Treatment of adult patients with renal failure

Recommended standards and audit measures

Prepared by Standards Subcommittee of the Renal Association on behalf of the Renal Association and the Royal College of Physicians of London

APRIL 1995
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Why try to produce a standards document for the clinical practice of nephrology? The first impetus to do so arose from the nephrologists themselves who wanted to know what was accepted practice in various areas of their speciality in the UK and how their own outcomes matched those of the nation as a whole. Another powerful stimulus has been the changes in the National Health Service since 1990, by which purchasers have had to try and identify best value in terms of quantity and quality of care in all areas of medicine. In public health terms, much of nephrology deals with relatively uncommon conditions for which the cost per patient is very high; hence the need for evaluation and comparative audit is pressing.

This document on standards of treatment for renal failure is produced jointly by the Renal Association and the Royal College of Physicians and is a first step in the production of a fully comprehensive document based on data collected on a national basis. In parallel, the Renal Registry for the UK has been created, funded by grants from the Department of Health and from industry involved in dialysis and transplantation. This will gather service and audit data and will firm up and expand the data given in this first, necessarily somewhat tentative, standards document.

Work on these standards will continue and a revised document will be published no later than the end of 1996. In particular, cooperation with the British Transplantation Society and UKTSS over the next 18 months should result in a more rigorous and useful document on renal transplantation.

Although this document concentrates specifically on the treatment of adult patients with renal failure, we have included an Appendix by the British Association for Paediatric Nephrology on the special needs of children.

April 1995

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Introduction

1.1 In 1990 the Executive Committee of the Renal Association resolved to produce two policy documents on the treatment of adult patients with renal failure and charged two subcommittees with their preparation. The first document, *Provision of services for adult patients with renal disease in the United Kingdom*,\(^1\) described the resources required and was published in 1991. This second and complementary document is a consensus statement of recommended standards and good practice for treatment of renal failure. The non-specialist reader is advised to read first Appendix 1 which is a review in lay language of the incidence, nature and treatment of renal disease.

1.2 The first draft of this document was circulated to all renal units in May 1993. Many nephrologists commented, as did the presidents of the European Dialysis and Transplant Nurses Association, the European Renal Care Association (EDTNA/ERCA), the Intensive Care Society, the British Transplant Society and the Dietitians Group. The document has been revised in the light of the feedback received. The subcommittee had to make some difficult decisions. These are discussed below together with the rationale for arriving at the conclusions reached.

1.3 We debated whether to recommend minimum or optimal standards and decided to define minimum standards while urging that higher standards should be the aim. We recognised that our initial recommendations would be refined in the light of the results of research and audit. A major contribution to both will be the simultaneous establishment of a Renal Registry which will collate patient data nationally.

1.4 One of the determinants of quality of services for renal disease is the mode of delivery. However, in the absence of clear evidence of the optimum arrangements we did not prescribe the means of delivering care.

1.5 Standards and comparative audit will be meaningful only if applied to a well defined population of patients. The point at which a patient is deemed to have started on a renal replacement programme is poorly defined because of the variation in mode of presentation and time spent in resuscitation and decision about suitability for long-term treatment. A few patients who initially appear to be dialysis-dependent recover sufficient renal function to survive without dialysis. In the US, to overcome this problem, patients are regarded as having entered the programme 90 days following their transfer to a free-standing renal unit or 90 days following their first dialysis session. The recommendation of this report is to make assessments from the time of first renal replacement therapy and from 90 days later.

1.6 Survival and rehabilitation are heavily influenced by factors such as age, race and medical co-morbidity. For purposes of standard setting and comparative audit, patients should be grouped according to these characteristics. Studies are currently
in progress which will evaluate the prognostic importance of concurrent illnesses and allow us to ascribe a risk score to each patient. Since this information is not yet available, we have taken account only of age, diabetes and cardiovascular disease, for which data are available, in keeping with the National Review of Renal Services in England.

1.7 The strength of the evidence that observing a minimum standard will benefit patients is variable. In some cases the evidence is not based on formal study and interpretation must be circumspect. The recommendations in this document are therefore titled ‘recommended standard’ if the evidence is strong and ‘recommendation’ if it is weaker.

Specific areas of concern were dialysis dose (especially in peritoneal dialysis), bicarbonate haemodialysis, twice-weekly haemodialysis and water standards. These have been addressed in this document.

1.8 Several centres were concerned with the workload that would be involved in documenting compliance with standards and recommendations. We judged that this problem would have to be resolved alongside many others, by negotiating with purchasing authorities for the resources required to collect the necessary data.

1.9 Standardisation of methods is necessary for standard setting and audit. The contentious areas are: urea kinetic modelling, methods of calculating mortality rates, microbiological methods, and measurements of variables such as serum albumin.

1.10 We agreed that common data should be presented as a cumulative frequency curve to illustrate the distribution of the outcome variable in the patient population. This is well suited to demonstrating quality of care given and for comparing outcomes from different units.

1.11 Undoubtedly, implementation of standards has cost implications which will need to be discussed with purchasing authorities. Prices and costs are not discussed in this document. The National Review of Renal Services in England recommends a template which can be used nationally to arrive at costs.

1.12 This is the first in a series of publications that the Renal Association are planning in association with the Royal College of Physicians. The next version, in 1996, will also include detailed methodology, data collection test schedules and definitions for the application of standards and audit for the treatment of patients with renal disease. We intend to work further with purchasers to translate the service specification set out in this report into a model contract for the delivery of acute and chronic renal care. We aim also to develop audit protocols, based upon the audit measures set out below, to monitor the quality of care given in a whole renal service or to an individual patient. Both these initiatives will be preceded by consultation with patients suffering from kidney disease.
2 Remit and purpose of this document

2.1 As in other medical specialties, the pattern of provision of treatment for patients with renal disease is changing rapidly within the context of the 1989 NHS reforms. While there are great opportunities to improve equity of access to renal services throughout the population, the costs are high. The Renal Association recognises that developing the service cannot be solely provider led and acknowledges its obligation to aid purchasers in making informed judgements. Provision of services for adult patients with renal disease in the UK, published in 1991, detailed the resource and manpower implications that would be required to approach a target end-stage renal failure (ESRF) acceptance rate of 80 new patients per million population per year. It aimed to assist purchaser/provider negotiations and to enable costs to be calculated.

2.2 The purpose of this complementary document is to propose a framework of quality standards and guidelines on patient-specific indicators which may be relevant in determining the wellbeing of, and outcomes in, patients with renal disease, in particular those with ESRF. It is hoped that this will allow contracts to be more focused and encourage providers to pursue comparative audit initiatives. The aim is to protect patients from the effects of substandard treatment and to improve the general quality of their care.

2.3 It is anticipated that this document will initiate a process which will involve the regular review and revision of the standards set and the introduction of further guidelines in new areas. The recommendations which follow have therefore been intentionally limited to only a part of medical activity in renal disease. The report concentrates on dialysis and deals more cursorily with the management of patients with transplantation, progressive chronic renal failure, acute renal failure and other renal diseases. These will be dealt with more fully in further publications.

2.4 This document considers:

- End-stage renal failure (haemodialysis, peritoneal dialysis);
- Transplantation, acute renal failure, pre-dialysis chronic renal failure, general nephrology (in less detail and at present only giving good practice guidelines);
- Audit.

It deals only with adult patients (ie those over 18 years of age). Additional requirements necessary for audit and treatment of children with renal failure are provided in Appendix 2.
3.1 The ESRF programme in the UK remains unbalanced. While the number of transplants performed and the results obtained compare well with other countries, the demand for sufficient dialysis facilities, particularly for haemodialysis (HD), remains largely unmet. Many hospital haemodialysis units are congested and the UK remains heavily dependent on continuous ambulatory peritoneal dialysis (CAPD), a method of treatment with inferior ‘technique survival’ compared with HD. Patient choice is often limited. The pressure to accept more new patients with ESRF within an ever tightening fiscal environment leads to clinical compromise, including a reduction in treatment time. A continuing decline in the number of hours of haemodialysis which European patients receive has recently been reported. The dangers involved in reducing dialysis dose became manifest in the United States in the 1980s when concern over the mortality rate in dialysis patients resulted in the introduction of a framework of quality standards which are now monitored as part of the Medicare reimbursement system under the auspices of the Health Care Finance Administration (HCFA). This led to an increasing awareness of the need to provide care within a framework of quality guidelines.

3.2 We feel that guidelines couched in moderate language will be more helpful than prescriptive standards. The concept of a minimum standard set seems acceptable as is the principle of recommending a higher target standard in some cases. No matter what the initial recommendations are, it is likely that standards will be refined and revised through the evolution of comparative audit. This standards initiative is thus linked to the work being done by the Registry Subcommittee of the Renal Association which has the remit to develop mechanisms for collecting and comparing patient data nationally. It builds on the Royal College of Physicians document on audit of renal units.

3.3 The standards and subsequent audits set out in this document are consistent with the ethos of the NHS reforms. However, quality of care cannot be guaranteed unless the purchasers agree to fund the necessary increase in provider costs.
Specific practical aspects of comparative audit

4.1 Standard setting and comparative audit will only be meaningful if they are carried out in a well defined population of patients. We lack internationally agreed definitions. In particular, there is no standard definition of the point at which an ESRF patient enters the renal replacement programme, particularly if he or she presents as a uraemic emergency.

4.2 ESRF may be defined as a creatinine clearance of <10 ml/min. This level of function is usually associated with uraemic symptoms and is an indication for starting dialysis, though the time chosen to start dialysis is also influenced by such factors as age, nutrition, co-morbid conditions and cause of ESRF. Once a planned decision to start dialysis is made it is usually continued uninterrupted and the date of initiation is clear.

4.3 The situation is more complicated if the patient presents as an emergency and requires resuscitation, investigation and rehabilitation before acceptance into a programme. We propose that, for those patients who are initially treated as acute uraemic emergencies but are subsequently shown to have ESRF, the date of the first dialysis should be deemed to be the point of entry into the renal replacement programme, as it is for those patients who enter the programme in a planned manner.

Some patients undergo repeated admissions during the first few months of treatment, sometimes requiring short periods of dialysis, before becoming permanently dependent on outpatient dialysis. The start of uninterrupted dialysis should then count as the initiation date.

4.4 In the United States patients are regarded as being on the dialysis programme 90 days after being transferred to a free-standing renal unit or 90 days following the first dialysis. The Medicare system starts complete reporting of patient data at day 91, as does the US Renal Data System (USRDS) which includes hospitalisation rates and mortality (using this 90 day rule). The Renal Association subcommittee feels that it would be a wasted opportunity of audit if the UK dialysis programme could not be compared directly with the US data. For this reason the standards outlined in this document for haemodialysis and CAPD recognise the 90 day rule. However we emphasise the importance of medical care, dialysis needs and outcomes during the first 90 days.

Recommendation

Analysis of data should be undertaken from both the point of initiation of uninterrupted dialysis and the 90 day time point.
This will make it possible to make a more accurate assessment of morbidity, outcome and hence costs in the first 90 days. In patients presenting acutely as uraemic emergencies the cost implications are considerable and will need to be emphasised to purchasers.

4.5 The annual incidence of new patients who can benefit from renal replacement therapy is at least 80 new patients per million population (pmp),\textsuperscript{7,8} but this figure is already exceeded in Scotland and Wales and in areas where there is a substantial population of ethnic minorities and if patients aged over 80 are considered.\textsuperscript{9} Age \textit{per se} (even > 80 years) is not a contraindication to dialysis therapy and the decision to offer therapy must be based on clinical considerations.

<table>
<thead>
<tr>
<th>Minimum target</th>
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<tr>
<td>The aim is to achieve an annual acceptance rate of new patients of at least 80 pmp, adjusted as necessary for ethnic and age distribution of the population.</td>
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### Co-morbidity scoring

4.6 The cost of the service is heavily influenced by the fitness of patients on renal replacement therapy (RRT). Comparative audit and setting of standards must necessarily take account of factors other than those of the renal disease itself. Survival on RRT is strikingly influenced by age, diabetes mellitus, ischaemic heart disease, congestive heart failure and peripheral vascular disease.\textsuperscript{10} A system for measuring such co-morbidity would be valuable; a number of approaches have been proposed.\textsuperscript{10,11} In the National Review of Renal Services just completed, age and diabetes mellitus were accounted for after an extensive study of the European Dialysis and Transplant Association (EDTA) database. Three groups of patients were identified:

- **standard risk:** all non-diabetics under the age 55;
- **medium risk:** non-diabetics 55–64 and all diabetics 15–54;
- **high risk:** non-diabetics 65 years and older, diabetics 55 years and older.

The median survivals for each of these groups after the first year were 14.2, 7.4 and 3.5 years respectively.

4.7 At present the system is sufficiently refined to indicate the variables likely to prove most important (ie age, diabetes mellitus, left ventricular failure, ischaemic heart disease, and peripheral vascular disease).\textsuperscript{10} It should be possible to calculate for each patient a risk index incorporating these and other variables, and future editions of this document will address this. In the meantime these recognised major risk factors should be recorded in audit data.

### Supporting evidence

4.8 Setting minimum standards for activities for which evidence of benefit is equivocal is contentious. We have reviewed several problem areas in some detail and concluded that the balance of evidence favours the need for the standard we pro-
pose. Our recommendations are preceded by an explanatory note. In these cases, as the evidence is not conclusive, interpretation must be circumspect.

4.9 In some instances it is necessary to specify methods when setting standards or conducting comparative audit of process or outcome. Important examples are urea kinetic modelling (UKM) and the calculation of mortality rates. These issues are addressed wherever appropriate in this document. More comprehensive guidelines on methodology are being collated and will be published as part of the next revised version of the document, which will also contain recommendations on the frequency of testing and sampling.

4.10 In making the appropriate choice of therapy, patient preference must be considered after informed guidance on dialysis options and transplantation. This will increase the demand for maintenance haemodialysis, particularly in-centre haemodialysis, which has obvious planning, staffing and cost implications. However, equity of access is a fundamental principle of the NHS and can only be exercised if all modes of renal replacement therapy are readily available. This need cannot be overemphasised.
5.1 All haemodialysis equipment should comply with the relevant European safety standards. For haemodialysis machines, the current standard is IEC 601-2-16 (1989) which is equivalent to BS 5724: Section 2.16 (1989).

5.2 The current standards for dialysers and the extracorporeal circuit are ISO 8637 (1989) and ISO 8638 (1989); the equivalent British Standard is BS 7297: Parts 1 and 2 (1990). Where possible, disposables should be purchased from suppliers registered with the DoH Manufacturers Registration Scheme.

5.3 When selecting machines and dialysers, providers should use the manufacturer’s specifications and the DoH evaluation reports to ensure that the performance of the equipment meets the requirements of the renal unit. Renal units should move towards the replacement of older machines with modern systems with facilities for producing bicarbonate based dialysate and volumetric control of ultrafiltration (fluid removal during dialysis).

5.4 Dialyser reprocessing (reuse) equipment should comply with the safety standard for electrical laboratory equipment BS EN 61010-1 (1993). It should be installed and used according to procedures that meet the Control of Substances Hazardous to Health (COSHH) regulations.

5.5 Drinking water standards are inadequate for haemodialysis since patients are exposed to many thousands of litres of dialysis fluid annually. In the USA a quality standard developed by the Association for the Advancement of Medical Instrumentation (AAMI) has been in place for over ten years.\(^{12}\) This AAMI report lists the impurities in treated water entering the dialysis unit, including trace metals like aluminium which has been proven to carry special risks for dialysis patients.

5.6 Microbiological contamination of dialysis fluid has been an increasing problem since the introduction of capillary dialysers with highly permeable membranes in the mid-1980s. The increasing complexity of the fluid path in dialysis machines and the revival of bicarbonate dialysis, which favours the growth of bacteria, have added to the problem.\(^{13}\) Both intact bacteria and endotoxins (potent pyrogenic materials arising from the outer layers of bacterial cells) carry risks for patients. Endotoxins diffuse across intact dialyser membranes which suggests that the ideal would be to use bacteria-free, non-pyrogenic fluid for all dialysis procedures.\(^{14}\) While this was not feasible in the past, expertise in this area has improved and systems have been developed to make this a realistic aim.
5.7 We accept the standard set by AAMI for levels of bacteria in water for dialysis and for dialysis fluid and recommend inclusion of a standard for endotoxin set at the same level as the AAMI standard for reuse water.

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<tr>
<th>Recommended standard</th>
<th>Endotoxin (LAL)</th>
<th>Microbial count</th>
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<tr>
<td></td>
<td>(Eu/ml)</td>
<td>(TVC Cfu/ml)</td>
</tr>
<tr>
<td>Water for dialysis</td>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>Dialysis fluid</td>
<td>2000</td>
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</table>

When testing the microbiological quality of water and dialysis fluid it is important to use correct methods for sampling and culture. ‘Standard’ laboratory techniques can give false levels. Recommended methods and test schedules will be incorporated in the revised version of this document.

5.8 Although it is not widely practised in the UK, we accept that the multiple use of a dialyser in the same patient is an economic necessity when using high flux membranes and there are strong environmental arguments for reprocessing disposable medical equipment. The quality of the water used should be high. We recommend acceptance of the AAMI standard.

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<tr>
<td></td>
<td>(Eu/ml)</td>
<td>(TVC Cfu/ml)</td>
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<tr>
<td>Rinsing water</td>
<td>10</td>
<td>200</td>
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5.9 Bicarbonate was the obvious choice in the early days of dialysis but there were problems with its preparation and delivery. The introduction of acetate in the mid-1960s solved many of these problems and provided the cornerstone for the worldwide expansion of dialysis. The disadvantage of acetate became apparent a decade later when improvement in the efficiency of dialysis highlighted the potential for exceeding the capacity of some patients to metabolise acetate. It is now generally accepted that bicarbonate is the buffer of choice in haemodialysis. It is mandatory if there is evidence of liver disease or when dialysis is carried out in short powerful sessions. There is a continuing trend towards ‘short’ dialysis in Europe.4

**Recommendation**

Renal units should move towards universal availability of bicarbonate dialysis.
5.10 Dialysis with cellulosic membranes produces a range of inflammatory responses. While synthetic membranes may be more beneficial, evidence for this has accrued mainly from laboratory in vitro testing rather than from any measurable clinical advantage. There is growing evidence that blood-membrane bio-incompatibility reactions may play a role in the development of dialysis amyloidosis. Synthetic high flux (high porosity) membranes may confer some benefit in patients with this condition. However, this has not yet been proven.

**Recommendation**

Although the potential benefits of synthetic high flux membranes are recognised, the Association feels that it would be inappropriate at this stage to set a standard for membrane type.

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**Clinical standards and targets**

5.11 As part of the holistic care of dialysis patients the anaemia of chronic renal failure should be corrected by the administration of erythropoietin (EPO). The haemoglobin concentration has a major impact on the quality of life, exercise capacity and sexual function. Repeated blood transfusions cannot maintain haemoglobin at a constant level, may jeopardise future successful transplantation by sensitising the patient, and carries a risk of transmitting viral infections and iron overload.

**Recommendation**

A haemoglobin concentration of 10–12 g/dl in at least 80% of the dialysis population should be achieved.

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5.12 Both inadequate dialysis and poor nutritional status are associated with increased mortality in dialysis patients. Low solute clearance during dialysis may be causally related to poor nutrition. The adequacy of dialysis was previously assessed by simply measuring the pre-dialysis concentrations of urea and creatinine. This method has been discredited because these measures can be misleading in poorly nourished patients.

5.13 Assessment of dialysis adequacy is now carried out using two methods. The reduction in blood urea concentration effected by dialysis — the urea reduction ratio (URR) — provides a crude assessment of the dialysis dose; it has been shown to correlate inversely with patient survival. Urea kinetic modelling (UKM) uses intradialytic urea clearance (K) to calculate a normalised cleared volume (KT/V) where T is the duration of dialysis and V is the volume of distribution of urea, a virtual space approximately corresponding to total body water. If the patient’s own residual urea clearance from the kidney is incorporated into the calculation it is possible to derive a value for the urea generation rate and convert it into protein catabolic rate (PCR). In the steady state this is equal to protein intake. This crude assess-
ment of nutritional status comprises part of the advantage of UKM over the URR. UKM allows better tailoring of the dialysis dose to the individual patient’s needs, given the wide range and variability of residual function in ESRF patients.

5.14 The Association accepts that URR and UKM are useful both to monitor dialysis dose and to identify patients whose dialysis is falling short of the minimum dose.

5.15 The mean number of dialysis sessions carried out per patient per week is 2.90 in the USA and 2.88 in Europe. Virtually all understanding of dialysis adequacy stems from research or observation in patients dialysed thrice weekly. The Association takes the view that while twice weekly dialysis may be necessary in some geographically remote areas, it is not generally recommended except when there is relatively good preservation of residual renal function. Slippage from thrice to twice weekly dialysis to accommodate more patients in congested facilities or to reduce costs should be discouraged.

5.16 The degree of pre-dialysis acidosis can reflect dialysis adequacy. In patients dialysing thrice weekly, pre-dialysis bicarbonate concentrations below 17.5 mmol/l are associated with poor survival. Inadequate dialysis dose, twice weekly dialysis and the use of acetate in relatively short dialysis sessions can compromise bicarbonate delivery.

**Recommendation**

Rather than set a minimum standard for pre-dialysis bicarbonate the Association feels it is appropriate at this stage to recommend regular audit of this parameter in all patients.

5.17 Protein malnutrition with low serum albumin is a powerful predictor of mortality in dialysis patients. Although it is likely that a high prevalence of hypalbuminaemia in a dialysis programme reflects systematic underdialysis, a direct causal relationship between KT/V and serum albumin has not yet been proven. It is therefore more appropriate to recommend regular audit of serum albumin than to
stipulate a precise standard. Since the reported concentration of serum albumin varies substantially with the method employed, the technique of measurement should be recorded in audit data.

**Recommendation**
Only a small percentage of patients should have albumin concentrations outside the normal range.

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**Blood pressure**

5.18 Hypertension is common in chronic renal failure and in ESRF patients. Left ventricular hypertrophy is common and is a predictor of cardiac death in dialysis patients.¹⁹

5.19 Although the literature gives conflicting views on the importance of hypertension as a predictor of death in dialysis patients, it is intuitively felt that its careful control is advisable and indeed that a relatively low target blood pressure is desirable.²⁰

**Recommendation**
The Association recommends the following target pre-dialysis blood pressures; to be achieved in at least 80% of the dialysis population:

- age < 65: 140/90
- age > 65: 160/90

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**Biochemical profiles**

5.20 Electrolyte homeostasis in dialysis patients is to some extent under the control of dialysis staff and is a marker for the quality of care given; dietary indiscretions undoubtedly influence it.

**Recommendation**
The following should be target values for pre-dialysis biochemical variables:

- Potassium: 3.0–6.5 mmol/l
- Phosphate: 1.1–2.0 mmol/l
- Calcium: 2.0–2.8 mmol/l
- iPTH (intact hormone assay): 2–3 times normal range²¹,²²

Regular audit of these parameters will eventually permit calculation of the minimum desirable standards.
5.21 Precautions against viral transmission, designed both for the protection of the staff and to prevent cross infection between patients, are an essential discipline in dialysis patients, the patients being managed as if they were chronic virus carriers. The current practice is based on the Rosenheim Report, which is now outdated, and the Association awaits the recommendations of the Department of Health Working Party on Hepatitis; these will be incorporated into the revised version.

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<tr>
<th>Minimum standards</th>
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<tr>
<td>All patients should be screened for hepatitis B virus (HBV) before admission to a dialysis programme and subsequently at a minimum of six-monthly intervals. Patients who are HBV carriers should be dialysed either in a separate facility or in a separate area within the renal unit.</td>
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5.22 This is heavily influenced by age, diabetes mellitus and cardiovascular disease as shown in 4.6. National and international survival data are available from the European Dialysis and Transplant Association — European Renal Association.23

<table>
<thead>
<tr>
<th>Recommendation</th>
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<tbody>
<tr>
<td>Survival data should be audited by the UK Renal Registry. The outcome results from the EDTA Registry should be used for target setting and comparative audit in the interim.</td>
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### 6 Recommended standards and targets for peritoneal dialysis

**6.1** A unit offering peritoneal dialysis should provide CAPD and automated peritoneal dialysis (APD) as continuous cycling peritoneal dialysis (CCPD) or intermittent peritoneal dialysis (IPD), and have access to adequate back-up haemodialysis facilities. Protocols, regularly reviewed, are essential for all procedures.

**6.2** All electromechanical equipment used to undertake peritoneal dialysis should comply with national and international standards for electromechanical safety (IEC 601: part 1). For peritoneal dialysis equipment the specific European standard is awaiting ratification; the British Standard is BS 5724: Section 2.29 (1992) (equivalent to haemodialysis BS 5724: Section 2.16 (1989)). Such equipment should be purchased from manufacturers registered with the Department of Health Manufacturers Registration Scheme [IRC 9001].

**6.3** Disconnect systems are superior to earlier systems. Their use results in a significantly lower incidence of peritonitis and a better quality of life. Such systems should be standard.

**Minimum standard**

Use of disconnect systems as standard.

**6.4** The use of cycling machines at home may be necessary for clinical [high transporter status of peritoneum and loss of ultrafiltration] or psychosocial reasons. These systems are more expensive and hence used sparingly. Their selective use should be reflected in charges to purchasers.

**6.5** In selected patients specialised solutions are preferable to standard solutions. Such solutions, with variations in the concentration of calcium, magnesium, osmotic agents and buffers, are likely to be more expensive and their selective use should be reflected in charges to purchasers.
Clinical standards and targets

6.6 Those standards listed for patients on haemodialysis (Section 5) which apply equally to peritoneal dialysis are:

- Correction of anaemia (5.11)
- Nutritional status (5.17)
- Blood pressure (5.19)
- Biochemical profiles (5.20)
- Prevention of transmissible infections to patients and staff (5.21)

6.7 Correction of acidosis is readily achieved by the use of higher lactate PD fluids and of oral calcium carbonate as phosphate binder.20

Recommendation
The steady state serum bicarbonate level should be within the normal range.

6.8 A peritoneal equilibration test (PET)27 assesses the peritoneal membrane transporter status. It may be helpful in prescribing the appropriate peritoneal dialysis regime.

Recommendation
Performance of PET in special situations of loss of ultrafiltration and poor biochemical control.

6.9 There are various measurements by which the adequacy of peritoneal dialysis can be assessed (KT/V urea, creatinine clearance, Brand’s efficacy number, dialysis index) but there is still controversy over the optimum parameter,28,29 and the link between dialysis dose and outcome.29,30 Targets of weekly KT/V urea > 1.7, or total weekly creatinine clearance > 50, have been advocated for standard CAPD31 and a KT/V of less than 1.65 was associated with poor outcome in one report.32 We believe that the concept of adequacy is important but at present no minimum standard can be set. Decline in residual renal function has an important bearing on the adequacy of dialysis. Consequently, residual renal function should be assessed whenever underdialysis is suspected.33 It can be combined with the measurement of renal urea excretion which is essential for the calculation of PCR to confirm that patients are taking their recommended protein intake (at least 0.8 g/kg/day but ideally >1.0 g/kg/day).

Recommendation
No minimum standard is recommended now but it is likely that minimum KT/V and creatinine clearance values for CAPD will become established soon and will exceed the values quoted above. For APD the values will need to be higher.
6.10 Peritonitis rates are improving with the introduction of disconnect systems.\textsuperscript{24,25} The successful diagnosis and management of peritonitis requires high quality microbiological facilities and close liaison with the microbiology department. Protocols for managing peritonitis episodes have been published\textsuperscript{34,35} which we recommend.

<table>
<thead>
<tr>
<th>Minimum standards</th>
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<tbody>
<tr>
<td>Peritonitis rates &lt; 1 episode/18 patient months</td>
</tr>
<tr>
<td>Culture negative rate &lt; 10%</td>
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<tr>
<td>Initial cure rate of peritonitis &gt; 80% (without removal of catheter)</td>
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</table>

6.11 Guidelines for insertion of peritoneal access catheters and their subsequent care have been published\textsuperscript{36} and we recommend these. Audit of outcome of catheter results is recommended.

6.12 Outcome measures of patients and technique survival are functions of case-mix, availability of appropriate dialysis facilities and patient related factors. Survival data are similar to those for haemodialysis (5.22) and similar recommendations apply.
Audit of the treatment of patients with ESRF on dialysis

7.1 Audit is mandatory for demonstrating the quality of care given and for guiding further improvement. To be effective, a wide range of quality outcomes must be measured frequently and compared between institutions. Comparative audit using agreed standardised formats for the exchange of data will create aggregate databases. We recommend that audit initiatives be concentrated on measurement of outcomes and on processes that have a proven role in determining morbidity and mortality in ESRF patients.

Haemodialysis

7.2 Demographic data:
- age distribution of patients receiving haemodialysis
- numbers on home haemodialysis v centre haemodialysis
- numbers on thrice v twice weekly dialysis

7.3 Technique: numbers of patients on:
- bicarbonate v acetate
- cellulosic v synthetic membranes
- standard v high flux dialysis v haemofiltration

7.4 Correction of anaemia:
- Percentage of patients receiving erythropoietin
- Haemoglobin frequency distribution (all patients)
- Percentage of patients with Hb < 10 g/dl

7.5 Dialysis adequacy and nutrition:
- KT/V or URR frequency distribution in dialysis population.
- Assessed dietary protein intake (DPI) frequency distribution

OR
- UKM-assessed protein catabolic rate frequency distribution
- Pre-dialysis serum bicarbonate frequency distribution
- Pre-dialysis serum albumin frequency distribution
7.6 Blood pressure control:

Systolic, diastolic and mean arterial pressure (MAP) frequency distribution.

7.7 Biochemical profiles:

Pre-dialysis potassium, calcium, phosphate and iPTH frequency distribution.

7.8 Transmissible disease:

Prevalence of hepatitis B surface antigen positive patients.

7.9 Hospitalisation:

The number of admissions to hospital and the mortality rate are crude markers of the general health of a population of dialysis patients. This information is only meaningful if the population is clearly defined and account is taken of co-morbidity factors.

7.10 Audit:

Mean admissions to hospital per patient per year
Mean days spent in hospital per patient per year
(Both calculated for patients >90 days on dialysis)

7.11 Water quality:

Bacterial counts and endotoxin levels: Test frequency and results.

7.12 Outcome:

Patient survival

Peritoneal dialysis

7.13 Demographic data:

Age distribution of patients receiving peritoneal dialysis

7.14 Technique:

Number of patients on disconnect systems
Numbers on CAPD, APD

7.15 Correction of anaemia:

As for haemodialysis (7.4)
7.16 Dialysis adequacy and nutrition
   Assessed dietary protein intake frequency distribution
   Serum bicarbonate frequency distribution
   Serum albumin frequency distribution

7.17 Blood pressure control:
   As for haemodialysis (7.6)

7.18 Biochemical profiles:
   As for haemodialysis (7.7)

7.19 Transmissible diseases:
   As for haemodialysis (7.8)

7.20 Peritonitis:
   Peritonitis rate — episodes/patient month of therapy
   Primary cure rate — % (without need to remove catheter)
   Culture negative rate — %

7.21 Hospitalisation:
   As for haemodialysis (7.9)

7.22 Temporary transfer (< 2 months duration) to haemodialysis:
   Number and rate

7.23 Catheter survival rate
8.1 Renal transplantation is the most cost effective treatment for patients with end-stage renal failure. Supply (averaging 30 kidneys per million population per year in the UK) is outstripped by demand (minimum need for 48 kidneys per million population per year). Donor organs are therefore an extremely valuable resource. It is important that equity of access to transplantation is achieved both in geographical terms and for those with uncommon HLA tissue types. Renal transplantation should be centralised. This avoids the duplication of specialised resources such as tissue typing laboratories and donor procurement teams.

**Recommendation**

There must be demonstrable equity of access to donor organs irrespective of sex, race or district of residence.

8.2 Allograft survival is improved by very close matching (0 DR mismatches and only 1 mismatch at the A and B loci); this is termed beneficial matching. Controversy exists as to the value of less close matches.

**Recommendation**

The current UKTSSA policy of beneficial matching be followed. Mismatches with common antigens should be avoided, particularly in younger recipients who may require further transplantation in the future.

8.3 The outcome (patient and graft survival) depends on the presence of co-morbid conditions at time of transplantation, the degree of sensitisation and the HLA matching and immunosuppressive regimes. Hence, no minimum standards can be set. However, with careful pre-operative selection of transplant recipients, a one-year patient survival of >95% and a subsequent annual death rate of <5% can be achieved. First cadaveric graft survival should exceed 80% at one year, with a five-year allograft survival of 70%. Gift survival in highly sensitised patients (peak PRA >85%) and other high risk groups (for example some diabetics) is less (approximately 75% at one year). Patient and allograft survival with well matched live related donors should be close to 100% and 90% respectively at one year with subsequent annual death and graft failure rates of <2.5%.

A method for assessing graft survival, with exclusion of functioning grafts lost because of a patient’s death from other causes, is appropriate. This technique removes the age factor in analysis and comparative audit is then possible. The Association feels that monitoring these outcomes as part of audit will set the appropriate standards.
8.4 Transplant audit

- number of renal transplants performed (live related, cadaveric)
- transplant waiting list at time of audit: % waiting >2 years, >5 years
- equity of access to organs.
- graft and patient survival for year of audit.
- % of patients highly sensitised (>85% PRA)

8.5 A more complete set of standards and audit guidelines is being formulated in conjunction with the British Transplantation Society and should be available by the end of 1996.
9.1 At a conservative estimate, the clinical incidence of acute renal failure is 70 patients pmp/year. Most of these patients require dialysis. There is however significant under-referral. Patients with acute renal failure complicating severe illness require multidisciplinary care in which the nephrologist plays a crucial role. Many of these patients are critically ill and may need transfer to intensive care units for appropriate care; safe transfer is essential and needs proper organisation.

9.2 Some units may be able to perform continuous haemofiltration within the ward or HDU but in the majority of centres this facility is only available in the ICU. Peritoneal dialysis can be used in non-catabolic patients. However it should not be regarded as a substitute for extracorporeal methods of blood purification on the grounds of lack of facilities.

9.3 These are as described in the sections on haemodialysis and peritoneal dialysis (Chapters 5 and 6).

9.4 Survival following acute renal failure depends upon the underlying disease processes and case mix, but overall a third are alive at two years. In those with simple acute renal failure uncomplicated by other organ failure, the mortality should be low (< 10%). Patients with multiple organ failure have a worse prognosis (mortality 40-90%); those with four or more organ system failures or an Apache II score >35 will have a mortality of greater than 90%. Currently the Intensive Care Society is undertaking a national audit on Apache and other systems for scoring and outcome prediction. The Association is thus unable to recommend a standard at present.

9.5 Data to be recorded should include:

- Number of patients annually with ARF requiring renal support with:
  - causes
  - duration of support
  - Apache II score or number of organs failing
  - outcome

- Number of patients with significant ARF (serum urea > 30 mmol/l, creatinine >300 µmol/l) not requiring dialysis
  - outcome
10.1 Patients with progressive renal insufficiency need careful follow-up and monitoring to slow progression of chronic renal failure when possible, to prevent complications of renal failure and to prepare patients for the appropriate renal replacement therapy. Early referral of such patients to a nephrologist is indicated but not always practised in the UK at present.

10.2 As control of systemic hypertension is so far the only intervention (other than treatment of the primary disease) that can slow the progression of CRF, optimal blood pressure control is essential. ACE inhibitors have shown some advantage over other antihypertensives, especially in diabetic patients.

### Minimum standard

Target blood pressure should be:

- Age <60 — BP <140/90
- Age >60 — BP <160/90

(for certain diabetic patients these may need to be lower)

10.3 Optimal control of calcium, phosphate, iPTH and metabolic acidosis is important and may well have an impact on the progression of renal disease. Dietary control is important. Each patient should be assessed by a renal dietitian at regular intervals to optimise mineral, protein, fat and total calorie intakes.

### Recommendation

Target ranges for:

- Serum calcium 2.2–2.6 mmol/l
- Serum phosphate 0.8–1.5 mmol/l
- Serum iPTH ≤ twice upper limit of normal (intact molecule assay)

10.4 Data should be collected on:

- Blood pressure: % of patients achieving target levels
- Serum calcium and phosphate: % achieving target levels.

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**Audit of CRF**

- Blood pressure: % of patients achieving target levels
- Serum calcium and phosphate: % achieving target levels.
11 General nephrology

11.1 The early diagnosis and prompt treatment of many forms of renal disease prevent renal failure, may obviate the need for renal replacement therapy and reduce co-morbidity in those requiring treatment for ESRF.

Recommendation

The care of patients with renal disease should be through a special renal clinic. In the case of patients with diabetic nephropathy, a joint specialist diabetic/renal clinic is a considerable advantage.
Appendix 1
Incidence, nature and treatment of renal disease — A guide for the non-specialist

Introduction
A.1 This appendix gives information on the issues discussed elsewhere in this document, provides background information on renal failure, and discusses the services available for its treatment.

Renal disease
A.2 Diseases of the kidney are not as common as cardiovascular conditions or cancers, but are much more common than some well-known disorders such as multiple sclerosis or muscular dystrophy. Renal conditions account for about 7,000 deaths per annum according to the Registrar General’s figures, but these are probably an underestimate since about one-third of deaths of patients with renal failure are not recorded as such in mortality statistics. These figures exclude deaths from cancers of the kidney and associated organs of the urinary tract such as bladder and prostate.

A.3 Over 100 different diseases affect the kidneys. These diseases may present early with features such as pain, blood or protein in the urine or peripheral oedema (swelling in the legs) but much renal disease is self-limiting; it occurs and heals with few or no symptoms or sequelae. On the other hand some kidney diseases start insidiously and progress but are undetected until renal failure develops.

Acute renal failure
A.4 Renal failure may be acute and reversible. It occurs in previously normal kidneys when their blood supply is compromised by a fall in blood pressure caused by crush injuries, major surgery, failure of the heart’s pumping action, loss of blood, salt or water, or when they are damaged by poisons or overwhelming infection. Renal support is then needed for a few days or weeks before renal function returns. However, about half such patients die during the illness because of other conditions.

Chronic renal failure
A.5 More common is chronic irreversible renal failure, in which the kidneys are slowly destroyed over months or years. To begin with there is little to see or find, and this means that many patients present for medical help very late in their disease, or even in the terminal stages. Tiredness, anaemia, a feeling of being ‘run down’ are often the only symptoms. However if blood pressure develops, as often happens when the kidneys fail, or is the prime cause of the kidney disease, it may cause headache, breathlessness and perhaps angina. Ankle swelling may occur if there is a considerable loss of protein in the urine.
A.6 Progressive loss of kidney function is often described as chronic renal insufficiency in its early stages, chronic renal failure when it becomes obvious, and end-stage renal failure when it reaches its terminal stage. At this point, if nothing is done, the patient will die. Two complementary forms of treatment — dialysis and renal transplantation — are available and both are needed if end-stage renal disease is to be treated.

A.7 The incidence of end-stage renal failure rises steeply with advancing age. Consequently an increasing proportion of patients treated for end-stage renal failure in this country are elderly and the proportion is even higher in some other developed countries. Evidence from the United States suggests that the relative risk of end-stage renal failure in the black population (predominantly of African origin) is two to four times higher than for whites. Data collected during the review of renal specialist services in London suggest that there is a similar greater risk of renal failure in the ethnic minority population (Asian and Afro-Caribbean) in the Thames regions than in whites. People from the Indian subcontinent have a higher prevalence of non-insulin dependent diabetes, and those with diabetes are more likely to develop renal failure than whites. This partly explains the higher acceptance rate of Asians on to renal replacement programmes.

A.8 Most renal diseases that cause renal failure fall into the following:

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

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

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

iv **Obstruction:** Anything which obstructs the free flow of urine can cause back-pressure on the kidneys. Much the commonest cause is enlargement of the prostate in elderly men; although only a small proportion of them develop kidney failure, prostatism is so common that it becomes a major cause of renal failure over the age of 70.
**Infection of the urine:** Cystitis is a very common condition, affecting about half of all women at some time in their lives, but it rarely has serious consequences. However, infection of the urine in young children or patients with obstruction, kidney stones or other abnormalities of the urinary tract may result in scarring of the kidney and eventual kidney failure.

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

### Prevention

A.9 Although many diseases causing chronic renal failure cannot be prevented or arrested at present, better control of diabetes and high blood pressure and relief of obstruction have much to offer, provided they are employed early in the course of the disease before much renal damage has occurred. Screening for renal disease has not been widely practised, because the relatively low incidence of cases renders population screening inefficient and costly. Urine tests for protein or blood, or blood tests for the level of some substances normally excreted by the kidney such as creatinine and urea, are potentially useful methods for screening, if populations at risk for renal failure can be identified — for example, diabetics and the elderly.

### Co-morbidity

A.10 Renal failure is often accompanied by other disease processes. Some are due to the primary disease, e.g. diabetes may cause blindness and damage to the nerves and blood vessels. Others, such as anaemia, bone disease and heart failure, are consequences of the renal failure. Coincidental diseases such as chronic bronchitis and arthritis are particularly common in older patients with renal failure. All these conditions, collectively called co-morbidity, can influence the choice of treatment for renal failure and may reduce its benefits. Expert assessment of the patient before end-stage renal failure can reduce co-morbidity and increase the benefit and cost-effectiveness of treatment. Thus early detection and referral of patients at risk of renal failure is important. A study in the United States showed that the mortality rate among patients over 55 at the start of regular dialysis increased dramatically if dialysis was started late in the illness.46

### Renal replacement therapy

A.11 The term ‘renal replacement therapy’ is used to describe those treatments for end-stage renal failure in which, in the absence of kidney function, the removal of waste products from the body is achieved by dialysis and other kidney functions are supplemented by drugs. It is also the term which covers the complete replacement of all kidney functions by transplantation.
Therapeutic dialysis ('renal dialysis')

A.12 Dialysis involves the removal of waste products from the blood by allowing these products to diffuse across a thin membrane into dialysis fluid which is then discarded along with the toxic waste products. The fluid is chemically composed to draw or ‘attract’ excess salts and water from the blood to cross the membrane, without the blood itself being in contact with the fluid.

A.13 The method first used to achieve dialysis was the artificial kidney, or haemodialysis. This involves the attachment of the patient’s circulation to a machine through which fluid is passed, and exchange can take place. A disadvantage of this method is that some form of permanent access to the circulation must be produced to be used at every treatment. Each session lasts 4–5 hours and is needed three times a week.

A.14 The alternative is peritoneal dialysis, often carried out in the form of continuous ambulatory peritoneal dialysis (CAPD). In this technique, fluid is introduced into and withdrawn from the peritoneal cavity which lies around the bowel; the washing fluid must be sterile in order to avoid peritonitis (infection and inflammation of the peritoneum), which is the main complication of the treatment. A silastic tube must be implanted into the peritoneum and this may give problems such as kinking and malposition. Each treatment lasts 30–40 minutes and is repeated three or four times daily.

A.15 Neither form of dialysis corrects the loss of the hormones secreted by the normal kidney so replacement with synthetic erythropoietin (EPO) and vitamin D is often necessary.

Renal transplantation

A.16 Renal transplantation replaces all the kidney’s functions so EPO and vitamin D supplementation are unnecessary. A single kidney is placed, usually in the pelvis close to the bladder, to which the ureter is connected. The kidney is attached to a nearby artery and vein. The immediate problem is the body’s acute rejection of the foreign graft, which has largely been overcome during the first months using drugs such as steroids and cyclosporin. These drugs, and others which can be used for that purpose, have many undesirable side effects, including the acceleration of vascular disease so that myocardial infarcts and strokes are commoner in transplant patients than in age-matched controls. During subsequent years there is a steady loss of transplanted kidneys from a process of chronic rejection; treatment of this is quite unsatisfactory at the moment so many patients require a second or even a third graft over several decades, with further periods of dialysis in between.

A.17 The main problem with expanding transplantation is the shortage of suitable kidneys to transplant. Although the situation can be improved it is now clear that whatever social and medical structures are present and whatever legislation is adopted, there will inevitably be a shortage of kidneys from humans. This remains
the case even if kidneys from the newly dead (cadaver kidneys) are retrieved with maximum efficiency, and living donors (usually but not always from close blood relatives of the recipient) are used wherever appropriate. Hope for the future rests with solving the problems of xenotransplantation (that is, using animal kidneys), probably from pigs, although baboons have also been suggested and are closer to humans. Many problems remain unsolved and it is thought highly unlikely that xenotransplantation will become a reliable treatment for end-stage renal failure within the next 20 years.

The nature of renal services

A.18 The work of a nephrologist includes the early detection and diagnosis of renal disease and the long-term management of its complications such as high blood pressure, anaemia and bone disease. The nephrologist may share the management with the GP or local hospital physician, and relies on them to refer patients early for initial diagnosis and specific treatment. Inpatient work accounts for perhaps 5% of patients under care at any one time, but is complex, and experienced medical advice must be available on a 24-hour basis. About 95% of renal work is sustained on an outpatient basis; this includes most renal replacement therapy by dialysis and the care of transplant patients. There are five major components to renal medicine:

i **Renal replacement therapy:** The most significant element of work is in relation to the preparation of patients in end-stage renal failure for renal replacement therapy and their medical supervision for the remainder of their lives. The patient population will present increasing challenges for renal staffing as more elderly and diabetic patients are accepted for treatment.

ii **Emergency work:** The emergency work associated with the specialty consists of:

- the treatment of acute renal failure, often involving multi-organ failure and acute-on-chronic renal failure. Close cooperation with other medical specialties, including intensive care, is therefore a vital component of this aspect of the service.
- the management of medical emergencies arising from an end-stage renal failure programme. This workload is bound to expand as the number and age of patients starting renal replacement therapy increase.

iii **Routine nephrology:** A substantial workload is associated with the immunological and metabolic nature of renal disease which requires investigative procedures in an inpatient setting. It is estimated that ten inpatient beds per million of the population are required for this work.

iv **Investigation and management of fluid and electrolyte disorders:** This is a variable proportion of the nephrologist’s work, depending on the other expertise available in the hospital.

v **Outpatient work:** The outpatient work in renal medicine consists of the majority of general nephrology together with clinics attended by dialysis and renal transplant patients.
Appendix 2
Special arrangements for children with renal disease

Submitted by the British Association for Paediatric Nephrology

The purpose of this appendix is to outline the additional requirements necessary for the audit and treatment of children with renal disease.

The British Association for Paediatric Nephrology’s document *The provision of services in the United Kingdom for children and adolescents with renal disease* describes in detail the service requirements for a paediatric nephrology unit. Three important principles must be abstracted from that document:

- Children with renal disease are first and foremost children. Any unit offering care for children and young people with renal disease would be expected to fully implement the Department of Health guidelines: ‘The welfare of young children in hospital’ (1991)
- A high quality paediatric renal service must be family orientated and delivered by a multidisciplinary team which includes specialist nursing, child psychiatry and psychology, dietetics, social work, teaching and play therapy, in addition to medical and surgical staff.
- All children with renal disease should be investigated and treated by paediatricians, paediatric nephrologists, paediatric urologists and paediatric surgeons.

*The numbers against the following items refer to paragraphs in the main document:*

2.1 The number of children entering ESRF programmes has shown a steady rise from 6.6 per million child population (aged 15 years or less) in 1984, to 7.4 pmcp in 1986 and 9.7 pmcp in 1992. However the total number of new patients per year is small, being 446 in the United Kingdom in 1992. To maintain expertise, the care of these children must be in specialist paediatric nephrology centres.

4.4 Even newborn infants are now accepted into ESRF programmes. However, as the overall numbers of children developing ESRF are small, there are variations in the annual take-on rate.

4.6 Co-morbidity may be an important factor in children with multiple congenital abnormalities.

5.9 All children should receive bicarbonate dialysis.

5.13 UKM is hard to measure in children in whom urine collection and satisfactory estimations of TBW are difficult. The best parameter for assessment of treatment adequacy in children is the rate of growth which should be formally assessed on a
6-monthly basis. Head growth should also be assessed. Pre-dialysis urea should be maintained below 30 mmol/l.

5.17 Some children may need enteral feeding (nasogastric, jejunal or by gastrostomy) to achieve adequate calorie intake.

5.19 Blood pressure should be maintained within 2 standard deviations from the mean for normal children of the same height.

5.20 The normal range for plasma phosphate falls throughout childhood, and should be kept within 2 standard deviations from the mean. There is no evidence that an iPTH above normal is beneficial in childhood, so iPTH should be maintained below twice the upper limit of the normal range.

6.4 Automated peritoneal dialysis is the most appropriate type of dialysis for infants, and for older children with loss of ultrafiltration.

6.6 Control of hyperparathyroidism is important in children to prevent long-term disability from bone disease and to maximise growth. Most children are best managed with low calcium dialysate.

6.9 see 5.13

7.4 Percent with a haemoglobin <10g/dl on 2 visits over 2 months.

7.5 Rate of growth
   Number of children receiving enteral feeds
   Progression in puberty
   Developmental assessment
   Psychosocial development
   Number on growth hormone
   Pre-dialysis serum urea

7.6 and 7.7 BP and biochemical profiles will be audited at clinic visits

7.9 Rates of hospitalisation do not reflect morbidity in children. Infants with structural abnormalities require frequent admissions for urological procedures. Simple procedures may require general anaesthesia in children. Respite care is needed more often in childhood.

8.3 Patient and graft survival post transplant improves with age during childhood. Three-year patient and graft survival is respectively 89% and 59% in those <6 years of age at grafting; 94% and 65% in 6–9 year olds; and 96% and 68% in children aged 10–14 years (EDTA 1992).
8.4  
- growth post-transplant  
- incidence of rejection episodes  
- percentage of children maintained on alternate day steroids  
- number of children with steroid resistant rejection  
- transplant waiting times by blood group.

9.1 The incidence of acute renal failure in children is 7.5 pmp per year. In 68% this is due to the haemolytic uraemic syndrome, the incidence of which continues to rise.

9.2 Most children are managed by peritoneal dialysis using automated peritoneal dialysis machines, unless there is a need for plasma exchange.

9.5  
- Number of children treated with plasma exchange  
- Audit of those not needing dialysis is difficult as many such children are not referred to paediatric nephrology departments

10.1 The prevalence of chronic renal failure was 53 pmcp on 31.12.92. The national acceptance rate of 4.2 pmp per year represents 240 new patients in the UK. These children should be managed in specialist nephrology centres, or in centres with shared care arrangements with a paediatric nephrologist.

10.2 Blood pressure should be maintained within 2 standard deviations of the mean for normal children of the same height.

10.3 Head circumference, growth and progress in puberty should be assessed at each visit.

10.4  
- Growth  
- Head circumference  
- Progress in puberty  
- Developmental stage  
- Psychosocial development

11.1 In many children with CRF it has a urological cause, and joint clinics with paediatric nephrologists and urologists are needed.
References


