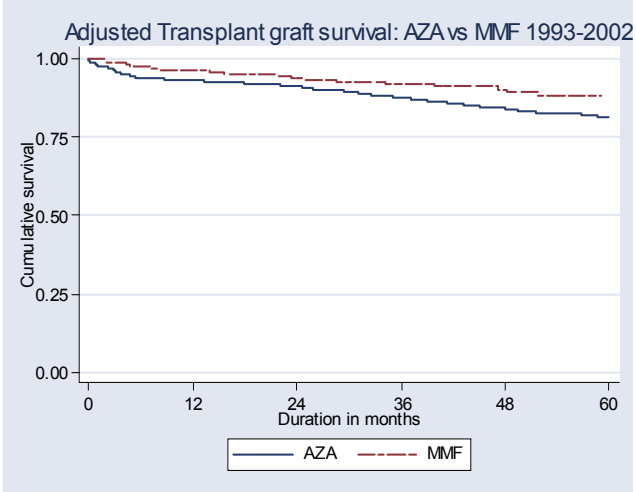


Figure 6.30 Transplant graft survival: CsA vs FK506 1993-2002

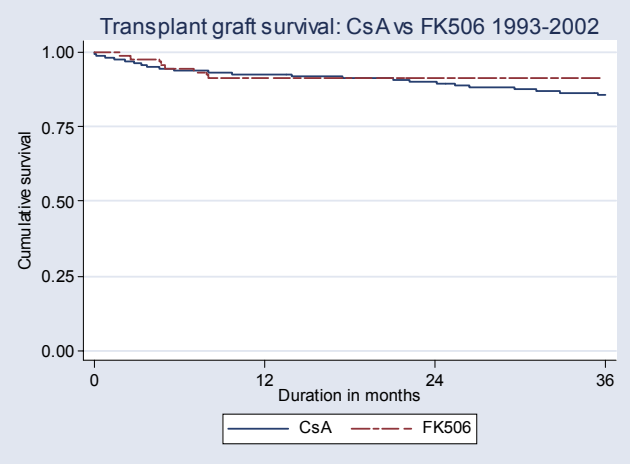
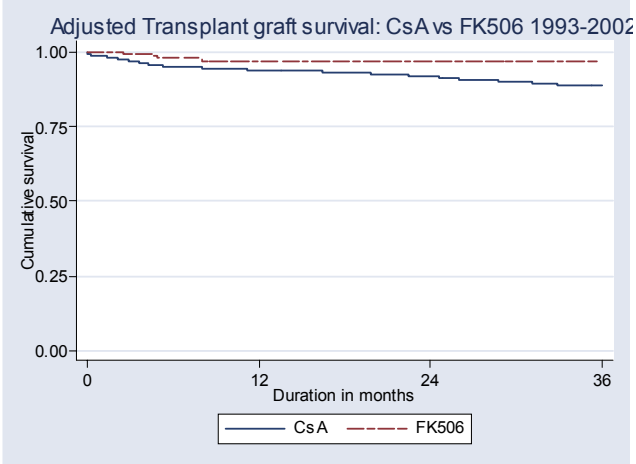


Figure 6.31 Adjusted transplant graft survival: CsA vs FK506 1993-2002



References

1. Calne RY, White DJG, Thiru S, Evans DB, McMaster P, Dunn DC, Craddock GN, Pentlow BD, Rolles K: Cyclosporin A in patients receiving renal allografts from cadaver donors. Lancet 2:1323-1327, 1978

2. Calne RY, Rolles K, White DJG, Thiru S, Evans DB, McMaster P, Dunn DC, Craddock GN, Henderson RG, Aziz S, Lewis P: Cyclosporin A initially as the only immunosuppressant in 34 recipients of cadaveric organs: 32 kidneys, 2 pancreases, and 2 livers. Lancet 2:1033-1036, 1979

3. Starzl TE, Weil R III, Iwatsuki S, Klintmalm G, Schröter GPJ, Koep LJ, Iwaki Y, Terasaki PI, Porter KA: The use of cyclosporin A and prednisone in cadaver kidney transplantation. Surg Gynecol Obstet 151:17-26, 1980

4. Starzl TE, Klintmalm GBG, Porter KA, Iwatsuki S, Schröter GPJ: Liver transplantation with use of cyclosporin A and prednisone. N Engl J Med 305:266-269, 1981

5. The Canadian Multicentre Transplant Study Group: A randomized clinical trial of cyclosporine in cadaveric renal transplantation. N Engl J Med 309:809-815, 1983

6. Macoviak JA, Oyer PE, Stinson EB, Jamieson SW, Baldwin JC, Shumway NE: Four-year experience with cyclosporine for heart and heart-lung transplantation. Transplant Proc 17(Suppl 2):97-101, 1985

7. Traeger J, Dubernard JM, Pozza G, Bosi E, Secchi A, Pontiroli AE, Touraine JL, Betuel H, El Yafi S, Da Ponte F, Cantarovich D, Diab N, Cardozo C, Martin X, Kamel G, Gelet A: Influence of immunosuppressive therapy on the endocrine function of segmental pancreatic allografts. Transplant Proc 15:1326-1329, 1983

8. First MR: Renal allograft survival after 1 and 10 years: Comparison between pre-cyclosporin and cyclosporin data. Nephrol Dial Transplant 9:90-97, 1993

9. Thorogood J, van Houwelingen JC, van Rood JJ, Zantvoort FA, Schreuder GMTh, Persijn GG: Factors contributing to long-term kidney graft survival in Eurotransplant. Transplantation 54:152-158, 1992

10. United States Renal Data System 2003 Annual Data Report: Atlas of End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2003

11. Roodbat JI, Zietse R, Mulder PG, Rischen VJ, Van GT. The vanishing importance of age in renal transpantation. Transplantation. 1999;67(4):576-80.

12. Fernandez FG, Zubimendi JA, Cotorruelo JG, Francisco AL, Ruiz JC. Significance of age in the survival of diabetic patients after kidney transplantation. Int Urol Nephrol. 2002;33(1):173-7.

13. Kappes U, Schanz G, Gerhardt U, Matzkies F, Suwelack B. Influence of age on the prognosis of renal transplant recipients. Am J Nephrol. 2001;(4):259-63.

14. Terasaki PI, Gjertson DW, Cecka JM, Takemoto S. Fit and match hypothesis for kidney transplantation. Transplantation. 1996; 62(4):441-5.

15. Howard RJ, Thai VB, Patton PR, Hemmning AW, Reed AI. Obesity does not portend a bad outcome portend a bad outcome for kidney transplant recipients. Transplatation. 2002 ;73(1):53-5.

16. Chertow GM, Brenner BM, Mori M, MacKenzie HS, Milford EL. Fit and match hypothesis for kidney transplantation. Transplantation. 1996 ; 62(4):441-5.

17. Kim Hyang, Jhoong S. Kidney transplantation in patients with type 1 diabetes mellitus: long term prognosis for patients and grafts. Korean Journal of Internal Medicine. 2001 ; 16(2):98-104.

18. Nampoory MR, Johny KV, Costandi JN, Gupta RK, Nair MP. Inferior long term outcome of renal transplantation in patients with diabetes mellitus. Med Princ Pract. 2002 ; 11(1):29-34.

19. Batty DS Jr, Swanson SJ, Kirk AD, Ko CW, Agodoa LY, Abbott KC. Hepatitis C virus seropositivity at the time of renal transplantation in the United States: associated factors and patient survival. Am J Transplant. 2001; 1 (2):179-84.

20. Hassan AA, El-Deeb S, Berthous P, Bonnevial L, Cecillon S, Berthoux F. Impact of hepatitis C on renal transplantation: a long-term study. Saudi Med J. 2003; 24 Suppl 2:S129.

21. Woo YM, Mc Lean D, Kavanagh D, Ward L, Aitken S. The influence of pre-operative electrocardiographic abnormailities and cardiovascular risk factors on patient and graft survival following renal transplantation. J Nephrol. 2002; 15(4):380-6.

22. Cosio FG, Falkenhain ME, Pesavento TE, Yim S, Alamir A, Henry ML, Ferguson RM. Patient survival after renal transplantation: II. The impact of smoking. Clin Transplant. 1999; 13(4):336-41.

23. Mange KC, Joffe MM, Feldman HI. Effect of the use or nonuse of long-term dialysis on the subsequent survival of renal transplants from living donors. N Engl J Med. 2001; 344(10):726-31.

24. Cacciarelli TV, Sumrani NB, Dibenedetto A et al. The influence of mode of dialysis pretransplantation on long term renal allograft outcome. Ren Fail. 1993;15:545-550.

25. Kasiske BL, Klinger D. Cigarette smoking in renal transplant recipients. J Am Soc Nephrol. 2000; 11 (4):753-9.

26. Sung RS, Althoen M, Howell TA, Ojo AO, Merion RM. Excess risk of renal allograft loss associated with cigarette smoking. Transplantation. 2001; 71(12):1752-7.

27. Mathew TH. Tricontinental Mycophenolate Mofetil Renal Transplantation Study Group. Transplantation. 1998 ; 65(11):1450-4.

28. Vincenti F, Jensik SC, Filo Rs, Miller J, Pirsch J. Transplantation. 2002 ; 73(5):775-82.

CHAPTER 7: ANAEMIA MANAGEMENT

Summary

Target Haemoglobin

- The mean and median haemoglobin for HD and CAPD patients range from 9.3 to 10g/dl.
- There is trend towards continued improvement in the level of haemoglobin achieved in all centres.
- Less then 50% of patients on haemodialysis or peritoneal dialysis has haemoglobin of >10g/dl.
- The haemoglobin level achieved in haemodialysis patients is similar to peritoneal dialysis

Factors Influencing Haemoglobin; Ferritin, Erythropoietin dosing.

- The majority of patients that were on erythropoietin have adequate iron stores as measured by the serum ferritin. The mean serum ferritin was 400 to 500 mcg/l.
- Most patients had transferrin saturation greater than 20% .
- Parenteral iron was rarely used in most dialysis units.
- The use of erythropoietin was steadily increasing over the years for both haemodialysis and CAPD patients, but the doses were lower.
- The majority of patients (>80%) were on 4000 units or less per week of erythropoietin.

Haemoglobin and Mortality

- In HD, the mortality was least in patients with haemoglobin of 10-12 gm/dl and highest with haemoglobin less than 8 gm/dl.
- In CAPD, there was no significant difference in mortality between the various haemoglobin groups, except in the less than 8g/dl group, where mortality was the highest.
- There was no survival advantage for dialysis patients with haemoglobin > 12 gm/dl.
- The risk of death was greater in HD patients compared to CAPD patients with a haemoglobin of less than 8 gm/dl.
- For all dialysis patients (HD & CAPD combined), significant difference was found in mortality between patients with haemoglobin < 10 g/dl compared to those with haemoglobin 10 to <11g/dl. There was however no difference in mortality in patients with haemoglobin 11 to <12g/dl or above

7.1 Target Haemoglobin

Introduction

A pivotal area in the management of renal patients on dialysis is the management of anaemia. Anaemia if uncorrected results in tiredness, lethargy, sleep disturbances, decreased exercise capacity, sexual dysfunction, poorer quality of life, left ventricular hypertrophy, disturbed brain function and other consequences including increased morbidity and mortality.

Recombinant human erythropoietin (RHuEpo) has been available since 1985 and used in Malaysia since 1989. This has increased haemoglobin concentration. There is however, more scope for improvement.

The target haemoglobin level as recommended by various authorities are;

European Best practice guidelines recommends that the target haemoglobin is that >85% of the patient population should have a haemoglobin concentration of >11g/dl. [1]

The K/DOQI guidelines states the target range for haemoglobin should be 11 – 12 g/dl. [2]

The UK Renal Association recommends that the target haemoglobin is 10g/dl and 85% of the dialysis population should reach this target after 6 months on dialysis. [3]

The Malaysian Dialysis consensus states that patients with chronic renal failure should achieve a target haemoglobin of 10g/dl within 6 months of being seen by a nephrologist, unless there is a specific reason. [unpublished]

Results

Over the last 10 years from 1993 to 2002, the mean and median haemoglobin level achieved in haemodialysis (HD) and peritoneal dialysis (PD) patients have improved. The percentage of patients with haemoglobin less than 10g/dl has decreased with a corresponding increase in patient with haemoglobin concentration of 10 to 12 g/dl and haemoglobin greater than 12g/dl. This finding was noted both in patients with and without erythropoietin treatment. (Tables 7.1.1 to 7.1.4, Figures 7.1.1 to 7.1.4) The haemoglobin level achieved in haemodialysis patients was comparable with peritoneal dialysis patients.

This trend, though encouraging is still far short of the target of 85% with haemoglobin greater than 11 g/dl recommended by the UK Renal Association and European Best Practice guidelines and is even short of the local unpublished recommendations. In the European Survey of Anaemia Management haemoglobin reached target levels of 11g/dl. in only 53.6% of patients. In the UK Renal Registry, 81% of HD patients and 86% of PD patients achieved the haemoglobin target of 10g/dl. [4]

Table 7.1.1 Distribution of Haemoglobin Concentration without Erythropoietin, all HD patients, 1993 – 2002

Year	No. of subjects	Mean	Std Dev	Median	LQ	UQ	% Patients <10 g/dL	% Patients ≥10 & ≤12 g/dL	% Patients >12 g/dL
1993	639	8.4	2	8.1	7.0	9.6	80	15	5
1994	784	8.6	1.9	8.4	7.1	9.7	79	15	6
1995	809	8.9	1.9	8.6	7.4	10.0	74	18	8
1996	812	9.1	1.9	8.9	7.7	10.3	71	21	8
1997	896	9.3	1.9	9	8.0	10.5	68	23	9
1998	1119	9.1	1.9	8.9	7.8	10.3	70	21	8
1999	1401	9.1	1.9	8.9	7.8	10.3	70	23	7
2000	1754	9.4	2.1	9.1	7.9	10.6	67	23	11
2001	1809	9.4	1.9	9.3	8.0	10.6	63	27	10
2002	1710	9.6	2.1	9.4	8.1	10.9	61	26	13

Table 7.1.2 Distribution of Haemoglobin Concentration on Erythropoietin, HD patients, 1993 – 2002

Year	No. of subjects	Mean	Std Dev	Median	LQ	UQ	% Patients <10 g/dL	% Patients ≥10 & ≤12 g/dL	% Patients >12 g/dL
1993	57	7.7	1.5	7.6	6.6	8.8	91	9	0
1994	149	7.8	1.4	7.6	6.8	8.8	93	7	0
1995	207	8.7	1.5	8.9	7.6	9.8	81	18	1
1996	400	8.7	1.6	8.5	7.5	9.6	81	17	3
1997	775	8.9	1.6	8.9	7.8	9.9	75	22	2
1998	972	9.1	1.6	9.1	7.9	10.2	71	27	2
1999	1504	9.1	1.5	9.1	8.1	10.2	71	27	3
2000	2336	9.4	1.7	9.4	8.3	10.5	64	30	5
2001	3051	9.4	1.6	9.4	8.3	10.5	64	31	5
2002	3617	9.5	1.7	9.5	8.4	10.6	62	31	7

Figure 7.1.1 Mean of haemoglobin Concentration without Erythropoietin (rHuEpo), HD patients, 1993-2002

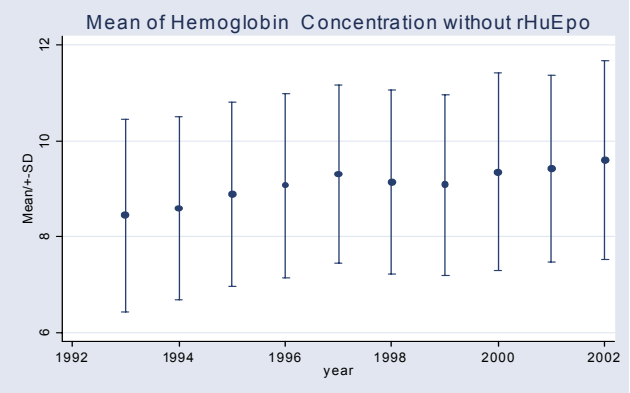


Figure 7.1.2 Mean of haemoglobin Concentration on Erythropoietin, HD patients, 1993-2002

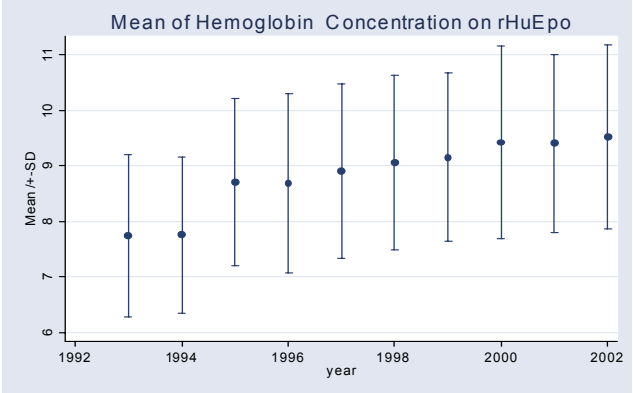


Table 7.1.3 Distribution of Haemoglobin concentration without Erythropoietin, CAPD patients, 1993 - 2002

Year	No of subjects	Mean	Std Dev	Median	LQ	UQ	% Patients <10 g/dL	% Patients ≥10 & ≤12 g/ dL	% Patients >12 g/dL
1993	91	9.3	2.0	9.1	7.9	10.2	71	20	9
1994	99	9.3	2.0	9.1	7.8	10.3	69	21	10
1995	209	9.1	1.6	8.9	8	10.1	73	22	5
1996	274	9.2	1.8	9.1	7.8	10.2	72	22	6
1997	298	9.2	1.6	9.1	8.1	10.3	71	24	5
1998	301	9.3	1.8	9.2	8.1	10.3	68	26	6
1999	336	9.5	1.6	9.5	8.4	10.5	64	29	7
2000	342	9.8	1.7	9.7	8.7	10.9	57	34	8
2001	405	9.8	1.8	9.7	8.6	10.7	58	33	9
2002	433	10	1.8	9.9	8.8	11	53	36	10

Table 7.1.4 Distribution of Haemoblobin concentration on Erythropoietin, CAPD patients, 1993– 2002

Year	No of subjects	Mean	Std Dev	Median	LQ	UQ	% Patients <10 g/dL	% Patients ≥10 & ≤12 g/ dL	% Patients >12 g/dL
1993	8	7.1	1.2	6.7	6.2	8.3	100	0	0
1994	20	7.9	1.0	8.0	7.0	9.0	100	0	0
1995	45	8.5	1.5	8.4	7.5	9.3	89	9	2
1996	92	8.5	1.5	8.5	7.3	9.4	86	13	1
1997	175	8.8	1.5	8.6	7.7	9.8	79	18	2
1998	238	9.0	1.6	8.8	8.0	10.1	74	21	5
1999	262	9.0	1.6	8.9	7.9	10.2	73	24	4
2000	299	9.4	1.7	9.2	8.1	10.6	65	29	6
2001	345	9.3	1.6	9.4	8.2	10.5	65	30	6
2002	431	9.4	1.6	9.3	8.4	10.4	67	27	6

Figure 7.1.3 Mean of haemoglobin Concentration with-out Erythropoietin, CAPD patients, 1993-2002

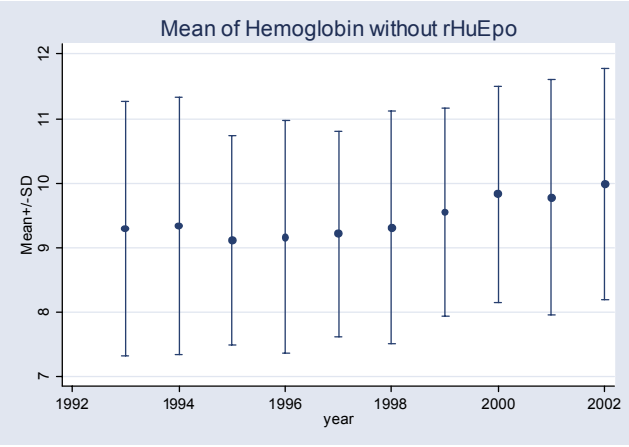
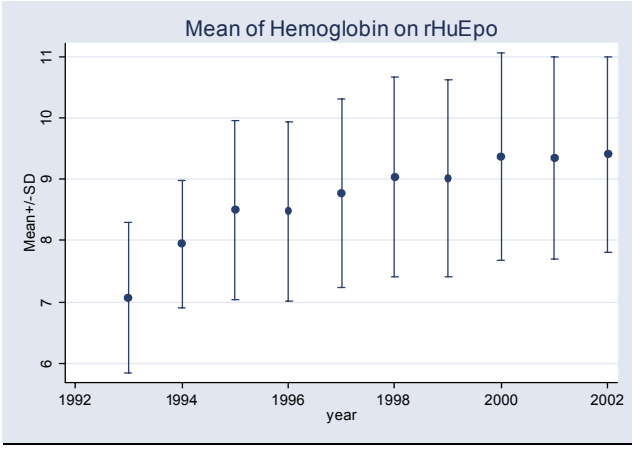


Figure 7.1.4 Mean of haemoglobin Concentration on Erythropoietin, CAPD patients, 1993-2002



7.2 Factors Influencing Haemoglobin – Iron Status and Erythropoietin Dosing

Introduction

Proper iron management is of paramount importance to ensure optimum response to erythropoietin. There are various markers/ parameters employed to indicate the iron status in patients. These are serum iron, ferritin, total iron binding capacity (TIBC), transferrin saturation (TSAT) and percentage hypochromic red blood cells. The common parameters used locally are serum iron, ferritin and transferrin saturation.

The European Best Practice Guidelines (EBPG) recommends the following:

"serum ferritin > 100 mcg/l, TSAT > 20%, percentage of hypochromic cells < 10%. The optimum levels are ferritin 200-500 mcg/l, percentage of hypochromic cells < 2-5% and TSAT 30-40%". [1]

The K/DOQI guideline also recommends that target serum ferritin should be > 100 mcg/l. [2]

The UK Renal Association Standard recommend a serum ferritin > 100 mcg/l and <10% hyopochromic red cells (transferrin saturation > 20%) ; serum ferritin should not consistently exceed 800 mcg/l. [3]

Findings from the European Survey of Anemia Management (ESAM) were as follows;

- The mean erythropoietin dose administered was 107.8 units/kg/week.
- Intravenous erythropoietin was used more often than subcutaneous erythropoietin for HD patients
- Two thirds of patients on intravenous erythropoietin had 3 injections per week compared to one quarter subcutaneous erythropoietin once per week and another third on twice weekly injections. [4]

For effective use and benefit of erythropoietin, guidelines on its use should be adhered to. Certain patient characteristics however determine erythropoietin dose requirements. [5] Children and young adults, black race, lower residual renal function, poor nutritional status, longer duration on HD, diabetes, failed kidney transplants, pregnancy and haemoglobinopathy require higher erythropoietin dose. On the other hand, the elderly, white race, higher residual renal function, good nutritional status, recently started on HD, non-diabetics, no history of previous transplant, polycystic kidney disease and hepatitis have been associated with lower erythropoietin requirement.

Results

Over the last 10 years, the percentage of patients having serum ferritin more than 100 mcg/l has been between 80 -90 %. The mean serum ferritin for all patients on dialysis both with and without erythropoietin therapy has been rising and has mostly been greater than 400 μg/L. (Table 7.2.3, 7.2.4, 7.2.7, 7.2.8). The majority of patients (> 90%) were on oral iron supplements. Only 2 to 7% of patients were exposed to parenteral iron. However of late there has been an increased use of parenteral iron most noticeable in the government haemodialysis centers. Erythropoietin use increased from 8% in 1993 to 67% in 2002 in HD patients compared to a smaller increase of 8 to 49% in CAPD patients over the corresponding period to achieve similar haemoglobin levels. (Tables 7.2.1 & 7.2.5). The median dose of erythropoietin for both HD and CAPD patients was 2000-4000 units of erythropoietin per week.

The percentage of patients on higher doses of erythropoietin has been steadily decreasing over the years with a corresponding increase in the percentage of patients on lower doses of erythropoietin– of less than 4000 units /week. The dose of erythropoietin required for patients on CAPD and the trend in erythropoietin dosage over the years were similar to patients on HD. (Tables 7.2.2 and 7.2.6)

Table 7.2.1 Treatment for Anemia, HD patients

Year	Number	% on Erythropoietin	% received blood transfusion	% on oral Iron	% received parenteral Iron
1993	718	8	20	0	0
1994	963	16	10	94	1
1995	1034	20	9	95	1
1996	1256	33	8	92	3
1997	1697	46	8	92	4
1998	2142	46	13	92	4
1999	2998	51	15	90	5
2000	4395	56	15	88	5
2001	5196	62	13	88	5
2002	5674	67	11	86	7

Table 7.2.2 Distribution of Erythropoietin dose per week, HD patients 1994-2002

Year	1994	1995	1996	1997
No. of patients	147	202	396	751
% - 2000 u/week	13	9	9	21
% 2-4000 u/week	56	67	67	61
% 4-6000 u/week	9	6	6	5
% 6-8000 u/week	19	16	16	11
% 8-12000 u/week	3	1	2	2
% >12000 u/week	1	0	0	0

Year	1998	1999	2000	2001	2002
No. of Patients	920	1474	2365	3134	3686
% - 2000 u/week	27	33	35	34	33
% 2-4000 u/week	54	52	51	50	51
% 4-6000 u/week	6	5	6	7	8
% 6-8000 u/week	10	9	6	6	6
% 8-12000 u/week	2	1	2	2	2
% >12000 u/week	0	0	0	0	0

In spite of good mean and median serum ferritin and transferrin saturation, and the greater use of erythropoietin in both the CAPD and HD patients, less than 50% of dialysis patients achieved the recommended target haemoglobin of 10g/dl. This could be due to various factors. The change of erythropoietin dosage over the years probably reflected the clinicians' confidence and experience in using erythropoietin. Perhaps in the early years only patients with persistently severe anaemia (haemoglobin <6g/dl) were started on erythropoietin. It is interesting to note that with the decreasing dose of erythropoietin being used albeit in larger proportion of patients, the level of haemoglobin has steadily increased over the years as noted earlier.

Table 7.2.3 Distribution of Serum Ferritin without Erythropoietin, HD patients, 1994 –2002

Year	No of subjects	Mean	Std Dev	Median	LQ	UQ	% Patients ≥100 ug/L
1994	15	256.4	279.2	189	36.5	274	67
1995	42	293.3	249.5	199.5	135	401	79
1996	63	310.3	286.8	218	82	492	71
1997	280	493.1	349.3	435.5	162.5	850.5	86
1998	224	430.8	383.2	297.5	128.4	636.5	80
1999	337	517.9	424.3	402.8	162.8	809.5	86
2000	571	487.5	416.8	363.2	152.5	741	83
2001	758	537.6	453.9	383.5	172	828	87
2002	755	518.9	441.1	376	170	781	85

Table 7.2.4 Distribution of Serum Ferritin on Erythropoietin, HD patients, 1994 – 2002

Year	No of subjects	Mean	Std Dev	Median	LQ	UQ	% Patients ≥100 ug/L
1994	9	286.6	288.3	210	148.5	295.5	78
1995	97	526.4	321.3	500	243	816	94
1996	156	494.9	348.7	397.5	173.5	856.3	89
1997	472	543.3	346.7	496.3	219	966.8	90
1998	329	549.8	381.8	477	249.5	803	91
1999	587	561.2	418.6	453	225	830	93
2000	1177	588.5	456.4	476	219	863	91
2001	1639	598.1	444.3	491.3	236	899	91
2002	2071	601	461	475.3	236	891	92

Figure 7.2.3 Mean of Serum Ferritin without Erythropoietin, HD patients, 1993-2002

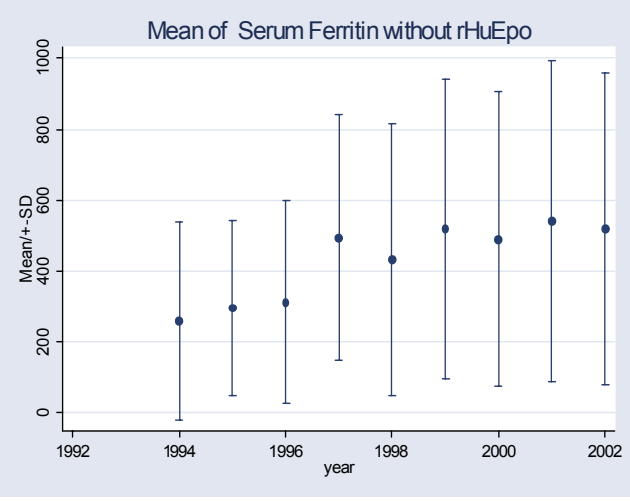


Figure 7.2.4 Mean of Serum Ferritin on Erythropoietin, HD patients, 1993-2002

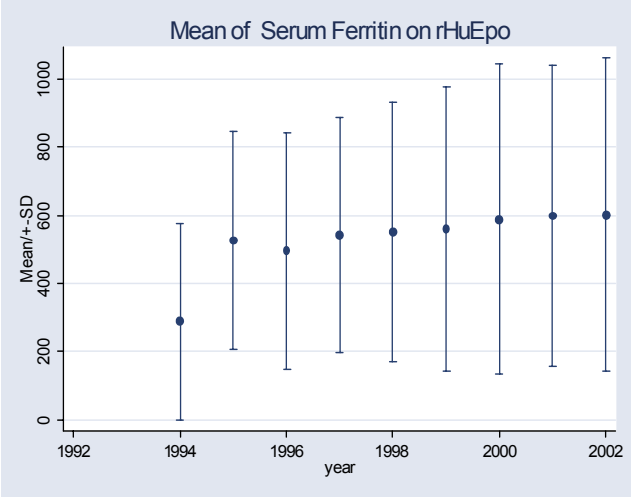


Table 7.2.5 Treatment for Anaemia, CAPD patients

Year	Number	% on Erythropoietin	% received blood transfusion	% on oral Iron	% received parenteral Iron
1993	102	8	13	0	0
1994	122	17	7	97	1
1995	256	18	9	98	1
1996	371	25	8	97	1
1997	477	37	12	96	3
1998	541	44	16	96	3
1999	610	44	14	94	0
2000	662	46	11	92	4
2001	781	45	11	91	2
2002	889	49	11	93	2

Table 7.2.6 Distribution of Erythropoietin dose per week, CAPD patients 1994-2002

Year	1994	1995	1996	1997
No of patients	20	45	86	170
% - 2000 u/week	30	31	28	19
% 2-4000 u/week	65	62	63	66
% 4-6000 u/week	0	0	0	2
% 6-8000 u/week	5	4	7	11
% 8-12000 u/week	0	2	2	1
% >12000 u/week	0	0	0	0

Year	1998	1999	2000	2001	2002
No of patients	225	259	287	336	427
% - 2000 u/week	25	35	31	32	30
% 2-4000 u/week	56	50	53	51	52
% 4-6000 u/week	6	3	5	7	6
% 6-8000 u/week	12	9	9	7	10
% 8-12000 u/week	1	2	3	2	3
% >12000 u/week	0	0	0	0	0

Table 7.2.7 Distribution of Serum Ferritin without Erythropoietin, CAPD patients, 1994 – 2002

Year	No of subjects	Mean	Std Dev	Median	LQ	UQ	% Patients ≥100 ug/L
1994	1	164.5	0	164.5	164.5	164.5	100
1995	4	532.3	405.9	548.5	181.5	883	100
1996	40	403.6	302.3	288.5	188.5	622.5	88
1997	133	469	333.5	392	198	718	88
1998	92	492.4	368.3	405	208.2	687.5	87
1999	124	553.7	400.1	499.3	255.3	686.8	94
2000	144	505.9	433.8	420	152.3	675.5	88
2001	223	543.8	417.5	440	216.9	754	91
2002	235	635	492.2	510	225	938	93

Table 7.2.8 Distribution of Serum Ferritin on Erythropoietin, CAPD patients, 1994 – 2002

Year	No of subjects	Mean	Std Dev	Median	LQ	UQ	% Patients ≥100 ug/L
1994	8	333.1	319.3	252.5	113.3	549	75
1995	11	497.2	349.2	349	175	999	100
1996	49	646.6	311.4	679	438	999	98
1997	129	550.8	323.7	496	256	862	93
1998	135	611.2	438.3	524.7	257	839.5	93
1999	136	604.8	436.3	540.6	264.6	870.1	93
2000	180	608.2	416.7	560	295.2	846.3	92
2001	261	645.9	449.2	557.5	275.7	885.4	93
2002	344	666.4	463	536	284	999.8	94

Figure 7.2.7 Mean of Serum Ferritin without Erythropoietin, CAPD patients, 1993-2002

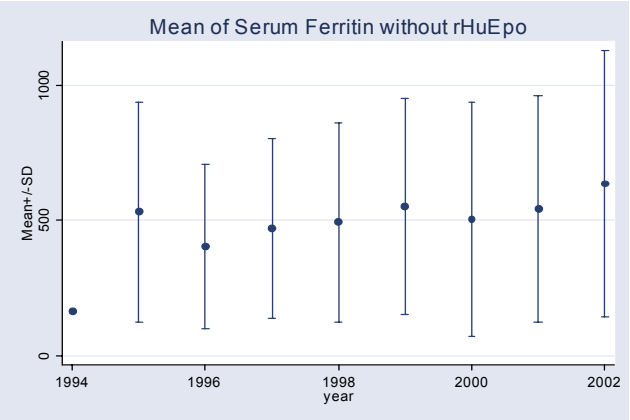
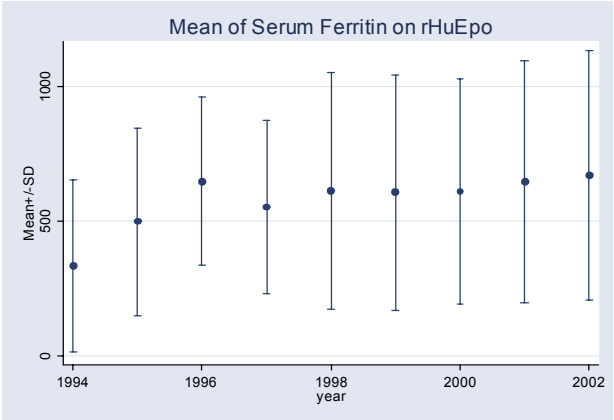


Figure 7.2.8 Mean of Serum Ferritin on Erythropoietin, CAPD patients, 1993-2002



7.3 Haemoglobin and Mortality

Introduction

It is well established that level of haemoglobin is an independent marker of mortality in dialysis patients. However the optimum haemoglobin affecting survival outcome is still debatable. Most registry data – USRDS, UK Renal Registry and Australian and New Zealand data advocate a haemoglobin of greater 11 g/dl. There has been no demonstrable survival benefit with achievement of higher haemoglobin level

Results

The adjusted 5-year survival (adjusted for age, gender, primary diagnosis and time on renal replacement therapy(RRT) in relation to haemoglobin for both the HD and CAPD patients were the best for patients with haemoglobin between of 10-12 gm/dl. It is the worst for those with haemoglobin less than 8 gm/dl. Haemodialysis patients with haemoglobin of 10-12g/dl have significantly better survival compared with all those with haemoglobin less than 10g/dl [p=0.000]. In CAPD patients however, those with haemoglobin 10 -12 g/dl have a significantly better survival only when compared to patients with haemoglobin less than 8g/dl and not the other groups with different levels of haemoglobin probably of the smaller Number of subjects in CAPD. There appears to be no survival benefits in both HD & CAPD patients with haemoglobin greater than 12 gm/dl. For those with haemoglobin less than 8 g/dl, the risk of death was greater in HD compared to CAPD patients. (Table 7.3.1, 7.3.2).

However, once the HD and CAPD patients were combined together for the same analysis, significant difference in risk for mortality were noted between all the groups of patients with haemoglobin less than 10 g/dl compared to the group with haemoglobin of 10 to < 11g/dl, hence justifying the added expenditure on erythropoietin. There was a non-significant difference in risk of mortality between patients with haemoglobin of 10 to < 11 g/ dl and those with haemoglobin 11 g/dl or higher. (Table and Figure 7.3.3). This may possibly be due to the small number of patients with haemoglobin more than 11 g/dl. This somewhat conforms to the European Best Practice Guidelines [1] and K/DOQI Guidelines [2] that advocate haemoglobin concentration of greater than 11 gm/dl and meets local standards. It would be interesting to know whether continued improvements in haemoglobin level over the years which had translated to improved patient survival up to 10 g/dl would continue to show improvement in patient survival once more patients achieve haemoglobin greater than 11 g/dl.

Table 7.3.1 Adjusted five-year patient survival in relation to Haemoglobin (Hb), HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Hb (g/dl)	*N*	*Hazard Ratio*	*95% CI*	*P value*
Hb <8	1374	3.26	(2.71,3.93)	0.000
Hb 8-<9	1493	1.62	(1.34,1.97)	0.000
Hb 9-<10	1486	1.42	(1.17,1.73)	0.000
Hb 10-<12*	1282	1.00		
Hb >12	184	1.16	(0.78,1.73)	0.466

* Reference group

Table 7.3.2 Adjusted five-year patient survival in relation to Haemoglobin (Hb), CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Hb (g/dl)	*N*	*Hazard Ratio*	*95% CI*	*P value*
Hb <8	164	1.60	(1.07,2.40)	0.022
Hb 8-<9	285	1.26	(0.91, 1.75)	0.172
Hb 9-<10	345	1.19	(0.89,1.59)	0.234
Hb 10-<12*	376	1.00		
Hb >12	59	1.06	(0.59,1.90)	0.847

* Reference group

Figure 7.3.1 Patient Survival in Relation to Haemoglobin, HD patients 1997-2002 (Adjusted for age ,gender, primary diagnosis, time on RRT)

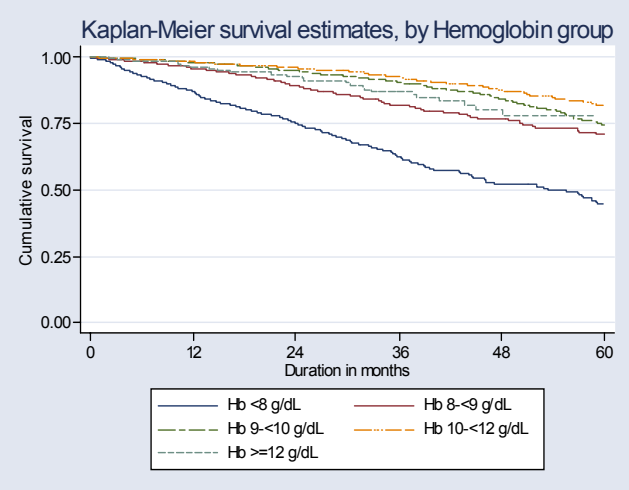


Figure 7.3.2 Adjusted Patient Survival in Relation to Haemoglobin, CAPD patients 1997-2002 (Adjusted for age ,gender, diagnosis, time on RRT)

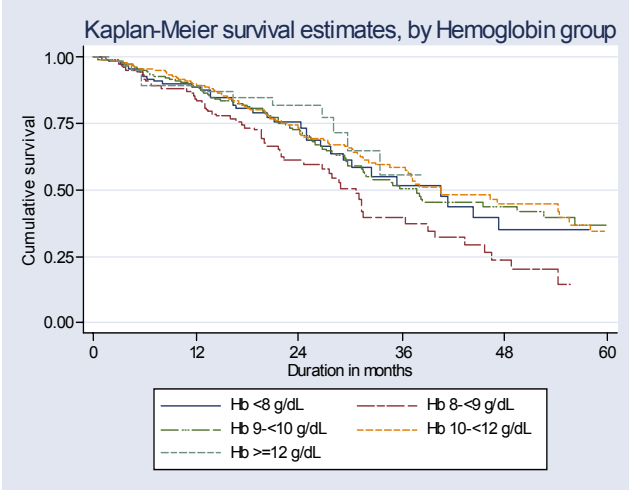
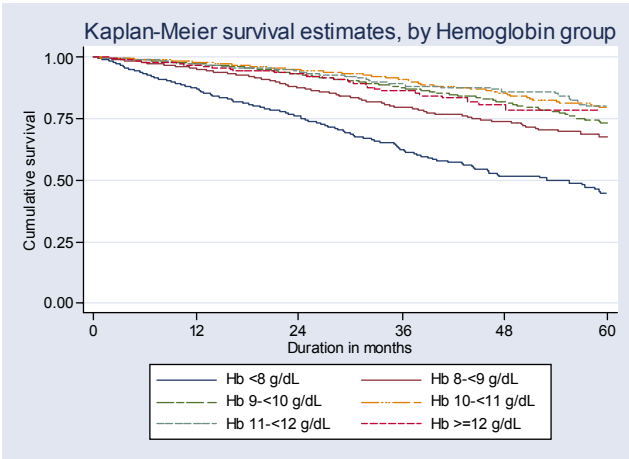


Table 7.3.3 Adjusted five-year patient survival in relation to Haemoglobin (Hb), All dialysis patients 1997-2002 (Adjusted for age, gender, modality, primary diagnosis and time on RRT)

Hb (g/dl)	N	Hazard Ratio	95% CI	P value
Hb <8	1538	2.99	(2.50,3.57)	0.000
Hb 8-<9	1778	1.56	(1.30,1.87)	0.000
Hb 9-<10	1831	1.40	(1.17,1.68)	0.000
Hb 10-<11*	1143	1.00		
Hb 11-<12	515	1.15	(0.89,1.49)	0.286
Hb >12	243	1.17	(0.83,1.64)	0.372

* Reference group

Figure 7.3.3 Patient Survival in Relation to Haemoglobin, All dialysis patients 1997-2002 (Adjusted for age ,gender, modality, primary diagnosis, time on RRT)



References

1. European Best Practice guidelines for the Management of Anemia in Patients with Chronic Renal Failure. *Nephrol Dial Transplant* 1999;14 [Suppl 5] : 1-50
2. NKF. DOQI Guidelines: Anaemia of chronic renal failure – II Target haematocrit/ haemoglobin: guideline 4. *Am J Kidney Dis* 1997:30 [Suppl. 3]:199 – 201
3. UK Renal Association Standards document (SD III) 3rd Edition 2002
4. European Survey of Anemia Management. *Nephrol Dial Transplant* 2000;15 [Suppl 4];15 – 19
5. Ifudu O. Patient characteristics determining erythro-poietin dose requirements. *Nephrol Dial Transplant* 2002;17(Suppl 5):38 -41
6. Eschbach JW et al. Is it time for a paradigm shift? Is erythropoietin deficiency still the main cause of renal anaemia? *Nephrol Dial Transplant* 2002;17(Suppl 5):2 – 7
7. Collins AJ, Keane WF. Higher haematocrit levels: do they improve patient outcomes, and are they cost effective? *Nephrol Dial Transplant* 1998; 13: 1627-1629
8. Jacobs C. Normalization of haemoglobin. Why Not? *Nephrol Dial Transplant* 1999;14 [Suppl. 2]: 11 -13
9. Levin A. The relationship of haemoglobin level and survival: direct or indirect effects? Nephrol Dial Transplant 2002; 17 [Suppl. 5]: 8-13

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

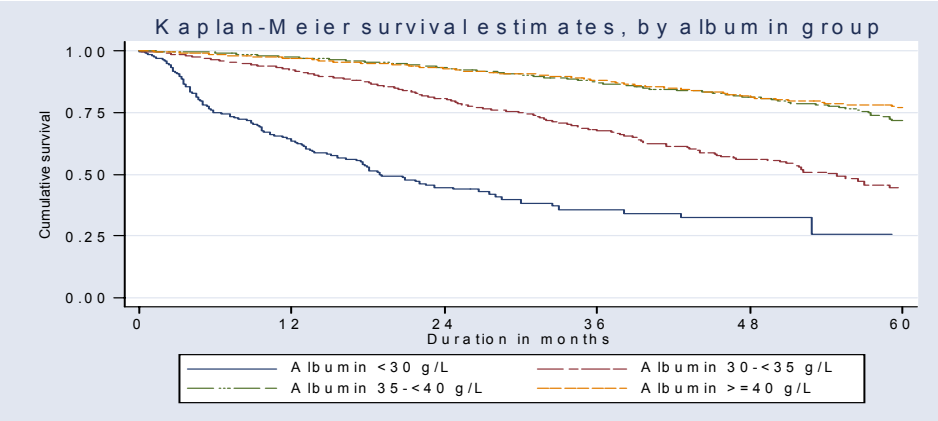
Table 8.1.5 Adjusted one-year patient survival in relation to Albumin, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

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

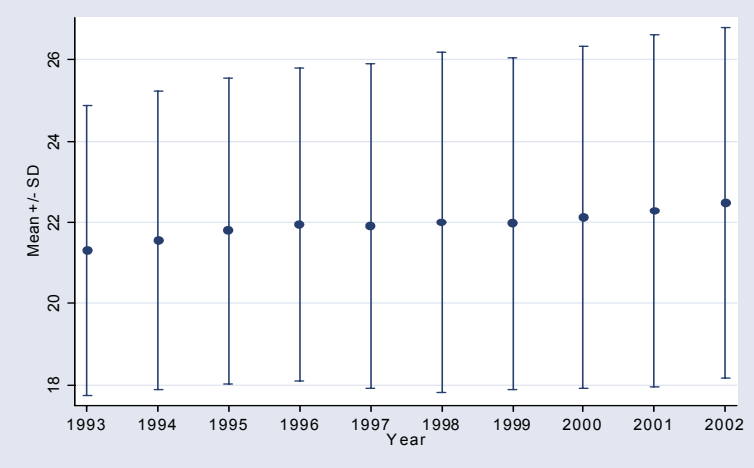


Table 8.1.8 Distribution of BMI in relation to Age, HD patients 1997-2002

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

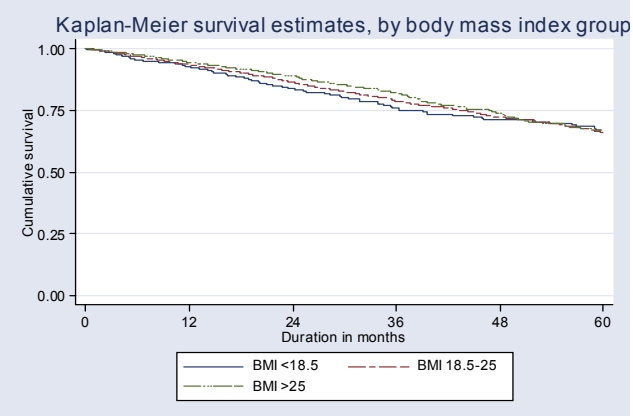
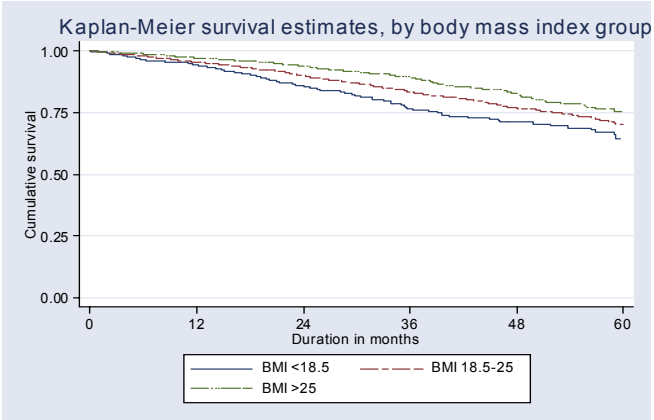


Table 8.1.12 Adjusted five-year patient survival in relation to BMI, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

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

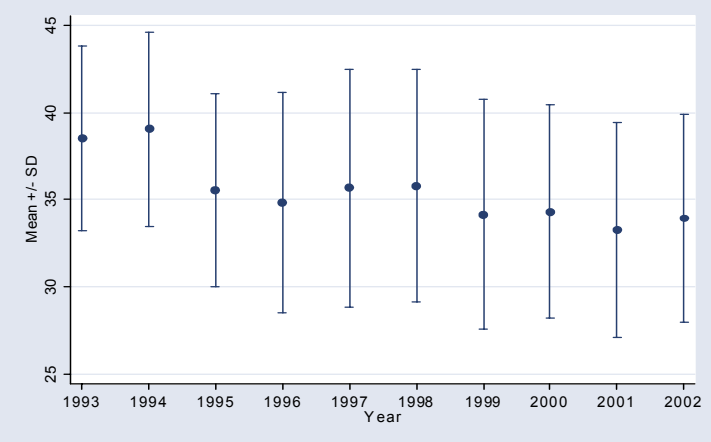


Table 8.2.2 Distribution of Albumin in relation to Age, CAPD patients 1993-2002

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

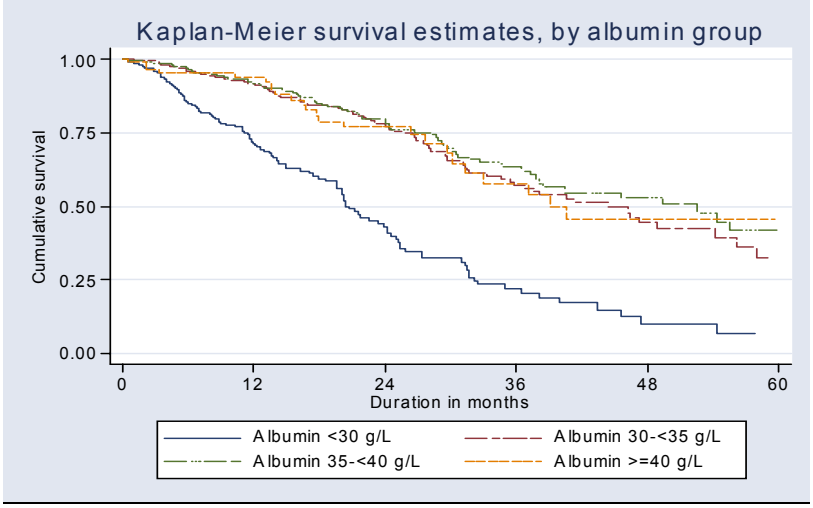
Table 8.2.5 Adjusted one-year patient survival in relation to Albumin, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

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

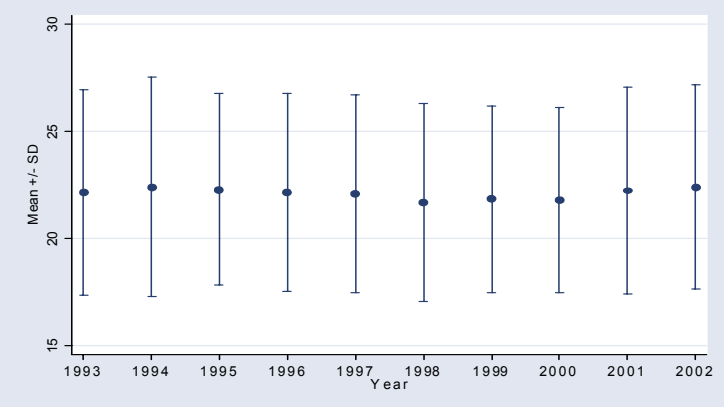


Table 8.2.8 Distribution of BMI in relation to Age, CAPD patients 1993-2002

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

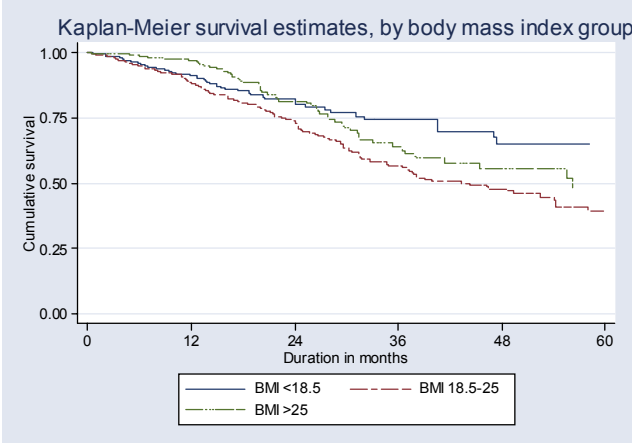
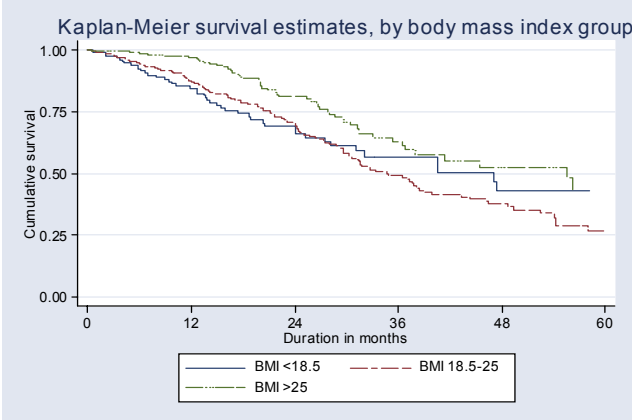


Table 8.2.12 Adjusted five-year patient survival in relation to BMI, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

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

CHAPTER 9: CARDIOVASCULAR DISEASE IN DIALYSIS PATIENTS

SUMMARY

- The percentage of patients who have achieved a systolic blood pressure of less than 140 mmHg had decreased from 48% in 1993 to 32% in 2002.
- When adjusted for age, gender, primary diagnosis and time on RRT, patients with systolic blood pressure less than 120 mmHg or 180 mmHg or higher were associated with a decreased five-year patient survival This suggests a 'U' curve relationship between systolic blood pressure and patient survival in haemodialysis patients.
- Blood pressure control was better in CAPD than haemodialysis patients.
- Patients on haemodialysis with a pulse pressure of 80mmHg or higher had a poorer outcome however this was not seen in patients on CAPD.
- Low total cholesterol levels in both CAPD and haemodialysis patients and low triglyceride levels (in haemodialysis patients only) were associated with significantly poorer adjusted 5 year patient survival. High triglyceride levels were associated with significantly better chance of patient survival in both haemodialysis and CAPD patients. High cholesterol levels were not associated with higher risk of mortality.

Introduction

Cardiovascular (CV) disease is a major problem among dialysis patients and cardiovascular complications account for more than 50% of deaths in the dialysis population. [1,2]

The excess risk of death from CV disease compared to the general population has previously been shown to vary from 500 times in young patients (i.e. 25 to 35 patients) to 5-fold in elderly patients above 85 years of age.[3]

In the general population, the major risk factors for CV disease include hypertension, diabetes mellitus, hyperlipidaemia and smoking. In the dialysis population, additional risk factors exist that contribute to the occurrence of vascular calcification and myocardial fibrosis that is characteristically seen in dialysis patients and contribute to the huge CV morbidity and mortality. These risk factors include:

1. Anaemia
2. Fluid and salt overload
3. Hyperdynamic circulation due to high fistula flow rates
4. Calcium and phosphate abnormalities
5. Hyperparathyroidism
6. Hyperhomocysteinaemia
7. Chronic inflammatory state
8. Increased oxidant stress
9. Prothrombotic tendency

Blood Pressure

The relationship between blood pressure (BP) and mortality in dialysis patients is bimodal i.e. a very high and very low pressure having an adverse effect.[4].

Low blood pressure in dialysis patients (i.e. pre-dialysis systolic BP < 110 mmHg) indicates poor myocardial function and is an indicator of poor outcome in these patients. Low blood pressure leads to myocardial ischaemia and fibrosis leading to diastolic dysfunction. On the other hand, uncontrolled blood pressure is also associated with increased mortality.

Hypertension in dialysis patients may be related to salt and water retention or renin. Long standing hypertension in chronic renal failure induces a cardiomyopathy characterized by small vessel disease. This leads to left ventricular hypertrophy (LVH), left ventricular dilatation and systolic dysfunction.

Death usually results from arrhythmias, cardiac failure or myocardial infarct. In patients with LVH, the median survival is 5 years. In the presence of systolic dysfunction or congestive cardiac failure, the median survival is reduced to 3 years. Following myocardial infarct, the one year survival is 40% and 5 years survival is just 10%.

Thus, there is increasing evidence that uncontrolled hypertension reduces survival on dialysis:

- High systolic BP is associated with LVH [5]
- High diastolic BP is associated with development of congestive cardiac failure. [6]
- A high pulse pressure is associated with poor arterial compliance and increase in mortality [7]
- Treating BP improves mortality [8]

Thus, the control of BP is paramount and the suggested targets according to the UK Renal Association Standards are:

- Pre-dialysis BP 140/90 mmHg
- Post-dialysis BP 130/80 mmHg

It is recommended that the BP should be taken at the sitting position in the non fistula arm at the heart level. Preferably the reading should be repeated in the standing position to exclude postural hypotension post dialysis.

Several studies have shown that post dialysis BP correlated more closely with the interdialytic ambulatory BP. This is because the BP rises rapidly in the pre-dialysis phase. (i.e. In the few hours preceding dialysis).

Systolic Blood Pressure

Data from 1993 to 2002 (Table 9.1 and Figure 9.1) show that there is an increasing trend in the mean and median systolic BP in HD patients. The percentage of patients with systolic BP of >140 mmHg has increased from 53% to 68% and the percentage of patients with a SBP of >160 mmHg increased from 19% to 32%.

These data show that the percentage of patients who have achieved a SBP of < 140 mmHg has decreased from 47% in 1993 to 32% in 2002 suggesting that efforts to achieve better BP control need to be intensified. This trend could also be contributed by greater acceptance into the dialysis programme of older and diabetic patients in recent years, and as shown in Table 9.2 and Table 9.4 older patients and those with diabetes had higher SBP. There was no gender difference in systolic BP observed over the years. (Table 9.3)

Table 9.5 and Figure 9.5 show the negative impact of uncontrolled SBP on mortality. Unadjusted five year patient survival was 72% in patients who achieved a SBP of 120-<140 mmHg compared with 63% in patients who achieved a SBP of 160-<180 mmHg and only 44% in patients with SBP ≥180 mmHg. Kaplan –Meier survival estimates also show that patients in the SBP ≥180 mmHg have much lower survival than patients with a SBP of < 180 mmHg.

When adjusted for age, gender, primary diagnosis and time on RRT, patients with SBP < 120 mmHg and > 180 mmHg were associated with a decreased five-year patient survival (Table.9.6). This suggests a 'U' curve relationship between SBP and patient survival in haemodialysis patients. Kaplan Meier survival estimates (Fig. 9.6) showed a significantly reduced cumulative patient survival at 5 years for patients with SBP > 180 mmHg compared to those with SBP <180 mmHg.

Table 9.1 Distribution of Systolic Blood Pressure (mmHg), HD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <120 mmHg	% patients 120-<140 mmHg	% patients 140-<160 mmHg	% patients 160-<180 mmHg	% patients ³180 mmHg
1993	715	141	20.3	140.8	127.3	154.6	13	34	34	16	3
1994	937	142.6	20.7	142.5	128.3	156.1	13	30	37	16	4
1995	1019	142.4	20.5	142.5	129.2	155.8	13	32	36	15	4
1996	1239	142.2	20.3	141.7	129	155.8	13	33	34	16	4
1997	1661	144.5	20.8	144.2	130.8	158.1	11	30	35	19	4
1998	2109	146	20.4	146.7	133.2	159.2	10	27	39	19	5
1999	2967	148.7	20.8	148.5	135.3	162.2	8	25	38	23	6
2000	4313	148.1	20.6	147.8	134.8	161.7	9	25	38	23	6
2001	5149	148.8	20.9	148.8	134.9	162.6	8	25	37	23	7
2002	5594	149.1	20.8	149	135.7	163.5	8	24	37	25	7

Figure 9.1 Distribution of Systolic Blood Pressure (mmHg), HD patients 1993-2002

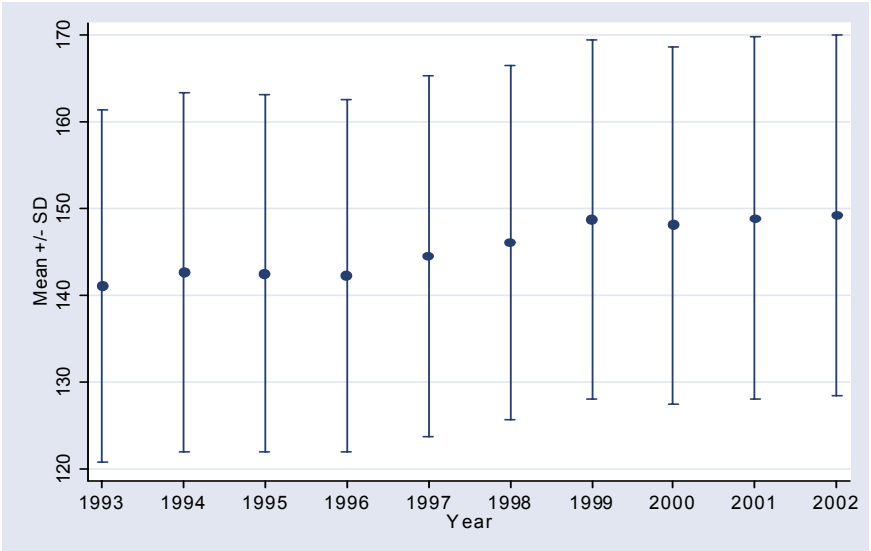


Table 9.2 Distribution of Systolic Blood Pressure in relation to Age, HD patients 1993-2002

Year		Age group (years)			
		<20	20-39	40-59	≥60
1993	Mean ± SD	128.5 ± 16.7	136.5 ± 18.8	145.4 ± 21.4	149.5 ± 15.3
	Median ± IQR	127.5 ± 13.3	136.1 ± 25.7	145 ± 30.1	148.5 ± 20.2
1994	Mean ± SD	131 ± 14.4	138.5 ± 20.1	146.1 ± 21	149.5 ± 18.4
	Median ± IQR	130.4 ± 20.4	138.3 ± 26.7	146.7 ± 26.5	152.5 ± 27.4
1995	Mean ± SD	129 ± 19.9	138.3 ± 20	145.7 ± 20.4	150.2 ± 18.7
	Median ± IQR	129.2 ± 22.4	137.5 ± 27.2	145.7 ± 25	150 ± 25.9
1996	Mean ± SD	130.3 ± 18.9	137.7 ± 19.1	145.1 ± 20.4	151.9 ± 18.5
	Median ± IQR	131.5 ± 23	136.7 ± 25.4	145 ± 26.1	153.5 ± 29.5
1997	Mean ± SD	131.3 ± 18.6	138.1 ± 19.5	149.2 ± 20.4	149.5 ± 20.4
	Median ± IQR	130 ± 23.5	137.7 ± 24	150 ± 25.4	149.7 ± 28.4
1998	Mean ± SD	131.2 ± 19.8	140.2 ± 19.1	150.2 ± 19.9	150.7 ± 20.5
	Median ± IQR	131.9 ± 34.6	140.6 ± 24.5	150.9 ± 24.7	150 ± 24.3
1999	Mean ± SD	132.3 ± 20.2	142.5 ± 19.4	152.1 ± 20	154.3 ± 21.2
	Median ± IQR	131.3 ± 31.9	142.1 ± 24.9	151.8 ± 26.1	153.6 ± 25.1
2000	Mean ± SD	132.2 ± 18.7	142.5 ± 19.3	150.6 ± 20.3	152 ± 20.8
	Median ± IQR	131.5 ± 28.6	142.5 ± 25.3	150.5 ± 27.5	151.2 ± 27
2001	Mean ± SD	132.4 ± 18.6	143.3 ± 19.8	151.4 ± 20.8	151.5 ± 20.5
	Median ± IQR	132 ± 23.4	143.2 ± 25.5	152.2 ± 28	150.8 ± 27.5
2002	Mean ± SD	133.6 ± 19.9	143.7 ± 19.3	151.8 ± 20.4	151.2 ± 21.4
	Median ± IQR	131.8 ± 26.1	144.1 ± 26.3	152.1 ± 27.5	150 ± 28.3

Table 9.3 Distribution of Systolic Blood Pressure in relation to Gender, HD patients 1993-2002

Year		Gender	
		Male	Female
1993	Mean ± SD	141.5 ± 20.2	140 ± 20.6
	Median ± IQR	140.8 ± 26	140 ± 28.3
1994	Mean ± SD	143.2 ± 20.5	141.3 ± 21.1
	Median ± IQR	143.3 ± 27.2	141.7 ± 29.8
1995	Mean ± SD	143.5 ± 20.2	140.4 ± 21.1
	Median ± IQR	143.3 ± 26.7	139.9 ± 26.9
1996	Mean ± SD	142.6 ± 19.9	141.3 ± 20.9
	Median ± IQR	142.8 ± 25.1	140 ± 30.2
1997	Mean ± SD	145.2 ± 20.2	143.3 ± 21.8
	Median ± IQR	145.5 ± 26.4	142 ± 28.4
1998	Mean ± SD	146.7 ± 19.8	144.9 ± 21.4
	Median ± IQR	147 ± 24.9	145.1 ± 27.6
1999	Mean ± SD	149.3 ± 20.1	147.7 ± 21.7
	Median ± IQR	149.4 ± 26.2	147.8 ± 27.8
2000	Mean ± SD	148.7 ± 19.7	147.2 ± 21.7
	Median ± IQR	148.4 ± 26.6	146.8 ± 27.7
2001	Mean ± SD	149.3 ± 20.2	148.1 ± 21.8
	Median ± IQR	149.4 ± 26.5	147.8 ± 30.1
2002	Mean ± SD	149.4 ± 19.8	148.8 ± 22
	Median ± IQR	149.3 ± 26.6	148.3 ± 30.5

Table 9.4 Distribution of Systolic Blood Pressure in relation to Diabetes mellitus, HD patients 1993-2002

Year		Diabetes mellitus	
		Without DM	With DM
1993	Mean ± SD	139.4 ± 20	152.8 ± 19
	Median ± IQR	138.5 ± 25	153.3 ± 25.8
1994	Mean ± SD	141.3 ± 20.4	150.4 ± 20.9
	Median ± IQR	141.7 ± 26.7	152.1 ± 30.1
1995	Mean ± SD	140.7 ± 20.5	152 ± 18.3
	Median ± IQR	140 ± 25.9	150.5 ± 22.6
1996	Mean ± SD	140.7 ± 20.1	150 ± 19.6
	Median ± IQR	140 ± 26.3	150.8 ± 26.5
1997	Mean ± SD	141.8 ± 20	155.6 ± 20.3
	Median ± IQR	141.4 ± 26	156.7 ± 27.3
1998	Mean ± SD	143.4 ± 19.8	155.3 ± 20.2
	Median ± IQR	143.8 ± 25.8	154.9 ± 24
1999	Mean ± SD	146 ± 20.1	156.7 ± 20.6
	Median ± IQR	146 ± 26	156.7 ± 26.2
2000	Mean ± SD	144.7 ± 20.2	156.1 ± 19.2
	Median ± IQR	144.7 ± 26.2	156.7 ± 25.7
2001	Mean ± SD	145 ± 20	156.9 ± 20.4
	Median ± IQR	145 ± 26.8	157.1 ± 27.2
2002	Mean ± SD	145.6 ± 20.2	156.6 ± 20
	Median ± IQR	145.7 ± 27.4	156.8 ± 27.5

Table 9.5 Unadjusted five-year patient survival in relation to Systolic Blood Pressure, HD patients 1997-2002

Systolic BP	<120 mmHg		120-<140 mmHg		140-<160 mmHg		160-<180 mmHg		≥180 mmHg	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	94	1	96	1	97	0	98	0	94	1
12	90	2	93	1	94	1	95	1	89	2
24	83	2	87	1	87	1	87	1	78	3
36	80	3	80	1	81	1	78	1	67	3
48	73	3	76	2	75	1	70	2	55	4
60	70	4	72	2	68	2	63	2	44	5

SE=standard error

Figure .9.5 Unadjusted five-year patient survival in relation to Systolic Blood Pressure, HD patients 1997-2002

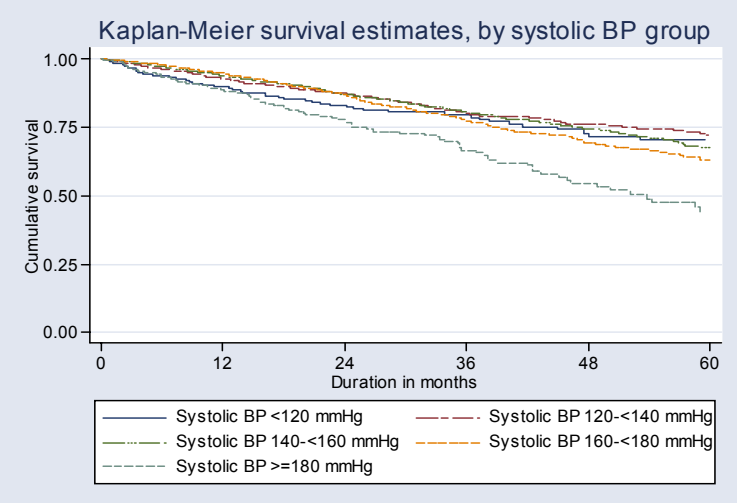
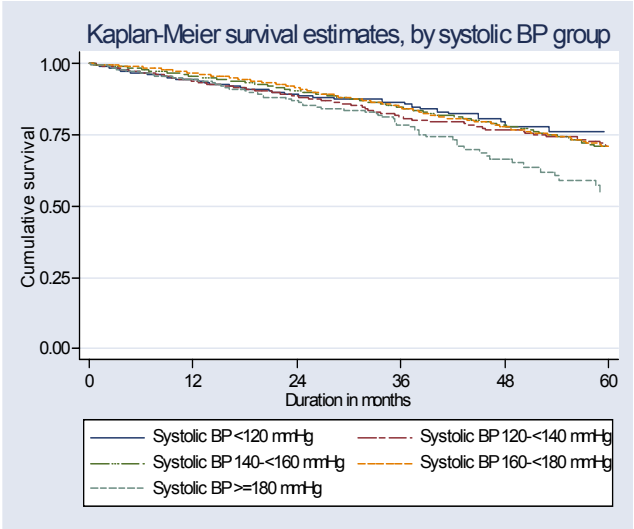


Table 9.6 Adjusted five-year patient survival in relation to Systolic Blood Pressure, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Systolic BP	n	Hazard ratio	95% CI	p-value
<120 mmHg	345	1.44	(1.11, 1.87)	0.006
120-<140 mmHg	1392	1.11	(0.94, 1.31)	0.206
140-<160 mmHg	2523	1.00	-	-
160-<180 mmHg	1481	0.96	(0.83, 1.12)	0.614
≥180 mmHg	331	1.54	(1.23, 1.92)	0.000

Figure 9.6 Adjusted five-year patient survival in relation to Systolic Blood Pressure, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



Diastolic Blood Pressure - Haemodialysis

In contrast to SBP, there appear to be a decreasing trend in the mean diastolic blood pressure (DBP) from 88.5 mmHg in 1993 to 81.1 mmHg in 2002 and median DBP from 86.7 mmHg in 1993 to 81.3 mmHg in 2002 (Table 9.7 and Figure 9.7). The percentage of patients with a DBP of <90 mmHg had increased from 59% to 80%. Thus a greater proportion of patients had achieved better DBP control over the 10 year period. This may be attributed to the fact that more patients in the older age groups have been accepted into the dialysis program in the last 10 years.

Table 9.8, Table 9.9 and Table 9.10 show that the decrease in both the mean DBP and the and the median DBP had occurred irrespective of age groups, gender and presence of diabetes.

Unadjusted 5-year patient survival showed that the groups with DBP between 80 to < 100 mmHg had a slightly higher survival compared to those with DBP 100 mmHg or higher or < 80 mmHg. (Table 9.11 and Figure. 9.11). However when adjusted for age, gender, primary diagnosis and time on RRT, five year patient survival was significantly lower only for patients with DBP of > 90 mmHg. This further emphasizes the importance of controlling DBP to < 90 mmHg. (Table 9.12, Figure 9.12)

Table 9.7 Distribution of Diastolic Blood Pressure (mmHg), HD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <70 mmHg	% patients 70-<80 mmHg	% patients 80-<90 mmHg	% patients 90-<100 mmHg	% patients ≥100 mmHg
1993	715	88.5	15.5	86.7	79.9	95	7	18	34	23	18
1994	937	85.3	11.3	85.3	79	91.9	8	20	38	24	10
1995	1019	84.3	11.2	84.2	77.5	90.9	8	23	38	22	8
1996	1239	84.4	10.9	84.2	77.7	90.8	9	23	37	22	8
1997	1662	83.7	10.9	84.2	77	90.7	10	23	38	22	6
1998	2109	83.5	10.7	83.9	76.9	90.6	10	24	38	23	5
1999	2967	83.5	10.5	83.5	77.1	90	10	24	40	21	6
2000	4312	82.2	10.4	82.3	75.7	89	11	28	39	18	4
2001	5148	81.6	10.4	81.7	75	88.3	12	30	37	17	4
2002	5590	81.1	10.4	81.3	74.4	88	13	30	37	16	3

Figure 9.7 Distribution of Diastolic Blood Pressure (mmHg), HD patients 1993-2002

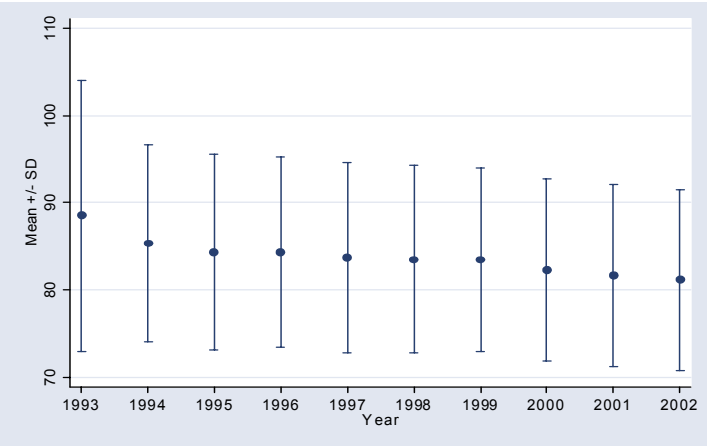


Table 9.8 Distribution of Diastolic Blood Pressure in relation to Age, HD patients 1993-2002

Year		Age group (years)			
		<20	20-39	40-59	≥ 60
1993	Mean ± SD	84.4 ± 16	89.9 ± 15.5	88.2 ± 15.4	82.9 ± 15.2
	Median ± IQR	80 ± 18	89.2 ± 17.9	86 ± 12.7	80.3 ± 11.6
1994	Mean ± SD	82.8 ± 10	87.6 ± 11.7	84.3 ± 10.8	79.6 ± 9.2
	Median ± IQR	82.5 ± 11.6	87.9 ± 15	84.5 ± 10.9	78 ± 12.5
1995	Mean ± SD	81.6 ± 15.5	86.2 ± 11.9	83.6 ± 10.3	79.6 ± 8.8
	Median ± IQR	80.7 ± 19.3	86.7 ± 14.3	84 ± 12.5	79.1 ± 10
1996	Mean ± SD	82.9 ± 12	86 ± 11.7	83.8 ± 10	79.9 ± 9.5
	Median ± IQR	82.4 ± 15.4	86.1 ± 14.5	83.8 ± 11.8	79.7 ± 14.7
1997	Mean ± SD	82.3 ± 12.8	85.4 ± 11.4	83.7 ± 10.1	77.9 ± 9.5
	Median ± IQR	84.4 ± 16.6	86 ± 13.5	84.2 ± 12.3	78.9 ± 13.5
1998	Mean ± SD	81.3 ± 13.3	85.6 ± 11.1	83.6 ± 10	77.2 ± 9.2
	Median ± IQR	81.3 ± 18.9	86.5 ± 13	83.7 ± 12.2	76.9 ± 13.1
1999	Mean ± SD	80.9 ± 13.4	85.8 ± 10.9	83.3 ± 10	79.4 ± 9.2
	Median ± IQR	82.7 ± 20.2	86.1 ± 12.7	83.5 ± 12.7	80 ± 10.9
2000	Mean ± SD	80.6 ± 12.3	85.5 ± 10.5	82.2 ± 9.8	77.5 ± 9.4
	Median ± IQR	80.8 ± 18.9	85.9 ± 12.8	82.5 ± 12.6	77.8 ± 11.7
2001	Mean ± SD	81.2 ± 12.3	85.1 ± 10.8	81.7 ± 9.8	77 ± 9.4
	Median ± IQR	81.7 ± 16	85.6 ± 13.1	81.7 ± 12.6	76.8 ± 11.8
2002	Mean ± SD	81.8 ± 12.8	85.2 ± 10.7	81.3 ± 9.6	76 ± 9.2
	Median ± IQR	83.8 ± 16.4	85.6 ± 13.5	81.5 ± 12.2	75.8 ± 12

Table 9.9 Distribution of Diastolic Blood Pressure in relation to Gender, HD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	89.7	± 16.4	86.2	± 13.5
	Median ± IQR	87.5	± 16.3	85.5	± 15.2
1994	Mean ± SD	86.1	± 11.6	83.9	± 10.7
	Median ± IQR	85.8	± 13.8	84.1	± 13.2
1995	Mean ± SD	85.5	± 11.6	82.2	± 10.2
	Median ± IQR	85.5	± 14	81.7	± 13
1996	Mean ± SD	85.1	± 11.2	83.1	± 10.3
	Median ± IQR	85.4	± 13.3	83.1	± 12.8
1997	Mean ± SD	84.5	± 11.1	82.5	± 10.5
	Median ± IQR	85	± 12.8	82.5	± 12.9
1998	Mean ± SD	84.2	± 10.8	82.4	± 10.4
	Median ± IQR	84.8	± 13.7	82.5	± 13.8
1999	Mean ± SD	84.3	± 10.5	82.2	± 10.4
	Median ± IQR	84.3	± 13.1	82.5	± 13.1
2000	Mean ± SD	83.1	± 10.4	81.1	± 10.3
	Median ± IQR	83	± 13.6	81.5	± 12.9
2001	Mean ± SD	82.6	± 10.6	80.4	± 10.1
	Median ± IQR	82.6	± 13.8	80.5	± 12.9
2002	Mean ± SD	82.1	± 10.6	79.9	± 10
	Median ± IQR	82.3	± 14.1	80	± 13.2

Table 9.10 Distribution of Diastolic Blood Pressure in relation to Diabetes mellitus (DM), HD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	88.5	± 15	88.7	± 19.1
	Median ± IQR	87	± 15.3	84	± 13.8
1994	Mean ± SD	86	± 11.4	81.2	± 9.9
	Median ± IQR	85.8	± 12.8	80.8	± 13.3
1995	Mean ± SD	84.8	± 11.4	81.6	± 9.4
	Median ± IQR	85	± 13.7	80.8	± 13.3
1996	Mean ± SD	84.8	± 11	82.1	± 10
	Median ± IQR	84.9	± 13	82.5	± 14
1997	Mean ± SD	84.2	± 11	81.7	± 10
	Median ± IQR	84.9	± 13.2	82	± 12.8
1998	Mean ± SD	84.3	± 10.7	80.7	± 10.2
	Median ± IQR	85	± 13.7	80.8	± 12.6
1999	Mean ± SD	84.2	± 10.6	81.2	± 10
	Median ± IQR	84.4	± 12.6	81.3	± 12.3
2000	Mean ± SD	83.2	± 10.6	80	± 9.5
	Median ± IQR	83.3	± 13.3	80	± 12.7
2001	Mean ± SD	82.6	± 10.6	79.6	± 9.7
	Median ± IQR	82.9	± 13.8	79.7	± 11.8
2002	Mean ± SD	82.2	± 10.6	79	± 9.5
	Median ± IQR	82.2	± 13.9	79.3	± 12.5

Table 9.11 Unadjusted five-year patient survival in relation to Diastolic Blood Pressure, HD patients 1997-2002

Diastolic BP	<70 mmHg		70-<80 mmHg		80-<90 mmHg		90-<100 mmHg		≥100 mmHg	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	95	1	97	0	97	0	98	1	94	2
12	90	1	94	1	94	1	94	1	90	2
24	81	2	86	1	88	1	90	1	75	4
36	73	2	78	1	82	1	82	2	66	4
48	64	3	71	2	76	1	76	2	64	5
60	62	3	62	2	69	2	71	2	61	6

SE=standard error

Figure 9.11 Unadjusted five-year patient survival in relation to Diastolic Blood Pressure, HD patients 1997-2002

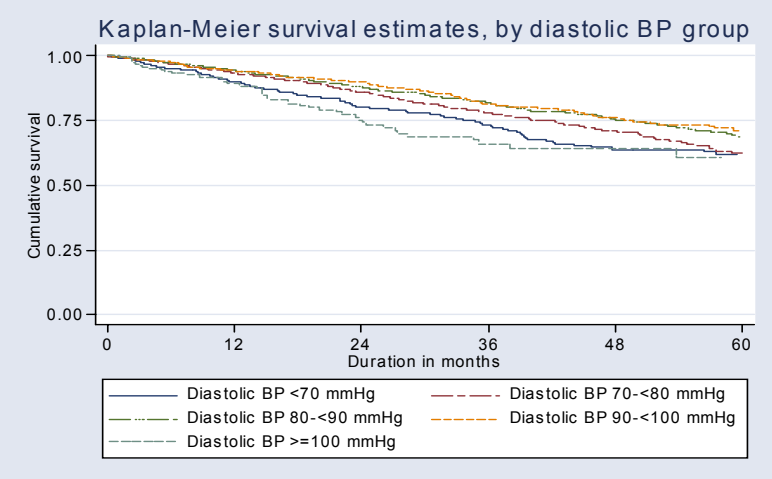
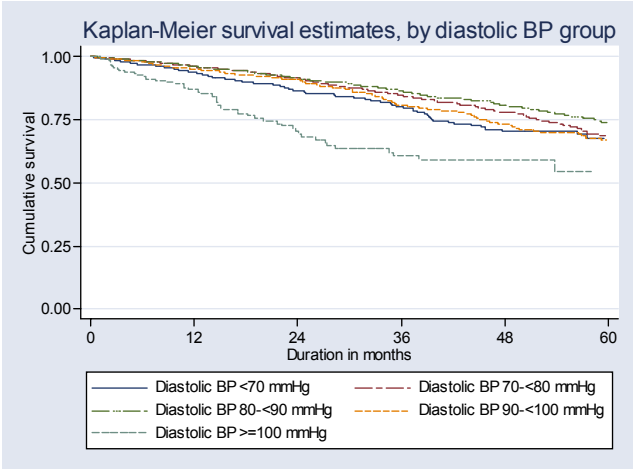


Table 9.12 Adjusted five-year patient survival in relation to Diastolic Blood Pressure, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Diastolic BP	n	Hazard ratio	95% CI	p-value
<70 mmHg	723	1.17	(0.97, 1.41)	0.101
70-<80 mmHg	1862	0.93	(0.81, 1.08)	0.364
80-<90 mmHg	2307	1.00	-	-
90-<100 mmHg	959	1.27	(1.05, 1.53)	0.012
≥100 mmHg	218	2.80	(2.07, 3.80)	0.000

Figure 9.12 Adjusted five-year patient survival in relation to Diastolic Blood Pressure, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



CONTINUOUS AMBULATORY PERITONEAL DIALYSIS (CAPD)

Systolic Blood Pressure – CAPD

The percentage of patients who achieved a SBP of <140 mmHg had increased from 41% to 50% and the percentage of patients who achieved a SBP of <160 mmHg increased from 79% to 84%. Percentage of patients with SBP >160 mmHg decreased from 20% to 16% (Table 9.13).

In 2002, the mean and median SBP in CAPD patients was about 9 mmHg lower than that of HD patients. Fifty percent of CAPD patients achieved SBP of < 140 mmHg compared with only 32% of HD patients demonstrating that BP control is better in CAPD than HD patients.

Both mean SBP and median SBP were higher in older patients, male patients and patients with diabetes. (Table 9.14, Table 9.15, Table 9.16)

Table 9.17 and Figure 9.17 show the impact of uncontrolled SBP on mortality. Unadjusted five year patient survival for patients on CAPD appears to be better with a SBP of <140 mmHg. However when adjusted for age, gender, primary diagnosis and time on RRT, there was no significant difference in five year survival among the different blood pressure groups as noted in patients on haemodialysis probably because of the smaller number of patients on CAPD especially in the group with SBP 180 mmHg or higher. (Table 9.18, Figure 9.18)

Table 9.13 Distribution of Systolic Blood Pressure (mmHg), CAPD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <120 mmHg	% patients 120-<140 mmHg	% patients 140-<160 mmHg	% patients 160-<180 mmHg	% patients ≥180 mmHg
1993	97	143.1	23.1	144	130	157.1	12	29	38	14	6
1994	112	143.4	23.1	143.5	128.2	155.9	15	27	35	16	7
1995	245	141.3	21.9	140.8	129	155	12	34	34	16	3
1996	358	142.5	21.8	142.9	128	158.3	15	28	34	18	4
1997	469	142.7	20.3	142.9	128.3	156	13	31	37	17	3
1998	519	141	21.2	140	126.4	157.5	16	34	29	18	3
1999	576	141	19.8	140	127.2	156	14	35	34	15	2
2000	638	137.2	20.4	136.1	123.3	150	18	39	29	13	2
2001	739	139	20.2	137.5	125.8	151.7	16	38	30	13	3
2002	841	139.8	20.5	140	127.1	151.8	14	36	34	12	4

Figure 9.13 Distribution of Systolic Blood Pressure (mmHg), CAPD patients 1993-2002

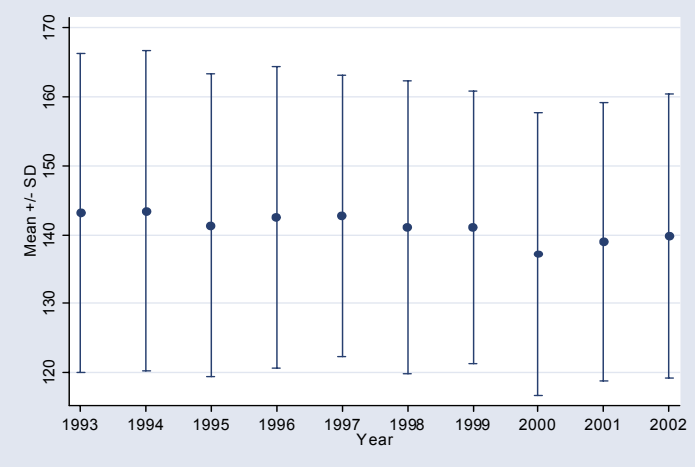


Table 9.14 Distribution of Systolic Blood Pressure in relation to Age, CAPD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		≥ 60	
1993	Mean ± SD	119.4	20.3	140	20	149.8	23.1	140.1	15.3
	Median ± IQR	116.7	27.6	145.4	25.2	147.1	35.6	142	10.2
1994	Mean ± SD	116.3	13.7	144.2	17.6	150.5	22.9	134.8	17.7
	Median ± IQR	116	22	141.5	18.3	151	31.9	134	23.7
1995	Mean ± SD	126.9	16.8	139.2	18.1	143.7	23.8	143.1	19.2
	Median ± IQR	125	27.2	137	19.1	145.7	28	138	29.8
1996	Mean ± SD	121.7	14.9	140.4	18.5	149.2	21.9	140.6	19.5
	Median ± IQR	120.9	18.9	140.4	24.3	152	28.8	141	27.2
1997	Mean ± SD	125.4	18.6	142.5	16.6	146.8	20.7	144.4	18.8
	Median ± IQR	123.8	19.3	143.5	21.1	146.9	27	145	27.5
1998	Mean ± SD	120.8	14.3	140.3	18.2	147.5	20.7	142.6	20.5
	Median ± IQR	119.4	20.5	137.1	22.9	148.2	28.7	143.4	28.8
1999	Mean ± SD	124.4	14.9	141.3	18.5	145.6	18.8	144.7	20
	Median ± IQR	121.5	14.2	140.7	27.7	144.5	25.5	145.8	26
2000	Mean ± SD	122.9	14.6	137.1	18	141.5	20.9	141.5	20.9
	Median ± IQR	123.3	14.5	135	21.6	141.1	28.4	145	26.1
2001	Mean ± SD	127.6	16.1	137.9	18.6	142.6	21.7	142.5	18.3
	Median ± IQR	126.7	18.5	134.7	22.2	143.6	26.8	140.2	27.1
2002	Mean ± SD	125.7	17.5	138.9	18.5	144.1	20.4	144.7	19.9
	Median ± IQR	127.2	19.1	139.3	22.1	143.3	24.4	145.8	29.9

Table 9.15 Distribution of Systolic Blood Pressure in relation to Gender, CAPD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	146.3	19.8	140.7	25.2
	Median ± IQR	143.4	23.3	144.2	30
1994	Mean ± SD	141.6	21.9	145.4	24.5
	Median ± IQR	141.5	27	145.7	31.7
1995	Mean ± SD	141.3	21.9	141.4	22.1
	Median ± IQR	140.8	25.2	140.8	29.2
1996	Mean ± SD	143.6	22.5	141.3	21
	Median ± IQR	145.6	29.8	140.8	30.6
1997	Mean ± SD	142.1	20.7	143.2	20
	Median ± IQR	143.9	27.7	141.5	28
1998	Mean ± SD	141.4	22.5	140.6	19.9
	Median ± IQR	140	32.8	139	28.9
1999	Mean ± SD	140.4	21.2	141.5	18.4
	Median ± IQR	140	29.2	140	28.7
2000	Mean ± SD	139	21	135.5	19.7
	Median ± IQR	138.3	28.2	134.3	24.9
2001	Mean ± SD	140.7	20	137.5	20.3
	Median ± IQR	140	24.6	134.7	25.9
2002	Mean ± SD	141.7	20.1	138.1	20.8
	Median ± IQR	142.5	22.5	135.9	26.3

Table 9.16 Distribution of Systolic Blood Pressure in relation to Diabetes mellitus, CAPD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	137.9	23.7	155.5	16
	Median ± IQR	135	26.3	150	24.1
1994	Mean ± SD	141.3	24.1	149.6	19.3
	Median ± IQR	142	29.8	150	27.2
1995	Mean ± SD	139.1	22.7	145.6	19.7
	Median ± IQR	138.8	25.2	147.8	27.7
1996	Mean ± SD	138.6	22.1	150.6	19
	Median ± IQR	137.5	29	153.3	23.2
1997	Mean ± SD	138.7	20.4	150.4	17.9
	Median ± IQR	137.6	26.9	152	22
1998	Mean ± SD	137.2	21.2	148.9	19
	Median ± IQR	135.5	27.5	150.8	26.8
1999	Mean ± SD	137.5	19.7	148.7	17.7
	Median ± IQR	136.3	26.7	150	24.3
2000	Mean ± SD	133.5	19.5	145.9	19.8
	Median ± IQR	133.3	23	145.7	28.5
2001	Mean ± SD	135.5	19.6	146.5	19.4
	Median ± IQR	133.8	25.8	146.7	28.4
2002	Mean ± SD	136	19.9	147.7	19.7
	Median ± IQR	135.6	24.1	146.8	26.8

Table 9.17 Unadjusted five-year patient survival in relation to Systolic Blood Pressure, CAPD patients 1997-2002

Systolic BP	<120 mmHg		120-<140 mmHg		140-<160 mmHg		160-<180 mmHg		≥180 mmHg	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	93	2	95	1	96	1	93	2	100	-
12	91	3	91	1	91	1	84	3	88	12
24	82	4	78	2	74	3	71	5	88	12
36	74	5	69	3	52	4	50	6	58	25
48	65	9	62	4	44	4	33	7	29	24
60	55	12	57	4	35	5	33	7	29	24

SE=standard error

Figure 9.17 Unadjusted five-year patient survival in relation to Systolic Blood Pressure, CAPD patients 1997-2002

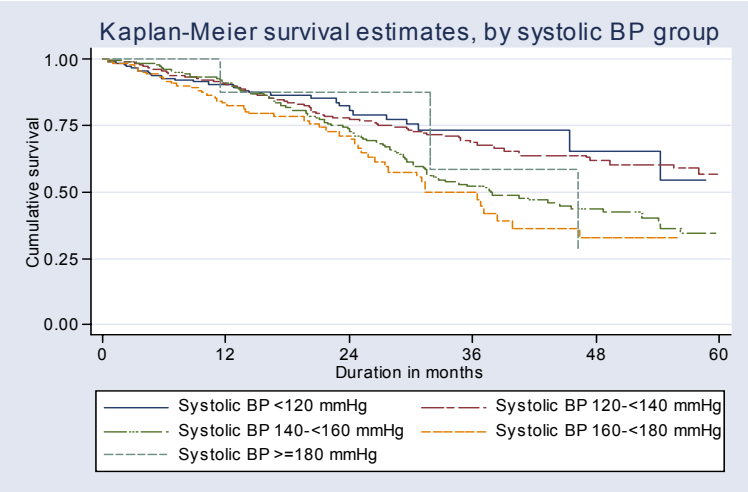
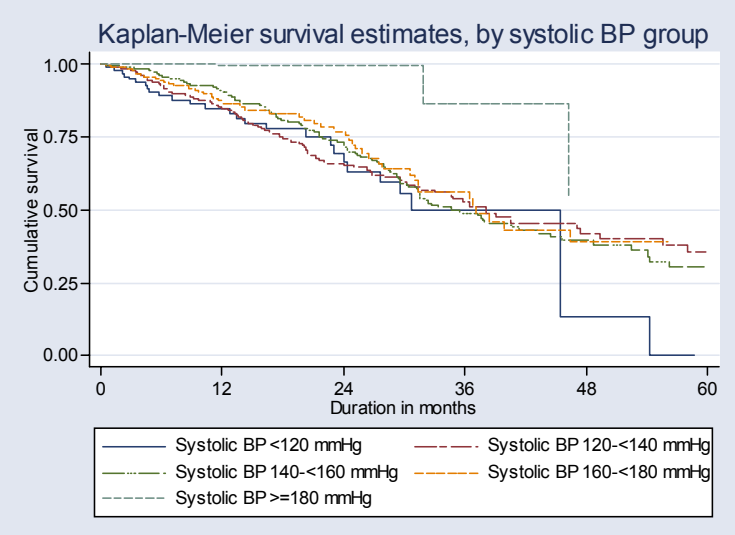


Table 9.18 Adjusted five-year patient survival in relation to Systolic Blood Pressure, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Systolic BP	n	Hazard ratio	95% CI	p-value
<120 mmHg	161	1.33	(0.86, 2.05)	0.203
120-<140 mmHg	449	0.94	(0.71, 1.22)	0.627
140-<160 mmHg	432	1.00	-	-
160-<180 mmHg	147	1.04	(0.75, 1.46)	0.800
≥180 mmHg	18	0.82	(0.26, 2.59)	0.737

Figure 9.18 Adjusted five-year patient survival in relation to Systolic Blood Pressure, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



Diastolic Blood Pressure – CAPD

The percentage of patients with mean DBP of <90 mmHg had increased from 62% to 76%. (Table 9.19)

Tables 9.20, 9.21 and 9.22 show that older age groups, male gender and presence of diabetes were not associated with a higher DBP.

In contrast to the impact of SBP in CAPD patients, the achievement of DBP control appeared to have no impact on unadjusted five year patient survival (Table 9.23 and Fig. 9.23). The unadjusted five year patient survival rate ranged from 35% to 54% with no obvious trend to suggest better survival with better DBP control. However, from Table 9.24 and Figure 9.24, it can be seen that when adjusted for age, gender, primary diagnosis and time on RRT, patients with a DBP of > 90 mmHg had a significantly poorer five year patient survival.

Table 9.19 Distribution of Diastolic Blood Pressure (mmHg), CAPD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <70 mmHg	% patients 70-<80 mmHg	% patients 80-<90 mmHg	% patients 90-<100 mmHg	% patients ≥100 mmHg
1993	98	86.5	12.4	85.4	80	93	3	17	42	30	8
1994	112	85.9	10.6	85	78.8	92.4	4	23	36	27	10
1995	244	83.9	10.9	84.2	78	90.3	9	22	39	25	7
1996	358	84.1	10.9	85	76.2	90.2	8	24	37	23	8
1997	468	85.3	10.6	85.9	79.9	91.4	6	19	41	26	8
1998	519	84.3	11.3	85	77.1	90.1	8	24	36	24	8
1999	576	84	10.9	84.2	77.9	90	9	20	44	20	7
2000	638	82.9	11	83.3	76.6	89.6	10	24	41	20	5
2001	739	83.1	10.9	82.7	76.4	89.6	9	29	38	18	6
2002	841	82.8	10.8	83.4	76.1	90	11	24	41	21	5

Figure 9.19 Distribution of Diastolic Blood Pressure (mmHg), CAPD patients 1993-2002

Table 9.20 Distribution of Diastolic Blood Pressure in relation to Age, CAPD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		≥ 60	
1993	Mean ± SD	78.7	14.6	91.3	10.9	88.2	12.2	79.5	8.3
	Median ± IQR	75.6	17.8	91.5	12	86.3	11.1	78.4	13.3
1994	Mean ± SD	78	7.1	93.3	10.1	87.2	9	76	10.1
	Median ± IQR	80	6.9	90	11.7	87.8	14.3	78.1	14
1995	Mean ± SD	83.6	9.5	89.5	11.6	84	11.2	79.9	8.5
	Median ± IQR	83.3	8.3	90	7.6	84.5	14.2	79.8	9
1996	Mean ± SD	79.3	8.7	90.1	10.5	85.8	10.5	78.1	9.3
	Median ± IQR	79.2	12.5	90	13.1	87	12.6	79.1	11.9
1997	Mean ± SD	81.7	9.8	90.8	9.8	85.7	10.2	80.1	9.5
	Median ± IQR	81.7	15	90	11.8	86.8	11.3	80	12.7
1998	Mean ± SD	78.2	9.6	90	11	85.4	10.1	78.9	11.2
	Median ± IQR	78.8	13.8	89	12	86.3	11.5	78.4	15.7
1999	Mean ± SD	81.1	11.2	89.5	9.7	83.8	10.3	79.6	10.4
	Median ± IQR	80	14.1	89	11.4	83.5	11.1	80.3	14.2
2000	Mean ± SD	79.3	10.6	87.5	9.8	82.9	11.1	80.1	10.4
	Median ± IQR	79.6	12.2	87.5	11.8	83.5	11.6	80	14
2001	Mean ± SD	82.7	11.9	86.4	10	83.2	10.8	79	10.1
	Median ± IQR	82.4	12.6	86.4	13.4	82.8	12	78.7	12.4
2002	Mean ± SD	80.3	12.2	87	10.6	82.9	9.9	79.1	9.9
	Median ± IQR	82.5	17.8	87.5	11.8	83.3	12.3	80	12.4

Table 9.21 Distribution of Diastolic Blood Pressure in relation to Gender, CAPD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	87.7	8.5	85.5	14.8
	Median ± IQR	86.7	9.7	84.2	17.8
1994	Mean ± SD	86.9	10.4	84.7	10.8
	Median ± IQR	86.7	13.2	84.3	12
1995	Mean ± SD	84.7	10.6	83.1	11.2
	Median ± IQR	84	11.7	84.5	14.1
1996	Mean ± SD	84.6	11.1	83.6	10.7
	Median ± IQR	85	13.7	85	14
1997	Mean ± SD	85.5	11	85	10.2
	Median ± IQR	86	11.4	85.9	13.2
1998	Mean ± SD	84.9	12.2	83.8	10.4
	Median ± IQR	85	14.3	85	12.9
1999	Mean ± SD	83.9	11.4	84.1	10.4
	Median ± IQR	84.8	12.8	84	11.8
2000	Mean ± SD	83.8	11.6	82.1	10.3
	Median ± IQR	84.5	11.9	82.2	14
2001	Mean ± SD	83.5	11.2	82.8	10.7
	Median ± IQR	83.7	13.2	82.5	13.1
2002	Mean ± SD	83.5	10.7	82.1	10.9
	Median ± IQR	84.3	13.1	82.3	13.7

Table 9.22 Distribution of Diastolic Blood Pressure in relation to Diabetes mellitus, CAPD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	86.9	13.9	85.4	8
	Median ± IQR	86.3	12.5	85	10
1994	Mean ± SD	86.4	10.7	84.3	10.5
	Median ± IQR	85.7	13.1	85	15.4
1995	Mean ± SD	84.6	11.5	82.7	9.5
	Median ± IQR	85	13.1	82.1	14.7
1996	Mean ± SD	84.8	11.4	82.8	9.8
	Median ± IQR	85.3	15.4	84	14.7
1997	Mean ± SD	86	11.2	83.8	9.1
	Median ± IQR	86.4	13.2	84.6	10.3
1998	Mean ± SD	85.4	11.9	82.2	9.6
	Median ± IQR	85.9	14.2	83.3	11.5
1999	Mean ± SD	85.2	11.4	81.6	9
	Median ± IQR	85.8	11.9	82	11.1
2000	Mean ± SD	83.6	11.8	81.4	8.8
	Median ± IQR	83.7	12.9	82.9	12.6
2001	Mean ± SD	84.4	11.1	80.3	10
	Median ± IQR	85	12.8	80	10.9
2002	Mean ± SD	84.3	11.1	79.6	9.5
	Median ± IQR	85	11.9	79.8	12.3

Table 9.23 Unadjusted five-year patient survival in relation to Diastolic Blood Pressure, CAPD patients 1997-2002

Diastolic BP	<70 mmHg		70-<80 mmHg		80-<90 mmHg		90-<100 mmHg		≥100 mmHg	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	91	3	95	1	97	1	94	2	96	3
12	86	4	90	2	93	1	87	2	84	6
24	70	6	74	3	79	2	77	3	80	7
36	58	8	57	4	63	3	64	5	56	11
48	44	14	41	5	55	4	60	5	45	14
60	44	14	35	6	48	4	54	6	45	14

SE=standard error

Table 9.24 Adjusted five-year patient survival in relation to Diastolic Blood Pressure, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Diastolic BP	n	Hazard ratio	95% CI	p-value
<70 mmHg	99	1.32	(0.85, 2.07)	0.218
70-<80 mmHg	332	0.94	(0.71, 1.25)	0.684
80-<90 mmHg	495	1.00	-	-
90-<100 mmHg	227	1.43	(1.03, 1.98)	0.035
≥100 mmHg	53	2.05	(1.12, 3.74)	0.019

Figure 9.23 Unadjusted five-year patient survival in relation to Diastolic Blood Pressure, CAPD patients 1997-2002

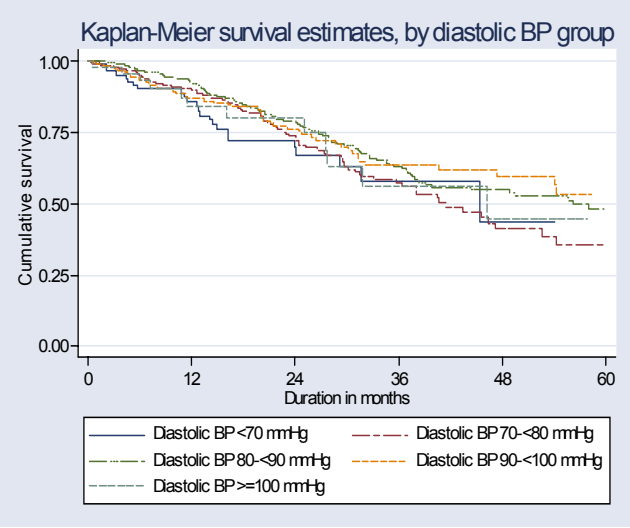
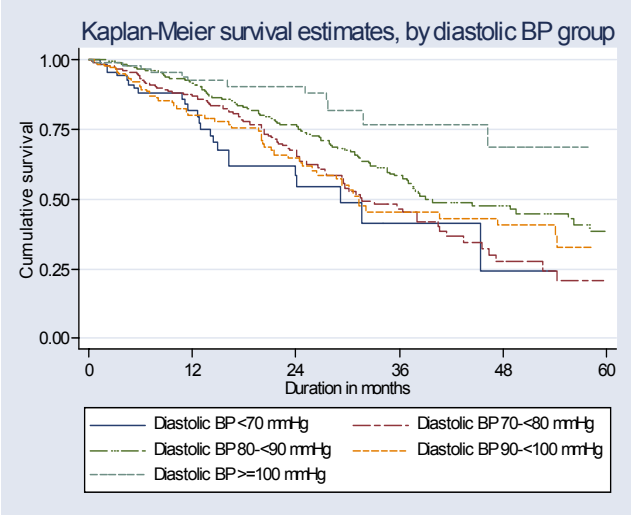


Figure 9.24 Adjusted five-year patient survival in relation to Diastolic Blood Pressure, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



Pulse Pressure

Hypertension is a recognized risk factor for cardiovascular morbidity and mortality in the dialysis population. Components of blood pressure including systolic, diastolic and mean arterial pressure have been used in various studies as parameters to show association between blood pressure and cardiovascular outcome. However there is increasing evidence that the oscillating pulsatile nature of the cardiac cycle can also provide important information about the cardiovascular risk conferred by hypertension, particularly in middle aged and elderly populations. [8] This pulsatile component is clinically described as the difference between the systolic and diastolic blood pressure or better known as the pulse pressure.

Patients with ESRD exhibit vascular abnormalities that contribute to elevated pulse pressure, including increased arterial stiffness, pulse-wave velocity and early wave deflection. [9] There is now evidence to suggest that pulse pressure particularly the post dialysis reading may be a predictor of cardiovascular outcome. In an observational study [6], it was shown that pulse pressure was associated with risk of death in a large sample of patients undergoing maintenance haemodialysis. Data submitted to the National Renal Registry was analysed to determine the trend and association if any between the pulse pressure and survival for both HD and CAPD patients.

Pulse Pressure - Haemodialysis

The mean pulse pressure in haemodialysis patients rose from 52.5 ± 20 mmHg in 1993 to 68 ± 17.9 mmHg in 2002. This represents an increase of 15.5 mmHg. This increase may be contributed by the increasing number of elderly patients receiving dialysis in the later years. (Table 9.25, Figure 9.25) Pulse pressure was also noted to be influenced by age and diabetes but not with gender. (Table 9.26). There was a trend towards higher pulse pressure readings in the older age group (≥60 years) as compared to the younger ages. Diabetes also affected the pulse pressure with diabetic patients having a higher pulse pressure compared to non diabetic patients. Both these data support the finding of increase vessel wall stiffness in elderly and diabetic patients.

Table 9.27 shows that patients with a pulse pressure ≥ 80 mmHg appeared to have poorer five year survival compared to patients with pulse pressure of < 80 mmHg. However when adjusted for age, gender, primary diagnosis and time on RRT the difference was not significant. Instead, those with pulse pressure < 50 mmHg had a significantly higher risk of mortality. (Table 9.28, Fig 9.28) A possible explanation may be that pulse pressure in our analysis was based on pre-dialysis blood pressure while most studies looked at the post-dialysis pulse pressure[3].

Table 9.25 Distribution of Pulse Pressure (mmHg), HD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients < 50 mmHg	% patients 50-<60 mmHg	% patients 60-<70 mmHg	% patients 70-<80 mmHg	% patients ≥80 mmHg
1993	715	52.5	20	51.8	41.8	64.3	43	24	15	9	9
1994	937	57.3	16.7	55.2	45	67.5	35	25	19	11	11
1995	1019	58.1	16.8	56.7	45.8	68.8	35	23	19	12	11
1996	1239	57.8	16.6	55.8	46	68.1	35	24	20	11	11
1997	1661	60.8	17.3	59.2	48.3	71.7	28	23	22	13	14
1998	2109	62.6	17.3	61.1	50	73.3	24	23	21	16	16
1999	2967	65.2	17.4	63.5	53	76.2	19	22	23	17	20
2000	4312	65.8	17.5	64.3	53	77.3	19	22	22	17	21
2001	5148	67.1	18	65.5	53.8	79.3	17	21	21	17	24
2002	5590	68	17.9	66.5	55	79.9	16	20	21	18	25

Figure 9.25 Distribution of Pulse Pressure (mmHg), HD patients 1993-2002

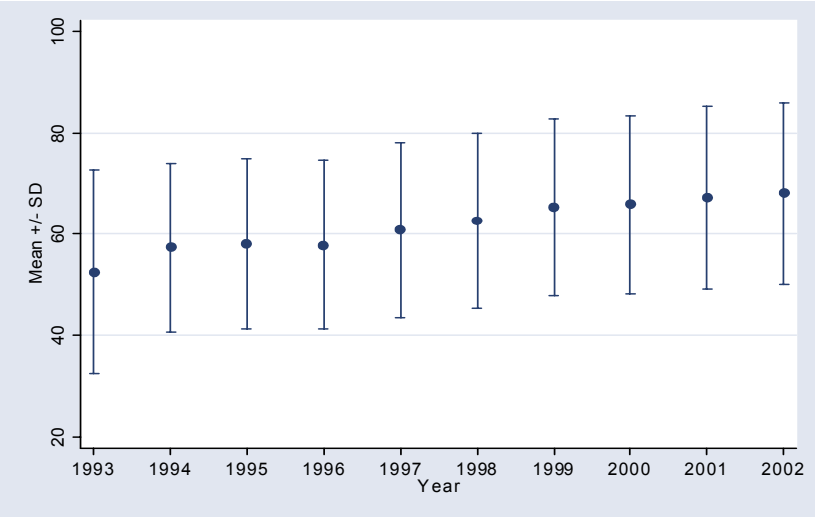


Table 9.26 Distribution of Pulse Pressure in relation to Age, HD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		≥60	
1993	Mean ± SD	44.1	11.2	46.6	17.4	57.2	20.8	66.6	19.8
	Median ± IQR	42.5	13.5	47.5	16.1	57	25.8	66.7	23.1
1994	Mean ± SD	48.2	10.2	51	13.7	61.9	17	69.9	16.9
	Median ± IQR	48.1	12	49.8	18.3	60.9	21.7	68	27.6
1995	Mean ± SD	47.4	10.2	52.1	13.9	62	16.8	70.6	17.9
	Median ± IQR	46.1	13.8	50.4	17.6	61.4	23	70.6	26.1
1996	Mean ± SD	47.5	12	51.7	13.1	61.3	17	72	16.2
	Median ± IQR	46.6	15.2	50	17	60	21.4	72.6	23.6
1997	Mean ± SD	49	11.1	52.7	13.1	65.4	17.4	71.6	17.2
	Median ± IQR	49.2	17.2	51.7	16.7	64.4	24.3	70	25.2
1998	Mean ± SD	49.9	11.6	54.5	13.4	66.6	17.1	73.5	17.7
	Median ± IQR	48.3	17.4	53.3	17.3	66.7	22.3	72.8	22.8
1999	Mean ± SD	51.4	12.5	56.8	13.3	68.8	16.8	74.9	18.6
	Median ± IQR	50.8	17.3	55.8	17.3	67.8	23	74.8	24.4
2000	Mean ± SD	51.6	12.8	57	13.6	68.4	17	74.5	17.9
	Median ± IQR	49.8	15.7	56.3	17.5	67.5	24	74.2	25.8
2001	Mean ± SD	51.1	11.1	58.1	14	69.7	17.5	74.6	18.4
	Median ± IQR	50.3	16.4	56.7	18	68.6	25	74.2	24.5
2002	Mean ± SD	51.8	12.5	58.5	13.5	70.5	17.4	75.3	18.6
	Median ± IQR	49.2	17	57.9	18	69.8	24.3	74.5	25.8

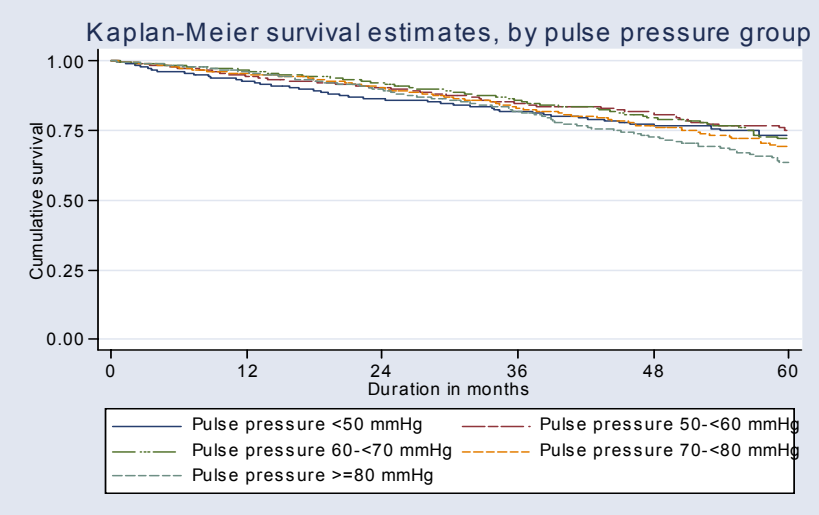
Table 9.27 Unadjusted five year patient survival in relation to Pulse Pressure, HD 1997-2002

Pulse Pressure	<50 mmHg		50-<60 mmHg		60-<70 mmHg		70-<80 mmHg		≥80 mmHg	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	96	1	97	0	98	0	97	1	97	0
12	92	1	94	1	95	1	93	1	93	1
24	86	1	89	1	89	1	87	1	82	1
36	82	2	84	1	82	1	78	2	72	2
48	78	2	81	2	76	2	71	2	62	2
60	75	2	76	2	70	2	64	2	53	2

Table 9.28 Adjusted five-year patient survival in relation to Pulse Pressure, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Pulse Pressure	n	Hazard ratio	95% CI	p-value
<50 mmHg	772	1.33	(1.06, 1.65)	0.012
50-<60 mmHg	1235	1.04	(0.85, 1.26)	0.718
60-<70 mmHg	1399	1.00	-	-
70-<80 mmHg	1214	0.95	(0.79, 1.13)	0.550
≥ 80 mmHg	1449	1.05	(0.88, 1.24)	0.581

Figure 9.28 Adjusted five-year patient survival in relation to Pulse Pressure, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



Pulse Pressure - CAPD

The mean pulse pressure for patients receiving CAPD remained constant through the years. (Figure 9.29) Gender did not appear to have any effect on pulse pressure however age and diabetes status influenced the pulse pressure. There was a trend towards higher pulse pressure readings in the older age group (≥60 years) as compared to the younger ages. Diabetes also affected the pulse pressure with diabetic patients having a higher pulse pressure compared to non diabetic patients.

Table 9.30 shows a poorer five year survival outcome for CAPD patients with a pulse pressure 70 to <80 mmHg as compared to the other age groups. However when adjusted for age, gender, primary diagnosis and time on RRT, there were no significant differences between the different groups including the group with pulse pressure 70 to < 80 mmHg when compared to the reference group with pulse pressure 60 to <70 mmHg. (Table 9.31, Figure 9.31)

Figure 9.29 Distribution of Pulse Pressure (mmHg), CAPD patients 1993-2002

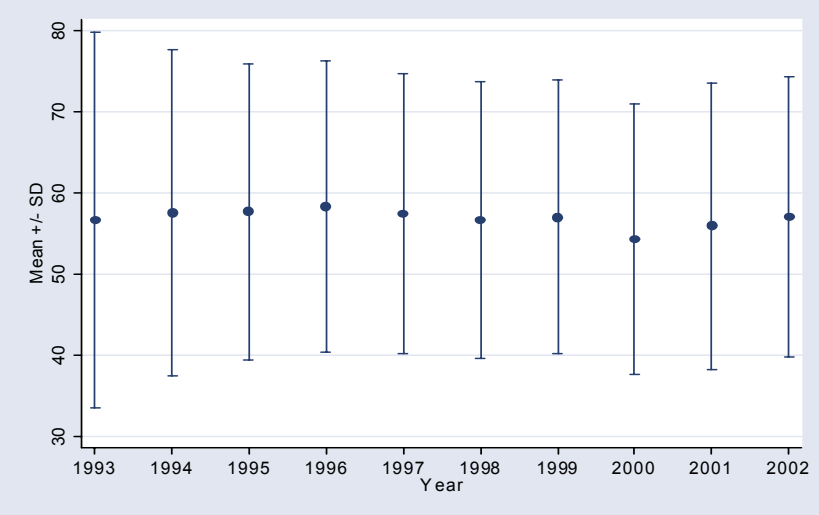


Table 9.30 Unadjusted five-year patient survival in relation to Pulse Pressure, CAPD patients 1997-2002

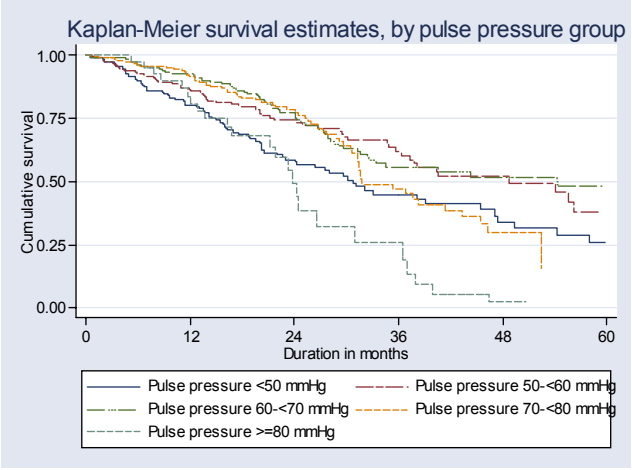
Pulse Pressure	<50 mmHg		50-<60 mmHg		60-<70 mmHg		70-<80 mmHg		≥80 mmHg	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	96	1	95	1	95	1	93	2	99	1
12	92	1	89	2	90	2	86	3	91	4
24	82	2	79	3	70	4	67	5	70	7
36	76	3	68	4	45	5	31	6	56	9
48	70	4	59	5	41	5	16	5	28	10
60	65	4	46	7	37	6	8	6	28	10

SE=standard error

Table 9.31 Adjusted five-year patient survival in relation to Pulse Pressure, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Pulse Pressure	n	Hazard ratio	95% CI	p-value
<50 mmHg	446	0.97	(0.68, 1.38)	0.872
50-<60 mmHg	294	0.83	(0.59, 1.16)	0.273
60-<70 mmHg	227	1.00	-	-
70-<80 mmHg	146	1.05	(0.75, 1.49)	0.763
≥80 mmHg	93	0.63	(0.39, 1.01)	0.055

Figure 9.31 Adjusted five-year patient survival in relation to Pulse Pressure, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



Treatment of Hypertension

There was a 10% increase in the number of patients on anti hypertensive drugs in haemodialysis patients. The number of patients requiring two or more antihypertensive has increased from 21% in 1994 to 32% in 2002. (Table 9.32)

Similarly, the number of CAPD patients on antihypertensive drugs had increased by 10% in 10 years studied. (Table 9.33) More patients on CAPD (50%) required two or more antihypertensives.

There had been consistently higher proportion of CAPD patients on antihypertensive drugs compared to haemodialysis. This may explain the better BP control achieved in CAPD patients.

Table 9.32 Treatment for hypertension, HD patients 1993-2002

Year	No.	% on anti-hypertensives	% on 1 anti-hypertensives	% on 2 anti-hypertensives	% on 3 anti-hypertensives
1993	718	57	57	0	0
1994	963	57	36	16	5
1995	1034	59	34	19	6
1996	1256	58	34	18	6
1997	1697	61	34	21	6
1998	2142	63	36	20	7
1999	2998	67	36	23	8
2000	4395	67	39	21	7
2001	5196	67	37	23	7
2002	5674	67	35	24	8

Table 9.33 Treatment for hypertension, CAPD patients 1993-2002

Year	No.	% on anti-hypertensives	% on 1 anti-hypertensives	% on 2 anti-hypertensives	% on 3 anti-hypertensives
1993	102	70	70	0	0
1994	122	76	33	32	11
1995	256	79	39	28	13
1996	371	82	38	25	20
1997	477	83	32	33	18
1998	541	88	34	31	23
1999	610	82	30	33	19
2000	662	78	31	27	20
2001	781	76	31	28	18
2002	889	81	31	31	19

DYSLIPIDAEMIA

Introduction

Over the past few decades, epidemiological studies have convincingly identified hyperlipidaemia as a modifiable major risk factor for cardiovascular disease in the general population. In the Framingham study, the risk for myocardial reinfarction was increased about 9 times in women and about 3 times in men with total cholesterol >270 mg/dl compared with individuals with total cholesterol lower than 190 mg/dl [13]. The Multiple Risk Factor Intervention Trial (MRFIT) showed that a male smoker with serum cholesterol and systolic blood pressure in the highest quartiles is 20 times more likely than a male non-smoker with cholesterol and systolic blood pressure in the lowest quartiles to die of coronary heart disease during a 12 year period[14]. The relationship between hypertriglyceridemia and coronary risk is complex. Renal failure is associated with altered lipoprotein metabolism. The characteristic plasma lipid abnormality is a moderate hypertriglyceridemia although this is not manifested in all patients with renal failure [18].

Results & Discussion

Serum Cholesterol

The data on lipid in this study is limited to total cholesterol levels and triglyceride levels.

The mean cholesterol levels in both haemodialysis patients and CAPD patients were relatively stable over the past 10 years (Table 9.34, Figure 9.34 and Table 9.35, Figure 9.35). CAPD patients appear to have higher mean cholesterol levels compared to haemodialysis patients over the past 10 years. In 2002, 37% of haemodialysis patients and 57% of CAPD patients have elevated total cholesterol levels (> 5.3 mmol/l)

Not unexpectedly, young haemodialysis patients (< 20 years) generally had lower total cholesterol levels than older patients (Table 9.36). For CAPD population, patients older than 40 years showed a decreasing cholesterol level over the ten years studied resulting in similar cholesterol levels in all age groups in the last two years of 2001 to 2002 (Table 9.37). Female patients had consistently higher cholesterol levels in both dialysis modalities (Table 9.38, Table 9.39) . Mean cholesterol levels were similar in diabetics and nondiabetics in both dialysis modalities (Table 9.40, Table 9.41)

Dialysis patients with very low total cholesterol levels (< 3.5 mmol/l) had a lower unadjusted and adjusted 5 year patient survival compared to those with normal or high cholesterol levels in both dialysis modalities (Table 9.42, Table 9.43, Table 9.45 , Figures 9.42, 9.43, 9.44). Cholesterol in our dialysis population possibly is more a nutritional marker and malnutrition led to low cholesterol level. Malnutrition has an adverse impact on the survival of dialysis patients.

Table 9.34 Distribution of Cholesterol (mmol/L), HD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <3.5 mmol/L	% patients 3.5-<5.3 mmol/L	% patients 5.3-<6.2 mmol/L	% patients ≥6.2 mmol/L
1993	319	5.2	1.8	4.9	4.2	5.9	8	48	25	19
1994	461	4.9	1.3	4.9	4.1	5.7	10	52	23	15
1995	559	5.1	1.4	5	4.2	5.8	8	50	26	16
1996	661	5.1	1.4	5	4.2	5.9	10	49	22	19
1997	1160	5.1	1.4	5.1	4.2	5.9	8	49	24	19
1998	1167	5.1	1.3	5	4.2	5.8	8	53	22	17
1999	1873	5	1.3	4.9	4.1	5.7	10	54	20	15
2000	2959	5	1.2	4.9	4.2	5.8	8	53	23	16
2001	3900	5.1	1.3	4.9	4.2	5.8	8	52	24	16
2002	4417	5	1.2	4.9	4.2	5.7	9	54	24	13

Table 9.35 Distribution of Cholesterol (mmol/L), CAPD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <3.5 mmol/L	% patients 3.5-<5.3 mmol/L	% patients 5.3-<6.2 mmol/L	% patients ≥ 6.2 mmol/L
1993	86	6.4	2.1	6	5.1	7.3	2	28	23	47
1994	113	6.3	1.7	6	5.3	6.9	0	26	28	46
1995	220	6.1	1.7	6	5	6.9	3	28	25	43
1996	318	6	1.5	5.9	5	6.8	3	30	29	39
1997	421	6.1	1.4	6	5.1	6.9	2	27	28	43
1998	348	6	1.4	5.9	5	6.8	3	29	28	41
1999	434	5.7	1.4	5.6	4.9	6.4	3	37	30	31
2000	526	5.9	1.6	5.7	4.9	6.7	3	31	30	36
2001	581	5.8	1.4	5.7	4.8	6.6	2	36	27	35
2002	764	5.6	1.4	5.5	4.6	6.5	4	38	28	29

Figure 9.34 Distribution of Cholesterol (mmol/L), HD patients 1993-2002

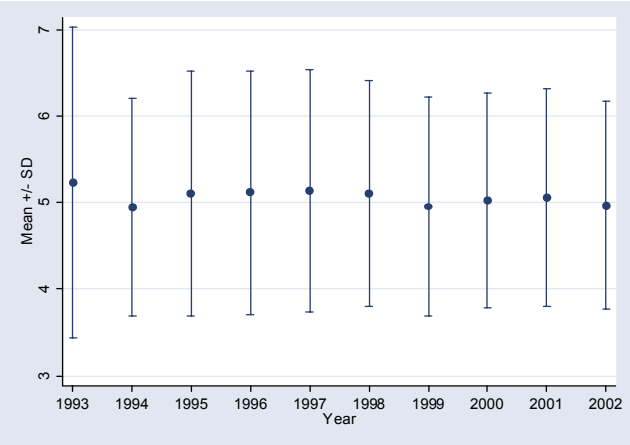


Figure 9.35 Distribution of Cholesterol (mmol/L), CAPD patients 1993-2002

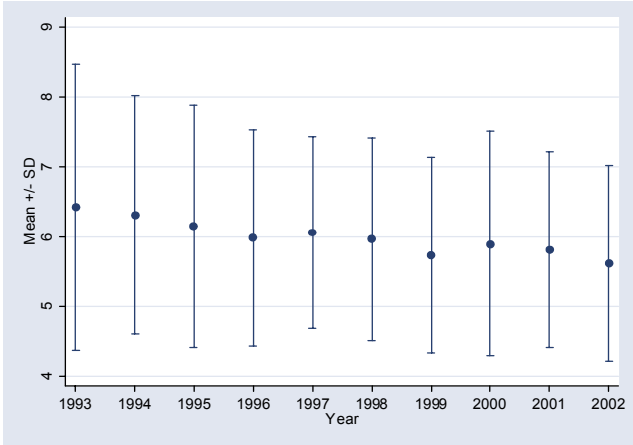


Table 9.36 Distribution of Cholesterol in relation to Age, HD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		≥60	
1993	Mean ± SD	5.2	3.4	5.1	1.9	5.3	1.5	5.2	1.8
	Median ± IQR	4.3	0.8	4.8	1.8	5.2	1.6	5.3	2.4
1994	Mean ± SD	4.2	1	4.9	1.2	5	1.3	5.2	1.4
	Median ± IQR	4.1	1.2	4.8	1.4	5.1	1.5	5.1	1.7
1995	Mean ± SD	4.5	0.9	4.8	1.2	5.3	1.6	5.3	1
	Median ± IQR	4.5	0.8	4.8	1.6	5.2	1.7	5.4	1.6
1996	Mean ± SD	4.4	0.9	4.8	1.3	5.4	1.5	5.4	1.3
	Median ± IQR	4.2	0.4	4.8	1.7	5.2	1.7	5.3	2.1
1997	Mean ± SD	4.4	1.5	5	1.4	5.3	1.4	5.3	1.2
	Median ± IQR	4.1	1.7	4.9	1.6	5.2	1.8	5.1	1.5
1998	Mean ± SD	4.5	1.5	4.9	1.2	5.3	1.3	5.3	1.3
	Median ± IQR	4.1	1.3	4.8	1.5	5.2	1.7	5.2	1.5
1999	Mean ± SD	4.4	1	4.8	1.2	5.1	1.3	5.1	1.3
	Median ± IQR	4.3	1.6	4.8	1.4	4.9	1.7	5	1.5
2000	Mean ± SD	4.3	1.5	4.9	1.2	5.1	1.2	5.1	1.3
	Median ± IQR	3.9	1.2	4.8	1.5	5	1.6	5	1.7
2001	Mean ± SD	4.5	1.4	4.9	1.2	5.1	1.3	5.1	1.3
	Median ± IQR	4.3	1.3	4.8	1.4	5.1	1.6	5.1	1.7
2002	Mean ± SD	4.4	1	4.8	1.2	5.1	1.2	5	1.2
	Median ± IQR	4.3	1.2	4.7	1.4	5	1.6	5	1.5

Table 9.37 Distribution of Cholesterol in relation to Age, CAPD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		≥60	
1993	Mean ± SD	5.2	1	5.7	2.2	6.8	2.1	6.7	1.8
	Median ± IQR	5.1	1.5	5.1	2.1	6.5	2.4	6	3.1
1994	Mean ± SD	5.8	1	5.8	1.1	6.4	1.7	6.9	2.5
	Median ± IQR	5.9	1.6	5.8	1.5	6	1.9	6.6	1.3
1995	Mean ± SD	6	1.7	5.5	1.4	6.4	1.9	6	1.4
	Median ± IQR	5.8	2.5	5.3	1.7	6.2	2	6.2	1.7
1996	Mean ± SD	5.8	1.8	5.7	1.5	6.1	1.6	5.9	1.4
	Median ± IQR	5.2	1.8	5.6	1.9	6	1.7	5.9	1.9
1997	Mean ± SD	5.9	1.3	5.7	1.3	6.2	1.4	6.3	1.4
	Median ± IQR	5.6	2	5.8	1.6	6.1	1.8	6.1	1.7
1998	Mean ± SD	6.3	1.7	5.8	1.2	6	1.6	5.8	1.3
	Median ± IQR	5.9	1.7	5.7	1.6	5.9	1.8	5.9	1.9
1999	Mean ± SD	5	1.7	5.7	1.4	5.9	1.3	5.7	1.3
	Median ± IQR	5.2	1.7	5.6	1.5	5.8	1.5	5.5	1.9
2000	Mean ± SD	5.4	2.4	5.9	1.6	6	1.4	5.9	1.6
	Median ± IQR	5.2	2.1	5.7	1.7	5.8	1.7	5.6	2.1
2001	Mean ± SD	5.9	1.4	5.8	1.6	5.9	1.4	5.6	1.1
	Median ± IQR	5.6	1.8	5.6	1.9	5.8	1.7	5.6	1.6
2002	Mean ± SD	5.7	1.7	5.6	1.3	5.6	1.3	5.6	1.4
	Median ± IQR	5.5	1.8	5.4	1.9	5.5	1.8	5.5	1.7

Table 9.38 Distribution of Cholesterol in relation to Gender, HD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	5	1.4	5.7	2.2
	Median ± IQR	4.8	1.7	5.4	2.1
1994	Mean ± SD	4.8	1.2	5.2	1.3
	Median ± IQR	4.8	1.6	5.2	1.3
1995	Mean ± SD	4.9	1.4	5.4	1.4
	Median ± IQR	4.8	1.6	5.3	1.5
1996	Mean ± SD	5	1.4	5.3	1.5
	Median ± IQR	4.8	1.6	5.2	1.8
1997	Mean ± SD	5	1.4	5.4	1.4
	Median ± IQR	4.9	1.6	5.3	1.7
1998	Mean ± SD	5	1.3	5.3	1.4
	Median ± IQR	4.9	1.5	5.2	1.6
1999	Mean ± SD	4.8	1.2	5.3	1.3
	Median ± IQR	4.7	1.5	5.1	1.6
2000	Mean ± SD	4.8	1.2	5.3	1.2
	Median ± IQR	4.8	1.6	5.2	1.6
2001	Mean ± SD	4.9	1.2	5.3	1.3
	Median ± IQR	4.8	1.5	5.2	1.6
2002	Mean ± SD	4.8	1.2	5.2	1.2
	Median ± IQR	4.7	1.4	5.2	1.5

Table 9.39 Distribution of Cholesterol in relation to Gender, CAPD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	6.2	2.5	6.6	1.6
	Median ± IQR	5.6	2.1	6.5	2.5
1994	Mean ± SD	6	1.5	6.7	1.8
	Median ± IQR	5.8	1.8	6.3	1.8
1995	Mean ± SD	5.8	1.7	6.4	1.8
	Median ± IQR	5.8	2.2	6.2	2.2
1996	Mean ± SD	5.8	1.4	6.2	1.6
	Median ± IQR	5.9	1.9	5.9	2.2
1997	Mean ± SD	5.8	1.3	6.2	1.4
	Median ± IQR	5.7	1.7	6.2	1.8
1998	Mean ± SD	5.8	1.4	6.1	1.5
	Median ± IQR	5.7	1.6	6	1.7
1999	Mean ± SD	5.5	1.3	5.9	1.4
	Median ± IQR	5.3	1.6	5.8	1.5
2000	Mean ± SD	5.5	1.5	6.2	1.6
	Median ± IQR	5.5	1.7	6.1	1.8
2001	Mean ± SD	5.5	1.2	6.1	1.5
	Median ± IQR	5.3	1.5	6	1.8
2002	Mean ± SD	5.2	1.3	6	1.4
	Median ± IQR	5.1	1.7	5.9	1.8

Table 9.40 Distribution of Cholesterol in relation to Diabetes mellitus, HD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	5.3	1.9	5.1	1.2
	Median ± IQR	4.9	1.8	5.1	1.6
1994	Mean ± SD	4.9	1.3	5	1.3
	Median ± IQR	4.8	1.5	5.1	1.6
1995	Mean ± SD	5.1	1.4	5.3	1.6
	Median ± IQR	4.9	1.6	5.3	1.8
1996	Mean ± SD	5.1	1.4	5.2	1.4
	Median ± IQR	4.9	1.7	5.2	1.9
1997	Mean ± SD	5.1	1.3	5.4	1.6
	Median ± IQR	5	1.7	5.3	1.7
1998	Mean ± SD	5.1	1.3	5.3	1.3
	Median ± IQR	4.9	1.6	5.2	1.6
1999	Mean ± SD	4.9	1.2	5.2	1.3
	Median ± IQR	4.8	1.6	5.1	1.8
2000	Mean ± SD	5	1.2	5.1	1.3
	Median ± IQR	4.9	1.6	5	1.7
2001	Mean ± SD	5	1.2	5.1	1.3
	Median ± IQR	4.9	1.5	5	1.7
2002	Mean ± SD	4.9	1.2	5	1.3
	Median ± IQR	4.9	1.4	4.9	1.6

Table 9.41 Distribution of Cholesterol in relation to Diabetes mellitus, CAPD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	6.3	2.2	6.7	1.7
	Median ± IQR	5.9	2	6.3	2.7
1994	Mean ± SD	6.2	1.5	6.7	2
	Median ± IQR	5.9	1.7	6.3	1.6
1995	Mean ± SD	6.1	1.9	6.1	1.4
	Median ± IQR	6	2.2	6.2	1.8
1996	Mean ± SD	6	1.6	5.9	1.5
	Median ± IQR	5.9	1.9	5.9	1.9
1997	Mean ± SD	6.1	1.3	6.1	1.5
	Median ± IQR	6	1.7	5.9	1.9
1998	Mean ± SD	6	1.4	5.9	1.5
	Median ± IQR	5.9	1.7	5.9	1.8
1999	Mean ± SD	5.8	1.4	5.6	1.4
	Median ± IQR	5.8	1.6	5.4	1.5
2000	Mean ± SD	6	1.7	5.7	1.3
	Median ± IQR	5.8	1.8	5.5	1.8
2001	Mean ± SD	5.9	1.4	5.7	1.4
	Median ± IQR	5.7	1.8	5.6	1.7
2002	Mean ± SD	5.7	1.4	5.4	1.4
	Median ± IQR	5.6	1.8	5.3	1.6

Table 9.42 Unadjusted five-year patient survival in relation to Cholesterol, HD patients 1997-2002

Cholesterol	<3.5 mmol/L		3.5-<5.3 mmol/L		5.3-<6.2 mmol/L		≥6.2 mmol/L	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	98	1	98	0	99	0	99	0
12	94	1	96	0	97	0	96	1
24	80	3	90	1	93	1	92	1
36	72	3	83	1	87	1	86	2
48	66	4	77	1	81	2	77	3
60	55	5	71	1	74	2	72	3

SE=standard error

Table 9.43 Unadjusted five-year patient survival in relation to Cholesterol, CAPD patients 1997-2002

Cholesterol	<3.5 mmol/L		3.5-<5.3 mmol/L		5.3-<6.2 mmol/L		≥6.2 mmol/L	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	93	5	96	1	98	1	96	1
12	69	10	90	2	95	1	91	2
24	69	10	76	3	81	3	76	3
36	49	14	58	4	65	4	59	4
48	49	14	45	5	59	4	50	4
60	-	-	45	5	57	4	34	6

SE=standard error

Figure 9.42 Unadjusted five-year patient survival in relation to Cholesterol, HD patients 1997-2002

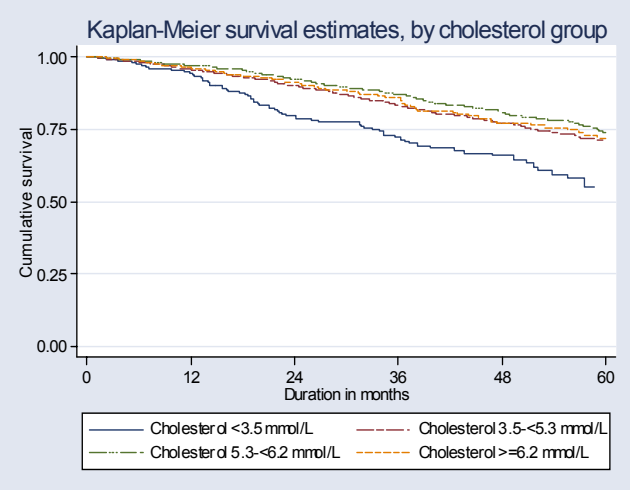


Figure 9.43 Unadjusted five-year patient survival in relation to Cholesterol, CAPD patients 1997-2002

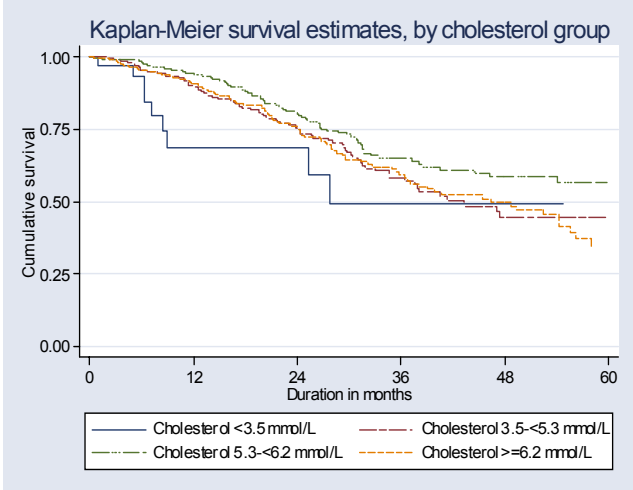


Table 9.44 Adjusted five-year patient survival in relation to Cholesterol, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Cholesterol	Hazard ratio	95% CI	p-value
<3.5 mmol/L	1.76	(1.39, 2.24)	0.000
3.5-<5.3 mmol/L	1.00	-	-
5.3-<6.2 mmol/L	0.76	(0.63, 0.91)	0.003
≥6.2 mmol/L	0.82	(0.65, 1.04)	0.100

Table 9.45 Adjusted five-year patient survival in relation to Cholesterol, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Cholesterol	n	Hazard ratio	95% CI	p-value
<3.5 mmol/L	34	2.24	(1.10, 4.54)	0.026
3.5-<5.3 mmol/L	350	1.00	-	-
5.3-<6.2 mmol/L	331	0.82	(0.60, 1.12)	0.219
≥6.2 mmol/L	365	1.14	(0.84, 1.54)	0.403

Figure 9.44 Adjusted five-year patient survival in relation to Cholesterol, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

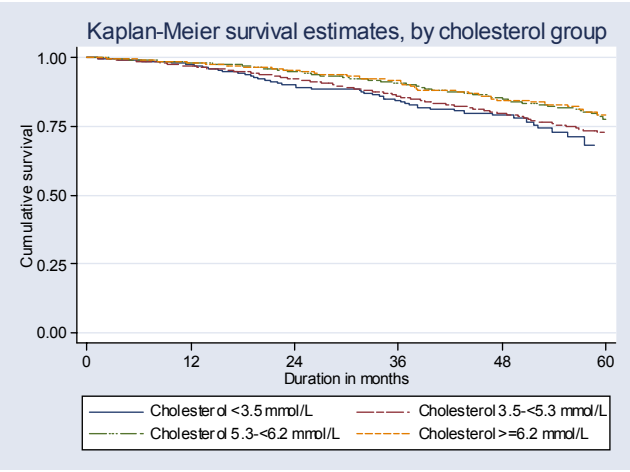
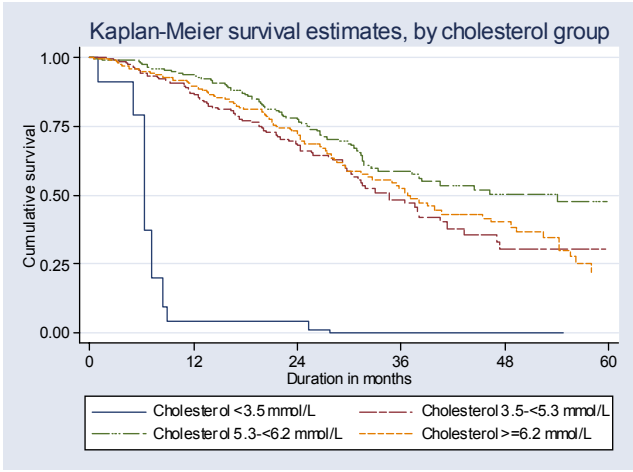


Figure 9.45 Adjusted five-year patient survival in relation to Cholesterol, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



Serum triglyceride

Mean triglyceride levels remained relatively stable over the past 10 years in both dialysis modalities (Table 9.46, Table 9.47). There was a higher proportion of patients with elevated triglyceride levels (> 2.3 mmol/l) in CAPD patients compared to haemodialysis patients (40% versus 30% in 2002) (Table 9.46, Table 9.47). There was no definite effect of age on triglyceride levels. (Table 9.48) There was no difference in the mean triglyceride levels between male and female patients in both dialysis modalities (Table 9.49, Table 9.50). Diabetics had slightly higher mean triglyceride levels compared to non-diabetics in both dialysis modalities (Table 9.51, Table 9.52).

In both CAPD and HD patients very high triglyceride levels (> 3.5 mmol/l) were associated with better adjusted 5 year patient survival (Table 9.54, Table 9.55). In addition very low triglyceride levels (<1.7 mmol/l) was associated with poorer adjusted 5 year patient survival in haemodialysis patients only and not in CAPD. These results are difficult to explain. Perhaps serum triglyceride like cholesterol in our dialysis population may be more a nutritional marker than a cardiovascular risk factor.

Hence further studies are needed on the effect of cholesterol and triglyceride on dialysis patient outcome. Till then, caution is needed to extrapolate evidence from the general population to the dialysis population.

Table 9.46 Distribution of Triglyceride (mmol/L), HD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <1.7 mmol/L	% patients 1.7-<2.3 mmol/L	% patients 2.3-<3.5 mmol/L	% patients ≥3.5 mmol/L
1993	316	2.3	2	1.8	1.3	2.6	48	22	17	12
1994	411	2.2	1.6	1.8	1.3	2.6	46	21	19	13
1995	504	2.1	1.4	1.7	1.3	2.6	48	22	17	12
1996	570	2.2	1.6	1.8	1.3	2.7	43	23	21	12
1997	1076	2.1	1.4	1.8	1.3	2.5	45	24	18	12
1998	1090	2.2	1.5	1.8	1.3	2.6	42	26	20	12
1999	1635	2.1	1.3	1.7	1.2	2.5	49	22	18	11
2000	2396	2.1	1.4	1.7	1.3	2.6	48	22	19	12
2001	3164	2.1	1.4	1.7	1.2	2.5	48	22	17	13
2002	3595	2.1	1.4	1.8	1.2	2.5	47	23	18	12

Table 9.47 Distribution of Triglyceride (mmol/L), CAPD patients 1993-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <1.7 mmol/L	% patients 1.7-<2.3 mmol/L	% patients 2.3-<3.5 mmol/L	% patients ≥3.5 mmol/L
1993	92	3.4	2.8	2.6	1.7	3.7	24	20	28	28
1994	115	3	2.5	2.4	1.5	3.5	30	18	26	25
1995	216	2.8	2	2.2	1.5	3.4	32	21	23	24
1996	318	2.7	2.1	2	1.4	3.3	37	21	19	22
1997	414	2.6	1.9	2.2	1.4	3	36	21	25	18
1998	344	2.4	1.8	1.8	1.3	3	42	22	17	19
1999	421	2.4	1.6	2	1.4	3	38	25	18	19
2000	520	2.7	2.2	2.1	1.5	3	33	24	23	21
2001	576	2.6	1.8	2	1.4	3	36	22	22	20
2002	765	2.5	1.7	2	1.4	3	39	21	22	18

Table 9.48 Distribution of Triglyceride in relation to Age, HD patients 1993-2002

Year		Age group (years)							
		<20		20-39		40-59		≥60	
1993	Mean ± SD	2.9	3.5	2.2	2.1	2.4	1.8	2	0.7
	Median ± IQR	1.6	1	1.6	1.1	1.9	1.4	1.9	1
1994	Mean ± SD	2	1	2	1.2	2.4	1.9	2.2	1.5
	Median ± IQR	1.7	1.1	1.7	1.2	1.8	1.4	1.7	1.6
1995	Mean ± SD	2	0.9	2	1.3	2.3	1.5	2.1	1.3
	Median ± IQR	2.1	1.1	1.6	1.1	1.9	1.4	1.6	1.6
1996	Mean ± SD	1.9	0.8	2	1.3	2.5	1.8	2	1.3
	Median ± IQR	2.1	1.4	1.7	1.3	1.9	1.6	1.8	1.3
1997	Mean ± SD	1.8	1.1	2	1.1	2.3	1.6	2.2	1.3
	Median ± IQR	1.6	0.8	1.7	1.2	1.8	1.4	1.9	1.2
1998	Mean ± SD	2.1	1.3	2.1	1.4	2.4	1.7	2.2	1.2
	Median ± IQR	1.7	1.1	1.7	1.2	1.9	1.4	1.9	1.3
1999	Mean ± SD	1.8	1	1.9	1.1	2.2	1.4	2.1	1.3
	Median ± IQR	1.5	1	1.6	1.3	1.8	1.3	1.8	1
2000	Mean ± SD	1.8	0.7	2	1.3	2.2	1.4	2.1	1.3
	Median ± IQR	1.6	1	1.6	1.2	1.8	1.5	1.8	1.3
2001	Mean ± SD	1.6	0.6	2	1.4	2.2	1.4	2.1	1.5
	Median ± IQR	1.6	0.8	1.6	1.3	1.8	1.4	1.8	1.5
2002	Mean ± SD	1.6	0.7	1.9	1.3	2.2	1.5	2.2	1.5
	Median ± IQR	1.5	0.9	1.6	1.1	1.8	1.4	1.8	1.4

Table 9.49 Distribution of Triglyceride in relation to Gender, HD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	2.3	1.9	2.3	2.1
	Median ± IQR	1.8	1.3	1.8	1.3
1994	Mean ± SD	2.2	1.5	2.3	1.8
	Median ± IQR	1.8	1.3	1.8	1.2
1995	Mean ± SD	2.1	1.2	2.2	1.7
	Median ± IQR	1.7	1.4	1.7	1.2
1996	Mean ± SD	2.2	1.4	2.2	1.8
	Median ± IQR	1.8	1.4	1.8	1.4
1997	Mean ± SD	2.2	1.4	2.1	1.4
	Median ± IQR	1.8	1.3	1.7	1.2
1998	Mean ± SD	2.2	1.5	2.2	1.7
	Median ± IQR	1.9	1.3	1.8	1.3
1999	Mean ± SD	2	1.3	2.1	1.3
	Median ± IQR	1.6	1.3	1.8	1.2
2000	Mean ± SD	2.1	1.4	2.1	1.3
	Median ± IQR	1.7	1.3	1.8	1.4
2001	Mean ± SD	2.1	1.5	2.1	1.3
	Median ± IQR	1.7	1.3	1.7	1.3
2002	Mean ± SD	2.1	1.4	2.2	1.4
	Median ± IQR	1.7	1.3	1.8	1.3

Table 9.50 Distribution of Triglyceride in relation to Gender, CAPD patients 1993-2002

Year		Gender			
		Male		Female	
1993	Mean ± SD	3.6	3.4	3.2	2.2
	Median ± IQR	2.3	2.3	2.7	1.7
1994	Mean ± SD	2.9	2.7	3	2.2
	Median ± IQR	2.2	1.9	2.6	1.8
1995	Mean ± SD	2.6	1.9	3	2.1
	Median ± IQR	2	1.9	2.3	1.9
1996	Mean ± SD	2.5	1.9	2.9	2.2
	Median ± IQR	2	1.9	2.1	2
1997	Mean ± SD	2.5	2	2.7	1.8
	Median ± IQR	2	1.8	2.3	1.7
1998	Mean ± SD	2.3	1.9	2.6	1.8
	Median ± IQR	1.7	1.3	2	1.8
1999	Mean ± SD	2.4	1.8	2.4	1.5
	Median ± IQR	1.9	1.7	2	1.6
2000	Mean ± SD	2.5	2.1	2.9	2.3
	Median ± IQR	2	1.4	2.3	1.9
2001	Mean ± SD	2.3	1.6	2.8	1.9
	Median ± IQR	1.9	1.4	2.3	2
2002	Mean ± SD	2.2	1.5	2.7	1.9
	Median ± IQR	1.8	1.3	2.2	1.8

Table 9.51 Distribution of Triglyceride in relation to Diabetes mellitus, HD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	2.2	1.9	2.9	2.3
	Median ± IQR	1.6	1.2	2.2	1.3
1994	Mean ± SD	2.1	1.5	2.6	1.9
	Median ± IQR	1.7	1.2	2.1	1.9
1995	Mean ± SD	2	1.2	2.5	1.9
	Median ± IQR	1.7	1.1	2.1	2.3
1996	Mean ± SD	2.2	1.4	2.5	2.2
	Median ± IQR	1.8	1.3	2	1.7
1997	Mean ± SD	2	1.2	2.6	1.8
	Median ± IQR	1.7	1.1	2.1	1.7
1998	Mean ± SD	2.1	1.4	2.5	2
	Median ± IQR	1.8	1.2	2	1.5
1999	Mean ± SD	2	1.2	2.3	1.4
	Median ± IQR	1.6	1.2	1.9	1.4
2000	Mean ± SD	2	1.3	2.3	1.5
	Median ± IQR	1.7	1.3	1.9	1.6
2001	Mean ± SD	2	1.3	2.3	1.5
	Median ± IQR	1.6	1.2	1.9	1.7
2002	Mean ± SD	2	1.3	2.4	1.6
	Median ± IQR	1.7	1.2	2	1.7

Table 9.52 Distribution of Triglyceride in relation to Diabetes mellitus, CAPD patients 1993-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1993	Mean ± SD	3.4	2.9	3.4	2.5
	Median ± IQR	2.6	2.3	2.8	1.8
1994	Mean ± SD	2.9	2.5	3.1	2.5
	Median ± IQR	2.4	1.8	2.3	1.9
1995	Mean ± SD	3	2.3	2.5	1.3
	Median ± IQR	2.2	2	2.2	1.8
1996	Mean ± SD	2.7	2.2	2.7	1.8
	Median ± IQR	2	1.5	2.1	2
1997	Mean ± SD	2.6	2	2.6	1.7
	Median ± IQR	2.1	1.7	2.2	1.7
1998	Mean ± SD	2.3	1.8	2.6	1.9
	Median ± IQR	1.7	1.3	2	2.2
1999	Mean ± SD	2.4	1.6	2.5	1.6
	Median ± IQR	1.9	1.5	2.1	1.8
2000	Mean ± SD	2.7	2.4	2.7	1.8
	Median ± IQR	2.1	1.5	2.2	1.8
2001	Mean ± SD	2.4	1.7	2.8	1.9
	Median ± IQR	2	1.5	2.2	2
2002	Mean ± SD	2.4	1.6	2.7	1.9
	Median ± IQR	1.9	1.6	2.1	1.9

Table 9.53 Unadjusted five-year patient survival in relation to Triglyceride, HD patients 1997-2002

Triglyceride	<1.7 mmol/L		1.7-<2.3 mmol/L		2.3-<3.5 mmol/L		≥ 3.5 mmol/L	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	98	0	99	0	98	0	99	0
12	95	1	96	1	96	1	98	1
24	87	1	91	1	91	1	96	1
36	80	1	84	1	86	2	91	2
48	74	1	80	2	80	2	85	2
60	68	2	74	2	72	3	78	3

SE=standard error

Figure 9.53 Unadjusted five-year patient survival in relation to Triglyceride, HD patients 1997-2002

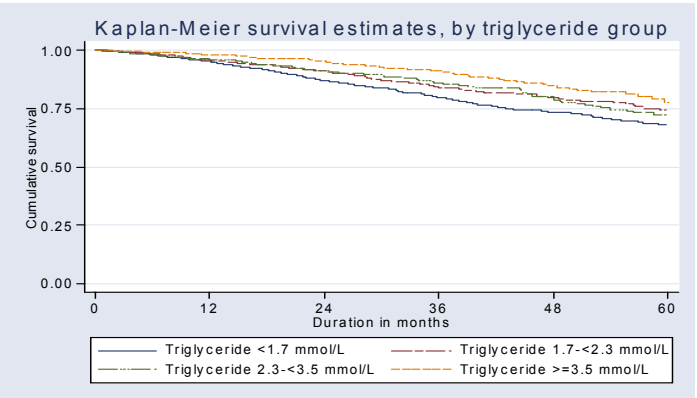


Table 9.54 Adjusted five-year patient survival in relation to Triglyceride, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Triglyceride	n	Hazard ratio	95% CI	p-value
<1.7 mmol/L	1640	1.37	(1.12, 1.66)	0.002
1.7-<2.3 mmol/L	962	1.00	-	-
2.3-<3.5 mmol/L	720	0.90	(0.70, 1.16)	0.427
≥3.5 mmol/L	486	0.60	(0.44, 0.82)	0.001

Table 9.55 Adjusted five-year patient survival in relation to Triglyceride, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

Triglyceride	n	Hazard ratio	95% CI	p-value
<1.7 mmol/L	356	0.91	(0.66, 1.24)	0.535
1.7-<2.3 mmol/L	278	1.00	-	-
2.3-<3.5 mmol/L	255	0.73	(0.52, 1.03)	0.077
≥ 3.5 mmol/L	189	0.69	(0.49, 0.98)	0.040

Figure 9.54 Adjusted five-year patient survival in relation to Triglyceride, HD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)

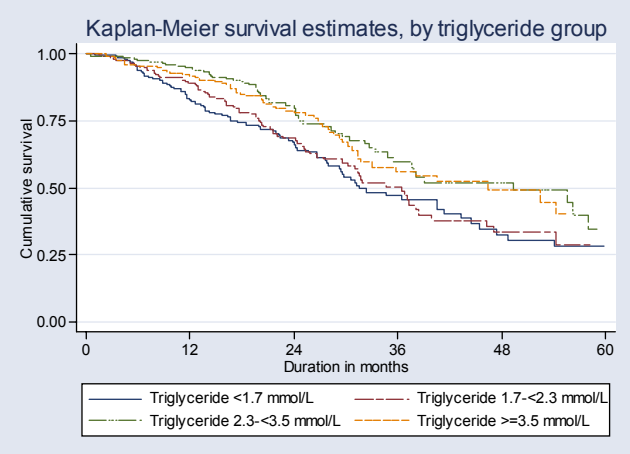
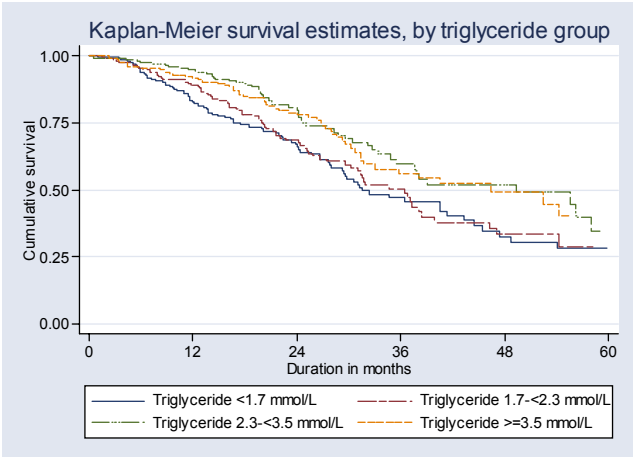


Figure 9.55
Adjusted five-year patient survival in relation to Triglyceride, CAPD patients 1997-2002 (Adjusted for age, gender, primary diagnosis and time on RRT)



References

1. Causes of Death. USRDS. United States of Renal Data System. Am J Kidney Dis 1997;S107-S117 (C)

2. The USRDS Dialysis Morbidity and Mortality Study: wave 2. United States Renal Data System. Am J Kidney Dis 1997;30:S67-S85 ©

3. Zager PG, Nikolic J, Brown RH, et al. 'U' curve association of blood pressure and mortality in haemodialysis patients. Kidney Int 1998;54-561-9

4. Parfrey PS, Foley RN, Harnett JD, et al. Outcome and risk factors for left ventricular disorders in chronic uraemia. Nephrol Dial Transplant 1996; 11:1277-85

5. Harnett JD, Foley RN, Kent GM, et al. Congestive heart failure in dialysis patients; prevalence, incidence, prognosis and risk factor. Kidney Int 1995; 47:884-90

6. Klassen PS, Lowrie EG, Reddan DN, et al. Association between pulse pressure and mortality in patients undergoing maintenance haemodialysis. JAMA 2002;287:1548-55

7. Charra B, Calemard E, Ruffet M, et al. Survival as an index of adequacy of dialysis. Kidney Int 1992;41:1287-91

8. Glynn RJ, Chae CU, Guralnik JM, Taylor JO, Hennekens CH. Pulse Pressure and mortality in older people. Arch Intern Med. 2000;160:2765-2772.

9. Barenrock M, Spieker C, Laske V, et al. Studies of the vessel wall properties in haemodialysis patients. Kidney Int. 1994;45:1397-1400.

10. Lakier JB. Smoking and cardiovascular disease. Am J Med 1992; 93 (suppl 1A): 8S – 12S

11. Rigotti NA, Pasternak RC. Cigarette smoking and coronary heart disease : risks and management. Cardiol Clin 1996; 14: 51-68

12. Tresch DD, Aronow WS. Smoking and coronary artery disease. Clin Geriatr Med 1996; 12: 23-32.

13. Wong ND, Wilson P, Kannel W. Serum Cholesterol as a prognostic factor after myocardial infarction : The Framingham Study. Ann Intern Me 1991; 115: 687-693.

14. Neaton JD, Wentworth D. Serum Cholesterol, Blood Pressure, Cigarette Smoking, and death from coronary heart disease. Arch Intern Med 1992; 152: 56-64

15. Gordon DJ, Probstfield J, Garrison R, Neaton J. High Density lipoprotein cholesterol and cardiovascular panel. Circulation 1989; 79: 8-15.

16. Fielding JE. Smoking : Health Effects and smoking. N Engl J Med 1985; 313: 491-498, 555-561.

17 Manson JE, Tosteson H. The primary preventionof myocardial infarction. N Engl J Med 1992; 326: 1406-1416.

18. Attman PO, Samuelsson O, Alaupovic P. Lipoprotein metabolism and Renal Failure. Am J Kidney Dis 1993; 21: 6: 573-592.

CHAPTER 10: RENAL BONE DISEASE

Summary

- The mean serum calcium level ranged from 2.3 to 2.4 mmol/l and mean serum phosphate level 1.8 to 1.9 mmol/l. The mean values of both parameters have remained stable from 1993 to 2002.
- The mean calcium-phosphate product ranged from 4.3 to 4.5 $mmol^2/L^2$.
- The mean serum intact PTH ranged from 118 to 420 ng/L. There was a significant decrease in the levels of intact PTH from 1993 to 1998.
- There is a U-shape distribution in survival among dialysis patients in relation to serum calcium, phosphate, calcium x phosphate product and serum intact PTH.

Introduction

Over the past decade there has been an increasing number of patients receiving renal replacement therapy throughout Malaysia. Renal bone disease remains an important morbidity suffered by these patients. Bone disease begins early in the pre-dialysis phase when 50% of kidney function is lost and the ill effects can persist even following a successful renal transplant. In the absence of bone biopsy patients on dialysis should be monitored for disturbances in calcium phosphate metabolism and for secondary hyperparathyroidism using serum calcium, phosphate and intact parathyroid hormone (iPTH) levels. We reviewed data on the levels of serum calcium, phosphorous and serum iPTH collected over the past 10 years from 1993 to 2002, and evaluated their effect on patient survival.

Results

The mean values of uncorrected and corrected serum calcium were 2.3 to 2.4 mmol/l. (Corrected calcium was taken as the sum of uncorrected calcium plus the product of 40 minus albumin multiply by 0.2) The levels showed little fluctuation over the 10 years. (Fig 10.1, Table 10.1). In accordance to KDOQI guidelines, 2003[1], patients on dialysis should maintain serum levels of corrected total calcium within the normal range for the laboratory used, preferably at the lower end (2.1 to 2.37 mmol/l]. The above results are within the desired limit set by KDOQI.

The mean serum phosphate in our patients was 1.8 to 1.9 mmol/l throughout 1993 to 2002 (Figure 10.2, Table 10.2]. This is higher than the recommended range set by KDOQI 2003 and the British Renal Association[2]. Following the KDOQI guidelines, the serum levels of phosphate for patients on haemodialysis should be maintained between 1.13 to 1.78 per day. The levels for haemodialysis patients according to the British Renal Association is 1.2 to 1.7 mmol/l [2]. High phosphate levels above 2.08 mmol/l [6.5 mg/dl] are associated with an increased risk of mortality as shown by Levin et al [3]. The local Malaysian diet may contain higher phosphate content. In addition, the main phosphate binder used was and continues to be calcium carbonate, a relatively ineffective phosphate binder. Aluminium hydroxide has fallen out of favour because of the risk of aluminium toxicity.

The mean calcium phosphate product varied between 4.3 to 4.5 $mmol^2/L^2$ (Figure 10.3, Table 10.3]. This is greater than the cut-off point of 4.2 $mmol^2/L^2$ as defined by KDOQI. This is best achieved by controlling serum phosphate levels within target range. Raised calcium phosphate products are associated with increased risk of cardiovascular mortality. [4].

The mean serum iPTH ranged from 118 to 420 ng/L. (Figure 10.4) There was a decreasing trend of iPTH levels from 1993 to 1998 after which the levels plateaued. This trend had mainly been contributed by a reducing proportion of patients with iPTH greater than 250 ng/L and an increasing proportion with iPTH less than 100 ng/L. (Table10.4) The falling levels of iPTH could be related to an increasing numbers of diabetic and elderly patients entering dialysis. Diabetic and elderly patients are associated with a higher incidence of adynamic bone disease and hence lower serum iPTH levels compared to non diabetic patients [5].

The survival of patients was analysed against variables such as serum calcium, phosphate, calcium x phosphate product and serum iPTH level [Figures 10.5,10.6, 10.7, 10.8, Tables 10.5, 10.6, 10.7, 10.8]. In general the survival curves showed a U-shaped distribution for all four parameters i,e. the values at either extremes of each parameter were associated with poorer survival.

Each parameter carried an optimal range between which survival was the highest. For serum calcium the optimal range was 2.2 mmol/l to 2.6 mmol/l, levels for optimum serum phosphate were between 1.8 to 2.0 mmol/l, calcium x phosphate product 4.5-5.5 $mmol^2/L^2$ and serum iPTH 100-250 ng/L. The survival outcomes were understandably poorer in the higher extremes of phosphate and calcium phosphate product as these are accepted as cardiovascular risk factors in the dialysis population. Besides hyperphosphataemia and elevated calcium x phosphate product, a high iPTH level is also recognized as independent risk factor

in the pathogenesis of cardiac disease. The reasons for the reduced survival in relation to the lower extremes of calcium, phosphate and calcium x phosphate product is unexplained. It is possible that the poorer survival related to a low serum phosphate and calcium x phosphate product is a reflection of malnutrition.

Hence, further studies on the factors affecting the U-shaped distribution of mortality among patients with low serum calcium, phosphate and iPTH levels are needed in order to plan strategies to reduce the proportion of patients in these extremes of ranges.

There was insufficient data in the Renal Registry on the type of bone disease in the dialysis population. This area too needs further studies.

Table 10.1 Distribution of corrected serum Calcium, all dialysis patients 1993-2002.

Year	Number of Subjects	Mean	SD	Median	LQ	UQ	% of patients ≥2.2& ≤2.6 mmol/L
1993	782	2.3	.3	2.3	2.2	2.5	57
1994	1044	2.3	.3	2.3	2.2	2.5	55
1995	1232	2.4	.3	2.4	2.2	2.5	59
1996	1477	2.4	.3	2.4	2.2	2.6	57
1997	2104	2.4	.3	2.4	2.2	2.5	58
1998	2566	2.3	.3	2.3	2.2	2.5	59
1999	3251	2.4	.3	2.4	2.2	2.5	60
2000	4336	2.4	.3	2.4	2.2	2.5	61
2001	5363	2.4	.3	2.4	2.2	2.5	63
2002	5975	2.3	.3	2.3	2.2	2.5	60

Table 10.2 Distribution of serum Phosphate, all patients 1993-2002

Year	Number of Subjects	Mean	SD	Median	LQ	UQ	% of patients ≥1.6&<1.8 mmol/L	% of patients ≥1.8&<2.2 mmol/L	% of patients ≥2.2&≤2.6 mmol/L
1993	774	1.9	.5	1.9	1.5	2.2	16	27	16
1994	1042	1.9	.5	1.8	1.5	2.2	18	29	14
1995	1261	1.8	.5	1.8	1.5	2.2	18	29	15
1996	1532	1.9	.5	1.8	1.5	2.2	16	28	14
1997	2122	1.9	.5	1.8	1.5	2.2	16	26	16
1998	2589	1.9	.5	1.9	1.5	2.2	16	30	16
1999	3446	1.8	.5	1.8	1.5	2.2	15	27	16
2000	4716	1.8	.6	1.8	1.5	2.2	16	28	14
2001	5499	1.8	.5	1.8	1.4	2.1	17	26	15
2002	6155	1.8	.5	1.8	1.5	2.2	16	25	16

Figure 10.1 Distribution of corrected serum Calcium, all patients

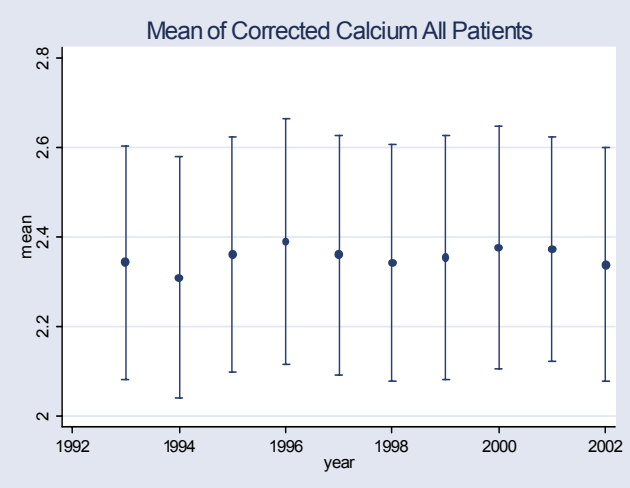


Figure 10.2 Distribution of serum Phosphate, all patients

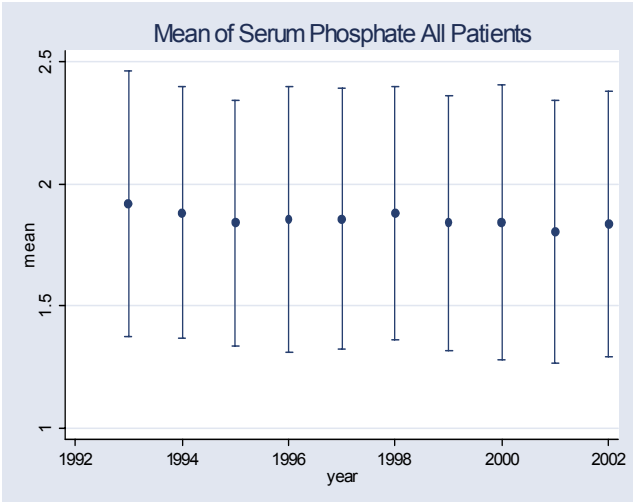


Table 10.3 Distribution of calcium x phosphate product, all patients 1993-2002

Year	Number of Subjects	Mean	SD	Median	LQ	UQ	% of patients <3.5 $mmol^2/L^2$	% of patients ≥3.5&<4 $mmol^2/L^2$	% of patients ≥4&<4.5 $mmol^2/L^2$	% of patients ≥4.5&<5 $mmol^2/L^2$	% of patients ≥5&<5.5 $mmol^2/L^2$	% of patients ≥5.5 $mmol^2/L^2$
1993	766	4.5	1.3	4.4	3.6	5.3	23	15	16	16	10	20
1994	1033	4.3	1.2	4.2	3.5	5	24	18	17	14	11	15
1995	1225	4.3	1.2	4.2	3.5	5	26	16	16	17	11	15
1996	1455	4.4	1.3	4.4	3.5	5.1	24	15	15	16	12	17
1997	2085	4.4	1.3	4.2	3.4	5.1	27	15	15	15	11	17
1998	2524	4.4	1.2	4.3	3.5	5.1	25	15	18	14	12	17
1999	3204	4.3	1.3	4.2	3.4	5.1	29	15	15	14	11	17
2000	4269	4.3	1.3	4.2	3.4	5.1	28	15	16	14	10	17
2001	5279	4.3	1.3	4.1	3.3	5.1	30	16	15	13	10	16
2002	5894	4.3	1.3	4.2	3.3	5.1	30	16	15	13	10	17

Figure 10.3 Distribution of calcium x phosphate product, all patients

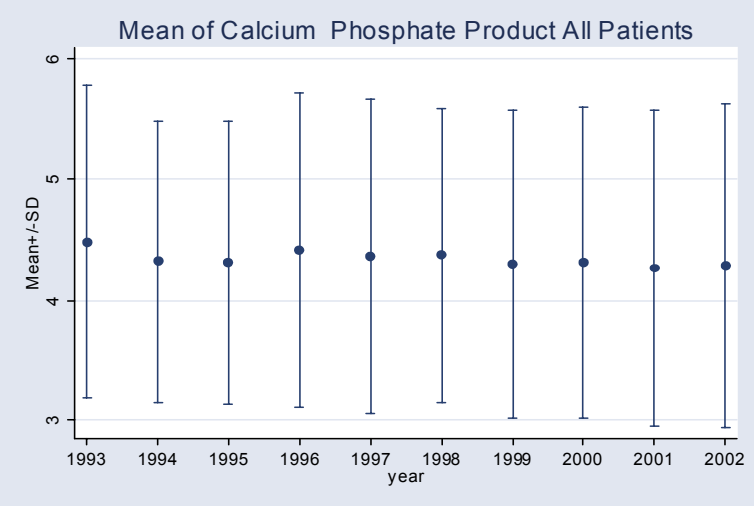


Table 10.4 Distribution of serum iPTH, all patients 1993-2002

Year	Number of Subjects	Mean	SD	Median	LQ	UQ	% of patients <100 ng/L	% of patients ≥100&<250 ng/L	% of patients ≥250 ng/L
1993	0								
1994	17	420.5	391	253	65	771.5	29	18	53
1995	266	307.6	385.2	169.5	50	408	40	19	41
1996	454	224.9	315.3	84	30	282	53	19	28
1997	1382	177.7	262.7	71	25	208	58	20	22
1998	1219	118.6	186.4	45	15.5	133	69	17	14
1999	1900	175.4	247.5	75.3	23	229.5	57	21	23
2000	2653	143.1	225	55	17	166	65	18	17
2001	3293	135.8	210.8	56	17	160	64	20	16
2002	3868	162.8	244.4	69	20.5	195	59	21	20

Figure 10.4 Distribution of serum iPTH, all patients

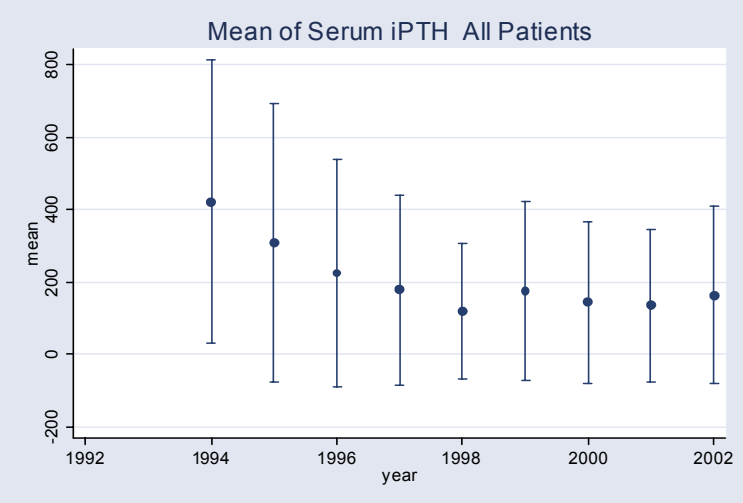


Table 10.5 Adjusted patient survival by serum Calcium, all dialysis patients 1997-2003
(Adjusted for age, gender, diagnosis, time on RRT and modality)

	N	Hazard Ratio	95% CI	P-value
< 2.2	1693	1.56	(1.38,1.78)	0.000
≥ 2.2-<2.6*	5059	1		
≥ 2.6	273	1.76	(1.39,2.22)	0.000

* Reference Group

Table 10.6 Adjusted patient survival by serum Phosphate all dialysis patients 1997-2003
(Adjusted for age, gender, diagnosis, time on RRT and modality)

Serum phosphate (mmol/L)	N	Hazard Ratio	95% CI	P-value
< 1.6	2385	1.43	(1.24,1.65)	0.000
1.6 -<1.8*	1721	1		
1.8 -<2.0	524	0.89	(0.70,1.14)	0.356
2.0-<2.2	857	0.94	(0.77,1.16)	0.577
2.2-<2.4	627	0.93	(0.73,1.17)	0.526
2.4-<2.6	493	1.20	(,0.94,1.52)	0.139
≥ 2.6	366	1.81	(1.41,2.33)	0.000

* Reference Group

Figure 10.5 Adjusted patient survival in relation to serum Calcium, all patients 1997-2002
(Adjusted for age, gender, diagnosis, time on RRT and modality)

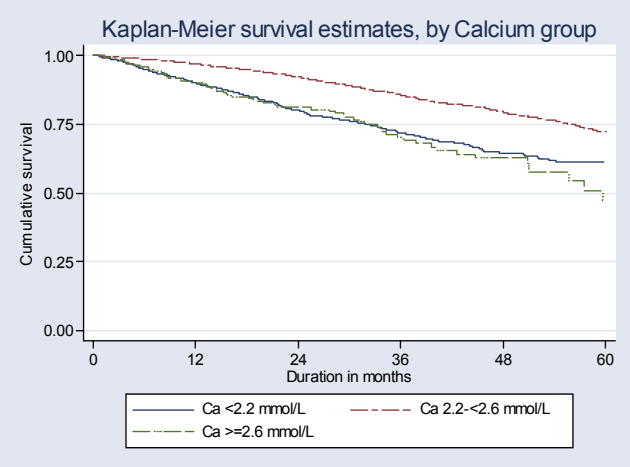


Figure 10.6 Adjusted patient survival in relation to serum Phosphate, all dialysis patients 1997-2002
(Adjusted for age, gender, diagnosis, time on RRT and modality)

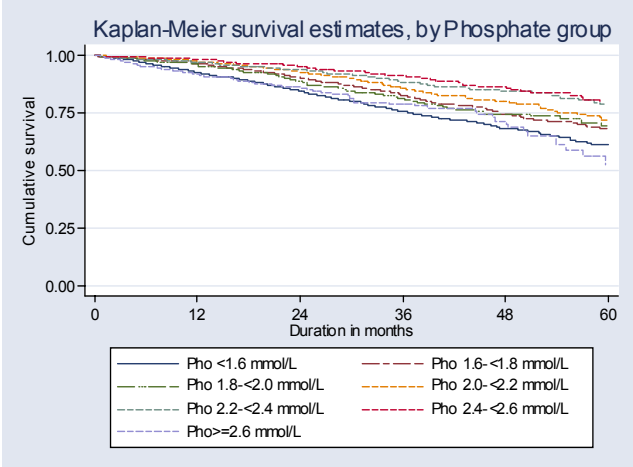


Table 10.7 Adjusted patient survival by calcium x phosphate product, all dialysis patients 1997-2003
(Adjusted for age, gender, diagnosis, time on RRT and modality)

Calcium phosphate product	N	Hazard Ratio	95% CI	P-value
<3.5	2008	1.41	(1.23,1.61)	0.000
3.5-<4.5*	2358	1		
4.5-<5.5	1488	0.84	(0.71,0.98)	0.032
≥ 5.5	855	1.23	(1.03,1.48)	0.023

* Reference Group

Figure 10.7 Adjusted patient survival in relation to calcium x phosphate product, all dialysis patients 1997-2002
(Adjusted for age, gender, diagnosis, time on RRT and modality)

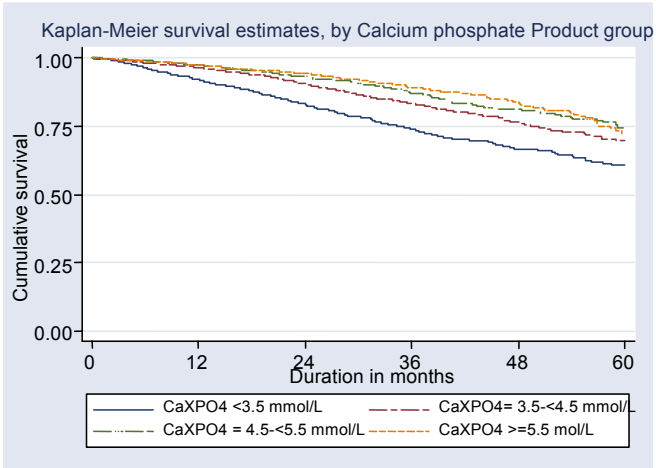
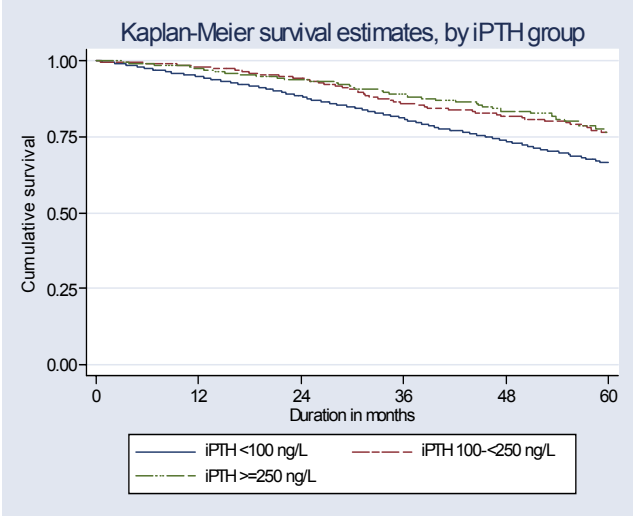


Table 10.8 Adjusted patient survival by serum iPTH , all patients 1997-2003
(Adjusted for age, gender, diagnosis, time on RRT and modality)

iPTH	N	Hazard Ratio	95% CI	P-value
<100	5582	1.59	(1.32,1.92)	0.000
≥ 100 -<250*	878	1		
≥ 250	518	1.19	(0.89,1.59)	0.244

* reference group

Figure 10.8 Adjusted patient survival in relation to serum iPTH , all patients 1997-2002
(Adjusted for age, gender, diagnosis, time on RRT and modality)



References

1. Eknoyan G, Levin A, Levin.N Bone metabolism and disease in chronic kidney disease. Am J Kidney Dis 2003, Suppl Vol 42,(4): 1-220.

2. Ansell D, Feest T. UK Renal Registry Report 2002. UK Renal Registry, Bristol, UK.

3. Ganesh SK, Stack AG, Levin NW, Hulbert-Shearon T, Port FK. Association of elevated serum PO(4) product, and parathyroid hormone with cardiac mortality risk in chronic haemodialysis patients. J Am Soc Nephrol. 2001; 12(10):2131-8.

4. Block GA, Hulbert-Shearon TE, Levin NW, Port FK, USRDS, Ann Arbor, MI, USA. Association of serum phosphorus and calcium x phosphate product with mortality risk in chronic haemodialysis patients: a national study. Am J Kidney Dis. 1998; 31(4): 607-17.

5. United States Renal Data System, USRDS 2003 Annual Data Report: Atlas of End Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2003

CHAPTER 11: HEPATITIS ON DIALYSIS

Summary

- Patients on haemodialysis run the risk of acquiring Hepatitis B virus (HBV) and Hepatitis C virus (HCV) infections.
- Despite the screening of blood products and the use of erythropoietin, the incidence of hepatitis especially HCV remains alarmingly high, suggesting nosocomial transmission within the dialysis unit.
- The overall prevalence of hepatitis is lower in CAPD compared to haemodialysis patients.
- The prevalence of HBV seropositive patients ranged from 1 to 4 % for CAPD and from 5 to 8% for haemodialysis.
- The seroconversion risk of HBV was low and comparable between CAPD and haemodialysis.
- The prevalence of HCV in CAPD ranged between 2 to 6% while the prevalence of HCV in haemodialysis patients is alarmingly high at 17 to 30%.
- The risk of acquiring HCV infection was 2.6 times higher for haemodialysis than for CAPD patients. This risk increased with the number of years on haemodialysis and men were also at greater risk.

Introduction

Hepatitis B virus (HBV) and Hepatitis B Viral (HCV) infections are public health issues within dialysis units. The prevalence of HBV infection in dialysis units has declined from 3.8% in 1980 to 0.9% by 1999 according to the national surveillance of dialysis associated diseases in the United States [1]. In contrast, the prevalence of HCV infection has not declined as markedly, ranging from 5 to 65% depending on geographical area and dialysis center [2]. Its prevalence increases with the duration on dialysis, from 12% for patients on dialysis less than 5 years to 37% for patients on dialysis for more than 5 years [1].

Both HBV and HCV infections are transmitted by percutaneous or permucosal exposure through infected blood or body fluids. Blood transfusion, volume of blood products transfused, number of years on haemodialysis and high prevalence (>30%) of HCV in the dialysis centers are recognized risk factors [3,4].

Results and Discussion

Between 1993 and 2002, the prevalence of haemodialysis (HD) patients with Hepatitis B surface antigen (HbsAg) ranged from 3 to 7%, and anti-HCV antibody 3 to 17% at the time of notification to the registry (Table 11.1). The corresponding figures among CAPD patients were 0 to 5% for presence of HbsAg and 2 to 6% seropositive for anti-HCV (Table 11.2).

Subsequent to the first notification, annual surveys of all patients conducted by the registry showed that the prevalence of HbsAg ranged from 5 to 8% and of anti-HCV antibody 17 to 30% among HD patients. (Table 11.3). The corresponding figures among CAPD patients were 1 to 4% for HbsAg and 0 to 6% for anti-HCV (Table 11.4). Clearly, patients became infected with hepatitis virus especially HCV while on dialysis.

To quantify the risk of infection, we assembled a cohort of patients commencing dialysis between 1997 and 2002, and who were sero-negative for both HBV and HCV at initial notification to the registry. We assumed patients were notified at the time of entry into dialysis. We then tracked their serology status at each subsequent year of survey.

As shown in Table 11.5 and Figure 11.5, the cumulative risk of HBV infection was 1.9% at 5 years on CAPD, and 1.5% for HD. The risks were low and comparable between CAPD and HD. Table 11.6 shows the risk of HBV infection in relation to other patient characteristics. There seems to be a trend of decreasing risk with increasing age and in more recent cohorts; but these were not statistically significant.

The situation with HCV infection is alarmingly different. As shown in Table 11.7 and Figure 11.7, the cumulative risk of HCV infection was 4.4% at 5 years on CAPD, but 15% for HD. These risks are large, especially on HD. The cumulative risk increased with each year on HD and was not just confined to the initial years on dialysis.

Table 11.8 shows the risk of HCV infection in relation to other patient characteristics. Men were at greater risk of acquiring HCV infection; there was no difference noted in the various age groups; and recent cohorts were at higher risk. The risk of infection with HCV was 2.6 times higher for HD than for CAPD patients. Clearly, further investigation is warranted to more precisely characterize the mechanism of transmission, especially in HD. What aspects of our current HD practices are putting patients at such great risk of HCV infection?

Table 11.1 Prevalence of HBsAg positive, Anti-HCV positive and Mixed infection at notification to the registry, HD patients 1993-2002

Year	N	Prevalence of HBsAg positive (%)	Prevalence of Anti-HCV positive (%)	Prevalence of mixed HBsAg positive and Anti-HCV positive (%)
1993	312	5.77	17.63	1.92
1994	445	6.52	15.73	0.45
1995	567	6.70	13.58	1.23
1996	789	4.44	14.45	0.51
1997	1019	4.42	10.21	0.39
1998	1144	4.55	9.27	0.35
1999	1399	5.08	7.86	0.36
2000	1668	5.16	4.98	0.42
2001	1757	4.38	4.04	0.11
2002	1527	3.27	3.34	0.26

Table 11.2 Prevalence of HBsAg positive, Anti-HCV positive and Mixed infection at notification to the registry, CAPD patients 1993-2002

Year	N	Prevalence of HBsAg positive (%)	Prevalence of Anti-HCV positive (%)	Prevalence of mixed HBsAg positive and Anti-HCV positive (%)
1993	69	1.45	5.80	0
1994	121	1.65	4.13	0
1995	170	5.29	4.71	0
1996	220	3.18	2.27	0
1997	197	3.05	5.58	1.52
1998	154	0	3.25	0
1999	209	1.44	3.83	0
2000	226	3.54	4.42	0
2001	339	4.42	3.54	0.59
2002	346	3.76	3.18	0.58

Table 11.3 Prevalence of HBsAg positive, Anti-HCV positive and Mixed infection at annual survey, HD patients 1993-2002

Year	N	Prevalence of HBsAg positive (%)	Prevalence of Anti- HCV positive (%)	Prevalence of mixed HBsAg positive and Anti-HCV positive (%)
1993	718	8	17	1
1994	962	6	26	1
1995	1033	5	30	1
1996	1254	7	25	2
1997	1696	6	23	1
1998	2141	6	22	1
1999	2995	6	23	1
2000	4393	6	25	1
2001	5193	6	23	1
2002	5673	5	21	1

Table 11.4 Prevalence of HBsAg positive, Anti-HCV positive and Mixed infection at annual survey, CAPD patients 1993-2002

Year	N	Prevalence of HBsAg positive (%)	Prevalence of Anti-HCV positive (%)	Prevalence of mixed HBsAg positive and Anti-HCV positive (%)
1993	102	1	0	0
1994	122	3	1	0
1995	256	4	2	0
1996	371	4	6	0
1997	477	3	5	0
1998	541	3	6	0
1999	610	2	5	0
2000	661	2	5	0
2001	780	2	3	0
2002	889	3	4	0

Conclusion

Our 10 year registry report shows a high prevalence of HCV among our haemodialysis patients. The risk of acquiring HCV infection increases with the duration on dialysis suggesting that nosocomial transmission within the haemodialysis unit plays a key role in HCV infection.

Strict implementation of infection control practices as recommended by the CDC guidelines [1], the use of dedicated machines, adequate personnel/patient ratio, isolation of anti-HCV positive patients and dialysers or single use of dialysers may reduce the transmission of HCV [5,6].

Prevalence of HBV is much lower than HCV and has not changed markedly over the years because of implementation of universal precautions, segregation of HBV positive patients, and the use of HBV vaccination. As predialysis patients' immune response is superior to those already on dialysis [7], early vaccination before initiation of dialysis is recommended. Annual monitoring of anti-HBs titres of staff and patients should be done and booster doses of hepatitis vaccine given as needed. Possible factors associated with poor response to vaccination like malnutrition, diabetes, dialysis adequacy and increased age need further studies [7].

Table 11.5 Cumulative risk of sero-conversion to HBsAg positive among sero-negative patients at entry into dialysis, comparing HD and CAPD 1997-2002

Modality	CAPD		HD	
Interval (years)	% Cumulative probability	SE*	% Cumulative probability	SE*
1	0.3	0.1	0.3	0.06
2	0.6	0.2	0.7	0.1
3	1.5	0.4	1.1	0.1
4	1.9	0.6	1.4	0.2
5	1.9	0.6	1.5	0.2

* SE=standard error

Figure 11.5 Cumulative risk of sero-conversion to HBsAg positive among sero-negative patients at entry into dialysis, comparing HD and CAPD 1997-2002

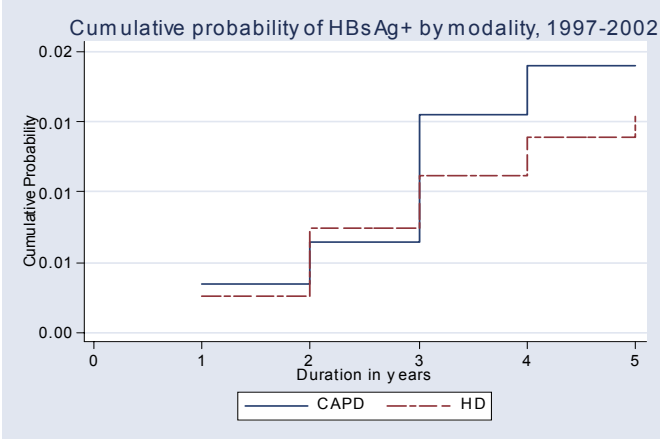


Table 11.6 Risk factors for sero-conversion to HBsAg positive among sero-negative patients at entry into dialysis, All dialysis patients 1997-2002

Factors	N	Risk ratio	95% CI	P value
Gender:				
Male (ref.*)	5269	1.00		
Female	4290	0.74	(0.60,1.39)	0.675
Age:				
<20 (ref.*)	367	1.00		
20-39	1802	0.90	(0.30,2.72)	0.848
40-54	3264	0.77	(0.26,2.30)	0.635
>=55	4126	0.74	(0.25,2.26)	0.601
Diabetes mellitus				
No (ref.*)	5516	1.00		
Yes	4043	1.32	(0.83,2.09)	0.243
Year start dialysis				
1997-1998 (ref.*)	2411	1.00		
1999-2000	3334	0.88	(0.56,1.40)	0.596
2001-2002	3814	0.55	(0.28,1.08)	0.082
Modality:				
CAPD (ref.*)	1426	1.00		
HD	8133	0.84	(0.47,1.52)	0.566

*ref: Reference group

Table 11.8 Risk factors for sero-conversion to Anti-HCV positive among sero-negative patients at entry into dialysis, All dialysis patients 1997-2002

Factors	N	Risk ratio	95% CI	P value
Gender:				
Male (ref.*)	5189	1.00		
Female	4214	0.84	(0.71,0.99)	0.033
Age:				
<20 (ref.*)	363	1.00		
20-39	1764	0.96	(0.57,1.64)	0.891
40-54	3222	1.22	(0.72,2.04)	0.461
>=55	4054	1.01	(0.60,1.71)	0.974
Diabetes mellitus				
No (ref.*)	5420	1.00		
Yes	3983	0.89	(0.74,1.05)	0.170
Year start dialysis				
1997-1998 (ref.*)	2288	1.00		
1999-2000	3291	1.23	(1.02,1.48)	0.025
2001-2002	3824	1.12	(0.86,1.46)	0.393
Modality:				
CAPD (ref.*)	1414	1.00		
HD	7989	2.66	(1.86,3.80)	0.000

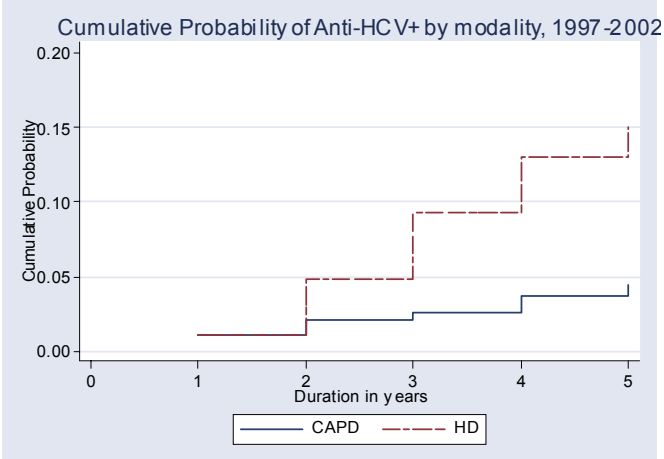
*ref: Reference group

Table 11.7 Cumulative risk of sero-conversion to Anti-HCV positive among sero-negative patients at entry into dialysis, comparing HD and CAPD 1997-2002

Modality	CAPD		HD	
Interval (years)	% Cumulative probability	SE*	% Cumulative probability	SE*
0.5				
1	1.1	0.3	1.2	0.1
2	2.1	0.4	4.9	0.3
3	2.6	0.5	9.3	0.4
4	3.7	0.8	13.0	0.6
5	4.4	1.1	15.0	0.7

* SE=standard error

Figure 11.7 Cumulative risk of sero-conversion to Anti-HCV positive among sero-negative patients at entry into dialysis, comparing HD and CAPD 1997-2002



References

1. CDC. Recommendations for prevention and control of Hepatitis C virus infection and HCV related chronic diseases. MMWR 1998;47 (No RR-19):1-39

2. Pol S, HCV Infection and Haemodialysis. Sem Nephrol 2002;22(4), 331-339

3. Saab S. Hepatitis C virus transmission in the haemodialysis community. Am J Kidney Dis 2001, 37

4. Meyers CM. Hepatitis C and renal disease: an update: Am J Kidney Dis 2003, 42. (4)

5. Santos JP. Impact of dialysis room and reuse strategies on the incidence of hepatitis C virus infection in haemodialysis units. Nephrol Dial Transplant 1996, 10: 2017-2022

6. Petrosillo N. Prevalence of infected patients and understaffing have a role in Hepatitis C virus transmission in dialysis. Am J Kidney Dis 2001, 37: 1004-1010

7. Eardley KS. Efficacy of the accelerated hepatitis B vaccination schedule used in heamodialysis patients post-exposure to virus: a single –centre experience. Nephrol Dial Transplant 2002,17(11):1982-87

CHAPTER 12: VASCULAR ACCESS INFECTION

Summary

- Vascular access infection is a major cause of morbidity and mortality in haemodialysis patients.
- The overall incidence of vascular access infection ranged from 0.67 to 1.71 percent.
- Risk factors for vascular access infection in our dialysis population include female gender, adult polycystic kidney disease, low serum albumin, low KT/V and usage of catheters and synthetic grafts.

Introduction

Vascular access infection accounts for 30 to 50% of bacteraemias in haemodialysis patients [1]. It also contributes significantly to the total cost of haemodialysis and is a frequent cause for hospitalisation [2]. In an infection surveillance by the Centres for Disease Control, USA, in 1999, vascular access infection with or without bacteraemia were experienced by 3.2% of patients each month [3]. Reported risk factors for vascular access infection include catheter use, low serum albumin level, diabetes and inadequate dialysis [1].

Results and Discussion

The overall incidence of vascular access infection ranged from 0.67-1.71% and appears to be decreasing (Table 12.1).

Table 12.2 shows the incidence of vascular access infection in relation to patient characteristics. Females have a higher incidence of vascular access infection. Tokars et al [1] have also noted a higher incidence of vascular access related bacteraemia in women. This may be due to smaller arm veins resulting in more usage of synthetic grafts or catheters [2,4]. Patients with autosomal dominant polycystic kidney disease appeared to have a higher incidence of vascular access infection. The cause for this is unknown.

Diabetes mellitus did not seem to increase the risk of vascular access infection. This finding was also noted in other studies [1,5]. Similarly, there was no apparent correlation between BMI and the risk of vascular access infection.

A low serum albumin level has been shown to be associated with higher mortality, as well as infections [5]. Similarly, our analysis showed that a low serum albumin level was an important risk factor. For instance, patients with a serum albumin of less than 30g/l had a 4 fold increased risk of vascular access infection compared to those with a serum albumin of more than 40g/l.

Kt/V of less than 1 was also associated with an increased risk of vascular access infection, similar to the findings of another study [1]. A low Kt/V or low serum albumin may be secondary to the use of catheters or may indicate problems with the vascular access. Inadequate dialysis and malnutrition can also suppress the immune function and predispose patients to infection.

The type of vascular access is an important determinant of infection risk [1,6] and mortality [2]. Our analysis showed a similar strong correlation between vascular access type and infection. The risk of vascular access infection was lowest with wrist arteriovenous fistulae (AVF), followed by brachiocephalic fistulae, grafts, and catheters. In particular, the use of catheters was associated with a 20-fold increase in risk of infection compared to native AVF. (Table 12.3)

As expected, vascular access usage problems, e. g., difficult needle placement, and access complications particularly venous outflow obstruction, access limb oedema and haematoma were associated with a high risk of infection. (Table 12.3)

Conclusion

A good and reliable vascular access is critical for successful chronic haemodialysis. Native fistulae have the longest patency rate and the lowest rate of complications including infection. Hence, we should aim for early creation of native AVF in all pre-dialysis patients to ensure adequate time for vascular access maturation and, thereby, prevent premature needling. This will also reduce the need for temporary catheter which is associated with a high risk of infection and possible future complications such as venous outflow obstruction.

Ensuring adequate dialysis and good nutrition is also of paramount importance to improve patient survival and prevent infection.

With the advancing age of our dialysis population and rising number of diabetic patients, graft and catheter usage may inevitably increase in the future. Future studies should look at ways of minimizing infections especially catheter related infections e.g., choice of catheter, catheter handling, policies on chronic nasal or skin Staphylococcus carriage, etc [7,8]. Outcomes of various treatment modalities, e.g., catheter removal, antibiotic duration, will need to be looked at. In addition, we should identify the organisms commonly associated with vascular access infection. This can provide a guide to empirical antibiotic therapy. Finally, we should study outcomes of vascular access infection such as access loss and the impact on patient morbidity and mortality.

Table 12.1 Incidence of Vascular Access Infection, HD patients 1997-2002

Year	1997	1998	1999	2000	2001	2002
No of patients	1697	2142	2998	4395	5196	5674
Incidence of Vascular Access Infection No. (%)	29 (1.71)	21 (0.98)	34 (1.13)	52 (1.18)	49 (0.94)	38 (0.67)

Table 12.2 Incidence of Vascular Access Infection in relation to patient characteristics, HD patients 1997-2002

Characteristics	N	Incidence (%)	P value
Age:			
0-14	121	0.00	0.203
15-24	1284	0.93	
25-34	3339	1.11	
35-44	4937	1.28	
45-54	5650	0.87	
55-64	4717	1.02	
>=65	2054	0.68	
Gender:			
Male	12841	0.75	0.000
Female	9261	1.37	
Primary diagnosis:			
Unknown	7244	1.05	0.000
Diabetes Mellitus	6194	0.86	
GN / SLE	3611	0.72	
Polycystic kidney	465	3.01	
Obstructive nephropathy	1285	1.48	
Others	3300	1.06	
Diabetes mellitus:			
No	15772	1.08	
Yes	6330	0.84	
BMI:			
<18.5	3419	1.14	0.560
18.5-<25	11491	1.01	
≥ 25	4100	1.20	
Serum albumin (g/l) :			
<30	694	3.03	0.000
30-<35	2374	1.31	
35-<40	7807	1.15	
≥ 40	9200	0.74	
KT/V:			
<1	980	2.14	0.002
1-1.2	2922	1.23	
1.2-1.4	4852	0.97	
1.4-1.6	4845	0.78	
>=1.6	7027	0.94	
Year start dialysis:			
1997-1998	5669	0.88	0.186
1999-2000	5618	0.98	
2001-2002	3006	0.60	
Location of HD:			
Centre HD	20466	1.02	0.940
Home/Office HD	1506	1.00	
Assistance on HD:			
Self care	7339	0.79	0.014
Assisted HD	14047	1.15	

Table 12.3 Incidence of Vascular Access Infection in relation to type of vascular access, HD patients 1997-2002

Type of vascular access:	N	Incidence (%)	P value
Wrist AVF	17612	0.49	0.000
BCF	3453	1.97	
Graft (venous/Gortex)	293	4.78	
Catheter (Permcath/ CVC)	526	10.46	
Vascular access difficulty:			
None	20408	0.67	0.000
Any reported difficulty*	16910	5.09	
Vascular access complications:			
Thrombosis	607	1.98	0.000
Haemorrhage or Haematoma	151	5.30	
Aneurysmal dilatation	918	1.20	
Access limb swollen/ oedema	247	8.91	
Access limb ischaemia	73	2.74	
Venous outflow obstruction	441	4.99	
Carpal tunnel syndrome	199	1.01	
Other complication(s)	352	2.84	

* Any reported difficulty includes difficult needle placement, difficulty getting desired blood flow, etc.

References

1. Tokars JI, Light P, Anderson J, et al. A prospective study of vascular access infections at seven outpatient haemodialysis centers. Am J Kidney Dis, 2001; 37 : 1232 - 1240.

2. Xue JL, Dahl D, Ebben JP, Collins AJ. The association of initial haemodialysis access type with mortality outcomes in elderly medicare ESRD patients. Am J Kidney Dis, 2003; 42 :1013-1019

3. Tokars JI. Infections control in heamodialysis units. Infectious Disease Clinics of North America 2001. Vol 15. No 3.

4. Astor BC, Coresh J, Powe NR, et al. Relation between gender and vascular access complications in haemodialysis patients. Am J Kidney Dis, 2000; 36: 1126-1134

5. Jaar BG, Hermann JA, Furth SL, Briggs W, Powe NR. Septicaemia in diabetic haemodialysis patients: Comparison of incidence, risk factors, and mortality with non diabetic haemodialysis patients. Am J Kidney Dis, 2000; 35 : 282-292

6. Kurt B. Stevenson et al. Epidemiology of haemodialysis vascular access infections from longitudinal infection surveillance data: Predicting the impact of NKF-DOQI clinical practice guidelines for vascular access. Am J Kidney Dis, 2002 ; 39 : 549 - 555

7. Bernard Canaud. Haemodialysis catheter-related infection: time for action. Nephrol Dial Transplant 1999; 14 : 2288-2290

8. Blankestijin PJ. Treatment and prevention of catheter-related infections in haemodialysis patients. Nephrol Dial Transplant 2001; 16 : 1975-1978.

CHAPTER 13: HAEMODIALYSIS ADEQUACY

Summary

- Median prescribed spKt/V had increased from 1.3 to 1.5 over the report period, with a significant decrease in patients achieving spKt/V < 1.2.
- While the frequency and duration of dialysis had remained largely the same, there had been an increase in patients dialyzing only twice a week, although they remained a minority (6% in 2002).
- There is a strong trend towards the use of synthetic membranes and bicarbonate-based dialysate. However the number of times of reuse has also increased.
- The elderly, males and diabetics were persistently dialysed to lower Kt/V compared to the rest of the dialysis population.
- Survival analysis identified spKt/V < 1.0 (but not 1.0 - <1.2) as an important risk factor for mortality, while Kt/V > 1.4 did not confer any survival advantage.

Introduction

The term "dialysis adequacy" is usually taken to mean nitrogenous solute removal. Although urea is non-toxic and only represent small solutes, measures of urea removal are often used as surrogates for nitrogenous solute removal. The measures of urea removal most often used in clinical practice are the Urea Reduction Ratio (URR) and the mathematically-related Kt/V urea. The latter was derived from urea-kinetics modeling by Gotch based on data from the National Cooperative Dialysis Study (NCDS) [1]. In this study, patients were randomized to either low or high time-averaged blood urea nitrogen (BUN) and short or long dialysis duration. Low time-averaged BUN was found to result in better clinical outcome, while the benefits of longer dialysis just failed to reach statistical significance. However, further analysis of this study [2] showed that urea removal was an even stronger predictor of outcome. Kt/V represents the clearance of urea (Kt) normalized to the patient's distribution volume for urea (V). Prescribed Kt/V is calculated from the dialyser KoA, dialysis duration and patient's V (usually from anthropometric equations). Delivered Kt/V is usually derived from pre- and post dialysis blood urea. The most commonly used measure of delivered Kt/V is the single pool Kt/V (spKt/V), where post-dialysis urea is sampled within ~15 seconds of slowing the blood flow. This misses the effect of post-dialysis urea rebound and therefore overestimates actual patient urea clearance [3]. However spKt/V and URR are the 2 measures which have been shown in the largest number of studies to predict patient outcome [2, 4-8].

The authors of the NCDS originally suggested spKt/V of 0.8-1.2 as offering adequate dialysis [2]. However, subsequent studies, mainly registry-based, suggested higher spKt/V would be better [4-8]. For example, Held et al [7] found that mortality decreased 7% for every 0.1 increase in spKt/V, but the benefits of further increases beyond 1.3 (corresponding to URR of 70%) did not reach statistical significance. The results of these studies were used as the basis for recommendations by various professional bodies. For instance, the NKF-K/DOQI guidelines recommended a target spKt/V of 1.2 per dialysis for a thrice-a-week haemodialysis regime [9]. The lack of benefits of higher spKt/V was also shown in the HEMO study, a prospective randomized multi-centre study [10]. In this study, patients randomized to the higher dialysis dose group (achieved spKt/V 1.71, URR 75%) did not have better clinical outcome than patients in the standard dialysis dose group (achieved spKt/V 1.32, URR 66%).

More recently, it has been found that urea clearance (Kt) was a better predictor of clinical outcome than Kt normalized to V [11,12]. This is probably because V is strongly correlated with nutritional status, which is itself a good prognostic factor in dialysis patients. Hence, of 2 patients with the same Kt, the one with the larger V (and thus lower Kt/V) is likely to have the better clinical outcome. The lack of benefits at high Kt/V found by Held et al [7] may be because of the inclusion of malnourished patients (with small V) in the highest Kt/V group. Despite its advantages, urea Kt has yet to become a popular measure of dialysis adequacy.

RESULTS

Several factors contributing towards more optimal haemodialysis have shown an improving trend in recent years. Median blood flow rate have increased over the years and is now in the 250-299 ml/min category, whereas that of 1994 was in the 200-249 ml/min category. The proportion of patients with blood flow rates 350 ml/min or higher had also increased from 0% in 1994 to 9% in 2002 (Table 13.01).

However, there appears to be an increasing proportion of patients on twice-a-week haemodialysis (rising from 2% in 1994 to 6% in 2002). This may be due to the increasing numbers of financially marginal patients dialyzing at NGO and private centres. For example, in 2002 Malaysian Dialysis and Transplant Registry Report, the frequency of patients on twice a week dialysis in government, NGO and private dialysis centers were 1%, 3% and 25% respectively [13]. The number of patients dialyzing more than thrice a week remained negligible (Table 13.02).

Similarly, there was no suggestion of increasing dialysis duration from 4 hours, despite a small increase in the proportion of patients on 4.5 hours or more per session in the 1996-2000 period. It is also unclear whether these patients on longer dialysis are dialyzing less frequently (Table 13.03).

There has been a shift towards greater use of synthetic membranes over the report period. The proportion of dialyses using cellulosic membranes had decreased from 76% to 19% between 1994 and 2002 whilst that of synthetic membranes had risen from 1% to 64% over the same period. There was also a smaller decrease in the use of cellulose acetate membranes (from 23% to 17%) (Table 13.04).

Most HD units continue to practise dialyser reuse, although 4% of patients do not practise dialyser reuse in 2002, up from 1 % in 1994. The commonest number of dialyser use was 3 times prior to 1998. In 1998, the commonest number of times of dialyser reuse increased to 6. There has also been increasing number of patients with 8 to 12 reuses, most likely as a consequence of greater use of the more expensive synthetic dialysers (Table 13.05).

The other significant trend over the report period is the move away from acetate-based dialysate towards bicarbonate-based dialysate. The use of bicarbonate-based dialysate increased from 13% in 1994 to 98% in 2002, with a corresponding decrease in the use of acetate-based dialysate (Table 13.06).

Currently, data on delivered Kt/V is not collected in the National Renal Registry dialysis patient notification forms. Therefore all spKt/V reported in this analysis are prescribed Kt/V.

There has been an improvement in median and mean spKt/V from 1.3 in 1994 to 1.5 in 2002. Importantly, the proportion of patients with spKt/V below 1.2 decreased from 40% to 18% over the these same period. The proportion of patients with spKt/V more than or equal to 1.6 increased from 13% to 36% (Table 13.07). However it is not clear whether these patients are on fewer than 3 dialysis sessions a week. This improvement could be attributed to the use of higher prescribed blood flow rates, as shown previously. The use of dialysers with larger KoA's may also have contributed.

The trend of improving spKt/V is seen in all age groups. Younger patients tend to have higher spKt/V than older patients at all periods (Table 13.08). In particular, the median spKt/V in those aged < 20 years has risen to 1.9-2.0 in recent years, possibly due to the inclusion of paediatric patients with a small V. However, even in the oldest age group (age > 60 years), the median spKt/V is 1.5. Better vascular access, ability to tolerate higher blood flow rates and greater effort by physicians to optimize dialysis may account for the difference between age groups.

Subpopulation analysis reveals a difference in spKt/V between certain groups. Female patients consistently achieved higher spKt/V than males, most likely due to their smaller V (Table 13.09). Similarly, non-diabetic patients consistently achieved a spKt/V 0.1-0.2 Kt/V points higher than diabetics (Table 13.10). This may be due to diabetics having suboptimal vascular access resulting in limitations to the blood flow rates. Further analyses of these factors would clarify the causes leading to the differences in Kt/V.

spKt/V was found to have a significant impact on patient survival in this population. Between 1997 and 2002, unadjusted 1-year patient survival for spKt/V of <1, 1.2-<1.4 and $\geq$1.6 were 88%, 94% and 95% respectively. Corresponding rates for 3-year survival were 66%, 79% and 83% whilst those for 5-year survival were 57%, 64% and 73% respectively (Table 13.11, Fig. 13.11). These rates are significantly better than those reported by other registries. For example, the latest USRDS report reported overall survival rates of 79% at 1 year, 51% at 3 years and 33% at 5 years for haemodialysis patients [14]. This could reflect the stricter acceptance criteria for entry into haemodialysis programmes in Malaysia or under-reporting by under-performing centers.

After adjusting for age, gender, primary diagnosis and time on dialysis, and using the spKt/V 1.2 to <1.4 group as reference, the group with spKt/V <1 still showed a significantly lower 5-year survival. However, the groups with higher spKt/V than the reference group failed to show an increase in 5-year survival rates (Table 1.12, Fig. 1.12). This is in contrast to data from Australia and New Zealand, where there is continuous improvement in survival when groups with increasing URR from $\leq$ 59% to $\geq$70% were considered. However, even in the group with the highest URR, one-year patient survival was less than 90% [15].

Table 13.01 Blood Flow Rates in HD Units 1994– 2002

Blood flow rates	1994		1995		1996		1997	
	No.	%	No.	%	No.	%	No.	%
<150 ml/min	2	0	2	0	1	0	2	0
150-199 ml/min	30	3	24	2	20	2	34	2
200-249 ml/min	575	62	604	61	605	50	650	40
250-299 ml/min	288	31	297	30	484	40	735	46
300-349 ml/min	28	3	62	6	82	7	176	11
>=350 ml/min	4	0	7	1	9	1	18	1
Total	927	100	996	100	1201	100	1615	100

Blood flow rates	1998		1999		2000		2001		2002	
	No.	%	No.	%	No.	%	No.	%	No.	%
<150 ml/min	4	0	6	0	9	0	7	0	9	0
150-199 ml/min	36	2	65	2	85	2	69	1	63	1
200-249 ml/min	735	35	963	33	1283	30	1234	25	917	17
250-299 ml/min	969	47	1368	47	1940	46	2230	44	2502	46
300-349 ml/min	298	14	455	16	814	19	1276	25	1486	27
>=350 ml/min	30	1	31	1	94	2	216	4	479	9
Total	2072	100	2888	100	4225	100	5032	100	5456	100

Table 13.02 Number of HD Sessions per week, HD Units 1994 – 2002

HD sessions	1994		1995		1996		1997	
Per week	No.	%	No.	%	No.	%	No.	%
1	3	0	1	0	0	0	1	0
2	23	2	5	0	6	0	6	0
3	923	97	1015	99	1226	99	1666	99
4	2	0	3	0	8	1	9	1
Total	951	100	1024	100	1240	100	1682	100

HD sessions	1998		1999		2000		2001		2002	
Per week	No.	%	No.	%	No.	%	No.	%	No.	%
1	1	0	4	0	8	0	8	0	9	0
2	5	0	153	5	341	8	337	7	325	6
3	2111	100	2813	95	3985	91	4763	92	5250	94
4	2	0	3	0	10	0	50	1	17	0
Total	2119	100	2973	100	4356	100	5161	100	5604	100

Table 13.03 Duration of HD in HD Units 1994 – 2002

Duration of HD	1994		1995		1996		1997	
per session	No.	%	No.	%	No.	%	No.	%
<=3 hours	5	1	0	0	2	0	7	0
-3.5 hours	5	1	4	0	1	0	3	0
-4 hours	924	97	1009	98	1199	97	1595	95
-4.5 hours	4	0	7	1	30	2	70	4
-5 hours	12	1	4	0	8	1	8	0
>5 hours	2	0	1	0	0	0	1	0
Total	952	100	1025	100	1240	100	1684	100

Duration of HD	1998		1999		2000		2001		2002	
per session	No.	%	No.	%	No.	%	No.	%	No.	%
<=3 hours	3	0	4	0	8	0	6	0	18	0
-3.5 hours	18	1	9	0	12	0	33	1	15	0
-4 hours	1994	94	2737	92	4056	93	4958	96	5454	97
-4.5 hours	91	4	160	5	189	4	106	2	63	1
-5 hours	8	0	61	2	77	2	59	1	46	1
>5 hours	3	0	0	0	13	0	0	0	0	0
Total	2117	100	2971	100	4355	100	5162	100	5596	100

Table 13.04 Dialyser membrane types in HD Units 1994 – 2002

Dialyser	1994		1995		1996		1997	
membrane	No.	%	No.	%	No.	%	No.	%
Cellulosic	718	76	792	80	932	78	1149	73
Cellulose acetate	222	23	183	19	235	20	360	23
Synthetic	10	1	14	1	34	3	74	5
Total	950	100	989	100	1201	100	1583	100

Dialyser	1998		1999		2000		2001		2002	
membrane	No.	%	No.	%	No.	%	No.	%	No.	%
Cellulosic	1077	57	987	46	1270	40	1145	31	858	19
Cellulose acetate	413	22	489	23	504	16	493	13	740	17
Synthetic	413	22	672	31	1415	44	2022	55	2826	64
Total	1903	100	2148	100	3189	100	3660	100	4424	100

Table 13.05 Dialyser Reuse Frequency in HD Units 1994- 2002

Dialyser reuse Frequency	1994		1995		1996		1997	
	No.	%	No.	%	No.	%	No.	%
1*	13	1	15	2	19	2	21	1
2	9	1	7	1	10	1	9	1
3	582	64	751	77	761	67	998	63
4	188	21	153	16	175	16	174	11
5	84	9	22	2	121	11	194	12
6	37	4	18	2	31	3	154	10
7	0	0	0	0	0	0	2	0
8	2	0	0	0	1	0	4	0
9	1	0	4	0	10	1	30	2
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0
>=13	0	0	0	0	0	0	0	0
Total	916	100	970	100	1128	100	1586	100

Dialyser reuse	1998		1999		2000		2001		2002	
Frequency	No.	%	No.	%	No.	%	No.	%	No.	%
1*	16	1	65	2	117	3	152	3	183	4
2	5	0	13	0	17	0	15	0	34	1
3	215	11	192	7	205	5	232	5	247	5
4	113	6	250	9	477	12	416	9	331	6
5	137	7	264	10	313	8	357	7	304	6
6	1073	55	1415	51	1731	43	1415	29	1121	21
7	37	2	46	2	69	2	85	2	123	2
8	66	3	122	4	357	9	793	16	850	16
9	109	6	179	6	101	2	132	3	55	1
10	84	4	96	3	246	6	400	8	482	9
11	23	1	6	0	4	0	43	1	36	1
12	64	3	118	4	333	8	470	10	831	16
>=13	0	0	0	0	91	2	331	7	618	12
Total	1942	100	2766	100	4061	100	4841	100	5215	100

1* is single use i.e. no reuse

Table 13.06 Dialysate Buffer used in HD Units 1994 – 2002

Dialysate buffer	1994		1995		1996		1997	
	No.	%	No.	%	No.	%	No.	%
Acetate	830	87	822	80	648	52	551	33
Bicarbonate	122	13	207	20	603	48	1125	67
Total	952	100	1029	100	1251	100	1676	100

Dialysate buffer	1998		1999		2000		2001		2002	
	No.	%	No.	%	No.	%	No.	%	No.	%
Acetate	610	29	549	19	381	9	233	5	112	2
Bicarbonate	1475	71	2417	81	3955	91	4900	95	5436	98
Total	2085	100	2966	100	4336	100	5133	100	5548	100

Table 13.07 Distribution of KT/V, HD patients 1994-2002

Year	No of subjects	Mean	SD	Median	LQ	UQ	% patients <1	% patients 1-<1.2	% patients 1.2-<1.4	% patients 1.4-<1.6	% patients ≥1.6
1994	891	1.3	.3	1.3	1.1	1.5	14	26	28	19	13
1995	977	1.3	.3	1.3	1.1	1.5	12	27	27	20	14
1996	1176	1.3	.3	1.3	1.1	1.5	10	25	26	22	17
1997	1560	1.4	.3	1.4	1.2	1.5	9	21	27	22	21
1998	2023	1.4	.3	1.4	1.2	1.6	7	17	27	25	24
1999	2833	1.5	.3	1.5	1.3	1.7	4	13	23	24	35
2000	4090	1.5	.4	1.5	1.3	1.7	4	13	23	24	37
2001	4910	1.5	.4	1.5	1.3	1.7	4	13	23	23	37
2002	5213	1.5	.4	1.5	1.3	1.7	4	14	23	23	36

Table 13.08 Distribution of KT/V in relation to Age, HD patients 1994-2002

Year		Age group (years)							
		<20		20-39		40-59		60	
1994	Mean ± SD	1.6	0.5	1.3	0.3	1.3	0.3	1.2	0.2
	Median ± IQR	1.5	0.6	1.3	0.4	1.2	0.4	1.2	0.3
1995	Mean ± SD	1.6	0.4	1.4	0.3	1.3	0.3	1.2	0.3
	Median ± IQR	1.6	0.6	1.3	0.4	1.2	0.3	1.2	0.3
1996	Mean ± SD	1.5	0.3	1.4	0.3	1.3	0.3	1.3	0.3
	Median ± IQR	1.6	0.5	1.4	0.4	1.3	0.4	1.3	0.3
1997	Mean ± SD	1.6	0.3	1.4	0.3	1.3	0.3	1.3	0.3
	Median ± IQR	1.6	0.3	1.4	0.4	1.3	0.4	1.3	0.4
1998	Mean ± SD	1.7	0.5	1.5	0.3	1.4	0.3	1.3	0.3
	Median ± IQR	1.6	0.6	1.5	0.4	1.4	0.4	1.3	0.4
1999	Mean ± SD	1.9	0.5	1.6	0.3	1.5	0.3	1.5	0.3
	Median ± IQR	1.9	0.7	1.6	0.4	1.4	0.4	1.4	0.4
2000	Mean ± SD	2	0.5	1.6	0.4	1.5	0.3	1.5	0.3
	Median ± IQR	2	0.6	1.6	0.5	1.4	0.4	1.4	0.4
2001	Mean ± SD	2	0.6	1.6	0.4	1.5	0.3	1.5	0.3
	Median ± IQR	1.9	0.7	1.6	0.5	1.4	0.4	1.5	0.4
2002	Mean ± SD	1.9	0.6	1.6	0.4	1.5	0.3	1.5	0.3
	Median ± IQR	1.9	0.8	1.6	0.5	1.4	0.4	1.5	0.4

Table 13.09 Distribution of KT/V in relation to Gender, HD patients 1994-2002

Year		Gender			
		Male		Female	
1994	Mean ± SD	1.2	0.3	1.4	0.3
	Median ± IQR	1.2	0.3	1.4	0.4
1995	Mean ± SD	1.2	0.3	1.4	0.3
	Median ± IQR	1.2	0.3	1.4	0.4
1996	Mean ± SD	1.3	0.2	1.5	0.3
	Median ± IQR	1.2	0.3	1.5	0.4
1997	Mean ± SD	1.3	0.3	1.5	0.3
	Median ± IQR	1.3	0.4	1.5	0.4
1998	Mean ± SD	1.3	0.3	1.5	0.3
	Median ± IQR	1.3	0.4	1.5	0.4
1999	Mean ± SD	1.4	0.3	1.6	0.4
	Median ± IQR	1.4	0.4	1.6	0.5
2000	Mean ± SD	1.4	0.3	1.7	0.4
	Median ± IQR	1.4	0.4	1.6	0.5
2001	Mean ± SD	1.4	0.3	1.6	0.4
	Median ± IQR	1.4	0.4	1.6	0.5
2002	Mean ± SD	1.4	0.3	1.6	0.4
	Median ± IQR	1.4	0.4	1.6	0.5

Table 13.10 Distribution of KT/V in relation to Diabetes mellitus, HD patients 1994-2002

Year		Diabetes mellitus			
		Without DM		With DM	
1994	Mean ± SD	1.3	0.3	1.2	0.2
	Median ± IQR	1.3	0.4	1.1	0.3
1995	Mean ± SD	1.3	0.3	1.2	0.2
	Median ± IQR	1.3	0.4	1.2	0.3
1996	Mean ± SD	1.4	0.3	1.2	0.2
	Median ± IQR	1.3	0.4	1.2	0.3
1997	Mean ± SD	1.4	0.3	1.2	0.2
	Median ± IQR	1.4	0.4	1.2	0.3
1998	Mean ± SD	1.5	0.3	1.3	0.3
	Median ± IQR	1.4	0.4	1.3	0.3
1999	Mean ± SD	1.6	0.4	1.4	0.3
	Median ± IQR	1.5	0.5	1.3	0.3
2000	Mean ± SD	1.6	0.4	1.4	0.3
	Median ± IQR	1.5	0.5	1.4	0.3
2001	Mean ± SD	1.6	0.4	1.4	0.3
	Median ± IQR	1.5	0.5	1.4	0.4
2002	Mean ± SD	1.6	0.4	1.4	0.3
	Median ± IQR	1.5	0.5	1.4	0.4

Figure 13.11 Unadjusted five-year patient survival in relation to KT/V, HD patients 1997-2002

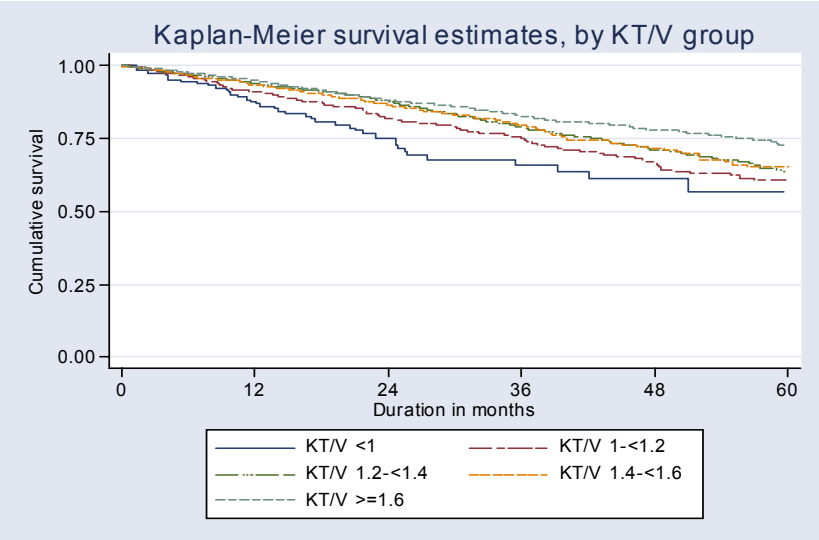


Table 13.12 Adjusted five-year patient survival in relation to KT/V, HD patients 1997-2002

KT/V	n	Hazard ratio	95% CI	p-value
<1	164	1.86	(1.34, 2.58)	0.000
1-<1.2	690	1.17	(0.97, 1.41)	0.096
1.2-<1.4	2133	1.00	-	-
1.4-<1.6	740	1.04	(0.86, 1.26)	0.691
≥ 1.6	2131	1.01	(0.87, 1.18)	0.888

Figure 13.12 Adjusted five-year patient survival in relation to KT/V, HD patients 1997-2002
(Adjusted for age, gender, primary diagnosis and time on RRT)

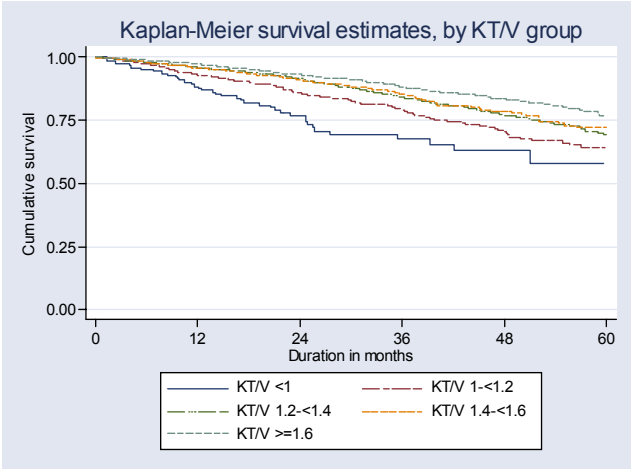


Table 13.11 Unadjusted five-year patient survival in relation to KT/V, HD patients 1997-2002

KT/V	<1		1-<1.2		1.2-<1.4		1.4-<1.6		≥1.6	
Interval (months)	% survival	SE	% survival	SE	% survival	SE	% survival	SE	% survival	SE
6	95	2	96	1	97	0	97	1	98	0
12	88	3	91	1	94	1	94	1	95	0
24	75	4	82	2	88	1	86	1	89	1
36	66	5	75	2	79	1	79	2	83	1
48	61	6	67	3	71	1	72	2	78	1
60	57	7	61	3	64	2	65	3	73	2

SE=standard error

Recommendations for future reports

1. The response rates from haemodialysis centres should be further improved to minimize the effect of under-reporting by centres offering suboptimal dialysis.
2. Analysis of dialysis parameters should distinguish between patients dialyzing 3 times a week from those dialyzing less so that a more balanced conclusion can be reached.
3. Data based consistently on delivered spKt/V, with standardized methods of blood sampling, would increase the value of our analysis.
4. Analysis of trends specific to centre type (government, NGO or private) should be done to identify factors influencing their dialysis practices and outcomes, and the changes in response to the sociopolitical and economic climate.
5. Analysis of dialyser KoA should be done to supplement data from dialyser membrane type in better identifying trends in dialyser usage.
6. Analysis of factors affecting delivered Kt/V should be done to identify areas for further improvement.
7. Data on dialysis adequacy for CAPD is not currently requested by the National Renal Registry. This should be rectified.

References

1. Lowrie EG, Laird NM, Parker TF, Sargent JA: Effect of the hemodialysis prescription on patient morbidity. *N Engl J Med* 305: 1176 – 1180, 1981

2. Gotch FA, Sargent JA: A mechanistic analysis of the National Cooperative Dialysis Study (NCDS). *Kidney Int* 28: 526 – 534, 1985

3. Daugirdas JT, Kjellstrand CM: Chronic Hemodialysis Prescription: A Urea Kinetic Approach. In Daugirdas JT, Blake PG, Ing TS: Handbook of Dialysis, 3rd edtion, Lippincott, Williams & Wilkins 121-147, 2001

4. Hakim RM, Breyer J, Ismail N, Schulman G: Effects of dose of dialysis on morbidity and mortality. *Am J Kidney Dis* 23:661–669, 1994

5. Collins AJ, Ma JZ, Umen A, Keshaviah P: Urea index and other predictors of hemodialysis patient survival. *Am J Kidney Dis* 23:272–282, 1994 [published erratum appears in *Am J Kidney Dis* 24:157, 1994

6. Parker TF 3rd, Husni L, Huang W, Lew N, Lowrie EG: Survival of hemodialysis patients in the United States is improved with a greater quantity of dialysis. *Am J Kidney Dis* 23:670–680, 1994

7. Held PJ, Port FK, Wolfe RA, Stanndard DC, Carroll CE, Daugirdas JT, Bloembergen WE, Greer JW, Hakim RM: The dose of hemodialysis and patient mortality. *Kidney Int* 50:550–556, 1996

8. Owen WF Jr, Lew NL, Liu Y, Lowrie EG, Lazarus JM: The urea reduction ratio and serum albumin concentration as predictors of mortality in patients undergoing hemodialysis [see comments]. *N Engl J Med* 329:1001–1006, 1993

9. NKF-DOQI clinical practice guidelines for hemodialysis adequacy. National Kidney Foundation. *Am J Kidney Dis* 30(3 suppl 2):S15–S66, 1997 [published erratum appears in *Am J Kidney Dis* 30(4 suppl 3): preceding table of contents, 1997]

10. Eknoyan G, Beck GJ, Cheung AK, Daugirdas JT, Greene T, Kusek JW, Allon M, Bailey J, Delmez JA, Depner TA, Dwyer JT, Levey AS, Levin NW, Milford E, Ornt DB, Rocco MV, Schulman G, Schwab SJ, Teehan BP, Toto R: Effect of Dialysis Dose and Membrane Flux in Maintenance Hemodialysis. *N Engl J Med* 347: 2010-2019, 2002

11. Lowrie EG, Chertow GM, Lew NL, Lazarus JM, Owen WF: The urea [clearance × dialysis time] product (Kt) as an outcome-based measure of hemodialysis dose. *Kidney Int* 56:729737, 1999

12. Li Z, Lew NL, Lazarus JM, Lowrie EG: Comparing the urea reduction ratio and the urea product as outcome-based measures of hemodialysis dose. *Am J Kidney Dis* 35:598–605, 2000

13. Lim TO, Lim YN, Lee DG (Eds): The 10th Report of the Malaysian Dialysis and Transplant Registry. National Renal Registry, Kuala Lumpur, 2002

14. Renal Data System. USRDS 2002 Annual Data Report: Atlas of End-stage Renal Disease in the United States. Bethesda, MD.: National Institute of Diabetes and Digestive and Kidney Diseases, 2002

15. Kerr, P: Haemodialysis. In McDonald SP, Russ GR (Eds): The 25th Report of the Australian and New Zealand Dialysis and Transplant Registry (ANZDATA). ANZDATA, Woodville, South Australia, 2002

CHAPTER 14: PAEDIATRIC RENAL REPLACEMENT THERAPY

Summary

- This chapter reports on RRT for paediatric population in-depth and separately for the first time from the adult registry report.
- The incidence of paediatric RRT in Malaysia was 8 per million age-related population and the prevalence rate was 39 per million age-related population as of December 2002. The incident and prevalent cases showed a very slow uptake from mid 1980s when RRT was first initiated in the paediatric population till 1995 when there was a rapid increase till now.
- The distribution of RRT was very uneven among the 14 states in Malaysia
- Overall male predominate in all treatment modalities
- The number of patients aged 0-4 years on RRT remained very low.
- Treatment rates seem to be levelling off for those in the age-groups 5-9 years and 10-14 years in recent years; but the rates for those aged 15-19 years continued to rise.
- CAPD is the commonest mode of renal replacement therapy followed by haemodialysis and renal transplant.
- The government is the predominant provider of dialysis treatment for children.
- The commonest causes of ESRD in children age were glomerulonephritis (54%), and reflux nephropathy (7%) with a male preponderance in all age groups
- Renal transplant recipients had the best survival outcome at 91% at 10 years, HD next at 82% and CAPD the worst at 18% only. Graft survival was 88% at 1 year, 75% at 5 years, 59% at 10 years and 49% at 15 years.

Introduction

The Malaysian National Renal Registry has published annual reports since its inception ten years ago with the paediatric data incorporated within the main report. This will be the first time the paediatric data is being reported separately as a chapter of the main Renal Registry report. In this chapter, we will present results on:

A. Provision of RRT for Malaysian children, and in relation to patient demography
B. Treatment modality (HD, CAPD and Transplant) and sector of provision (Government, NGO, Private)
C. Causes of ESRD (Primary renal diseases)
D. Survival outcomes on RRT

While we track the trends in paediatric RRT provision from 1980, most results only focus on the years from 1990 onwards to 2002 as the numbers were too few prior to 1990 for meaningful analysis. The paediatric RRT population in this report is defined as children less than 20 years of age

A. RRT provision for Paediatric patients

Stock and Flow of Paediatric patients on RRT

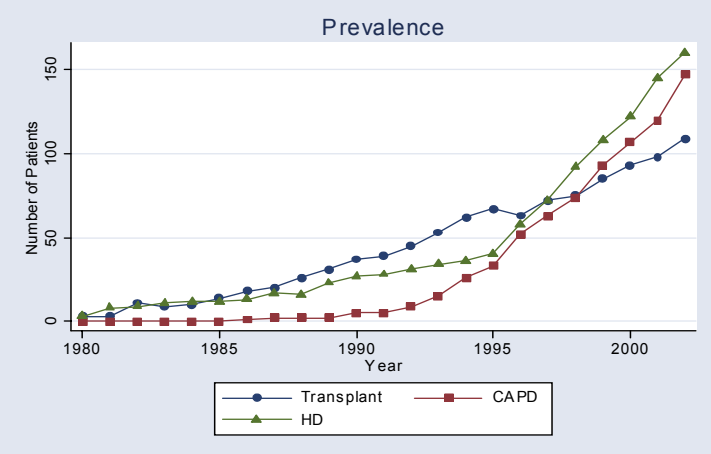
Table and figure 14.1 shows the stock and flow of patients from 1990. Prior to 1990, only a handful of patients less than 20 years of age were accepted for RRT and even then mainly onto haemodialysis or for renal transplants. The earliest treatment modality for children with ESRD in Malaysia was in 1980 with the acceptance of a patient less than 20 years of age into the haemodialysis programme, followed in 1984 by renal transplantation and CAPD in 1985. In 1990, only 11 patients less 20 year old were accepted into dialysis but this increased rapidly after 1995 to reach new dialysis intakes of 78 in 2002. The total patients dialysing at the end of each year increased from 32 in 1990 to 307 in 2002.

Renal transplantation in this age group comprised mainly of living related renal transplants unlike in adults where the majority were from live unrelated or paid cadaveric donation done overseas. In the initial years of renal replacement therapy when chronic dialysis was scarce, parents made the sacrifice to donate one of their kidneys. Once chronic dialysis became more freely available, children could then be commenced on chronic dialysis. Hence it is not surprising that the number of renal transplantations done each year had not changed much in the years 1990 to 2002, ranging from 5 to 15 per year. At the end of 2002, there were 109 patients aged less than 20 years with functioning renal transplants. (Table 14.1)

Table 14.1 Stock and Flow, Paediatric Renal Replacement Therapy 1990 – 2002 (Age < 20 years)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
New HD Patients	9	5	9	10	4	7	21	21	21	23	14	24	27
New CAPD Patients	2	2	5	6	13	13	23	20	28	30	34	37	51
New Transplants	8	6	7	9	11	8	5	14	6	11	15	9	12
HD Deaths	0	2	1	2	0	2	0	3	3	2	4	1	10
CAPD Deaths	0	2	0	0	0	2	2	3	7	2	3	8	8
Transplant Deaths	1	0	0	0	1	0	2	0	0	0	1	0	1
On HD at 31st December	27	28	31	34	36	40	58	72	92	108	122	145	162
On CAPD at 31st December	5	5	9	15	26	33	52	63	74	93	107	120	145
Functioning Transplant at 31st Dec	38	40	46	54	63	68	64	73	76	86	94	99	109

Figure 14.1 Prevalent cases of RRT by modality in children under 20 years old



RRT treatment rates

Dialysis acceptance increased from one per million age related population in 1990 to 8 per million in 2002. (Table 14.2, Figure 14.2) The RRT prevalence rates had increased from 8 per million age related population to 39 over the same period. (Table 14.2, Figure 14.2). This reflected the increasing availability and acceptability of RRT for the paediatric population with increasing affluence of the country, and an increasing number of centres with expertise in paediatric ESRF care.

The incidence and prevalence of treated ESRF is lower than that reported by ERA-EDTA [2] and the USRDS but higher than that reported in the Japanese Registry [5] for similar years as shown in Table 14.3. The Malaysian registry captured data on those children who received long-term dialysis or transplantation. Until recently, the situation in Malaysia still preclude children younger than 5 years and particularly those <2 years of age from being routinely accepted for chronic dialysis or transplant. Hence the incidence on RRT is an underestimation of the true incidence of end stage renal failure (ESRF) in children unlike in Europe and North America where incident cases of RRT remained relatively stable while prevalent cases continue to rise [2].

The incidence rate of renal transplantation had been static for the last 10 years at one per million age related population compared to a total RRT incidence of 8 per million. This situation is quite different when compared to Europe and North America with more established paediatric RRT programmes where renal transplantation is the commonest modality of treatment for paediatric RRT (73.6% in UK 2001(1), 78.9% NAPRTCS 2002 [4]).

Table 14.2 Paediatric Dialysis and Transplant Treatment Rates per million age-group population, 1990 – 2002

Year Incidence rate	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
New HD	1	1	1	1	0	1	2	2	2	2	1	2	3
New CAPD	0	0	1	1	1	1	2	2	3	3	3	4	5
New Transplant	1	1	1	1	1	1	1	1	1	1	1	1	1
Prevalence Rate at 31st December													
On HD	3	3	3	4	4	4	6	7	9	11	12	14	15
On CAPD	1	1	1	2	3	4	5	7	8	9	10	11	14
Functioning Graft	4	5	5	6	7	7	7	8	8	9	9	9	10

Figure 14.2 Incidence and prevalence rate per million age related population years old on RRT

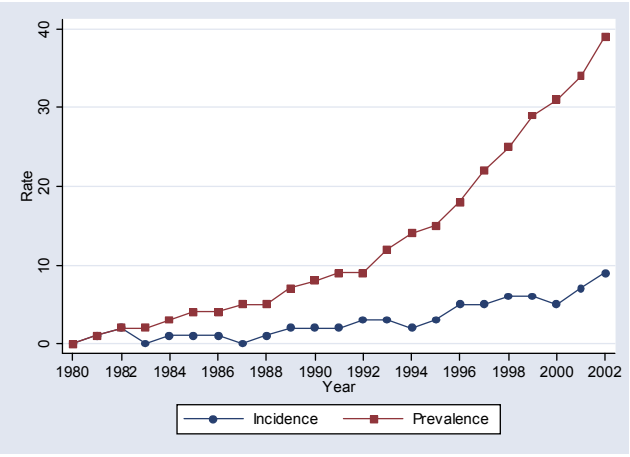


Table 14.3 Age definition, incidence and prevalence of paediatric RRT compared to other registries per million age related population (pmarp)

Registry	Age definition	Year of report	Incidence (pmarp)	Prevalence (pmarp)
Malaysia	< 20 years	2002	8.0	39.0
ERA-EDTA[2]	< 20 years	2000	10.0	62.1
UK Renal Registry[1]	< 15 years	2001	7.4	47.5
USRDS [6]	< 20 years	1995	13.0	58.0
Japanese Registry [5]	< 20 years	1998	4.0	22.0

RRT in relation to geography, gender and age

It is no mere coincidence that the highest number of children on dialysis was found in Selangor and Federal Territory (Table 14.4) as these were the states that had the first adult as well as paediatric nephrologists. Johor was the next state to have the services of a paediatric nephrologist. The economically developed states of Malaysia reflected higher intake of patients into dialysis. The east coast states of Peninsular Malaysia and Sabah which are also the most economically disadvantaged states as well as relatively large regions without easily available paediatric nephrology services to date recorded the least number of patients on dialysis. Perlis and Melaka are both states with very small population that could explain the small number of children on dialysis. This distribution of patients which probably reflected maldistribution of dialysis provision rather than actual lower incidence of ESRF needs to be rectified.

Figure 14.5 shows an overall male preponderance in all modalities of treatment which is similar to other registries [1, 2] The ratio of male to female dialysis or transplant children had not shown a dramatic change over the years to reflect a gender bias.

In relation to age, as shown in Table 14.6 and Figure 14.6(a), the number of new patients accepted into dialysis increased from the late 1980's to the late 1990's. Since then, the rising treatment rates have begun to level off for the age-groups 5-9 years and 10-14 years. The number of 0-4 year-olds provided chronic dialysis treatment remained very low. The dialysis acceptance rate for the age group 15-19 years has continued to rise however. The reason for this is unclear and needs further study.

The number of transplants done each year for the various child age-groups had either leveled off or shown a decrease for reasons alluded to earlier (Table 14.6 and Figure 14.6(b))

Table 14.4 Geographical Distribution of paediatric (<20 years) RRT 2002

State	Prevalent Cases (n)	Percentage (%)
Selangor	76	18
Johor	50	12
Federal Territory	48	12
Sarawak	42	10
Kedah	35	8
Perak	27	7
Penang	25	6
Negeri Sembilan	24	6
Pahang	20	5
Sabah	19	5
Terengganu	18	4
Kelantan	11	3
Melaka	11	3
Perlis	8	2
Total	414	101

Table 14.5 Gender distribution of New Dialysis and Transplant Patients 1980-2002

	New Dialysis		New Transplant	
	N=296	N=206	N=104	N=59
Year	% Male	% Female	% Male	% Female
1980 – 1984	65	35	69	31
1985 – 1989	65	35	66	34
1990 – 1994	54	46	63	37
1995 - 1999	60	40	61	39
2000 - 2002	58	42	64	36

Figure 14.5 Number of New dialysis and Transplant patients by gender 1980 - 2002

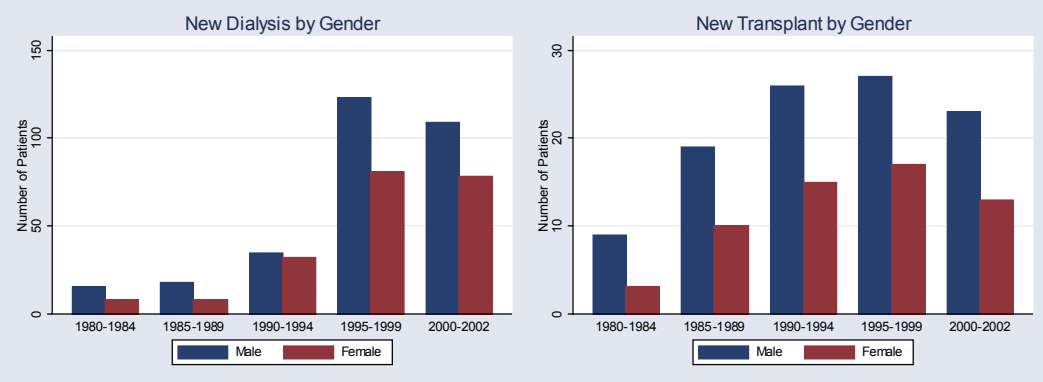


Table 14.6 Dialysis acceptance and New Transplant rate per million age group population 1990-2002

	New Dialysis				New Transplant			
	Age groups (years)				Age groups (years)			
Year	0 – 4	5 – 9	10-14	15-19	0 – 4	5 – 9	10-14	15-19
1990	0	0	1	4	0	0	1	2
1991	0	0	0	3	0	0	2	1
1992	0	1	2	4	0	0	1	2
1993	0	1	2	5	0	0	1	3
1994	1	1	3	2	0	0	1	3
1995	0	1	4	4	0	0	0	3
1996	0	3	9	9	0	0	1	1
1997	1	1	5	12	1	0	2	3
1998	0	3	8	10	0	0	1	1
1999	0	3	9	11	1	0	2	2
2000	0	4	5	11	0	0	4	3
2001	1	2	9	15	0	1	1	2
2002	3	2	10	17	0	0	3	2

Figure 14.6(a) Dialysis Treatment Rate by Age Group 1990-2002

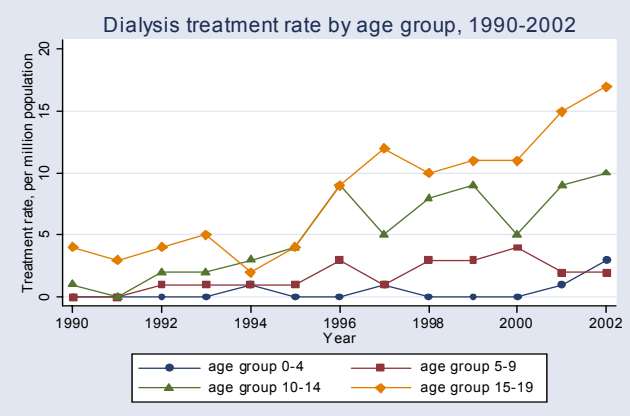
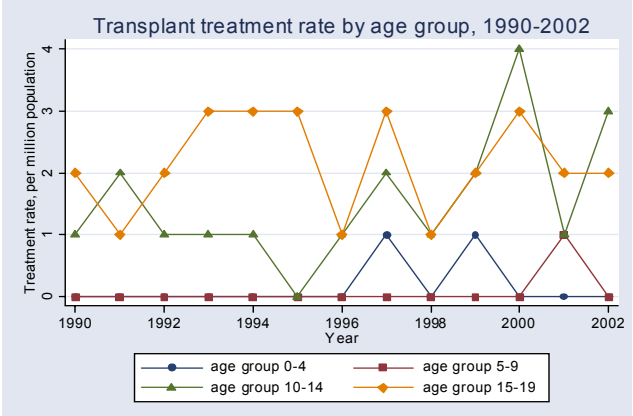


Figure 14.6(b) Transplant Treatment Rate by Age Group 1990-2002



B. Treatment modality and Sector of provision

HD was surprisingly the commonest dialysis modality in Malaysian children in the early 1990's even though CAPD treatment has been available in the country since 1981. Since 1994 however, CAPD has rapidly overtaken HD as the preferred treatment modality for children; by 2002 65% of new patients were taken on CAPD. At year end 2002, 56% of all children on dialysis were on CAPD, while HD constituted 16.5% of all children on RRT.

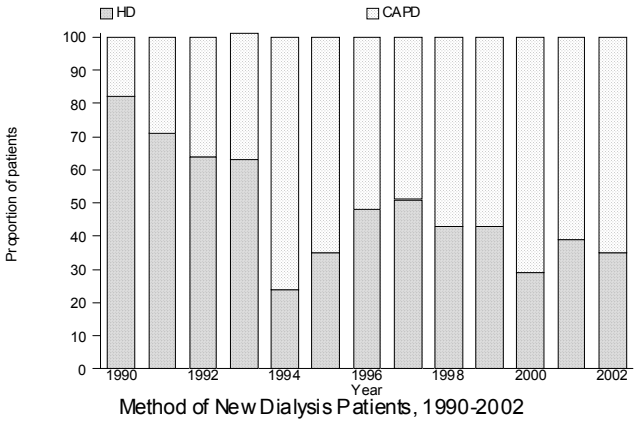
HD in children was usually initiated secondary to failure of CAPD treatment or where there was an absolute contraindication to CAPD. In the NAPRTCS[4] report, the predominant mode of dialysis is still peritoneal dialysis (2/3 of all dialysis) with automated peritoneal dialysis as the preferred mode at 75% and CAPD at only 25%. In Malaysia, the majority of patients on peritoneal dialysis were on CAPD and only a handful on automated peritoneal dialysis. This is purely because of economics – automated peritoneal dialysis cost considerably more than CAPD and the price differential between the two modalities of peritoneal dialysis would usually have to be paid by the child's own family.

Thus, provision of RRT services is still largely confined to the public sector, as shown in Table 14.8 and Figure 14.8. For example in 2002, 92% of patients aged less than years had their dialysis therapy provided by the public sector. This is as expected for a specialty (paediatric nephrology) not widely available in the private or NGO sector and where CAPD is the dominant mode of therapy, unlike the case for adult nephrology.

Table 14.7 New Dialysis by treatment modality 1990 - 2002

Year	N	% HD	% CAPD	Year	N	% HD	% CAPD
1990	11	82	18	1997	41	51	49
1991	7	71	29	1998	49	43	57
1992	14	64	36	1999	53	43	57
1993	16	63	38	2000	48	29	71
1994	17	24	76	2001	61	39	61
1995	20	35	65	2002	78	35	65
1996	44	48	52				

Figure 14.7 New Dialysis by treatment modality 1990 - 2002

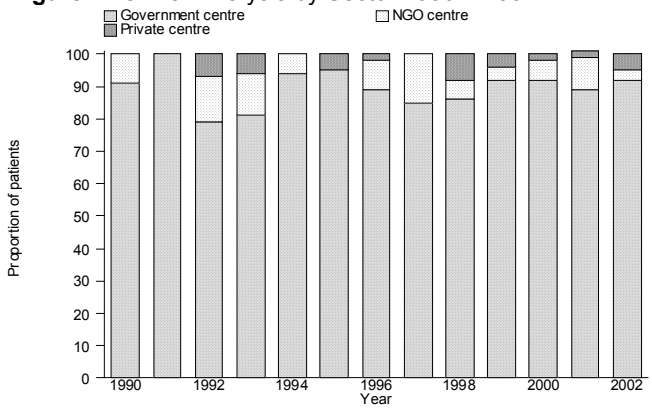


Method of New Dialysis Patients, 1990-2002

Table 14.8 New Dialysis by Sector 1990 - 2002

Year	N	% Govt	% NGO	% Private	Year	N	% Govt	% NGO	% Private
1990	11	91	9	0	1997	41	85	15	0
1991	7	100	0	0	1998	49	86	6	8
1992	14	79	14	7	1999	53	92	4	4
1993	16	81	13	6	2000	48	92	6	2
1994	17	94	6	0	2001	61	89	10	2
1995	20	95	0	5	2002	78	92	3	5
1996	44	89	9	2					

Figure 14.8 New Dialysis by Sector 1990 – 2002



Distribution of New Dialysis Patients by sector, 1990-2002

C. Primary Renal Disease

Table 14.9 shows that more than half (54%) of treated ESRD in those aged <20 years was caused by glomerulonephritis, and 20% of this 54% was due to focal segmental glomerulosclerosis. Reflux nephropathy accounted for 7%. The number of patients with reflux nephropathy has fallen from 26% (1990-1994) to 7% (2002). This may be due to earlier detection and better management of urinary tract infection although literature about the effectiveness of this intervention differs. Renal dysplasia and obstructive uropathy contributed to less than 10% of patients which is lower than other registry reports [1, 4]. In the ERA–EDTA database glomerulonephritis and pyelonephritis were the two commonest causes of ESRD[2]. In the 2003 ANZDATA Registry report glomerulonephritis and hypoplasia /dysplasia were the two leading causes of ESRD in both Australia and New Zealand.[3] In Kuwait chronic glomerulonephritis was the leading cause followed by obstructive uropathy and vesicoureteric reflux[7]. There was still an unacceptably high percentage of children with unknown cause of F.

There was a preponderance of boys particularly in the glomerulonephritis group (Table 14.9). Posterior urethral valve was the commonest cause of obstructive uropathy; hence it is no surprise that boys also predominated in this disease category. Glomerulonephritis and reflux nephropathy were commoner causes in the older age group while renal dysplasia presented at a younger age.

D. Patient Survival outcome by RRT modality

Table and Figure 14.10 show the patient survival rates by modality of treatment from 1980 to 2002. Among the three modalities of treatment; renal transplantation had the best whereas CAPD had the worst survival outcome.

Patient survival on CAPD was 97% at one year, 84% at 5 years with a rapid deterioration from 8 years onwards to only 27% at 10 years. The survival on CAPD was fairly comparable to survival on HD until 8 years into dialysis when a rapid deterioration is seen in CAPD but not in HD. The leading causes of mortality in CAPD were cardiovascular and sudden death at home (42%) and infection (21%); half of which was caused by peritonitis. On the other hand, patient survival on HD was 96% at one year, 87% at 5 years, 75% at 10 years. As a dialysis modality it had a more favourable long term outcome than CAPD. Although deaths were few in the HD population, the recorded causes of death in HD patients were infection related (57%) and cardiovascular causes and sudden death at home (28.5%).

Table 14.11 and Figure 14.11 show an average of 10% progressive deterioration in CAPD technique survival annually. Technique survival on CAPD was 94% at 1 year, 61% at 5 years and only 7% at 10 years. The causes of technique failure could not be analysed from the existing database and need further study.

Haemodialysis technique survival was 92% at one-year, 80% at 5-years, and 69% at 10 years.

Table 14.9 Primary Renal Disease 1990– 2002

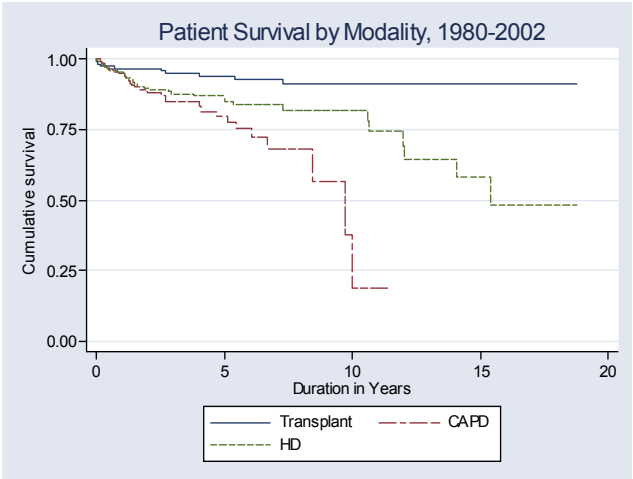
Primary Renal Disease	Male		Female		All	
	N	%	N	%	N	%
Glomerulonephritis	130	60%	111	40%	241	54%
• (FSGS)						(20%)
Reflux nephropathy	34	75%	12	25%	46	7%
Renal dysplasia	13	50%	9	50%	22	5%
Obstructive uropathy	14	75%	5	25%	19	5%
Unknown	63	46%	43	54%	106	26%

Table14.10 Patient Survival by Modality of RRT, 1980-2002

Modality Interval (years)	Transplant % survival	SE	CAPD % survival	SE	HD % survival	SE
1	97	1	95	1	95	1
5	94	2	80	4	87	2
10	91	3	19	16	82	3
15	91	3			58	10

* SE Standard Error

Figure 14.10 Patient Survival by Modality



(Table 14.11) Haemodialysis technique survival was comparable to that of CAPD in the first 2 years of therapy but showed progressive advantage subsequently. Six to 10% of patients of patients on CAPD were transferred to HD yearly compared to 2-3% from HD to CAPD (data not shown). This is lower than that reported by NAPRTCS where the change in modality of dialysis (PD to HD and vice-versa) was 20% at 2 years. Before 2 years of therapy the incidence of change of modality was less in CAPD than HD, equalized at 2 years but increased for CAPD till 30% at 3 years while it plateaued for HD at 3 years.[4]

The first paediatric renal transplantation in Malaysia was done in 1984. Since then a total of 69 paediatric transplantations were performed from 1984 to 2002. Of these, living related renal transplantation contributed 75.5%, cadaveric transplantation 16% and commercial transplantation 8.5%. (Table 14.12) There was an increase in the proportion of cadaveric transplantations from 2000 onwards.

The overall patient survival for paediatric renal transplants was 97% at 1 year, and 92% at five, ten and 15 years (Table & Figure 14.10).

Table 14.13 and Figure 14.13 show that the graft survival for our paediatric renal transplants was 86% at 1 year, 73% at 5 years, 63% at 10 years and 53% at 15 years. We could not analyse the difference in survival between living related and cadaveric transplantation, nor the causes of graft loss in this report. In the NAPRTCS data the graft survival are 93% at 1 year, 86% at 3 years and 80% at 5 years for living related transplantation and 84% at 1 year, 74% at 3 years and 66% at 5 years for cadaveric transplantation.[4]

Table 14.11 Dialysis Technique Survival by Modality 1980-2002

Modality	CAPD		HD	
Interval (years)	% survival	SE*	% survival	SE*
1	89	2	93	2
5	54	4	83	3
10	5	4	76	4
15			54	10

* SE Standard Error

Figure 14.11 Dialysis Technique survival by modality

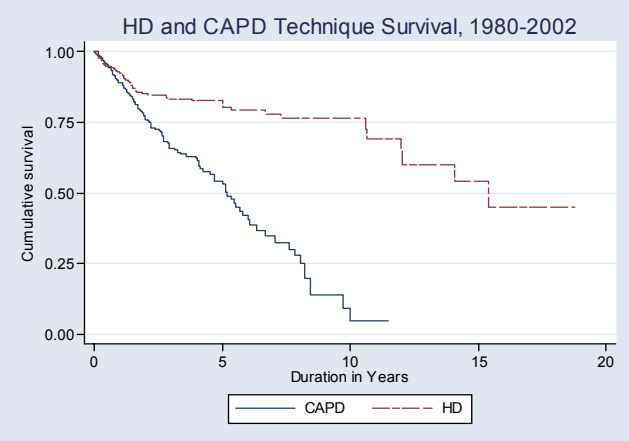


Table 14.12 Types of Transplant 1985-2002

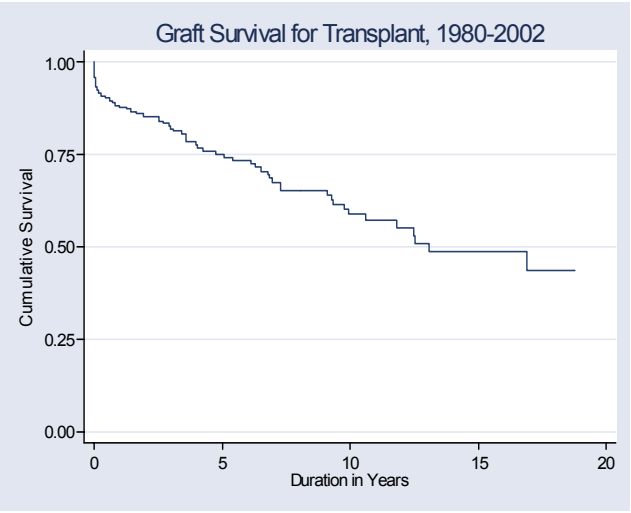
Year	1985-1989		1990-1994		1995-1999		2000-2002	
	No.	%	No.	%	No.	%	No.	%
Commercial cadaver	0	0	1	2	9	20	4	11
Commercial living donor	5	17	9	22	2	5	5	14
Living related donor	23	79	31	76	31	70	14	39
Living emotionally related	0	0	0	0	0	0	0	0
Cadaver	1	3	0	0	2	5	13	36
Total	29	100	41	100	44	100	36	100

Table 14.13 Transplant Allograft survival, 1980-2002

Interval (years)	% survival	SE*
1	88	3
5	75	4
10	59	5
15	49	6

* SE Standard Error

Figure 14.13 Transplant allograft survival 1980-2002



References

1. Ansell D, Feest T, Byrne C. UK Renal Registry Report 2002, UK Renal Registry, Bristol UK.

2. Heijden BJ van der, Dijk PCW van, Verrier-Jones K, Jager KJ, Briggs JD. Renal replacement therapy in children: data from 12 registries in Europe. Pediatr Nephol (2004)19:213-221.

3. Craig JC. Paediatrics. In: Russ GR (ed) ANZDATA Registy Report 2001. Australia and New Zealand Dialysis and Transplant Registry, Adelaide, South Australia pp 91-93.

4. Neu AM, Ho PLM, McDonald RA, Warady BA. Chronic dialysis in children and adolescents. The 2001 NAPRTCS Annual Report. Pediatr Nephrol (2002) 17:656-663

5. Hattori S, Yosioka K, Honda M, Ito H. The 1998 report of the Japanese National Registry data on paediatric end-stage renal disease patients. Pediatr Nephrol (2002) 17: 456-56

6. 1997 Annual Data Report USRDS Atlas of ESRD in the US. Am J Kidney Dis (1997); 30(2) Suppl.1: S128-S144

7. Kamal El Rashid Mdan M Kapoor MR Naryanan Paediatric dialysis and renal transplantation in Kuwait over past 11 years. Pediatr Nephrol (1999) 13: 259-264

8. 2002 Annual Data Report USRDS Atlas of ESRD in the US. Am J Kidney Dis (2003); 41(4) Suppl.2: S121-S134

APPENDIX 1: DATA MANAGEMENT

Introduction

Data integrity of a register begins from the data source, data collection tool, data verification and data entry process. Data held in a registry is never perfect. Hence, caution should be used when interpreting the results.

Data source

The initial phase of the data collected in the Register covered all Renal Replacement Therapy (RRT) patients in the Ministry of Health program since its inception in 1976. The Register subsequently received the data from other sectors of RRT providers like the private, non-government organization, armed forces and the university.

The Register continues to actively ascertain new RRT centres in the country. The mechanism of ascertainment is through feedback from the dialysis related companies, Source Data Providers (SDP) and public propagandas. This will gradually and eventually result in a complete RRT centre database. The identified RRT centre is then invited to participate in data collection. Those RRT centres that have expressed interest in participating will be recruited as Source Data Providers (SDP).

The NRR currently receives data from 267 SDPs comprising 218 HD centres, 18 CAPD centres and 31 centres that performed transplants or provide follow-up care for post transplant patients. This represents coverage of 81% of potential SDPs in the country as shown in the table below:

Facilities	Known centre	Submitting data in 2003	
	N	N	%
HD	257	218	85
CAPD	24	18	75
TX follow-up	51	33	65
All modality	332	269	81

Data collection

The data collection tools were designed to mimic the data capture format in the patient case notes to facilitate data transcription and minimise transcription error. All the SDPs are provided with an instruction manual on data collection and submission to the Register.

The Register collects the RRT patients' demographic details, clinical data, dialysis treatment data, transplant data, peritonitis data and outcome data. The Register holds individual patient's identifiable data that allow complete follow-up despite unit transfers or change of modality which are especially common among the RRT patients. These registered patients are monitored and tracked from the time they commenced on RRT till their death. For those patients who are lost to follow-up, the Register will verify their outcome with the National Vitals Registration System. Patients profiles are submitted to the Register through out the year.

Centre-specific reports are generated and forwarded to the SDPs on a quarterly basis. This has generated increased feedback from SDPs and improved the patient ascertainment rate and the accuracy of the data transmitted to the Registry.

At the end of each year, the Register conducts a survey on the Staff and Facility Profile. The survey questionnaire provides summary information about the number of patients on various treatments. This acts as the basis for the calculation of patient ascertainment rate.

Database System

The initial database of the Register was created in DBASE IV in a single computer environment. It was then upgraded to Microsoft Access as a client server application. Currently the NRR data system is a Pentium Xeon 2.4 with dual processors, with a total of 1GB RAM memory and 72GB of RAID-5 (Redundant Array of Independent Disks, level 5). In view of capacity ability, performance and security issues of Microsoft Access, the database will be migrated to SQL Server 2000 by the end of this year.

Data management personnel

The data management personnel in the Register office are trained based on the standard operating procedures (SOP). The data entry process is also designed to enhance data quality. Quality assurance procedures are in place at all stages to ensure data quality.

Visual review, Data entry and de-duplication verification, Data Editing

On receiving case report forms (CRF) submitted by SDP, visual review is performed to check for obvious errors or missing data in the important fields. Data entry will not be performed if a critical variable on the CRF is missing or ambiguous. The CRF is returned to the SDP for verification.

After passing duplicate checks the data is than entered and coded where required. Edit checks are performed against pre-specified validation rules to detect missing values, out of range values or inconsistent values. Any data discrepancy found is verified against the source CRF and resolved within the Register office where possible. Otherwise the specific data query report will be generated and forwarded to the SDP to clarify and resolve the data discrepancy.

Data coding, data cleaning / data analysis

Most of the data fields have auto data coding. Those data in text fields will be manually coded by the Register manager. A final edit check run is performed to ensure that data is clean. All queries are resolved before database is locked to ensure data quality and integrity. Data is subsequently exported to the statistician for analysis.

Limitation

The majority of the RRT centres in this country are still paper base. Currently there is no satisfactory electronic patient information systems in the country. Computer literacy among staff is still low.

The data submission to the Register is voluntary and is done manually using the standard data collection tools. The process is tedious and time consuming for the SDP and the Register office. Some SDPs do have difficulty in data submission for the current year in time for inclusion in the yearly report. Thus, this inevitably results in slight differences when the existing data is being reported in subsequent year. The continuing efforts to improve the timely data submission is important.

Data release policy

One of the primary objectives of the Registry is to make data available to the renal community. There are published data in the annual report in the NRR website: http://www.crc.gov.my/nrr. The Registry would appreciate that users acknowledge the Registry for the use of the data. Any request for data that requires a computer run must be made in writing (by e-mail, fax, or registered mail) accompanied with a Data Release Application Form and signed Data Release Agreement Form. These requests need prior approval by the Advisory Board before data can be released.

Distribution of report

The MSN has made a grant towards the cost of running the registry and the report printing to allow distribution to all members of the association and the source data producers. The report will also be distributed to Health Authorities and international registries.

Further copies of the report can be made available with a donation of RM60.00 to offset the cost of printing. The full report is also available on the registry web site: http://www.crc.gov.my/nrr

APPENDIX 2: ANALYSIS SETS AND STATISTICAL METHODS

Analysis sets

This refer to the sets of cases whose data are to be included in the analysis.
Three analysis sets are defined:
1. Dialysis patients notified between 1980 and 2003
This analysis set consists of patients commencing dialysis between 1980 and 2002. This analysis set is used for the analysis in Chapter 1 and 2.

2. Dialysis patients between 1993 and 2002
Since 1993, the NRR conducted an annual survey on all dialysis patients to collect data on dialysis and drug treatments, clinical and laboratory measurements. All available data were used to describe the trends in these characteristics.
However, in the early years, these data collected from annual survey were relatively incomplete. Hence, for survival analysis in relation to these characteristics, we used only data from 1997 onwards when the data were more complete. Remaining missing data in this analysis set was imputed using first available observation carried backward or last observation carried forward.

3. Rehabilitation outcomes
Analysis is confined to the relevant population. Hence we exclude the following groups.
(i) Age less than or equal to 21 years
(ii) Age more than or equal to 55 years
(iii) Homemaker
(iv) Full time student
(v) Retired

Statistical methods

Population treatment rates (new treatment or prevalence rates)

Treatment rate is calculated by the ratio of the count of number of new patients or prevalent patients in a given year to the mid-year population of Malaysia in that year, and expressed in per million-population.
Results on distribution of treatment rates by state are also expressed in per million-population since states obviously vary in their population sizes.
Classification of level of provision in a state is based on dialysis treatment rate over period 2000-2002. High provision states are defined as those with rate > 100pmp, mid provision states 50-100pmp and low provision states <50pmp.

Death rate calculation

Annual death rates were calculated by dividing the number of deaths in a year by the estimated mid-year patient population.

Odds ratio

The odds of an event is the probability of having the event divided by the probability of not having it.
The odds ratio is used for comparing the odds of 2 groups. If the odds in group 1 is O1 and group 2 is O2, then odds ratio is O1/O2. Thus the odds ratio expresses the relative probability that an event will occur when 2 groups are compared.
With multiple factors, logistic regression model was used to estimate the independent effect of each factor, expressed as odds ratio, on the event of interest.

Cumulative odds ratio

For QOL outcome, which is measured on an ordinal scale, the cumulative odd ratios for a factor that affected the outcome expresses the relative cumulative probability for the QOL score. This is best explained by an example. The cumulative OR for QOL score for female dialysis patients compare to males is 0.77. This means the odds for higher QOL score are lower for female than male patients. In other words, the cumulative distribution for the QOL score for female patients is shifted to the left of male patients.
The cumulative odds ratio associated with a factor of interest is estimated using the proportional odds model. In this model, the cumulative probabilities for the ordinal dependent variable (QOL score), after suitable transformation (logit transform), is modelled as a linear function of all the factors of interest (covariates).

Survival analysis

The unadjusted survival probabilities (with 95% confidence intrevals) were calculated using the Kaplan-Meier method, in which the probability of surviving more than a given time can be estimated for members of a cohort of patients without accounting for the characteristics of the members of that cohort. Where centres are small or the survival probabilities are greater than 90%, the confidence intervals are only approximate.

In order to estimate the difference in survival of different subgroups of patients within the cohort, a proportional hazards model (Cox) was used where appropriate. The results from Cox model are interpreted using a hazard ratio. Adjusted survival probabilities are with age, gender, primary diagnosis and time on RRT used as adjusting risk factors. For diabetics compared with non-diabetics, for example, the hazard ratio is the ratio of the estimated hazards for diabetics relative to non-diabetics, where the hazard is the risk of dying at time t given that the individual has survival until this time. The underlying assumption of a proportional

hazards model is that the ratio remains constant throughout the period under consideration.

Analysis of trend of intermediate results

For summarizing intermediate results like continuous laboratory data, we have calculated summary statistics like mean, standard deviation, median, lower quartile, upper quarter and interquartile range (IQR). For QOL and rehabilitation outcomes of dialysis patients, cumulative distribution plot shows a listing of the sample values of a variable on the X axis and the proportion of the observations less than or greater than each value on the Y axis. An accompanying table gives the Median (50% of values are above or below it), upper quartile (UQ, 25% of values above and 75% below it), lower quartile (LQ, 75% of values above and 25% below it) and other percentiles. The table also shows percent of observations above or below a target value, or within an interval of values; the target value or interval obviously vary with the type of laboratory data. For example, interval of values for prescribed KT/V is <1, 1-<1.2, 1.2-<1.4, 1.4-<1.6 and $\geq$1.6 and that for haemoglobin is <10, 10-$\leq$12 and >12 g/l. The choice of target value is guided by published clinical practice guidelines, for example, the DOQI guideline; or otherwise they represent consensus of the local dialysis community.

APPENDIX 3: GLOSSARY

MOH	Ministry of Health, Malaysia
NRR	National Renal Registry
CRC	Clinical Research Centre
RRU	Renal Registry Unit
MSN	Malaysian Society of Nephrology
DAMAN	Dialysis Association of Medical Assistants and Nurses
USRDS	United States Renal Data System
EDTA-ERA	European Dialysis and Transplant Association – European Renal Association
NAPRTCS	North American Pediatric Renal Transplant Cooperative Study
K/DOQI	Kidney disease outcomes quality initiative
QC	Quality control
SDP	Source Data Provider
SOP	Standard Operating Procedure
CRA	Clinical Registry Assistant
CRM	Clinical Registry Manager
CRF	Case report form
HKL	Hospital Kuala Lumpur
NGO	Non-governmental organization
ESRD	End stage renal failure
HD	Haemodialysis
PD	Peritoneal dialysis
CAPD	Continuous ambulatory peritoneal dialysis
BMI	Body mass index
pmp	Per million population
pmarp	Per million age related population