Pre-dialysis hospital use and late referrals in incident dialysis patients in England: a retrospective cohort study

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ABSTRACT

Background. Timely referral to specialist kidney care can improve outcomes for patients and delay the onset of dialysis, yet late referral (LR) remains a problem in many countries. We aimed to estimate the proportion of LRs that could potentially have been detected earlier because of increases in patients’ general hospital activity.

Methods. A cohort of patients starting dialysis in the English NHS (National Health Service) during 2010/11 was approximated using hospital administrative data. The time between first recorded contact with a consultant nephrologist and starting dialysis was used to categorize the timeliness of referral. Monthly rates of inpatient activity prior to starting dialysis for both referral types were compared with the national average.

Results. A cohort of 3928 patients was detected. One-third (34%) of the cohort started dialysis <90 days after their first referral to a nephrologist. Rates were higher for patients starting haemodialysis than peritoneal dialysis. The proportion of patients receiving their first dialysis as an emergency rises from 27% for those referred before 3 months to 67% for those referred on or after the day of starting dialysis. Half of the late referred patients (49%) have hospital activity rates more than double the national average (adjusted for age and sex) at 90 days before they start dialysis.

Conclusions. A substantial proportion of patients (49%) referred late for specialist kidney care have had regular contact with other hospital services. This could represent a missed opportunity to improve outcomes by timely management of their kidney disease.

Keywords: chronic renal failure, data linkage, dialysis, ESRD, hospitalization

INTRODUCTION

In 2011, 50% of the 44 665 adults receiving renal replacement therapy (RRT) in England were on dialysis [43% via haemodialysis (HD) and 7% using peritoneal dialysis (PD)] [1], and the cost of dialysis treatment to the National Health Service (NHS) was £527 million [2]. The UK Renal Registry reported that 20% of patients starting dialysis in 2009 and 2010 were referred to specialist kidney care late (defined as <90 days before starting dialysis) [3]. Previous international studies estimated between 11 and 83% of patients starting dialysis were referred to a consultant nephrologist late [4, 5].

Dialysis reduces the patient’s quality of life and is best delayed until the optimum point [6]. Chances of achieving this are improved when a patient has contact with a specialist nephrologist [7]. Indeed, the accepted definition of ‘late’ referrals is cast in terms of optimal management of the patient: ‘when management could have been improved by earlier contact with renal services’ [8]. Studies have demonstrated an association between late referral (LR) and negative outcomes, which include extended hospital stays and increased risk of mortality [9, 10].

Practical definitions of LR vary, but it is most commonly operationalized as less than either 3 or 4 months [4, 5, 10]. After establishing which referrals are late, the next question is to what extent these LRs might be avoidable. While the question is commonly posed [4, 11], only a limited number of studies have suggested answers. Their estimates range from 4 to 82%, due to differences in the definition of ‘avoidable’ [12, 13].

Reasons for LR have been categorized into three types [14]:

(i) Disease-related, where the mode of onset is either sudden or undetectable (estimated as 15–20% of LRs).
(ii) Patient-related, where the patient avoids referral due to personal concerns or the lack of understanding of their condition.

(iii) Physician- or health system-related, where either the primary care physician prefers to manage complex comorbid patients themselves, is not aware of the benefits of early referral to a nephrologist, or access to nephrologists is limited.

This study used hospital administrative data to examine what proportion of patients in this third category—where a patient is known to the health system but not receiving specialist kidney care—could be detected by comparing their pre-dialysis hospital use with average activity rates.

**Materials and Methods**

**Study population**

Hospital administrative data were used to approximate a cohort of patients starting dialysis in the English NHS during 2010/11. The data were drawn from Hospital Episode Statistics (HES)—a data warehouse containing details of all inpatient and outpatient visits to NHS hospitals in England. The data are anonymized but a pseudonymous patient ID allows care episodes to be linked together over time. These data include limited clinical information (coded diagnoses, operations and treatment specialty), information about the patient (age, gender and ethnicity) and administrative information (provider, dates of admission and discharge, and type of admission).

These administrative datasets do not directly record test results (such as glomerular filtration rate) or prescribed medication, meaning that disease stage for CKD has to be inferred using other approaches. We used HES data from April 2001 to March 2011 to identify a cohort of patients starting dialysis in 2010/11 using the following process:

(i) Select any patient receiving codes that indicate dialysis between April 2010 and March 2011 (codes available in Supplementary file).

(ii) The secondary care histories of these patients between April 2001 and March 2010 were examined, and patients with a prior history of kidney transplantation or receiving dialysis before April 2010 or aged under 18 in 2010/11 were excluded.

(iii) Patients starting PD were identified based on the surgical procedure required for PD (insertion of an ambulatory PD catheter) or having any recorded sessions of PD.

(iv) Remaining individuals will have received HD, but some have only had single events (for example, as treatment for acute kidney injury, AKI). To identify the patients on a regular regime of HD, we applied a threshold number of dialysis events (three) beyond which a patient’s dialysis was considered regular. This was set when the number of individuals identified in the data became fewer than that listed in the UK Renal Registry [3] for patients starting dialysis in 2010.

**Measures**

Distributions of age, gender and ethnicity within the cohort were measured by modality. For each member of the cohort, we calculated the time between their first recorded care under the nephrology specialty and the date of their first dialysis treatment. The cost of each patient’s secondary care activity was calculated according to the method used by Dixon et al. [16]. Rates of inpatient activity were defined as a rolling 12-month average of the number of inpatient admissions for each patient.

**Assessment and statistical analysis**

The cohort was validated by comparing distributions of age, gender and ethnicity with those reported by the UK Renal Registry [3].

The time between first recorded contact with a consultant nephrologist and starting dialysis was used to categorize the timeliness of referral. Rates of patient recruitment to nephrologists were estimated by training a linear regression on the rate of recruitment in the 48- to 12-month period and projected the trend forward.

Age- and sex-specific rates of inpatient activity were calculated monthly for the entire population of England. The numerator was all inpatient admissions in HES and the denominator was the national population estimate [17] that applied to each month. Ages were grouped in 5-year blocks, and set relative to age at April 2010. Activity for cohort members was compared with that for the general population, matched on age, sex and month.

Data analysis was done using SAS v9.3 and Excel.

**Results**

Identifying patients receiving dialysis treatment in national administrative databases yielded 3928 adult patients starting their dialysis in 2010/11. Of these, 2949 (75%) were on HD and 979 (25%) on PD. This compares with 3755 and 1043 reported by the Renal Registry in England for 2010. Around one-fifth (19%) of the cohort were aged under 50, and nearly half of the cohort (44%) were aged over 70. Patients on HD tended to be older (44% of patients starting HD were over 70, compared with just 26% starting PD). Distributions of age, gender and ethnicity were broadly similar to those reported by the Renal Registry (Figure 1).

The proportion of the cohort under the care of a consultant nephrologist increased in both modalities as patients approach dialysis (Figure 2). For HD patients, this increased from 18% of the cohort 5 years before starting dialysis to 49% 1 year before, and from 30 to 71% for PD patients.

The rate of recruitment increased markedly in the period less than 1 year before starting dialysis. One month before starting dialysis, 66% of the HD cohort and 88% of the PD cohort had been referred to a specialist nephrologist, compared with 54...
and 78% had the established trend continued. Despite this increase, 30% (HD) and 9% (PD) do not see a nephrologist until the day they start their dialysis.

Previous studies have used many definitions of a ‘late’ referral. Table 1 presents the proportion of patients in the cohort that had seen a nephrologist at each of the most common definitions of ‘late’ referral. These were consistent with the ranges found in two systematic reviews [4, 5].

Adopting a definition of ‘late’ referral as patients referred <90 days before RRT, 40% (HD) and 17% (PD) of patients in this cohort were referred late. Patients with timely referral (≥90 days before starting dialysis) received their first dialysis session as an emergency in 27% of cases, which increased to 35% for patients referred between 90 and 1 day(s) before starting dialysis and finally reached 67% for patients referred on the day of starting dialysis or afterwards. In some cases, the need for dialysis would have been caused by an irreversible AKI, which would not necessarily be preventable by a nephrologist. We found that 28% of patients referred late had a new diagnosis of AKI associated with their dialysis, compared with 6% for patients with timely referral.

Table 2 compares the total cost of hospital use of patients who have timely referrals with those who have LRs. Over the 5-year period before starting dialysis, patients with timely referrals tend to use more secondary care than those with LRs. However, as patients approach dialysis the costs for the LR group rise more sharply, and exceed those of their counterparts from ∼3 months before dialysis.

Rates of inpatient admissions for the cohort before starting dialysis were compared with the national average, adjusted for age and sex. At 5 years before dialysis, 20% of the cohort already had activity levels twice the comparable national average. This included 13% of the LR group. A further 21% did not have increased hospital activity until after starting dialysis (35% LR and 14% TR). Figure 3 shows the way in which the proportion of the cohort who had elevated activity rates increases over time. While there was a marked increase in the number of patients with LRs whose increase in activity occurs within that 3-month window, nearly half of the LR group (49%) already have elevated activity rates before referral. Indeed, 44% of the LR group have activity rates twice the comparable national average full 12 months before starting dialysis. The proportion of patients who

![Figure 1: Description of key feature of cohort and comparison with data reported by the UK Renal Registry.](https://academic.oup.com/ndt/article-abstract/30/1/124/2332881)
DISCUSSION

Key findings

We were able to produce a cohort of patients starting dialysis in England in 2010/11 with recorded evidence of dialysis, and similar distributions of age, sex and ethnicity to that reported by the UK Renal Registry using an algorithm based on hospital administrative data.

Patient recruitment to a consultant nephrologist increased rapidly in the year before starting dialysis, but 40% of the HD cohort and 12% of PD were referred <90 days before beginning RRT—a common threshold for ‘late’ referral. It was much more common for late referred patients to receive their first dialysis during an emergency admission than those with timely referrals (>90 days).

Forty-nine percent of patients with LRs have rates of general inpatient admission more than double the national average (adjusting for age and sex) in the period before referral. If it is assumed that a patient’s end stage renal disease could have been detected at some point during their increased hospital activity, this analysis suggests that up to half of LRs may have been avoidable.

Comparison with existing knowledge

This study is consistent with previous estimates of the level of LR [4, 5]. This consistency was present at all thresholds except the proportion referred <1 day before starting dialysis, where our findings were lower. The finding that patients referred late have higher costs when on dialysis is consistent with a previous study [18].

Very few studies have estimated the proportion of LRs that were avoidable, and their results are substantially different. Our study has a much larger sample size than previous studies, and it is important to remember that 49% represents an upper limit on avoidable LRs.

Strengths and weaknesses

It is a strength of the study that it attempted to capture activity for every patient starting dialysis in England, using a complete database of activity in English hospitals that covers more than a decade of care. This provided a very large sample of patients for study.

While our method found similar numbers of patients to those reported by the Renal Registry, there is no guarantee these are the same individuals as appear on register. However,
distributions of age, gender and ethnicity in the selected cohort were compared with the similar distributions reported by the Renal Registry.

The study uses a narrow definition of ‘avoidable LR’, in that it only covers patients with elevated hospital use. It does not estimate the number of LRs that may have been avoided by more timely detection in primary care. It also represents only an upper limit on those detectable in secondary care, as we cannot be certain what CKD stage patients were at when their level of general hospital activity increased. It is also important to remember that it is not known how amenable this group would have been to the techniques used to delay the onset of dialysis.

This study uses contact with a nephrologist as a key outcome. However, it is possible that some patients classed as ‘LRs’ had already been referred to a nephrologist and were waiting for an appointment. While this is still consistent with the concept of a LR as the contact did not happen until after the optimum point, it would imply that the cause of LR is not a lack of detection but barriers to timely access to specialist kidney care. Similarly, this study is not able to explore what proportion of patients receiving emergency dialysis without prior contact with a nephrologist either because their primary care physician believed them to too frail or co-morbid for dialysis to be an appropriate option [19], or because the patients themselves did not wish to be referred. Doing so would require primary care data on estimated kidney function. Finally, specialty information refers to the specialty under which the patient was treated while in hospital. Contact with consultant nephrologists while under the care of another specialty cannot be ruled out, and may result in overestimation of the number of LRs.

**Implications for practice**

We show that a substantial proportion of patients referred late to specialist kidney care have ongoing interactions with secondary care for some time prior to starting dialysis. It is possible that the reduction in a patient’s kidney function could be detected at some point during these interactions and a more timely referral made to a nephrologist. Actions could include routine monitoring of kidney function in the community for all patients exceeding an annual activity threshold. Routine monitoring of kidney function is already recommended during inpatient stays [20].

The volume of patients with increased hospital activity relative to the national average far exceeds the number estimated to be developing end-stage kidney disease. It may not be cost effective to routinely screen each of these patients. However, it may be possible to develop a predictive model, based on a combination of inpatient activity and other factors, which could be used to target testing.

Reducing the number of LRs should improve outcomes for patients, delay the onset of dialysis and reduce costs in the long term. However, it would also increase the workload of existing nephrology care facilities.

**Implications for research**

This study has shown important associations between patient’s kidney care and their general hospital use. This should be explored further by creating a sustained pseudonymous linkage between HES and the Renal Registry. Initial work in this area has already been completed [21]. Such linkage would allow exact validation of the algorithm used to detect dialysis patients.

This study assesses secondary care activity. It is possible that similar associations exist with primary and community care, and similar methods could be used to study this using data from general practice. This could also be extended to person-level linkage with the Renal Registry.

Finally, further research is needed to refine the threshold used to define ‘elevated’ hospital activity. This could be done in conjunction with the development of a predictive model.

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**CONFLICT OF INTEREST STATEMENT**

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**REFERENCES**

Phosphate, urea and creatinine clearances: haemodialysis adequacy assessed by weekly monitoring

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ABSTRACT

Background. The specific distribution of phosphate and the control mechanisms for its plasma level makes phosphate kinetics during haemodialysis (HD) considerably different from those of urea and creatinine and makes the quantitative evaluation of adequacy of phosphate removal difficult. We propose the application of equivalent continuous clearance (ECC) as a phosphate adequacy parameter and compare it with ECC for creatinine and urea.

Methods. Three consecutive dialysis sessions were evaluated for 25 patients on maintenance HD. Concentrations of phosphate, urea and creatinine in plasma were measured every 1 h during the treatment and 45 min after, and every 30 min in dialysate. ECC was calculated using the removed solute mass assessed in dialysate and weekly solute profile in plasma. Similar calculations were performed also for the midweek dialysis session only. Different versions of the reference concentration for ECC were applied.

Results. ECC with peak average reference concentration was 5.4 ± 1.0 for phosphate, 7.0 ± 1.0 for urea and 4.7 ± 1.0 mL/min for creatinine. ECC for urea and creatinine were well correlated in contrast to the correlations of ECC for phosphate versus urea and creatinine. Midweek ECC were higher than weekly ECC, but they were well correlated for urea and creatinine, but only weakly for phosphate.

Conclusions. HD adequacy monitoring for phosphate may be performed using ECC, but it is less predictable than similar indices for urea and creatinine. The values of ECC for phosphate are within the range expected for its molecular size compared with those for urea and creatinine.

Keywords: EKR, equivalent continuous clearance, ECC, haemodialysis adequacy, KT/V, mineral metabolism

INTRODUCTION

Elevated levels of phosphate, often presented as inorganic phosphorus, is a common complication in end-stage renal disease (ESRD) patients, and hyperphosphatemia contributes to higher morbidity and mortality in this population [1–3]. The mass balance of phosphate is the result of dietary intake, removal by binders, residual renal function and the removal by dialysis. In clinical practice the control of phosphate