Does community-wide chronic kidney disease management improve patient outcomes?

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ABSTRACT

Background. The number of patients starting renal replacement therapy (RRT) is increasing in England, as it is worldwide. Improvements in the management of chronic kidney disease (CKD) across communities to alter this trend are a public health priority. We have prospectively studied changes in the incidence and modality of treatment for end-stage renal disease following the introduction of a CKD management programme in the West Midlands region of England.

Methods. Nephrology service to approximately 700 000 adult population of mixed ethnicity in urban and suburban areas, many with social deprivation. The programme was introduced in stages between 2003 and 2006 and comprised primary care education and financial incentives, personal clinical reports written directly to patients following every consultation, routine laboratory estimated glomerular filtration rate (eGFR) reporting, eGFR graph surveillance to identify and monitor patients at risk, multidisciplinary pre-RRT care and conservative care. Prevalent patients: 10 552 with CKD and 8509 without CKD with diabetes. Outcomes: access to nephrology care, trends in RRT incidence and starting modality, place of death without RRT. Incident count was adjusted for changes in the local adult population recorded in national censuses.

Results. Ninety-one per cent of patients aged ≥75 years with incident CKD stage 5 were known to a nephrologist. The population-adjusted incident RRT rate peaked in 2005 and then declined; the proportion starting with transplant, peritoneal dialysis or haemodialysis by arterio-venous fistula increased to 63% by 2012 (P = 0.001 versus 2005). Fifty-two per cent of patients receiving planned conservative care without dialysis died out of hospital.

Conclusions. Following the introduction of a community-wide systematic CKD management programme, the population-adjusted incidence of RRT reduced, modality of initiation of RRT improved and a majority of patients receiving planned conservative care without dialysis died out of hospital.

Keywords: renal replacement therapy, service improvement

INTRODUCTION

The number of people starting renal replacement therapy (RRT, i.e. dialysis or pre-emptive transplantation) in England, as in most other countries, continues to increase year-on-year [1]. Identifying effective and affordable ways of reducing this growth is a global public health priority [2].

In the West Midlands region of England, care for people with chronic kidney disease (CKD) is provided almost exclusively by the National Health Service (NHS). The Heart of England NHS Foundation Trust (HEFT) is the major provider of adult CKD and clinical chemistry services to an estimated 0.7 million adult people living in the east of Birmingham and the surrounding area. The population has mixed ethnicity, particularly from the Indian subcontinent, and there are large areas of social deprivation.

Between 2003 and 2006, a CKD management programme was introduced with the aims of (i) minimizing progression of CKD to end-stage renal disease (ESRD), (ii) transferring patients appropriately to pre-ESRD multidisciplinary care, (iii) increasing pre-emptive transplantation, (iv) starting RRT with permanent access, (v) using conservative kidney management when appropriate and (vi) reducing the proportion of patients with ESRD not treated by dialysis dying in hospital.

The comprehensive and long-term nature of NHS primary care, nephrology and clinical chemistry services provides an opportunity to study the effectiveness of a community-wide CKD management programme in meeting the stated aims.
**MATERIALS AND METHODS**

The nephrology service at HEFT (formerly East Birmingham Hospital) has provided RRT since 1966. The population served is estimated from the combined populations of the Local Authorities of Lichfield, Tamworth, Solihull and half of the Birmingham Local Authority as recorded in the censuses of 1991, 2001 and 2011 [3]. Census data above the age-band threshold of 14 years were used to reflect the adult population served by HEFT. Denominator populations for each year were calculated from the slope in the census intervals.

Adult patients attending HEFT nephrology or diabetes outpatient clinics are registered on the nephrology department database (Proton®, CCL Ltd). Records are updated prospectively by automated data transfer from the clinical chemistry laboratory database and by manual entries of clinical events.

The CKD management programme comprised elements that we have previously described. These were introduced as follows: in 2003, education sessions for primary care clinicians [4, 5]; pre-ESRD multidisciplinary care and conservative management; weekly database extract listing patients with estimated glomerular filtration rate (eGFR) <15 mL/min/1.73 m² for review by the multidisciplinary team [6]. In 2004, routine eGFR reporting by the clinical chemistry laboratory service [5]; diabetes eGFR graph surveillance by weekly database extract listing patients with diabetes (i) aged <65 years and eGFR <50 mL/min/1.73 m² and (ii) aged >65 years and eGFR <40 mL/min/1.73 m², from which a nephrologist (H.R.) reviews graphs of eGFR values over the previous 5 years to identify those with a declining trend [7]. In 2005, patient empowerment by writing a personal report directly to the patient following every consultation which is copied to the patient’s general practitioner (primary care physician) [8].

In April 2004, a national reimbursement system, the Quality and Outcomes Framework, was introduced to reward primary care general practices for identifying and managing patients with hypertension and/or diabetes. In April 2006, this was extended to include CKD [9].

In April 2012, the eGFR graph surveillance system used in patients with diabetes [7] was implemented by the HEFT clinical chemistry laboratory on all serum creatinine tests requested from primary care and secondary care outpatient clinics [10].

Further information was extracted from hospital electronic patient records. Patients were excluded if they transferred to another nephrology centre prior to death or were not eligible for NHS treatment.

To study referral patterns of older patients with advanced CKD from primary to secondary care, incident CKD stage 5 patients aged ≥75 years (eGFR <15 mL/min/1.73 m² on two occasions ≥3 months apart first recorded between 1 January 2010 and 30 June 2011) were identified in the HEFT clinical chemistry database and linked with a nephrologist via the UK Renal Registry.

Data on RRT incidence refer to the combined number of patients either starting dialysis or receiving a pre-emptive kidney transplant. The decision regarding planned modality of ESRD care (haemodialysis, peritoneal dialysis or conservative care) was recorded prospectively following multidisciplinary patient education and discussion.

**RESULTS**

In 1991, 2001 and 2011, the population of the area served by HEFT aged over 14 years of age was 665 586, 681 230 and 738 042, respectively [3].

The prevalent population under active surveillance on the nephrology database on 31 December 2012 was 19 061. This comprised 10 552 patients with CKD not on RRT of whom 6319 had diabetes, and 8509 patients with diabetes without CKD (i.e. eGFR > 60 mL/min/1.73 m² and albuminuria ≤3.4 mg/mm mol). Three hundred and eighty-three patients were receiving multidisciplinary nephrology care: 334 planning for RRT (mean eGFR = 19.7 mL/min/1.73 m²) and 49 for conservative management (mean eGFR = 16.3 mL/min/1.73 m²). Five hundred and three patients with CKD had received dialysis for acute kidney injury and recovered sufficient function to stop dialysis.

We tested how completely the community-wide programme ensured that patients with CKD stage 5 gained access to a nephrologist. Of a sample of 55 patients aged ≥75 years identified with incident CKD5 from the HEFT clinical chemistry database between January 2010 and June 2011, 50 (91%) were known to the nephrology service at either HEFT or the University Hospitals Birmingham NHS Foundation Trust (UHB), which serves the neighbouring population.

The incident count of RRT increased to a peak in 2005. Following the introduction of the CKD programme, the incident count stabilized and the rate adjusted for the increase in the adult population declined (Figure 1).

The change in the trend of RRT incidence was seen in patients with and without diabetes (Figure 2a) and of different ethnicities (Figure 2b).

The mean eGFR at start of dialysis and age at start of RRT were stable between 1998 and 2012 (Figure 3a and b).

The proportion of patients starting RRT with a transplant, peritoneal dialysis, or HD via an arteriovenous fistula or graft increased between 2004 and 2012 (Figure 4). The Chi-square statistic of a 2 × 2 contingency table comparing categories of tunnelled or untunnelled catheter versus other modalities in 2005 and 2012 was 10.74, P = 0.001.

Within the NHS, patients are generally referred to the service closest to their place of residence. We investigated whether the change in RRT incidence was due to a reduction in the catchment area for HEFT, with a shift of patients residing in the area bordering the adjacent nephrology service provided by UHB to that service. This was not the case; the proportion of patients starting RRT at HEFT who resided in postcodes on the border with UHB (B1–9 and B42–47, urban areas, many with deprivation) increased between the periods 1993–2003 and 2004–2012. Conversely, the proportion of HEFT patients residing in postcodes furthest from UHB (B90–98, more affluent suburban areas) reduced. Other postcodes were unchanged.
To assess the care of patients known to the nephrology service dying with ESRD without dialysis irrespective of their planned treatment, we identified patients dying without RRT with an eGFR <10 mL/min/1.73 m² immediately prior to death. The mean age at death showed an increasing trend from 1998 to 2012 (Figure 3b). Between 2004 and 2012, 183 patients died without RRT with an eGFR <10 mL/min/1.73 m² immediately prior to death; one had insufficient data. Of the 182, 120 (66%) received multidisciplinary nephrology care: 73/182 (40%) planned to have conservative management, of whom 38 died out of hospital; 47/182 (26%) had planned to have RRT, of whom 10 died out of hospital. Of the 182, 62 (34%) received routine care prior to death, all of whom died in hospital.

Of the 62 that did not receive multidisciplinary nephrology care, 6 (10%) were at CKD stage 5 for at least 3 months prior to death; 3 had dementia, 2 had multiple co-morbidities and 1 refused dialysis. Of the 62, 56 (90%) had acute-on-CKD prior to death. One was at CKD stage 2, 17 at stage 3 and 38 at stage 4 for at least 3 months prior to the acute fatal illness.

Between 2006 and 2012, 22 patients who planned to have conservative care changed the decision and did start dialysis, mean eGFR at start of dialysis = 8.1 mL/min/1.73 m², range 3.9–16.

**DISCUSSION**

After its inception in 1966, the number of patients starting RRT in our centre grew steadily as the size and life expectancy of the population increased, the prevalence of diabetes rose, more people survived to develop ESRD and access to RRT improved. This placed a growing burden on the healthcare system. Between 2003 and 2006, a community-wide programme was introduced comprising all elements of the CKD chronic care model [11]. Its aims were to improve the detection and referral of CKD patients to a nephrologist, reduce the rate of progression to ESRD and improve the preparation of patients for RRT and the end of life.

Due to the large size (>10 000 CKD patients) and length of prospective follow-up, it has been possible to demonstrate a stabilization in the number of patients starting RRT (the incident count) and a reduction in the incident rate adjusted for changes in the adult population, distinct from year to year variation. In England overall, the incident count rose by an average of 1.1% per year from 2001 to 2011 [1]. The incident rate per million population rose until 2006 and was stable between 2006 and 2011 in both England and centres neighbouring to HEFT [1].

The incident RRT rate at HEFT is high compared with the rest of England [1], associated with ethnicity and the large areas of socio-economic deprivation in the community [12]. In insurance-based healthcare systems, deprivation is associated with reduced access to healthcare, lower health literacy, non-concordance with therapy and risk of progression to
ESRD and death [13]. Access to a nephrologist or multidisciplinary team leads to a reduced rate of decline in GFR [14–16] and reduces the incidence of dialysis [17]. However, even in the nationally funded NHS, not all patients receive optimal assessment and treatment of blood pressure and proteinuria [18]. The improved outcomes we report are likely due to the way that patients at risk of progressing to ESRD are systematically identified, managed by nephrologists, and educated, monitored, prepared for RRT or managed conservatively without dialysis by a multidisciplinary team. We also supported self-care through the sending of personal reports to patients after each consultation and the sharing of eGFR graphs to highlight progression of CKD.

We were concerned that elderly patients with CKD stage 5 may not have been offered access to nephrology care. However, of a sample of 55 patients aged ≥75 years identified from the clinical chemistry laboratory with incident CKD stage 5, only five had no recorded nephrology contact. Furthermore, it is possible that nephrology advice was sought regarding these five but they did not attend a nephrology clinic due to frailty.

The introduction of routine reporting of estimated GFR and financial incentives to identify and monitor CKD caused an increase in renal function blood testing and referrals from primary to secondary care [19, 20]. This has led to a reduction in the percentage of referrals to nephrology <90 days prior to starting RRT in England from 23.9% in 2006 to 19.6% in 2011 [1, 21]. The eGFR at the time of referral increased with our diabetes CKD surveillance programme [6]. We have previously reported reduced mortality and hospitalization in patients on RRT who received multidisciplinary nephrology care [5]. Earlier referral combined with improvement in the processes of care prior to ESRD has enabled us to improve significantly the proportion of patients either receiving a pre-emptive transplant or starting RRT using long-term access.

Pay for performance in primary care has been shown to improve blood pressure control in the population with CKD in Kent, UK [22]. Although we do not have data on blood pressure, this effect is likely to have played a role in the stabilization of our RRT incidence.

There is variation between centres and clinicians in the criteria used to define when a patient is receiving conservative kidney management. We prospectively identified patients receiving conservative management when they made an explicit choice not to have dialysis. The mean age (80 years) and proportion of patients opting for conservative management rather than dialysis (1 to 6.8 ratio) were similar in our centre to those reported in Australia (1 to 7 ratio) [23]. The decision not to start dialysis was reversible; a number patients initially opting for conservative management changed their decision and started dialysis.

We used an arbitrary threshold of eGFR <10 mL/min/1.73 m² to define those patients dying with, although not necessarily due to, ESRD. The CKD programme ensured that most patients dying with ESRD without dialysis received multidisciplinary nephrology care prior to death. For many, this avoided them receiving inappropriate procedures, hospital and intensive care, and they ended their lives outside hospital. Patients dying with acute-on-CKD without dialysis remained in hospital. Prevention of acute kidney injury in patients with CKD remains an important area for service improvement.

**FIGURE 3:** Changes between 1993 and 2012 in the characteristics of patients with ESRD. (a) eGFR and age at start of RRT. (b) Age at death in those dying with an eGFR <10 mL/min/1.73 m² without RRT.

**FIGURE 4:** Changes in distribution of modality at start of RRT between 2000 and 2012. Percentage starting with a catheter in 2012 is significantly lower than in 2005, P = 0.001.

ESRD and death [13]. Access to a nephrologist or multidisciplinary team leads to a reduced rate of decline in GFR [14–16] and reduces the incidence of dialysis [17]. However, even in
The main limitation of this study is the fact that the CKD programme comprised multiple interventions implemented over a period of time without any matched control population. We therefore cannot assess the absolute or relative contribution of each element of the programme to the subsequent changes in patient outcomes. Quality and Outcome Framework incentive payments were introduced simultaneously across England, and routine eGFR reporting 2 years after it was introduced by HEFT. The difference between our results and England overall may be due to the other elements of our programme. Nonetheless, our results require confirmation by other, ideally controlled, studies of population-wide CKD management.

The programme was designed to improve outcomes in patients with CKD. However, other explanations for the change in RRT incidence should be considered. The increasing incidence of RRT in the years leading up to 2005 may partly have been due to more, particularly older, patients being identified as suitable for dialysis until full ascertainment was reached in 2005. If this explanation is correct, the mean age of patients starting RRT would have increased until 2005 as an increasing proportion of elderly patients were considered suitable for dialysis. However, Figure 3b shows that the age of patients starting RRT was stable after 1998 with no change after 2005.

There was no evidence of a shift of patients to the neighbouring nephrology service. Similarly, there was no evidence of a move away from using RRT to treat ESRD. Indeed, the mean age at death of patients with eGFR <10 who died without dialysis increased. That the mean age at the start of RRT did not increase in parallel suggests that an increasing proportion of older patients died with an eGFR >10 before starting RRT, i.e. due to causes other than ESRD. The mean eGFR at start of RRT remained stable. Personnel in the medical consultant team did not change. It therefore seems likely that the reduction in the adjusted RRT incident rate was causally linked to the CKD programme, although this cannot be proven.

The generalizability of these results will depend upon the local healthcare system. We have extended the diabetes surveillance system to all CKD patients in the community by implementing it in the clinical chemistry service [10]. Integration of nephrology and pathology services is a key part of CKD management.

Under the ‘payment-by-results’ reimbursement arrangements that apply to RRT within the NHS, reducing the number of patients starting RRT leads to a reduction in income. Activity-based reimbursement arrangements may act as a disincentive for providers to implement a CKD management programme, even though it is cost-effective [24] and the potential savings to the healthcare system as a whole from avoided RRT are substantial.

In conclusion, a community-wide CKD management programme comprising detection and monitoring in primary care, and systematic identification of patients at risk of ESRD from a database integrated with the clinical chemistry service was implemented. This has been followed by a reduction in the population-adjusted incidence of RRT, improved initiation of RRT and lower intensity of care at the end of life.

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**CONFLICT OF INTEREST STATEMENT**

My co-authors and I have no conflicts of interest to declare. The results presented in this paper have not been published previously in whole or part, except in abstract format.

**REFERENCES**

17. Wu IW, Wang SY, Hsu KH et al. Multidisciplinary predialysis education decreases the incidence of dialysis and reduces mortality—a controlled
A randomized controlled trial evaluating the erythropoiesis stimulating agent sparing potential of a vitamin E-bonded polysulfone dialysis membrane

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ABSTRACT

Background. Vitamin E (VE) bonded polysulfone dialysis membranes have putative erythropoiesis stimulating agent (ESA)-sparing and anti-inflammatory properties based on data from a small number of studies. We sought to investigate this in a large, prospective 12-month randomized controlled trial.

Methods. Two-hundred and sixty prevalent haemodialysis (HD) patients were randomized to dialysis with VE-bonded polysulfone membranes or non-VE-bonded equivalents. All ESA-dosing was performed by means of a computer-based anaemia management decision support system. Monthly data were used to calculate the ESA resistance index (ERI) and blood tests were performed at baseline, 6 and 12 months for measurement of C-reactive protein (CRP) levels.

Results. Of the 260 patients, 123 were randomized to dialysis with the VE-membrane and 12-month data was available for 220 patients. At the study population level, no beneficial effect of the VE membranes on the ERI or CRP levels was observed. Post hoc analyses indicated that there was a significant fall in ERI for patients with the highest baseline ESA resistance dialysed with the VE (9.28 [7.70–12.5] versus 7.70 [5.34–12.7] IU/week/kg/g/dL Hb, P = 0.01) but not the control membranes (9.45 [7.62–12.3] versus 8.14 [4.44–15.6] IU/week/kg/g/dL Hb, P = 0.41); this was not attributable to changes in CRP levels.

Conclusions. Wholesale switching of all chronic HD patients to dialysis with VE-bonded polysulfone membranes appears not to be associated with improvements in ESA-responsiveness or CRP. These membranes may have utility in patients with heightened ESA resistance.

Keywords: anaemia, haemodialysis, inflammation, vitamin E