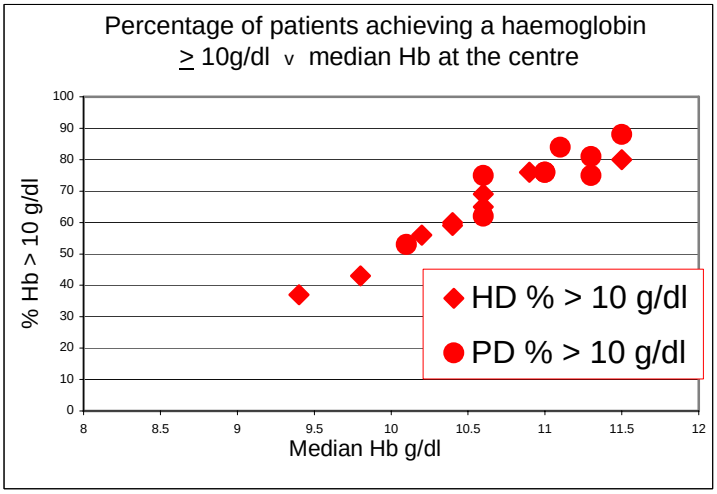
The First Annual Report

The
UK Renal Registry

September 1998

UK RENAL REGISTRY



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Retired Members 1997	Dr C Brown (secretary) Dr C Winearls (ex officio, Secretary, Renal Association) Dr D Briggs (BTS representative)
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Participating Centres

Birmingham	Heartlands Hospital
Bristol	Richard Bright Renal Unit, Southmead Hospital
Cardiff	University of Wales Hospital
Gloucester	Gloucester Royal Infirmary
Hull	Hull Royal Infirmary
Leeds	St James Hospital and Leeds General Infirmary
Leicester	Leicester General Hospital
Middlesborough	South Cleveland Hospital
Nottingham	Nottingham City Hospital
Plymouth	Derriford Hospital
Sheffield	Northern General Hospital
Stevenage	Lister Hospital

Sites in progress :-

Carlisle	Cumberland Infirmary
Carshalton	St Helier
London	Kings College Hospital
Oxford	Churchill Hospital
Sunderland	Sunderland Royal Infirmary
Scotland	(awaiting consent from clinicians to analyse Scottish data)
Di Proton system	Preston, Swansea, Southend

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Chapter 1 Introduction To The UK Renal Registry

1:1 The purpose of the Renal Registry

The primary intention of the UK Renal Registry is to carefully monitor the quantity and quality of renal care in the UK, and thus to improve the quality and efficiency of this care.

1:2 UK National Registries

The Department of Health has recognised the desirability of developing national registries which will identify the cost and effectiveness of both medical and surgical treatments. Within the United Kingdom registries have been planned and implemented in cardiac surgery, intensive care, and diabetes. A Renal Registry was initiated in Scotland in 1992. The data contained in these registries will be used for national comparative speciality audits and identification of good practice in patient care. This activity is especially important in high cost, low volume services such as renal replacement therapy.

1:3 The need for a Renal Registry

The number of patients in the UK who enter endstage renal failure (ESRF) and subsequently require renal replacement therapy (RRT) continues to grow. Renal replacement therapy consumes nearly 2% of the NHS budget at an approximate cost of £25,000 per patient per annum. This is forecast to rise towards 3% of the total NHS budget within five years.

At the last survey of renal services in England and Wales in 1995 (Ref 1) there were 23,115 patients undergoing renal replacement therapy. The numbers in England had risen by 3,900 since the National Review of 1993, an increase of 20%. Only 5,500 of these patients, less than 25%, were registered on the National Organ Matching waiting list for a renal transplant. It is clearly essential for the National Health Service that the quality and efficiency of a service which is both expensive and expanding rapidly is monitored carefully. Until 10 years ago some information useful for management of the service was collected and analysed by the European Dialysis and Transplant Association (EDTA) registry. This registry is based on paper returns and the data collected from the UK in recent years has not been sufficiently complete to be of great value. The data set collected is also small, with little clinical information of help in monitoring the processes of care.

1:4 Recommended standards of renal care and the Renal Registry

The UK Renal Association, together with the Royal College of Physicians of London, has produced a comprehensive document of recommended standards and audit measures in the treatment of adult patients with renal failure. The Renal Registry will act as a source of comparative data for audit of compliance with the standards.

The Registry Subcommittee will maintain close links with the Renal Association Standards Subcommittee to support the further development of the Standards document and to monitor implementation.

1:5 Summary of the Renal Registry

The UK Renal Registry was established by the Renal Association with support from the Department of Health, the British Association for Paediatric Nephrology, and the British Transplant Society. It is intended to be a resource in the development of patient care in renal disease. The Registry provides a focus for the collection and analysis of standardised data relating to the incidence, clinical management and outcome of renal disease. It will thus act as a source of comparative data for audit/benchmarking, planning and research. The UK Renal Registry will monitor indicators of the quality as well as quantity of care, with the aim of improving the standard of care. There will be an early concentration on data concerning renal replacement therapy, including transplantation. At a later date there will be an extension to other forms of treatment of renal disease..

There are a number of renal registries abroad which provide data on the acceptance of patients for renal replacement therapy, the stock of patients, treatment modalities and survival. However the regular collection and analysis of biochemical and haematological information is a unique feature of the UK Registry. This has been attempted before by very few groups

Data will be collected quarterly by automatic downloading from renal unit databases. Reports will be published twice yearly to allow comparative audit of facilities, patient demographics, quality of care and outcome measures.

The Registry will provide data for participating renal units, NHS Trusts, district health authorities and regional offices. It will also be in a position to submit data to the EDTA Registry, and other registries, if requested. The development of the Registry will be open to influence by all interested parties including clinicians, trusts, primary care groups, district health and other commissioning authorities, and patients organisations.

The initial development of the Registry has been financed by grants from the Department of Health and from industry. However its continuing activity will have to be funded through payment by participating renal units of an annual fee per patient registered. In this way the Registry will be able to remain an independent source of data and analysis on national activity in renal disease.

A more full explanation of the Registry is contained in the document 'The Registry Rationale' in Appendix A. The outline composition of the Renal Registry subcommittee is illustrated in Figure 1.1. A summary of the functions of the Renal Registry is contained in table 1.1

Functions of the UK Renal Registry
• To collect demographic and descriptive data for comparison of equity of care and planning of service development • To facilitate comparative audit by means of a carefully defined data set • To collect data on indicators of quality of care to facilitate: Audit of the effectiveness of care against recommended national standards Improved care by identification of good practice • To produce national and local outcome data, having regard to case mix • To be a resource for research studies

Table 1.1 Functions of the UK Renal Registry

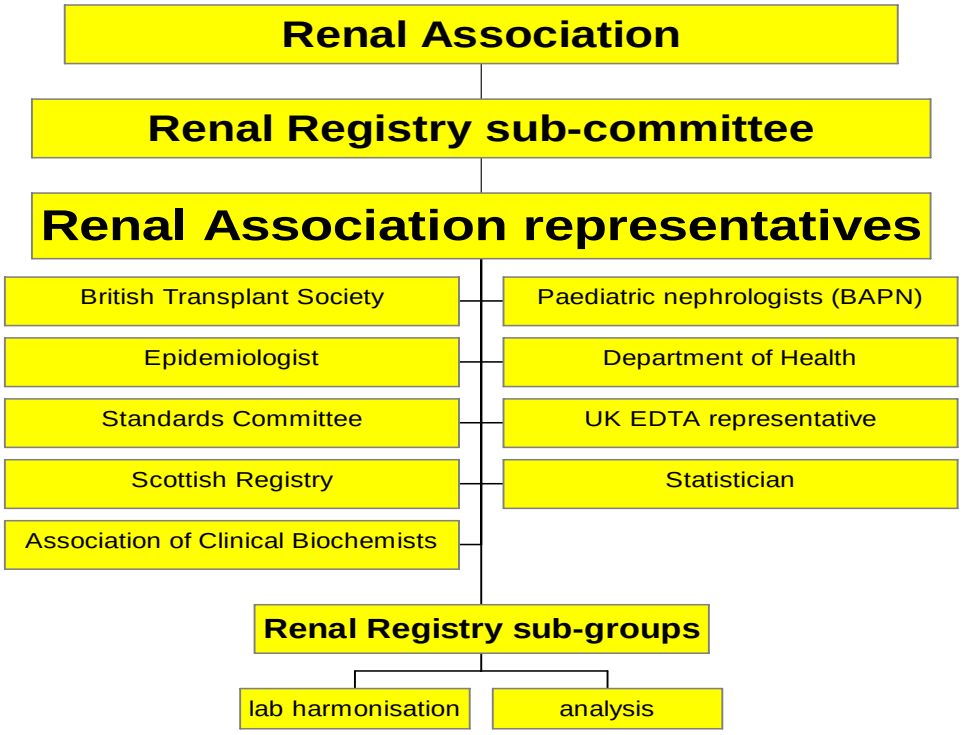

Figure 1.1 Composition of the Renal Registry Subcommittee

1:6 The question of nationwide participation in the Renal Registry

Participation in the Renal Registry is voluntary but the expectation is that all United Kingdom renal and transplant units will ultimately take advantage of the opportunities offered by the Renal Registry database. Ability to participate could be limited by the individual unit's information technology and data quality.

The ultimate aim is participation by all renal centres. Renal registries traditionally collect demographic data on patients receiving renal replacement therapy, giving information on acceptance rates, treatment types and patient characteristics. This needs a relatively small data set, often only 40 items, but demands countrywide coverage to be most useful. It allows the monitoring of trends, comparison between centres and countries, and planning. The Renal Registry will continuously evaluate the characteristics of the registered patients to check how representative they are of what is known of the country as a whole. It will also carry out simple surveys to collect demographic data from the whole of the UK.

To monitor indicators of quality of care and improve practice needs a large data set - the Registry is currently collecting 200 data items per patient quarterly, but does not need nationwide coverage. The data are useful as long as they are complete for each participating unit. The current database allows preliminary conclusions on national activity.

1:7 The development of the Renal Registry

A two year pilot project was started in April 1995. The first task of the Registry subcommittee was to specify a data set and then to commission the writing of a database. The software was originally written to run on a VAX cluster at the United Kingdom Transplant Service Special Authority (UKTSSA). Due to lack of space at UKTSSA, the Registry relocated to rented premises at Southmead Hospital in May 1997. The move delayed development, but forced the Registry to become fully independent. It now employs its own staff, runs its own payroll and purchases its own computer equipment and software licences.

Part of the initial specification of the database was portability. At the time of relocation the database was transferred to run on the Registry's own hardware. The database is on a Dec Alpha with 128 megabytes ram and 10 gigabytes of hard disk storage. The operating system runs Digital's open VMS, with a multi-user licence, and the database uses Oracles RDB file structure. This was sponsored by Oracle without charge to the Registry. All the database validation routines and screen handling have been written in Powerhouse (by Cognos), a 4GL language.

By March 1997 it had been demonstrated that the database was sufficient for the task and that the rigorous data validation routines developed were functioning. In April 1997 the Registry started to enrol further renal units and by July 1998 11 units, within

England and one in Wales were participating. They cover a combined population of at least 13 million, which includes 22% of the population of England.

Close links have been maintained with the Scottish Renal Registry and software has been successfully written to enable transfer of data from the Scottish Registry to the UK Registry. This will be facilitated when once all the Scottish renal units have given permission for this transfer. During 1998 many more of the Welsh units will enrol with the Registry. The participating units, and those currently planning to join are listed on the inside cover of this report.

1:8 Data transfer and management

There are no paper returns to the UK Renal Registry. Data extraction and transfer is electronic. For units to participate it is simply necessary that they have an Information Technology system storing required patient data. When a unit intends to join the Registry, staff from the Registry visit to study the local database. They then load software to extract the Registry data items from the unit database. The software prepares a file with identifiers for each data item. Data extraction is quarterly and file transfer is via modem over the NHS Healthnet. This is a secure system approved by the Department of Health. The data transfer on 1,000 patients takes less than 10 minutes.

On receipt of the file, the Registry holds data in a buffer area until staff are ready to process it. Validation routines are run to identify missing data, inconsistencies and unexpected changes. The Registry data manager discusses these problems with the local nominated Registry representative and will not load the data on the definitive database until the data are considered complete and accurate. Data transfer and management are summarised in tables 1.2 and 1.3

UK Renal Registry - data collection
• Initial visits to unit for:: - Standardisation of local system - Installation of extraction routines • Quarterly local extraction carried out: - File produced with identifiers for each data item - Transfer by NHS Healthnet - Data transfer - 200 items per patient - 1000 patients in 10 minutes - File held at Registry until staff ready to process

Table 1.2 Data extraction and transfer

UK Renal Registry - data management
• Load unit file to database • Validation routine generates a report - e.g. duplications, omissions, inconsistent patient transfer date • Data manager: - Returns report by BT Healthnet - Telephone nominated contact in unit to discuss - Receives new revised report - Loads data to database when satisfied • Statistical routines - half day - Finds inconsistencies, unexpected changes, out of range results, etc - Further checks with unit on accuracy • Data report finally accepted

Table 1.3 Data management

It is only with electronic extraction and transfer of data that quarterly returns can be achieved. Such frequent returns allow for close monitoring of change. The most useful interval is yet to be explored and established. With electronic transfer the UK Renal Registry is able to provide reports to units on data not more than six months old. Most other major renal registries are unable to report more quickly than eighteen months to two years, largely because they accept paper returns. This is a slow process needing transcription on receipt into a database.

1:9 Definitions

In order to allow meaningful comparative audit it was necessary for the Registry subcommittee to make clear definitions of the data collected. This was completed through a process of wide consultation. The definitions used by the Renal Registry are shown in appendix B. Further refinement and standardisation of these is likely in the future.

1:10 Registry funding

The initial development of the UK Renal Registry has been financed by grants from the Department of Health and from industry. Continuing activity will have to be funded through payment by participating renal units of an annual fee per patient registered. In this way the Registry will be able to remain an independent source of data and analysis on national activity in renal disease. It is intended to make an annual charge per patient registered, which in the first phase will be £10.00 per patient per annum. This is 0.05% of the annual patient treatment cost and is considerably less than that charged by registries within other specialities in the United Kingdom.

The registry income will therefore be dependent on the number of patients registered, and thus the number of renal units participating. It is important that renal units put these charges into their Business Plans. They may need to help commissioning health

authorities to recognise the significance of the Renal Registry and the fact that it is the only vehicle for comparative audit of the provision of renal care, including DHA acceptance and patient stock rates, quality of renal care, outcomes of renal care, and identification of best practice.

In the intermediate term, until more patients are registered, further support will be sought both from the Department of Health and from industry. It is hoped that the Registry will become self-financing within two years.

The Renal Registry is non profit making and as part of the Renal Association is recognised as a charitable activity by the Charity Commission.

1:11 Other activities of the Renal Registry

The Registry has been commissioned by the Renal Association to maintain a database of medical staff in renal units within the United Kingdom.

Funding has been provided by the Department of Health to Professor Feest, Dr. Ansell, and Dr. Roderick to work with the UK Renal Registry to repeat a survey of UK renal services similar to those carried out in 1993 and 1995. In the future, as the number of units participating in the Registry grows these data will be available for most of the country from within the Renal Registry database. These surveys collect only a small proportion of the data routinely collected by the Renal Registry. Such surveys will however help the Renal Registry in the short term to compare some of the characteristics of the patients on the Registry (age, sex, underlying diagnosis, modalities of therapy) with the national picture, thus enabling an assessment of the reflection in the Registry database of the country as a whole.

Professor Feest and Dr. Roderick are negotiating for further funding to carry with the Renal Registry a retrospective study of the outcomes of cohorts of patients starting renal replacement therapy in the UK over the last ten years. This will be combined with some data available until 1988. The prognosis of patients starting renal replacement therapy in successive years in the United Kingdom, with allowances for age and underlying diagnosis, is not known. Whether outcomes have improved over the last ten years is uncertain. The provision of these data will provide a baseline for an assessment of the effect on patient outcomes of the introduction of the Renal Standards document and the Renal Registry.

Further ideas for studies will be welcome. If individuals wish to work with the Registry in audit or research they should apply through the Chairman or Secretary of the Renal Registry Subcommittee. No access to the Registry data, or additional activity within the Registry, will be allowed without approval by the subcommittee. Any additional costs will have to be met by the applicant.

By the end of 1998 the Registry hopes to be able to submit data returns to the EDTA database for the participating units, should they so require.

Chapter 2 Introduction to the UK Renal Registry report of July 1998.

2:1 Data included in the analysis

This is the first substantive report from the UK Renal Registry. It is an analysis and presentation of data from the 9 units who participated throughout the calendar year 1997. In addition data from 4 pilot units for the calendar year 1996 are also studied.. Only the units from whom the Registry received a complete set of data for 1997 are included in the analysis. They are listed in table 2.1. Many units have joined subsequently and will be included in the next annual report. The time periods for analysis of quarterly data are listed in appendix C.

Birmingham	Heartlands Hospital
Bristol	Richard Bright Renal Unit, Southmead Hospital
Gloucester	Gloucester Royal Infirmary
Leeds	St James Hospital (excluding Leeds General Infirmary)
Leicester	Leicester General Hospital
Middlesborough	South Cleveland Hospital
Nottingham	Nottingham City Hospital
Plymouth	Derriford Hospital
Sheffield	Northern General Hospital

Table 2.1 Renal units included in the subsequent report

Inevitably a first report is somewhat limited. One year is an inadequate time to follow changes in sequential data. Even simple outcome measures such as one year or even three month survival necessitate follow-up of patients into the next calendar year. This has limited the number of analyses possible. This year's material will therefore be somewhat cross-sectional in nature; subsequent reports will be better able to analyse outcomes and trends and look in more detail at the determinants of various outcomes.

All the units who reported throughout 1997 were from England. Software has recently been written to extract data from the Scottish Renal Registry, but we are unable to incorporate this until permission has been obtained from all the Scottish renal units. Scottish data are therefore not included in this report, but it is intended to include them in the future. Welsh units are now joining the Registry, and it is also hoped to have data from Northern Ireland shortly.

Although over 7,000 patients are currently registered, with over 5,000 available for this report,. this is still a relatively small number for detailed analysis, especially if stratifying patients by age, diagnosis, co-morbidity etc. Much of this report will therefore be descriptive, with little interpretation. As the Registry develops more detailed statistical analysis and interpretation will be possible.

Co-morbidity data were not available for the new patients starting dialysis in 1997, but this information is now being collected for 1998 and will be included in the next annual report.

2:2 Biochemical and haematological data.

Quarterly biochemical and haematological data is extracted from local renal unit systems as the last data items stored for that quarter. For haemodialysis patients the last pre-dialysis blood value is extracted.
For comparative audit of this data, the Renal Association, Renal Standards document has been referenced (reference 1)

In attempting to compare clinical performance indicators such as serum bicarbonate, calcium, phosphate etc. a potential problem became apparent. While data from an individual laboratory are both appropriate and valid for use within that hospital environment with the use of local reference ranges, the results for a sample analysed in a particular laboratory using one analytical method may differ significantly from that generated by another laboratory using the same or another method. Such variations make the interpretations of a national standard difficult. As renal units' performances are being assessed and compared against these standards, and compared with one another, it is important to understand the variations within laboratory data. This is dealt with in detail in chapter 5, with an explanation of the attempts of the Registry at harmonisation of data to allow comparison. Such harmonisation has not been previously reported in the literature.

In the presentation of haematological and biochemical clinical performance measures, clear reference is made to the national recommended standards.

2:3 Main areas of emphasis of the report

This report will concentrate on four main areas :-

1. Analysis of new patients and the stock of patients receiving treatment. Comparisons are made with available statistics from previous surveys, and published reports from the USA, Australasia and Scotland (Chapters 3 and 4).

2. The difficulties encountered in attempting to compare biochemical results from different laboratories. Chapter (5) reports on the harmonisation of laboratory results in order to allow valid comparisons..

3. A comparison of adequacy of haemodialysis using urea reduction ratio (chapter 7).

4. An analysis of data of relationship of haemoglobin, serum ferritin, and use of erythropoeitin (chapter 8)

The comparative audit of biochemical indicators of clinical performance is in chapter 6, and blood pressure in chapter 9.

2:4 Anonymity and confidentiality

Centre anonymity has been carefully maintained. Neither the Chairman of the Registry nor the subcommittee members are aware of the identity of the centres within the analysis. Only the Renal Registry co-ordinator, data manager and statistician are able to identify the centres. This identification is necessary so that any issues raised, and discrepancies in the analysis, can be discussed with the relevant units.

Whilst relatively few centres are participating in the Registry it may be possible to identify a centre by the number of patients it returns. For this reason throughout this report the analyses which compare units quote percentages and not actual numbers of patients.

2:5 Statistical analysis

The Renal Registry employs a full-time biostatistician. All the analyses in the subsequent report have been performed using the SAS statistical package. In addition Microsoft Excel and Powerpoint have been used to produce graphs, illustrations, and tables

Non-parametric tests have been used, except where the data has been found to be normally distributed.

The cumulative frequency distribution graphs for the biochemistry and haematology data have been smoothed using a cubic spline algorithm (reference 2). This may result in a discrepancy between reading a figure from the graph and the figure listed in the comparable table.

2:6 Comparison with other available data.

Throughout this document five major sources of data for comparison are frequently quoted. Data from England and Wales in 1995 are from the recently published renal specialty survey (reference 3); data from England in 1993 are from the National Renal Review (reference 4); data from the USA are from the USRDS data report 1997 which contains data up to and including 1995 (references 5,6); data from Australia is from the Australian and New Zealand Registry report 1997 (reference 7); data from Scotland from an abstract of a presentation to the European Renal Association in June 1998 (reference 8) and a report in Nephrology Dialysis and Transplantation 1997 (reference 9); and data from Europe from the European Renal Association annual report on the management of renal failure in Europe,XXVIII,1997, which contains data from 1995 (reference 10).

2:7 Distribution of this report.

One copy of this report will be sent to all renal units in the United Kingdom. Copies will be widely available to interested parties, and can be purchased from the Renal Registry price £9.95

Each renal unit will be able to purchase a specific data report in which its own figures and performance will be clearly identifiable compared with the national figure.

Chapter 3 Patients starting Renal Replacement Therapy in 1996 and 1997

This analysis only includes patients starting end stage renal replacement therapy for the first time as defined in appendix B, and does not include patients who transferred into centres participating in the Registry who had already been started on therapy elsewhere.

For 1996 data is only available from four pilot units (Bristol, Leeds, Leicester, Sheffield) covering an estimated catchment population of 6.0 million. For 1997 full data was available from nine units in England covering an estimated catchment population of 9.2 million.

The Renal Association standards document recommends **a minimum annual acceptance rate of new patients with renal failure of 80 per million population, adjusted upwards as necessary for ethnic and age distribution of the population.**

3:1 Patient characteristics

The median age and gender distribution of patients starting renal replacement therapy in 1996 and 1997 are shown in table 3.1.

Centre	1995 Median Age	1996 Median Age	1997 Median Age	1995 M:F Ratio	1996 M:F Ratio	1997 M:F Ratio
A			65.5			1.5
B			63.5			1.2
C			63			1.3
D		65	59		2.0	1.9
E		57	56		1.3	1.8
F		65	64		1.4	1.5
G			61			1.6
H		58	60		1.3	1.4
I			72			3.3
All	61	62	61	1.6	1.5	1.6
No.		460	822		460	818

Table 3.1 Median age of patients starting renal replacement therapy

Four hundred and sixty patients are recorded in 1996 and 822 for 1997. For 1997 this gives an approximate combined take on rate from the 9 units of 89 per million population per year. This is a very crude figure as we have not been able to make any allowance for cross-boundary flow of patients, and the estimated catchment populations are not precise.

The age distribution of patients starting renal replacement therapy is illustrated in Fig 3.1. Of these new patients 43% were aged 65 or more, and 15% were aged 75 or more.

For comparison figures from the English national survey of renal units in England in 1995 are included. The age group divisions are comparable except that in the English review the youngest age group was 16 to 24 not 18 to 24.

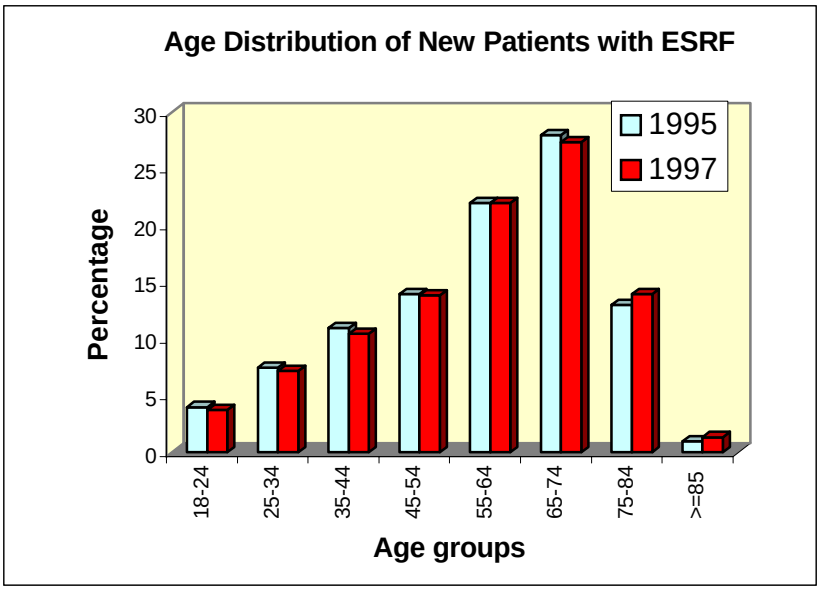

Figure 3.1 Age distribution of patients starting renal replacement therapy

The distribution of aetiology of renal failure for new patients is given in table 3.2. Diagnoses categories were aggregated from EDTA codes for diagnosis.

Diagnosis	1995*	1996 (4 units)			1997 (9 units)				
	ALL	% men	% women	M:F ratio	% men	% women	M:F Ratio	<65	≥ 65
Aetiology uncertain	17.0	52.0	48.0	1.1	58.0	42.0	1.4	17.8	27.9
Glomer. not proven		62.5	37.5	1.7	71.4	28.6	2.5	0.8	2.8
Glomerulonephritis	12.4	63.0	37.0	1.7	70.7	29.3	2.4	15.1	6.0
Pyelonephritis	9.1	57.9	42.1	1.4	64.3	35.7	1.8	7.9	9.7
Diabetes	13.8	62.0	38.0	1.6	66.9	33.1	2.0	21.0	11.7
Reno-vascular dis.	5.5	77.8	22.2	3.5	56.3	43.8	1.3	3.0	14.5
Hypertension	7.8	68.0	32.0	2.1	80.0	20.0	4.0	5.1	4.6
Polycystic Kidney	5.9	45.7	54.3	0.8	57.8	42.2	1.4	11.0	3.4
Not sent	15.7	80.0	20.0	4.0	62.5	37.5	1.7	4.5	5.4
Other	12.6	65.7	34.3	1.9	50.0	50.0	1.0	13.8	14.0
Total numbers		279	181	460	505	313	818	471	351

- figures from the English national survey

Table 3.2 Diagnoses of patients starting renal replacement therapy

The differences in the diagnosis of patients starting treatment in 1997 in different units are shown in table 3.3

Diagnosis	**Centre A**	**Centre B**	**Centre C**	**Centre D**	**Centre E**
Aetiology uncertain	23.2	35.0	18.7	26.5	17.7
Glomer. not proven	3.7	0.0	0.0	0.8	1.8
Glomerulonephritis	7.3	15.0	15.4	5.3	18.6
Pyelonephritis	12.2	12.5	5.5	5.3	9.7
Diabetes	17.1	15.0	23.1	13.6	15.0
Reno Vascular disease	8.5	12.5	7.7	9.1	4.4
Hypertension	6.1	0.0	9.9	1.5	4.4
Polycystic Kidney	4.9	5.0	8.8	9.8	8.0
Not sent	1.2	0.0	2.2	8.3	0.0
Other	15.9	5	8.8	19.7	20.4
Diagnosis	**Centre F**	**Centre G**	**Centre H**	**Centre I**	**All**
Aetiology uncertain	26.9	18.6	18.8	19.6	22.1
Glomer. not proven	1.9	0.0	0.0	13.0	1.7
Glomerulonephritis	14.4	9.7	7.9	8.7	11.2
Pyelonephritis	10.6	6.2	7.9	15.2	8.6
Diabetes	15.4	29.2	8.9	13.0	17.0
Renal Vascular disease	5.8	5.3	11.9	10.9	7.9
Hypertension	4.8	7.1	5.9	0.0	4.9
Polycystic Kidney	8.7	8.0	6.9	6.5	7.8
Not sent	0.0	1.8	21.8	4.3	4.9
Other	11.5	14.2	9.9	8.7	13.9

Table 3.3 Diagnoses of patients starting renal replacement therapy in the 9 units

The median age of new patients (table 3.1) was 61 years, but there was a large variation between centres from 56 to 72. The median age of new patients differed significantly between the centres (Kruskal Wallis test, X^2=40.1,df=8, p<0.001). Centre I, which is the most outlying centre is small, with small numbers of patients accepted. As the Registry matures, and more sequential data are collected, it will be possible to compare over a two or three year running average the characteristics of new patients accepted for dialysis. Centre differences, if present, may become more apparent, and will clearly have an effect on comparison of patient survival between centres (see section 3.3).

The age distribution of new patients in registry units in 1997 is illustrated in Fig 3.1. 43% are 65 or over, compared with 41% in England in 1995 and 37% in 1993. 29% of new patients are 70 or over. Although the catchment populations for these figures differ, there appears to be a trend for accepting older patients.

The overall male to female ratio of new patients was 1.6:1, similar to the stock (1.6:1). Centre I was again the outlier, with a high male to female ratio of 3.3:1. However this centre has the oldest group of patients starting renal replacement therapy, and from the figures on stock of patients (vide infra) it does appear that there is a considerable excess of men on treatment in the older age groups. The English review data also confirm that there is a marked male preponderance amongst older patients starting treatment. There

was no significant difference in the proportion of males and females at the different centres (X^2=8.0, d.f=8, p=0.430).

The age distribution and gender ratio of patients on the Registry in 1997, with the exception of the over 75's, is similar to that of the English figures for 1995 and suggests that the units currently returning to the Registry may be reasonably representative of England as a whole.

Considering the aetiology of renal failure, there is very little missing data, and this was mostly from one centre, I (tables 3.2,3.3). When applying the chi squared tests to figures for the underlying diagnosis, patients with diagnosis "not sent" were removed from the analysis. Hence the corrected percentages quoted below differ slightly from table 3.3. The number of patients recorded is currently too small to analyse data by ethnicity.

It would be expected that some diagnoses are more apparent in younger and some in older patients and some of the differences shown between those above and below 65 are therefore not surprising.. When comparing the proportion of patients with "uncertain aetiology" above and below the age of 65, the chi-squared test indicates that the proportion of patients aged under 65 with the a diagnosis "aetiology uncertain", at 19%, is significantly different from 30% found in those over 65. (X^2 = 12.6, d.f = 1, p<0.001)

Of all patients, 17% had diabetic nephropathy compared with 14% nationally in 1995. The percentage with diabetes in the younger group, is twice that in the older group, a pattern somewhat different from that in the English review (15.7% and 11.1% respectively) and the United States (42.7% vs 33.9%.). The similar distribution of pyelonephritis across the ages may appear surprising, as this commonly thought to be largely due to reflux nephropathy. However the EDTA diagnosis codes on which this is analysis is based are very poor in this area, and include obstructive uropathy in the pyelonephritis category. Elderly men with prostatic obstruction to bladder outflow are thus included.

There does appear to be a wide variation in the diagnostic distribution of patients starting treatment in different renal units (Table 3.3). The proportion of those with diabetes varies from 9% to 30%, and is not highest in the units with high ethnic minority populations. The proportion of diabetic patients in the different units differed significantly (X^2 = 17.4, d.f = 8, p = 0.026). Unknown diagnosis varies from 19% to 35%, glomerulonephritis from 5% to 18%, and hypertension from 0% to 10%.

A chi squared test was used to determine whether the percentage of males and females starting renal replacement therapy (table 3.2) varies by diagnosis. The few patients with no diagnosis sent are excluded from this analysis. There is a significant variation in the diagnostic categories between the two sexes (X^2 = 20.0, D.F = 8, p = 0.010).

The similar incidence in the sexes of autosomal dominant adult polycystic kidney disease is expected. There is no evidence for a male predominance of reno-vascular disease. There is a high male to female ratio for the diagnosis of hypertensive renal disease

3:2. First elective modality of renal replacement therapy.

The Registry defines the first elective modality of renal replacement therapy as transplantation if it is immediate, peritoneal dialysis if it is started within 90 days of initiation of renal replacement therapy, and haemodialysis if this continues uninterrupted for 90 days. If patients die in the first 90 days they can be difficult to classify as they may have been on haemodialysis but with the intention of starting peritoneal dialysis. Such patients were classified as starting electively on haemodialysis.

The first elective modality was calculated and compared with the treatment which patients were receiving at 90 days. As some patients died in that time the populations are slightly different. The results are compared in table 3.4. The differences are small. As the established modality at 90 days is a more clearly defined figure which is easier to derive this has been used in subsequent analysis of elective modality of treatment.

Unit	**Elective treatment**			**Established treatment at 90days**		
	HD	**PD**	**Transplant**	**HD**	**PD**	**Transplant**
A	81	19	0	75	25	0
B	56	44	0	58	40	3
C	81	19	0	73	24	3
D	38	59	3	38	57	5
E	70	30	0	71	29	0
F	53	44	3	52	45	3
G	62	37	1	61	39	0
H	69	25	5	68	25	3
I	63	37	0	62	38	0
TOTAL	**62**	**36**	**2**	**60**	**37**	**3**
No. of pats	**477**	**275**	**13**	**407**	**252**	**17**

Table 3.4 Chosen treatment modality and that established at 90 days

In order to study the established modality of treatment at 90 days during 1997, it is necessary to consider the 765 new patients who started renal replacement therapy from 1st October 1996 until 1st October 1997. Fig 3.2 shows the distribution of treatment modalities established at 90 days after initiation of renal replacement therapy.

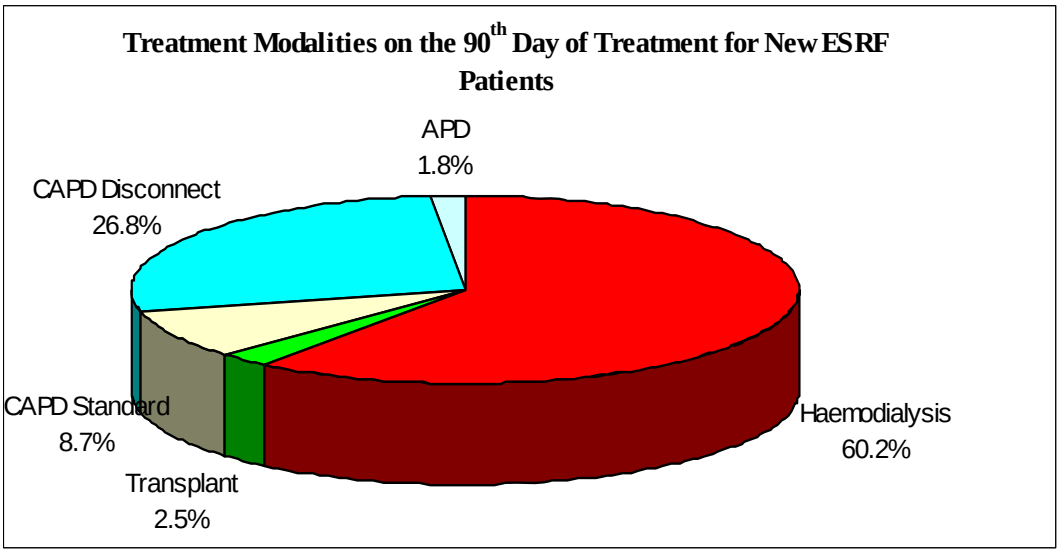

Figure 3.2 Treatment modalities at 90 days of renal replacement therapy.

As only 2% of patients started with pre-emptive transplantation, the subsequent figures indicate the proportions of dialysis patients receiving haemodialysis or peritoneal dialysis. Figure 3.3 shows the unit variation in the percentage of new dialysis patients established on haemodialysis as opposed to all forms of peritoneal dialysis, with a variation from 40% to 75%. A chi-squared test showed that this variation is significant ($X^{2=}42.9$, d.f=8, $p<0.001$)

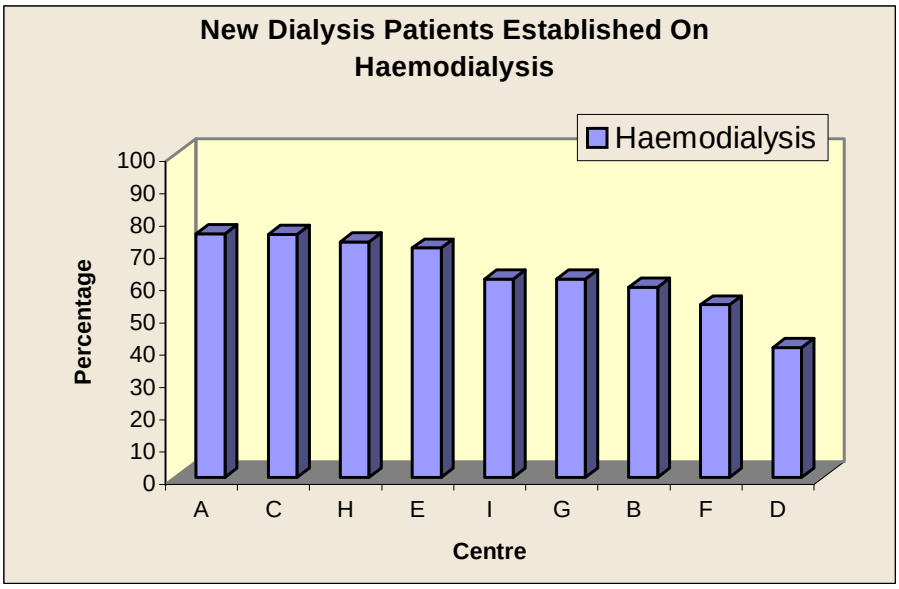

Figure 3.3 Percentage of new patients established on haemodialysis at 90 days.

Figure 3.4 shows the proportions of patients on haemodialysis as opposed to peritoneal dialysis with regard to age above and below 65.

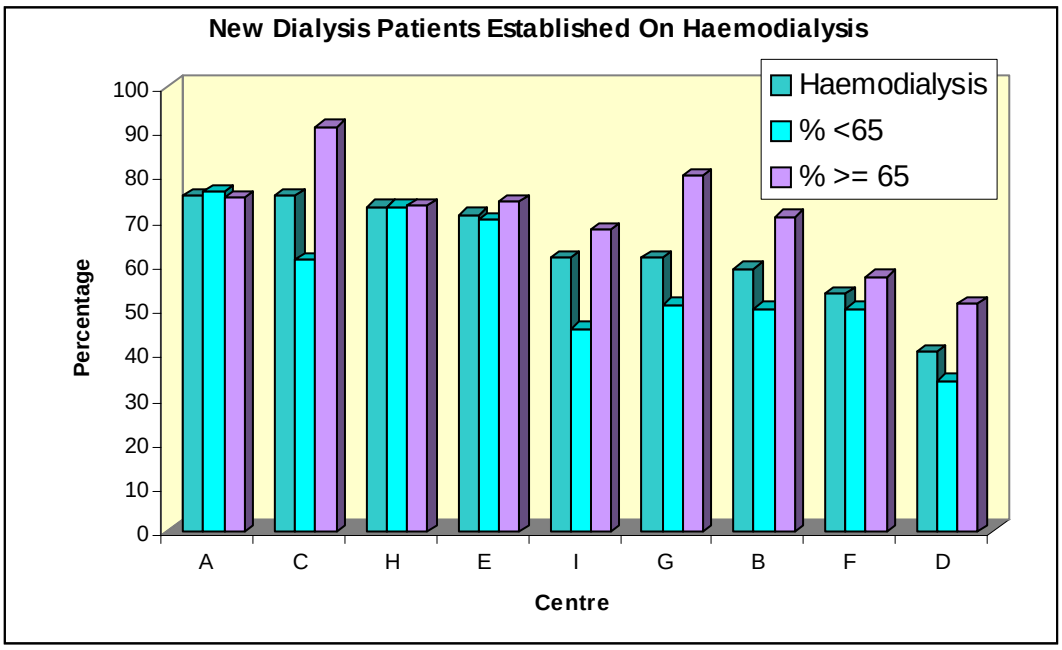

Figure 3.4 Percentage of old and young new patients established on haemodialysis at 90 days.

Overall 56% of dialysis patients under 65 were established on haemodialysis compared with 70% over 65. There was again wide unit variation. Centres A E and H showed no difference in proportion of patients first established on haemodialysis with regard to age whereas all the other units showed a distinct preference to start older patients on haemodialysis. In no unit was there a preference for starting older patients on peritoneal dialysis.

Fig 3.5 shows the distribution of dialysis modality with regard to gender.

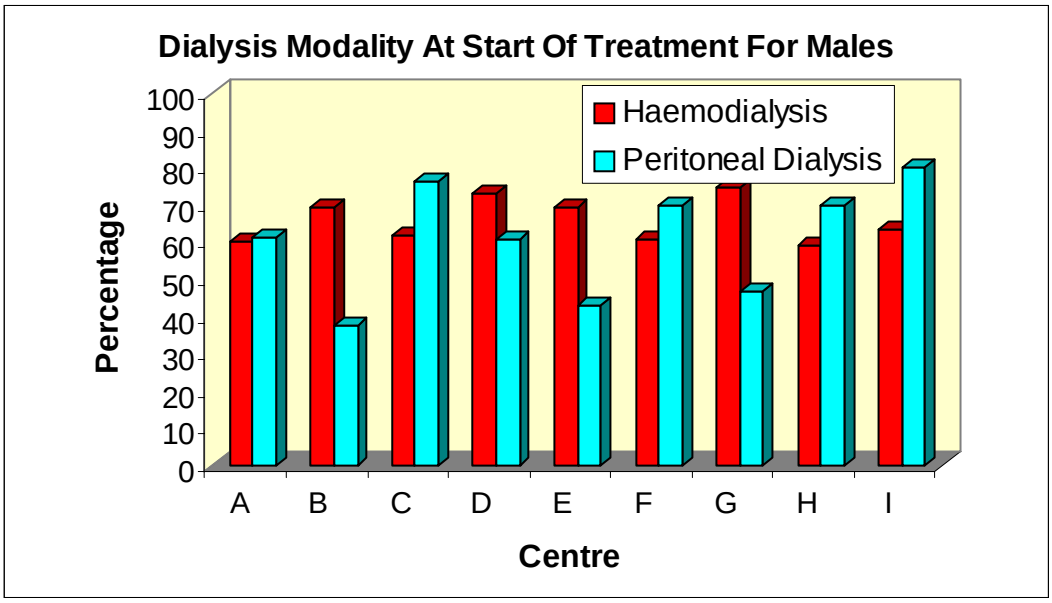

Figure 3.5 Dialysis modality by gender

The overall male to female of ratio for this sample is 1.8:1, but there appears to be a preference to put men on haemodialysis, with a male to female ratio of 2:1, compared with a ratio of 1.5:1 for peritoneal dialysis. There appeared to be a wide variation in unit practice, but a chi-squared test comparing the percentage of haemodialysis patients who were male showed no significant difference between units (X^2=5.9,d.f=8, p=0.66). This will need further investigation when larger numbers and cumulative figures become available to see whether each individual unit's performance remains consistent.

As it is widely believed that peritoneal dialysis may be the treatment of choice for diabetics we compared the treatment modalities on 90th day for diabetics and non-diabetics. There was no significant difference using the Chi-squared test (X^2 = 0.0, d.f = 1, p = 0.992).

3:2.2. The first change of treatment modality within the first year

This analysis considers the 490 patients from 4 centres who started renal replacement therapy between 1.10.95 and 31.9.96, and follows patients for the first 12 months after their first 90 days of treatment.
Changes in treatment modality within that year were analysed. The following rules were applied:

1. A patient was classified as having changed to transplantation even if the transplant only lasted one day.

2. If a patient changed from haemodialysis to peritoneal dialysis the patient was classified as changed to PD, independent of the subsequent length of time on PD.

3. Patients on peritoneal dialysis who changed to haemodialysis for less than 31days before changing back to peritoneal dialysis were classified as remaining on peritoneal dialysis. Those remaining on haemodialysis for more than 30 days and then changing back to peritoneal dialysis were classified as having changed to haemodialysis.

5. Patients who transferred out to a centre not on the Registry were categorised as unknown.

The results are shown in table 3.5.and illustrated in figure 3.6

Haemodialysis ***Modality***	**% all patients**	**no. of patients**
Remains on HD	67.8	156
Changed to PD	4.8	11
Transplanted	9.1	21
Transferred out elsewhere	0.4	1
Died	17.8	41

Table 3.5a Haemodialysis patients: change in modality

Peritoneal Dialysis ***Modality***	**% all patients**	**no. of patients**
Remains on PD	66.3	136
Change to HD	10.2	21
Transplanted	11.2	23
Transferred out elsewhere	0.5	1
Recovered	1	2
Died	10.7	22

Table 3.5b Peritoneal Dialysis change in modality

As there were small numbers of patients to study, we have not attempted to interpret these findings. In subsequent reports there will be large enough numbers of new patients returned to the Registry for a statistical analysis to be undertaken. It is possible that some of the changes from haemodialysis to peritoneal dialysis were elective, some patients not having stabilised by 90 days. In subsequent reports it may be possible to study this data with reference to time between referral to the renal unit and renal replacement therapy.

3:3 One year patient survival

This was studied in the 458 hundred patients from the four units who sent returns for 1996. The two patients who recovered renal function were not included. The figures quoted are from the day of first renal replacement therapy.

The probability of surviving one year was calculated using the Kaplan-Meier estimate.

The death rate per 100 patient years was calculated by counting the number of deaths and dividing by the person years exposed. This includes all patients, including those who died within the first three months of therapy. The person years at risk was calculated by adding up for each patient the number of days at risk (until they died or transferred out) and dividing by 365.

Results are shown in table 3.6

	Death Rate **Per 100 Patient Years**	Deaths **No of Patients**	**KM Survival Analysis**	**K-M 95% Confidence Interval**
< 65	9.7	22/260	0.91	0.88 - 0.95
≥ 65	39	62/198	0.68	0.62 - 0.75
All	21	84/458	0.81	0.78 - 0.85

Table 3.6 One year survival of new patients, by age at start of therapy

The death rate for diabetic patients has not been analysed separately, as there were insufficient numbers to draw any conclusions. In future Registry reports when larger numbers of patients will be included, analysis of survival by diagnosis and other means of stratification, including co-morbidity and gender, will be possible. It will also be possible to study survival in smaller age bands.

Eighteen percent of those starting on haemodialysis died within the first year, compared with 10.7% of those starting on peritoneal dialysis. This is probably a reflection of the clinical setting as the median age of patients starting haemodialysis was older (61 compared with 59) and initial review suggests that those starting on haemodialysis had greater co-morbidity.

The 90 day survival is shown in table 3.7. The probability of a new patient surviving the first 90 days is 92%, with a death rate of 8.6 per 100 patient '3 months'.

	Death Rate	Deaths No of Patients	KM Survival Analysis	K-M 95% Confidence Interval
All	8.6%	38/458	0.92	0.89 - 0.94

Table 3.7 Ninety day survival of new patients

The figures produced here are not comparable with those reported by the USRDS which excludes patients dying within the first 90 days of renal replacement therapy. The USRDS is unable to collect data with regard to the first 90 days of treatment as much of their data is collected by billing systems, and patients are not eligible for Medicare payment until 90 days of therapy have passed. The Australian registry does not produce a separate figure for deaths of new patients and stock.

Chapter 4 All patients receiving Renal Replacement Therapy in 1997

4:1 Introduction

At the end of 1997 the Renal Registry had details of 5111 patients receiving renal replacement therapy in 9 renal units. Of these patients 216 were within the first 90 days of treatment. Figures quoted in this chapter are the status on 31st December 1997 unless specified otherwise.

Many patients present in imminent need of renal replacement therapy without having been prepared for dialysis. As a result, temporary treatments are often given initially, the most common being haemodialysis via a central venous catheter. This early period does not reflect the overall treatment policy and pattern of the renal units. When considering the modalities of therapy, only patients who have been established on renal replacement therapy for 90 days have been considered.

The relative proportions of patients receiving dialysis therapy and transplant follow-up are shown for the whole registry, but not for individual renal units. Some centres do not transplant locally, but refer their patients to other centres. The practice as to when these patients are transferred back to the parent centre for follow-up varies widely from 4 weeks post transplant to an indefinite period. Thus transplanting renal units may appear to have a greater proportion of their renal failure patients transplanted. In addition the transplant units have an apparent relatively young population on renal replacement therapy, as transplant patients have a lower median age than dialysis patients. Therefore, for comparisons between renal units only dialysis patients will be considered. When the Registry has wider and more contiguous coverage of the UK, the data will be analysed by postcode and region, allowing study of access to transplantation.

4:2 Age and sex distribution

The median age of the patients currently alive (the "stock") recorded at the Registry is 53. The median age calculated at their start of ESRF treatment was 45.
The age distributions of the whole population and of individual modalities of treatment are illustrated in figure 4.1

24% of the stock were age 65 or more and 15% were 70 or more, similar to the 14% aged over 70 of the 1995 Renal Survey. This is much lower than the figures for new patients with 43% aged over 65 and 29% over 70.

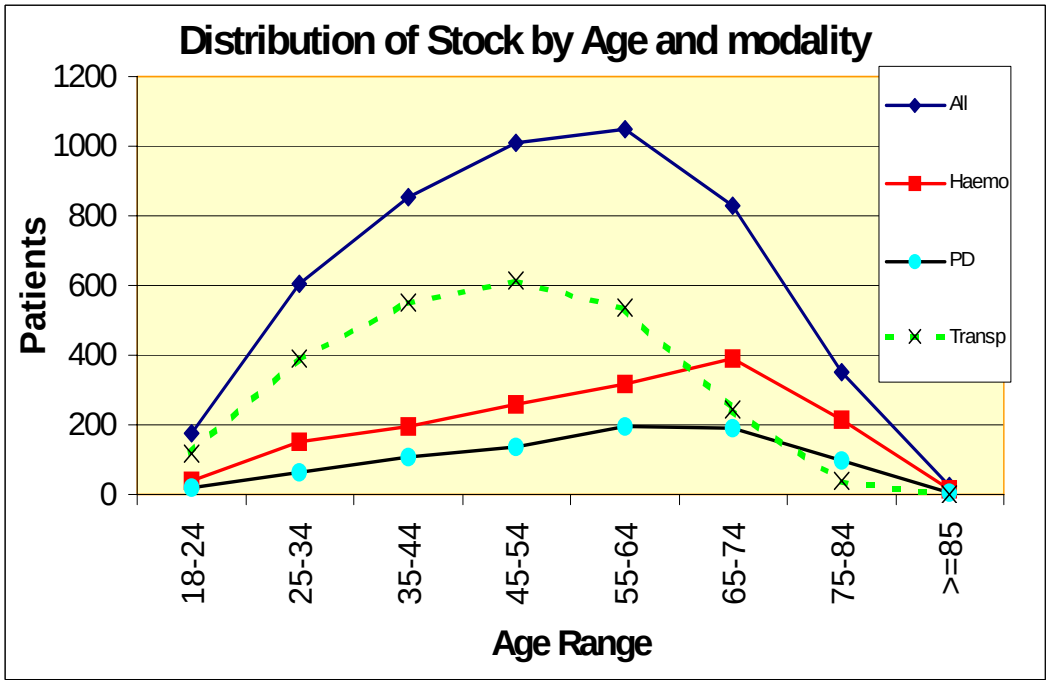

Figure 4.1 Age distribution of patient stock by modality of treatment

The median age of transplanted patients was 48 years with a range between renal units from 45 to 51. The median age of both peritoneal dialysis and haemodialysis patients was 59 years, but there was a great variation between renal units. Four units appear to have younger patients on HD and 5 units had younger patients on PD. These variations are illustrated in figures 4.2 and 4.3.

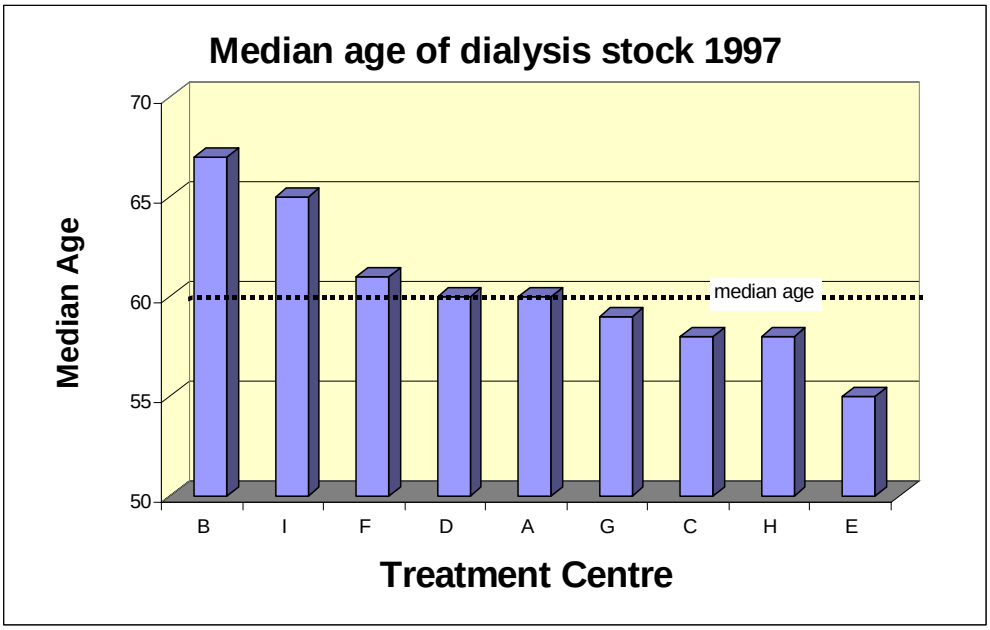

Figure 4.2 Median age of dialysis patients in rank order,

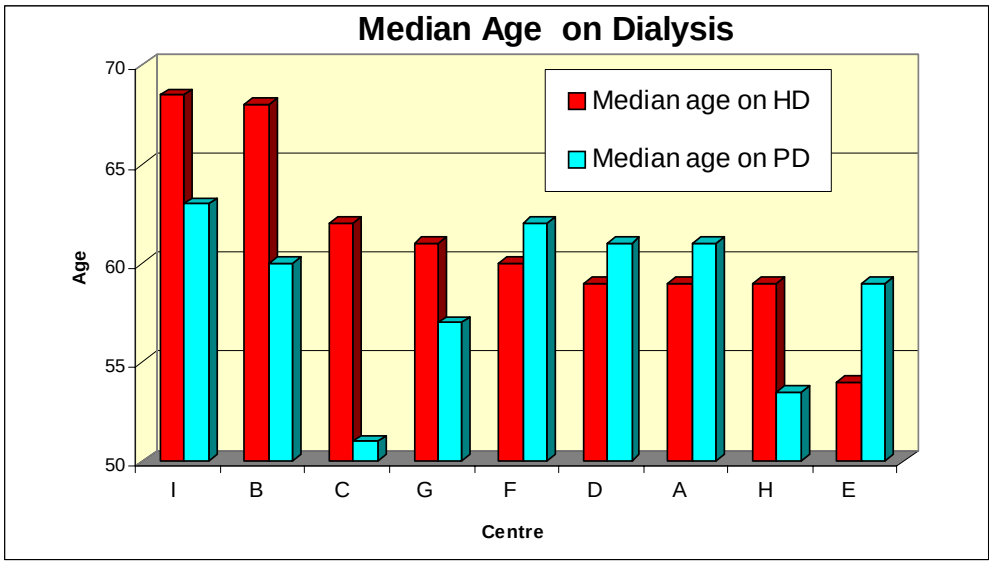

Figure 4.3 Median age by unit for PD and HD.

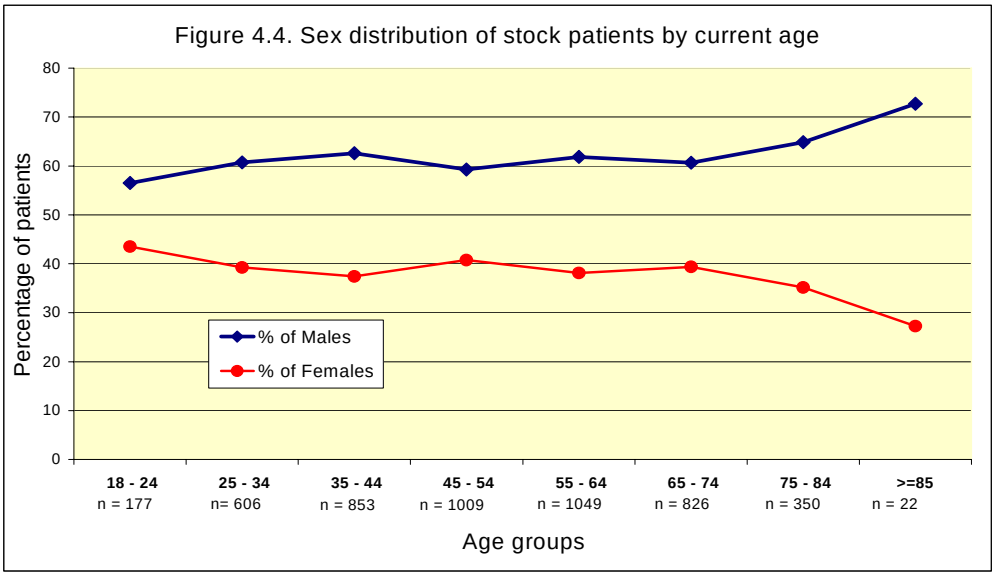

Figure 4.4 Age and sex distribution

The age distribution by sex is illustrated in figure 4.4.

The overall male: female ratio for the stock is 1.6:1. This appears to increase above the age of 74.

4.3 Primary renal diagnosis

The primary renal diagnosis of the stock of patients on 31/12/97 is shown in table 4.1. The differential sex distribution by diagnosis is illustrated in figure 4.5.

Diagnosis	All pats*	Age <65	Age ≥ 65	M:F
Aetiology uncertain	19.2	17.1	30.6	1.6
Glomer. not proven	5.4	5.9	2.5	1.8
Glomerulonephritis	15.4	16.9	7.9	2.4
Pyelonephritis	16.9	17.2	15.4	1.1
Diabetes	8.9	8.9	9.1	1.8
Renal Vascular disease	2.8	1.5	9.3	1.8
Hypertension	6.0	6.1	5.4	2.7
Polycystic Kidney	9.5	10.4	6.0	1.1
Not Sent	0.9	0.5	1.7	2.4
Other	15.1	15.5	12.1	1.4
All Patients				1.6
All Patients Total	4895	3996	771	

- The total for 'all patients' includes those whose start date of ESRF treatment is unknown.

Table 4.1 Percentage diagnoses of stock, and by age at start of RRT

Figure 4.5. Sex distribution of stock by diagnosis

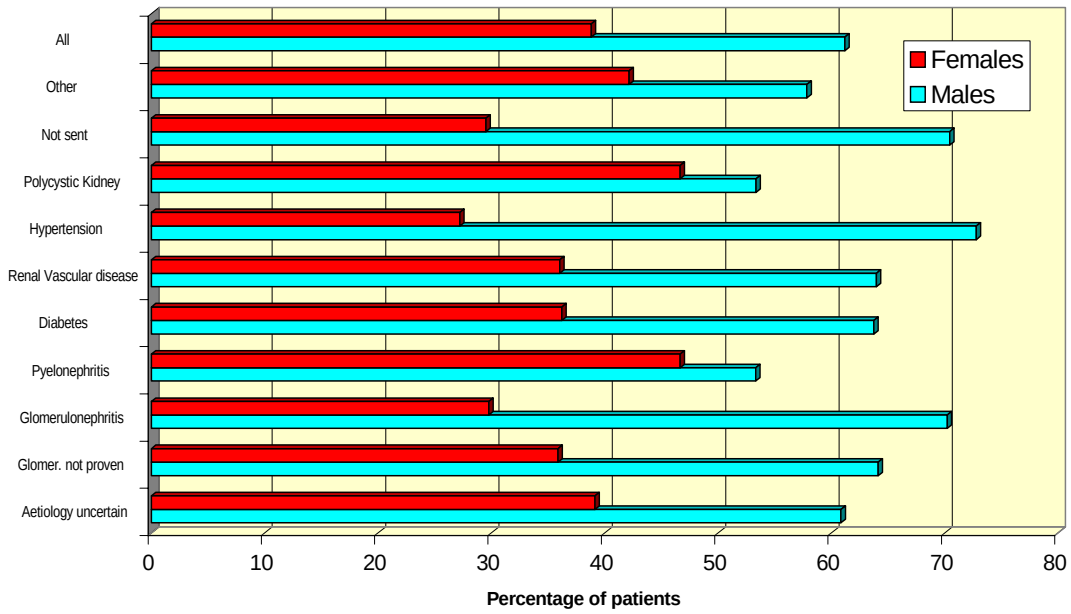

Figure 4.5 Sex distribution by diagnosis

Only 9% of the stock are diabetic compared with 17% of those starting renal replacement therapy in 1997. The inter-unit variation was from 7% to 11%. The relatively lower proportion of diabetics in the stock compared with new patients, reflects a combination of the poorer prognosis for diabetic patients, and historical attitude of a lower acceptance rate of diabetic patients.

The median age of the diabetic stock was 49 years for type I diabetics and 65 for type II diabetics. The median age at which these diabetic patients started renal replacement

therapy was 43 and 62 respectively. The median length of time on treatment for diabetics was 3.3 years for type I and 2.3 years for type II, this short length of time for type II reflects both the recent increase in acceptance of type II diabetics and their older age group with increased mortality.

4:4 Modalities of treatment

The treatment modalities of the stock of patients are illustrated in figure 4.6.

Satellite centres have been defined as dialysis centres physically separate from the main centre, where the main centre still has responsibility for the patients and usually there is no medical on-site cover during the dialysis. Some centres are linked to 4 or 5 satellite units. These facilities may be shared with adjoining regional renal units.

Automated Peritoneal Dialysis (APD) is defined as use of a cycling peritoneal dialysis machine on 6 or 7 nights per week, with or without the use of CAPD during the day. Less frequent cycling is considered as Intermittent Peritoneal Dialysis (IPD).

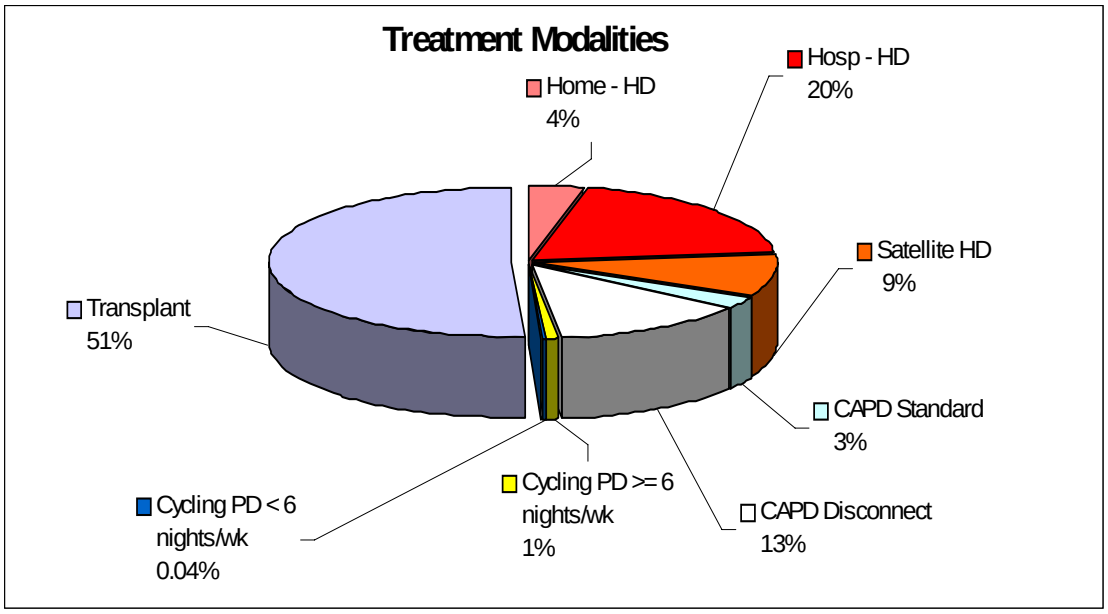

Figure 4.6 Treatment of modalities of stock patients

	All	HD		PD		Transplant	
	No.	%	No.	%	No.	%	No.
All Patients	4895	32	(1586)	17	(815)	51	(2494)
Age < 65	3696	26	(963)	14	(523)	60	(2210)
Age > 65	1199	52	(623)	24	(292)	24	(284)
All Diabetes *	436	38	(166)	28	(120)	34	(150)
Type I diabetes *	304	31	(95)	27	(82)	42	(127)
Type II diabetes *	132	54	(71)	29	(38)	17	(23)
Non – diabetics *	4415	32	(1403)	15	(680)	53	(2332)
Male	2996	33	(986)	16	(481)	51	(1526)
Female	1899	31	(598)	18	(334)	51	(967)

***** excludes patients where no diagnosis sent

Table 4.2 Treatment modalities of stock patients

Details of treatment modalities are given in table 4.2. There was no difference between the sexes in the modality distribution. A chi-squared test showed that patients aged 65 and over receive significantly different treatments from younger patients (X^2 = 475.8, d.f.=2, $p<0.001$). This is entirely due to the low transplant rate in the elderly.

The overall ratio of haemodialysis to all forms of peritoneal dialysis was 1.9:1. There was wide variation between the units from 1.0 to 3.7 as illustrated in figure 4.7. The ratio does not appear to differ with age.

Using a chi-squared test, diabetics had a significantly different distribution of modality from the non-diabetic population (X^2=66.5, d.f = 2, $p<0.001$). Looking in more detail, type II diabetics are similar to the older population from which they are largely drawn, but type I diabetics differ from the under 65 non-diabetic population: they are much less likely to have a transplant (42% vs 62%), and if on dialysis are more likely to be on peritoneal dialysis (46% vs 33%).

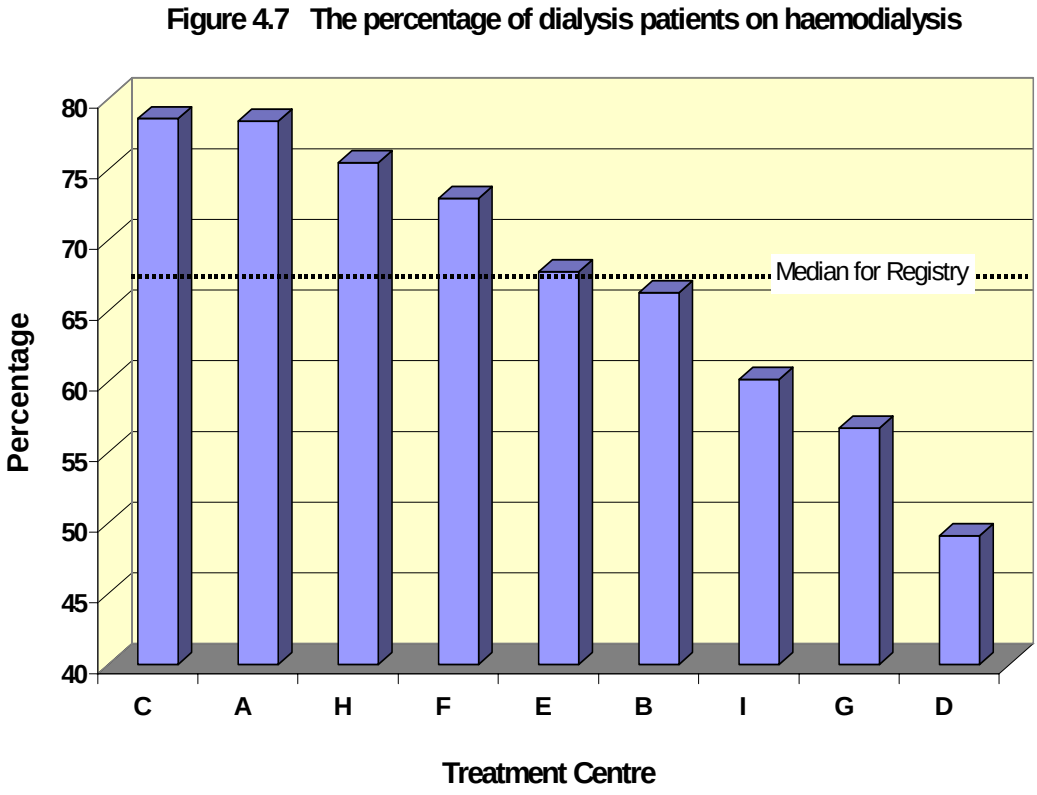

Figure 4.7 Percentage of dialysis patients on haemodialysis by Centre

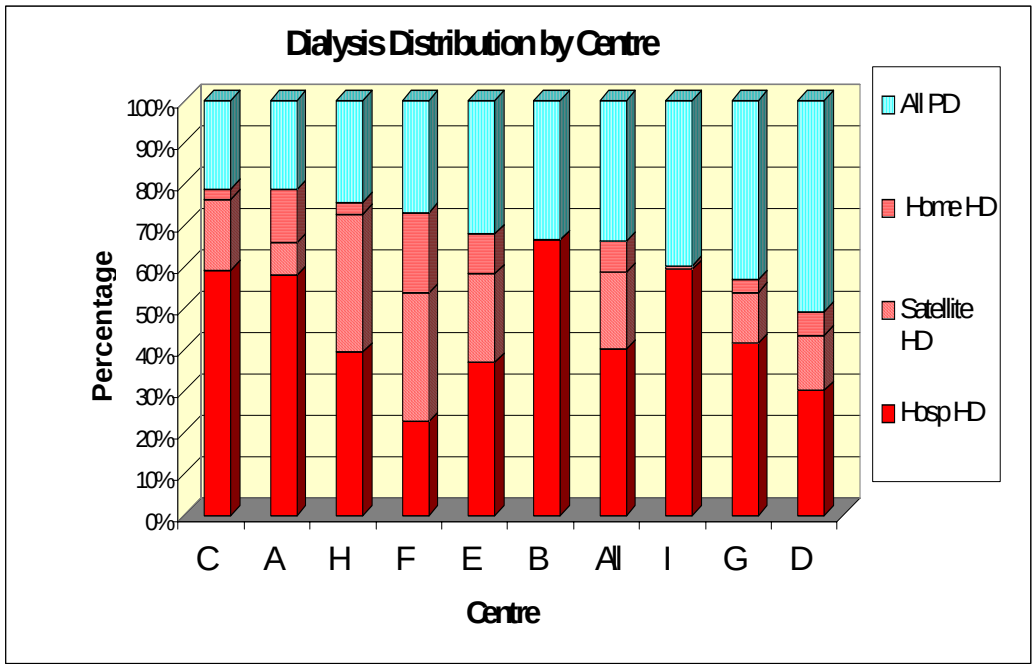

Figure 4.8 Dialysis modalities by centre ordered by total percentage on haemodialysis

The overall distribution of dialysis modalities and the variation between renal units is illustrated in figure 4.8. Further details are given in table 4.3

	All	Haemodialysis						Peritoneal dialysis							
		Hosp		Satellite		Home		Disconnect		Standard		APD		IPD	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
Age < 65	1486	36	(542)	17	(252)	11	(169)	28	(414)	5	(70)	3	(39)	0	(0)
Age ≥ 65	915	46	(421)	21	(190)	1	(12)	24	(218)	7	(61)	1	(11)	0	(2)
All Diabetes *	286	41	(118)	16	(46)	1	(2)	35	(101)	4	(11)	3	(8)	0	(0)
Type I diabetes*	177	41	(72)	13	(23)	0	(0)	40	(70)	4	(7)	3	(5)	0	(0)
Type II diabetes*	109	42	(46)	21	(23)	2	(2)	28	(31)	4	(4)	3	(3)	0	(0)
Non – diabetics*	2083	40	(829)	19	(395)	9	(179)	25	(520)	6	(120)	2	(38)	0	(2)
Male	1467	40	(583)	18	(268)	9	(135)	25	(369)	5	(80)	2	(31)	0	(1)
Female	932	41	(379)	19	(173)	5	(46)	28	(263)	5	(51)	2	(19)	0	(1)
All Patients	**2401**	**40**	**(963)**	**18**	**(442)**	**8**	**(181)**	**26**	**(632)**	**5**	**(131)**	**2**	**(50)**	**0**	**(2)**

* excludes patients where no diagnosis sent

Table 4.3 Details of dialysis modalities of the stock of patients

4:4.2 Transplantation

51% of all ESRF patients had a functioning renal transplant, 60% of those were aged under 65. In England in 1993 the total figure was 53%, and in 1995 it was 52%. The percentage alive with a functioning graft does not simply reflect transplant activity. The figure reflects the combination of :- past transplant activity, graft survival, patient survival, and rate of take on of new patients for renal replacement therapy. Thus, in 1994 the US had only 27% of its stock with a functioning graft, but had a much higher transplant rate of 44 per million population per year compared with the UK rate of 30 per million population per year. The low proportion of functioning grafts in the US is due to the very high acceptance rate of new patients at 253 per million population per year compared with 82 per million population per year in England in 1995, and 109 per million population per year in Wales. If the acceptance rate for renal replacement therapy in the UK continues to rise without a concomitant increase in the supply of donor organs a continuing reduction in the proportion of the stock transplanted is to be expected.

Two hundred and sixty five patients under follow up in participating units were transplanted in 1997. Details are given in tables 4.4 and 4.5. The median age was 49, compared with 59 for the dialysis population from which they were drawn. They did not differ by sex or primary diagnosis from the general stock.

No. transplanted	Median age	No. of men	% men
265	49	171	65

Table 4.4 Patients Transplanted during 1997

Only those on treatment for ESRF within participating units are included in the above figures. Patients transferring in from non-registry units specifically for transplantation

are excluded. Patients from registry units transferring to non-registry transplant units for transplantation are included.

Diagnosis	Number	Percentage
Aetiology uncertain	49	19.4
Glomer. not proven	9	3.6
Glomerulonephritis	38	15.1
Pyelonephritis	37	14.7
Diabetes	21	8.3
Renal Vascular disease	4	1.6
Hypertension	15	6
Polycystic Kidney	33	13.1
Not sent	2	0.8
Other	44	17.5

Table 4.5 Diagnoses of stock patients transplanted in 1997.

4:4.3 Haemodialysis

The median age of home haemodialysis patients was considerably younger than both other HD groups at 48. The median age of 62 for all satellite patients, was similar to hospital dialysis patients at 61. Not all centres had satellite dialysis facilities. For Centres with these facilities, comparing the median age of hospital and satellite patients, 4 centres had older patients on satellite dialysis and 2 centres had younger patients on satellite dialysis.

The use of home dialysis in the renal units ranged from 0 to 27% of all HD patients, with 11% of all HD patients on home treatment. In the 1995 Renal Review home dialysis accounted for 13% of HD patients, having fallen from 20% in 1993 **.** 14% of men on haemodialysis, were at home compared with 8% of women.

4:4.4 Peritoneal dialysis

The Renal Association standards document recommends ***the use of disconnect systems should be standard unless contraindicated. Automated peritoneal dialysis should be available as clinically indicated and not constrained by financial considerations.***

Of all PD patients, 78% were on a disconnect system (Figure 4.10) This is the same as the figure for England in the 1995 Renal Review. The types of PD used varied widely between centres. One centre uses no disconnect PD, while 4 centres no longer use CAPD standard. The use of automated cycling PD (APD) was 6% for all centres, but ranges between centres from 0 to 19% . Units report that financial restrictions and not clinically determined decisions limit the use of disconnect and cycling systems.

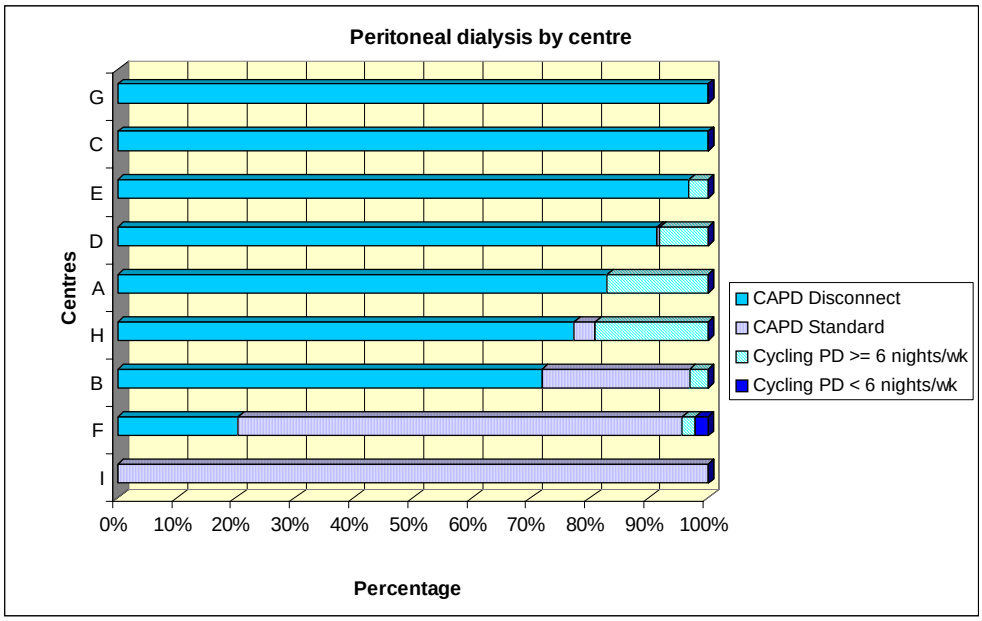

Figure 4.9 Distribution of types of PD by Centre ordered by Disconnect PD.

4:4.5 Trends in dialysis modalities

	England		Registry		Wales	Scotland	
	1993	**1995**	**1996**	**1997**	1995	1991	1996
Total on dialysis	**9045**	**10988**	**2344**	**2401**	735	-:-	
% on haemodialysis	**52**	**56**	**64**	**66**	57	49	67

Table 4.6 Trends in dialysis modalities.

Some figures with regard to trends in modalities of dialysis are shown in table 4.6 . The HD:PD ratio in England was 1.0:1 in 1993, 1.3:1 in 1995, and 1.9:1 in the registry in 1997:1. In Scotland the ratio was 1:1 in 1991 and 2:1 in 1996. Despite the fact that several units have reported to us a severe restriction in availability of haemodialysis facilities, limiting their ability to place all people they consider suitable on haemodialysis, there is a continued trend to more haemodialysis. The proportion of dialysis patients in the UK receiving peritoneal dialysis is still higher than that in most other developed countries (figure 4.11).

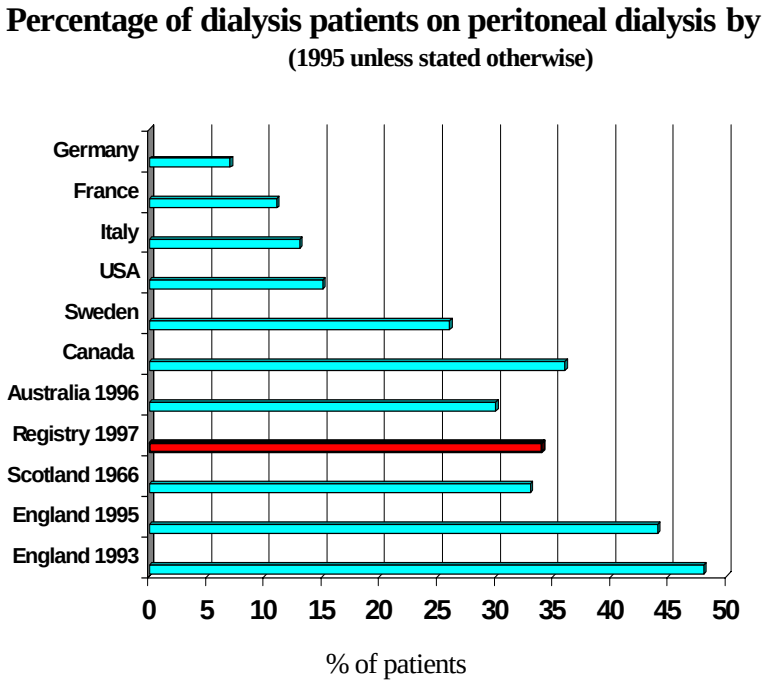

Figure 4.10 Proportion of dialysis patients on peritoneal dialysis in different countries

The use of satellite dialysis is expanding.. In 1993 in England 20% of dialysis stations were at satellite units, by 1995 33% were at satellite units. The number of satellite units rose from 36 to 60. In unit F in 1997 the minority of haemodialysis patients received treatment at the main unit.

The use of APD has not yet made a major impact overall, but is significant in some individual centres.

4:5 Deaths from the stock of patients alive on 1/1/97.

The death rate within year was calculated separately for the patients established on dialysis and with a functioning transplant on 1st January 1997. Only patients established for 90 days on renal replacement therapy on that date were included. As there is an increased death rate in the first six months following transplantation, patients were only included in the analysis if they had not received a transplant between 1st July 1996 and 31st December 1996. For the same reason patients who received a transplant within the year were censored at the time of transplantation.

The sample criteria thus became:

1. Patients who had been receiving renal replacement therapy for more than 90 days on 1/1/97.

2. Patients who had a transplant between 1/7/96 and 31/12/96 were excluded

3. Patients who transferred into a Registry centre were excluded if information was not available to confirm that they had not received a transplant between 1/7/96 and 31/12/96.

4. The few patients who recovered renal function in 1997 were excluded.

5. Patients who transferred out of a Registry centre to a non-Registry centre were censored at that date

6. A transplant patient whose transplant failed was censored at the time of restarting dialysis, and dialysis patients who received a transplant were censored at the time of transplant.

7. Patients who died, received a transplant, or transferred out on 1/1/97 were included and were counted as being at risk for one day.

8. Patients who died on the day of the transplant were censored on this day, rather than counted as a dialysis death.

Analysis of the death rate from centre I showed it to be 50% lower than other centres. On discussion with this centre it was found that not all deaths had been logged on their computer system. Patients from this centre were therefore excluded from this analysis.

The number of patients on the registry is currently too small to allow stratification by diagnosis, or by age bands smaller than above and below age 65.

The results are given in Table 4.7

	No. of patients	**No. of deaths**	**Deaths per 100 patient years**
All dialysis patients	2215	370	19.4
Dialysis patients <65	1395	138	11.3
Dialysis patients ≥ 65	820	232	33.5
Transplant [1]	2092	38	1.9
Transplant [2]	2092	45	2.2

Transplant [1] - patients censored at time of return to dialysis.
Transplant [2] - patients not censored at time of return to dialysis.

Table 4.7 Deaths during 1997 of the patients alive 1/1/97

The one year death rate for patients established on dialysis on 1/1/97 who had not had a transplant in the past six months was 19.4 per 100 patient years. The figure quoted for the Australian registry is 15.6, but this may not be comparable as their report does not give precise details as to how the figure was calculated. American figures exclude patients dying from non-dialysis related causes e.g trauma and AIDS, and do not have the same inclusion criteria. The quoted American figure for 1996 is 22%. The EDTA death rate figure for the EEC is 14.4% with a range of 12.1% to 23.5% although inclusion and exclusion criteria will vary from country to country.

On analysis of the survival experience of patients by centre, there was no significant difference between the centres in the 1997 one year survival using log rank test (X^2 = 3.87, d.f. = 7, p = 0.7949).

There is the expected higher death rate amongst the more elderly patients, by a factor of three.

The one year death rate for patients with a transplant established for at least six months on 1/1/97, censoring patients who subsequently changed to dialysis at the time of change, was 1.9 per 100 patient years. It could be argued that this technique omits some deaths occurring shortly after the transfer to dialysis which should be accounted as related to the failing transplant. A calculation was therefore made including those patients whose transplant failed within year and later died on dialysis. The death rate then rises to 2.2%.

There were insufficient data to analyse death rates within six months of transplantation as a longer period of follow-up is needed to assess the patients transplanted in the second half of 1997. This analysis will be included in the next Registry report.

As the Registry develops, there will be sufficient numbers of patients registered to study survival with correction for age, gender, co-morbidity, etc.

Chapter 5 Inter laboratory variation of biochemical data and the Renal Association Standards

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The inclusion of laboratory results within the UK Renal Registry data collections sets it apart from other Renal Registries, and whilst this will provide an invaluable clinical and research database it may lead to significant difficulties in data interpretation

5:1 The Renal Association Standards

The Renal Association Standards document recommends specific target limits for some analytes (e.g. phosphate), and recommends the use of local laboratory reference ranges for others such as serum albumin, calcium, and iPTH.

For each analyte, different laboratories use different methods of analysis which give slightly differing results for the same sample. Where the Standards document quotes specific limits for an analyte, it is possible that the ability of a unit to meet these standards may be compromised not only by clinical efficiency or case mix but also by the analytical method used and the bias contained within the laboratory data.

With the use of local laboratory reference ranges, the interpretation of a result may depend upon the choice of normal reference range. For many analytes, the local laboratory reference range is derived from a population distribution; for others (e.g. iPTH), this may alternatively be derived from a reference text book, or the manufacturers kit specification (which would be derived from a US population distribution). While the laboratory data may be appropriate and valid for use within the local hospital environment, it is possible that the ability of a unit to meet the Renal Association standards may be compromised not only by clinical efficiency or case mix, but also by the derivation of the local reference range.

Many are aware of this issue with acknowledged “difficult” analytes such as PTH, but this is also a significant problem with some of the other analytes on which the Renal Registry is collecting data.

5:2 Errors in transfer of results from laboratory to renal unit data systems

The Renal Registry makes significant efforts, in collaboration with contributing renal units, to ensure the accuracy of transfer of the data sets, but with regard to the laboratory data there is an earlier transfer of information between the laboratory(ies) and the units. In this link by which clinical results are transferred for local use, accompanying error messages e.g. “haemolysed sample”, comments or flags such as “pre-dialysis”, may be lost. Manual transcription steps are still sometimes found in the chain linking the laboratory generated result and the renal unit database, with the

inherent possibility of transcription errors. The Association of Clinical Biochemists (ACB) supports the aims of the Renal Registry, but some individual laboratory consultants have expressed significant concerns about transfer these potentially corrupted data from the renal unit databases. Nevertheless there is considerable goodwill within laboratories to support the Renal Registry. The interdisciplinary nature of this process needs to be recognised, in order for renal units and laboratories to work closely together, ensuring that accurate data is supplied to the Renal Registry.

5:3 Inter-laboratory variation and quality assessment schemes

Clinical laboratories are all required to participate in national external quality assessment schemes, in which samples are distributed to all participating laboratories for analysis and then results compiled by organisations such as UK NEQAS to evaluate the degree of agreement between methods and between laboratories. These schemes act as an objective management tool for maintaining and improving professional standards, analogous to the Registry's own aims.

On behalf of the ACB the Clinical Biochemistry laboratories contributing results to Registry linked renal units were approached for permission to look at their External Quality Assessment data, access to which is only given if permission is granted. Out of the 11 units, which are Registry, linked we have obtained permission from 10 laboratories and the results discussed represent the available data from these laboratories. The individual laboratories, and therefore renal units, will not however be identifiable.

5:4 UK NEQAS data

Quality assessment schemes use stabilised specimens, and since the behaviour of these may differ from that of clinical specimens, in most cases method-related target values are used for performance assessment. This limits the use of UK NEQAS data to harmonise the results from laboratories employing significantly different methods.

5:4.1 Variation between results from different laboratories

To illustrate the distributions of results obtained nationally, example data for 1998 from the UK NEQAS Clinical Chemistry scheme for selected analytes are shown in Table 5.1. The coefficient of variation (CV) has been calculated from the geometric mean.

	N	Mean	CV (%)
Albumin (g/L)	535	36.4	4.6
Calcium (mmol/L)	546	2.05	3.1
Phosphate (mmol/L)	513	1.52	3.7
Cholesterol (mmol/L)	504	3.90	4.0
Urea (mmol/L)	553	9.67	4.1
Creatinine (umol/L)	558	346	3.0

Table 5.1 Laboratory agreement data from the UK NEQAS Clinical Chemistry

5:4.2 Creatinine

Data in Table 5.2 are shown classified by method principle and by instrument for creatinine. These data show predominantly the influence of different methods, but also highlight the subtle differences found between results for the same method principle implemented on different instruments with different reagent and calibration materials.

	N	Mean (umol/L)	CV (%)
All methods	558	346	3.0
Endpoint Jaffe	63	346	4.7
Centrifugal analyser	5	334	6.2
Other discrete analyser	42	344	5.1
Olympus systems	14	352	4.2
Beckman Creatinine Analyser	71	360	2.6
Beckman Astra	12	361	1.9
Beckman CX3/CX7 systems	58	360	2.8
DuPont Analyst	7	356	2.3
Other kinetic Jaffe	250	341	4.5
Bayer Axon	12	349	3.6
Bayer DAX	13	344	2.7
Bayer RA/Opera systems	15	342	4.3
Beckman CX4/CX5 systems	14	355	2.7
DADE Behring Dimension	7	352	1.8
Hitachi 717	25	339	3.2
Hitachi 737/747	25	334	4.0
Hitachi 911/917	39	335	3.8
IL Monarch	7	354	6.4
Olympus systems	22	333	6.6
Kone systems	6	348	6.4
Roche Integra	25	341	3.5
Roche Cobas Mira	15	362	11.4
ILab 900/1800	4	315	9.6
Other instrument	5	348	3.6
J & J Vitros systems	142	348	2.3
Shield DT60	7	348	5.5
Vitros 700/750/950	80	348	2.2
Vitros 500	4	350	1.4
Vitros 250	49	348	2.0
O'Leary method	17	344	3.9
Other method	7	346	7.4
Enzymic (creatininase)	5	337	7.6

Table 5.2 Example between-laboratory agreement data from the UK NEQAS for Clinical Chemistry for creatinine, classified by method

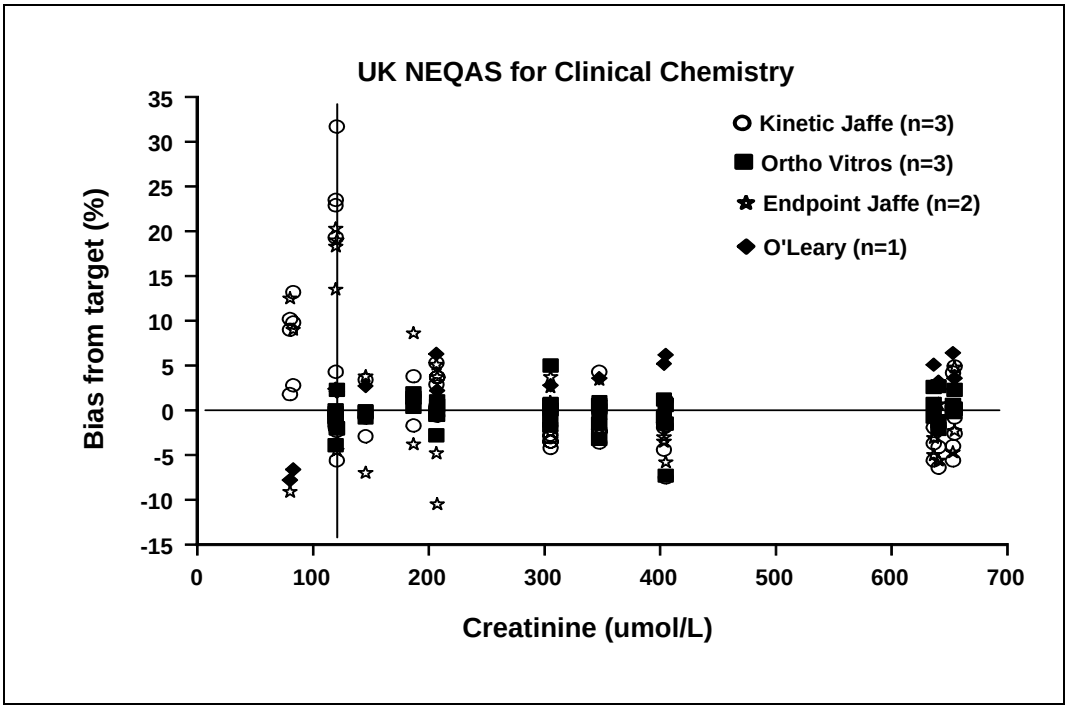

Figure 5.1 Creatinine measurement: bias from the relative target concentration by method

Above a creatinine of 200 µmol/L the range of individual laboratories' bias is of the order of 10 –15%

5:4.3 Albumin

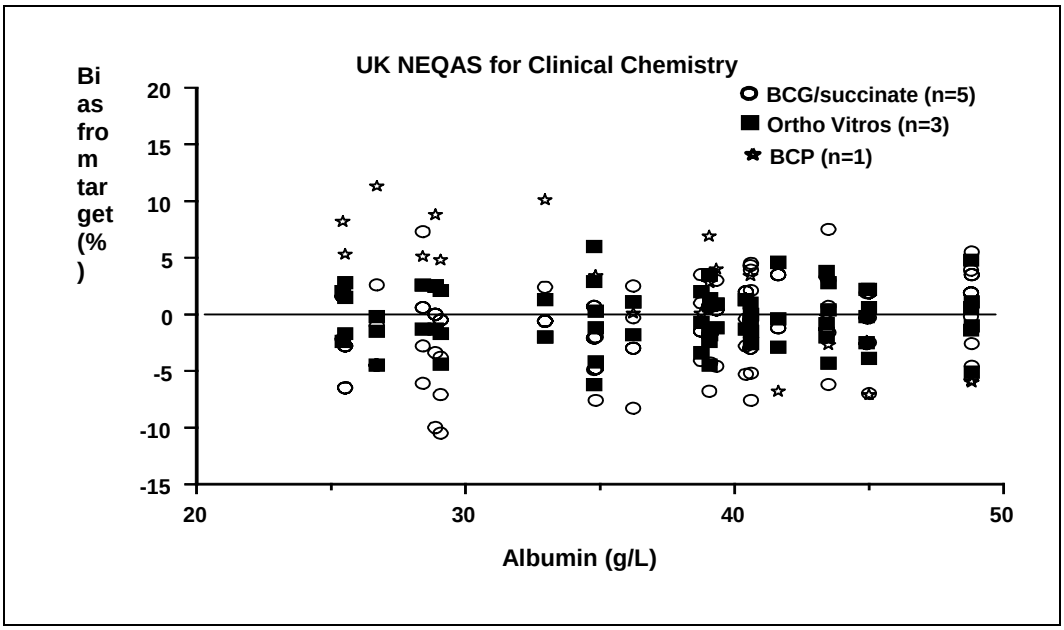

Figure 5.2 Albumin measurement: bias from the relative target concentration by method

Figure 5.2 illustrates that for albumin, the variation in bias, from the relative target concentration by the method used, varies by $\pm$ 12%.

5:4.4 Intact parathyroid hormone assay

For other analytes the influence of method is more marked. Table 5.3 shows the between-laboratory agreement (expressed as a geometric CV) for iPTH, classified by method. The specimen comprised of a mixture of sera from normal subjects and patients with chronic renal failure. Although laboratory performance with scheme specimens may not truly reflect performance with specimens from patients, these data suggest that significant method differences exist. Furthermore, these differences may not be consistent between different disease states.

	n	**Mean (pmol/L)**	**gCV (%)**
All methods	94	14.8	27.5
Method A	7	10.6	9.6
Method B	9	7.8	18.0
Method C	38	16.5	9.6
Method D	5	16.0	3.9
Method E	25	15.8	7.3
Method F	7	18.9	20.8

Table 5.3 Example between-laboratory agreement data for PTH from the UK NEQAS for Peptide Hormones, classified by method (reproduced with permission)

5:5 Harmonisation of laboratory results

5:5.1 Local laboratory methodology

Table 5.4 gives a breakdown of method, reference range and, for calcium measurements, correction formulae differences, for the laboratories contributing data to renal units included in this report.

	Albumin (g/L)		Bicarbonate (mmol/L)		Calcium (mmol/L)		Phosphate (mmol/L)		PTH	
Lab	Method	Ref Range	Method	Ref Range	Method	Correcting Formula	Method	Ref Range	Method	Ref Range
A	BCG	35-48	Actual	22-30	CPC	+0.025(40-Alb)	PMb	0.80-1.45		
B	BCG	35-53	PEPC	24-32	CPC	+0.02(40-Alb)	PMb	0.82-1.55	Cardiff	0.9-5.4 pmol/L
C	BCG	35-50	PEPC	22-29	Arsenazo	+0.02(40-Alb)	PMb	0.80-1.40	DPC	12-72 ng/L
D	BCG	35-55	PEPC	22-30	Arsenazo	+ ((40-Alb)/40)	Fish/Sub	0.80-1.40	DPC	1.3-7.6 pmol/L
E	BCG	36-50	PEPC	22-31	Arsenazo	+0.0175(40-Alb)	Fish/Sub	0.8-1.40	Chiron	10-65 ng/L
F	BCG	35-50	PEPC	20-29	CPC	+0.02(40-Alb)	PMb	0.75-1.35	Chiron	<4.0 pmol/L
G	BCP*	30-52	PEPC	19-28	CPC	+0.017(43-Alb)	PMb	0.80-1.40	DPC	12-72 ng/L
H	BCG	37-49	PEPC	20-28	CPC	+0.06(46-Alb)	PMb	0.80-1.30	Nichols	10-65 ng/L
I	BCG	35-50	PEPC	20-30	CPC	Not applicable	PMb	0.80-1.40	Nichols	10-65 ng/L

Table 5.4 Laboratory methodologies and reference ranges

5:5.2 Harmonisation method

In an initial approach, to reduce the effects of such variations on Registry assessments, the mean bias, from their NEQUAS EQA samples, over the preceding 12 months was calculated The number of samples to calculate this figure ranged from 15 to 22. This developed an adjustment factor for each laboratory to bring their method in line with the national consensus for their method principle.

Some example of the distribution of the reported results before and after this adjustment is shown below. Many of the centres on the Registry are close to the mean bias, and the maximum bias variation is 4%. This bias range will increase and the harmonisation factor become more important as more centres join the Registry.

After a harmonisation factor has been applied the local laboratory reference range is no longer applicable, and the Renal Registry will need to apply a 'standard' reference range.

5:5.2 Serum phosphate measurements

The phosphate bias correction factor for centres on the Registry ranges from 0.9780 to 1.0403. This is small, but other centres joining the Registry may require larger corrections. Harmonisation does slightly alter the percentage achieving the standards at some of the centres.

This is illustrated by the following example from haemodialysis data collected by the Registry. Figures 5.3 and Fig 5.4 show the distribution of phosphate concentration a) uncorrected for method-related bias and b) harmonised.

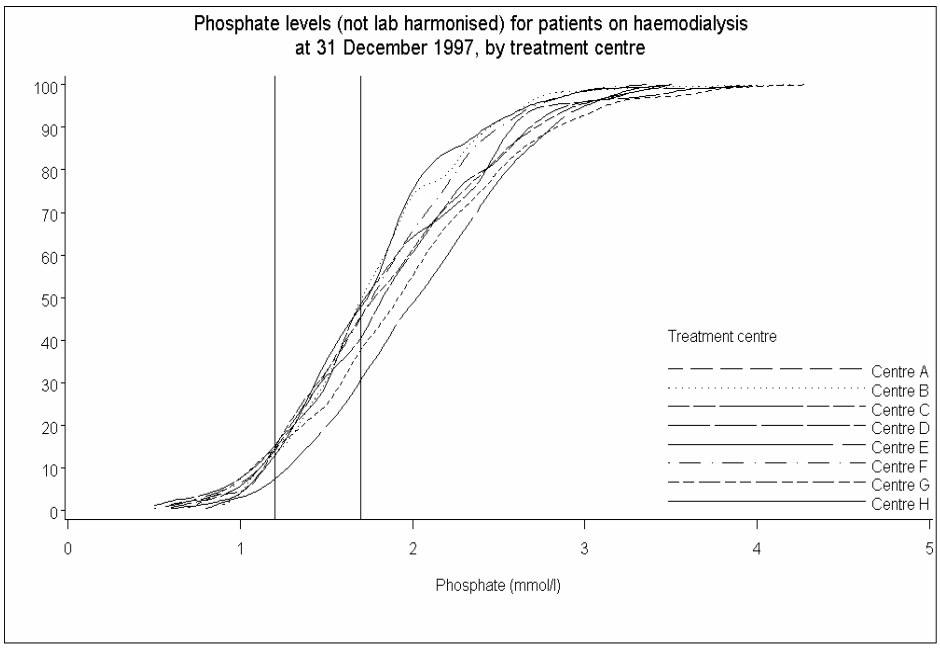

Figure 5.3 Cumulative distribution of non-harmonised serum phosphate for patients on haemodialysis.

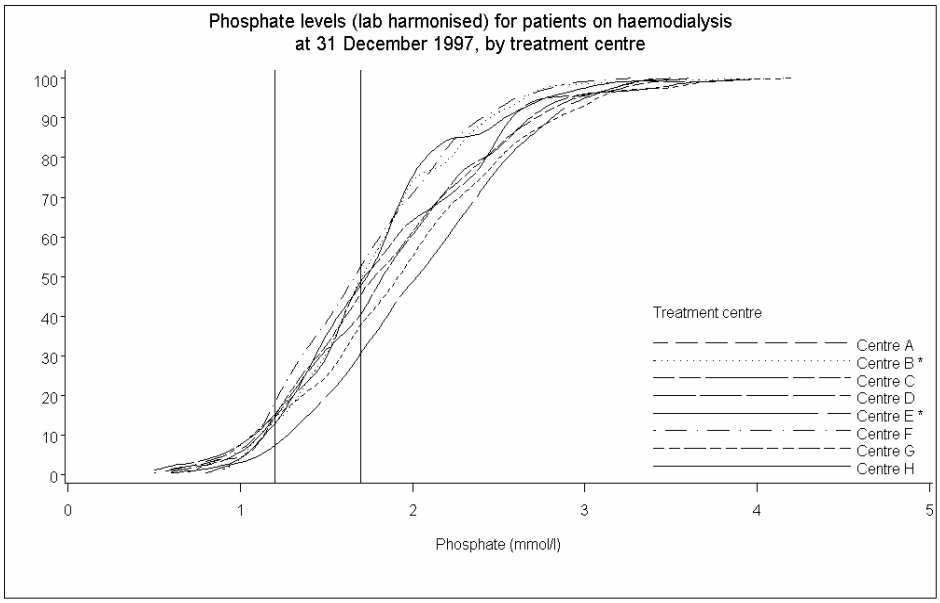

Figure 5.4 Cumulative distribution of harmonised phosphate for patients on haemodialysis.

5:5.3 Serum albumin

The harmonisation factor for centres ranged from 0.9655 – 1.0002, using non-uraemic samples. Most centres were about 1.00, but the NEQAS data shows that the harmonisation factor could range from 0.8 to 1.2 as more centres are included.

There are essentially two methods for albumin measurement in clinical use. Both use dye binding, but with different dyes, Bromocresol Green (BCG) and Bromocresol Purple (BCP). The latter method is acknowledged to be more specific for albumin (but is more expensive) whilst BCG measures additionally other proteins, but is cheaper and more widely available. External quality assessment studies have shown that this difference is exaggerated at low albumin concentrations, but overall BCP methods report lower albumin concentrations than BCG. The mean difference has been of the order of 5 g/L.

From the information supplied by the laboratories to the Registry it is clear that significantly different methods are being used to measure albumin. This is illustrated by the following examples from data collected by the Registry.

Haemodialysis

Figure 5.5 shows the non-harmonised distribution of patient results from patients on haemodialysis for serum albumin. One centre (method), G, stands out from the rest.

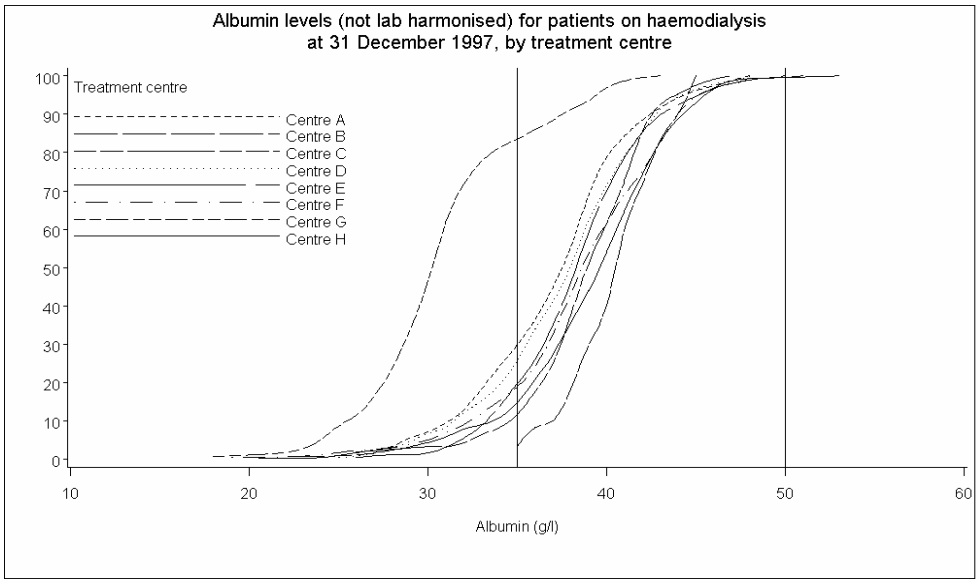

Figure 5.5 Cumulative distribution of serum albumin, non-harmonised, for patients on haemodialysis

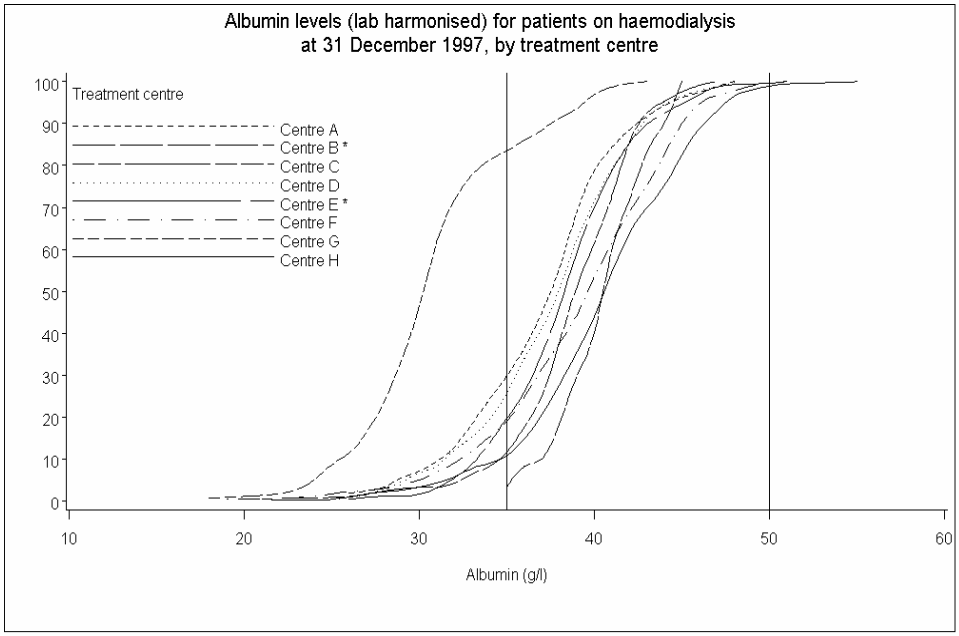

Figure 5.6 Cumulative distribution of serum albumin, harmonised, for patients on haemodialysis

Correction for method group bias reduces the scatter but the same pattern remains.

Peritoneal dialysis

The cumulative distribution curves for serum albumin of peritoneal dialysis patients are shown in figures 5.7 and 5.8

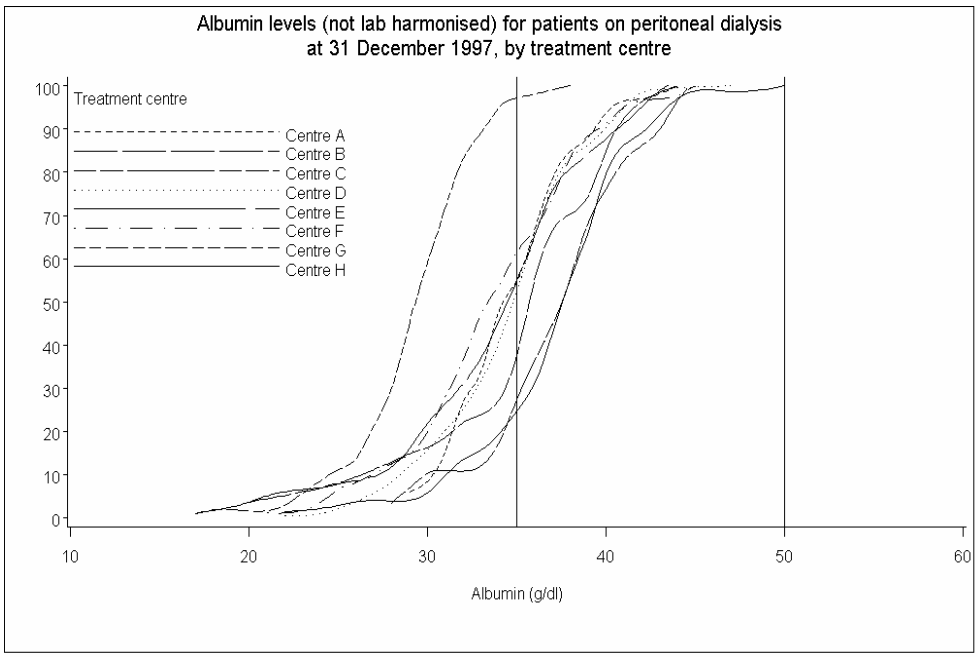

Figure 5.7 Cumulative distribution of non-harmonised serum albumin of patients on peritoneal dialysis

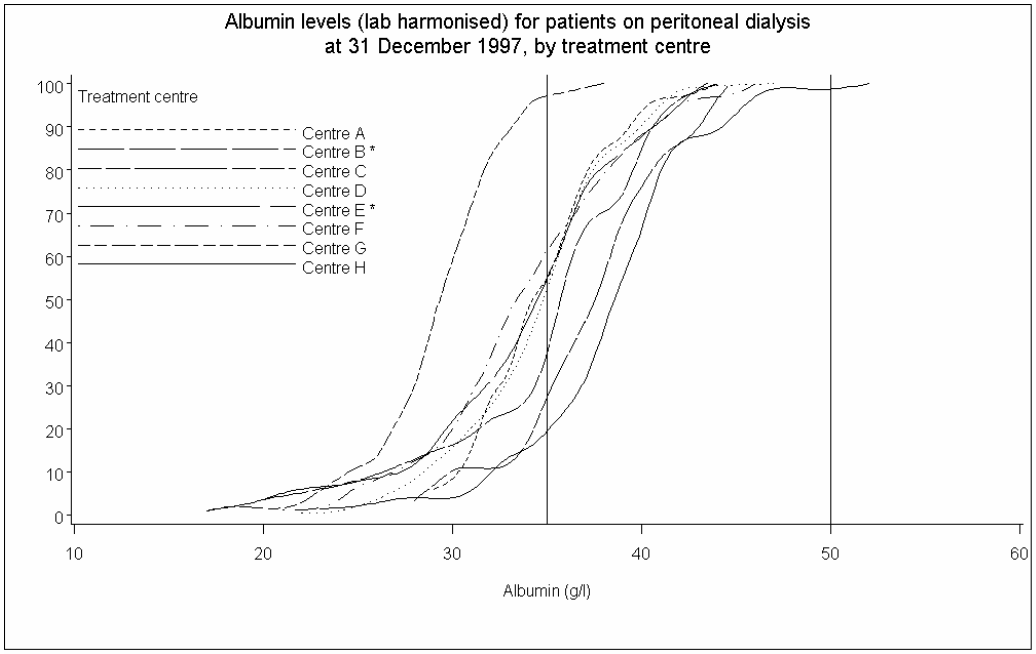

Figure 5.8 Cumulative distribution of harmonised serum albumin of patients on peritoneal dialysis

A laboratory using a BCP assay supports centre G. and reports lower results, shown in figures 5.5 to 5.77. For haemodialysis patients centre G has the lowest number of patients achieving the Renal Association standard, even using their lower reference range of 30 g/l as compared with 35g/l for most other centres. This is in contrast to peritoneal dialysis, where using the lower reference range, the compliance with the standard for centre G appears to be more comparable to other centres.

The large discrepancy between BCP and BCG could not have been predicted from the EQA data and indicates that serum samples from patients with end-stage renal failure contain substances which interfere significantly with one or other of the methods. Unfortunately there is only one unit using the BCP method and this result needs confirming by other centres. There is some literature suggesting interference with the BCP method in sera from haemodialysis patients, but not peritoneal dialysis patients.

The implications for the laboratories are that a special distribution of EQA samples based around renal patients is required to explore the methodological differences. There may need to be a recommendation made as to which method is most appropriate for monitoring renal patients. The Renal Association Standards committee may need to redefine the guidelines on serum albumin measurement.

5:5.4 Serum Calcium

Total calcium is calculated by laboratories by adjusting for the serum albumin. There are many different formulae used and these are listed in Table 5.4. To standardise the data for comparative audit, the Renal Registry requires to unadjust calcium, apply the calcium harmonisation factor, and then apply a consistent correction formula. This data is also dependent on the method the laboratory uses to measure albumin, and the bias from the NEQAS mean. The 'standard' formulae in use to correct calcium do not take this variation in albumin measurement into account. Application of this technique to the data from centre G, which reads albumin on average 5 g/l lower than other centres, still leaves a discrepancy in the data.

5:5.4 Intact parathyroid hormone assay

The Standards document specifies that iPTH should be < 3 x (upper limit of reference range).

All laboratories appear to be using assays that measure only the intact PTH. Only one laboratory (centre F) calculates its own population based reference range. This results in a much lower upper limit of the reference range and accounts for the discrepancy between centre E and F using the same manufacturer's kit. The other laboratories either use a range taken from a standard reference textbook, or the assay kit manufacturer's specified range. This discrepancy in defining the reference range markedly affects how the centre 'achieves' the Standards, as shown in figure 5.9 and table 5.5. Centre F appears non-compliant, but when compared against an upper limit of 7.6 pmol/l has one of the highest compliances. Because of these anomalies in local ranges, the Registry has shown compliance against a reference limit of 23 pmol/l (7.6 x 3) on the figures.

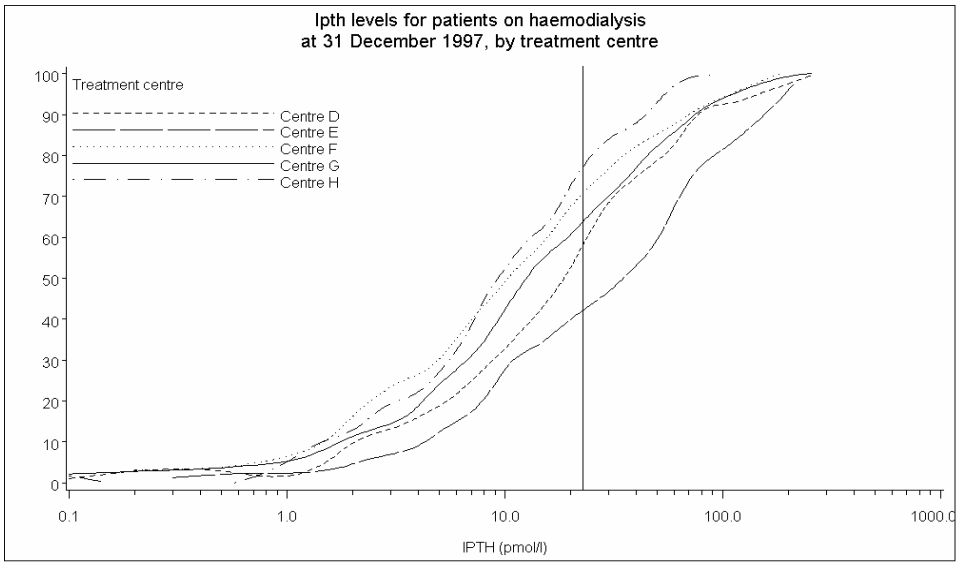

Figure 5.9 Cumulative distribution of serum iPTH for patients on haemodialysis

Unit	% <x3 local range	% <23 pmol/l	Median	Lower quartile	Upper quartile	Local range	Method
A							
B						0.9 - 5.4 pmol/l	
C						1.3 - 7.6 pmol/l	DPC
D	55	55	19	7	43	1.3 - 7.6 pmol/l	DPC
E	39	42	37	9	74	1.1 - 6.8 pmol/l	Chiron
F	54	71	10	3	28	< 4.0 pmol/l	Chiron
G	63	63	12	5	37	1.3 - 7.6 pmol/l	DPC
H	73	76	10	5	21	1.1 - 6.8 pmol/l	Nichols
						1.1 – 6.8 pmol/l	Nichols

Table 5.5 Range of iPTH for patients on haemodialysis

5:6 Discussion

This is the first time harmonisation of laboratory results has been attempted on this scale and for this purpose. The approach of taking EQA data to harmonise laboratory results from centres does appear to provide a closer agreement between centres. This harmonisation needs to be extended and monitored as more units join the Registry database. Extending this to include analytes such as PTH will be even more problematic than the albumin example discussed above. In the case of PTH discussions continue between the appropriate professional groups to develop a workable approach for use on 1998 data. In the case of albumin, and possibly other analytes, there may also be concentration-dependent biases in renal samples, which would require something other than a simple adjustment factor to correct.

Some analytes such as bicarbonate will require the co-operation of the Welsh EQAS scheme, which is currently the only scheme in the UK to offer this analyte. There may be further issues compounding the bicarbonate harmonisation due to the relative

instability of this analyte. An illustration of the difficulties for bicarbonate is shown in figure 5.10. The data represents a period from 29/12/1997 to 11/05/1998, and show the mean value for each method against the trimmed overall mean from the 200 participants analysing bicarbonate in the scheme.

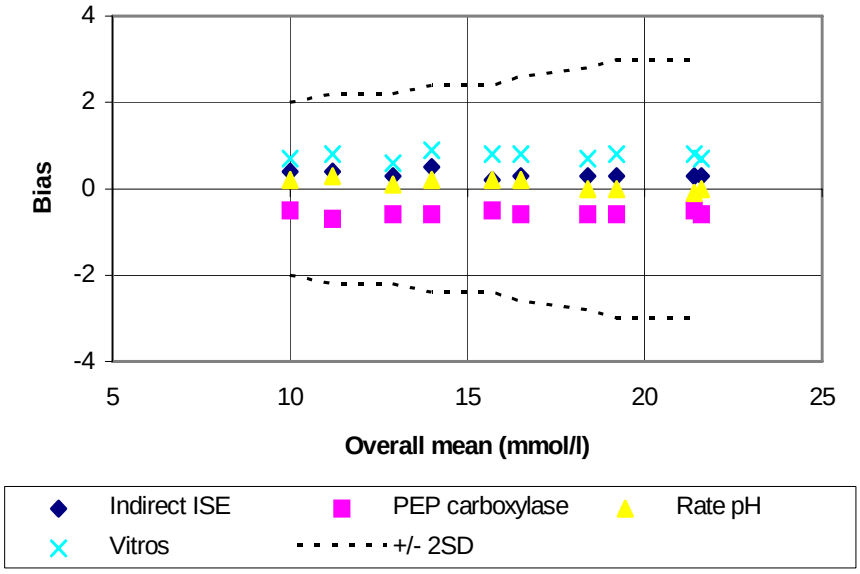

Figure 5.10 National variation in bicarbonate results according to method group from the Welsh EQAS Scheme (with permission).

This indicates a preponderance of the distributed sample concentrations lying in the acidotic range. Although this is perhaps more relevant to results from patients on haemodialysis, the Renal Standards document specifies that bicarbonate should be within the local laboratory range.

Some renal units have satellite dialysis units, from which samples are sent to laboratories other than that used by the base centre. This would require different adjustment factors to be applied to samples analysed at the different laboratories. At present there is no simple means of automatically identifying the laboratory at which a sample had been analysed. Unique laboratory identifiers may therefore need to be developed, and this issue is under national consideration.

The use of EQA data requires monitoring to ensure that the correction factors are correctly updated: this will need a continuing dialogue between the renal units and their local laboratories. Updating will be required at intervals even if the method used has not changed. This updating by use of UK NEQAS data must be with the renewed permission of the head of the laboratory, although annual renewal should not be necessary in subsequent years.

Different analytical methods have individual advantages and disadvantages. Instrument and method selection are based on the laboratory's overall role and many other practical considerations may require accepting some compromises on particular methods to

achieve an overall advantage. Different choices will continue to be appropriate for different laboratories. Limiting freedom of choice to one method is not appropriate and would limit progress.

The harmonisation of laboratory results between contributing centres is also an issue for all multi-centre clinical trials, and the Registry's collaboration with the ACB and UK NEQAS may provide answers to these not insignificant problems in the coming years. By working closely with renal units and their laboratory medicine colleagues, the Registry database will provide an invaluable audit and research resource.

Chapter 6 Quarterly Biochemical Data

6:1 Introduction

Where the Renal Standards document specifies that the local reference range should be used to define a standard, the percentage of patients achieving the standard was calculated without using the laboratory harmonisation factor produced for the Registry by UK NEQAS (see Chapter 5). Where the Renal Standards document specifies a range of values for a standard, harmonisation is achieved by using an adjustment for that laboratory from UK NEQAS, against the all laboratory mean for that method held by UK NEQAS. Where cumulative frequency distributions are shown, the data has been harmonised where possible, to allow a direct comparison on the figures. The UK NEQAS data was not available for centre B as this centre is in a separate quality assurance scheme. The laboratory at centre E is currently unwilling at this stage to contribute to the study in harmonisation and its UK NEQAS data was not made available to the Registry. Direct comparison of the cumulative frequency distribution data for centre B and E with other centres is therefore not possible**.**

For this analysis, all patients had been stable on their current modality for > 90 days. Patients who changed treatment modality within a quarter, or were transferred in from another centre, were excluded. Data are from the last quarter in 1997. If there was no result from this quarter a value from the previous quarter was used. Data completeness from centres is therefore shown for 6 months unless stated otherwise.

Although the Renal Association Standards document recommends several targets for the following biochemical variables, it makes no specific recommendations on the frequency of monitoring. As is demonstrated below, recent tests are often not available.

6:2 Serum Albumin

6:2.1 Methodological considerations

As discussed in Chapter 5, harmonisation of laboratory values is only currently possible between the same laboratory method. Centre G uses the BCP method for measuring albumin, while all the other centres use the BCG method. The BCP method is thought to be more accurate against the ‘gold standard’ of immuno-turbidimetry, because the BCG method partially measures globulin. Lowrie’s paper elucidating the relationship between mortality and albumin (reference 11) used the BCG method. The BCP method on average reads lower than the BCG by approximately 5 g/l.

6:2.2 Haemodialysis

The Renal Standards document recommends *a target serum albumin within the local laboratory reference range after six months on regular haemodialysis*.

Centre G uses the BCP method and has the smallest number of patients achieving the recommended standard, even using their lower local reference limit of a minimum serum albumin of 30 g/l, compared with the 35g/l quoted for most other centres (table 6.1). This is in contrast to peritoneal dialysis where the results for centre G appear to be more comparable to other centres. There has been some discussion by laboratories as to whether haemodialysis causes some interference with the BCP methodology, producing a false low albumin reading (see Chapter 5). In centre G there do not appear to be any unusual practices in haemodialysis treatment that would account for this discrepancy between modalities.

Centre	% below reference range	Median g/l	Lower quartile g/l	Upper quartile g/l	Local range g/l	% return of data
A	24	38	35	40	35-48	94
B*	0	41	39	43	35-53	95
C	8	39	38	42	35-50	98
D	19	39	35	41	35-55	93
E*	20	39	36	41	36-50	100
F	16	40	37	44	35-50	100
G*	34	31	29	33	30-52	95
H	21	41	38	45	37-49	88

* - not harmonised

Table 6.1 Serum albumin in haemodialysis patients

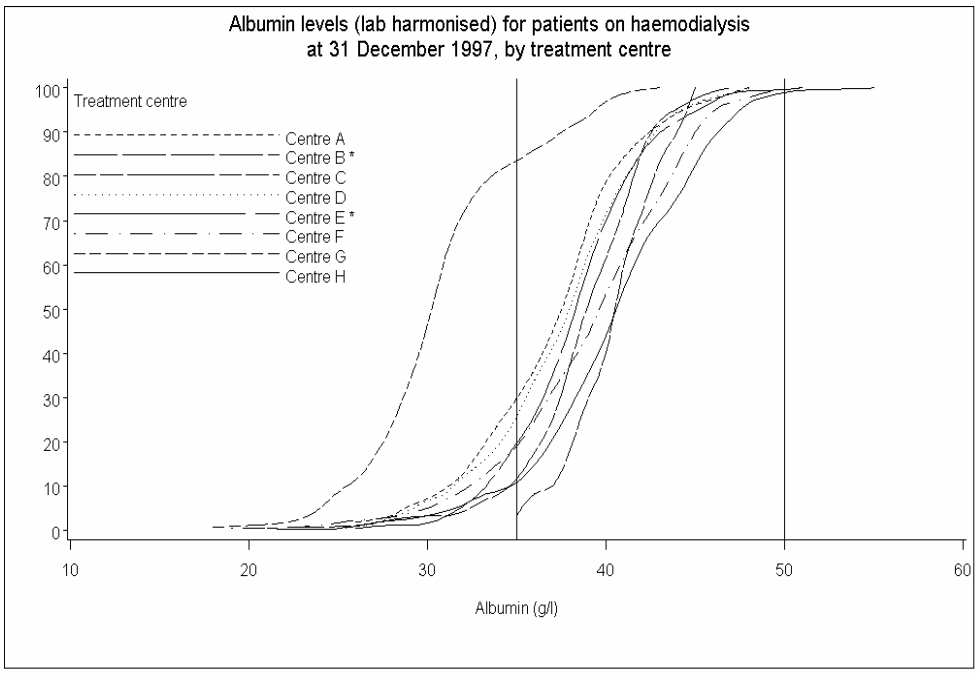

Figure 6.1 Cumulative frequency plots of serum albumin levels on haemodialysis

6:2.2 Peritoneal dialysis

The Renal Standards document recommends ***the serum albumin of at least 70% of patients on peritoneal dialysis should be within the local normal range.***

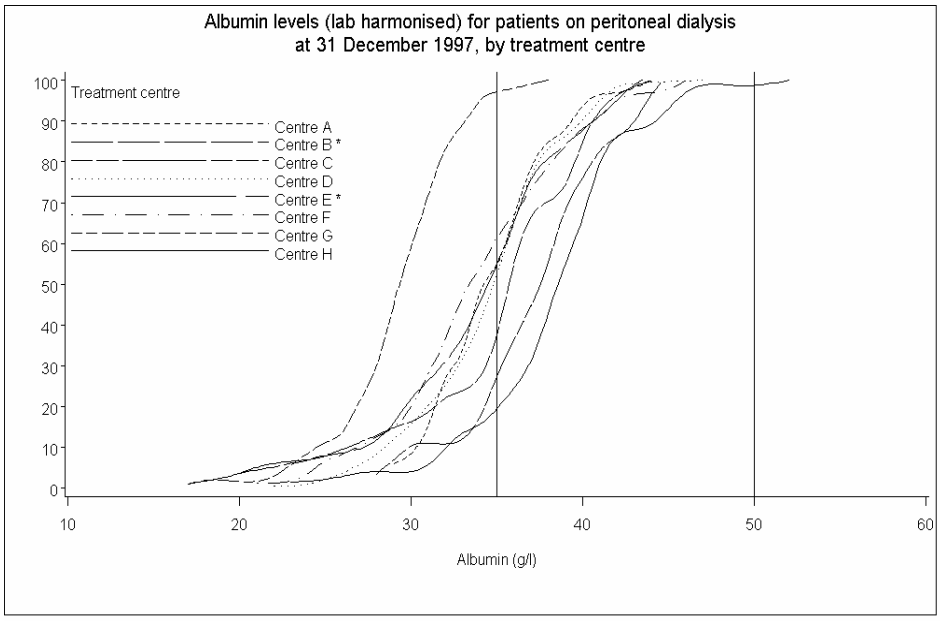

Figure 6.2 Cumulative frequency plots of serum albumin levels in peritoneal dialysis patients

Centre	% below reference range	Median g/l	Lower quartile g/l	Upper quartile g/l	Local range g/l	% return of data
A	48	35	32	37	35-48	78
B*	22	36	35	40	35-53	94
C	17	38	35	40	35-50	94
D	40	35	33	37	35-55	98
E*	55	35	31	37	36-50	96
F	53	34	31	39	35-50	100
G*	46	30	28	32	30-52	92
H	31	39	37	41	37-49	89

* - not harmonised

Table 6.2 Serum albumin in peritoneal dialysis patients

In all units peritoneal dialysis patients have lower serum albumins than haemodialysis patients. The lower reference range for centre H is higher than for other centres and the range is in addition narrower. The Renal Association Standard is defined against 'locally specified laboratory ranges', which not only vary for the same method of measurement but may also not have been derived locally. The source for this range may have been obtained from the kit specification by the manufacturer (derived from a U.S. population).

6:3 Serum calcium

The Renal Standards document recommends that ***total calcium should fall within the normal range quoted by the local pathology laboratory, corrected for serum albumin concentration.***

6:3.1 Methodological considerations.

There are many different formulae to calculate total calcium, taking the measured value and correcting for serum albumin. The specific formula used varies from site to site. For comparison it is important that the same formula is used for all centres. Wherever possible the Renal Registry has collected the calcium data from centres uncorrected for albumin and then applied the same correction formula throughout. Some laboratories only supply corrected calcium values to the renal units. For three centres the uncorrected value was not available and the corrected calcium was taken and a derived uncorrected value was calculated using the local formula supplied by each centre, in conjunction with the albumin (non-laboratory harmonised) measured.

The Renal Registry has applied a standard formula to all the calcium data of :-

Corrected calcium = uncorrected calcium + ((40 – albumin) x 0.02)

The correction formula applies a laboratory harmonisation value to both the uncorrected calcium and the albumin.

The value for corrected calcium is therefore dependent on the local method for measuring albumin. Centre G uses the BCP method for measuring albumin, and this reads on average 5 g/l lower than the other sites using the BCG method. Corrected calcium values for this site will therefore be slightly high and make comparison with other centres invalid.

6:3:2 Haemodialysis

Calcium uncorrected for albumin, (lab harmonised)

Centres C, E and H only send corrected calcium values to the Registry. These values have been uncorrected using the local formula supplied by the laboratory (and verified with the local renal unit).

Centre	% in lab range	% below range	% above range	Median	Lower quartile	Upper quartile	% return 6 months
A	82	4	13	2.36	2.23	2.48	94
B*	74	5	22	2.47	2.34	2.60	95
C^	69	15	16	2.32	2.19	2.48	97
D	78	10	12	2.32	2.19	2.45	92
E^	14	76	10	2.39	2.26	2.50	99
F	79	7	14	2.35	2.20	2.47	99
G	57	26	16	2.33	2.20	2.51	93
H^	64	15	21	2.38	2.23	2.53	84

^ denotes centres which only supplied corrected calcium values.

* - not harmonised

Table 6.3 Serum calcium uncorrected for albumin in haemodialysis patients

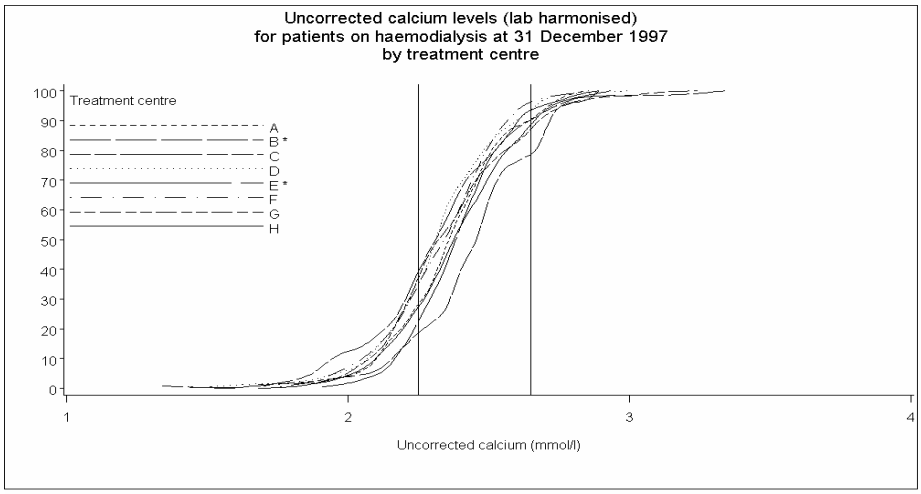

Figure 6.3 Cumulative frequency plots of uncorrected serum calcium in haemodialysis patients

Calcium corrected for albumin by Renal Registry (lab harmonised)

Centre	% between 2.25- 2.65	% < 2.25	% > 2.65	Median	Lower quartile	Upper quartile
A	70	20	10	2.42	2.28	2.56
B*	60	20	20	2.42	2.31	2.58
C^	55	36	9	2.32	2.20	2.46
D	64	28	8	2.36	2.22	2.51
E^	82	12	6	2.42	2.30	2.52
F	63	32	5	2.33	2.21	2.46
G	70	6	24	2.51	2.42	2.65
H^	63	30	7	2.36	2.20	2.51

^ denotes centres which only supplied corrected calcium values.
*- not harmonised

Table 6.4 Haemodialysis patients: serum calcium corrected for albumin

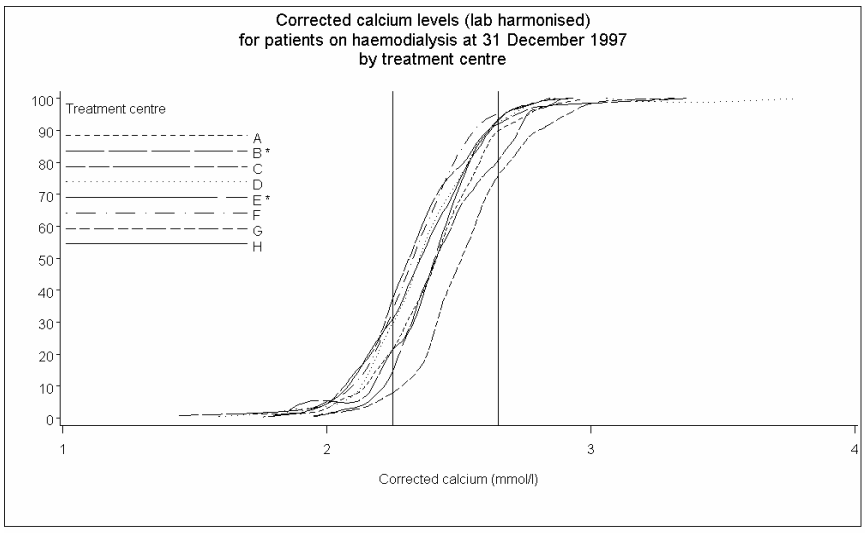

Figure 6.4 Cumulative frequency plots of corrected serum calcium in haemodialysis patients

After applying the harmonisation factors, a range of 2.25 – 2.65 mmol/l was used to enable comparison between centres as the locally defined range is no longer applicable.

The harmonised uncorrected calcium data appear to show a narrower inter-centre distribution than the corrected values. This is attributable to the problems of comparing albumin between different laboratories.

6:3.3 Peritoneal dialysis

Calcium uncorrected for albumin, (lab harmonised)

The peritoneal dialysis data demonstrates a much wider variation of the data between centres, both corrected and uncorrected (figures 6.5, 6.6; tables 6.5,6.6). This wider distribution cannot be accounted for by different laboratory methodologies as this spread is not seen for patients on haemodialysis.

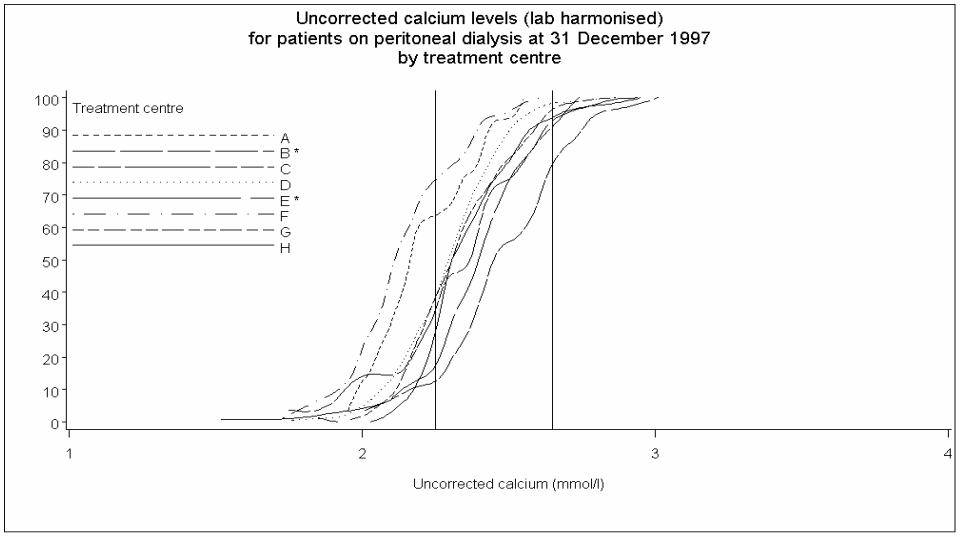

Figure 6.5 Cumulative frequency plots of uncorrected serum calcium in peritoneal dialysis patients

Centre	% in lab range	% below range	% above range	Median	Lower quartile	Upper quartile	% return 6 months
A	90	10		2.17	2.09	2.34	70
B*	67	7	26	2.45	2.35	2.64	90
C^	67	15	18	2.38	2.20	2.53	88
D	84	11	5	2.30	2.18	2.41	97
E^*	74	13	13	2.40	2.29	2.51	90
F	78	18	4	2.12	2.01	2.26	99
G	65	27	8	2.32	2.19	2.46	87
H^	83	6	11	2.31	2.25	2.46	87

^ denotes centres which only supplied corrected calcium values.
* - not harmonised

Table 6.5 Serum calcium uncorrected for albumin in peritoneal dialysis patients

Calcium corrected for albumin by Renal Registry (lab harmonised)

Centre	% between 2.2 – 2.65	% < 2.25	% > 2.65	Median	Lower quartile	Upper quartile
A	59	41	0	2.29	2.18	2.46
B*	60	7	33	2.61	2.40	2.76
C^	63	22	15	2.41	2.25	2.52
D	81	15	4	2.39	2.30	2.51
E^*	75	4	21	2.50	2.40	2.63
F	46	52	2	2.23	2.12	2.37
G	72	4	24	2.52	2.41	2.65
H^	76	17	7	2.37	2.27	2.49

^ denotes centres which only supplied corrected calcium values.
* - not harmonised

Table 6.6 Serum calcium corrected for albumin in peritoneal dialysis patients

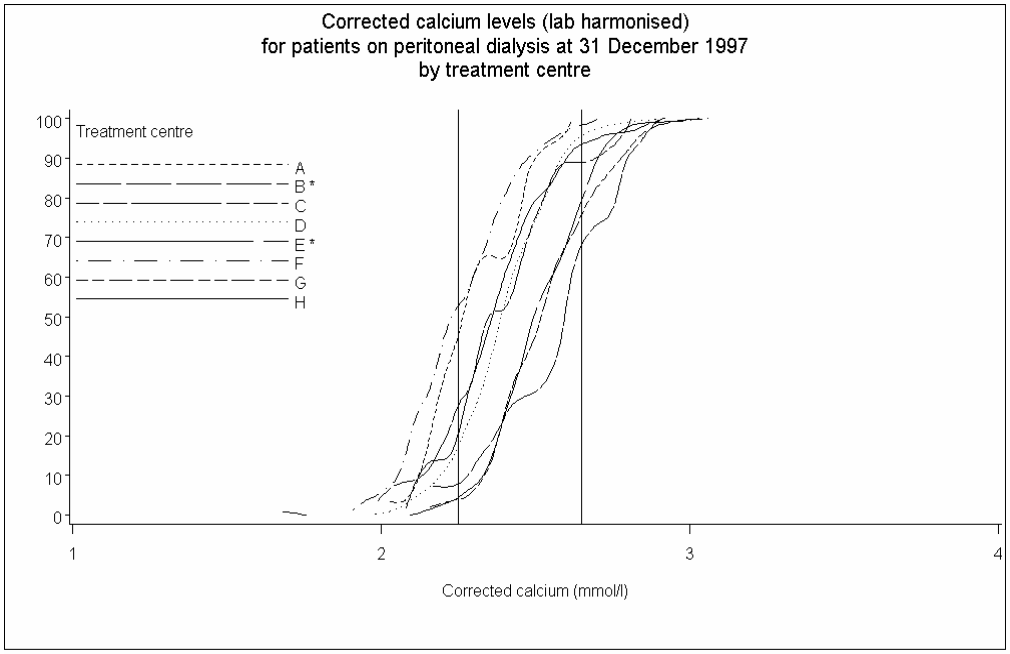

Figure 6.6 Cumulative frequency plots of corrected serum calcium in peritoneal dialysis patients

6:4 Serum phosphate

6:4.1 Haemodialysis

The Renal Standards document recommends ***a target range for predialysis serum phosphate of 1.2 – 1.7 mmol/l.***

Centre	% in ref range	% >1.2	% > 1.7	Median	Lower quartile	Upper quartile	% return
A	28	12	60	2.0	1.6	2.5	94
B*	40	10	50	1.8	1.5	2.1	95
C	40	9	51	1.8	1.5	2.4	98
D	29	11	60	1.9	1.4	2.3	92
E*	27	4	67	2.1	1.7	2.5	99
F	43	9	48	1.7	1.3	2.1	99
G	39	6	55	1.8	1.4	2.4	93
H	39	9	52	1.8	1.4	2.0	84

* - not harmonised

Table 6.7 Predialysis serum phosphate of patients on haemodialysis

The data for centre B has not been harmonised This centre in conjunction with centre H has the smallest interquartile range of 0.6 mmol/l.

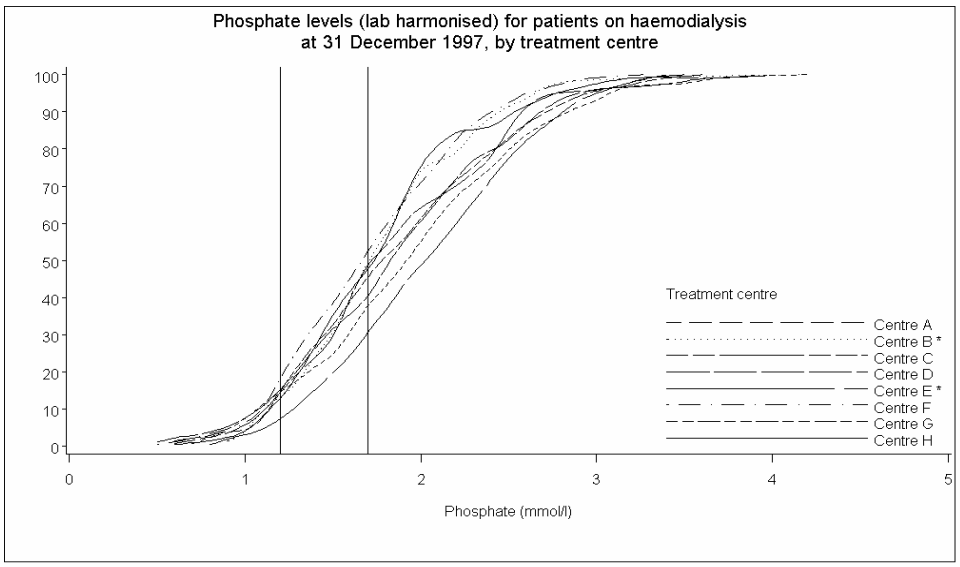

Figure 6.7 Cumulative frequency plot of serum phosphate for patients on haemodialysis

6:4.2 Peritoneal dialysis

The Renal Standards document recommends ***a target range for serum phosphate of 1.1 –1.6 mmol/l.***

Some centres have small numbers of patients on peritoneal dialysis. The smoothing algorithm used in these circumstances produces the irregular dips shown in figure 6.7.

Centre B and centre H have the highest percentage of patients falling within the Standards recommendation. However the data for centre B is not directly comparable with other centres as it could not be harmonised.

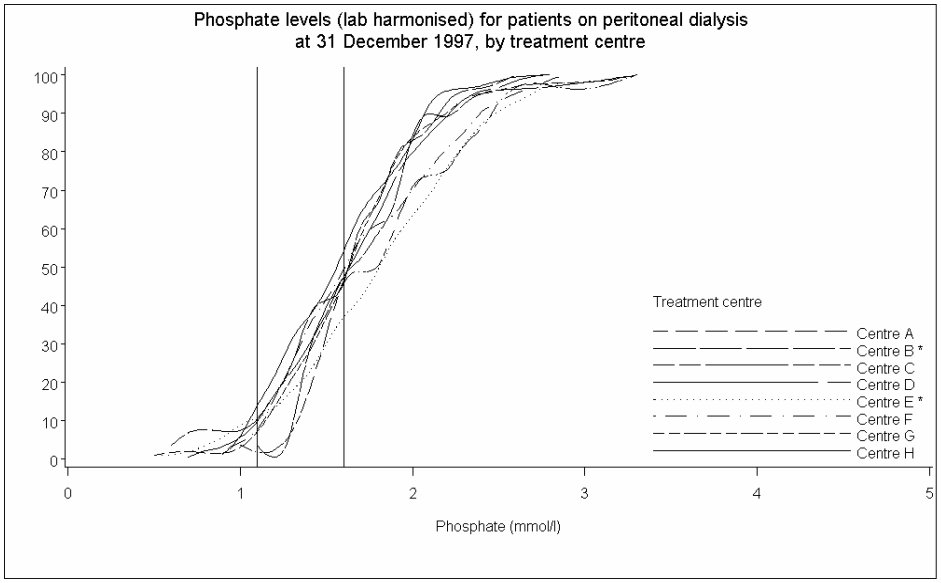

Figure 6.8 Cumulative frequency plot of serum phosphate for patients on peritoneal dialysis

The interquartile ranges for peritoneal dialysis patients were much narrower at 0.5 – 0.7 mmol/l than the ranges for haemodialysis patients of 0.6 – 1.0 mmol/l.

Centre	% in ref range	% < 1.1	% > 1.6	Median	Lower quartile	Upper quartile	% return
A	43	4	53	1.9	1.5	2.3	65
B*	48		52	1.7	1.4	2.0	94
C	38	7	55	1.7	1.4	1.9	94
D	42	6	52	1.7	1.4	2.0	99
E*	28	9	63	1.9	1.5	2.2	91
F	45	5	50	1.7	1.4	2.1	99
G	43	3	54	1.7	1.4	1.9	87
H	49	6	45	1.6	1.3	1.9	87

* - not harmonised

Table 6.8 Serum phosphate of patients on peritoneal dialysis

6:5 Serum bicarbonate

6:5.1 Methodological considerations

For bicarbonate there is no UK NEQAS data available to harmonise these results. There are 3 different methods used by the contributing centres to measure bicarbonate (PECP, enzymatic, actual). The variation in the local reference range supplied by the laboratories does not reflect any specific method. The percentage of patients outside the Renal Association standard seems dependent upon the locally specified laboratory range. The mechanism used by each laboratory to determine the quoted range is not known by the Renal Registry, but it is known that very few have a locally derived

normal range. A reference range of 22 – 30 mmol/l has been shown in the figures as 22 mmol/l is the most widely quoted lower limit of normal.

There were not sufficient data from centre G to reliably calculate the distributions.

	Haemodialysis		Peritoneal dialysis	
Centre	3 months	6 months	3 month	6 months
A	70	83	28	54
B	95	95	90	94
C	97	98	88	94
D	84	92	80	95
E	96	99	75	89
F	100	100	90	99
G				
H	91	94	87	93

Figures are the % of patients with a result available in the given time period.

Table 6.9 Completeness of serum bicarbonate data

6:5.2 Haemodialysis

The Renal Standards document recommends ***that a target predialysis serum bicarbonate within the normal range quoted by the local pathology laboratory should be the aim in all patients after 3 months on haemodialysis.***

All patients on home haemodialysis have been excluded from this analysis. This is because bloods may have been sent in by post, which will produce an inaccurate serum bicarbonate result.

The percentage of patients achieving the Renal Association standard shows a wide variation from 10% - 83% (table 6.10, figure 6.9) The median and interquartile values are included. The centre with lowest compliance with the standard has the highest locally defined lower reference range.

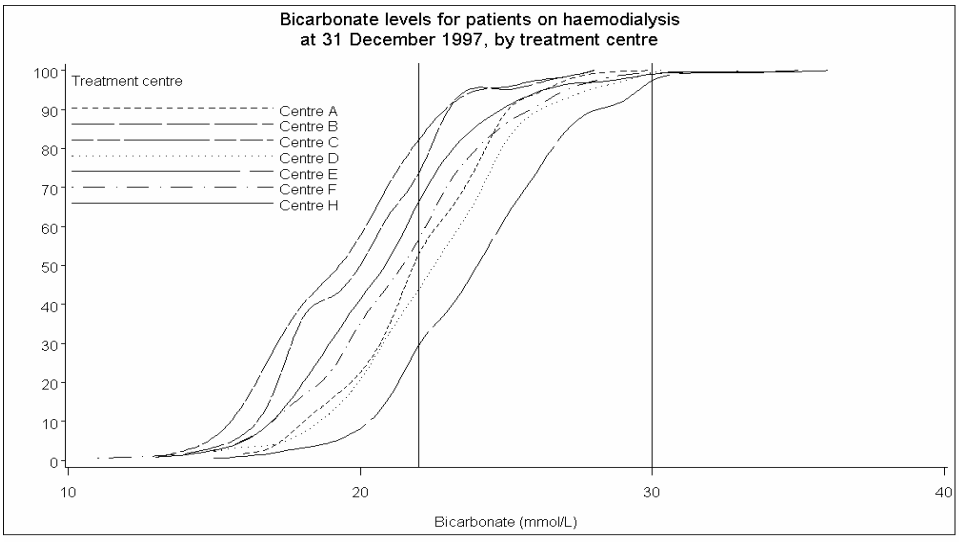

Figure 6.9 Cumulative frequency plots of serum bicarbonate for patients on haemodialysis

Centre	Median	Lower quartile	Upper quartile	% in lab range	% below range	% above range	% in 22-30 mmol/l	Local range mmol/l
A	22	21	24	**65**	35	0	**65**	22 - 30
B	21	18	23	**10**	90	0	**37**	24 - 32
C	20	17	22	**29**	71	0	**29**	22 - 29
D	23	21	25	**66**	33	1	**66**	22 - 30
E	25	22	27	**83**	16	1	**82**	22 - 31
F	22	20	24	**77**	22	1	**54**	20 - 29
G								19 - 28
H	21	19	23	**66**	31	3	**48**	20 - 28

Table 6.10 Serum bicarbonate range for patients on haemodialysis

For comparison the percentage within a standard range of 22 – 30 mmol/l is shown. Using this range the compliance of unit B is improved and that of F and H reduced.

6:5.3 Peritoneal dialysis

The Renal Standards document recommends in peritoneal dialysis patients that ***serum bicarbonate level should not fall below the local normal range, or rise more than 3 mmol/l above it.***

The percentage within local range varied between centres from 82% to 98%. Centre B with the highest locally defined lower reference value has 93% of patients within range.

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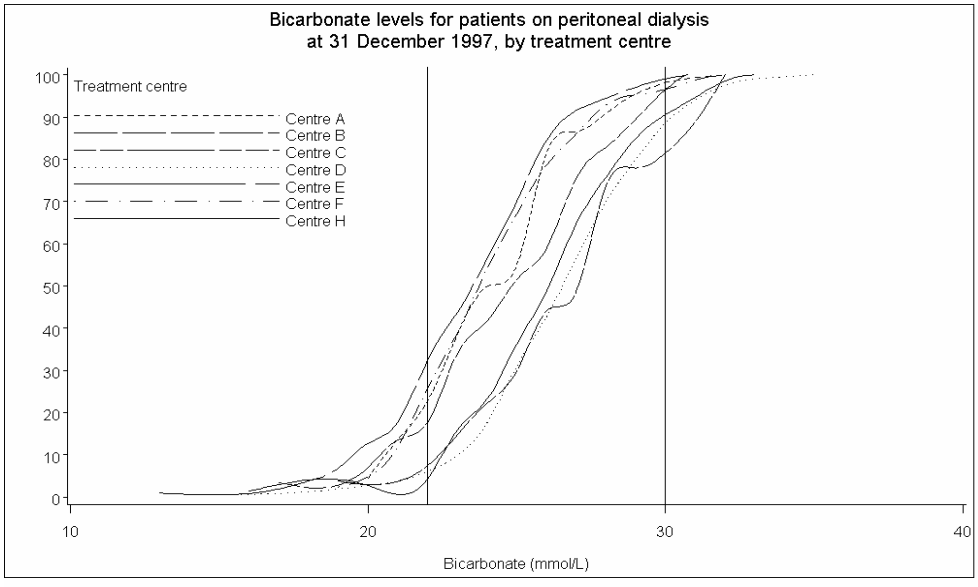


Figure 6.10 Cumulative frequency plots of serum bicarbonate for patients on peritoneal dialysis

Centre	% in lab range	% below range	% above range	Median	Lower quartile	Upper quartile	Local range
A*	86	14	0	25	24	26	22 - 30
B	93	7	0	28	25	29	24 - 32
C	83	14	3	25	23	27	22 - 29
D	95	4	1	27	25	29	22 - 30
E	82	17	1	24	22	26	22 - 31
F	98	2	0	24	22	26	20 - 29
G							19 - 28
H	93	1	6	27	25	28	20 - 28

* Note 46% of bicarbonate data was missing for centre A even after including data from the previous quarter (i.e. no data was available from the last 6 months).

Table 6.11 Serum bicarbonate of patients on peritoneal dialysis

6:6 Parathyroid Hormone

The Renal Standards document recommends ***that iPTH (intact hormone assay) should be maintained at between 2 and 3 times the local normal range.***

6:6.1 Methodological considerations

The Registry has converted all iPTH values to pmol/l. The conversion factor for ng/l to pmol/l is pmol/l = ng/l / 9.5

This analysis includes iPTH data collected over the 9 months from March to December 1997. The latest value from the centres was used. If patients had changed dialysis modality during this period, they were classified according to their latest modality.

All laboratories appear to be using assays that measure only the intact PTH. Only one laboratory (centre F) calculates its own population based reference range. This results in a much lower upper limit of the reference range and accounts for the discrepancy between centres E and F using the same manufacture's kit. The other laboratories either use a range taken from a standard reference textbook, or the assay kit manufacturer's specified range. This discrepancy in defining the reference range markedly affects how the centre 'achieves' the Standards. Centre F appears non-compliant, but when compared against the widely used upper limit of 7.6 pmol/l has one of the highest compliances. Because of these anomalies in local ranges, the Registry has shown compliance against a reference limit of 23 pmol/l (7.6 x 3) on the figures.

6:6.2 Completeness of data

Table 6.12 shows that recent tests of serum iPTH are frequently not available.

	Haemodialysis			Peritoneal dialysis		
Centre	**3 months**	**6 months**	**9 months**	**3 month**	**6 months**	**9 months**
A	2	4	5	2	9	12
B	0	2	2	7	10	21
C	1	3	4	9	15	29
D	23	33	48	18	29	43
E	16	25	33	11	24	37
F	34	60	77	46	71	78
G	83	85	95	18	42	60
H	2	4	47	0	0	22

Figures are the percentage of patients with results within the specified time period

Table 6.12 Completeness of serum iPTH data

Centres F and G have a high percentage of data completeness and this must reflect the differing attitudes of centres to the importance of measuring PTH. Direct comparison with centres with a much lower percentage of data completeness may be invalid. It is not known whether missing data reflects a policy that in patients with a low PTH repeat measurement is not indicated within 9 months, or whether the measurement has simply not been checked.

6:6.3 Haemodialysis

The serum iPTH data for haemodialysis patients are shown in figure 6.11 and table 6.13

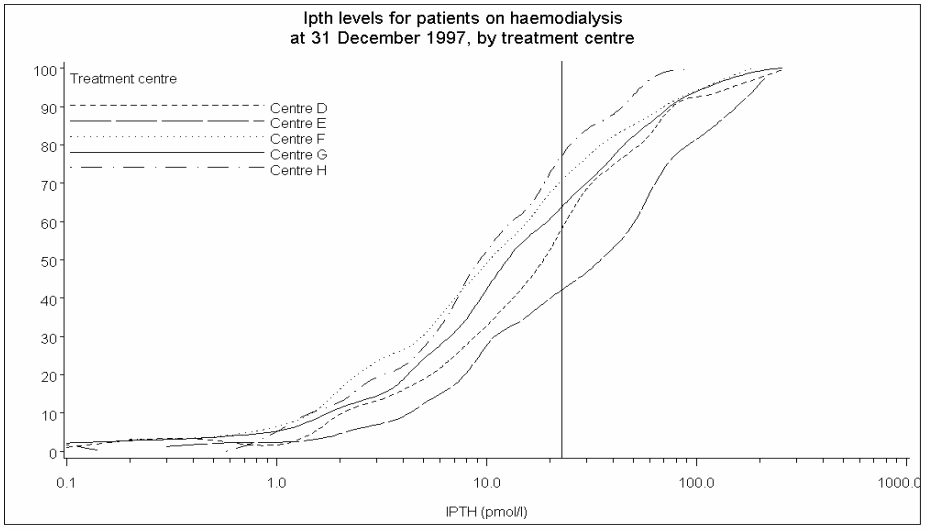


Figure 6.11 Cumulative frequency plots of intact parathyroid hormone for patients on haemodialysis

Centre	% in x3 local range	% < 23 pmol/l	Median	Lower quartile	Upper quartile	Local range	Method
A*							
B*						0.9 - 5.4 pmol/l	
C*						1.3 - 7.6 pmol/l	DPC
D	55	55	19	7	43	1.3 - 7.6 pmol/l	DPC
E	39	42	37	9	74	1.1 - 6.8 pmol/l	Chiron
F	54	71	10	3	28	< 4.0 pmol/l	Chiron
G	63	63	12	5	37	1.3 - 7.6 pmol/l	DPC
H	73	76	10	5	21	1.1 - 6.8 pmol/l	Nichols

* data completeness too low for assessment

Table 6.13 Serum iPTH range for patients on haemodialysis

Compliance with the standard is low. Using the Registry upper limit of 23 pmol/l, centre F moves from 55% to 71% achieving this standard.

6:6.4 Peritoneal dialysis

Centre	% in x3 local range	% < 23 pmol/l	Median	Lower quartile	Upper quartile	Local range	Method
A*							
B*						0.9 - 5.4 pmol/L	
C*						1.3 - 7.6 pmol/L	DPC
D	46	46	25	10	43	1.3 - 7.6 pmol/L	DPC
E	56	64	16	6	36	1.1 - 6.8 pmol/L	Chiron
F	40	62	15	7	33	< 4.0 pmol/L	Chiron
G	66	66	10	3	30	1.3 - 7.6 pmol/L	DPC
H*						1.1 - 6.8 pmol/L	Nichols

* data completeness too low for assessment

Table 6.14 Serum iPTH range for patients on peritoneal dialysis

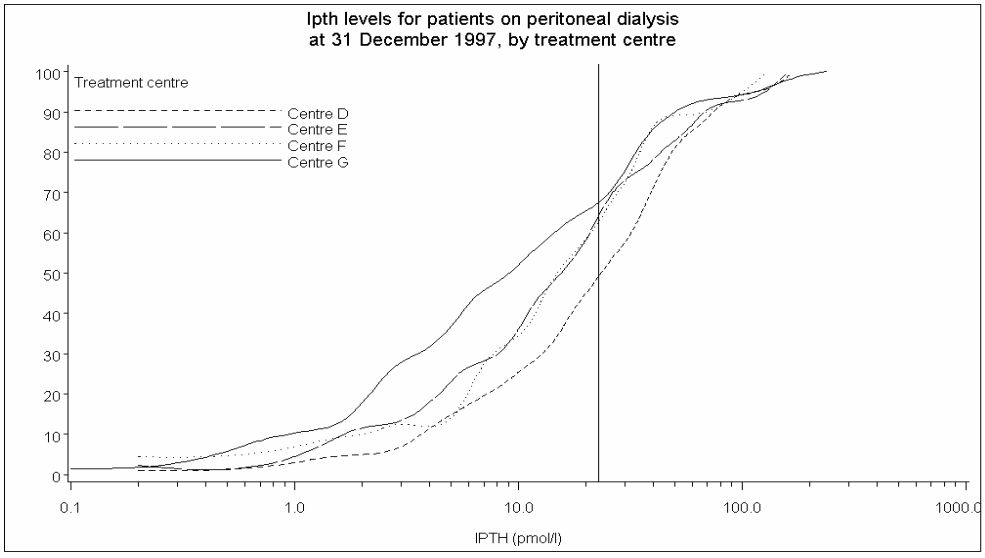


Figure 6.12 Cumulative frequency plots of serum intact parathyroid hormone for patients on peritoneal dialysis

Centres E, F and G have a similar distribution of data for patients on peritoneal dialysis with a variation of 57% - 66% achieving a value lower than the Registry upper limit. Centre D results have a different distribution from these three centres.

The interquartile range for all centres except E, is much larger for patients on peritoneal dialysis. This may partially reflect the lower data completeness in this group. Centres D and F have higher median PTH level in peritoneal dialysis patients compared with haemodialysis patients, while centres E, G, H have a lower PTH level in these patients. This implies a variation in local policy and attitudes to both measurement PTH and its management in peritoneal dialysis and haemodialysis patients.

6:7 Serum cholesterol

The Renal Standards document has no recommended range for serum cholesterol

6:7.1 Introduction

The Renal Registry is able to harmonise cholesterol data to facilitate direct comparisons of measurements between centres.

Most nephrologists are probably looking towards serum cholesterol levels of ≤ 5.5 for men and women, especially in patients with vascular disease or diabetes, in order to follow the Chief Medical Officer's guidelines. The current recommendation by the Chief Medical Officer is to collect LDL cholesterol and the Renal Registry will be adding this item to its database for future analysis.

The Renal Registry has analysed the cholesterol data over 1 year as many centres only measure this annually. It may even be the case, where this has been measured previously and the result was normal without use of a lipid lowering agent, that the centre may not measure it again.

The analysis is split between dialysis and transplant patients, and by gender. The treatment modality was defined on 31/12/97. Some patients may have changed modality over the course of the preceding year, but they were analysed as their category of modality on 31/12/97.

6:7.2 Completeness of data

There was a high percentage of missing data (table 6.15). There are clearly strong local policy factors influencing the measurement of cholesterol which account for the variation in completeness of these data. The Renal Registry has not collected data on the use of 'statins' as many centres do not hold this information in their renal computer system.

Centres with less than 20 results have been removed from the analysis, although the data was retained when calculating the overall median result. As there is a large amount

of missing data for most centres, the total percentage of patients for any centre above or below a value may not correctly reflect the whole population in that centre.

Centre	Dialysis % returned	Transplant % returned
A	27	80
B	44	48
C		
D	44	7
E	10	6
F	54	64
G	5	63
H	15	25

Figures are the percentage of patients with a result within the last year

Table 6.15 Completeness of serum cholesterol data

6:7.3 All Dialysis patients

The figures for patients on dialysis appear to show a fairly close distribution of cholesterol results between centres (table 6.16, figure 6.13).

	Male dialysis		Female dialysis	
Centre	% ≤ 5.5 mmol/	% ≤ 6.5 mmol/	% ≤ 5.5 mmol/	% ≤ 6.5 mmol/l
A	61	95	28*	72*
B	56	84	44*	75*
C				
D	67	86	41	80
E	68*	93*	17*	50*
F	73	92	48	77
G	42*	75*	**	**
H	59	78	60	70

* indicates > 10 and ≤ 20 results recorded for that modality by the centre

** indicate < 10 results recorded for that modality

Table 6.16 Serum cholesterol by gender and modality

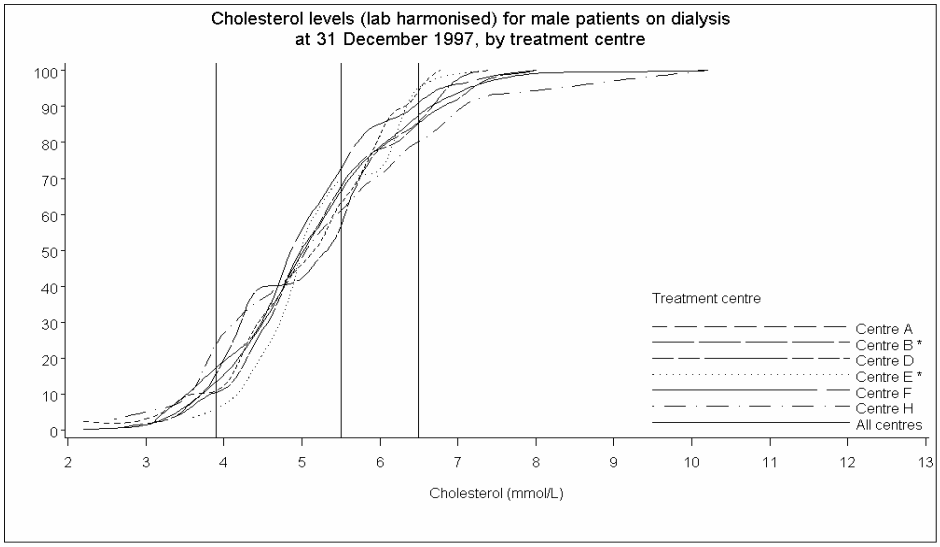


Figure 6.13 Cumulative frequency plots of serum cholesterol for male patients on dialysis

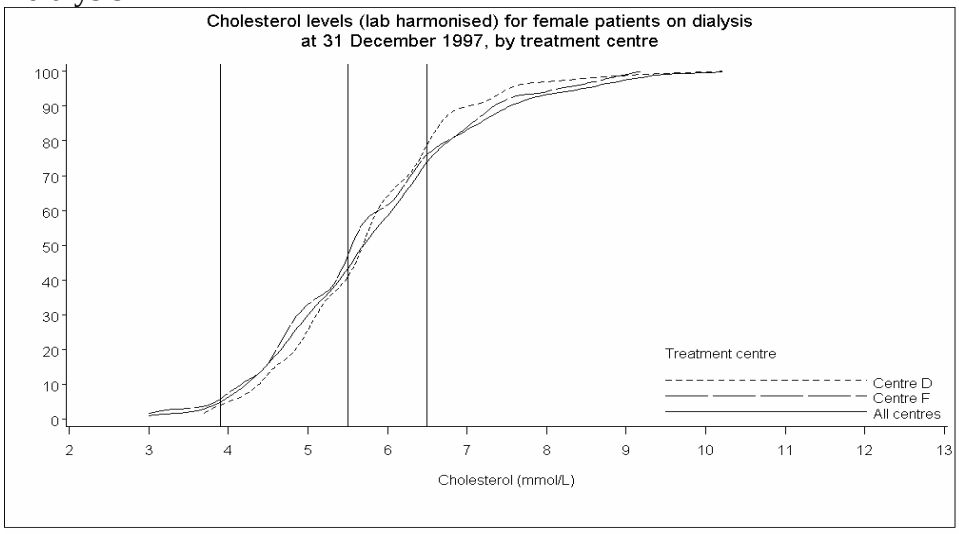


Figure 6.14 Cumulative frequency plots of serum cholesterol for female patients on dialysis

6.7.3 Significance of a low serum cholesterol in dialysis patients

Lowrie et al. showed that for patients on haemodialysis, a low cholesterol was associated with an increased relative risk of death. Compared with a cholesterol value of 5.2 – 6.5 mmol/l, a cholesterol of 2.6 - 3.9 mmol/l was associated with a 2.4 increase in the relative risk of death. Below 2.6 mmol/l the relative risk was increased to 4.3. Lowrie et al. did not analyse this data by stratification into male and female groups. A high cholesterol above 9.1 mmol/l was only associated with an increased relative risk of death of 1.3. These results from 1987-88 pre-dated the widespread use of 'statins' and it can be assumed that these patients were not on lipid lowering agents and that these results reflected the nutritional status of the patients. With the widespread use of lipid

lowering agents it may not be correct to apply the above risk factors to current haemodialysis patients.

Lowrie did not analyse cholesterol data for peritoneal dialysis patients, and the relative risk for this group of patients is unknown. Table 6.17 shows the data on low cholesterol from the Renal Registry.

Centre	Males % < 3.9 on dialysis	Females % < 3.9 on dialysis	Males % < 3.9 Transplanted	Females % < 3.9 Transplanted
A	10*		6	3
B	12			
C				
D	10	3	0	
E	4*			
F	15	3	3	1
G			1	1
H	22*	5*	3	0

* indicates > 10 and ≤ 20 results recorded for that modality by the centre

Table 6.17 Patients with low serum cholesterol

6:7.4 Transplant patients

In transplanted patients, centre G has a high proportion of patients with a serum cholesterol above the desired range, (table 6.18, figures 6.15, 6.16), although there is insufficient data to compare this with its dialysis patients. It also has a higher median cholesterol than other centres.

	Male transplanted		Female transplanted	
Centre	% ≤ 5.5 mmol/	% ≤ 6.5 mmol/	% ≤ 5.5 mmol/	% ≤ 6.5 mmol/l
A	59	88	43	61
B	56*	81*		
C				
D	25*	50*		
E	60*	80*	18*	45*
F	39	73	33	71
G	19	51	12	35
H	43	70	31	64

* indicates > 10 and ≤ 20 results recorded for that modality by the centre

Table 6.18 Serum cholesterol range of transplant patients, by gender

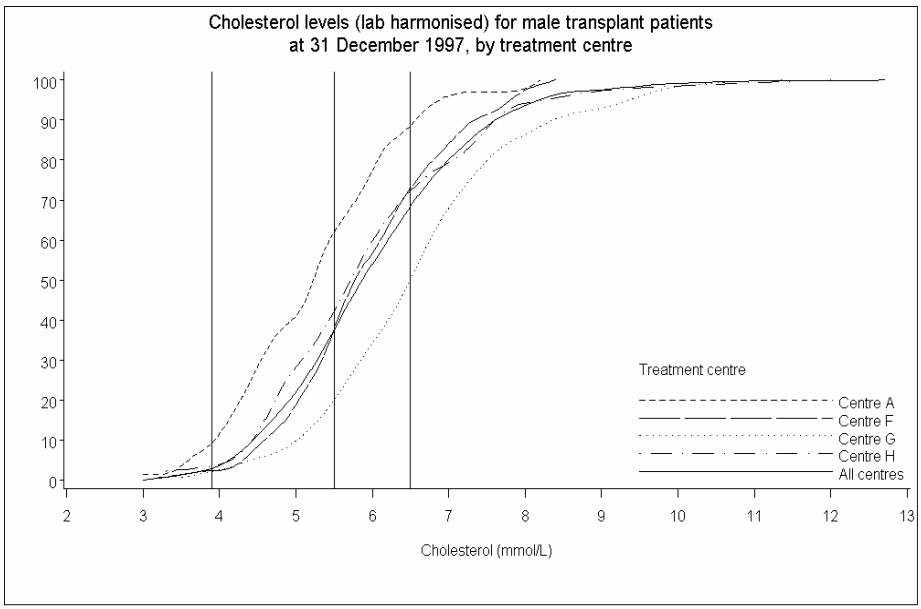
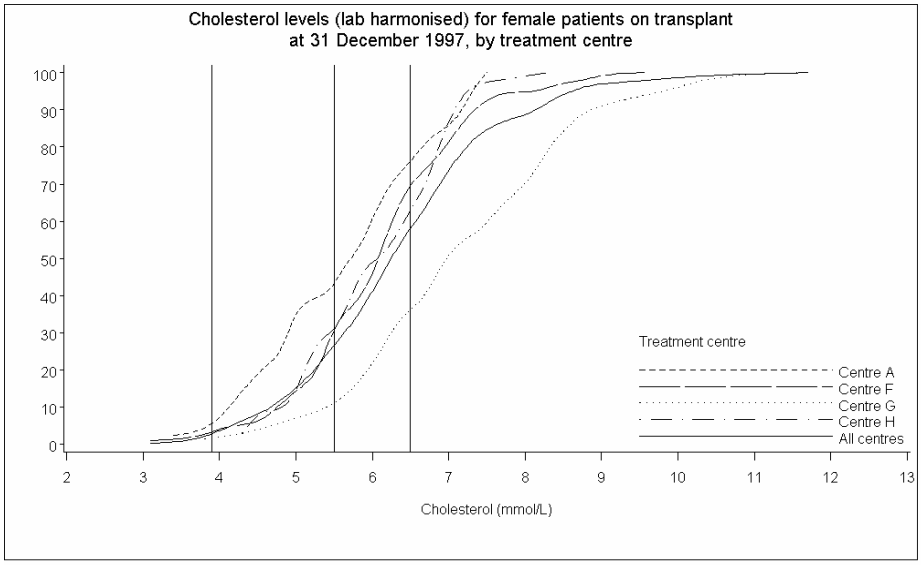


Figure 6.15 Cumulative frequency plots of serum cholesterol for male transplant patients



Vertical lines indicate 3.9, 5.5 and 6.5 mmol/l.

Figure 6.16 Cumulative frequency plots of serum cholesterol for female transplant patients

Chapter 7 Haemodialysis standards

7:1 Frequency of haemodialysis

The Renal standards document recommends ***the adoption of thrice weekly dialysis sessions as a minimum in the majority of patients.***

Four centres were unable to supply data on the frequency of dialysis. Of those centres that sent this data, after excluding the 23% of patients with missing data, 92% of patients were dialysing three times a week. The 1995 Renal survey recorded 82% of patients in England on three times a week dialysis**.**

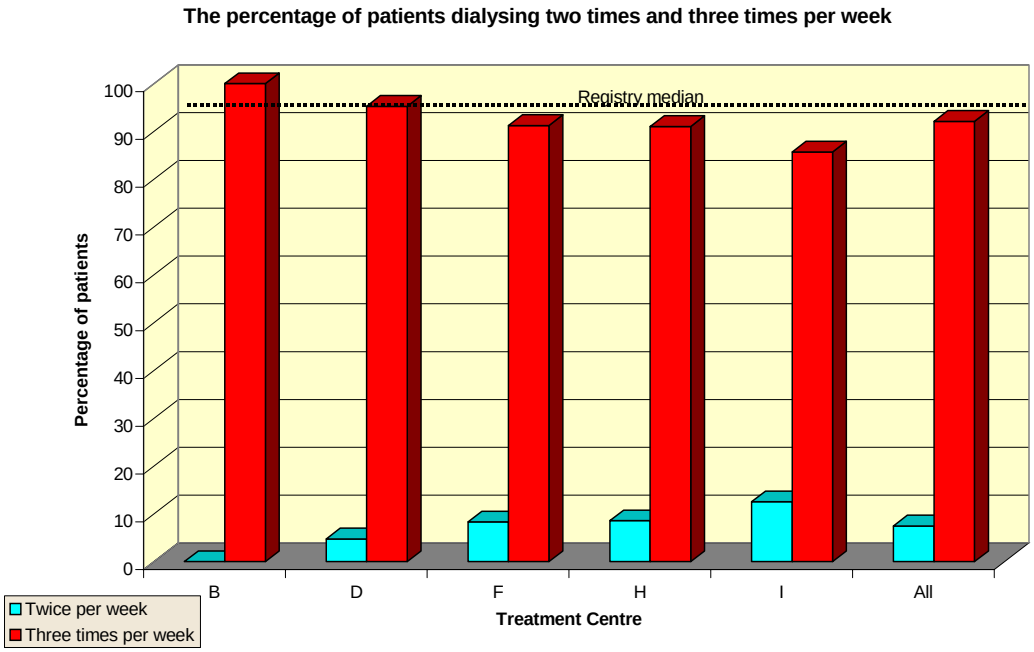


Figure 7.1 Percentage on twice and thrice weekly haemodialysis.

7:2 Bicarbonate dialysis

The Renal Standards document recommends that ***renal units should move towards universal availability of bicarbonate and phasing out of acetate as the routine buffer base in haemodialysis fluid.***

Only three centres were able to send this data. Two centres used only bicarbonate dialysis, while the third had 82% of patients on bicarbonate dialysis. This centre aims to convert all patients to bicarbonate dialysis in the near future (personal communication). In the survey of renal services in England in 1995 over 90% of patients received bicarbonate dialysis, around 80% in Wales.

7:3 Adequacy of dialysis

The Renal Standards document recommends ***that all patients stable on three times a week dialysis should show:***

a urea reduction ratio ≥ 65 %.

or Kt/V>1.2 (dialysis and residual renal function)

The has been increased from the previous Standards document which recommended urea reduction ratio > 55%.

7:3.1 Methodology

Many centres calculate a KT/V urea but use different methods of calculation, and thereby produce widely varying values, which do not permit comparability across centres. The Registry in future plans to calculate its own KT/V, but as the raw data for this calculation has not been available from all sites, the urea reduction ratio has been used for this report as a marker of dialysis adequacy.

Home haemodialysis patients have been excluded from the analysis for direct comparability between units.

7:3.2 Urea reduction ratio (URR)

Urea reduction ratios were extracted from centre databases when stored. In other centres pre- and post- dialysis blood urea results were identified and extracted, and the Registry calculated the URR.

The Registry has not been able to standardise the timing and technique of the post dialysis urea sample.

The quoted targets for URR are for patients dialysing thrice weekly. Centres A, C, and E could not return this information to the Registry. For the other centres, exclusion or inclusion of the patients dialysing twice weekly did not alter the proportion of patients achieving the threshold for URR. This indicates that those dialysing twice weekly do not receive more vigorous dialysis at each session. For the following analysis those known to be dialysing once or twice a week have been excluded.

The results are shown in tables 7.1, 7.2 and figure 7.2. For comparison, the Scottish Registry data (1996) is included in table 7.1. Centre B has achieved the highest percentage of patients dialysing to the recommended standard of a URR > 65%. with 90% reaching this value. It is one of the smaller centres, but clearly other centres may be able to learn from its practice.

Centre	**Percentage achieving URR ≥ 65%**	**Percentage achieving URR ≥ 60%**
A	58	80
B	90	95
C	43	72
D	52	76
E	70	85
F	61	84
G	53	78
H	53	76
I	N/A	N/A
All	**58**	**79**
Scotland	52	74

N/A - not available

Table 7.1 Urea reduction ratio achievement by centre

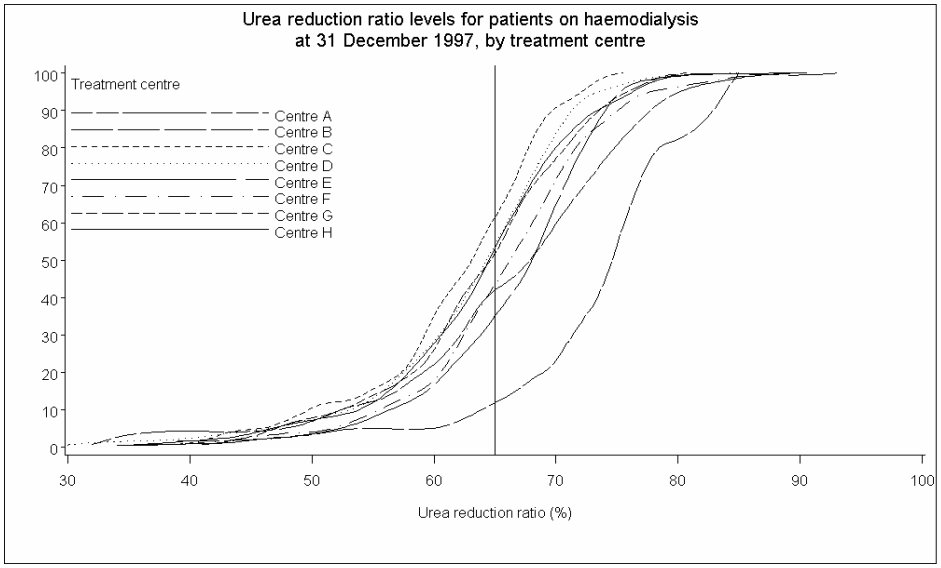


Figure 7.2 Cumulative distribution plot of urea reduction ratio.

Centre	Median URR	Lower quartile	Completeness of data in quarter
A	68	62	98
B	75	71	94
C	64	59	99
D	65	60	99
E	69	63	100
F	67	62	98
G	65	60.5	99
H	65	60	98
I			20
All	**66**	**61**	

Table 7.2 Urea reduction ratio distribution

It is apparent from table 7.2 that the distributions are uniform, The Registry extraction software installed on systems will only return a URR if the value is greater than 30%. If the software calculates a value from two urea pairs (samples taken on the same date) that is less than this, it will look for another set of urea values.

To achieve a URR $\geq$65% for the large majority of patients within a unit would require a median URR value of 75% for the whole population. At this level 10% would remain below the minimum, as shown by the data from centre B. The "aim" for unit URR will need to be 75% if compliance with the standard is to be achieved.

Chapter 8 Haemoglobin and related variables

8:1 Inclusion criteria for the analysis

No laboratory harmonisation is required for haemoglobin. The data which follows are the latest relevant values of haemoglobin in the last 6 months of 1997. For these analyses, patients were only included if: -

1. They had received renal replacement therapy by dialysis for at least 3 months.
2. There had been no change of modality between haemodialysis and peritoneal dialysis in the last 3 months.
3. Patients who had transferred in to the centre in the previous 3 months.

These inclusion criteria are suggested by our later analysis (section 8:3) and are compatible with the recommendations in the Renal Association standards document.

8:2 The achievement of the recommended standard for haemoglobin

8:2.1 Achievement of the recommended standard.

The Renal Association standards document recommends ***a target haemoglobin of not less than 10 g/dl should be achieved by*** 85% of ***dialysis patients stable on therapy for 3 months. Transfusions should be avoided in patients likely to be transplanted to avoid sensitisation.***

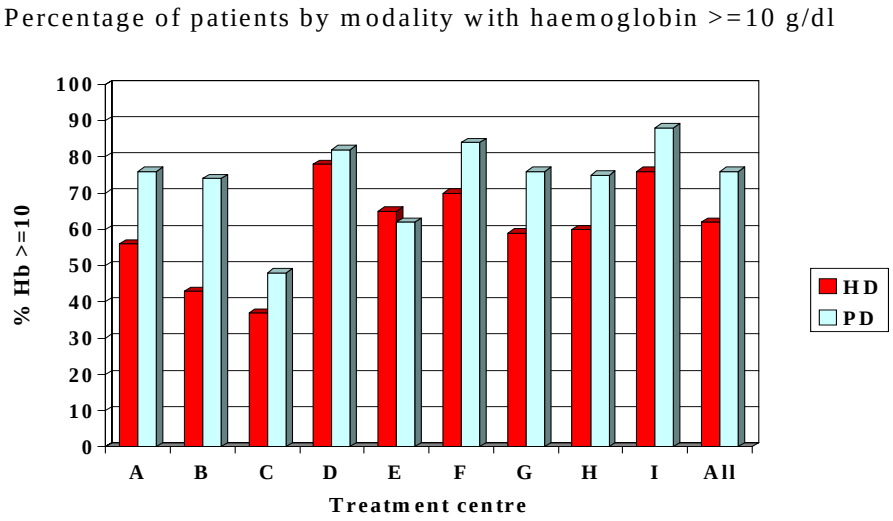


Figure 8.1 Percentage of patients on each modality of dialysis with haemoglobin ≥ 10 g/dl.

The median haemoglobin for all haemodialysis patients registered, was 10.5 g/dl, and for peritoneal dialysis patients was 11 g/dl. Figure 8.1 illustrates the percentage of patients in each renal unit on haemodialysis and peritoneal dialysis with haemoglobin above 10 g/dl. Results from centre I are difficult to interpret as the percentage return is low (tables 8.1 and 8.2)

8:2.2 Haemodialysis patients

The frequency distribution plots for haemoglobin of haemodialysis patients are shown in figure 8.2

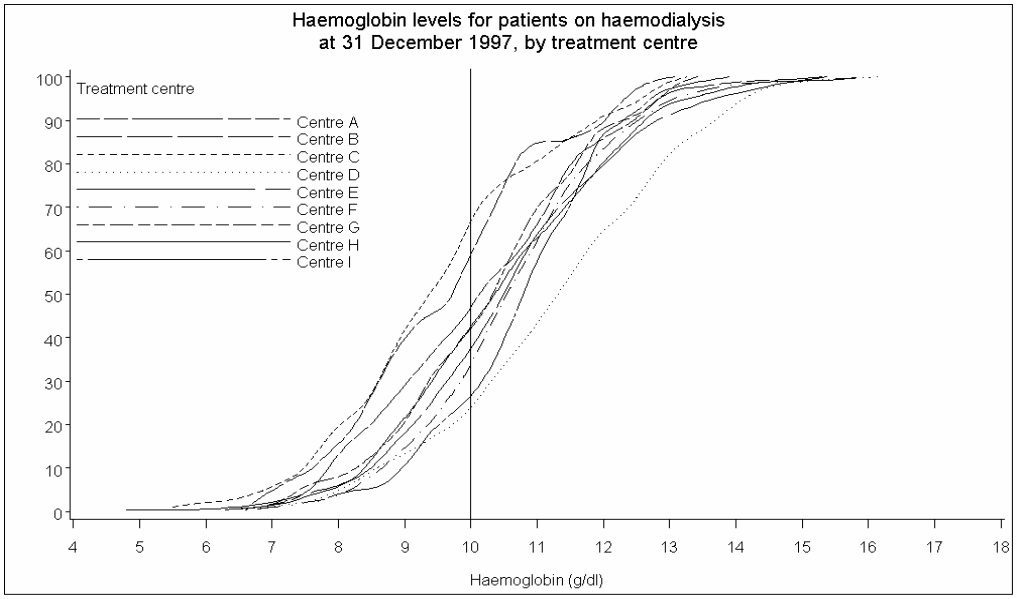


Figure 8.2 The frequency distribution plots for haemoglobin of haemodialysis patients.

The achievement of a haemoglobin of 10 g/dl varies between units from 37% to 78%, with the unit median haemoglobin ranging from 9.4 to 11.4 g/dl. The results are in table 8.1.

Centre	% ≥ 10 g/dl	% return	Median Hb g/dl	Lower quartile	Upper quartile	Quartile range
A	56	88	10.2	8.9	11.4	2.5
B	43	86	9.8	8.5	10.6	2.1
C	37	98	9.4	8.5	10.7	2.2
D	78	94	11.4	10.2	12.7	2.5
E	65	97	10.6	9.5	11.7	2.2
F	70	100	10.6	9.6	11.5	1.9
G	59	100	10.4	9.2	11.4	2.2
H	60	96	10.4	9.3	11.8	2.5
I	*76*	*59*	*10.9*	*10.0*	*11.7*	*1.7*
Total N=1449	**62**	**94**	**10.5**	**9.3**	**11.7**	**2.4**

Table 8.1 Haemoglobin attained in 1449 haemodialysis patients

To achieve adequate compliance with the standards, the data indicate that it may be necessary to achieve a median haemoglobin of 11.45 g/dl. The quartile range, where 50% of patients lie, varies between centres from 1.7 to 2.5, suggesting that local intervention policies may be able to influence this range. The first standards document recommended an upper limit for haemoglobin of 12 g/dl, but an upper limit was omitted from the second edition. Even those centres with the narrowest interquartile range could not hope to achieve a standard range as narrow as the 10 - 12 g/dl. which was originally recommended.

8:2.3 Peritoneal dialysis

The frequency distribution plots for haemoglobin of peritoneal dialysis patients are shown in figure 8.3. The results are given in table 8.2. The numbers in this group are small for some of the centres. The percentage of patients achieving an haemoglobin >= 10 g/dl ranges from 48% to 88% in different centres. The median value for each renal unit varies from 9.7 g/dl to 11.5 g/dl.

The interquartile range is lower for peritoneal dialysis patients. As with haemodialysis, a narrow target range for haemoglobin of 2 g/dl. does not appear possible.

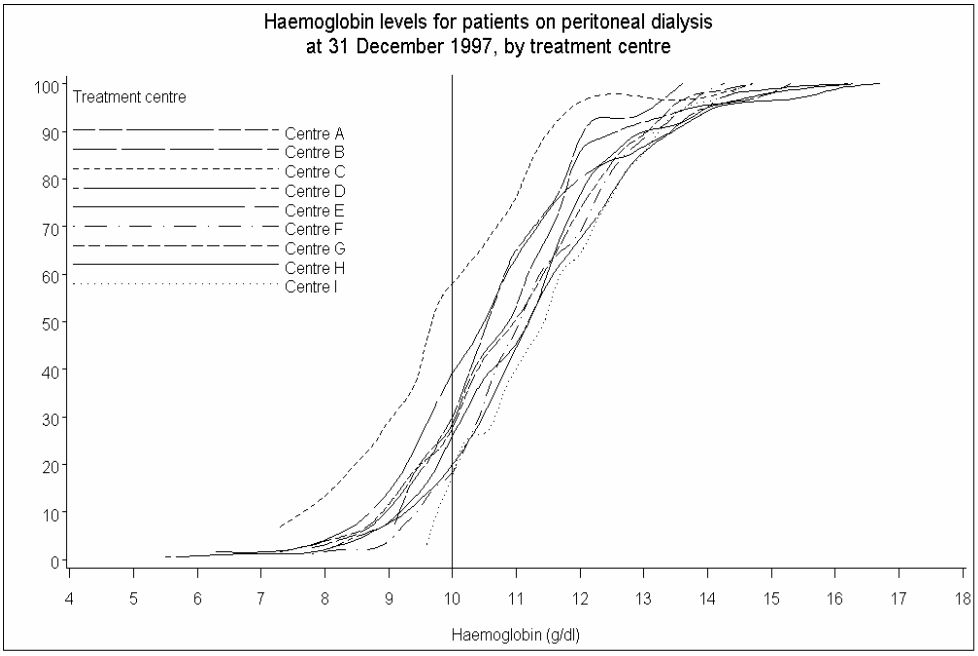


Figure 8.3 The frequency distribution plots for haemoglobin of peritoneal dialysis patients.

Centre	% >= 10 g/dl	% return	Median Hb g/dl	Lower quartile	Upper quartile	Quartile range
A	76	98	11.0	10.0	11.8	1.8
B	74	90	10.6	9.8	11.7	1.9
C	48	94	9.7	8.9	11.0	2.1
D	82	95	11.2	10.3	12.5	2.2
E	62	100	10.6	9.5	11.6	2.1
F	84	100	11.1	10.2	12.2	2.0
G	76	99	11.0	10.0	12.1	2.1
H	75	94	11.3	9.9	12.0	2.1
I	*88*	*71*	*11.5*	*10.6*	*12.5*	*1.9*
Total	**76**	**95**	**11**	**10**	**12.1**	**2.1**
N=741						

Table 8.2 Haemoglobin attained in peritoneal dialysis patients

8:2.4 The relationship between median haemoglobin and percentage patients with haemoglobin above 10g/dl.

This relationship is shown in figure 8.4

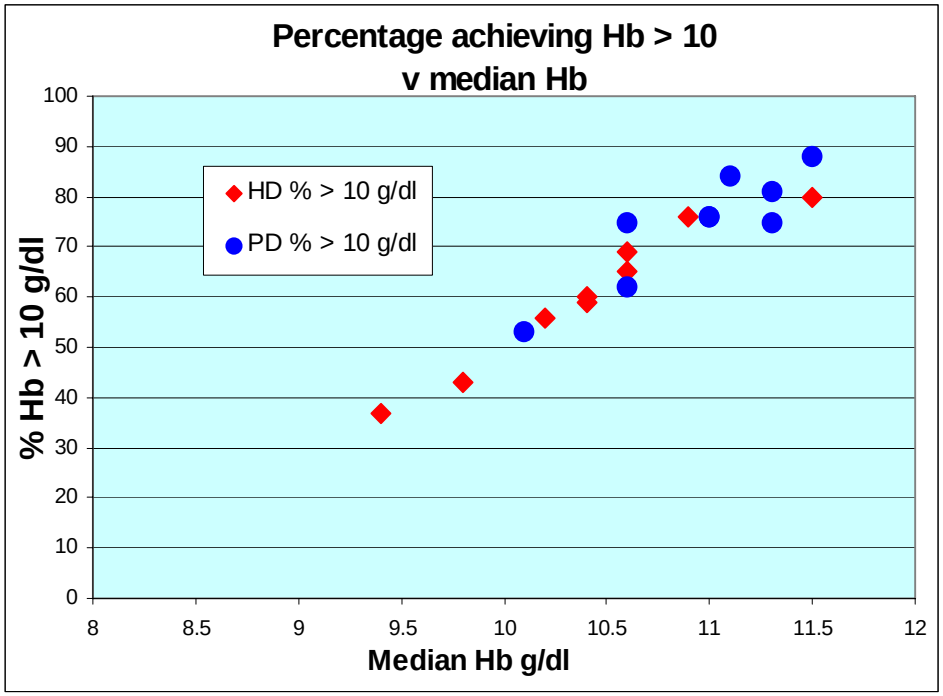


Figure 8.4 Relationship between median haemoglobin and percentage of patients with a haemoglobin above 10 g/dl.

Figure 8.4 indicates that for all the centres, there is a close association between the median haemoglobin achieved and the percentage of patients with an haemoglobin greater than 10 g/dl. The increased discrepancy for patients on peritoneal dialysis is probably caused by the smaller numbers in this patient group.

8:3 Demographic and historical factors influencing haemoglobin

Data was analysed to assess the influence of the following on haemoglobin.

1) Age
2) Gender
3) Duration of endstage renal failure
4) Recent change of dialysis modality
5) Previous transplantation

8:3.1 Age

Spearman's correlation was used to measure the degree of association between patient age and haemoglobin. Spearman's correlation was chosen rather than the Pearson correlation coefficient as patient age was not normally distributed. It also has the advantage that it detects an increasing or decreasing relationship rather than specifically a linear relationship. The results are shown in table 8.3.

Modality	Number of patients	Spearmans Correlation (r_s)	P-value
Haemodialysis	1449	-0.04	0.0918
Peritoneal dialysis	741	0.10	0.0093

Table 8.3 Spearman's correlation between patient age and haemoglobin

The results show no evidence of an association between patient age and haemoglobin for patients on haemodialysis. The very weak association between patient age and haemoglobin for patients on peritoneal dialysis is unlikely to be of practical importance.

These results will be influenced by erythropoietin therapy. The percentage of patients above and below the age of 65 who had a haemoglobin of 10 g/dl. or more without the use of erythropoietin was studied (table 8.4)

	Haemodialysis patients		Peritoneal dialysis patients	
Age	<65	>=65	<65	>=65
Number	703	407	349	203
% Hb>= 10 g/dl without EPO	20%	15%	39%	39%

Table 8.4 Attainment of haemoglobin >=10 g/dl without erythropoietin

There appears to be no notable relationship between age and haemoglobin attained without use of erythropoietin. Table 8.5 shows there is no relationship between age and the use of erythropoietin.

	Percentage on erythropoietin in each age range					
Age	18-34	35-44	45-54	55-64	65-74	75+
HD	76	73	73	69	71	76
PD	55	63	42	40	54	43

Table 8.5 Percentage on erythropoietin in each age range

There is thus no evidence that older patients are maintained with lower haemoglobin than younger patients, that they less frequently spontaneously attain a haemoglobin of 10 g/dl, or need more erythropoietin to attain the target haemoglobin. Data on use of blood transfusion is not available.

8:3.2 Gender

Two sided t-tests have been used to compare the mean haemoglobin levels of men and women. Men have a higher haemoglobin than women (tables 8.6, 8.7)

Gender	**Number of patients**	**Mean haemoglobin**	**Standard deviation**
Male	905	10.7	1.8
Female	542	10.2	1.6

T=4.8, d.f. = 1445, p<0.0001.

Table 8.6 Mean haemoglobin of haemodialysis patients on 31/12/97.

The results show that for patients on haemodialysis the haemoglobin of men is significantly higher than the haemoglobin of women.

Gender	Number of patients	Mean haemoglobin	Standard deviation
Male	432	11.3	1.7
Female	309	10.7	1.5

T=4.7, d.f = 739, p<0.0001.

Table 8.7 Mean haemoglobin of peritoneal dialysis patients on 31/12/97.

The results show that for patients on peritoneal dialysis the haemoglobin of men is significantly higher than the haemoglobin of women

8:3 3 Duration of renal replacement therapy

Modality	Number of patients	Spearmans Correlation (r_s)	P-value
Haemodialysis	1402	0.14	<0.0001
Peritoneal dialysis	727	-0.11	0.0044

Table 8.8 Relationship between duration of renal replacement therapy and haemoglobin.

Spearman's correlation was used to measure the degree of association between patient age and haemoglobin. Spearman's correlation was chosen rather than the Pearson correlation coefficient as patient age was not normally distributed. It also has the advantage that it detects an increasing or decreasing relationship rather than specifically a linear relationship. The results (table 8.8) show there is only a weak correlation between haemoglobin and time on renal replacement therapy in both haemodialysis and peritoneal dialysis.

	Percentage on erythropoietin by years on renal replacement therapy					
Modality	<1 year	1-2 years	2-3 years	3-5 years	5-10 years	10+ years
Haemodialysis	59	72	76	77	79	73
Peritoneal dialysis	35	43	56	45	67	65

Table 8.9 Duration of renal replacement therapy and use of erythropoietin.

The use of erythropoietin could affect these results. The percentage of patients receiving erythropoietin with regard to length of time on renal replacement therapy is shown in table 8.9. In the first year of haemodialysis, and the first 5 years of peritoneal dialysis there appears to be lower use of erythropoietin. This is probably related to retention of residual renal function.

8:3.4 Recent change of dialysis modality

The haemoglobin levels of patients who had been on the same dialysis modality (haemodialysis or peritoneal dialysis) throughout the quarter were compared with haemoglobins of patients who were previously on the alternative dialysis type in the quarter, regardless of the duration.

For this analysis haemoglobin levels have only been taken from the last 3 months.

2 sided t-tests were used to compare the mean haemoglobin levels of the two groups of patients.

Changed dialysis modality	Number of patients	Mean haemoglobin	Standard deviation
Yes	20	8.8	1.3
No	1390	10.5	1.7

T=4.4, d.f = 1408, p<0.0001.

Table 8.10 Mean haemoglobin of haemodialysis patients on 31/12/97.

The results show that the haemoglobins of patients who recently changed from peritoneal dialysis to haemodialysis are significantly lower than the haemoglobins of patients who remained on haemodialysis throughout the quarter.

Changed dialysis modality	Number of patients	Mean haemoglobin	Standard deviation
Yes	25	9.8	1.5
No	711	11.1	1.7

T=3.7, d.f = 734, p=0.0002.

Table 8.11 Mean haemoglobin of peritoneal dialysis patients on 31/12/97.

The results show that the haemoglobin of patients who recently changed from haemodialysis to peritoneal dialysis are significantly lower than the haemoglobin of patients who remained on peritoneal dialysis throughout the quarter.

Thus changes in dialysis modality in either direction between haemodialysis and peritoneal dialysis within a quarter are associated with a lower haemoglobin.

8:3.5 Previous transplantation

Two-sided t-tests were used to compare the mean haemoglobin of patients who had and had not previously had a transplant.

Previously had a transplant	Number of patients	Mean haemoglobin	Standard deviation
Yes	321	10.7	1.8
No	1095	10.5	1.7

T=2.0, d.f = 1414, p=0.0502.

Table 8.12 Previous transplantation and mean haemoglobin of haemodialysis patients on 31/12/97.

Previously had a transplant	Number of patients	Mean haemoglobin	Standard deviation
Yes	112	10.9	1.8
No	615	11.1	1.6

Results from T-test: T=1.6, d.f = 725, p=0.1022

Table 8.13 Previous transplantation and mean haemoglobin of peritoneal dialysis patients on 31/12/97

Chi-squared tests (with continuity correction) were used to compare the proportion of patients on erythropoietin for patients who had and had not previously had a transplant.

Previously had a transplant	Number of patients	Number of patients on erythropoietin	% of patients on erythropoietin
Yes	246	190	77
No	883	625	71

Results from chi-squared test: $X^2 = 3.7$, d.f = 1, p=0.0550

Table 8.14 Previous transplantation and use of erythropoietin for haemodialysis patients on 31/12/97.

Previously had a transplant	Number of patients	Number of patients on erythropoietin	% of patients on erythropoietin
Yes	77	57	74
No	486	214	44

Results from chi-squared test: $X^2 = 22.8$, d.f = 1, $p<0.0001$.

Table 8.15 Previous transplantation and use of erythropoietin for peritoneal dialysis patients on 31/12/97.

The results show some evidence for a difference in the haemoglobin of haemodialysis patients who have and have not previously been transplanted. The result did not quite reach statistical significance using the two sample t-test (T=2.0, d.f = 1414, p = 0.0502). There is also some evidence that the proportion of haemodialysis patients receiving erythropoietin is higher in those who have previously received a transplant. This did not quite reach statistical significance using the chi-squared test with continuity correction (p=0.055) (table 8.14).

There is no significant difference in the haemoglobin of peritoneal dialysis patients who have and have not previously been transplanted, but the proportion of peritoneal dialysis patients receiving erythropoietin is significantly higher in those have previously received a transplant (table 8.16).

Overall, it appears that a previous renal transplant may increase the need for erythropoietin in dialysis patients. The information on whether the transplants were left in situ or removed is not available.

8:4 Serum ferritin

The Renal Association standards document does not recommend a range for serum ferritin.

Patients with renal failure appear to have a relatively inability to utilise iron and need well-maintained iron stores to maintain haemoglobin and to respond to erythropoietin. There is argument concerning the best indicator of iron stores in end stage renal failure. Despite the fact that serum ferritin is an acute phase reactant and rises during acute inflammation it is the most widely used marker in the UK of iron status in endstage renal failure. The Registry is therefore collecting serum ferritin values as a marker of iron stores. It has been recommended that for maximum response to erythropoeitin therapy in endstage renal failure that serum ferritin be maintained at least as high as 100 µmol/l **(**ref. 12) although some authors have suggested this level is not always adequate.

Figures 8.5 and 8.6 show the cumulative frequency plots of serum ferritin in haemodialysis and peritoneal dialysis patients respectively. The details are in table 8.16. The latest result is used. If there has been no result recorded in the last 9 months the item is regarded as missing. Data from centre A are not included as this centre uses a different marker of iron stores.

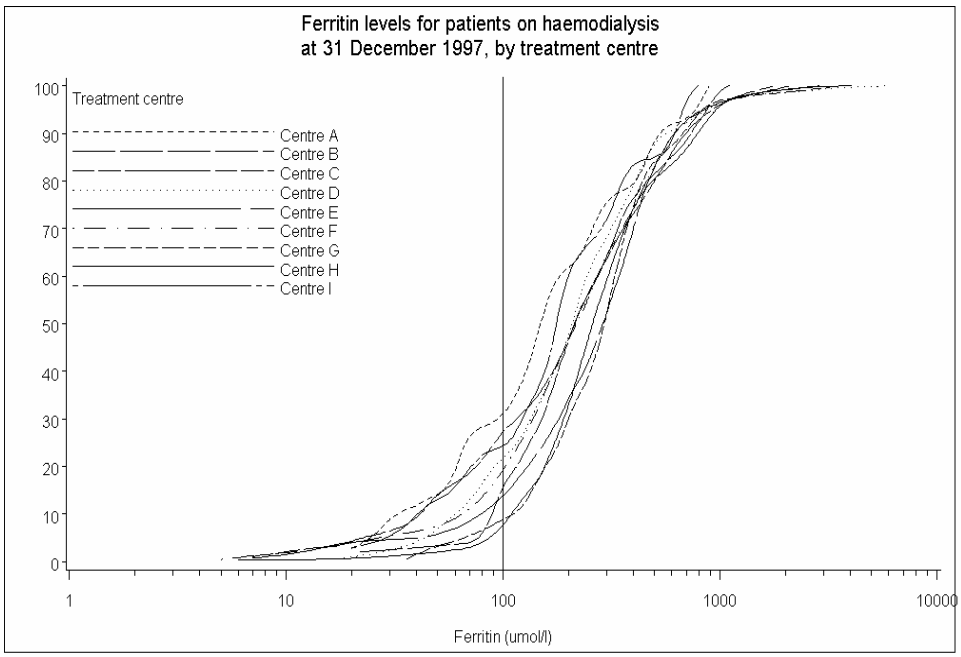


Figure 8.5 Haemodialysis patients: cumulative plots of serum ferritin levels by treatment centre –

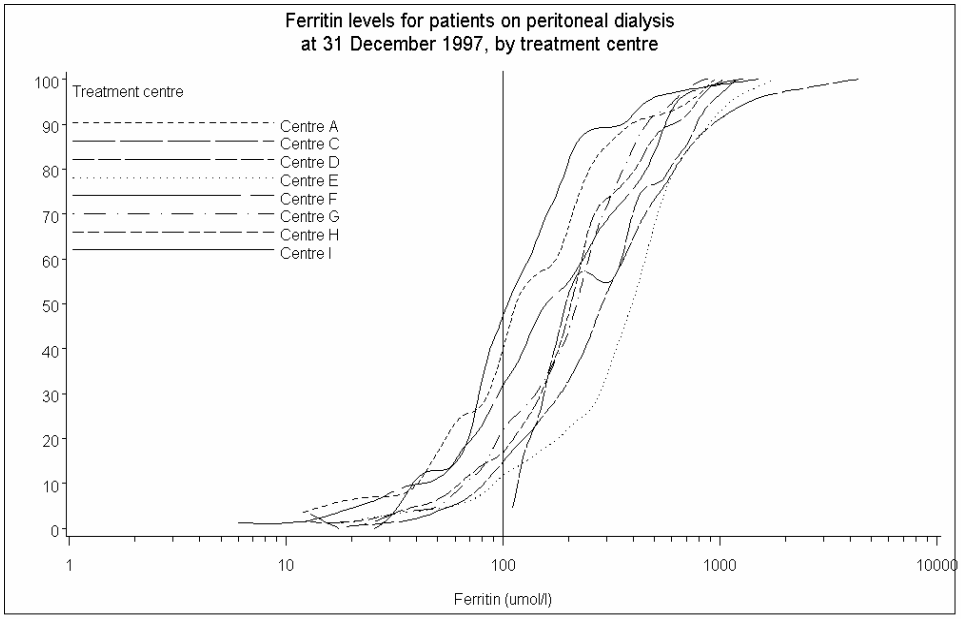


Figure 8.6 Peritoneal dialysis patients: cumulative plots of serum ferritin levels by treatment centre -.

	% ferritin ≥100		% ferritin ≥200		% return	
Unit	HD	PD	HD	PD	HD	PD
B	86	*	56	*	79	24
C	72	100	55	50	87	71
D	79	86	53	67	83	95
E	87	88	65	79	52	74
F	81	68	54	46	98	94
G	91	79	70	57	97	87
H	93	85	68	54	93	84
I	77	56	40	19	50	68
Total	**84**	**80**	**59**	**58**	**75**	**82**

For haemodialysis n=1162, peritoneal dialysis n=642
* - less than 10 patients with results, omitted

Table 8.16 Percentage of patients with serum ferritin over 100 µmol/l and 200 µmol/l

It could be argued that patients with serum ferritin between 15 and 100 µmol/l who maintain adequate serum haemoglobin without support from erythropoietin therapy do not need further iron supplementation, but that those with a serum ferritin below 100 µmol/l who do not spontaneously maintain an adequate haemoglobin do. Centres A,G,I are unable to provide data on use of erythropoietin and so cannot be included in this analysis. Figure 8.7 shows the proportion of patients in each renal unit on haemodialysis and peritoneal dialysis who appear to need further iron supplementation.

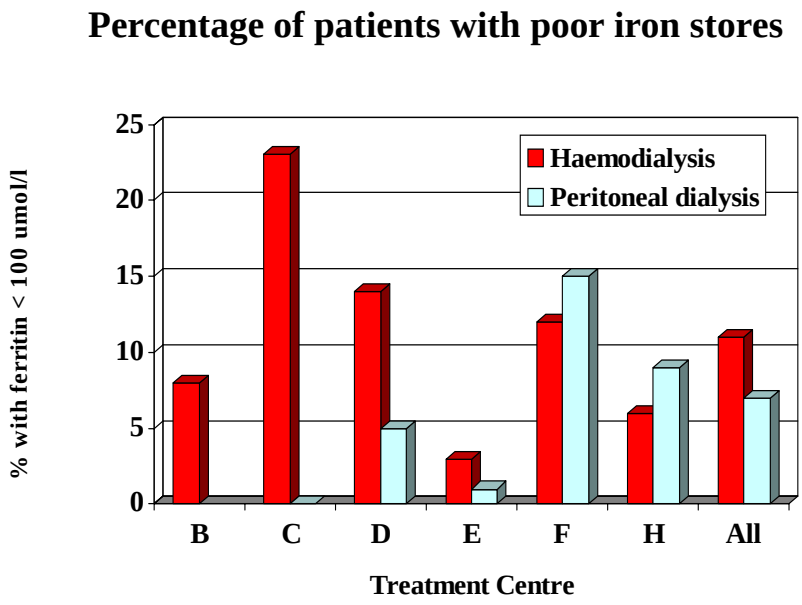


Figure 8.6 Percentage of patients anaemic or on erythropoietin with serum ferritin below 100 µmol/l.
No results are shown for peritoneal dialysis patients from centre B as there were less than 10 patients with data available.

In centre C, no peritoneal dialysis patients have low iron stores, but 23% of haemodialysis patients do. The figures for centre D are 5% and 14% respectively.

8:5 Haemoglobin and erythropoietin therapy

8:5.1 Haemoglobin, erythropoietin, serum ferritin, and adequacy of dialysis

The use of erythropoietin therapy and haemoglobin attained was studied, especially in relationship to body iron load and, in haemodialysis patients, adequacy of dialysis. Urea reduction ratio was used as a measure of adequacy of haemodialysis. The results are shown in tables 8.17 and 8.18.

Unit	% Hb ≥ 10 g/dl	% patients Hb≥10 without EPO	% ferritin ≥100 µmol/l	% ferritin ≥200 µmol/l	% 0n EPO	URR ≥60 %	URR ≥65 %
A	56	na	-	-	na	80	58
B	43	26	86	56	33	95	90
C	37	9	72	55	74	72	43
D	78	20	79	53	77	76	52
E	65	28	87	65	61	85	70
F	70	20	81	54	76	84	61
G	59	na	91	70	na	79	53
H	60	8	93	68	86	76	53
I	76	na	77	40	na	*	*
All patients	62	18	84	59	73	79	58

na = not available. - = not applicable * = numbers too small

Table 8.17 Haemoglobin, use of erythropoietin, serum ferritin, and urea reduction ratio in haemodialysis patients

Unit	% Hb ≥ 10 g/dl	% patients Hb>=10 without EPO	% ferritin ≥100 µmol/l	% ferritin ≥200 µmol/l	% on erythropoietin
A	76	na	-	-	na
B	74	74	*	*	*
C	48	21	100	50	48
D	82	35	86	67	59
E	62	46	88	79	33
F	84	45	68	46	47
G	76	na	79	57	na
H	75	27	85	54	61
I	88	na	56	19	na
All patients	76	39	80	58	48

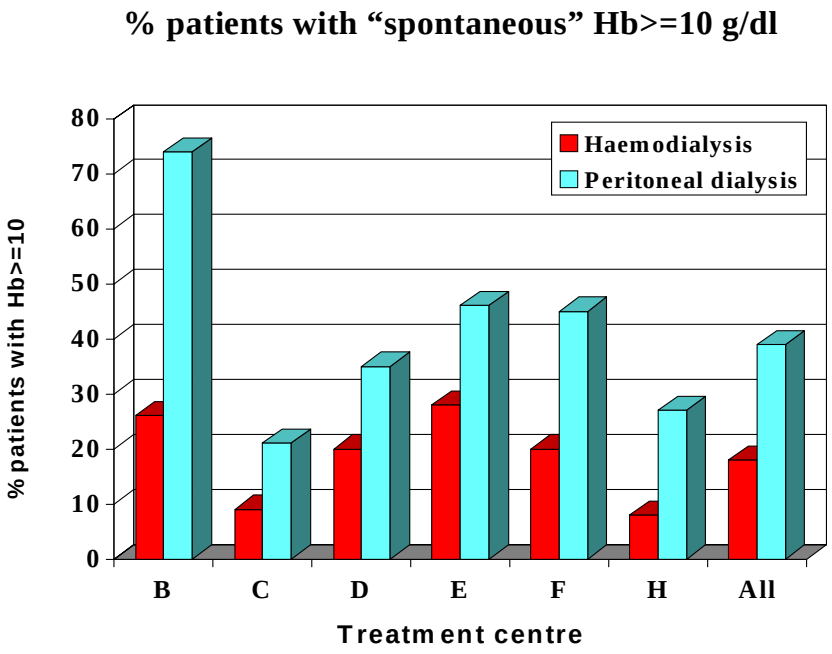
na = not available. - = not applicable * = numbers to small too include

Table 8.18 Haemoglobin, use of erythropoietin, and serum ferritin in peritoneal dialysis patients

8:5.2 "Spontaneous" haemoglobin

The use of erythropoietin makes the relationship between haemoglobin and serum ferritin and urea reduction ratio difficult to interpret, especially as the prescription of erythropoietin is often influenced by financial restrictions and is not always decided on strictly clinical grounds. In an attempt to eliminate the effect of erythropoietin prescription, the patients not using erythropoietin were studied.

As an indicator of optimal background renal replacement therapy the percentage of patients achieving a haemoglobin above 10 g/dl without the use of erythropoietin was assessed (figure 8.7). For haemodialysis the range is from 8% to 28%, for peritoneal dialysis from 21% to74%.



For haemodialysis n=1110 patients, for peritoneal dialysis n=552 patients.

Figure 8.7 Percentage of patients in each treatment centre with "spontaneous" haemoglobin of 10 g/dl. or more.

8:5.3 The prescription of erythropoietin and serum ferritin

The prescription of erythropoietin was analysed in relationship to haemoglobin attained and serum ferritin. The results are in tables 8.20 and 8.21

Treatment centre		**Haemoglobin <10**		**Haemoglobin ≥10**	
		Fe<100	Fe ≥100	Fe<100	Fe≥100
B	No EPO	5	27.5	5	22.5
	On EPO	2.5	17.5	0	20
C	No EPO	6	10	5	4
	On EPO	8	38	9	21
D	No EPO	1	1	7	12
	On EPO	2	20	11	47
E	No EPO	1	8	10	20
	On EPO	. 0	25	2	34
F	No EPO	0	3	7	12
	On EPO	3	24	8	42
H	No EPO	0	3	1	6
	On EPO	0	37	5	48

Table 8.20 Use of erythropoietin therapy, serum ferritin, and haemoglobin attained in haemodialysis patients.

Treatment centre		**Haemoglobin <10**		**Haemoglobin ≥10**	
		Fe<100	Fe ≥100	Fe<100	Fe ≥100
B *					
C	No EPO	0	36	0	23
	On EPO	0	23	0	18
D	No EPO	1	5	10	24
	On EPO	1	10	3	45
E	No EPO	1	17	11	38
	On EPO	0	16	0	17
F	No EPO	2	6	27	24
	On EPO	0	9	12	29
H	No EPO	0	9	6	19
	On EPO	3	15	6	42

- - numbers too small to include.
-

Table 8.21 Use of erythropoietin therapy, serum ferritin, and haemoglobin attained in peritoneal dialysis patients

The data indicate a difference of approach between units with regard to iron replenishment and erythropoietin usage (tables 8.20, 8.21). These tables show that some units rarely give erythropoietin to patients without replenishing iron stores such that serum ferritin is above 100, whereas others are giving erythropoietin to relatively iron deficient patients in whom a less efficient response is to be expected. The percentage of haemodialysis patients with serum ferritin below 100 μmol/l and who receive erythropoietin ranges between units from 2% to 17%, for peritoneal dialysis patients it ranges from 0% to 17%.

8:5.4 Access to erythropoietin therapy

Although peritoneal dialysis patients maintain better haemoglobin levels than haemodialysis patients, they are less likely to receive erythropoietin therapy when anaemic (figure 8.8)

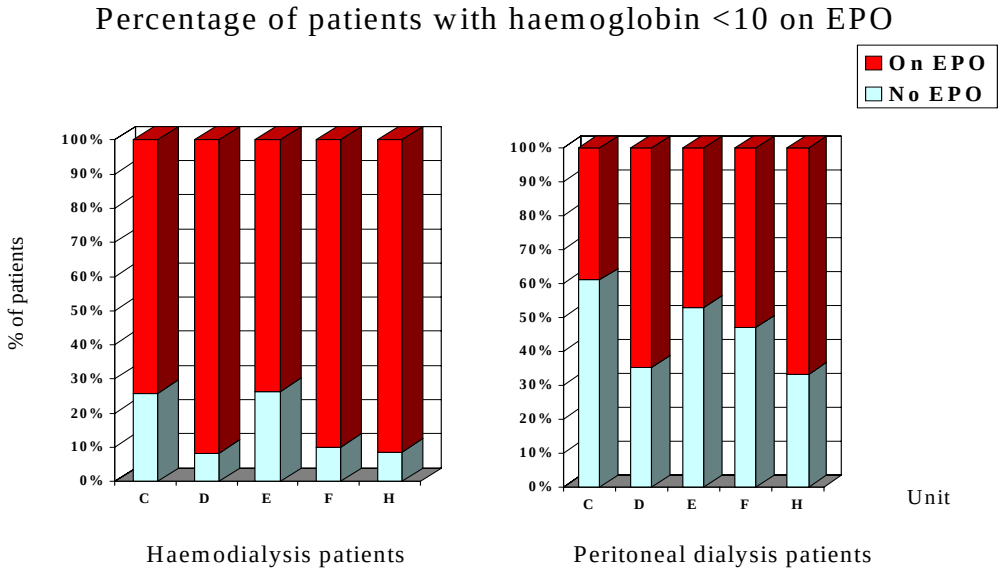


Figure 8.8, 8.9 Percentage of patients with haemoglobin <10 g/dl receiving erythropoietin therapy

The variation between units in the proportion of haemodialysis patients receiving erythropoietin was from 33% to 86%, and for peritoneal dialysis patients from 31% to 61% (tables 8.17, 8.18). Whether the prescription rate is appropriate can only be interpreted when the proportion attaining a haemoglobin of 10 g/dl is also considered.

Table 8.22 shows the difference in erythropoietin prescription between the sexes. Although men attain higher haemoglobin than women (section 8:3.2) they are significantly less frequently prescribed erythropoietin.

	% patients on erythropoietin	
Modality	Men	Women
Haemodialysis	69.5	77.9
Peritoneal dialysis	43.4	555.4

For haemodialysis: $X^2 = 9.1$, d.f. = 1, p = 0.003
For peritoneal dialysis: $X^2 = 7.6$, d.f. = 1, P = 0.006
Table 8.22 Prescription of erythropoietin by gender

8:5.5 Factors determining haemoglobin attained and erythropoietin prescription.

In neither haemodialysis nor peritoneal dialysis is there any apparent relationship between haemoglobin attained and use of erythropoietin (tables 8.20, 8.21, figure 8.10).

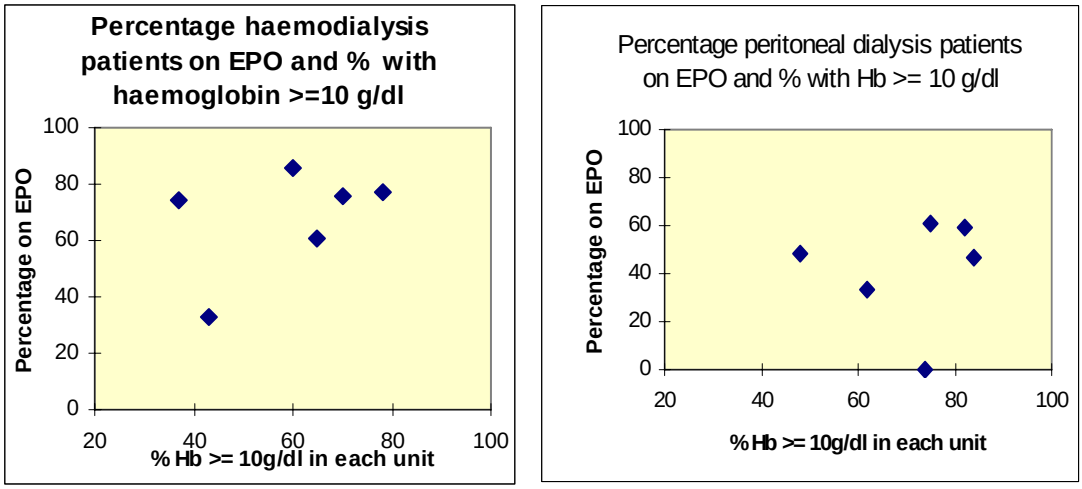


Figure 8.10 Relationship between erythropoietin therapy and haemoglobin.

Neither is there any apparent relationship between adequate iron stores and haemoglobin (figures 8.11,8.12).

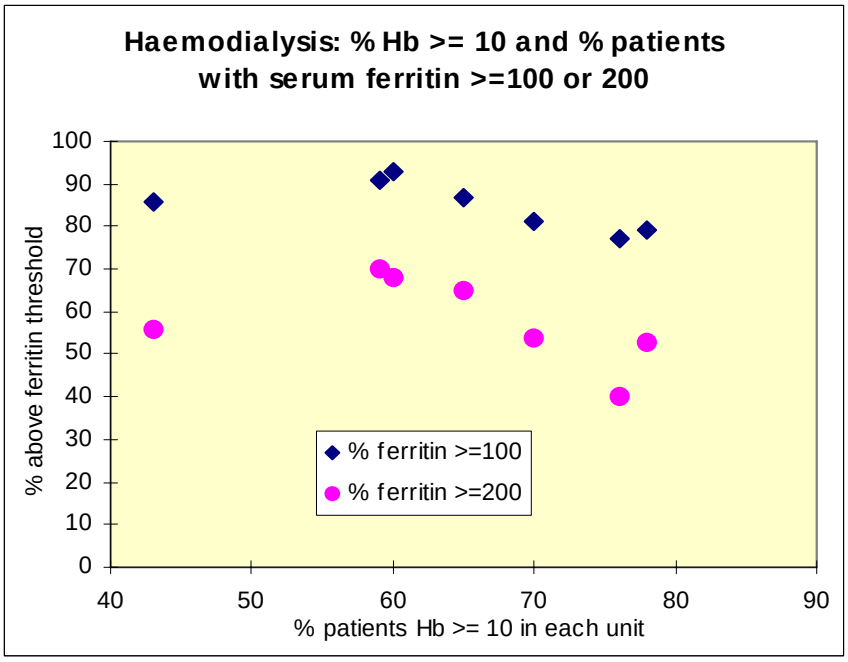


Figure 8.11 Relationship between serum ferritin and haemoglobin in haemodialysis patients

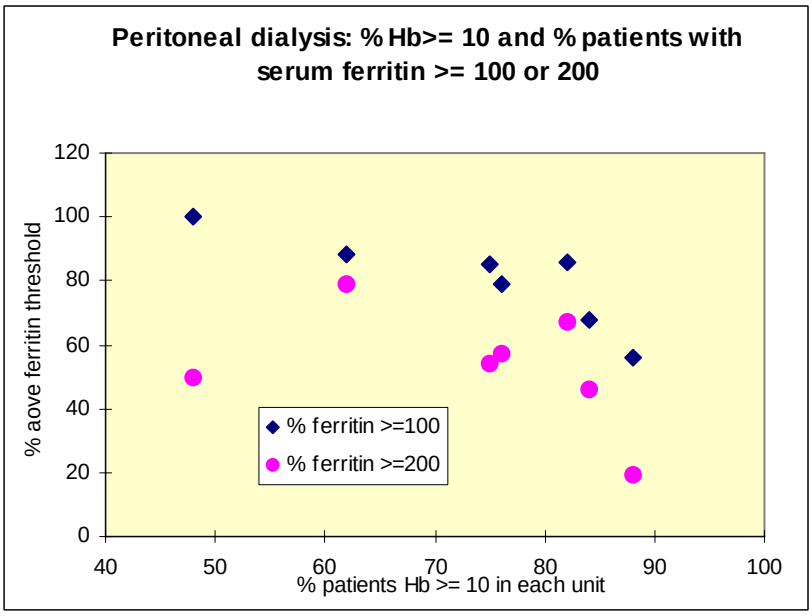


Figure 8.12 Relationship between serum ferritin and centre haemoglobin in peritoneal dialysis patients

In haemodialysis patients the use of erythropoietin and haemoglobin obtained was studied in relationship to dialysis adequacy as indicated by the urea reduction ratio. This is illustrated in figures 8.13 and 8.14. The unit with the highest proportion of patients with a urea reduction ratio above 65% (B) had a low proportion of patients with haemoglobin >= 10 g/dl, but had a very low prescription rate of erythropoietin. The data gives some support to the possibility that in a treatment centre a high proportion of patients with a urea reduction ratio >=65% is associated with lower use of erythropoietin and possibly better haemoglobin levels .

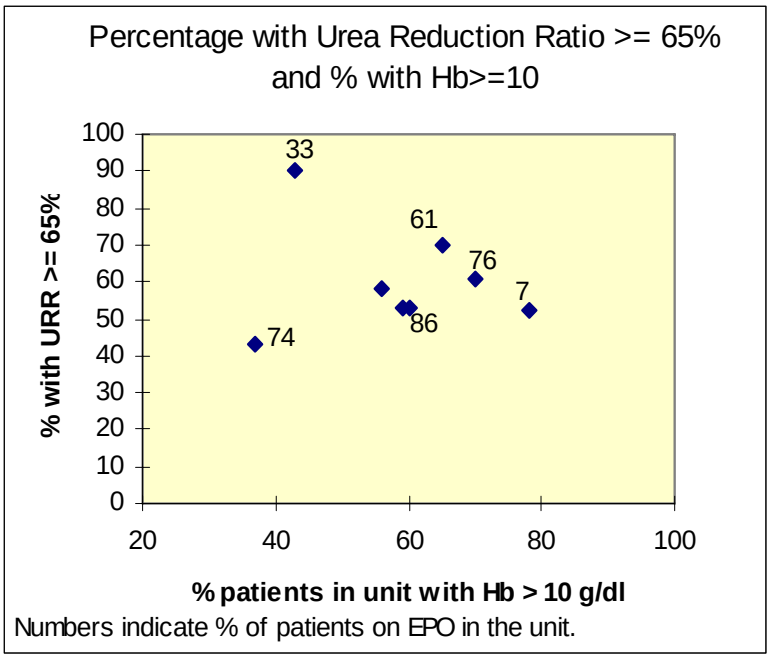


Figure 8.13 Urea reduction ratio and haemoglobin

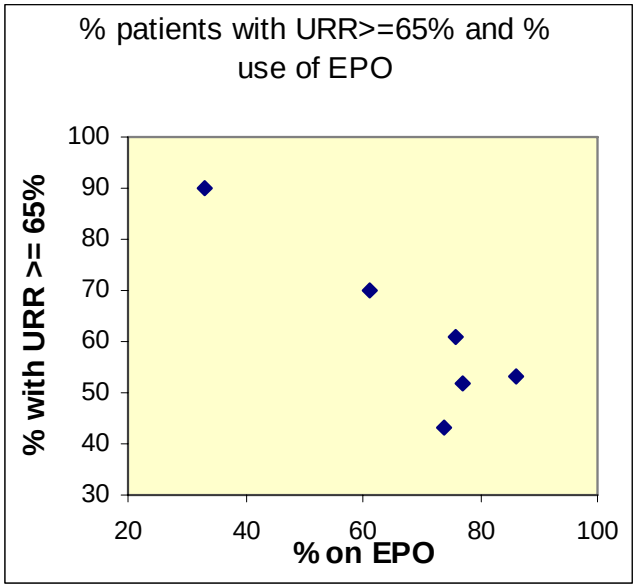


Figure 8.14 Urea reduction ratio and use of erythropoietin

The prescription of erythropoietin is often partly determined by non-clinical factors such as financial restriction: this renders the above relationships difficult to interpret. To try to eliminate this problem the proportion of patients with a "spontaneous" (i.e. not supported by erythropoietin) haemoglobin >= 10g/dl was studied in relationship to serum ferritin and to urea reduction ratio. There is no apparent relationship with serum ferritin (figures 8.15,8.16), but a strong suggestion of a relationship with urea reduction ratio (figure 8.17).

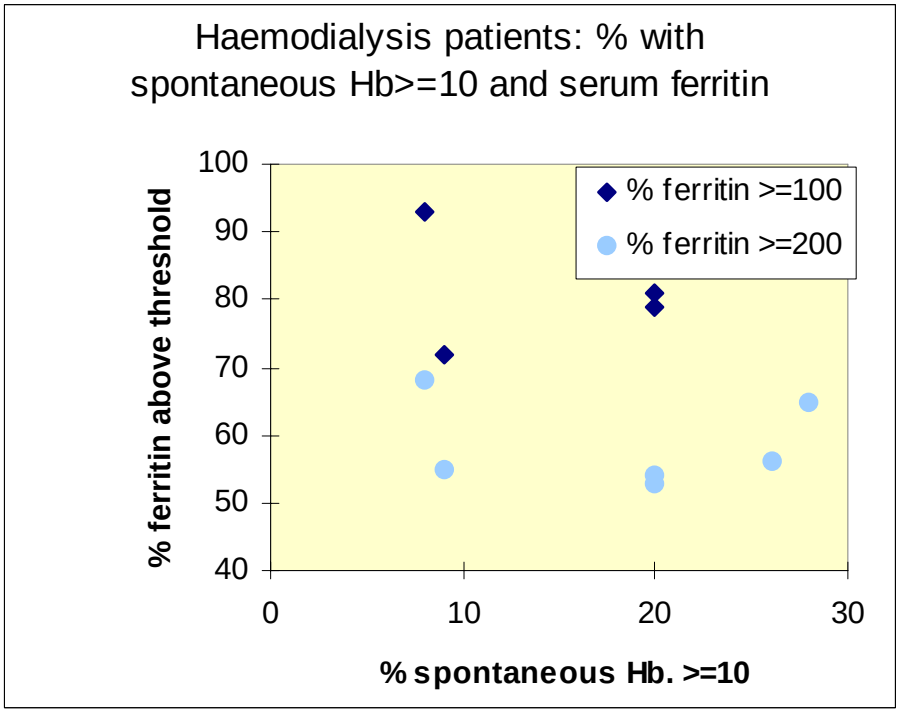


Figure 8.15 "Spontaneous" haemoglobin and serum ferritin of haemodialysis patients

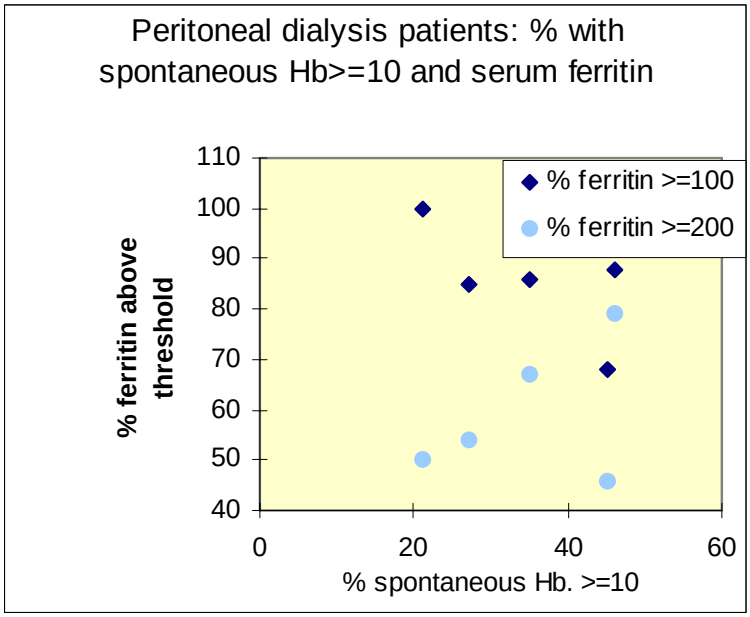


Figure 8.16 "Spontaneous" haemoglobin and serum ferritin of peritoneal dialysis patients

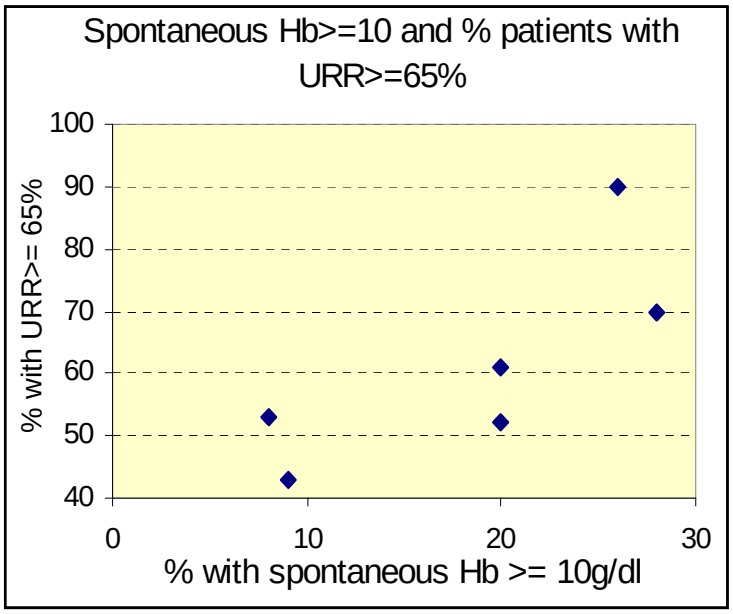


Figure 8.17 "Spontaneous" haemoglobin and urea reduction ratio

8:5.6 Sequential changes in haemoglobin

As the Registry has collected sequential quarterly data for only 1 year very little analysis has been performed on changes over time. There do seem to be changes in the percentage haemoglobin >= 10 g/dl between the first and last quarters of 1997. Details from units returning sufficient data to analyse in both quarters are given in table 8.23.

	Haemodialysis		Peritoneal dialysis	
Unit	1st quarter	4th quarter	1st quarter	4th quarter
A	45	58	81	74
C	39	37	40	48
D	66	78	69	81
E	58	64	70	63
F	56	70	68	84
G	56	59	64	76
H	49	60	83	75
Total	**54**	**62**	**69**	**75**
N =	1227	1390	676	711

Table 8.23 Changes through 1997 in % patients with haemoglobin >=10 g/dl.

As can be seen from figure 8.18, there has been a rise in all the units, with the exception of unit C, in the proportion of haemodialysis patients with haemoglobin >= 10 g/dl over the year. Although the proportion in the whole Registry of peritoneal dialysis patients with haemoglobin >=10 g/dl has risen, there is considerable variation between treatment centres (figure 8.19). This is partly due to the fact that haemoglobin is higher in peritoneal dialysis patients leaving little opportunity for improvement in some centres.

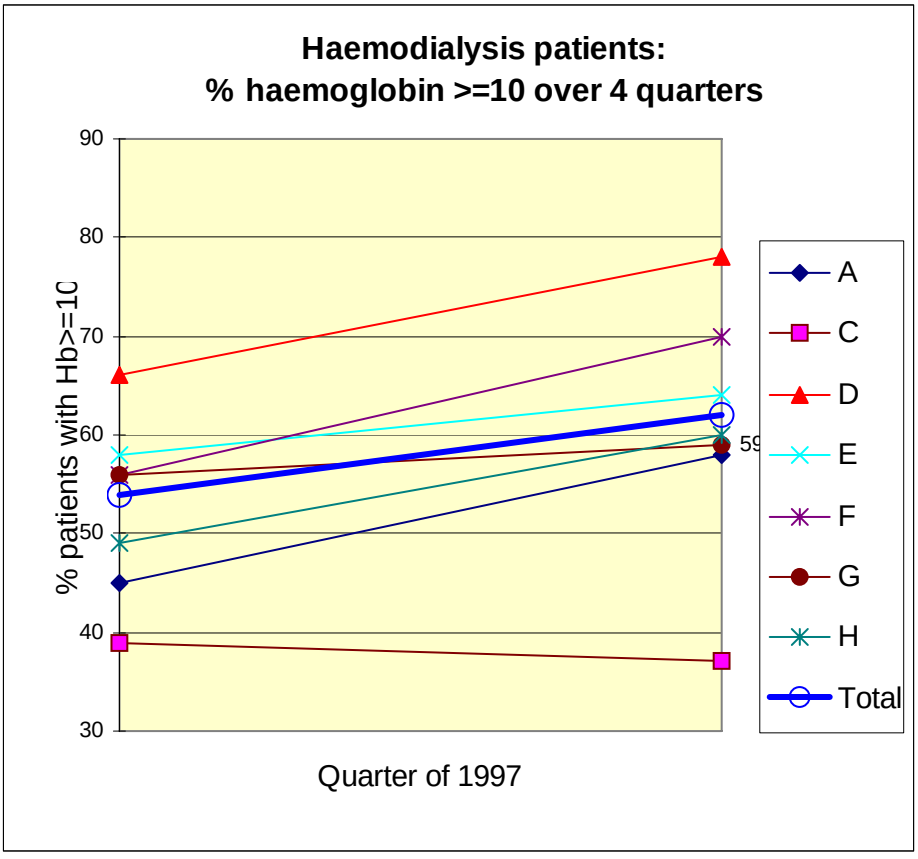


Figure 8.18 Haemodialysis patients: changes in % haemoglobin ≥ 10 g/dl through 1997 by centre.

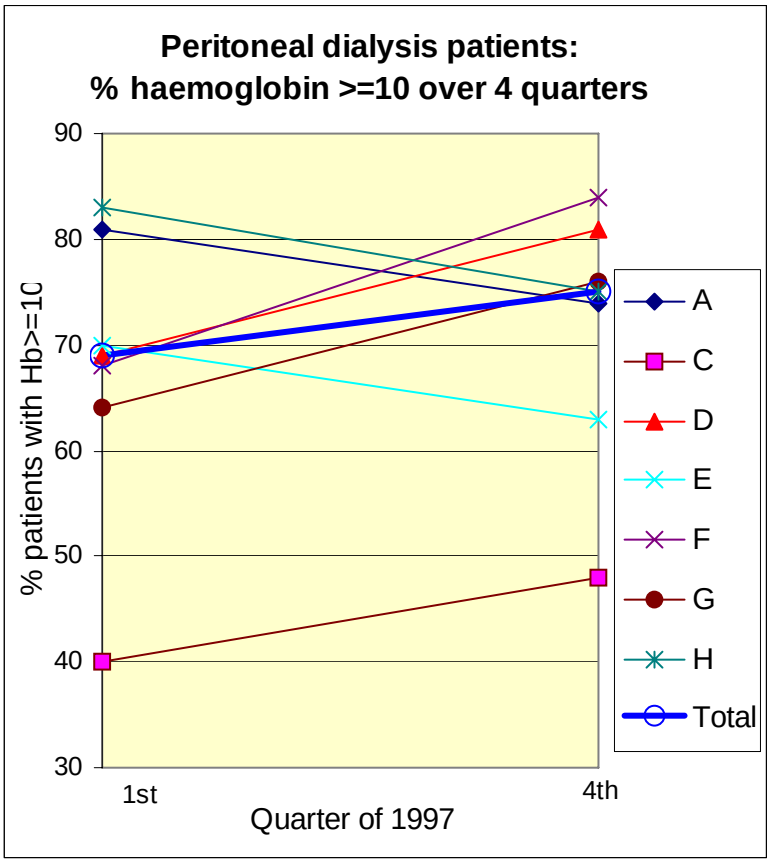


Figure 8.19 Peritoneal dialysis patients: changes in % haemoglobin ≥ 10 g/dl through 1997 by centre

8:5.7 Conclusion

As some units were unable to return data on use of erythropoietin and some could not returned data on serum ferritin, only a small number of treatment centres are included in these analyses, and the data must not be over-interpreted. There are however important pointers to further studies the Registry will undertake which will be more instructive with time as sequential data becomes available, data returns improve, and more units participate. Even with this preliminary data it is clear that there is wide variation in practice between treatment centres with regard to the availability of erythropoietin therapy and policy with regard to erythropoietin treatment and iron replenishment. Peritoneal dialysis patients may be less likely than haemodialysis patients to be given erythropoietin if anaemic. In haemodialysis dialysis adequacy may be a major determinant of haemoglobin and need for erythropoietin. Through 1997 patients in the participating units had an overall improvement in haemoglobin.

Chapter 9 Management of blood pressure in renal replacement therapy

The Renal Association Standards document recommends ***target predialysis blood pressures should be:***

Age <60 BP < 140/90 (Korotkoff V if auscultation is used)
Age >60 BP < 160/90 (Korotkoff V if auscultation is used)

These standards equally apply to peritoneal dialysis

The Standards document does not contain guidelines for blood pressure control in transplant patients. The Registry has chosen to audit against similar standards for transplanted patients.

The Renal Registry does not currently record the prescription of anti-hypertensive medication. This is because few centres record this data accurately in their computer systems.

9:1 Haemodialysis patients

The data are shown in tables 9.1 and 9.2. Compliance with the standard varies between units. Compliance is least good and most varied for systolic pressure of the younger haemodialysis patients (figures 9.1 - 9.4)).

Centre	Age < 60 % ≤ 140	Age > 60 % ≤ 160	Age < 60 Median	Age > 60 Median
A	43	74	145	149
B				
C	30	61	159	153
D	71	92	124	129
E				
F	61	71	137	149
G	60	75	134	140
H	66	83	130	140
I				
All	**58**	**77**		

Table 9.1 Systolic BP for patients on haemodialysis

Centre	Age < 60 % ≤ 90	Age > 60 % ≤ 90	Age < 60 Median	Age > 60 Median
A	75	89	83	75
B				
C	65	84	85	79
D	90	96	71	70
E				
F	78	84	80	76
G	75	89	78	74
H	90	97	76	70
I				
All	**81**	**90**		

Table 9.2 Diastolic BP for patients on haemodialysis

Many centres achieve similar median systolic pressures in both those under and over 65. Centre F has the largest increase in those over 65 compared with younger patients of 12 mm Hg. The median diastolic blood pressure was lower in those under 65 in all centres.

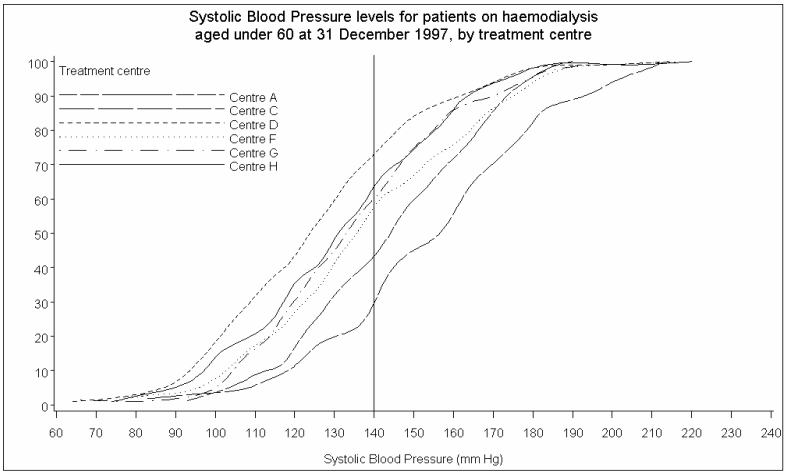


Figure 9.1 Cumulative frequency plot of systolic BP of patients < 60 on haemodialysis

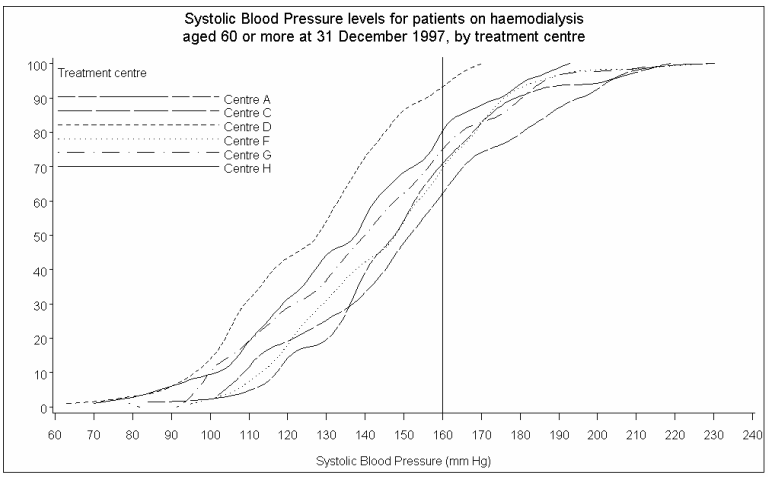


Figure 9.2 Cumulative frequency plot of systolic BP of patients $\geq$ 60 on haemodialysis

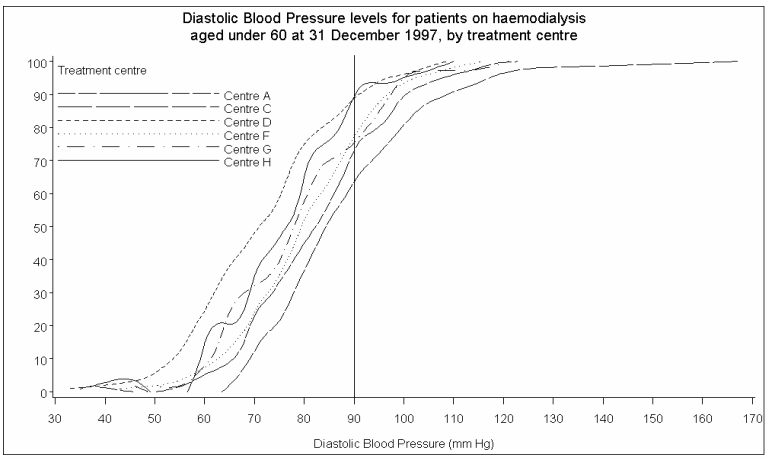


Figure 9.3 Cumulative frequency plot of diastolic BP of patients < 60 on haemodialysis

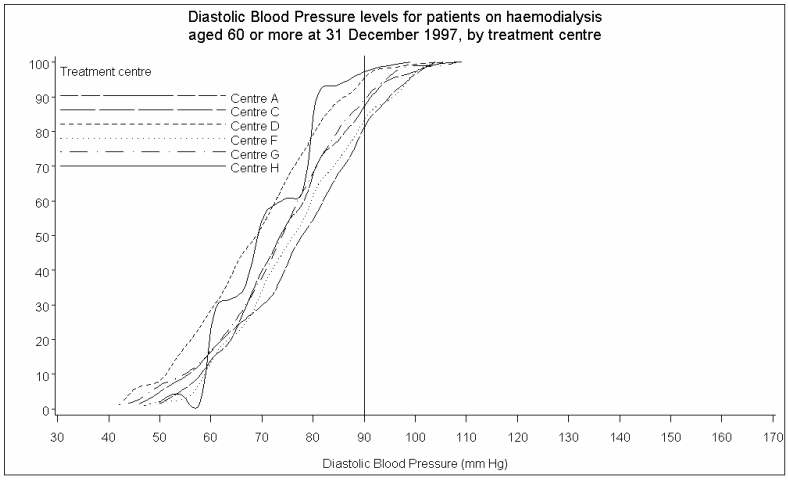


Figure 9.4 Cumulative frequency plot of diastolic BP of patients ≥ 60 on haemodialysis

The 'steps' in the diastolic frequency distribution curve for patients on haemodialysis at Centre H are caused by this Centre recording diastolic pressures in 10 mm Hg intervals.

9:2 Peritoneal dialysis patients

There was less blood pressure data available from peritoneal dialysis patients. There were fewer patients on peritoneal dialysis, and most centres omitted to record the blood pressure of peritoneal dialysis patients on the renal computer system. The data are shown in tables 9.3 and 9.4.

Centre	Age < 60 % ≤ 140	Age ≥ 60 % ≤ 160	Age < 60 Median	Age ≥ 60 Median
A	**	**	**	**
B				
C	38	**	150	**
D	52	81		143
E			140	
F	55	83	140	140
G	61	82	140	150
H	71	78*	130	140*
I				
All	**56**	**81**		

* indicates < 20 results
** indicates < 10 results

Table 9.3 Systolic BP of patients on peritoneal dialysis

For peritoneal dialysis patients aged 60 and over, there is a remarkably similar compliance with the standard for all centres, with a range of 78 – 83% having a systolic BP ≤ 160. Centre H appears to perform well against the standards. for both systolic and diastolic blood pressure in patients aged < 60. In comparison for the same age group of patients, centre C achieves only 38% of patients reaching the systolic standard, although 67% achieve the diastolic standard.

Centre	Age < 60 % ≤ 90	Age ≥ 60 % ≤ 90	Age < 60 Median	Age ≥ 60 Median
A	**	**		
B				
C	67	**	90	
D	75	76	80	80
E				
F	63	89	84	80
G	90	93	78	75
H	74	89*	80	80
I				
All	**77**	**84**		

Table 9.4 Diastolic BP for patients on peritoneal dialysis

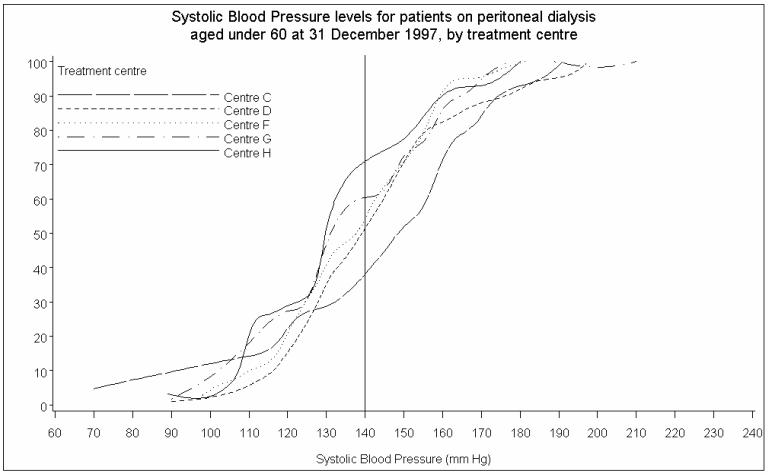


Figure 9.5 Cumulative frequency plot of systolic BP of patients < 60 on peritoneal dialysis

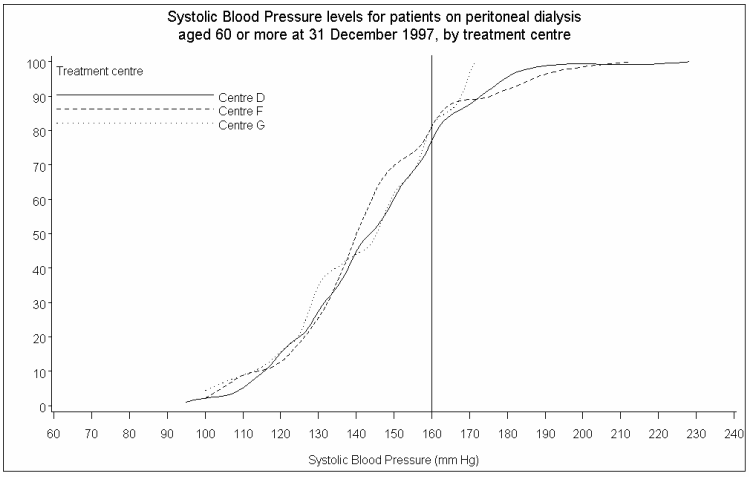


Figure 9.6 Cumulative frequency plot of systolic BP for patients aged ≥ 60 on peritoneal dialysis

Achievement of the recommended standards for systolic pressures seems similar in both haemodialysis and peritoneal dialysis. Compliance with the standards for diastolic pressure is lower in peritoneal dialysis.

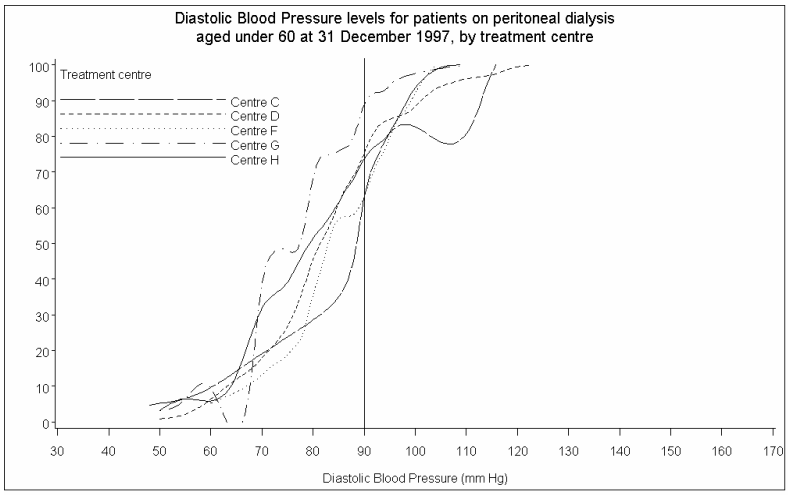


Figure 9.7 Diastolic BP for patients aged < 60 on peritoneal dialysis

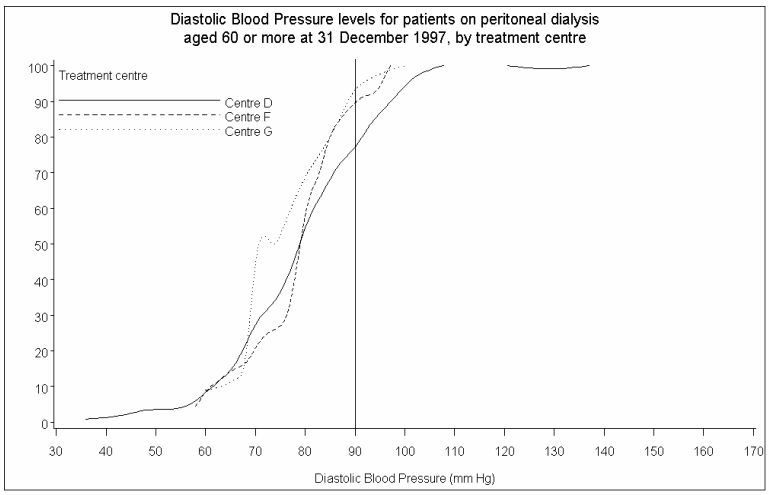


Figure 9.8 Diastolic BP for patients aged ≥ 60 on peritoneal dialysis

9:3 Transplant patients

Blood pressure figures for established transplant patients are shown in tables 9.5 - 9.8, and figures 9.9 - 9.12.

There is little difference in compliance with the standard between centres for diastolic pressure in the older age group, but there is a wider range in the younger patients. Systolic pressures vary much more between units, and the variation is again greatest in younger patients.

Centre	Systolic		Diastolic	
	Age < 60 % ≤ 140	Age ≥ 60 % ≤ 160	Age < 60 ≤ 90	Age ≥ 60 ≤ 90
A				
B				
C	48	54	74	75
D	68	78	85	94
E				
F	59	68	76	75
G	59	88	89	99
H	62	82	75	85
I				

Table 9.5 Systolic and diastolic BP of transplant patients

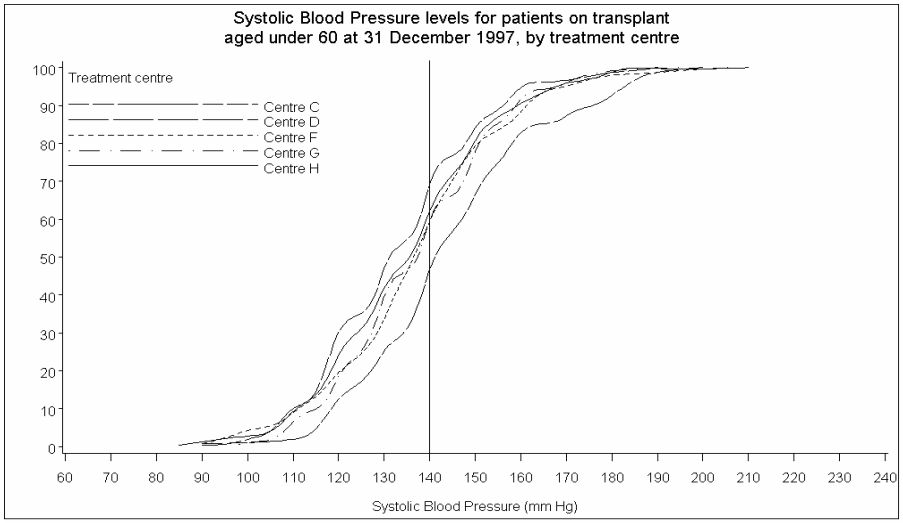


Figure 9.9 Cumulative plot of systolic BP for transplant patients aged < 60

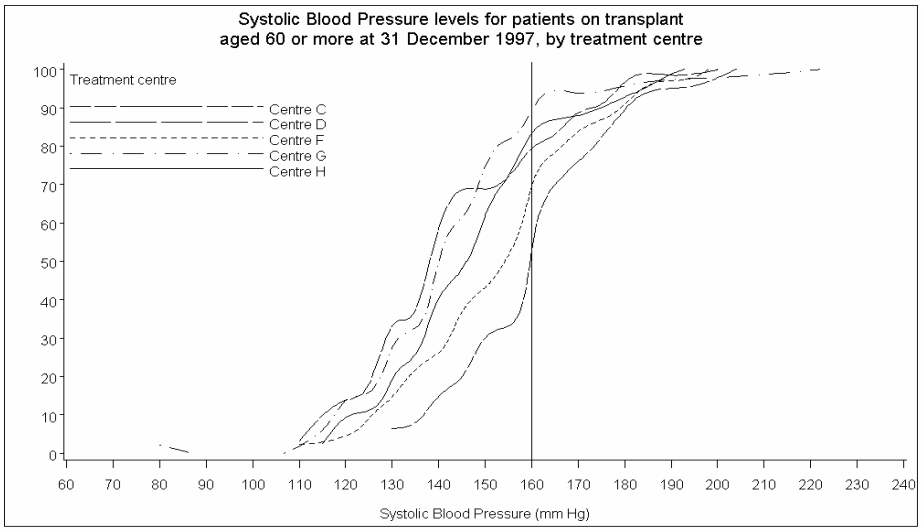


Figure 9.10 Cumulative plot of systolic BP for transplant patients aged ≥ 60

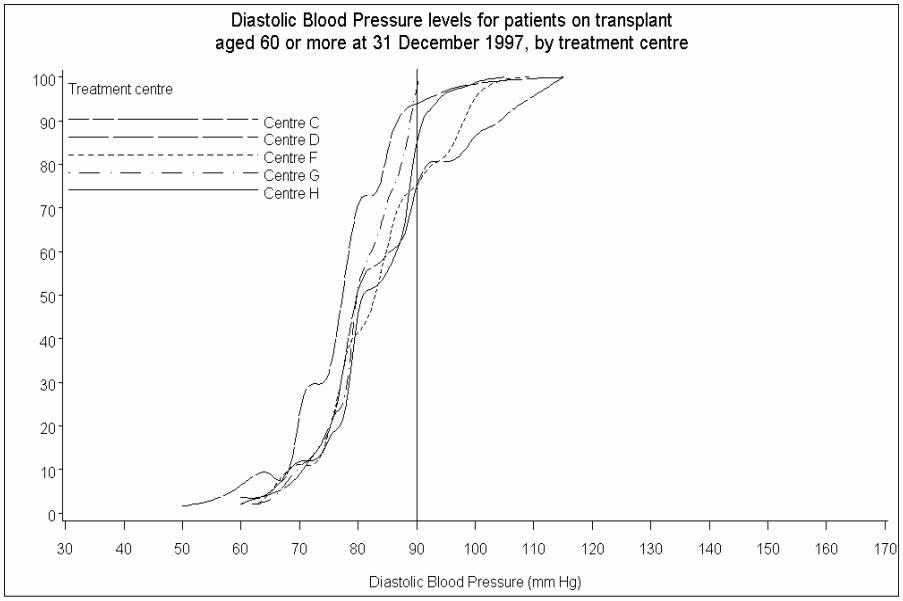


Figure 9.11 Cumulative plot of diastolic BP for transplant patients aged < 60

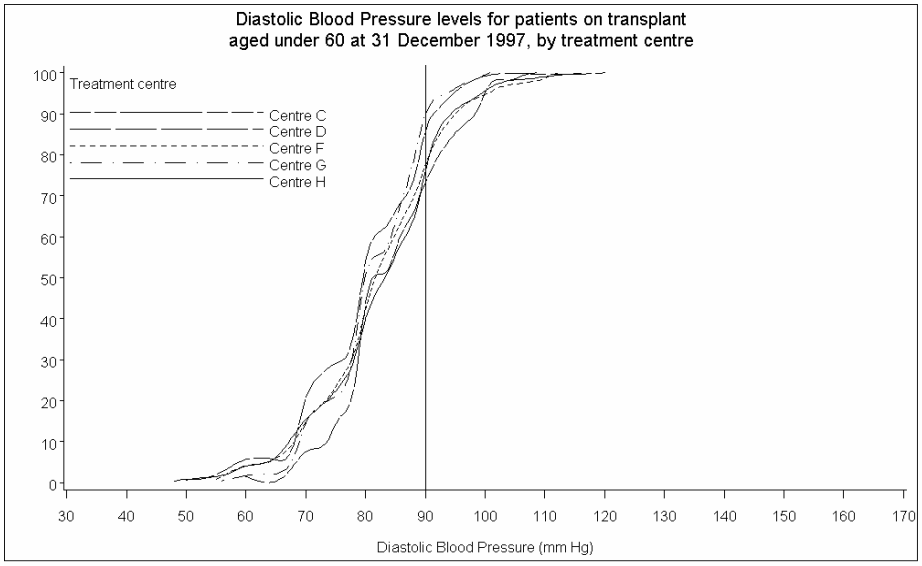


Figure 9.12 Cumulative plot of diastolic BP for transplant patients aged ≥ 60

9:4 Summary

Comparing tables 9.1 – 9.5 and figures 9.9 - 9.12, within each centre there is a remarkably similar attainment of standards across treatment modalities. Centres who perform well with haemodialysis patients, perform equally well with transplant and peritoneal dialysis patients.

Chapter 10 Commentary

This first substantive report from the Renal Registry allows some preliminary conclusions to be drawn.

The pilot study has been completed and the Registry is now in a phase of development. The software and methodology has been vindicated , and this report demonstrates the ability of the Registry to collect quarterly data and analyse it. The low percentage returns on some areas of data indicate that a major limitation in this audit and research exercise will be the quantity and quality of the data held by each unit. The Registry will work with units to facilitate improvement in their data collection and quality.

The patient demographic information may have provided few surprises, although the variation in the basic features of case mix, such as age, is important. The data on co-morbidity anticipated in the next round of data collection will further characterise the clinical task undertaken by each centre, and will be important in assessing outcomes, although it will be three years at least before the Registry has enough sequential data on new patients to begin to produce survival data.

The unit preferences for renal replacement therapy modalities show significant differentiation. Each unit is working in a particular historical and contemporary context: the Registry hopes to be able to provide further description of the factors determining and/or restricting choice of treatment modality, and will eventually relate this to outcome measures.

The comparison of clinical performance data with the recommendations of the Renal Association Standards document was always going to be of interest. The exercise immediately brought into focus the problems of data harmonisation, and the use and derivation of local "normal" ranges. Although a start has been made in addressing these problems they need further discussion and exploration, and have implications for those setting the recommended standards. These difficulties imply that the comparative data must be considered with great care and without judgement at this stage. Nevertheless individual units will be able to draw conclusions and start to act on them.

In many areas current practice is adrift from the recommended standards. The inability to comply with the recommendations regarding serum phosphate may not be surprising, but it raises questions on the achievability of the standard. The data on haemoglobin demonstrate that the restatement of the recommendation in terms of an acceptable minimum (10 g/dl), rather than a range (10 - 12 g/dl) was wise. The data confirm that compliance with the guidelines will only be achieved with a median haemoglobin well over 11 g/dl, and a range of individual values greater than originally recommended. Whether it is possible to narrow the range of values within each unit and thus achieve compliance with the current standard without a significant number of patients having a haemoglobin above 12 g/dl is uncertain. The desirability of the 12 g/dl upper limit is currently under debate.

The homogeneity of much of the data suggests that most units represented take similar approaches to therapy in many areas. With some exceptions there is little evidence for wide variation in medical practice. The exceptions include the outstanding urea reduction ratio and haemoglobin results from one centre, and these deserve further study. This is an example of how the Registry can help to identify and disseminate good practice. It is also anticipated the report will enable individual units to identify areas where their practice appears to be less successful than other units, and so address possible reasons and means of improvement.

A number of questions of methodology have been raised. Standardisation of sampling technique will be important for further assessment of urea reduction ratio and KT/V. Discussion is needed with regard to appropriate sampling intervals for each variable and on quality control.

The Registry is collecting large volumes of data. This first report is inevitably somewhat exploratory and experimental. The act of producing it is a stimulus to discussion on the most appropriate analyses to perform. Having presented this report in the frame of the Renal standards document is still unclear what role it is anticipated that the Registry should have in providing a commentary, drawing conclusions, and facilitating changes in practice. A continuing dialogue with the Standards Sub-committee and within the Renal Association itself will help to resolve some of these issues and be essential to the development of the Registry as an effective agent for audit, research, and improvement in the quality of renal care.

Appendix A The Renal Registry Rationale

Prepared by Dr E Will

A:1 Executive summary

1.1 The Renal Registry has been established by the Renal Association to act as a resource in the development of patient care in renal disease.

1.2 The Registry will act as a source of comparative data for Audit/Benchmarking, Planning, Policy and Research. The collection and analysis of biochemical and haematological data will be a unique feature of the Registry.

1.3 Agreements will be made with participating renal centres which ensure a formal relationship with the Registry and safeguard confidentiality

1.4 The essence of the Agreement will be the acceptance of the Renal Registry Data Set Specification as the basis of data transfer and retention.

1.5 Data will be collected quarterly to maintain Unit-level quality assurance, with two reports per annum.

1.6 A pilot study has been successfully completed, with funding from the Department of Health and donations from industry. Subsequent activity will have to be self-funded by capitation of renal patients from commissioning agencies.

1.7 The Registry is likely to become responsible for reporting UK activity in ESRF to the EDTA Registry as well providing data to Trusts, Commissioning Authorities and Regional Offices.

1.8 The development of the Registry will be open to influence from all interested parties, including Clinicians, Trusts, Commissioning Authorities and Patient Groups.

The Registry has charitable status through the Renal Association.

A:2 Introduction

2.1 Few important developments have a single origin and that is true of The Renal Registry. Information on patients receiving Renal Replacement Therapy (RRT) was first collected in the Registry of the European Dialysis and Transplant Association (EDTA) after 1965 and that continues with a base in London and Annual Reports to the membership. This exercise was voluntary for Renal Units throughout Europe and was conducted on paper and by post. As well as the main Centre Questionnaire and individual patient follow up data occasional detailed studies of specific topics were undertaken. Latterly, the completeness of data recording, particularly patient-specific detail, has become a problem, for a number of reasons. The development of single country databases, such as RENINE in the Netherlands, has improved the quality of data and there have been several models of computer-based returns. Registries developed later in the USA (USRDS) and the Antipodes have benefited from the earlier experience. They have been typically better resourced, as well as more conveniently embedded in the administrative infrastructure of renal services. In the United Kingdom the Scottish Renal Registry was established with initial assistance from the Scottish Office and has demonstrated the practicalities of data collection in a UK renal environment.

2.2 In recent years the incompleteness of UK data returns to EDTA has meant that it was not possible to build a picture of RRT activity for planning and policy purposes. The Renal Association steered an investigation of renal demographics in three centres which was published subsequently, but national data for England only became available through two *ad hoc* national data collections solicited from renal centres in 1992 and 1996. The first of these not only led to a report of national demographic and treatment data but also carried a review of the cultural and clinical expectations of RRT activity (The National Renal Review). One of the recommendations of the Review was the participation of renal units in comparative audit. The two data collections were not resourced at unit level and clearly did not provide a robust model for information gathering in the future.

2.3 After the NHS Reforms of 1990 the need for accurate and timely information about clinical services became pressing and that remains the case. The interests of both Trusts and Health Authorities demand knowledge of activity in Renal Services, which is costly to produce and express.

2.4 Together with the need to know the demographic and economic elements of the Health Service has developed a need to underpin clinical activity more rigorously through the scientific evidence base (for example the Cochrane Initiative) and quality

assure that activity through audit. These initiatives require comprehensive information about the 'Structures. Processes and Outcomes' of RRT, which go well beyond the detail previously compiled by EDTA.

2.5 The Renal Association has made a start in the area of Audit by publishing guidelines in 'Renal Standards' documents. It was apparent during the development of the guidelines that many criteria of clinical performance were uncertain or unknown, and that only the accumulated data of practising renal units could provide the evidence for advice on best practice and what might realistically be achieved. The impetus towards comparative audit between renal units, piloted in preliminary exercises by Lister/St.James's and the West Midlands Group, has become irresistible. A common data registration provides the most simple device for comparative audit.

2.6 Similar cultural pressures have affected all clinical disciplines, so that Registries are implemented or planned in cardiac surgery, intensive care, diabetes etc. Where information is held for other purposes there has also been a move to use it for reporting and audit. This has been apparent in the renal field where UKTSSA have published data drawn from information held for the management of organ matching and graft follow-up. These are useful data of course, but UKTSSA is unfortunately not in a position to provide comprehensive data on other modes of renal replacement therapy. The longitudinal consequences of the national renal replacement programme must be derived from additional sources.

Registry-based National Specialty Comparative Audit is likely to be one of the cornerstones of NHS development. More specifically, the aspiration for renal services to be provided within a National Service Framework is underpinned by the development of the Renal Registry (A First Class Service: Quality in the new NHS).

2.7 The recent emphasis on Evidence Based Practice is being supported by the changes in research funding (Culyer Report), which lean towards collaborative projects and include both basic science and 'Health Services Research' components. It is apparent that a RRT database could be invaluable to a wide range of research studies. The Renal Association has recognised the potential for integrated work in renal disease through a Clinical Trials Committee, which is supporting a number of national studies in renal disease.

2.8 It can be seen that the need for a Registry of RRT, at least, has developed for a variety of reasons; international comparisons *2.1*, national planning *2.2/2.6*, local Trust and Health Authority management *2.3*, standard setting / audit *2.4/2.5*, and research *2.7*. The opportunity for data gathering partly arises from improvements in information technology, a field in which renal units have always been strong compared with the clinical community. While it was possible to see the need for a national renal database a decade and a half ago, the circumstances are now ideal for the maintenance of a data repository for all the purposes described above, supported by the clinical users and resourced for national benchmarking as a routine part of orthodox RRT management.

A:3 Statement of intent

The Renal Registry provides a focus for the collection and analysis of standardised data relating to the incidence, clinical management and outcome of renal disease. Data will be accepted quarterly according to the Renal Registry Data Set Specification (RRDSS) by automatic downloading from renal centre databases. There will be a core data set, with optional elements of special interest which may be entered by agreement for defined periods. Reports will be published twice yearly to allow comparative audit of facilities, patient demographics, quality of care and outcome measures. Participation is voluntary but the expectation is that all UK renal and transplant units will take advantage of the database by their involvement ultimately. There will be an early concentration on RRT, including transplantation, with an extension to other nephrological activity at a later date. The Registry will provide an independent source of data and analysis on national activity in renal disease.

A:4 Pilot study

4.1 A two year pilot project was started in April 1995.

4.2 The Renal Registry Data Set Specification was developed by the Clinical Co-ordinator in consultation with a Steering Committee and implemented on the computer system at UKTSSA, Bristol. It consists of approximately 200 core items, with additional data sets which are regarded as optional.

4.3 A limited number of renal sites with well-developed information systems were visited* and their database structures aligned with the RRDSS. Data on ESRF patients were then transferred to the registry database to provide the substrate for the first report to the Renal Association, March 1997.

4.4 The pilot study was funded partly by the Department of Health and partly by donations from industry.

4.5 The pilot study demonstrated the feasibility of data capture from a range of sites and was regarded as successful by the Renal Association and the Registry management committee. The Registry has subsequently been opened for any renal unit to participate. Software to accommodate reporting from centres without a CCL database has been written.

4.6 * Bristol, Gloucester, Leeds (St.James's), Leicester, Plymouth, Sheffield

A:5 Relationships of the renal registry

5.1 The Registry is a registered Charity through the Renal Association (No. 800733). It was established by a sub-committee of the Renal Association, with additional representation from the British Transplantation Society and the British Association for Paediatric Nephrology. There is cross representation with the Renal Association

Standards and Clinical Trials Committees. The Registry has a Chairman and Secretary nominated by the Renal Association. The Registry is pleased to receive an observer from the Department of Health.

5.2 It is anticipated that there will be a need for the development of a number of sub-committees as the database and participation enlarges, particularly for data analysis and interpretation.

5.3 The Registry is grateful to UKTSSA for early assistance with accommodation and supporting services and regrets the constraints which prevented further sharing of resources. It is hoped to continue to work closely with UKTSSA in future for the sharing and validation of data held by the two groups.

5.4 It is anticipated that the return of English, Welsh and at least Northern Irish data to EDTA will be through the Renal Registry. Further discussions are to be undertaken with the Scottish Renal Registry and renal centres in Eire regarding collaborative data reporting and comparison.

5.5 Data from paediatric renal units will be entered on the database, which will allow long-term studies of renal cohorts over a wide range of age.

5.6 The basis of participation for Renal Units nationally will be an Agreement to accept the Renal Registry Data Set Specification for the transmission and retention of data. This will consist of a core data set of some 200 items and further optional elements, which will be returned on a special understanding with the unit for a defined period of reporting. The Agreement specifies the conditions of participation and guarantees confidentiality of the data. The responsibilities of the Unit and Registry are clarified in the clauses of the Agreement, as well as the conditions of publication of data.

A:6 Registry role for nephrologists

6.1 The clinical community have become increasingly aware of the need to define and understand their activities, particularly in relation to national standards and other renal units.

6.2 The Renal Standards documents are designed to give a basis for unit structure and performance, as well as patient-based elements such as case-mix and outcomes. It is anticipated that Standards will become increasingly based on research evidence and the Cochran Collaboration has resourced reviews of renal topics recently which will support the conversion from clinical anecdote.

6.3 The registry data will be available to allow comparative review of many elements of renal unit practice. Data will be anonymised and presented as graphical output in various convenient formats to allow a contrast of individual unit activity and results with national aggregated data.

6.4 Reports of demographic and treatment variables will be available to the participating centres for distribution to Trust, Health Authorities and Regional Offices

as required and agreed with the Unit. EDTA reporting should be transparent for the Unit where complete data have been registered. Common reports should facilitate discussion with Trust officers and Purchasers, particularly for Clinical Directors where appointed.

6.5 Customised data reports will be available after negotiation in regard to feasibility and costs. A charge may be levied if requests are outside Registry objectives for the current round.

6.6 The database has been designed to provide research database facilities for future participation in national and international trials. There will be an opportunity to be involved in the selection of topics for national audit and research according to local and professional interests.

6.7 The Registry is run by a sub-committee of the Renal Association and therefore by colleagues with similar concerns and experience.

6.8 These facilities will only be sustainable through co-operation with the need for high quality and comprehensive data entry at source. Attention is drawn to the conditions listed in the formal Agreement with the Registry.

A:7 Registry role for trust managers

7.1 One of the principles of health service informatics is that the best data are acquired from clinical information recorded at the point of health care delivery.

7.2 The gathering and registration of data relating to patient management should be regarded as an essential part of routine patient management in the health service.

7.3 Renal Services data entered on local systems by staff directly engaged with patients is likely to be of the highest quality, and it is this that the Registry intend to capture through the RRDSS.

7.4 The regular reports of the Registry will supply the details of patient demographics, treatment numbers and changes, treatment quality and outcomes. Data will be compared with national standards and national performance for benchmarking and quality assurance. The assessment of contract activity and service delivery will be possible through the data returns without the need for further, costly Trust administrative activity. These data should be particularly valuable to Contracts Managers and Medical Directors.

7.5 The comparisons with other centres will allow unbiased estimates of Renal Unit performance against costs. Data will be available on Unit infrastructure and facilities.

7.6 The Registry is focused on Renal services and will provide a cost-effective source of detailed information.

7.7 It is anticipated that data on patients with renal disease other than those requiring RRT will become available in time.

7.8 It is anticipated that Trust interests will ultimately be served by the participation of a national trust representative in the management body of the Registry as the database expands.

A:8 Registry role for commissioners of health care

8.1 The use of information sources such as the Registry is advised in the National Renal Review so as to promote benchmarking and quality assurance on renal programmes. The comprehensive tracking of a relatively small but costly renal cohort should be regarded as a routine part of case management.

8.2 The Registry will be able to provide validated, comparative reports of renal unit activity on a regular basis to participating centres. These will allow assessment of unit performance in a wide range of variables relating to 'Structure, Process and Outcome' measures.

8.3 There must be economies of scale in the performance of audit through the Registry, since multiple local audits will no longer be required.

8.4 The incidence of ESRF treated locally will be apparent from new patient registrations. Mortality and renal transplant rates should also be of interest. The geographical origin of ESRF cases will be indicated by postcode data which allows the assessment of referral and treatment patterns. This information will allow the expression of geographical and ethnic variations. These data will indicate unmet need in the population and permit judgements of the equity of service provision. The later Registry database should give information on nephrology and pre-dialysis patients which will allow prediction of the need for ESRF facilities.

8.5 Registry data will be used to track patient acceptance and ‘stock’ rates over time, which will allow the modelling of future demand and validation of predictions.

8.6 Information on the clinical diagnosis of new and existing RRT patients will give a lead to possible preventive measures in regard of hypertension and diabetes in particular. Any clusters of genetic disorders should also be apparent. The origin of ESRF in acute renal failure (ARF) that does not recover will be of interest in assessing the quality of local ARF Services. The results of higher acceptance rates in the elderly and the consequences of increasing demand from ethnic groups bearing a high prevalence of renal, circulatory and diabetic disease will be measurable.

8.7 Comparative data will be available in all categories for national and regional benchmarking.

8.8 The Registry offers independent expertise in the analysis of Renal Services data and their interpretation, a resource which is widely required but difficult to obtain.

8.9 The cost of supporting the Registry is estimated at between £10 and £20 per registered patient per annum, which is less than 0.1% of the typical cost of a dialysis patient per annum. It is expected that the costs will need to be explicit in renal services contracts so as to ensure the continuation of the Registry on a sound basis.

8.10 It is anticipated that the joint Commissioning Authorities will be asked to suggest a representative for the management committee of the Registry as the database expands, which will allow for purchasers to influence the development of the Registry and the topics of interest in data collection and analysis.

A:9 Abbreviations

ARF	Acute Renal Failure
CCL	Clinical Computing Limited
EDTA	European Dialysis and Transplant Association (European Renal Association)
ESRF	End Stage Renal Failure
NHS	National Health Service
RRDSS	Renal Registry Data Set Specification
RRT	Renal Replacement Therapy
UKTSSA	United Kingdom Transplant Support Service Authority
USRDS	United States Renal Data System

Appendix B Definitions

Home haemodialysis

A home haemodialysis patient ceases to be classed as such, if they need greater than 2 weeks of hospital dialysis when not an inpatient.

Satellite dialysis unit

A satellite unit is a centre which is distinct from the parent hospital where the consultant nephrologist is based.

Treatment modality at 90 days

This is used by the USRDS and is the modality that the patient is on at day 90 regardless of any changes from the start. It is a general indicator of initial dialysis, but could miss failed CAPD. This would also miss patients intended for home haemodialysis, who will not be home yet. This is modality is calculated by the Registry, which allows the definition to be changed.

Co-morbidity definitions

For simplicity, all the co-morbidity data are yes/no fields

The co-morbidity screen :-

```
_ Angina                                    _ Claudication
_ Previous MI within last 3 months          _ Ischaemic / Neuropathic ulcers
_ Previous MI > 3 months ago                _ Angioplasty (non coronary)
_ Previous CABG or coronary angioplasty     _ Amputation for Periph Vasc Dis

_ Cerebrovascular disease                       _ Smoking
_ Diabetes (not causing ESRF)
_ Chronic Obstructive Pulmonary Disease
_ Liver Disease
_ Malignancy
```

Angina

History of chest pain on exercise with or without ECG changes, ETT, radionucleotide imaging or angiography.

Previous MI within last 3 months

MI diagnosed by :-

ST segment elevation, Q waves in relevant leads, enzyme rise > x2 upper limit of normal (or rise in CKMB above local reference range)

Previous MI > 3 months ago

From time of ESRF

Previous CABG or coronary angioplasty

Cerebrovascular disease

Any history of strokes (whatever cause) and including TIA caused by carotid disease

Diabetes (not causing ESRF)

This includes diet controlled diabetics

Chronic Obstructive Pulmonary Disease

This is defined as a slowly progressive airways disorder characterised by obstruction of the expiratory airflow which does not change markedly over several months, may be accompanied by airways hyper-reactivity and may be partially reversible.

N.B. chronic bronchitis and emphysema may occur in the absence of airflow obstruction. Asthma patients may rarely develop airflow obstruction that does not improve with steroids

Liver Disease

This is defined as any abnormal LFTs at the time of registration

Malignancy

Defined as any history of malignancy (even if curative). e.g removal of basal cell carcinoma, melanoma.

Claudication

Current claudication based on a history, with or without Doppler or angiographic evidence.

Ischaemic / Neuropathic ulcers

Current presence of these ulcers.

Angioplasty (non coronary)

Amputation for Peripheral Vascular Disease

Smoking

Current smoker or history within the last year.

Appendix C Definitions of Analysis Quarters

Quarter	Dates
Quarter 1	1 January – 31 March
Quarter 2	1 April – 30 June
Quarter 3	1 July – 30 September
Quarter 4	1 October – 31 December

The quarterly biochemistry data are extracted from Proton systems as the last data item stored for that quarter. If the patient treatment modality is haemodialysis, the software tries to select a pre-dialysis value.

Appendix D Definition of Criteria for inclusion or exclusion in this analysis

D:1 Take-On Population

The take-on population in a year included patients who later recovered from ESRF after 90 days from the start of treatment. Patients newly transferred into a centre who are already in ESRF are not included in the take on population for that centre.

Since patients who restarted ESRF treatment after recovering from ESRF, are included in the take-on population the following scenario's can occur:- A patient may start ESRF treatment in 1996, recover and then restart ESRF treatment in 1996. These patients are counted twice in the analysis providing they have been receiving ESRF treatment for greater than 90 days on each occasion.

Patients who started treatment at a centre and then transferred out soon after receiving treatment are counted at the original centre for all analyses of treatment on the 90th day..

D:2 Criteria For Analysis by Treatment Modality In A Quarter.

The following quarterly entries were included and excluded: -

Patients on haemodialysis with a treatment centre of 'elsewhere' were **removed**. It should be noted that there were some patients on transplant with a treatment centre of 'Elsewhere'. These patients were **included.**

Entries for which the hospital centre was not the primary treatment centre were removed from the analysis of data for that centre.

Patients who had been on ESRF treatment for less than 90 days were removed. (by definition of ESRF) There were a few exceptions to these rules:-
If a patient's initial entry on the treatment time line contained a **'transferred in'** code, then the patient was assumed to have been on ESRF for longer than 90 days, since the patient must have started ESRF treatment earlier than this elsewhere. Therefore, patients with an initial entry on the treatment timeline with a **'transferred in'** code were included for all quarters. For example, a patient with an initial treatment modality of

'**transferred in**' on the 1st March 1996, would be included for quarter 1/97, even though the number of days on ESRF treatment would be calculated as 30 days.

For patients who **recovered renal function**, for a period of time, then went into ESRF, the length of time on ESRF treatment was calculated from the day the patient restarted ESRF treatment. For example, for a patient with an initial treatment start date of the 1st March 1996, who recovered on the 1st June 1996 and then resumed ESRF treatment again on the 1st November 1996, the number of days on ESRF treatment would be calculated from the 1st November 1996. The patient would be excluded from the analysis for quarter 4/96, since on the 31st December 1996, they only would have been on ESRF treatment for 60 days. The patient would be included in the analysis from quarter 1/97 onwards.

Patients who had **transferred out** or **stopped treatment without recovery of function** before the end of the quarter, were excluded.

D:3 Criteria For Analysis Of Biochemistry In A Quarter.

The analysis used information from the quarterly treatment table. In addition to the treatment modality criteria listed above, patients with the following quarterly entries were also excluded: -

Patients who had **'transferred in'** to the centre in that particular quarter were excluded. For example, if a patient transferred in on the 1st March 96, then the patient was excluded from that biochemistry analysis of the centre they transferred to in that quarter.

Patients who had changed treatment modality in that particular quarter were excluded

D:4 Treatment Modality On Day 90 Of Starting ESRF Treatment

This is obtained from the treatment modality of the take-on population after 90 days of being on ESRF. For this reason patients who started treatment between 1/10/96 and 31/9/97 were used in this analysis.

The sample used was that defined by the take-on population.

Patients are counted at their take-on hospital centre rather than at their hospital centre on day 90. This is important since some patients had transferred out of their initial hospital centre by day 90.

Patients who died before they reached 90 days are excluded.

D:5 One Year Survival Of The Take-On Population

The sample used was the same as that defined for the take-on population except for patients who recovered, who were excluded.

Patient's who transferred out of their initial treatment centre, were censored on the day they transferred out of their treatment centre if there was no further information in the timeline.

D:6 Analysis Of One Year Survival of stock

The death rate within year was calculated separately for the patients established on dialysis and with a functioning transplant on 1st January 1997. Only patients established for 90 days on renal replacement therapy on that date were included. As there is an increased death rate in the first six months following transplantation, patients were only included in the analysis if they had not received a transplant between 1st July 1996 and 31st December 1996. For the same reason patients who received a transplant within the year were censored at the time of transplantation.

The sample criteria thus became:

1. Patients who had been receiving renal replacement therapy for more than 90 days on 1/1/97.

2. Patients who had a transplant between 1/7/96 and 31/12/96 were excluded

3. Patients who transferred into a Registry centre were excluded if information was not available to confirm that they had not received a transplant between 1/7/96 and 31/12/96.

4. The few patients who recovered renal function in 1997 were excluded.

5. Patients who transferred out of a Registry centre to a non-Registry centre were censored at that date

6. A transplant patient whose transplant failed was censored at the time of restarting dialysis, and dialysis patients who received a transplant were censored at the time of transplant.

7. Patients who died, received a transplant, or transferred out on 1/1/97 were included and were counted as being at risk for one day.

8. Patients who died on the day of the transplant were censored on this day, rather than counted as a dialysis death.

Appendix E Renal services described for non-physicians

(reproduced from the Renal Association Standards document)

This appendix, taken from the Renal Association Standards document, provides background information on renal failure and discusses the services available for its treatment.

Chronic renal failure

1. In chronic irreversible renal failure, the kidneys are slowly destroyed over months or years. To begin with there is little to see or find, and this means that many patients present for medical help very late in their disease, or even in the terminal stages. Tiredness, anaemia, a feeling of being 'run down' are often the only symptoms. However, if high blood pressure develops, as often happens when the kidneys fail, or is the prime cause of the kidney disease, it may cause headache, breathlessness and perhaps angina. Ankle swelling may occur if there is a considerable loss of protein in the urine.

2 Progressive loss of kidney function is often described as chronic renal insufficiency when in its early stages, chronic renal failure when it becomes obvious, and end stage renal failure when it reaches its terminal stage. At this point, if nothing is done, the patient will die. Two complementary forms of treatment, dialysis and renal transplantation are available and both are needed if end stage renal disease is to be treated.

3 The incidence of end stage renal failure rises steeply with advancing age. Consequently an increasing proportion of patients treated for end stage renal failure in this country are elderly and the proportion is even higher in some other developed countries. Evidence from the United States suggests that the relative risk of end stage renal failure in the black population (predominantly of African origin) is two to four times higher than for whites [US Renal Data System 1993]. Data collected

during the review of renal specialist services in London suggest that there is in the Thames regions a similar greater risk of renal failure in certain ethnic populations (Asian and Afro-Caribbean) than in whites [Roderick et al 1994]; this is supported by national mortality statistics [Raleigh et al 1996]. people from the Indian subcontinent have a higher prevalence of non-insulin dependent diabetes, and those with diabetes are more likely than whites to develop renal failure. This partly explains the higher acceptance rate of Asians on to renal replacement programmes.

Causes of renal failure

4 Most renal diseases that cause renal failure fall into a few categories.:-

Auto-immune disease. 'Glomerulonephritis' or 'nephritis' describes a group of diseases in which the glomeruli (the filters that start the process of urine formation) are damaged by the body's immunological response to tissue changes or infections elsewhere. Together, all forms of nephritis account for about 30% of renal failure in Britain. The most severe forms are therefore treated with medications that suppress the immune response, but treatment makes only a small impact on the progress of this group of patients to end stage renal failure

Systemic disease. Although many generalised diseases such as systemic lupus, vasculitis, amyloidosis and myelomatosis can cause kidney failure, by far the most important cause is diabetes mellitus (about 20% of all renal disease in many countries). Progressive kidney damage may begin after some years of diabetes, particularly if the blood sugar and high blood pressure have been poorly controlled. Careful lifelong supervision of diabetes has a major impact in preventing kidney damage.

High' brood pressure. Severe ('accelerated') hypertension damages the kidneys, but the damage can be halted — and to some extent reversed — by early detection and early treatment of high blood pressure. This is a common cause of renal failure in patients of African origin.

Obstruction. Anything that obstructs the free flow of urine can cause

back-pressure on the kidneys. Much the commonest cause is enlargement of the prostate in elderly men; although only a small proportion of them develop kidney failure, prostatism is so common that it becomes a major cause of renal failure over the age of 70 [Feest et al 1990, 1993].

Infection of urine. Cystitis is a very common condition, affecting about half of all women at some time in their lives, but it rarely has serious consequences. However, infection of the urine in young children or patients with obstruction, kidney stones or other abnormalities of the urinary tract may result in scarring of the kidney and eventual kidney failure.

Genetic disease. One common disease, polycystic kidneys, and many rare inherited diseases affecting the kidneys account for about 8% of all kidney failure in Britain. Although present at birth, polycystic kidney disease often causes no symptoms until middle age or later. Understanding of its genetic basis is rapidly advancing and may lead to the development of effective treatment.

Disease of renal blood vessels. This is being more and more frequently recognised as a cause of renal failure, both acute and chronic. It is especially common in patients aged more than 65 years.

Comorbidity

5. Renal failure is often accompanied by other disease processes. Some are due to the primary disease, eg diabetes may cause blindness and diseases of the nerves and blood vessels. Others, such as anaemia, bone disease and heart failure, are con sequences of the renal failure. Coincidental diseases such as chronic bronchitis and arthritis are particularly common in older patients with renal failure. All these conditions, collectively called comorbidity, can influence the choice of treatment for renal failure and may reduce its benefits. Expert assessment of the patient before end stage renal failure can reduce comorbidity and increase the benefit and cost effectiveness of treatment. Thus early detection and referral of patients at risk of renal failure is important. Studies in France and in the United States showed

that the mortality rate among patients aged over 55 years at the start of regular dialysis increased dramatically if dialysis was started late in the illness [Jungers et al 1993; Byrne et al 1994]

Renal replacement therapy

6. The term renal replacement therapy is used to describe treatments for end stage renal failure in which, in the absence of kidney function, the removal of waste products from the body is achieved by dialysis and other kidney functions are supplemented by drugs. The term also covers the complete replacement of all kidney functions by transplantation.

Renal dialysis

7. Dialysis involves the removal of waste products from the blood by allowing these products to diffuse across a thin membrane into dialysis fluid which is then discarded along with the toxic waste products. The fluid is chemically composed to draw or "attract' excess salts and water from the blood to cross the membrane, without the blood itself being in contact with the fluid.

Haemodialysis

8 The method first used to achieve dialysis was the artificial kidney, or haemodialysis. This involves the attachment of the patient's circulation to a machine through which fluid is passed, and exchange can take place. A disadvantage of this method is that some form of permanent access to the circulation must be produced to be used at every treatment. Each session lasts 4-5 hours and is needed three times a week.

Peritoneal dialysis

9 The alternative is peritoneal dialysis, often carried out in the form of continuous ambulatory peritoneal dialysis (CAPD). In this technique, fluid is introduced into the peritoneal cavity (which lies around the bowel) for approximately 6 hours before withdrawal. The washing fluid must be sterile in order to avoid peritonitis (infection and inflammation of the peritoneum), which is the main complication of the treatment. A silastic tube must be implanted into the peritoneum and this may give problems such as kinking and malposition. Each fluid exchange lasts 30-60 minutes and is repeated three or four times daily. Neither form of dialysis corrects the loss of the hormones

secreted by the normal kidney so replacement with synthetic erythropoietin and vitamin D is often necessary.

Renal transplantation

10. Renal transplantation replaces all the kidney's functions, so erythropoietin and vitamin D supplementation are unnecessary. A single kidney is placed, usually in the pelvis close to the bladder, to which the ureter is connected. The kidney is attached to a nearby artery and vein. The immediate problem is the body's acute rejection of the foreign graft, which has largely been overcome during the first months using drugs such as steroids and cyclosporin. These drugs, and others that can be used for that purpose, have many undesirable side effects, including the acceleration of vascular disease, so myocardial infarcts and strokes are commoner in transplant patients than in age matched controls. During subsequent years there is a steady loss of transplanted kidneys owing to a process of chronic rejection; treatment of this is quite unsatisfactory at the moment, so many patients require a second or even a third graft over several decades, with further periods of dialysis in between.

11. The main problem with expanding transplantation is the shortage of suitable kidneys to transplant. Although the situation can be improved it is now clear that, whatever social and medical structures are present and whatever legislation is adopted, there will inevitably be a shortage of kidneys from humans. This remains the case even if kidneys from the newly dead (cadaver kidneys) are retrieved with maximum efficiency, and living donors (usually but not always from close blood relatives of the recipient) are used wherever appropriate. Hope for the future rests with solving the problems of xenotransplantation (that is using animal kidneys), probably from pigs, although baboons have also been suggested and are closer to humans. Many problems remain unsolved and it is thought highly unlikely that xenotransplantation will become a reliable treatment for end stage renal failure within the next 10 years.

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