# 2 Renal Disease

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## 1 Summary

### Background

This chapter addresses critical questions in the organisation and planning of services for adult patients with renal disease. The chapter summarises:

- information concerning the epidemiology of renal diseases
- needs for services
- current service delivery
- cost-effectiveness data
- the implications for future service development.

The chapter should be read in conjunction with purchasing guidance produced by the Department of Health, and the Renal Association/Royal College of Physicians report, *Treatment of Adult Patients with Renal Failure. Recommended Standards and Audit Measures* (the 'standards' document).[1,2]

### Types of renal disease (sections 3 and 4)

Renal disease can be divided into disease without failure of kidney function and kidney failure itself, which divides into chronic and acute forms. These sections of the chapter review the main classification systems and causes of renal disease.

The management of patients with the advanced stage of chronic renal failure (CRF) called end-stage renal failure (ESRF) is the most costly item of care. These patients require chronic renal replacement therapy (RRT), either by dialysis or transplantation. Such treatment is highly effective in providing a good quality of life in an otherwise inevitably fatal condition. This chapter therefore largely focuses on chronic and end-stage renal failure.

Nevertheless there are larger numbers of patients with symptoms/signs of renal disease who will require assessment and/or medical supervision at district hospitals or tertiary centres. A number of patients develop acute renal failure (ARF), some require dialysis for short periods of time, a few ending up with chronic failure. Prognosis is poor if there is multiorgan damage, but recovery is greater when disease is limited to the kidneys.

## Population need (section 5)

### *Renal replacement therapy*

The main sociodemographic characteristics that will influence population need for RRT are those driving the incidence and progression of CRF to ESRF:

- age
- gender
- ethnic origin (specifically Indo-Asian and African-Caribbean).

Indicators of social deprivation will also influence need as CRF is greater in deprived groups.

Age, deprivation and ethnic origin are all associated with relatively common conditions like diabetes mellitus, which can lead to progressive CRF.

Population-based studies show:

- the incidence of ESRF to be 130–150 per million population (pmp) in predominantly white European populations
- that approximately 75–80 pmp under age 80 would be suitable for RRT each year in such populations.

However, as the risk of ESRF is higher among the elderly, and among African-Caribbean and Indo-Asian populations, the overall level of need is likely to be significantly higher. Moreover, numbers requiring RRT will increase sharply as these ethnic minority populations age. Several European countries, including Wales and Scotland, which are predominantly Caucasian and do not have large ethnic minority populations, already have annual acceptance rates over 100 pmp.

While it is hard to be precise it is likely therefore that population need in England is likely to be at least 100 pmp and probably 120–130 pmp (new patients accepted on to RRT programmes per year).

This figure will vary substantially between health authorities (HAs) depending on their population characteristics.

The incidence of CRF is less readily available. One study of diagnosed disease with creatinine over 150 $\mu$mol/l shows a rate of over 1600 pmp. This will also vary between populations.

### *Acute renal failure/general nephrology*

Current estimates are limited:

- 600 patients pmp per year need assessment for renal disease
- 100–140 individuals pmp per year develop ARF, of whom 70 pmp require nephrological assessment.

## Renal services in the UK (section 6)

RRT services only consume around 1% of the NHS budget but these funds are spent on a disproportionately small number of patients. When the predicted rise in RRT stock levels has levelled, it has been estimated that RRT services will consume between 2 and 4% of the NHS budget but patients receiving RRT will only account for 0.08% of NHS patients.

The main methods of treatment for ESRF are:

- haemodialysis (HD)
- continuous ambulatory peritoneal dialysis (CAPD)
- transplantation.

These are used in combination in an RRT programme (for further details of these treatments *see* Appendix I). Each method is effective in prolonging survival, but if quality and duration of survival are considered, successful transplantation is the most cost-effective method of treatment. However, this mode is only applied to selected patients. Transplantation is therefore the preferred option for patients but it is limited by the availability of donor organs.

In the past, renal services have been provided through multidistrict tertiary centres. Centralisation may allow specialists to achieve better results through greater experience and efficient use of scarce manpower, but populations in districts remote from specialist centres underutilise renal services. This has resulted in geographical inequity of provision and use, particularly for RRT. In recent years, there has been a recognition of this problem. The national 'purchaser guidance' document encouraged the development of a 'hub-and-spoke' model, geographical factors permitting.[1]

Comparisons of service provision in 1993 and 1995 in England and in Wales demonstrated evidence of expansion and decentralisation. Key findings were:

- an increase in the number of satellite renal units linked to main renal units (most of which provide a full range of services including transplantation); satellites were heterogeneous in size, location, medical input, NHS/private and other, patient case-mix
- an increased use of hospital HD, in both main and satellite units
- a much slower expansion of CAPD
- a decline in home HD
- an overall improvement in standards of care but still unacceptable variation in the quantity and quality of dialysis delivery
- persisting regional variation in supply of services and acceptance rates
- that the number of main units pmp was low compared to European countries and relatively static although there was some growth in autonomous district general hospital (DGH) based renal units
- there was evidence that some units were operating under considerable pressure which may have limited the quality of dialysis care provided.

In terms of current demand:

- the acceptance rate for RRT in the UK was rising and was 82 pmp by 1995 in England and there was evidence of regional variation
- the prevalent ('stock') rate was 476 pmp
- the characteristics of patients being treated had changed with an increasing proportion being elderly with associated co-morbidity.

There is still evidence of unmet need as this acceptance rate is below the rate in many western European countries and less than the estimate of population need above. Unmet need is higher in older ages and it varies by area.

A recent survey will bring information up to the end of 1998 and will be available soon.

## Effectiveness and cost-effectiveness (section 7)

The evidence base for renal services is growing. There is now a Cochrane Collaboration Renal Review Group, which is co-ordinating systematic reviews of the evidence. New trials are being commenced under the auspices of the Renal Association's Clinical Trials Group. The Renal Association's standards document is an important summary of the current evidence, and it is being regularly updated.

There is a need for more randomised controlled trials (RCTs) in renal disease although this is complicated by the requirement in most instances for multicentre studies to achieve adequate numbers.

### *Prevention*

This can be considered as:

- primary – preventing renal disease
- secondary – preventing progression/recurrence
- tertiary – reducing complications and handicap associated with renal failure.

Primary and non-specialist secondary care providers can contribute to the primary and secondary prevention of renal disease through the detection and management of diabetes, hypertension, urinary tract infection, obstructive uropathy and mild CRF. Health improvement strategies for reducing cardiovascular disease (CVD) may contribute to a reduction in renal disease because risk factors such as diabetes and hypertension are important in both conditions. The progression of CRF may be slowed through use of appropriate interventions, particularly the control of hypertension. However, the reduction in the incidence of ESRF, although valuable, is likely to be small in the short term even if greater preventive efforts are made.

Greater efforts are needed to educate GPs and physicians about the management of renal disease. Further research is needed to determine the effectiveness of preventive measures.

Nearly 40% of patients starting RRT are referred to the renal unit less than four months before dialysis is needed. This predicates against appropriate management of CRF and planning for dialysis (secondary/tertiary prevention). Such patients fare badly and use greater resources in establishing dialysis. In some cases, this is inevitable (e.g. because of rapid progression), but there is scope for more timely referral of patients with CRF. However, even some patients under longer-term nephrological care start dialysis in emergency. Greater attention is needed to ensure that facilities are available for establishing timely vascular access to reduce this as far as possible.

For ARF, avoidable factors may contribute to some cases, although more research is needed to define the scope for prevention.

### *Renal replacement therapy*

For all modalities there have been marked improvements in survival in the last decade, particularly after transplantation, despite the increasing proportions of elderly and 'high-risk' patients. In general:

- 50% of patients in Europe on RRT are alive after 10 years and 40% after 15 years
- patients under 55 years without diabetes or other coincidental diseases can expect a 94% survival to year one and an average life expectancy of 14.3 years thereafter
- the best patient survival rates are reported following transplantation but these are a selected patient group (younger with less co-morbidity)
- graft survival is influenced mainly by tissue type match, the type of donor (live versus cadaveric), the type of immunosuppression and the underlying cause of the renal disease
- it is difficult to compare CAPD and hospital HD directly because case-mix varies but there does not appear to be any difference in overall survival when selection factors are taken into account.

Treatment (or modality) survival is better on HD, because of the risk of recurrent peritonitis with CAPD, although this problem has declined with the introduction of disconnect catheters. Dialysis by CAPD can become inadequate over time as any remaining patient renal function declines. Continuous ambulatory peritoneal dialysis has, in the past, been used preferentially in the UK for patients with diabetes, patients with CVD and elderly patients. Some argue that many older patients who are being increasingly accepted on to RRT require accessible, medically supervised hospital HD as an alternative option to CAPD. Furthermore, the modalities are best considered as interdependent and patients should have a choice between them when first established on RRT. There are concerns that choice is limited due to inadequate HD facilities. There will be increasing need for hospital HD as the older age group expands and as patients first established on CAPD fail on this modality. Although the UK has a much higher proportion of patients on CAPD than other European countries, recent growth in provision has largely been of hospital HD, with CAPD showing much slower growth and home HD declining. There has also been a growth of automated peritoneal dialysis (APD) as an alternative to home HD and CAPD. Further evidence of its cost-effectiveness needs to be established.

Cost-effectiveness studies indicate that the main methods of treatment can be ranked in diminishing order of cost-effectiveness as follows:

- successful transplantation
- CAPD
- home HD
- hospital HD.

However, these comparisons cannot be used directly; in the local context there may be significant variations in case-mix and the costs of expanding different components of the service may depend on local circumstances. Moreover, there are significant problems in separating interdependent modalities, for example CAPD requires back-up hospital HD both for temporary and permanent technique failures. In addition, cost shifts and the introduction of technology (Y connectors and bicarbonate dialysis fluid) can affect the analyses: many of the studies pre-date these technological changes.

The evidence on relative cost-effectiveness of modalities and the characteristics of the existing stock of patients on RRT, together with the likely sorts of patients who would enter the RRT programme if acceptance rates were to increase, indicate the purchase of a combination of transplantation (within the constraints of organ supply) and a balanced programme of CAPD and HD, though with greater emphasis on HD. HD is increasingly being delivered in satellite units. Their cost-effectiveness in coping with elderly co-morbid patients remains to be established.

It has to be accepted that the proportion of patients who are elderly and or with co-morbidity will increase, a development that may reduce the marginal cost-effectiveness of RRT services. The scope for improvement in organ harvesting for transplantation appears modest at present, unless it can be given greater priority (and funding) by provider units, and additional strategies for organ procurement are developed.

Better evidence of the relative cost-effectiveness of hospital HD, CAPD and APD is needed, ideally by randomised methods, as observational studies are problematic because of selection factors in the use of these modalities.

## Modelling future demand and its implications (section 8)

Various researchers have used modelling techniques to predict the future prevalence ('stock') of patients who will be receiving RRT when a steady state is reached. Key findings are:

- for an estimated need of 80 new patients pmp under age 80 there will be a rise in the stock levels of between 50 and 90% over the next 15 years depending on the assumed rates of patient survival (this is probably a conservative estimate with a more realistic figure being a doubling of stock levels to a rate of 800 pmp)
- stock rates will rise even if acceptance rates remain constant

- to meet projected demand, year-on-year growth in provision will be required
- elderly patients with associated co-morbidity will increase both in absolute terms and as a proportion of total patient stock
- the main growth in demand by modality will be in dialysis, particularly hospital HD, as transplantation and CAPD may not be appropriate for elderly patients with co-morbidity
- the increase in demand will be influenced by the rates of patient acceptance and patient survival
- changes in transplantation rates will only have a small effect on stock levels, though they would alter the dialysis to transplantation ratio.

Further modelling is needed to investigate the effects of a higher target acceptance rate (including the impact of demographic change in ethnic minorities), and the balance of dialysis modalities under different assumptions about future case-mix and availability of dialysis facilities.

## Transplantation (section 8)

Transplantation is the preferred modality for RRT but demand outstrips supply of organs. Policies to increase the supply of kidneys for transplantation are required. HAs need to consider how cadaver donation from intensive care units (ICUs) and neurosurgical units can be maximised. ICUs, neurosurgical facilities and transplant teams must be well resourced. Brain-stem death testing and organ harvesting should be audited. Procurement co-ordinators should be adequately funded and supported to fulfil their roles of professional and public education, co-ordination of organ harvesting and bereavement counselling. 'Elective ventilation' of non-ICU patients purely for the purpose of providing organs for transplantation has been declared illegal. The use of asystolic donors needs further pilot studies to demonstrate its feasibility and effectiveness. National policies to enhance the profile and coverage of the donor card scheme and the development of the NHS organ register are important. The opt-out policy of 'presumed consent' needs wider debate. Providers should be encouraged to use the national kidney sharing scheme and to participate in larger local (e.g. regional) lists with clear criteria for allocation. This would enhance the effectiveness and equity of transplantation. Of concern is the difficulty of ensuring equitable access to transplants for ethnic minority groups.

The use of living donors has been less well established in the UK than in some countries. The programme is expanding and now includes unrelated donors. It has helped to maintain kidney supply in the face of declining cadaver kidneys, though it is not applicable to all recipients.

### *Organisation of services (section 8)*

### *Renal replacement therapy*

The key dilemma is how to enhance the quantity of RRT, invest in quality improvements and ensure geographical access to reduce current inequities. The new infrastructure of regional and sub-regional groups for commissioning specialist services will need to review population needs, trends in demand and current service disposition in order to plan with their constituent HAs how and where supply could be increased over a 5–10-year time frame.

This would entail, for example, supporting the development of autonomous DGH renal units outside major cities, and satellite units. The former will provide a more complete service which improves the care for all types of renal disease and particularly ARF.

Conversely, there are grounds for rationalising transplant services into fewer large centres to ensure a critical mass of medical, nursing and pathological expertise.

In Scotland, there is a recommendation to develop 'managed clinical networks', which would facilitate seamless care between renal units, transplant centres and primary and community-based services. This concept requires further exploration in England and Wales.

In terms of the delivery of services:

- RRT expansion has knock-on implications for other hospital services (e.g. vascular and cardiac) as well as for primary and community care
- access surgery is key to a timely start to dialysis – surgical manpower must be adequate to cope
- expansion of hospital HD has considerable resource implications in terms of need for buildings, infrastructure, technology, and skilled nursing and technical staff
- a major constraint on service development is a shortage of skilled nurses
- further work is required to identify different skill mixes and to develop policies for recruitment training and retention of staff
- research is needed to establish good models of satellite units in providing more accessible care for elderly RRT patients
- with the increasing numbers of elderly on RRT the role of community support linked in with primary care is crucial
- in parallel with RRT expansion, pre-ESRF care needs to develop in order to improve the delivery of secondary/tertiary prevention measures
- primary care also has an important role in the primary prevention of renal disease and in early diagnosis and prompt referral
- explicit rationing of RRT is very difficult to implement; the cost-effectiveness of RRT can be improved by enhancing efficiency of delivery of RRT and earlier referral of patients
- the need to develop policies on withdrawal and terminal support is growing with the increasingly elderly population on dialysis.

There is a need for more information on the organisation of and patterns of care for ARF. Access to nephrologists would be improved by the development of more autonomous renal units/DGH nephrology posts.

## Monitoring and evaluation, research needs (sections 9 and 10)

Evaluation is essential for RRT, a highly complex and costly area of health care. Clinical standards for allareas of renal disease, though predominantly for dialysis and transplantation, have been developed by the Renal Association and widely disseminated. Some are evidence-based, others are consensus statements.

Comparative audit will be facilitated by the development of the UK and the Scottish Renal Registries. The geographical and person specific equity of RRT delivery can then be evaluated, and comparative audit of units' performance undertaken. Health authorities should encourage and support the involvement of their units in the Registry, including its funding.

Key evidence-based measures of the quality of care could be introduced into service agreements.

## Conclusion

Renal replacement therapy is effective in prolonging life of good quality in patients with ESRF. Provision will have to continue to expand to meet population need and to cope with in-built growth in the prevalent pool. To achieve an accessible, high-quality service, specialist service commissioning groups will have to consider how to decentralise nephrological expertise and dialysis facilities and to develop a quality assurance framework. Service delivery will need to be increasingly responsive to needs of the elderly population on RRT.

Improvements in the quality of RRT will need to be funded alongside growth in quantity. Transplantation services should be restricted to large tertiary centres and measures to increase the organ supply given high priority.

Commissioning groups will need to work together with providers and constituent HAs to co-ordinate and evaluate these developments with the ultimate goal of achieving more equitable, accessible and cost-effective renal services.

# 2 Introduction

This section discusses the needs of HA populations for specialist services for the treatment of adults with renal disease. The main emphasis is on organising services for patients with ESRF, the endpoint of progressive CRF. End-stage renal failure is inevitably fatal unless treated by RRT, including dialysis or transplantation. Renal replacement therapy is a complex treatment that has to be given regularly for the rest of the patient's life. It is a costly form of intervention. Large amounts of NHS resources are therefore spent keeping a relatively small number of patients alive who would otherwise die. It is estimated that 1% of the NHS budget is currently spent on 0.08% of the population, rising to 2% at steady state.[3]

Services required for diagnosis and treatment of ARF and for other renal diseases are also discussed briefly. Conditions that are mainly treated by urologists are not included.

The level of RRT provision has expanded considerably in the UK in the past decade from a position of significant underprovision. Acceptance rates increased from 20 pmp in 1982 to 82 pmp in England and 109 pmp in Wales in 1995.[4] The UK acceptance rate is still below the estimate of population need and lower than several comparable European countries. Older individuals, and patients with associated co-morbidity, such as diabetes, formerly had low rates of acceptance on to RRT but are now being treated in greater numbers. The percentage of new acceptances in England who were aged over 65 was 41% in 1995.[4] Such expansion was possible within the resource constraints of the NHS by the widespread use of CAPD and the expansion of the kidney transplantation programme. More recently the main increase in relative and absolute terms has been in hospital HD. This mode predominates in most European countries.

Rationing of RRT has been largely covert; providers (GPs and hospital physicians/surgeons) have not always referred patients to nephrologists for assessment when they might have benefited but there has been a liberalisation of attitudes to referral of patients with ESRF in the past decade.[5]

Services for patients with renal disease are still largely provided through multidistrict renal units, following the regional model first instituted in the 1960s when dialysis first became available. Most units support a full range of specialist services except transplantation, this being largely restricted to academic centres. There has been a considerable increase in renal satellite units, i.e. units without full-time, on-site consultant nephrology staff that are linked to main renal units. There are also some new autonomous DGH renal units. Within districts the number of patients receiving services is small, but there is evidence of under-referral of patients at present. This is a greater problem in districts that are remote from renal units,[6] particularly in older individuals.[7]

Commissioning policy has changed from the internal market to the establishment of regional and sub-regional specialist commissioning groups. An important consideration in any HA/specialist commissioning group strategy will be to determine the priority to be given to the RRT programme, given its proven effectiveness but significant resource use, and whether the provision of services locally would be advantageous within a regional strategic framework.

There have been significant developments in defining the evidence base for the management of renal disease and for monitoring and evaluating the care provided. These include the new Cochrane Collaboration Renal Review Group, the production of regularly updated standards of care by the Renal Association and the development of the UK Renal Registry of patients on RRT which will, among other things, facilitate comparative audit of the quality of and equity of care.

This chapter describes what is currently known about the epidemiology of renal disease, the need for renal services, and the effectiveness and cost-effectiveness of these services. It identifies gaps in the knowledge, which commissioning groups would find useful in assessing their needs for renal services, and makes recommendations for relevant research.

# 3 Statement of the problem

The essential functions of the kidney are the excretion of waste products of metabolism, the control of salt and water balance and blood pressure (BP), and the regulation of bone metabolism and haemoglobin production. If kidney function is impaired all these body systems are affected. The standard measure of renal function is the creatinine clearance, which reflects the ability of the kidneys to excrete most waste products of protein metabolism. The normal range is about 100 ml/min; rates less than 30 ml/min imply severe renal impairment. When clearance falls below 10 ml/min patients become severely symptomatic and usually need RRT. For long-term monitoring of renal function measurement of simple serum creatinine is used.

## Categories of renal disease

The following terms are used in this chapter:

- **Renal diseases without renal failure** – acute and chronic diseases of the kidney not resulting in a significant or progressive reduction in renal function. This workload is often termed ‘general nephrology’, e.g. investigation of proteinuria, haematuria (microscopic and macroscopic), recurrent urinary tract infection.
- **Renal failure** – a reduction in renal function sufficient to cause substantial increases in blood urea and creatinine concentrations.
- **Acute renal failure (ARF)** – this is of sudden onset and is potentially reversible. It develops over days or weeks, and dialysis may be required. Some patients die, usually from the precipitating condition, but full recovery of renal function usually occurs if the patient survives. It is now recognised that some cases of ARF never recover renal function.[8]
- **Chronic renal failure (CRF)** – develops over months or years and is not usually reversible although intervention may modify the rate of progression. It may present as ARF if there is a precipitating event.
- **End-stage renal failure (ESRF)** – is the irreversible reduction of renal function to levels incompatible with the maintenance of life without dialysis or transplantation.

## Coding systems

The relevant ICD9 and 10 codes[9,10] are given in Table 1, ONS operation codes[11] in Table 2, and Health Care Resource Groups (HRGs) in Table 3. The HRG classification includes much that is urological rather than nephrological.

**Table 1a:** Diagnostic codes (ICD ninth revision).

| | |
|---|---|
| 016.0 | TB kidney |
| 250.3 | Diabetes with renal manifestations |
| 274.1 | Gouty nephropathy |
| 403 | Hypertensive renal disease |
| 404 | Hypertensive heart and renal disease |
| 580 | Acute glomerulonephritis |
| 581 | Nephrotic syndrome |
| 582 | Chronic glomerulonephritis |
| 583 | Nephritis and nephropathy, not specified as acute or chronic |
| 584 | Acute renal failure (excludes postoperative renal failure and complications of pregnancy) |
| 585 | Chronic renal failure (excludes hypertensive renal disease) |
| 586 | Renal failure, unspecified |
| 587 | Renal sclerosis, unspecified |
| 588 | Disorders resulting from impaired renal function |
| 589 | Small kidney of unknown cause |
| 590 | Infections of kidney |
| 591 | Hydronephrosis |
| 592 | Calculus of kidney and ureter |
| 593 | Other disorders of kidney and ureter |
| 599.7 | Haematuria |
| 634-8 | Acute renal failure complicating abortion |
| 669.3 | Acute renal failure complicating labour and delivery |
| 788.9 | Extrarenal uraemia |
| 997.5 | Postoperative acute renal failure |

*Source*: ref. 9.

**Table 1b:** Diagnostic codes (ICD tenth revision).

| | |
|---|---|
| I12.0 | Renal failure with hypertension |
| I13.0 | Hypertensive heart and renal disease |
| NO1 | Rapidly progressive nephritic syndrome |
| NO2 | Recurrent and persistent haematuria |
| NO3 | Chronic nephritic syndrome |
| NO4 | Nephrotic syndrome |
| NO5 | Unspecified nephritic syndrome |
| NO6 | Isolated proteinuria with specified norphological lesion |
| NO7 | Hereditary nephropathy |
| N10 | Acute tubulo-interstitial nephritis |
| N11 | Chronic tubulo-interstitial nephritis |
| N12 | Tubulo-interstitial nephritis not acute or chronic |
| N13 | Obstructive and reflux uropathy |
| N14 | Drug and heavy metal induced tubulo-intestitial and tubular conditions |
| N15 | Other renal tubulo-interstitial disease |
| N16 | Renal tubulo-interstitial disorders in diseases classified elsewhere |
| N17 | Acute renal failure |
| N18 | Chronic renal failure |
| N19 | Unspecified renal failure |
| N27 | Small kidney of unknown cause |
| N28.0 | Ischaemia and infarction of kidney |
| N29.1 | TB kidney |
| N99.0 | Post-procedural renal failure |
| 0 00-072 | Renal failure complicating abortion/ectopic or molar pregnancy |
| 0 90.4 | Renal failure following labour |
| R31 | Unspecified haematuria |
| R39.2 | Extra-renal uraemia |
| | Pre renal uraemia |
| R80 | Isolated proteinuria |
| R94.4 | Abnormal kidney function test |
| T79.0 | Traumatic anuria |
| T82.4 | Complication of vascular disease |
| T85.6 | Peritoneal dialysis (PD) catheter |
| T86.1-9 | Kidney transplant failure or rejection |

*Source*: ref. 10.

**Table 2:** OPCS 4 operation codes.

| Operation | OPCS code |
|---|---|
| Transplantation of kidney | M01 |
| Total excision of kidney | M02 |
| Partial excision of kidney | M03 |
| Other open operations on kidney (including open biopsy) | M08 |
| Percutaneous puncture of kidney (including percutaneous biopsy) | M13 |
| Compensation for renal failure | X40 |
| Renal dialysis | X40.1 |
| Peritoneal dialysis (PD) | X40.2 |
| Haemodialysis necessary | X40.3 |
| Other specified | X40.8 |
| Unspecified | X40.9 |
| Placement of ambulatory apparatus for compensation of renal failure | X41 |
| Insertion of ambulatory PD catheter | X41.1 |
| Removal of ambulatory PD catheter | X41.2 |
| Other specified | X41.8 |
| Unspecified | X41.9 |
| Placement of other apparatus for compensation of renal failure | X42 |
| Insertion of temporary PD catheter | X42.1 |
| Other specified | X42.8 |
| Unspecified | X42.9 |
| Donation of organ | X45 |
| Donation of kidney | X45.1 |
| Reconstruction of renal artery | L41 |
| Other open ops on renal artery | L42 |
| Transluminal operation on renal artery | L43 |

*Source*: ref. 11.

**Table 3:** Health Care Resource Groups.

| | |
|---|---|
| L01 | Kidney transplant |
| L02/3 | Kidney major open procedure |
| L04 | Kidney major endoscopic procedure |
| L05/6 | Kidney intermediate endoscopic procedure |
| L07/8 | Non operating room admission for kidney or urinary tract neoplasms |
| L09/10 | Kidney or urinary tract infections |
| L45 | Extracorp lithotripsy |
| L46 | Renal replacement associated procedures |
| L47/48 | Renal replacement therapy |
| L49/50 | Acute renal failure |
| L51 | Chronic renal failure |
| L52/53 | Renal general disorders |
| L54/55 | Renal findings |
| L99 | Complex elderly with urinary tract or male reproductive system primary diagnosis |

*Source*: National Case Mix Office (http://www.casemix.org.uk).

# 4 Sub-categories

## Renal diseases without renal failure

The clinical and pathological features of renal diseases have been described in standard texts.[12,13] This category includes a wide range of conditions, many of which are rare. The importance of these conditions is their common potential to cause renal damage, which may subsequently progress over a variable time period to renal failure. Thus the aim of diagnosis and treatment should be to prevent or minimise the extent of renal damage.

## Acute renal failure

Acute renal failure is characterised by the rapid deterioration in renal function to levels at which dialysis may be required to support life. After an interval, recovery of renal function may occur but there may be residual impairment of renal function. Acute renal failure may result from a number of conditions. Most common are pre-renal causes (e.g. hypovolaemic, cardiogenic and septic shock); but intrinsic renal disease or the effects of toxins or drugs and post-renal causes such as acute obstruction also contribute. In most cases of ARF, there are several contributory causes. The Renal Association Standards document[2] recognised the following groups:

- *Medical* – glomerulonephritis (GN), infections, adverse drug reactions, renovascular disease (RVD).
- *Multiple injuries* – road traffic accidents, industrial injuries, burns, etc.
- *Surgical* – following major procedures, e.g. aortic or cardiac surgery, especially when complicated by hypotension or infection
- *Obstetric* – obstetric causes of ARF are now rare in the UK
- *Urinary tract obstruction* – most often caused by prostatic hyperplasia.

## Chronic renal failure

Chronic renal failure results from a number of conditions, which cause slow deterioration in renal function. A minority of cases arise after ARF (*see* Figure 1 overleaf). Once significant chronic renal damage is established it tends to be steadily progressive with the eventual development of ESRF. Most diseases affecting the kidney fall into the following categories.

### *Auto-immune*

Glomerulonephritis describes a group of diseases in which the glomeruli (the filters in which start the process of urine formation) are damaged by the body's immunological response to tissue changes or infection. The more severe forms are treated with immunosuppressive drugs but treatment makes only a small impact on the progress of this group of diseases to ESRF.

### *Systemic disease*

The most important cause is diabetes, both insulin-dependent (type I) diabetes and non-insulin-dependent (type II) diabetes. Progressive renal disease develops in a significant proportion, especially if

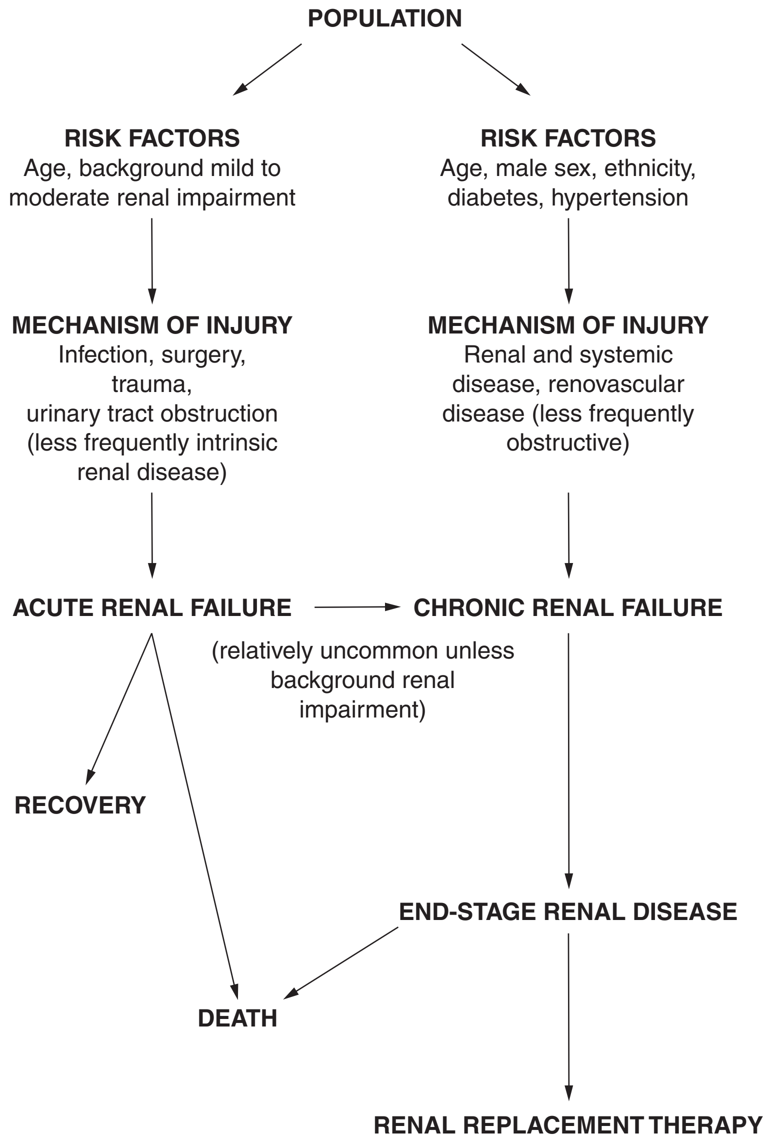


**Figure 1:** Causes and outcome of renal failure.

BP and blood glucose control have been poor. Diabetes is particularly prevalent in Indo-Asian and African Caribbean populations.

Atherosclerotic vascular disease may also affect the renal arteries, causing progressive impairment of renal function. Renovascular disease is increasingly recognised in the elderly and carries a poor prognosis as it is associated with generalised vascular disease. Other systemic diseases that affect the kidneys include systemic lupus, vasculitis and multiple myeloma.

### *High blood pressure*

Severe hypertension damages the kidney. Establishing it as a cause is difficult because renal impairment is complicated by hypertension. It is a particular problem in African-Caribbean populations.

### *Obstruction/infection*

Obstruction to urine flow causes back-pressure on the kidneys. The most common form is benign prostatic hypertrophy. When combined with infection it is especially damaging. Two other important conditions are reflux nephropathy in young children and urinary tract stones.

### *Genetic disease*

One important inherited disease, polycystic kidney disease, affects the kidney. It causes no symptoms until middle age or later but is a common cause of ESRF.

### *Toxic damage*

This can be produced by several drugs and environmental toxins (e.g. lead).

## End-stage renal failure

The distribution of renal diseases among patients accepted for RRT in the UK in 1985–86 and 1990–91 are shown in Table 4. It is important to note the difficulties in ascribing a cause to ESRF. In a substantial minority, no cause is identified ('unknown' group), as patients present with small, shrunken kidneys and invasive investigations are not justified. As mentioned above, ascribing hypertension as the primary cause can be difficult. Moreover, data on RRT acceptances will under-represent certain causes (e.g. diabetes) because of selective referral patterns.

**Table 4:** Causes of ESRF in patients accepted on to renal replacement therapy in the UK, 1985–86 and 1990–91.

| | Percentage of new patients | |
|---|---|---|
| | **1985–86** | **1990–91** |
| Unknown | 20 | 24 |
| Glomerulonephritis | 20 | 15 |
| Pyelonephritis and interstitial nephritis | 15 | 13 |
| Polycystic kidney | 9 | 8 |
| Renovascular disease[a] | 12 | 14 |
| Diabetes | 11 | 14 |
| Multisystem | 6 | 6 |
| Other | 7 | 6 |

[a] Includes hypertension.
*Source*: EDTA 1985/6, 1990/1.

**Table 5:** Causes of ESRF in patients accepted on to RRT in England and Wales in 1995.

| | Percentage of new patients | | |
|---|---|---|---|
| | **Under 65 ($n = 2058$)** | **Over 65 ($n = 1429$)** | **All ages ($n = 3487$)** |
| Glomerulonephritis | 14.9 | 8.9 | 12.4 |
| Pyelonephritis | 9.0 | 9.3 | 9.1 |
| Diabetes | 15.7 | 11.1 | 13.8 |
| Renal vascular disease | 4.1 | 8.2 | 5.5 |
| Hypertension | 7.5 | 8.3 | 7.8 |
| Polycystic kidney | 7.5 | 3.5 | 5.9 |
| Uncertain | 14.3 | 20.9 | 17.0 |
| Other | 13.8 | 10.7 | 12.6 |
| Missing | 13.2 | 19.2 | 15.7 |

*Source*: ref. 4.

More recent data for England and Wales from a special survey conducted in 1995/6 shows a slight rise in the proportion with diabetes to 14% (Table 5).[4]

A distinction can be made between primary renal diseases and systemic diseases with renal involvement. The prognosis is generally better for patients with primary renal diseases than for patients with systemic disease. Chronic GN and chronic pyelonephritis are the most important primary renal diseases, while hypertension and diabetes mellitus are the most important systemic causes of ESRF.

Patients on RRT have been sometimes grouped according to level or risk according to the following criteria:

| Level of risk | Age (years) and diabetes |
|---|---|
| Standard | $< 55$ non-diabetic |
| Medium | $< 55$ diabetic or 55–64 non-diabetic |
| High | $> 65$ diabetic, 55–64 diabetic |

However, newer prognostic indices are being developed which take better account of the presence and severity of co-morbidity (*see* below).

# 5 Incidence and prevalence

## Data sources

Mortality data are an unreliable source for investigating the epidemiology of renal disease as there is considerable underascertainment. The cause of death in renal failure, for example, is often ascribed to an end complication, e.g. heart failure, rather than to the underlying renal disease. Moreover, ICD coding does not reliably distinguish between acute and chronic forms of renal failure. There is, however, evidence of a substantial fall in the mortality from renal diseases over the past century, pre-dating the introduction of RRT.[14] The exact reasons for this decline are not clear, but it may partly reflect reductions in ARF, in turn arising from the decline in infectious causes, and from improvements in the management of shock and of pregnancy.

Hospital episode statistics (HES) data are likewise an unreliable measure of incidence or prevalence. First, they only relate to known cases; second, most RRT is delivered to outpatients or to patients at home; third, although there is a correlation between hospital episodes and numbers of patients on RRT, this is not direct. ICD coding lacks specificity (*see* above).

Renal registries have been set up to describe patterns of RRT, so reflect access and availability of care as well as incidence of disease.

## Renal diseases without renal failure

The epidemiology of renal diseases has been reviewed,[14,15] but further work is needed in this field.[16] There is a wide range of conditions for which specialist facilities for diagnosis and treatment might be required. The Renal Association estimates that there are at least 250 referrals pmp requiring a nephrological opinion per year and 400–800 pmp attending for follow-up (excluding chronic dialysis and transplant patients).[17] Further population-based studies of the epidemiology of renal diseases are required.

## Acute renal failure

There is no accepted epidemiological definition of ARF. Two population-based studies have been carried out in Britain. Feest *et al.*[18] considered patients to have ARF if the serum creatinine rose above 500 $\mu$mol/l for the first time and either (i) returned below that level and remained there, or (ii) the patient died in the acute illness and the history or postmortem findings confirmed a diagnosis of ARF. Khan *et al.*[19] included patients in whom the serum creatinine rose above 300 $\mu$mol/l for the first time and either (i) the serum creatinine returned to below that level and remained there, or (ii) the patient died and the clinical features were suggestive of an acute deterioration.

Patients in both of these studies who remained dialysis dependent for more than 90 days were considered to have CRF. For patients presenting in renal failure for the first time, the distinction between acute and chronic renal failure may be difficult but it is now recognised that about 17% of patients with ARF may not recover renal function[8] and these may be described as having acute irreversible renal failure.[20]

### *Incidence of ARF*

Results from the studies by Feest *et al.*[18] and Khan *et al.*[19] are shown in Table 6 overleaf. The overall annual incidence of ARF in the study of Feest *et al.* was 140 per million total population. Khan *et al.* found that the overall incidence of ARF with creatinine > 500 $\mu$mol/l, after excluding patients with cancer and those over 80 years of age, was 102 per million. Both studies showed a substantial increase in the incidence of ARF with age, but for comparable age groups the more recent study by Khan *et al.* showed incidence rates that were four to five times higher than those documented by Feest *et al.* While these two estimates are in reasonable agreement, detailed comparison of the two studies serves to emphasise the magnitude of

**Table 6:** Incidence of acute renal failure according to age.

| Feest *et al.*[18] | | | Khan *et al.*[19] | | |
|---|---|---|---|---|---|
| **Age group (years)** | **No. cases (pmp)** | **Annual incidence** | **Age group (years)** | **No. cases (pmp)** | **Annual incidence** |
| 16–49 | 7 | 17 | 0–19 | 4 | 30 |
| 50–59 | 8 | 83 | 20–49 | 46 | 157 |
| 60–69 | 20 | 186 | 50–69 | 86 | 834 |
| 70–79 | 53 | 660 | 70–79 | 76 | 2,694 |
| 80–89 | 35 | 949 | > 80 | 98 | 5,188 |
| > 89 | 2 | – | | | |

variations which may arise as a result of different case definitions, different populations and differing patterns of clinical activity. There are several obvious differences between the studies:

- Khan *et al.* used a lower threshold value for serum creatinine (300 rather than 500 $\mu$mol/l).
- Feest *et al.* excluded patients with obvious terminal illnesses such as cancer but Khan *et al.* found that differences between the studies were substantial even after excluding cases with cancer.
- Feest *et al.* did not attempt to include resident subjects who developed ARF outside the district. For example, they noted that patients were referred out of the district for cardiothoracic surgery.
- Khan *et al.* studied a population in the north of Scotland while Feest *et al.* studied a population in southwest England.

## Chronic and end-stage renal failure

As with ARF, the incidence of CRF in the population has been investigated by using a raised serum creatinine as a marker, as creatinine is measured as part of a routine urea and electrolytes test. This is a specific marker of renal failure, which is sensitive to moderate to severe renal failure, creatinine rising above the normal range when 60–70% of renal function is lost.

A population-based study in the Grampian Region showed that the incidence of CRF (creatinine > 300 $\mu$mol/l) was 450 pmp.[21] There was a steep age gradient; the gender difference was not reported. A study using Southampton and South West Hampshire Health Authority as the population base has shown that in 1992–94, the incidence of new diagnosis of CRF (creatinine > 150 $\mu$mol/l) was 1625 pmp (CI: 1540–1716), and there was a steep age gradient.

The incidence of ESRF in a district population determines the number of new cases that could be accepted for RRT. The prevalence of ESRF is almost the same as the prevalence of patients receiving RRT ('stock') because untreated survival is poor.

The incidence of ESRF (based on routine creatinine results over 500 $\mu$mol/l) has been defined by studies undertaken in Devon and the Northwest by Feest *et al.*,[18] and in Grampian by Khan *et al.*[21,22] These two studies gave results which showed that:

The incidence of ESRF was 148 pmp per annum in the Feest study and 130 pmp in the Khan study.

The incidence of ESRF will vary by district depending on the population age distribution and ethnic composition, and according to indicators of social deprivation.

### ESRF and age

The incidence of ESRF increases with age (Table 7) but because of the small numbers of cases in these studies the confidence limits of the age-specific incidence rates are wide.

**Table 7:** Age-specific incidence rates for end-stage renal disease.

| Age group | Annual incidence rate per million population (95% CI) |
|---|---|
| 0–20 | 6 (−2–14) |
| 20–49 | 58 (38–78) |
| 50–59 | 160 (96–224) |
| 60–69 | 282 (197–367) |
| 70–79 | 503 (370–636) |
| $\geq 80$ | 588 (422–754) |

*Source*: ref. 22.

### ESRF and ethnicity

Ethnicity is an important influence on the incidence of ESRF. Two ethnic groups require separate consideration: people of African or African-Caribbean (AAC) origin and people of Indian subcontinent descent (Indo-Asians). In the USA, the acceptance rate of African Americans (AA) on to RRT is four to five times higher than for whites.[23–25] Rates of all renal diseases except polycystic disease are higher in AA than in white populations. Although the prevalence and severity of hypertension is greater in AA populations than in whites in the USA, this does not explain the increased acceptance rates, nor does correction for educational level or access to medical care.[26] Similar findings apply to ESRF from diabetes in AA populations in the USA.[27]

Although direct extrapolation to AAC communities in the UK is not appropriate, there is evidence that there is higher mortality from cerebrovascular and hypertensive disease[28] and a higher prevalence of hypertension[29,30] among AAC populations than white populations in the UK.

Recent work for the 1993 National Renal Review in England found that population-based ethnic-specific acceptance and stock rates in England were almost three times higher in AAC populations than white populations (Table 8)[31] and the rate ratio increased with age.

**Table 8:** Ethnic rates of renal replacement therapy acceptances (1991–92) in England.

| | White | | Indo-Asian | | African-Caribbean | |
|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female |
| Number of cases per annum | 3,063 | 1,871 | 262 | 178 | 161 | 111 |
| Rate per million population | 90 | 50 | 281 | 196 | 272 | 172 |
| Relative rate | 1.0 | 1.0 | 3.1 | 3.9 | 3.0 | 3.4 |

*Source*: ref. 31.

The National Renal Review found that acceptance and stock rates were likewise higher for Indo-Asians, which in part may be due to higher rates of diabetic ESRF. People of Indian subcontinent descent are known to have a higher prevalence and mortality from diabetes.[32] A study in Leicester found that the rate of acceptance from diabetic ESRF was ten times higher in Indo-Asians compared with whites.[33] The relative rate was even higher when diabetic populations were compared, suggesting that Indo-Asian people with diabetes are more susceptible to renal damage.[34] In the National Renal Review, there was a five- to sixfold higher acceptance rate for diabetic ESRF in both African-Caribbean and Indo-Asian populations compared with whites, and for uncertain cause among Indo-Asians.[31]

The National Renal Review findings were confounded by access to renal units. Multilevel modelling of the data on the characteristics and location of all patients accepted on to RRT in England in 1991–92, demonstrated the independent effects of ethnicity (population levels of Indo-Asians and African-Caribbeans) on acceptance rates, after controlling for access to renal units – indirect evidence of increased population need for RRT in these ethnic groups.[6]

The increased acceptance rates among ethnic minority populations does not rule out inequality in access to services. Population-based data are needed on the epidemiology of CRF in ethnic minorities.

Ethnic minority populations are much younger than white populations. The implication is that as these populations age there will be an increased need; this will be disproportionate because of the age-related increases in relative rates. Age-standardised acceptance rate ratios using the 1991–92 acceptance data were 90 for whites, 422 for Asians and 374 for African-Caribbeans.[31] It has been estimated that the need for RRT in Greater London will grow at 25–33% between 1991 and 2011 due to ageing of ethnic minorities despite a net loss of the white population.[35]

In summary:

- Extrapolating from RRT data, a higher incidence of ESRF is probably found among African-Caribbeans and Indo-Asians than among whites in the UK.
- Further work is needed to evaluate the incidence, aetiology and treatment of ESRF among the ethnic minorities in the UK.

### *ESRF and socioeconomic status*

Another potentially important determinant of the incidence of ESRF is socioeconomic status. The evidence for this is indirect:

- There is a strong inverse social class gradient in mortality from renal failure.[36]
- The population-based rates of creatinine over 150 $\mu$mol/l in Southampton and SW Hampshire increased in those areas with the highest Townsend deprivation index (personal communication, N Drey).
- There is evidence for socioeconomic gradients in underlying causes of ESRF, such as non-insulin-dependent diabetes, hypertension and RVD.[37]
- The modelling study above showed that area deprivation was positively associated with RRT acceptance.[6]

### *ESRF and diabetes mellitus*

ESRF is an important complication of both type I (insulin-dependent) and type II (non-insulin-dependent) diabetes mellitus (DM). As type I DM is the less common form, ESRF secondary to type II DM now predominates. Patients with type I DM usually present aged 40–50 years and may have other diabetic microvascular complications such as blindness. Patients with type II DM are usually older and often have clinical macrovascular disease. The proportion of diabetic patients accepted for RRT in England and Wales is approximately 14%. In the USA, the figure is much higher at 37%.[25] It has been suggested that the prevalence of diabetic nephropathy is lower in the UK than in North America, although there is little direct evidence to support this contention. There has been concern that the needs of people with diabetes with renal disease have not been met in the UK. This was confirmed in the 1980s by the findings of the Joint Working Party of the British Diabetic Association, the Renal Association and the Royal College of Physicians which found that one third of diabetic patients with renal disease died without receiving RRT.[38,39] Some of the deaths were considered unavoidable, but half of the patients who died were considered to have died from untreated ESRF. However, people with diabetes have been more readily accepted on to RRT in the UK in recent years. Diabetic ESRF will be greater in districts with a high prevalence of ethnic minorities. A recent report estimated that because of increasing numbers of older people in ethnic minority groups, between 1991 and 2011, the number of patients with diabetes will increase by 33.5% in African-Caribbean men, 79.4% in African Caribbean women, 83% in Indo-Asian men and 137% in Indo-Asian women.[40]

### *What is the level of population need for RRT?*

Feest *et al.*[18] estimated that the overall incidence of ESRF suitable for RRT in those aged less than 80 was 78 pmp per year (95% CI: 63–93) (22). This 'suitability' criterion excludes patients who would have a severely restricted or hospital-based existence if accepted on to RRT (e.g. those with severe vascular disease or advanced malignancy). In the Feest study, 54% of incident cases of ESRF were referred for nephrological opinion and 35% were accepted.

This is probably a minimum estimate of need because:

- It does not take into account the needs of ethnic minorities.
- The over-80s should be included, as chronological age is not a bar to treatment.
- Clinical thresholds vary, for example in Wales in 1995 the acceptance rate was 109 pmp and in several European countries with complete data acceptance rates were well over 100 pmp.[41]
- The population is ageing; population estimates predict increases between 1994 and 2011 of 15% in the 60–74 age group and 14% in over-75s.[42]

It is difficult to be precise about the level of national need for RRT, but a more realistic figure is probably an acceptance rate in the range 120–130 pmp.

At the HA level it will depend on the sociodemographic factors determining the incidence of ESRF, the most important being age and ethnic structure. Some HAs with large ethnic minorities may have rates approaching 200 pmp as these populations age.

A final point is that these rates are based on total populations, i.e. they include childhood ESRF cases and the population aged 0–15 in the denominator. The latter may have a disproportionate effect, as ESRF is rarer in children. Ideally all population rates should be age- (and sex-) standardised.

# 6 Services available

Services for the prevention, diagnosis and treatment of renal disease are provided in the primary care setting, in district hospitals, in renal satellite units (which may be on hospital sites) and in tertiary referral centres. Treatment for ESRF represents by far the most costly item of care.

## Renal disease without renal failure (general nephrology)

Diagnosis and initial management of patients with renal disease is the responsibility of GPs and physicians in district hospitals. It can be argued that most cases should be referred for nephrological opinion so that appropriate investigations and treatment can be undertaken. Such work is primarily outpatient-based and relatively high volume. Protocols are required to facilitate appropriate referral from GPs and hospital doctors (e.g. for haematuria, *see* below). In addition to routine hospital services, histopathology, specialist radiology and radioisotope imaging services may be required.

A report from the Renal Association of the United Kingdom suggests that around 250 new patients pmp population annually will require assessment for renal disease.[17] More work is needed to establish this, and the overlap with other specialties managing renal problems (e.g. urology).

## Acute renal failure

Patients with significant ARF will usually need to be referred to a specialist for diagnosis and temporary RRT, if required. Renal support is usually required for days or weeks. Patients may develop ARF in hospitals with or without nephrological expertise. Many patients with ARF are seriously ill, often with multiorgan failure, and may need high-dependency or intensive care for respiratory and/or other organ failure, and expert medical and nursing care. Ideally, nephrological opinion should be sought, but in some cases ICU staff may have the necessary expertise to manage ARF.

Little is known on a population basis of patterns or outcomes of care. It is not clear whether there is inequitable access to renal advice and dialysis support for ARF. Expansion of nephrology services in DGHs to allow expansion of RRT programmes should also improve the management of ARF. Nephrological input is also particularly important for centres with cardiothoracic surgery units because ARF is a complication of surgery for vascular disease, congenital heart disease and cardiac transplantation.

Feest *et al.* found that only 36% of patients with ARF were referred for specialist advice.[18] They suggested that a further 14% of patients might have benefited from referral to a renal specialist; this would have resulted in a referral rate of 70 pmp per year. The incidence of patients receiving dialysis was 18 pmp per year. Khan *et al.* found that only 23% of patients in their series were referred for a specialist opinion and that younger or lower-risk patients were more likely to be referred.[19] In this study, 50 patients pmp per year received dialysis for ARF.

These observational studies point to the need to develop guidelines for referral of patients with ARF and to disseminate them to doctors responsible for providing acute care in other specialities and in district hospitals. More evaluation of ARF care is needed.

## Chronic renal failure

Chronic renal failure can present insidiously with non-specific symptoms, or be detected in patients with hypertension, diabetes or urinary abnormalities. It can be diagnosed by GPs and hospital doctors by measurement of blood urea and creatinine concentrations, although repeated measurement may be required to establish chronicity in some cases. Early referral to nephrologists is desirable, since treatment of hypertension, diabetes, urinary tract infections, and obstruction and dietary modification can reduce the rate of progression of CRF, and measures can be taken to reduce the associated morbidity (e.g. renal bone disease, CVD, malnutrition).[43] The Renal Association recommends referral of all patients with a persistently raised creatinine above 150 $\mu$mol/l.[2]

Specific interventions may be of benefit in certain types of GN. A programme of management can also be planned before the patient develops ESRF requiring dialysis. Currently, 30–40% of patients present late in ESRF,[44] and a similar percentage require emergency access despite prior nephrological follow-up. Patients referred late have more associated co-morbidity and poorer survival. Moreover, initial hospitalisation is prolonged and they are more likely to end up on long-term HD (*see* section 7).

Further research is needed to define the extent to which late-referred cases could have been referred earlier and the difference in outcome this would achieve.

Most care of CRF patients can take place in outpatients. There has been a growth in the establishment of joint diabetic–nephrology clinics – this is to be welcomed as a strategy to reduce the incidence of diabetic nephropathy. There are effective evidence-based interventions to reduce the risk of nephropathy such as the use of angiotensin-converting enzyme (ACE) inhibitors in people with diabetes with hypertension and proteinuria.[45–48] Microalbuminuria testing has been recommended, as it appears to be cost-effective on modelling, but there is no formal testing programme in place.[49] Further research is needed on the cost-effectiveness of such screening.

There are also guidelines for the investigation of haematuria and proteinuria produced by the Scottish SIGN group,[50,51] though the recommendations have not necessarily been widely accepted. This is a complex area with limited long-term prognostic information. Local policies are needed to co-ordinate the respective roles of primary care, urologists and nephrologists in diagnosis and follow-up, especially in cases with microscopic haematuria.

## End-stage renal failure

End-stage renal failure is incompatible with life and RRT is required. This can either be by transplant (from live or cadaver donor), or by dialysis using an artificial membrane (HD) or the peritoneum (mainly CAPD, though APD is being increasingly used).

A renal service for patients with ESRF includes main renal unit HD, a CAPD training and support programme, home dialysis (though the numbers are falling as few new cases are started on this), a transplant programme and, increasingly, subsidiary satellite units for HD. These modalities are discussed in more detail in Appendix I. Hospital HD requires considerable infrastructure in terms of space, technology and trained staff. Care is provided by a multidisciplinary team including social workers, dietitians, pharmacists and dialysis technicians (the staffing is more fully described in the Renal Association report).[17] Renal and transplant wards are needed for undertaking transplantation, for treating related complications and unrelated co-morbid illnesses, and for establishing vascular or peritoneal access. Inpatient stays can be protracted in complicated cases. Sufficient expertise in vascular and transplant surgery are crucial, as well as theatre time.

## Renal facilities in England and Wales, 1993–95

Data on service provision are available from national reviews undertaken in 1993 and 1995.[4] Further data to 1998 will be available in 2000.

Key findings are presented in Table 9 overleaf (note station = space for a HD machine).

The number of renal units in England fell by one between 1993 and 1995, three new units opened and there were mergers in London. The size of existing units grew (Table 9). In England, there were 52% more HD stations, 8% of stations were designated 'temporary', meaning that due to lack of facilities regular outpatients were attending for HD in wards or other areas not designated for the purpose. This indicates the pressure felt by some units in coping with demand for HD. There were also more HD shifts per day.

**Table 9:** Renal unit facilities in England 1993–95 and Wales 1995.

| | England 1993 | England 1995 | Wales 1995 |
|---|---|---|---|
| Main units | | | |
| Main renal units | 52 | 51* | 5 |
| total beds | 990 | 1,105 | 59 |
| unit beds median (range) | 19 (0–43) | 20 (0–64) | 11 (0–38) |
| total HD stations | 932 | 1,423 | 97 |
| unit HD stations median (range) | 15 (3–55) | 23 (7–86) | 13 (10–35) |
| fixed stations | 743 | 832 | 65 |
| satellite stations | 189 | 472 | 28 |
| Temporary stations | N/A | 119 | 4 |
| HD shifts/week | 694 | 856 | 62 |
| unit shifts median (range) | 12 (0–31) | 18 (8–35) | 16 (12–18) |
| Satellite units | | | |
| Current satellites | 36 | 60 | 3 |
| no. main units with current satellites (range/unit) | 17 (1–6) | 30 (1–5) | 2 (1–2) |
| Planned satellites | 14 | 37 | 5 |
| no. units with planned satellites | 9 | 28 | 5 |
| no. of planned satellites where unit has no existing satellites | 5 | 8 | 1 |
| total patients in satellite units | 476 | 1,476 | 64 |
| median patients per satellite (range) | 15 (1–41) | 24 (1–68) | 32 (25–39) |
| total HD stations in satellite unit | 189 | 472 | 28 |
| median HD stations per satellite (range) | 6 (2–10) | 7 (2–31) | 8 (6–14) |

* Facilities data from 50/51 units.

The dialysis service in most main units (51/56) remained under NHS management. Continuous ambulatory peritoneal dialysis training and care was provided in 54 units.

The number of satellite units rose by 60%, with many more planned (Table 9). Thirty-three percent of all HD stations were in satellites, compared with 20% in 1993. Half of the satellite units were located on DGH sites and 19% were privately managed. Medical support varied, only four had permanent medical staff, and nine had 24-hour emergency medical cover on site. The majority (49/60), including these 13, had regular visits from consultant, staff-grade or clinical assistant nephrologists.

Consultant nephrology staffing in England increased by 22 additional posts between 1993 and 1995 and there was an increase in all grades of non-consultant medical staff. Consultant nephrologist whole time equivalents (WTE) varied by region from 1.5 to 2.6 pmp, the average for England being 2.0 pmp and 1.9 pmp in Wales.

There was geographical variation in service provision. In 1995, regional rates of HD station varied from 21 to 36 pmp, the English rate being 29 pmp, and the Welsh 33 pmp. These compare with 1993, when the variation in the old regional rates was from five to 29 stations pmp, with a national rate of 20 pmp.

There was one transplant centre in Wales and 24 in England compared with 29 in 1993. The reduction was largely due to reorganisation in London. There were 0.5 WTE transplant surgeons pmp.

The number of renal units per capita in England (1995 rate of about 2.2 pmp including satellites) is low compared with other Western European countries (*see* Table 10 overleaf).

**Table 10:** Renal centres known to EDTA-ERA Registry in 1994.

| Country | Known centres | Known centres (pmp) |
|---|---|---|
| Austria | 47 | 5.9 |
| Belgium | 61 | 6.0 |
| Denmark | 14 | 2.7 |
| Finland | 26 | 5.1 |
| France | 271 | 4.7 |
| Germany | 566 | 7.0 |
| Greece | 82 | 7.9 |
| Ireland | 5 | 1.4 |
| Italy | 649 | 11.3 |
| Luxembourg | 5 | 12.5 |
| Netherlands | 52 | 3.4 |
| Norway | 20 | 4.6 |
| Portugal | 67 | 6.8 |
| Spain | 227 | 5.8 |
| Sweden | 64 | 7.3 |
| Switzerland | 46 | 6.6 |
| United Kingdom | 84 | 1.4* |

* There is a difference between the estimates of renal centres pmp given in Table 10 and in the main text. The estimate in Table 10 covers the UK, as opposed to England, and the data were provided by the EDTA register, as opposed to national reviews in 1993 and 1995. The latter data source is probably the most reliable.
*Source*: ref. 41.

### *Processes of care*

The use of better-quality process measures, many recommended by the Renal Association's Standards document,[2] increased during this period, particularly use of bicarbonate HD, thrice-weekly HD and disconnect CAPD systems, although there was wide variation between units (*see* Figure 2 overleaf). Twenty five percent of units used synthetic HD membranes. There was lower usage in Wales for each of these measures. The proportion of dialysis patients on HD increased from 43 to 50%, with considerable inter-unit variation (27–100% in 1995).

### *Characteristics of patients*

The age distribution for patients accepted in 1995 is shown in Figure 3 overleaf. The median age of new acceptances in England was 61 compared with 59 in 1991–92, and 41% were over 65 compared with 37% in 1991–92. In Wales, the median age was 60, with 40% over 65. In both countries, 13% were over age 75. The male:female ratio was 1.58 in England and 1.55 in Wales, compared with 1.71 in England in 1991–92. The main single cause of ESRF was diabetes (14%), but in 17% the cause was defined as 'unknown' (Table 5). Patterns differed by age, with a greater proportion being unknown in the old; the contribution of RVD in the older individuals should be noted. Renal units varied considerably in their case-mix, as indicated by the age distribution and proportion with diabetic nephropathy.

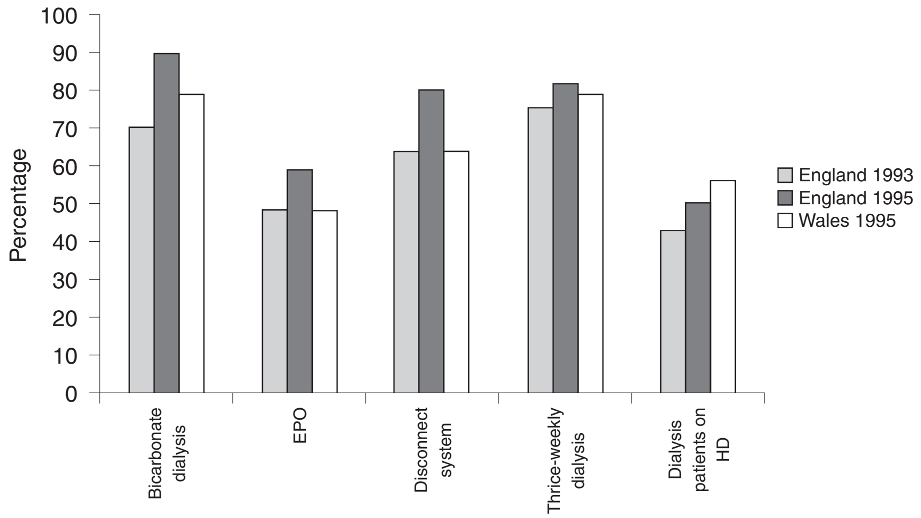


**Figure 2:** Percentage of patients on selected treatments in England (1993, 1995) and Wales (1995).

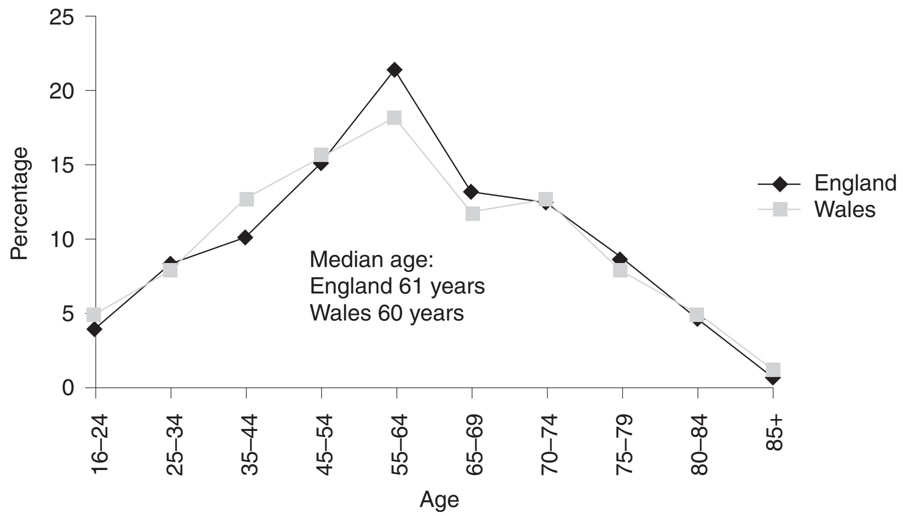


**Figure 3:** Age distribution for patients accepted on to RRT in England and Wales in 1995.

## *Constraining factors*

Renal unit directors were asked about potential constraints on the development of their dialysis programme. The most common responses were the level of funding, physical space and shortage of trained nurses (76%, 80% and 70% of units respectively). Only 22% of units found medical staff availability to be a constraint.

### *What are current patterns of acceptance rate – is need being met?*

During the 1980s acceptance rates rose from 20 pmp in 1982 to reach 60 pmp by 1990. Unfortunately the completeness of the EDTA resister has fallen in the past decade and it is no longer a reliable source of data on RRT rates in the UK.

This highlights the need for national surveys until the developing UK Renal Register approaches complete coverage.

The annual acceptance rate in England rose from 67 (65–70) pmp ($n = 3247$) in 1991/2 to 82 (80–85) pmp ($n = 4024$) in 1995. Annual increases were 9, 5 and 10% respectively (Figure 4). The Welsh rate was significantly higher at 109 (98–122) pmp in 1995. Regional acceptance rates in 1995, uncorrected for cross-boundary flows, varied from 64 to 105 pmp. It is clear then that there has been a continued rise in acceptances, largely due to liberalisation of referral to nephrologists rather than changing acceptance policies or rising incidence of ESRF. Nevertheless, this rate in England is below estimates of need. The types of patients being accepted have changed dramatically, in 1982–84 only 11% were over 65 and 8% were diabetic, by 1995 these figures were 41% and 14% respectively. There is still unmet need which is greater in the old – age- and sex-specific acceptance rates are still lower than the gradients of incidence found by Feest *et al.*[18] Khan *et al.*[19] showed that age and co-morbidity were significant determinants not only of survival but also of referral to nephrologists.[52] Significant regional variation in supply and in acceptance rates persists, which is a key issue for the specialist services commissioning groups.

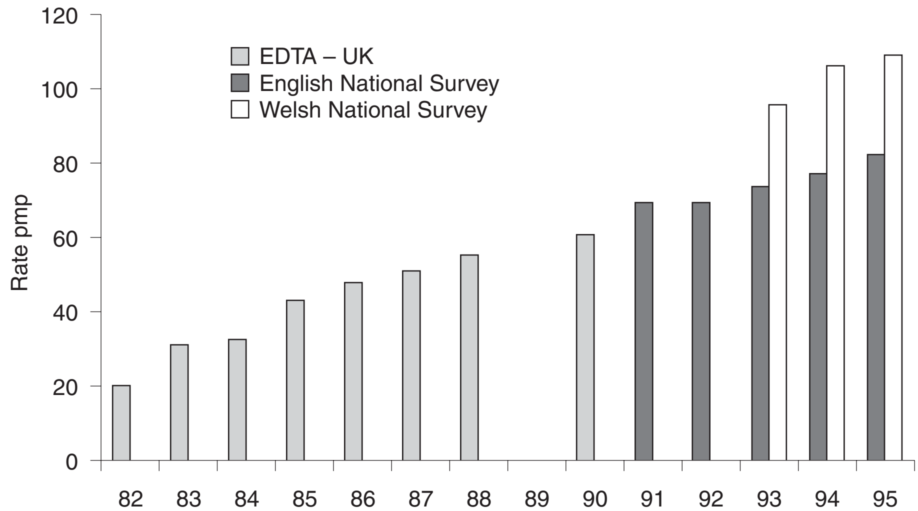


**Figure 4:** Acceptance rates pmp in the UK 1982–90, England 1991–95 and Wales 1993–95.

### *Prevalent patients on RRT – 'the stock'*

The prevalence of patients in England increased from 396 pmp ($n = 19\,212$) in 1993 to 476 pmp ($n = 23\,115$) in 1995, and it was 487 pmp ($n = 1560$) in Wales. In England, this was largely facilitated by expansion of hospital HD patients and an increase in patients with functioning grafts; PD numbers rose less and home HD declined by 11% (Figure 5 overleaf).

Acceptance for treatment levels of 80 new patients pmp population will lead to much higher levels of patient stock. Eventual 'steady-state' stock levels of 800 patients pmp population have been predicted (*see* section 8). Even if current acceptance rates remain unchanged, further rises in patient stock are likely

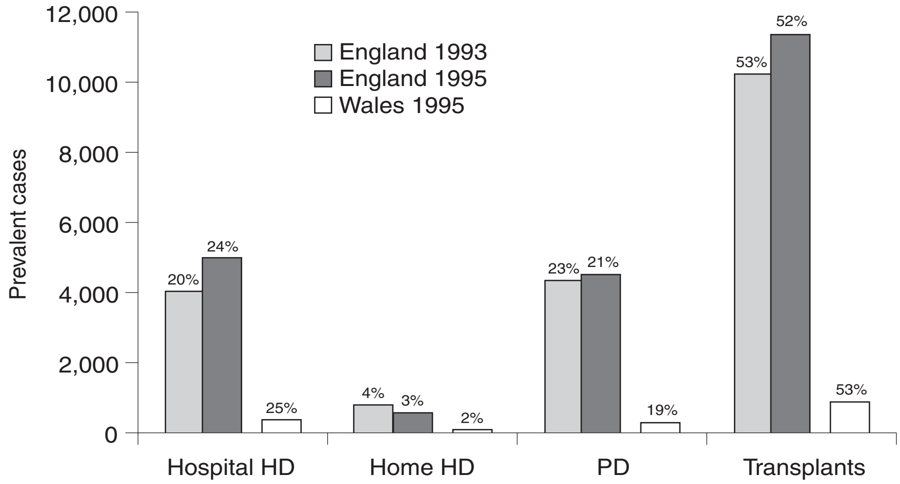


**Figure 5:** Modalities of treatment for prevalent cases in England (1993, 1995) and Wales (1995).

because the 'steady-state' (when the number of patients entering and leaving the RRT process balance) has not yet been reached. The UK stock rate is low by European standards and there is considerable inter-regional variation.

## *Modalities of RRT*

UK prevalence rates are increasing. The pattern has been to shift from PD to HD. There are considerable international differences in the use of different modalities of RRT. The UK differs from most European countries in its high proportion of patients on CAPD and transplantation (Table 11). Hospital HD accounted for only 24% of patients treated in 1995 in the UK but for over two-thirds in, for example, Italy and West Germany.[41] The CAPD proportion in the UK is the highest in Europe and the transplant proportion is only exceeded by a few countries, e.g. Norway.

The method of funding health care may be a major reason why there are differences between countries in their use of treatments. In the UK, centres have had to function within a fixed financial budget growth, meaning that expansion in caseload could often only be achieved by making more intensive use of existing funds. This has led to its greater use of lower-cost domiciliary treatments such as CAPD, and to transplantation. Renal units were also encouraged to transfer the costs of CAPD fluid to GPs, although this option is not available now. The method of funding services has also contributed to the UK's low geographic dispersion of hospital and specialist services. Availability of skilled staff has also limited the spread of renal units.[4]

It has also been argued that the geographic dispersion of renal units limits the choices regarding the types of treatment offered to individual patients, and means that some have to be assigned to suboptimal treatments. It has been claimed that some patients who should ideally be treated by hospital HD are assigned to CAPD. Distance may make it impossible for patients to travel to centres for hospital HD on a regular basis, hence constraining them to have PD unless there is a satellite unit nearby.

In addition to international differences, there are also differences in the methods of treatment used among the UK units, only part of which can be explained by differences in case-mix between centres. Other factors include past investment decisions, available facilities and resources, and clinical preferences. For example, in England and Wales, the proportion of dialysis patients on HD within units varied from 27 to 100% with a mean of 50%.[4]

**Table 11:** New patients accepted for RRT in 1994 in a sample of European countries (source EDTA-ERA registry).

| Country | Haemodialysis | | Peritoneal dialysis | | Graft | | Total* | |
|---|---|---|---|---|---|---|---|---|
| | *n* | pmp | *n* | pmp | *n* | pmp | *n* | pmp |
| Austria | 743 | 92.8 | 60 | 7.5 | 6 | 0.7 | 848 | 106.0 |
| Belgium | 1,128 | 111.7 | 100 | 9.9 | 106 | 10.5 | 1,334 | 132.1 |
| Denmark | 264 | 50.8 | 152 | 29.2 | 29 | 5.6 | 445 | 85.6 |
| Finland | 0 | 0 | 11 | 2.2 | 0 | 0 | 306 | 60.0 |
| France | 3,238 | 55.8 | 560 | 9.6 | 256 | 4.4 | 4,054 | 69.9 |
| Germany | 6,247 | 76.9 | 539 | 6.6 | 514 | 6.3 | 10,170 | 125.2 |
| Greece | 854 | 82.1 | 185 | 17.8 | 32 | 3.1 | 1,071 | 103.0 |
| Ireland | 140 | 38.9 | 67 | 18.6 | 1 | 0.3 | 208 | 57.8 |
| Italy | 3,205 | 56.0 | 709 | 12.4 | 176 | 3.0 | 4,090 | 71.5 |
| Luxembourg | 29 | 72.5 | 1 | 2.5 | 0 | 0 | 30 | 75.0 |
| Netherlands | 895 | 58.1 | 369 | 24.0 | 23 | 1.5 | 1,287 | 83.6 |
| Norway | 218 | 50.7 | 40 | 9.3 | 44 | 10.2 | 302 | 70.2 |
| Portugal | 622 | 62.8 | 12 | 1.2 | 98 | 9.9 | 971 | 98.1 |
| Spain | 2,249 | 57.4 | 349 | 8.9 | 124 | 3.2 | 3,137 | 80.0 |
| Sweden | 618 | 70.2 | 341 | 27.4 | 35 | 4.0 | 894 | 101.6 |
| Switzerland | 456 | 65.1 | 117 | 16.7 | 12 | 1.7 | 585 | 83.6 |
| United Kingdom | 1,885 | 32.3 | 1,356 | 23.2 | 54 | 0.9 | 3,295 | 56.4* |

* There are differences between the figures given in Table 11 and those given in the main text. The estimates in Table 11 cover the UK, as opposed to England, and the data were provided by the EDTA Register, as opposed to national reviews. The latter data source is probably the most reliable.
*Source*: ref. 41.

### *Survival trends*

For all modalities there have been marked improvements in survival in the past decade, particularly after transplantation, despite the increasing proportions of older individuals and 'high-risk' patients.[4] In general, 50% of patients in Europe on RRT are alive after 10 years and 40% after 15 years. 'Standard-risk' patients (i.e. those under 55 years without diabetes or other coincidental diseases) can expect a 94% survival to year one and an average life expectancy of 14.3 years thereafter (Table 12).

**Table 12:** Average life expectancy on RRT by risk group.*

| | Standard risk | Medium risk | High risk |
|---|---|---|---|
| All modalities | | | |
| 1-year survival (%) | 94 | 83 | 77 |
| life expectancy at 1 year (years) | 14.3 | 8.6 | 3.5 |
| Successful transplant | 12.7 | 11.1 | Not applicable |

* Standard = < 55 years, non-diabetic; medium = < 55 years diabetic, 55–64 years non-diabetic; high = > 65 years diabetic, 55–64 years diabetic.
*Source*: National Renal Review.

Newer indices have taken into account the presence and severity of co-morbidity.[52,53] New survival data will be available from the UK Registry as numbers and follow-up increases[54] and from an ongoing survey of trends in survival.

The US RDS 1997 report gives life expectancy for patients commencing RRT (actually at day 90) at different ages by age, sex and ethnicity, compared with the general population. Presented below are the figures for US whites, using 1990 national data and 1996 USRDS data.[25]

Years of life expected:

| Age group | RRT males | RRT females | Gen pop males | Gen pop females |
|---|---|---|---|---|
| 35–39 | 12.4 | 11.9 | 40.0 | 45.6 |
| 50–54 | 6.8 | 6.6 | 26.5 | 31.5 |
| 65–69 | 3.4 | 3.4 | 15.2 | 18.9 |
| 80–84 | 2.0 | 2.0 | 7.0 | 8.8 |

Key findings are that adult RRT patients have only 20–35% of the life expectancy of the general population. The gender difference in the general population is all but lost. Not shown is the improved survival of transplanted patients. In the 1998 UK Registry report, survival databased in four units (458 patients) showed a mortality rate of 21/100 person years; this was considerably greater in those over 65 (39/100 versus 9.7/100).[54] Current research is underway to determine time trends in mortality on RRT in the UK.

The best patient survival rates are reported following transplantation, but these patients are highly selected. Graft survival is influenced by the type of donor (live versus cadaveric), the tissue typing match, the type of immunosuppression and the underlying cause of the renal disease (e.g. patients with diabetes have poorer survival).

The UK Transplant Services Support Authority (UKTSSA) Audit evaluated transplantation from 1981 to 1991 in the UK. The following survivals were found (graft survival was taken as survival to death or to loss of the graft).[55]

| | Graft | Patient |
|---|---|---|
| 1 year | 78 | 91 |
| 5 year | 64 | 73 |
| 10 year | 50 | 50 |

For regrafts the one-year graft survival was slightly lower at 71%.

The factors affecting one-year rates were studied using multivariate analysis. The main factor affecting graft survival was HLA mismatch; donor age $> 55$, and 'imported' kidneys (i.e. from another unit) (after adjusting for other factors) were also significant. There was evidence of improving graft and patient survival over this period.

## *Costs of RRT*

Renal replacement therapy is expensive relative to other health interventions. Although RRT services consume only around 1% of the NHS budget[3] these funds are spent on a disproportionately small number of patients. When the predicted rise in RRT stock levels has levelled it has been estimated that RRT services will consume between 2 and 4% of the NHS budget, but patients receiving RRT will only account for 0.08% of NHS.[3]

Table 13 includes data from publications that have estimated the annual costs of maintaining a patient on RRT. Where appropriate, the costs in the original papers have been converted to a common price base of 1998 using data on annual pay and price inflation in hospital and community health services. In general, the costs include items directly associated with the treatment modality, such as erythropoietin (EPO) and cyclosporin, and an allowance for the 'knock-on' costs of complications and co-morbidities linked to treatment with the various modalities.

**Table 13:** Annual costs of care by treatment modality.

| **Source** | **Annual costs (£) (at 1998 prices)** | | | |
|---|---|---|---|---|
| | **Hospital HD (£)** | **Home HD (£)** | **CAPD (£)** | **Transplant (£): (a) Operation (b) Maintenance** |
| West[56] | 25,230 | 16,790 | 19,850 | (a) 15,270<br>(b) 4,580 |
| Bolger and Davies[57] | 27,550 | 13,780 (year 1)<br>11,350 (after) | 10,330 (year 1)<br>9,820 (after) | (a) 17,090<br>(b) 3,950 |
| Mallick[3] | NA | NA | NA | (a) 14,800<br>(b) 5,100 |
| Krupa *et al.*[58] | 28,450 | 18,390 | 19,250 | NA |
| NHS Exec[1] | 31,520 | 25,530 | 18,930 | (a) 12,550<br>(b) 5,840 |
| North Thames[59] (patients aged 70 and over) | 20,700 | NA | 15,100 | NA |
| MacLeod *et al.*[60] | NA | NA | 13,900 | NA |

NA = not available.

The costs derived by Bolger and Davies[57] and by Krupa *et al.*[58] were based on studies of individual renal units, those derived by the NHS Executive[1] on a study of two units based in large teaching hospitals, and those derived by North Thames on a study of four renal units.[59] The costs of Mallick[3] were based on a survey of all renal units in England. Finally those quoted by Macleod *et al.*[60] were based on a systematic review of the literature.

In addition to the costs given in Table 13, the North Thames study[59] estimated that the annual costs of maintaining an older patient on APD were £24 100.

Mallick[3] argued that in practice, it is difficult to separate the costs of the different methods of dialysis. Instead he gave a cost of £26 800 at 1998 prices, this being the average across all dialysis modalities. He also argued that because patients can switch between therapies it is more meaningful to link costs to patients rather than modalities. In his publication, the costs of maintaining a patient on RRT for three years were estimated as ranging from £31 900 to £95 700 (at 1998 prices), for five years from £38 300 to £153 100, and for ten years from £76 500 to £267 900. The wide ranges in costs were linked to the assumed rate at which patients changed modalities and to the assumed rates of occurrence of patient morbidity and complications.

Health authorities should only use the above costs as a guide when estimating the costs of care in their local unit. For the estimates in Table 13, there is variation in both the annual costs of modalities and in their relative costliness, although hospital HD is always the most expensive.

Variations in the costs of care in different renal units can be due to variations in the methods that they use to derive costs by modality and in the elements that they cover. In the North Thames study,[59] annual cost estimates covered care provided by GPs, district nurses and social services. These items were only found to account for 2.9% of annual costs.

Assumptions about the use of expensive medications, such as EPO, also affect cost estimates by modality. In the North Thames study, use of EPO accounted for 91% of the costs of medications (mean annual costs per patient £3100), and 53% of dialysis patients received EPO. Unpublished source material for the Renal Purchasing Guidelines[1] suggests that 70% is a more appropriate value for the percentage of dialysis patients who should receive EPO.

In addition, cost estimates by modality are affected by assumptions relating to the rates of occurrence of treatment complications and co-morbidities, with peritonitis being an example of one of the most expensive. The review by Macleod *et al.*[60] estimated that an episode of peritonitis costs £2000.

Satellite unit costs are not available in the literature. These will vary as their structure, process and patient case-mix is heterogeneous (*see* above).

In practice, HAs and trusts should derive their own estimates of the costs of local renal services. To support them in this task they should refer to the costing templates detailed in the paper by Mallick[3] and in the Renal Purchasing Guidelines.[1] These templates will help them to identify the important elements that should be covered when deriving the costs of local care.

# 7 Effectiveness of services

The evidence base for renal services should improve as there is now a Cochrane Renal Review Group, which is undertaking systematic reviews of the evidence using the Cochrane Collaboration methods. The Group was established in March 1997 and has its base in Lyon France. A list of ongoing work is shown in Appendix II. However, more RCTs are needed in nephrology, and small numbers of patients mean that multicentre studies are usually required.

Within the UK, the Renal Association has a standing group responsible for the development and implementation of standards of care. The standards recommended are based on existing evidence where possible.[2]

The NHS R&D programme has funded completed reviews in dialysis – namely bicarbonate versus acetate fluid in HD, disconnect catheters, CAPD versus HD, frequency of dialysis, type of dialysis membrane and re-use of dialyser.[60]

The Renal Association Clinical Trials Group is co-ordinating multicentre trials into many aspects of renal disease. Initial trials include CVD prevention using aspirin and simvastatin in CRF and RRT patients, and immunosuppressive treatment of membranous GN. Not all areas of care are amenable to RCT and evaluating dialysis patients is particularly difficult as dialysis care is a multifaceted intervention with multiple, often interdependent, effects especially on pathophysiological measures.

## Effectiveness of services for preventing renal disease

A major problem with understanding the aetiology and hence potential for primary and secondary prevention of chronic renal disease is the lack of early markers of renal impairment which can be used in large studies.

The incidence of renal failure could be reduced by the primary and secondary prevention of diabetes and hypertension and their complications, and possibly by better management of reflux nephrology in children and urinary obstruction in older men.

While hypertension and diabetes each contribute to the risk of developing ESRF, they are also important risk factors for the much more common coronary heart disease and stroke. For this reason, national health strategy targets for reducing deaths from coronary heart disease and stroke are also relevant to the prevention of end-stage renal disease (ESRD). This has been recognised in guidelines for the control of hypertension.[61]

More effective diagnosis and treatment of diabetes and hypertension will have some impact in the long term but this is unlikely to be substantial in the short term.

### *Hypertension (quality of evidence: I)*

Hypertension is mainly primary ('essential') but it can also be secondary to both renal and non-renal diseases. There is no doubt that the control of severe and malignant hypertension can prevent the development of end-organ damage, including renal failure. The relationship of mild and moderate hypertension to ESRF is less clear. Observational data from the MRFIT study in the USA suggest that control of hypertension would reduce ESRF.[62] The US National High Blood Pressure Education Working Group concluded that the aim should be for a BP below 140/90 and this target should be lower for high-risk groups, namely people with diabetes, blacks and those with CRF.[63]

Primary prevention population strategies to reduce hypertension include lower consumption of salt, and reduction in body weight and alcohol intake. Detection and management of hypertension is primarily undertaken by GPs. GPs require guidelines on the investigation and management of hypertension with input from nephrologists particularly about the investigation of renal disease in patients with hypertension.

### *Diabetes mellitus*

#### Type I diabetes mellitus (quality of evidence: I*)*

The Diabetes Control and Complications Trial (DCCT) studied the effect of intensive control of blood glucose in type I diabetes on the development of microalbuminuria as a surrogate marker of renal involvement. This study showed that intensive insulin therapy reduced the occurrence of microalbuminuria (urinary albumin excretion of = 40 mg per 24 hours) by 39% (95% CI: 21–52%) and albuminuria (= 300 mg per 24 hours) by 54% (95% CI: 19–74%). The study provided evidence that intensive insulin treatment can reduce the onset and progression of nephropathy in insulin-dependent diabetes (IDDM).[64]

There is evidence that the rate of progression of diabetic nephropathy in IDDM can be reduced by control of hypertension and that this may lead to reduced mortality.[46] Moreover in short-term studies antihypertensives reduce the progression of microalbuminuria (the precursor stage before actual nephropathy). Reduction of other cardiovascular risk factors is important in improving the survival of people with diabetes.

ACE inhibitors have been shown to be particularly efficacious in the management of hypertension in diabetic patients and in diabetic patients with proteinuria without hypertension. They appear to reduce proteinuria independently of their effect on BP.[47,48]

It has been argued that screening for microalbuminuria and intensive BP treatment may be used to prevent ESRD in type I diabetes.[49]

**Type II diabetes mellitus (quality of evidence: I)**

Prevention of diabetes presents potentially the most productive strategy for the prevention of ESRD from diabetes. Observational studies suggest type II diabetes may be preventable by measures to reduce obesity and enhance exercise participation.[65] A large cluster randomised study in China, showed that intervention by means of diet and exercise could reduce the progression of impaired glucose tolerance to DM.[66] Another prevention study is currently underway in the USA.[67]

Recently reported results from the United Kingdom Prospective Diabetes Study analysed the effects of intensive blood glucose control and tight BP control on the occurrence of complications in type II diabetes. Over ten years the haemoglobin A1c was 0.9% lower in the intensively treated group and this was associated with a 12% (1–21%) lower risk of diabetes-related events. The study did not have sufficient statistical power to detect a change in the occurrence of renal failure, but at nine and 12 years the occurrence of microalbuminuria was reduced by approximately one third in the intensively treated group.[68] The effect of tight BP control was to reduce diabetes-related end-points by 24% (8–38%) and deaths related to diabetes by 32% (6–51%). Subjects in the tight BP control group had a 29% (1–49%) reduction in risk of microalbuminuria at six years.[69]

Overall, the results of the UKPDS suggest that intensive blood glucose control may reduce diabetic microvascular disease while hypertension control reduces both microvascular and macrovascular disease.

### *Treatment of urinary tract infection/reflux nephropathy (quality of evidence: II-2)*

Urinary tract infections in childhood secondary to urinary reflux are associated with a risk of permanent renal damage.[70] Although it is not possible, even with optimal management, to prevent renal scars after urinary tract infection in all children, failure to investigate urinary tract infections and arrange appropriate follow-up and prophylactic antibiotics does appear to contribute to avoidable renal damage in some cases.[71] These deficiencies are not confined to general practice but also occur in hospital. There is no evidence on the cost-effectiveness of screening for reflux; this would have to be undertaken in the neonatal period.

### *Treatment of urinary tract obstruction (quality of evidence: III)*

Three to five percent of ESRF in patients over the age of 65 is due to acquired urinary tract obstruction. End-stage renal failure secondary to urinary tract obstruction is preventable if cases are treated early and the obstruction relieved.[72] A retrospective audit of older male patients presenting with ESRF due to prostatic outflow obstruction identified delays in referral for assessment of renal function in patients with untreated prostatism.[72] The symptoms and clinical size of the prostate did not correlate with the degree of obstruction. Earlier detection of impaired renal function in men with untreated prostatism and closer follow-up of patients with impaired renal function at the time of prostatectomy could avert, in part, progressive nephropathy requiring eventual long-term dialysis.

### *Other causes of CRF (quality of evidence: variable IV to I)*

The scope for the prevention of renal failure secondary to other causes (e.g. GN) requires further study. Some forms, such as rapidly progressive GN benefit from aggressive immunosuppression, in other forms the balance of risk and benefit is less clear. There is not space to review the evidence for each type of GN, suffice to say more RCTs are needed.

There are consensus guidelines from the Scottish SIGN group on management of proteinuria and haematuria.[50,51] Neither recommend screening for these abnormalities.

### *Prevention of ARF (quality of evidence: III)*

In cases of ARF acquired in hospital, there is some evidence of avoidable factors in the management of cases that contribute to the incidence of the condition,[73] such as the use of nephrotoxic drugs and the development of postoperative shock. The scope for prevention requires further research.

## Effectiveness of services for diagnosing and treating renal disease

### *Acute renal failure (quality of evidence: III)*

Mortality from ARF reflects the severity of the condition and overall is between 50 and 60% at one year.[74,75] It is greater if there is multiorgan failure, especially hepatic failure. The recent study by Feest *et al.* found that age per se was not a prognostic factor, and survival was better for cases secondary to prostatic obstruction.[18] Survival was at two years 34%, similar to Khan's study (30%).[19] In the absence of hospital dialysis, mortality in severe cases would be virtually certain.[74] There has been a progressive though not especially marked improvement in survival after ARF in the past 35 years, despite an increase in the proportion of older patients with complicated medical and surgical conditions.[75]

The prognosis of uncomplicated ARF in young adults has been good ever since the advent of adequate dialysis. Subsequent changes in dialysis technology appear to have made little difference to survival in this group. Improvements in prognosis have occurred in the management of complicated ARF predominantly in older patients. Recent studies have suggested that dialysis using biocompatible membranes may result in a better outcome. In the main, improvements in prognosis have been brought about not by dialysis alone, which nonetheless remains a prerequisite for recovery, but by attending to the precipitating causes of the episode of ARF and to the related complications. In some cases, recovery is not complete, and long-term follow-up may be required; this is especially true in older individuals.[8]

Many patients with ARF will be managed in ICUs and in this clinical setting the APACHE score is of value for prognostic stratification.[76]

### *Secondary prevention of CRF progression (quality of evidence: I–III)*

The main approaches have been control of hypertension and the use of low-protein diets. Systematic reviews of low-protein diets has demonstrated the beneficial effect in terms of progression of renal disease to ESRF in non-diabetics, and in reducing decline in creatinine clearance in people with diabetes.[77,78] There is debate over the appropriate level and how to ensure patient compliance. The evidence for control of hypertension is less robust, but the Renal Association recommends a target BP of $< 140/90$ for age $< 60$ and $< 160/90$ for those over 60.[2] ACE inhibitors may have a particular role if proteinuria is present.[47]

Renovascular disease (predominantly due to atherosclerotic narrowing of the renal arteries) is an increasingly common cause of ESRF, but the appropriate management of those with CRF and underlying

RVD is uncertain – trials are needed to compare conservative medical treatment with angioplasty and stenting. Guidelines are needed on the appropriate diagnostic and interventional pathways.

Early referral to renal units is recommended by the Renal Association. Despite this, up to 40% of patients requiring dialysis are referred within four months of starting RRT.[44] In some cases this is inevitable because of the insidious nature, so that symptoms do not occur until late, and some patients have rapidly progressive forms of renal failure. However, there are patients whose referral is clearly delayed.

The benefits of early referral include establishing an underlying diagnosis (some of which respond to specific treatments), better control of hypertension, judicious use of low-protein diet, reduction in the complications of CRF such as renal bone disease, and elective planning for commencement of dialysis. Detection of obstruction and management of urinary tract infections and attention to fluid balance may also contribute. However, a quantitative estimate of the extent to which the onset of dialysis can be delayed cannot be given, and hence there are few cost-effectiveness data on a more proactive approach to pre ESRF care.

There is evidence of under-referral by GPs and general physicians to specialist renal services in relation to the population incidence of ESRF, which is associated with insensitivity to a renal diagnosis, or a belief that specialist help would not be appropriate or that resources would not be available to treat the patient.

There is no research focusing specifically on how the diagnosis of renal disease by GPs and general physicians can be improved. It must be recognised that advanced CRF is rare in general practice – the average GP would have only one patient suitable for RRT every six years. The numbers with raised creatinine are more significant. The Southampton incidence study found a rate of 17 new cases per a practice of 10 000 patients. Renal physicians should aim to ensure that GPs and other doctors identify and refer suitable cases in a timely manner.

### *End-stage renal failure (quality of evidence: II-2)*

The aim of RRT is not only to prolong life but also to restore quality by permitting a sufficiently independent existence with minimal support. All modalities of RRT are effective in prolonging life of reasonable quality, even in patient sub-groups regarded as 'high-risk' (i.e. older patients or patients with diabetes). The quality of life often improves with time after the initial dislocation of starting dialysis and once there is acceptance of the restrictions for example on diet and mobility. Expectations are in general lower in older individuals and several studies show that they can have a good quality of life on RRT; mental health (SF36) compares well with the general population of a similar age and gender.[59]

The different modalities do not represent straightforward alternatives in all cases of ESRF since each modality may not be suitable for some individuals, even though the range of indications for each modality has widened. For example, PD may be contraindicated in patients with previous major abdominal surgery or in those unable for physical and mental reasons to cope with undertaking CAPD fluid exchanges themselves. Patient choice is important, for example PD is more suitable for those patients who desire autonomy (e.g. to carry on working), while HD provides an infrastructure of medical and social support which may be valued in particular by the frail elderly. The 'choice' of modality is then determined by a combination of clinician and patient preference, in turn dependent on patients' social and clinical characteristics and by the availability of the different modes of RRT. Most argue that availability should not limit choice.

Patients may move between modalities, especially between CAPD and transplantation, but also between CAPD, and hospital HD, either on a temporary or a permanent basis.

The presence and severity of co-morbidity, especially CVD, is the most important predictor of survival.[52,53,59] It is important to adjust for such case-mix differences when comparing unit outcomes.

### *Cardiovascular disease in CRF and ESRF (quality of evidence: extrapolation of grade I evidence in non renal patients)*

There is substantial evidence that patients with CRF and ESRF are at very high risk of CVD and it is the major cause of death in both groups. This problem has recently been highlighted by the National Kidney Foundation Task Force.[79] This is due to enhanced atherosclerotic disease as a consequence of classical risk factors such as hypertension, dyslipidaemia, diabetes, other risk factors for arterial disease (e.g. homocysteinaemia) and other factors leading to cardiac muscle damage (e.g. fluid overload, anaemia, hyperparathyroidism). The Task Force recommended that such patients be considered at very high risk of CVD and that preventive measures be taken accordingly. Most of the evidence for effectiveness has to be extrapolated from studies of CVD in the general population.

### *Dialysis (quality of evidence: II-2)*

Home HD patients are a selected and dwindling group and few patients are now started in this modality. Continuous ambulatory peritoneal dialysis has taken over as the main form of home treatment, though its role is also declining in relative importance. There is still considerable debate about the relative merits and appropriateness of the two main forms of dialysis, hospital HD and CAPD. There have been no RCTs comparing them and so evidence has been derived from observational studies of large data sets with adjustment for important confounders.[80,81]

Such inter-modality comparisons of survival have to be interpreted with caution because of possible selection effects. Survival rates between modes of dialysis appear very similar, after adjustment for case-mix differences. This suggests that transfer between modalities can be made without undue concern for survival.

### *Morbidity and quality of life (quality of evidence: II-2)*

Successful transplantation is generally regarded as offering the best quality of life of all methods of RRT, although it is not suitable for all types of patient. It reverses the metabolic and haematological effects of renal failure. Quality of life post-transplant has been improved by the use of cyclosporin for immunosuppression. Newer agents such as mycophenoloate have been shown to reduce the acute rejection rate but there is no evidence as yet that they prevent long-term rejection.[82]

The differences between the types of dialysis in morbidity and quality of life are far less clear-cut. In part, the interpretation of inter-modality comparisons depends on whether morbidity, health status, quality of life or social functioning are regarded as most important for judging more or less successful treatment. For example, transplant patients tend to have higher perceived health status than hospital HD patients despite experiencing more frequent inpatient episodes.

Technique survival (i.e. whether the patient has to change the type of dialysis) is better in most but not all studies with HD,[81] largely because of the problem of recurrent peritonitis with CAPD. This can lead to treatment failure (temporary and permanent) and malnutrition (from protein loss and appetite suppression). Peritonitis rates have declined with the use of Y connector systems[60] and newer sterilisation methods. Another problem with CAPD is inadequate dialysis (especially when residual renal function is lost) and evaluating the dialysis dose is more difficult than for HD.[2]

Continuous ambulatory peritoneal dialysis allows more independence than HD and may be beneficial to young people awaiting transplantation. It may also have advantages for people with CVD because of the continuous nature and because there is no need for a fistula. It is unclear whether people with diabetes do better on CAPD. There is no evidence that complication rates of CAPD are greater in the elderly, though some may have difficulty performing it.

There have been innovations in the delivery of hospital HD which enhance its effectiveness, such as monitoring of adequacy and use of bicarbonate dialysate rather than acetate.[60] There is no space here to review the evidence for setting standards for dialysis.[2]

Continued expansion of CAPD is unlikely to be a cost-effective way of increasing acceptance rates. Newer patients are predominantly elderly and more dependent and may do better in the supervised environment of unit HD, not least because of social contact. The main factors affecting the appropriateness of modalities for the elderly are well documented by Nissenson.[83]

Newer methods of APD have been introduced for those with particular clinical (e.g. lower filtration) or psychosocial needs. These are more expensive and their place needs to be evaluated more rigorously. A new development which has not been widely introduced in the UK is the concept of daily home HD. The technology is now available, and patients are reported to have much greater quality of life and less requirement for supportive therapies such as EPO. Its cost-effectiveness and feasibility need to be established.

There is no right solution to the balance of modalities as evidenced by the considerable variation in CAPD:hospital HD ratio worldwide. Most would agree that patients should have a choice of modalities (i.e. they should not be forced to choose CAPD because of a shortage of facilities for HD). The modalities are best viewed as being interchangeable and decisions made on the basis of clinical and social grounds. Whatever the balance of modalities, treatment must be made more accessible to patients to reduce travel times (and costs) and to contribute to improving the equity of service provision.

### *Erythropoietin*

The potential to improve the quality of life of patients on maintenance HD has recently been increased by the availability of recombinant human EPO to combat the anaemia associated with long-term HD.

Erythropoietin increases blood haemoglobin concentration and enhances quality of life for patients on HD, particularly reducing fatigue and physical symptoms and improving exercise tolerance. It also removes the risks associated with transfusions. Side effects include a higher incidence of hypertension and clotting of the vascular access, though these occur less than was first thought. It is generally regarded that the patient benefits outweigh the impact of the side effects on patients at least in the short term.

According to a European collaborative study of the benefits of EPO in ‘transfusion-dependent’ (anaemic) ESRF patients, it can improve the quality of patients’ lives, according to their own assessments, by between 2 and 5% of a quality-adjusted life year (QALY).[8] There is no evidence to date that EPO increases length of survival.

There is an ongoing systematic review into the use of EPO in ESRF including route of administration and dosage.

Despite good evidence of effectiveness, the problem is the high cost in an already costly patient group. A fall in EPO prices from one of two drug firms making it would help ease financial pressures.

### *Summary*

Table 14 overleaf summarises key findings concerning existing evidence about the effectiveness of measures to prevent and treat renal disease.

## Cost-effectiveness of preventing CRF/ESRF

There are limited data available. The high costs of RRT services (Table 13) emphasise the importance of measures to prevent the onset of renal disease. A study by Rodby *et al.*[85] indicates that for patients with

**Table 14:** Summary of levels of evidence of effectiveness.

| Intervention | Quality of evidence | Reference |
|---|---|---|
| Prevention | | |
| Chronic renal disease | | |
| Hypertension | I | 61 |
| Diabetes mellitus, type I | I | 64, 48 |
| Diabetes mellitus, type II | I | 66, 67 |
| Urinary tract infection | II-2 | 70 |
| Urinary tract obstruction | III | 72 |
| Acute renal failure | III | 73 |
| Treatment | | |
| Acute renal failure | III | 75 |
| Chronic renal failure | I–III | 77, 78 |
| End-stage renal failure | II-2 | 52, 53, 59 |

diabetic nephropathy, the use of captopril is effective in reducing future spending on RRT services. Studies by Borch-Johnsen *et al.*[49] and by Kibberd and Jindal[86] also indicate that in type I diabetes screening for microalbuminuria and antihypertensive treatment is cost-effective in reducing future spending on ESRD.

### *Comparative cost-effectiveness of methods of RRT*

Tables 15 (*see* overleaf)and 16 (*see* p. 113) summarise the principal studies of the cost-effectiveness of RRT (for further information see Macleod *et al.*[60]). The results of the studies presented are not comparable with one another because of different methodologies, base years, currencies, etc. They are presented to give an indication of the general direction of the cost-effectiveness comparisons.

Successful transplantation, especially from a live, related donor, preceded by a period of CAPD, is the most cost-effective means of RRT even when the full range of health service and patient/family and social costs are taken into account.

Economic studies to date show that CAPD is more cost-effective than hospital HD and since peritonitis rates associated with CAPD have decreased, CAPD is more cost-effective than home HD in most situations. In perhaps the most detailed, recent economic appraisal of dialysis methods in the UK, CAPD emerged as unequivocally the most cost-effective modality, particularly when expansion of RRT was concerned.[87] The investment decision will depend on predictions of the likely patient mix to be treated.

### *Factors affecting results and interpretation of comparisons*

None of the cost-effectiveness comparisons is based on data from RCTs, a fact confirmed by the systematic review conducted by MacLeod *et al.*[60] This means that selection (case-mix) factors will affect patient outcomes, including factors such as patient rehabilitation and treatment costs, and, thereby, the results of comparisons.

The magnitude and, on occasions, the direction of cost-effectiveness comparisons are affected by the outcome variable used (life year gained, QALY, etc.), the use of discounting (or not) and the specification of costs (direct treatment costs, social costs, etc.) included in the analysis. All costs should ideally be included regardless of which agency meets the bill.

**Table 15:** Summary of studies of cost-effectiveness of different methods of RRT.

| Study | Currency/ year of costs** | Discount rate | Years | LRD Tx* | CAD Tx* | CAPD | Home HD | Hospital HD |
|---|---|---|---|---|---|---|---|---|
| Buxton and West*** (UK)[88] | £1,972 | 10% | 20 | – | – | – | 2,600 | 4,720 |
| US General Accounting Office (USA)[89] | $1,981 | – | 2nd | – | – | – | 17,767 | 35,535 |
| Stange and Sumner (USA)[90] | $1,981 | 5–7% | 10 | 24,900 | 28,815 | – | 28,456 | 44,142 |
| Roberts *et al.* *(USA)*[91] | $1,981 | – | life | 12,319 | 23,839 | – | 21,212 | 39,630 |
| Ludbrook (1981) (UK)[92] | £ | – | – | – | – | – | 5,150 | 7,100 |
| Bulgin (1981) (Canada)[93] | $ | – | – | – | – | 12,630 | – | 18,048 |
| Maxwell and Grass, US DHSS (1982) (USA)[94] | $1,981 | – | pa | – | – | – | 16,706 | 18,600–23,250 |
| Mancini and Davis**** (1982) (UK)[95] | £ | – | first | – | – | 9,500–11,400 | 9,800–9,950 | 11,200–13,650 |
| | £ | – | subsequent | – | – | 7,550–9,800 | 7,100–8,700 | 11,200–13,650 |
| Lameire (Belgium)[96] | £1,984 | – | pa | – | – | 11,850 | 17,260 | 25,850 |
| Garner and Dardis (USA)[97] | | | | | | | | |
| Low | $1,981 | 10% | 20 | 22,400 | 31,148 | – | 25,177 | 31,582 |
| High | $1,981 | 10% | 20 | 16,974 | 22,578 | – | 25,381 | 31,989 |
| Haggar (1988) (UK)[98] | £ | – | first | – | – | 22,790 | 30,724 | 30,403 |
| | £ | – | subsequent | – | – | 21,574 | 18,971 | 29,029 |
| Smith *et al.**** *(UK)*[87] | £1,988 | – | pa | – | – | 8,196 | 10,221 | 14,476–16,291 |
| Sesso *et al.**** (Brazil)[99] | $1,985 | – | first | 3,851 | 7,283 | 12,578 | – | 10,981 |
| | $1,985 | – | second | 3,022 | 6,978 | 12,134 | – | 10,065 |
| Karlberg and Nyberg (Sweden)[100] | $1,991 | – | – | – | 10,000 | 30,000 | 40,000 | 60,000 |

* Gross social costs i.e. excluding output gains due to treatment. LRD Tx = live-related donor transplant; CAD Tx = cadaveric transplant.
** Where different from year of publication.
*** Net social costs i.e. including output gains due to treatment.
**** Health service costs only.

**Table 16:** Cost per QALY estimates for RRT methods.

| Study | Cost per QALY | | | | | |
|---|---|---|---|---|---|---|
| | **Currency/ year of costs** | **Discount rate** | **Transplant** | **CAPD** | **Home HD** | **Hospital HD** |
| Smith *et al.* (1989)* (UK)[87] | £1,988 | 5% | – | 6,731 | 9,292 | 15,594–17,549 |
| Hutton *et al.* (1990)** (UK)[101] | £1,988 | 5% | 1,724 | – | – | 11,071 |
| Maynard in West (1991) (UK)[56] | £1,990 | 5% | 4,710 | – | 17,260 | 21,970 |

* Average costs per QALY over five years assuming 100% survival.
** Adapted from Gudex.[102] Average annual costs per QALY for a transplant lasting ten years; hospital HD over eight years.

The results are also affected by technological change (e.g. the effects of cyclosporin and EPO) which influences survival, complication rates, health service costs, family costs, social costs, quality of life, etc.

- In practice, comparisons between modalities are affected by the efficiency with which each modality of RRT can be used under the specific conditions prevailing locally.
- The practical policy choice concerns the best mix of modalities since not all patients are suitable for all modes of treatment and optimal therapy for the individual may change over time. Also transplantation is constrained by an absolute shortage of organs.
- More research is required to establish the relative cost-effectiveness of the main methods of RRT in a range of patient sub-groups, such as the elderly and people with diabetes. The average cost-effectiveness of RRT methods in the past may not be entirely relevant to the patient mix coming forward for RRT in the future if programmes expand and as populations age. Studies should be on an intention to treat basis.

### *Relative cost-effectiveness of differences in the methods of delivering individual treatment modalities*

A recent systematic review of the literature considered the effectiveness and cost-effectiveness of variations in methods of service delivery within treatment modalities.[60] Its conclusions are summarised below.

- Synthetic compared with cellulose membranes in HD: synthetic membranes were associated with reduced patient morbidity but higher costs. The authors recommended that cellulose membranes be the preferred option.
- Bicarbonate- versus acetate-buffered dialysis: bicarbonate-buffered dialysis was recommended as it achieved improved patient co-morbidity at the same cost as acetate-buffered dialysis.
- Short duration ($<3.5$ hours) versus standard duration ($>3.5$ hours) dialysis: the authors warned against the use of short duration dialysis based on an assumption that it reduces costs because it may also lead to increases in patient morbidity.

- Y-set versus standard spike delivery systems in CAPD: Y-set systems were found to lead to significant reductions in the incidence of peritonitis. Although they are more expensive than standard systems their use is likely to be cost-effective.
- CCPD versus CAPD: CCPD leads to significant reductions in the incidence of peritonitis but it is more expensive.

### *Conclusion*

RRT is effective in prolonging life and in providing an acceptable quality of life for most patients, including the old. Modality-specific cost-effectiveness analyses are difficult to undertake because patients may undergo two or more modalities in their lifetime on RRT. It is clear that greater resources need to be invested in measures to increase the supply of kidneys for transplantation (*see* section 9). The appropriate balance between CAPD and hospital HD is a matter for debate as shown by the variations worldwide and between English Regions. Certainly there will have to be an overall expansion of facilities to cope with the increasing stock.

# 8 Models of care

This section focuses on the organisation of services for RRT.

The planning of specialist services, of which renal is one, is changing. Prior to the 1990 NHS reforms, RRT was organised as a regional speciality. Each region decided on the priority accorded to specialist renal services through its budget for regional specialities. Each district's consumption of renal services, particularly RRT, depended on the referral thresholds of GPs and consultants, in turn influenced indirectly by local availability including the distance to the nearest renal unit. Renal units nominally provided services to a number of districts, but district managers had no say in how this role was performed.

The 1990 NHS reforms placed responsibility on local HA purchasers, albeit working together with, in many areas, a 'lead' purchaser taking responsibility for negotiating the contract. The recent consultation document 'the new NHS Commissioning Specialist Services' proposes the establishment of a regional group and area sub-groups with representation from each HA.[103] This group will have overall responsibility for ensuring an appropriate level and distribution of services in the region.

Health authorities will be responsible for developing service agreements with providers, in consultation with primary care groups (PCGs) and within the overall regional strategy. They will need to know what is their population's need, based on age and ethnic structure, how such need is being met, likely trends in demand and what is the projected growth in the numbers of patients on RRT. They need to know how many of their residents are currently on RRT or have been taken on (i.e. current stock and acceptance rates), by which units, what is the balance of modalities and what is the quality of care (this will be facilitated in future by the UK Renal Registry).

The remainder of this section discusses in greater detail the key tasks and decisions that will be faced by HA/specialist services commissioning groups.

## Estimating future demands for, and costs of, services for RRT

The aim here is to illustrate the ways in which the types of data presented in earlier sections might be synthesised into meaningful information for planning local renal services. The approach focuses on services for RRT.

The issues addressed are:

- the key information that is needed to support local decision making
- the data that will be required to provide this information
- and the analytical approaches that can be used to transform these data into useful information.

The discussion draws on previous publications which have either addressed planning issues relating to renal services or developed approaches for projecting future requirements (Davies and Roderick,[104] Krupa *et al.*,[58] Wight *et al.*,[105] Davies and Roderick,[106] Bolger and Davies,[57] Forte,[107] Mallick[3]). Some results from these papers are also presented in order to highlight the trends in activity levels and the key variables that affect future demand for RRT services.

Readers are also referred to the *Renal Purchasing Guidelines* produced by the NHS Executive.[1] This document provides further guidance about how to generate information about future activity levels and costs.

### *Key information needed to plan and model services for RRT*

The main questions surrounding the future provision of RRT services might be summarised as follows:

- how many patients will require RRT services?
- what amount of resources will they require in terms of facilities and both the mix and quantities of modalities?
- what will it cost to provide these resources?
- how will patient numbers and the need for resources and costs evolve over time?

### *Data needed to generate this information*

Staff within HAs and trusts will need to obtain the following data relating to local services (a regional perspective will also be required to plan the appropriate location of services):

- opening patient stock levels by treatment modality and risk group (at least age)
- the demographic composition of the population to be served and hence an assessment of potential need
- annual patient acceptance rates, preferably by risk category (e.g. age, presence of co-morbidities)
- proportionate assignment of new patients to treatment modalities, again preferably linked to risk categories
- annual supply of transplants
- patient survival rates
- mode of dialysis and transplant graft survival rates
- the incidence of key complications and co-morbidities
- the unit costs of key elements of the service (e.g. modality costs and the costs of complications such as peritonitis)
- disposition of services in relation to population need – main and satellite, available manpower (medical, nursing, associated specialties).

In practice there may be uncertainty surrounding the values of some of the variables, e.g. future acceptance rates. Here planning assumptions will need to be made and the effects of varying these assumptions tested as part of the analysis. In addition, although average cost data will provide an initial indication of the cost consequences of change, in practice costs do not vary in a linear manner. For example, existing staffing levels may initially be able to meet increases in activity levels. Eventually, extra staff may be needed and there will be a step-change in costs. For more sophisticated analysis, commissioners and providers may want to collect data which allows an analysis of such step-changes.

### *Methods of analysing the data*

Some form of computer modelling package will be needed to analyse the data that are collected. In addition, use of computer modelling will allow 'what if' analysis to be undertaken whereby the impacts of different planning scenarios, assumptions and variables are tested.

Two modelling approaches have been used in the literature: computer simulation (Bolger and Davies[57]) and spread-sheet modelling (Krupa *et al.*,[58] Wight *et al.*[105]). A further example of spread-sheet modelling is found in a project being undertaken on behalf of the Welsh Office by Paul Forte and Peter Rutherford. They have taken an existing model, the Balance of Care approach,[107] and are adapting it for the planning of renal services.

The two techniques are probably complementary. Supporters of simulation modelling argue that it provides a more realistic and sophisticated technique for estimating long-term trends in activity and costs over time.[104] It is a dynamic technique, which models individuals with specific characteristics, and the effects of resource constraints, such as the supply of transplants, can easily be allowed for. Spread-sheet modelling provides snapshots at points in time and is more relevant to the analysis of short-term needs for resources. The software is probably easier to develop and therefore it may be a more accessible approach for staff in HAs and trusts.

Whichever approach to modelling is selected the analysis that will be undertaken can be subdivided into the following components:

- a prediction of patient stock levels year on year, taking account of opening stock levels, acceptance rates, and patient survival
- the assignment of patients to treatment packages taking account of the initial assignment of new patients to treatment modalities and subsequent changes in modality linked to technique survival and complication rates
- a prediction of year-on-year resources required (e.g. stock levels by modality) and the costs of these resources.

### *Key findings from published research*

The following recent publications have projected the future demands for and costs of RRT services: Davies and Roderick[106] and the NHS Executive.[1] These papers provide consistent messages so their key conclusions are summarised here.

- At current estimated levels of need (80 new patients pmp per annum) there will be a rise in patient stock levels of between 50 and 90% over the next 15 years depending on assumed rates of survival.
- Stock levels will rise by around half this amount even at the average annual acceptance rate in 1991/2 of 65 pmp.
- Predicted steady state stock levels resulting from differing rates of acceptance are: 65 new patients pmp per annum, steady state stock around 588 patients pmp; 80 new patients pmp per annum, steady state stock around 663 patients pmp; 100 new patients pmp per annum, steady state stock around 769 patients pmp.
- The assumed rates of patient acceptance and survival are the key determinants of future stock levels. A change in the assumed transplant rate has only a small effect on projected stock levels.
- There will be a disproportionate rise in the number of patients using dialysis modalities, reflecting an increase in the proportion of older high-risk patients being accepted on to treatment programmes.

- At steady state around 0.08% of the population will require RRT and they will consume 2% of the NHS budget.
- Future stock and cost levels will vary considerably between districts depending on their socio-demographic characteristics and opening stock.

The above only indicate trends in activity and cost levels and the key variables which affect projections. Specialist services groups/HAs and providers must generate their own information for planning the development of local renal services. The importance of them addressing this task is emphasised by the projected growth in activity and cost levels.

## Planning the supply of services for transplantation

There are two sources of kidneys for transplantation.

- Most kidneys are cadaveric, derived from donors certified as dead while on life support in ICU and who are free of major diseases that would compromise kidney function. Such patients usually have severe head injuries or intracerebral bleeding due to stroke. Death is certified following the application on two separate occasions, normally several hours apart, of standard tests for brain-stem functions by clinicians independent of the transplant team.
- A minority come from live donors, traditionally related, but increasingly unrelated (e.g. spouses).

The major problem facing the transplant programme is the shortage of kidneys.

### *The shortfall of kidneys for transplantation*

The latest published figures from the UKTSSA indicate that in 1997 and 1998 there were 2817 cadaver kidneys and 418 live kidneys (13% of total) transplanted in the UK and there were also 45 kidney and pancreas transplants.[108] Compared to 1995–96 there was an absolute fall of 325 cadaver kidneys, partly offset by an increase of 91 live kidneys. The donor rate was 13.5 pmp in the UK and Eire; this was similar to other European countries except Spain (31.5 pmp).

Cadaver kidney donor rates are slowly falling in the UK, consequent on welcome declines in road traffic accidents and cerebral haemorrhage from strokes. Also the wider use of computerised tomography (CT) scanning may have reduced the number of poor prognosis head injuries who were ventilated on ICU. The gap between the need and supply of kidneys has meant that the transplant waiting list continues to rise, reaching 5702 patients by December 1998.[108]

UKTSSA estimated that the current annual need for kidneys is approximately 2500 in the UK, a rate of 48 kidneys pmp population per year.[109] The Hoffenberg report argued that the requirement could rise as high as 4000 in the foreseeable future.[110]

As waiting lists for transplantation lengthen, there has been investigation into ways of improving the level of organ procurement. Two main approaches have been suggested.

- Increase cadaveric donation in cases of confirmed brain-stem death on ICUs.[111,112] Strategies include reducing relatives' refusal, improving procurement and increasing the pool of donors.
- Make greater use of living donors, particularly by encouraging donations from living, related HLA identical donors and living, unrelated donors.

### *Barriers to cadaver organ donation from ICUs and elsewhere*

It was believed that the demand for organs could be satisfied if an increased proportion of the organs assumed to be available were donated for transplantation. A detailed audit of all deaths in 278 (98%) of the ICUs in England throughout 1989 by Gore identified several principal barriers to organ donation, which affect different stages in the process of obtaining transplantable organs.[112]

1 Brain-stem death may not be a possible diagnosis – it was a possible diagnosis in 14% of cases (ca. 1700 per year).
2 Brain-stem death tests may not be performed even though brain-stem death is a possible diagnosis – it was not tested in 24% of these cases. In many there were good reasons but in some, negative attitudes and resource restraints may have contributed. Brain-stem death criteria were confirmed in 10% of the total audited cases (ca. 1200 per year) of which 95% had suitable kidneys for donation.
3 There may be general medical contraindications to organ donation – general medical contra-indications to donation were found in 17% of the cases of criteria-confirmed brain-stem deaths in (2) above. Brain-stem death, criteria-confirmed, actual donors were achieved in only half the cases in (2) above (i.e. in 5% of the total audited cases, equivalent to ca. 600 donors per year, a rate of 13.7 heart-beating cadaver solid organ donors pmp population). This amounts to a rate of 24 kidneys pmp population per year as against an estimated demand of 48pmp per annum.
4 Brain-stem death was confirmed and there were no contraindications in 8% of the audited cases (ca. 1000 per annum).
5 Ninety-three percent of families of potential donors were asked about the possibility of donation. Nonetheless, lack of discussion was responsible for the non-retrieval of organs in a number of cases equivalent to 10% of the actual brain-stem donors.
6 Relatives may refuse consent to organ removal – consent for donation was given in 70% of the cases when organ donation had been suggested to relatives.
7 Specific organs may be found to be unsuitable upon investigation; and suitable, offered organs may not be able to be harvested.

With the exception of the level of non-performance of confirmatory tests of brain-stem death, there was noticeable regional variation in the frequency with which these obstacles occurred, suggesting that there might be scope for improvements in practice in some ICUs and hospitals. It is important to note Gore's study did not look at cases taken off ventilation before brain-stem death tests.

### *Possible ways of improving the level of cadaveric organ donation*

As a result of the audit described above[112] and other studies,[113] a number of steps which could increase the availability of cadaveric donors have been recently proposed.

- An increase in the number of ICU places which would help to increase the incidence of brain-stem death since the incidence depends in part on the availability of mechanical ventilators and the willingness of staff to refer patients who might become brain-stem dead. ICU beds are always scarce in the NHS and are also expensive to support.
- Ensuring that there is adequate funding and staffing of first, neurosurgical facilities as these are a major source of donors, and second, adequately resourced transplant teams.
- Performance of brain-stem function tests in all possible patients and if necessary more aggressive cardiovascular support that could contribute to an increase in organ supply.
- Early consultation with the local transplant co-ordinator and/or transplant team which would establish the suitability of organs for transplantation in good time for their eventual use, which

could ensure that irrelevant contraindications are not arrived at in ICUs or on the wards. There is some evidence that transplant teams tend to operate broader criteria of eligibility than ICU staff and others imagine. It has been suggested that clinicians should be obliged to discuss all potential brain-stem death patients with the local transplant co-ordinator whether in ICU or elsewhere. A transplant co-ordinator should be available in every region. Such 'required referral' could be audited. Moreover co-ordinators can ensure that the patient is adequately maintained to preserve renal function prior to transplantation.
- Publicity and education programmes which could contribute to increasing the consent level among relatives (70%) still further and thereby increase the proportion of potential donors. Since 1994 there has been a national organ register held at UKTSSA with nearly 5.5 million people registered and indicating their consent.[108] Applications can be made when driving licences, passports or new GP registrations are made. This list is not of sufficient in size and there is no evidence that it has maintained donor rates.
- Publicity campaign to increase the acceptability of organ transplantation and hence the donation rate in the South Asian community. These groups have a significant excess of renal disease but there is a particular shortage of kidney donors, compounded by the need for blood group and HLA matching.[114] Strategies to remedy this shortfall not only includes increasing the acceptance of organ donation but also ensuring equitable access to ICU and encouraging living donation.

A key component of these approaches is a well-resourced team of transplant co-ordinators. They are responsible for education programmes, co-ordinating the process of transplantation and also in providing bereavement support. There are crucial issues to ensure sufficient numbers of staff in each area to fulfil these roles and that they are appropriately trained. The country with the highest donor rate, Spain, is the one which has invested most heavily in procurement co-ordination (with one in each general hospital, often a doctor). While this model may not be suitable for the UK, better links between ICUs and co-ordinators, e.g. by link nurses, is one positive approach.

### *Other strategies*

- Although the use of previously unventilated patients dying outside ICUs with primary and progressive cerebral disease might contribute substantially to increasing the pool of donors,[115] this process of 'elective ventilation' has been deemed illegal.
- Increased use of asystolic kidney donation (i.e. patients who suffer cardiac arrest). This is limited by the need to remove kidneys within 30 minutes for best results but this policy has only been successfully implemented in a few centres, e.g. Leicester. Schemes like this are difficult to organise and may not offer a generalisable solution.
- Increase in live donation. UK rates have been low compared with some Scandinavian countries, e.g. Norway, which has a rate of 17 pmp. There is significant variation between units. However, more units are promoting the approach, partly by employing recipient co-ordinators within each renal unit. The results of unrelated transplants (e.g. spouses) are comparable to related. An increase in live donors has meant that kidney supply has been maintained in the face of declining cadaver kidneys.
- Increasing the amount by which the Department of Health reimburses hospitals for each donor to cover the costs of the organ retrieval.

### *'Opt-out policy'*

Currently people 'opt in' to organ donation by voluntarily carrying a donor card. Evidence shows that although most people approve of the scheme only about a quarter carry a card and at the time of consideration the card (and therefore the intentions of the patient) may not be available.

Some countries have introduced 'opt-out' schemes where it is assumed that consent is given unless people actively register to opt out. The impact of this development is unclear and there are obstacles to its introduction in the UK. There is evidence from abroad that because all relatives have to be approached to obtain a medical history for the donor, the system is no longer of particular relevance. It is important that public confidence in the transplant programme is maintained. Any move to a system of presumed consent would have to be carefully debated at national level.

### *Organisation of transplantation services*

Currently, many UK transplant units are small, performing under 50 operations a year.

| No. of operations per year | No. of units |
|---|---|
| > 100* | 3 |
| 75–99 | 4 |
| 50–74 | 4 |
| 20–49 | 9 |
| < 20 | 2 |

* North and South Thames listed as one centre.
*Source*: UKTSSA annual report 1998.

The London ImpIementation Group's Review and Purchaser Guidance recommended that all units should undertake about 100 transplants in order to produce economies of scale, concentrate expertise and improve research into transplantation.[116] The Renal Standards document (in conjunction with the British Transplant Society) recommends that units should serve at least a 2 million catchment population, depending on geography, communications and population density, and that they should perform at least 50 transplants per year.[2]

This requires considerable rationalisation of existing small units. The UKTSSA audit found no evidence that transplant survival is associated with unit size, though in other fields of specialist care hospital and physician volume has been shown to influence outcome.

### *Xenotransplantation*

The most appropriate donor is the pig, but this technique is still at an early stage. Although promising in the long term, the current focus is on overcoming early rejection and acute rejection. There are unresolved issues about the safety of such cross species transplant with regards transmission of infectious disease.

### *Equity and effectiveness of transplantation*

Kidneys are a scarce resource. It is imperative that they are allocated in a manner that balances effectiveness and equity considerations. Clear policies for putting patients on transplant waiting lists are required. National allocation system and several regional ones take account of both equity and effectiveness considerations. The proportion of kidneys that are exchanged (i.e. put into the national pool and used outside the donating unit) rather than used locally has been falling with the introduction of some regional waiting lists, as use by these lists counts as local. About a third of cadaver transplants were beneficially HLA matched in 1991–96, hence maximising outcome. This proportion is higher with exchanged kidneys.

The main problem with cadaveric transplantation is chronic rejection. Newer immunosuppressive drugs have shown benefits in reducing acute rejection episodes and graft loss in the first year. Further research is needed to identify successful methods of reducing long-term failure.

## Further issues surrounding the organisation and planning of renal services

### *Funding*

With the availability of finite resources how can one reconcile the need for increased quantity of care, improvements in its quality and greater emphasis on reducing inequity of access? What investment should be made over what time period? Modelling does not predict a steady state for over 15 years so a medium to long-term planning cycle is needed. Moreover there is in-built growth in the resources needed even if the acceptance rate were to remain the same, which is very unlikely. If there is an increase in acceptance to meet population need this would add to the resources required. Improvements in quality outlined below also require financial investment. The regional specialist services group and its constituent HAs will have to grapple with maintaining growth within resource constraints.

### *Geographical equity of RRT*

Existing specialist renal services and personnel are still concentrated, by European standards, in a relatively small number of centres in each region. This leads to continual disparities in accessibility and utilisation. Are there population groups who are distant from existing services; what are their acceptance rates? What practical scope is there for altering the volume, location or balance of services used?

To some extent this pattern is being superseded by the provision of more local renal services, for example by investing in additional autonomous consultant-led DGH renal units or satellite units. This has reduced the travel costs of patients on hospital HD and in training for other modalities. This could be an important consideration for HAs if they have to fund the full costs of RRT for their residents, including travel to the main renal unit. Savings on NHS-funded patient travel could be invested in the new renal unit under this option.

Evidence from other countries in Europe and from areas of England and Wales where satellite renal units have been built indicates that the more renal units there are, whatever their precise role, the higher the referral and acceptance rates and the prevalence of patients on RRT in the areas concerned. If units have full- or part-time nephrologists the effect of decentralisation is likely to be magnified as the local specialists diagnose increasing numbers of cases suitable for RRT. Specialists generally have broader inclusion criteria than GPs or general physicians for RRT. The nephrologists will also act as a focus for local charitable effort and will lobby for a continuing expansion of RRT. HAs will therefore have to be prepared to face the consequences of encouraging strategies of decentralisation.

### *Reducing need*

What preventive activity is ongoing which might reduce the need for RRT by reducing incidence of ESRF or delaying progression of CRF? Foremost would be integration of renal services with diabetes care (e.g. joint diabetologist–nephrologist clinics), and policies as part of CVD prevention to identify and manage hypertension. The scope for earlier referral to nephrologists locally needs to be explored.

### *Appropriateness of care*

Stanton describes and analyses policy development in RRT provision in the UK over the last four decades,[117] showing how explicit rationing was replaced by covert rationing by under-referral and how little impact the emerging health economic evidence had on policy.

Given the considerable expansion predicted and high cost of RRT, can explicit criteria be set to ensure the appropriateness of RRT? This is a contentious issue.

There are a few severe co-morbidities for which there would be general agreement among nephrologist and physicians that RRT could be withheld (e.g. severe dementia, terminal malignancy).[4] Wiltshire HA prioritised RRT to those most likely to benefit from treatment based on the following criteria: potential life years gained should be over one year; there should be an absence of severe co-morbidity; and the patient should be capable of independent living. All of these criteria are open to debate (e.g. what is independent living? Should we exclude RRT from those who are partially dependent? Can we always predict who will survive one year?).[118] It may be difficult therefore to be explicit and the decision to treat an individual patient should be left to the clinician, in conjunction with the patient and their family.

A recent study has shown that although it is possible to identify a high-risk group of patients with poor survival on RRT (under 20% at one year), excluding them would only save about 3% of RRT costs and it would deny dialysis to several long-term survivors, i.e. any prognostic index will have false positives and negatives.[53] Many would also argue that the modality of treatment in relation to patient characteristics should not be specified either, but should depend on clinical and social needs. The Renal Association Standards document recommends that decisions on dialysis commencement or withdrawal should be made jointly by the patient and the consultant nephrologist, in consultation with relatives, other members of the renal team and the patient's GP.[2]

A consequence of relatively unrestricted access to dialysis is dealing with the consequences. Withdrawal from RRT is likely to be an increasing feature of RRT programmes, with associated terminal care needs for patients and carers and for staff. Better prospective information on this issue is required.

Further work is required to determine if there are explicit criteria that are acceptable to the public, professionals and HAs and to identify prognostic factors that severely limit survival and quality of life on RRT.

### *Cost-effectiveness*

The evidence on relative cost-effectiveness of modalities and the characteristics of the existing stock of patients on RRT, together with the likely sorts of patients who would enter the RRT programme if acceptance rates were to increase, indicate the purchase of a combination of transplantation (within the constraints of organ supply) and a balanced programme of CAPD and HD. As argued above, hospital HD may be the most appropriate option for many of the older individuals who are being accepted, and the predominance of CAPD as the main form of dialysis may have to be reduced, although CAPD is particularly attractive if the objective is to expand the RRT programme over a relatively short space of time, as no major capital investment is required. The scope for improvement in organ harvesting for transplantation appears modest at present, unless it can be given greater priority (and funding) by provider units, and additional strategies for organ procurement are developed. Policies to improve live donation should be encouraged.

Better evidence of the relative cost-effectiveness of hospital HD, CAPD and APD is needed, ideally by randomised methods, as observational studies are problematic because of selection factors in the use of the these modalities. The feasibility of such a trial needs to be established, including overcoming patient and clinician preferences.

It has to be accepted that the proportion of patients who are elderly and/or with co-morbidity will increase, reducing the marginal cost-effectiveness. The manpower constraints on RRT expansion need to be considered, e.g. in skilled nurses, transplant surgeons, specialist dietitians. There will be additional knock-on effects on other services, such as vascular surgery, cardiology and community services.

Service changes that inflate costs need to be justified by their impact on the quality of care. Here, evidence about the relative cost-effectiveness of different treatment modalities and alternative ways of providing care within individual modalities needs to be consulted.

Where possible, measures which reduce cost per case while maintaining standards of care should be pursued. Possibilities include changes in the skill mix of staff, though further research is needed to identify appropriate balance in relation to different types of patient case-mix.

### *Transplantation*

The Department of Health's *Renal Purchasing Guidance* recommended rationalisation of transplantation to fewer centres, which would have an academic role, and with the surgical, immunological and medical expertise undertaking sufficient volume of transplantation (though there is no direct evidence for a volume outcome relationship).[1] Regional specialist services groups will need to review the disposition of renal transplantation.

What contribution can or should the local acute services commissioned by HAs be expected to make to increasing the number of transplantable kidneys available to district residents and to the UK Transplant Service? Key issues are the role of transplant co-ordinators in co-ordinating a programme of education (public and professional), and liaison with ICUs to facilitate organ donation and harvesting. An increased investment in recipient co-ordinators to promote live donation must be considered.

### *Service agreements*

What form should these take? Given that ESRF is a relatively rare condition with an annual need of only 120–130 pmp or so on average, there are only likely to be about 60 new occurrences of ESRF requiring RRT in a district of 500 000 in any year. The eventual steady-state pool of patients on RRT, although hard to predict exactly, is likely to be well over ten times this.

The majority of the renal budget in any one year will be spent on the opening stock of patients, with fluctuations around this value being due to deaths and the take-on of incident cases. Given this, an appropriate agreement might be a mixture of a basic block budget for the majority of expenditure with appropriate adjustments being made on a cost per case basis.

### *HA organisation*

In order to plan the appropriate disposition of services there is a clear role for regional specialist services groups and their sub-groups to co-ordinate activity at HA and provider level.

In Scotland, the concept of 'managed clinical networks' has been proposed as a way of integrating service provision at primary secondary and tertiary levels.[119] This requires further consideration.

### *What is the role of the private sector?*

Private operators have demonstrated in England and Wales that they can provide supplementary in-centre HD capacity for the NHS in small subsidiary units flexibly and quickly, as long as specialist clinical support is available from a main NHS renal unit, although there is no evidence that the private HD units are cheaper or more cost-effective than their nearest NHS counterparts. HAs will have to decide whether to invite private operators to compete for service contracts with NHS main renal units. Private operators are keen to offer centre HD and CAPD support services to NHS purchasers. They offer a possible means of either rapidly expanding RRT or, within the existing resources, of altering the balance and location of RRT. Two potential drawbacks are pressures to reduce costs which compromise quality and the necessity in some cases of using a fixed range of products supplied by the private organisation. It is essential therefore that a quality assurance framework is in place to maintain and enhance standards in both public and private sector units.

# 9 Monitoring and evaluation of renal services

It is imperative that there is good information on the cost-effectiveness and equity of care for these complex and costly services.[120] For RRT this will now be greatly facilitated by the UK Renal Registry. UKTSSA provides valid transplant data. There is a dearth of information on ARF.

Two national initiatives are relevant here. First the establishment of the National Institute for Clinical Excellence (NICE) should ensure that there is readily available information on cost-effectiveness of treatments and should disseminate evidence-based guidelines. Standards of care may be performance managed by the Commission for Health Improvement (CHI).

## Prevention of renal failure

A reduction in the number of patients developing ESRF with diabetes has been suggested as an outcome measure for diabetic services.[67] The necessary data are currently not routinely available, but should become available in future. Similar measures could be applied to essential hypertension. Any strategy to reduce CVD should incorporate this.

### *Acute renal failure*

The case fatality from ARF could be monitored and rates interpreted in the light of patient age, disease aetiology and other severity measures, and treatment provided. Further work is needed to develop guidelines on definitions, preventable causes and appropriate management and methods of information collection. More information is required on patterns of care and outcomes.

### *End-stage renal failure*

The effectiveness of RRT in ESRF can be assessed in terms of survival, complications (e.g. renal bone disease (rare), peritonitis, hospitalisations, symptoms, biochemical/haematological measures such as haemoglobin and calcium level), subjective health status, quality of life, patient satisfaction and the impact on family and carers. Ad hoc studies can be added, e.g. on quality of life.

Traditionally data on patients accepted on to RRT was collected by EDTA and annual reports produced. In recent years, the completeness of the EDTA Register has fallen in the UK, for a variety of reasons, including use of paper data and the lack of feedback to participating centres. To address this, a new national UK Renal Registry has been established under the auspices of the Renal Association with support from the British Transplant Society, the Association of Paediatric Nephrologists and the Department of Health. The main aims are to provide UK data on the quantity and quality of RRT services by collating and analysing data on the structure of services, patient characteristics and processes and outcomes of RRT. The

Register will provide important information for renal units to allow comparative clinical audit, national data to feed into EDTA, and information to HAs and DH on the development of RRT services, including the equity and effectiveness of care. Its functions are listed below. It is computer-based and has extensive validity checks built in. Eventually it is hoped that there will be complete coverage of England, Wales and Northern Ireland. There is already a Scottish Register; data will be pooled to give a UK wide perspective.

The functions of the UK Renal Registry are:

- to collect demographic and descriptive data for comparison of the equity of care and for planning of service development
- to facilitate comparative audit by means of a carefully defined data set to audit effectiveness of care against recommended national standards and to identify good practice
- to produce national and local data on outcomes with regards to case mix
- to be a resource for research studies.

In time the Registry will expand to monitor pre-ESRF care.

The first substantive report of the Registry was produced in September 1998, which included data from nine units.[54]

The following are important measures that can be considered. An important caveat is that RRT is rare at district level, relatively small numbers of patients are treated, and random variation in incidence and variations in case-mix have to be taken into account in interpreting local measures.

### *Population-based rates*

Health authority, regional and national acceptance and stock rates are required. These must be age- and sex-standardised for comparative purposes. These rates must be compared to estimates of local need taking account of the age, sex, ethnic and deprivation profile of the population. Such data will provide information on the equity of care by 'place' and by 'person' and time trends.

Districts with low acceptance rates should examine the effectiveness of services used for detection and referral of cases and the accessibility of RRT to their residents.

The stock of patients and its breakdown by modality and risk group should be monitored. The balance between CAPD and HD could be a marker of the degree of choice for patients. The growth of care in renal satellite units should be monitored.

The national and regional retrieval and transplant rates are collected by UKTSSA. It is important that targets are not set by HAs for a specified number of transplants on their patients as this would be inequitable and ineffective.

### *Survival*

The survival of patients on RRT will be analysed by the Registry, and for transplant patients it is already being monitored by UKTSSA. It is debatable whether this should be analysed at HA level as there are problems of small numbers, multiple providers and need for case-mix adjustment for valid comparison. Comparisons of renal units have the same problems but participation of units in national audit would be beneficial. Case-mix adjustment for key prognostic factors such as co-morbidity is crucial (*see* above). This must be collected in a complete and standardised format.

Survival analyses are important in providing prognostic data and for monitoring improvements in care. They include survival curves, one-, three- and five-year outcomes, annual mortality rates and life expectancy. More complex analyses can be undertaken to determine the factors influencing survival, particularly treatment input and processes (e.g. adequacy of dialysis).

### *Quality of dialysis and transplantation*

Evaluation of renal services should be expanded to evaluate the quality of dialysis. The morbidity and quality of life of dialysis patients is dependent on the safety and effectiveness of the procedure. Dialysis is, in general, a safe procedure, long-term survival is improving and a reasonable standard of life is available for most patients. As the proportion of patients being started who are elderly with co-morbidity rises, it is incumbent on renal services to evaluate the balance between quality of care and survival.

Chronic problems have been revealed, e.g. dialysis arthropathy, which arises because of the accumulation of a substance that is poorly removed by conventional dialysers. More expensive, high-permeability dialysis postpones the complication. Moreover, the US experience in the 1980s of rising mortality of dialysis patients has been salutary. This has been attributed to the inadequacy of dialysis, in turn brought on by pressure to reduce the time on dialysis and hence costs.

The essential parameters which determine morbidity must be determined and standards set where possible.

The Renal Association, in conjunction with the Intensive Care Society and the British Transplant Society, produced its second report on standards in renal disease in 1998.[2] Standards are evidence-based wherever possible and include not only RRT care but also smaller sections on ARF and CRF and general nephrology.

The report will be continually updated to take account of new evidence. particularly that arising from systematic reviews (e.g. those being undertaken by the Cochrane Renal Group) and large trials.

The key areas for evaluation are listed below. For more detail on the rationale readers should consult the report.

Renal units will be striving to monitor their own performance against these benchmark standards and clearly the Registry will provide an invaluable method for assembling and disseminating relevant data. Improvements in quality will require additional investment, although they may be cost effective, few are likely to be cost saving.

Items for comparative audit in RRT are:

- demographic data on dialysis patients
- techniques used (e.g. bicarbonate versus acetate)
- correction of anaemia
- dialysis adequacy and nutrition
- BP control
- CVD
- biochemical profiles
- transmissible disease
- hospitalisation
- water quality
- access for dialysis
- outcomes incl peritonitis rates for PD.

Items for transplantation are:

- pretransplant, e.g. number of transplants, donors, waiting list, matching
- first year post, e.g. postoperative problems, hospitalisation, acute rejection, patient survival, graft survival
- long-term, survival and cause of death, graft failure, neoplasia, cardiovascular events, BP and creatinine.

Items for ARF are:

- demographics
- causes
- techniques used
- severity
- outcomes.

# 10 Research priorities

Ideally, HAs require considerably more information than is generally available for most health services. This section sets out the main areas where better data and improved understanding could ensure an optimal pattern of renal services. In general, the research evidence is far better developed for ESRF than any other aspect of renal disease.

The National Health Technology Assessment Programme is an obvious way of identifying and funding renal research priorities. Systematic reviews have already been completed on several aspects of dialysis, and evaluation of renal satellite units is ongoing. A randomised study to evaluate HD versus CAPD versus APD is planned. An appropriate method of identifying priorities is to take the research recommendations from the systematic reviews that are likely to be forthcoming in the next few years (*see* Appendix II). The Cochrane Renal Group is currently mapping out the available evidence to identify areas where there are sufficient trials to warrant a review.

The following are a selection of areas where further research could be undertaken.

## *Epidemiology*

In general, there is considerable scope to improve knowledge of the epidemiology of renal diseases. Limited data are available on the incidence of CRF, but further work is needed, particularly to assess the incidence, aetiology and access to treatment of CRF and ESRF among ethnic minorities in the UK. Estimates of the age-specific incidence of ESRF are derived from studies with relatively small numbers of cases and should be improved by performing larger studies. Epidemiological studies to determine the risk factors for renal disease are needed, this requires development of early markers of renal disease that can be used in population studies. Similarly, there is a lack of information on the incidence and determinants of ARF.

## *Prevention*

There is very little literature on the primary prevention of renal disease. Research should be undertaken to determine the scope for primary prevention of acute and chronic renal failure and the steps required to bring this about. For example, the identification of hypertension, the treatment of diabetes and urinary tract problems, and the effective management of ARF. This should include research on screening for urinary abnormalities (e.g. microalbuminuria in diabetes, haematuria, proteinuria) and could involve modelling techniques. The results of the DCC trial and the UKPDS clearly have relevance to the prevention of renal disease in persons with diabetes. The Diabetes Prevention Program due to report after 2002 should provide clearer evidence on the feasibility of preventing diabetes especially in minority groups.[67]

Future research is needed on the determinants of progression and mortality, and secondary prevention of renal disease. Given the high prevalence of CVD in renal disease, studies are needed of the risk factors for CVD in renal patients and secondary CVD prevention trials in such patients. Further trials are needed to identify best treatments of various forms of GN. The most effective management of RVD is uncertain – trials are needed comparing interventional and conservative approaches.

The development of ARF can be considered potentially avoidable in certain cases. All cases should be subject to retrospective evaluation through a system of clinical audit. Evaluation of the scope for reducing late referral in ESRF should be undertaken. Research is also needed to assess the impact of late referral on outcome. Finally, greater efforts are needed to educate GPs and physicians about the management of renal disease.

### *Diagnosis of CRF/access to care*

Research is required to obtain a better understanding of the reasons for variations in diagnosis and referral rates for specialist services, particularly for CRF. Research specifically focusing on how the diagnosis of renal disease by GPs and general physicians can be improved is also required. Finally, renal physicians should aim to ensure that GPs and other doctors identify and refer suitable cases in a timely manner.

### *Treatment*

The workload and costs of treating ARF are not currently known in the NHS. Data should be collected to allow districts to estimate these.

Research is needed to provide better evidence of the relative effectiveness and cost-effectiveness of hospital HD, CAPD and APD. Ideally, this evidence should be generated by RCTs, although this is complicated by the requirement in most instances for multicentre studies to achieve adequate numbers. Observational studies are problematic because of selection factors in the use of these modalities.

Published comparisons of the relative effectiveness and cost-effectiveness of the different modalities of RRT are all influenced to some degree by the selective recruitment of patients on to the different modalities. Comparisons should control for characteristics such as age, cause of renal disease, co-morbidities, social circumstances, length of time on RRT, etc.

This programme of research should also establish the relative effectiveness and cost-effectiveness of the available modalities: (a) in all the principal patient sub-groups presenting for RRT (e.g. older individuals, people with diabetes, etc.); and (b) in a range of configurations of services. It is particularly pertinent to assess the relative cost-effectiveness of methods of RRT for those types of patient most likely to be coming forward for RRT in the near future if RRT programmes expand and as populations age. Such research must incorporate the inter-dependence of different modalities.

Research is also required into the determinants of morbidity and mortality and quality of life of patients on RRT, and the relationship with the adequacy of dialysis and other dialysis processes. The impact of early initiation of dialysis also needs to be assessed.

The main problem with cadaveric transplantation is chronic rejection. Newer immunosuppressive drugs have shown benefits in reducing acute rejection episodes and graft loss in the first year. Further research is needed to identify successful methods of reducing long-term failure.

Further comparative research should be encouraged to assess the consequences (e.g. in terms of improved accessibility) and cost-effectiveness of alternative policies and organisational solutions to the provision of RRT (e.g. decentralised patterns of service, including the use of satellite renal units fulfilling a variety of possible functions). The role of satellite units in providing more accessible care for elderly RRT patients needs to be established.

Where possible measures which reduce cost per case while maintaining standards of care should be pursued. Possibilities include changes in the skill mix of staff, though further research is needed to identify an appropriate balance in relation to different types of patient case-mix.

### *Cessation of treatment*

A consequence of relatively unrestricted access to dialysis is dealing with the consequences. Withdrawal from RRT is likely to be an increasing feature of RRT programmes, with associated terminal care needs for patients and carers and for staff. Better prospective information on this issue is required. Further work is required to determine if there are explicit criteria for the cessation of treatment that are acceptable to the public, professionals and HAs, and to identify prognostic factors that severely limit survival and quality of life on RRT.

### *Models of care*

Further modelling is needed to investigate the effects of a higher target acceptance rate (including the impact of demographic change in ethnic minorities), and the balance of dialysis modalities under different assumptions about future case-mix and availability of dialysis facilities.

# Appendix I: Types of renal replacement treatment

## Dialysis

### *Haemodialysis*

Haemodialysis is effective in a wide range of settings. It can be based in hospitals (as an inpatient for acute problems and for establishing dialysis), as an outpatient, in a free-standing unit or at home (HD) for maintenance dialysis.

Hospital outpatient dialysis is the main form. One machine can support up to nine patients. Patients have to travel. The frail elderly and patients with CVD can tolerate it if the quality of dialysis is high. It provides social support and medical supervision.

Home dialysis is for patients who can adapt their home and can manage self-treatment (with carers) and who will be on dialysis long term. It allows independence. Back-up nursing and technical support are needed and training is essential. One machine is needed per person. It has been largely replaced by CAPD.

### *Continuous ambulatory peritoneal dialysis*

As it is continuous there are fewer fluctuations in fluids and electrolytes compared with HD and it may be more suitable for patients with cardiovascular problems.

The main drawback is the risk of peritoneal infection; if this is recurrent despite changes in catheters a switch to HD is needed. There is a high demand for consumables and nurse support, and it is time-consuming. It allows greater independence than outpatient HD and is suitable for patients who live a distance from a renal unit.

### *Automated peritoneal dialysis*

This is being increasingly used in sub-groups of patients with specific clinical/psychosocial indications. PD is driven by a machine, one approach allows intermittent PD at night.

The technique is more expensive than standard methods of PD.

## Transplantation

### *Cadaver*

Success depends largely on the degree of HLA tissue-type matching. There is a shortage of donors and hence a waiting list. If successful, it is the most effective option as it reverses all side effects of ESRF, although patients need to take powerful immunosuppressants to prevent graft rejection.

### *Live, related donor*

If well-matched there is a high success rate. Not as widely performed.

## Indications for assigning patients to appropriate RRT modalities

The modalities have tended to be used in the following individual circumstances in the UK, although the inter-dependence of the modalities must be recognised and the evidence base for some is not clear.

Transplantation:

- age under 55/60 years
- availability of a suitable donor organ.

CAPD:

- disciplined, motivated and alert patients
- remoteness from a hospital centre
- patients with cardiovascular problems.

Hospital HD:

- multisystem disease
- previous persistent peritonitis with CAPD
- patient poorly motivated or lacking alertness
- old, infirm
- repeated transplant failure.

Home HD:

- likelihood of long wait for a transplant
- reasonable home conditions
- co-operation of another household member
- a good level of patient training
- remoteness from a hospital centre.

# Appendix II: Systematic review programme of the Cochrane Renal Collaboration 1998

### *Completed reviews*

- Cytomegalovirus prophylaxis with antiviral agents in solid organ transplantation
- Comparison of cellulose, modified cellulose and synthetic membranes in the haemodialysis of patients with end-stage renal disease
- Systematic review comparing continuous cyclic peritoneal dialysis (CCPD) with continuous ambulatory peritoneal dialysis (CAPD) as treatment for patients with end-stage renal disease (ESRD)
- A systematic review comparing short duration with standard duration dialysis treatments in haemodialysis as treatment for patients with end-stage renal disease (ESRD)
- A systematic review bicarbonate-buffered dialysate with acetate-buffered dialysate in haemodialysis of patients with end-stage renal disease (ESRD)
- Comparison of CAPD delivery systems: Y-set/modified Y-set versus standard spike

### *Protocols*

- Prophylactic treatments for recurrent urinary infections in women
- Effects of levocarnitine supplement in chronic renal failure patients
- Corticosteroid, cyclophosphamide and cyclosporin treatment of adult-onset minimal change nephropathy
- Effects of low-protein diet in delaying the onset of end-stage renal disease in non-diabetic adults with chronic renal failure

### *Titles*

- Comparison of haemodialysis with continuous ambulatory peritoneal dialysis
- The use of human recombinant erythropoietin in pre-dialysis chronic renal failure patients
- A comparison of subcutaneous with intravenous erythropoietin in the treatment of anaemia in patients with end-stage renal disease maintained on dialysis
- The effects of corticosteroids in acute drug-induced interstitial nephritis
- Long-term antibiotics versus surgery for vesicoureteric reflux in children
- Double or triple immunosuppressive therapy in renal transplantation: patient and graft survival
- Long-term antibiotic administration to prevent recurrent urinary tract infection in children
- Treatment of idiopathic membranous nephropathy
- Early steroid therapy in the prevention of anaphylactoid purpura nephropathy in children
- A comparison of different cortiscosteroid regimens for children with nephrotic syndrome
- Multiple risk factor interventions and primary prevention of renal disease
- Is stent insertion more effective than angioplasty or conservative medical management in renal artery stenosis?
- Renal function in clinical trials of antihypertensive drug treatment
- Calcium channel blockers for prevention of cyclosporin A nephrotoxicity
- Correction of metabolic acidosis in pre-end-stage renal failure
- Efficacy and safety of cyclosporin in inducing remission of childhood idiopathic nephrotic syndrome
- Comparison of the renal effects of angiotensin-II antagonists and ACE-inhibitors
- The effectiveness of cranberry juice in the prevention and treatment of urinary tract infections in adults
- Short versus conventional duration of therapy for acute urinary tract infection in childhood

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