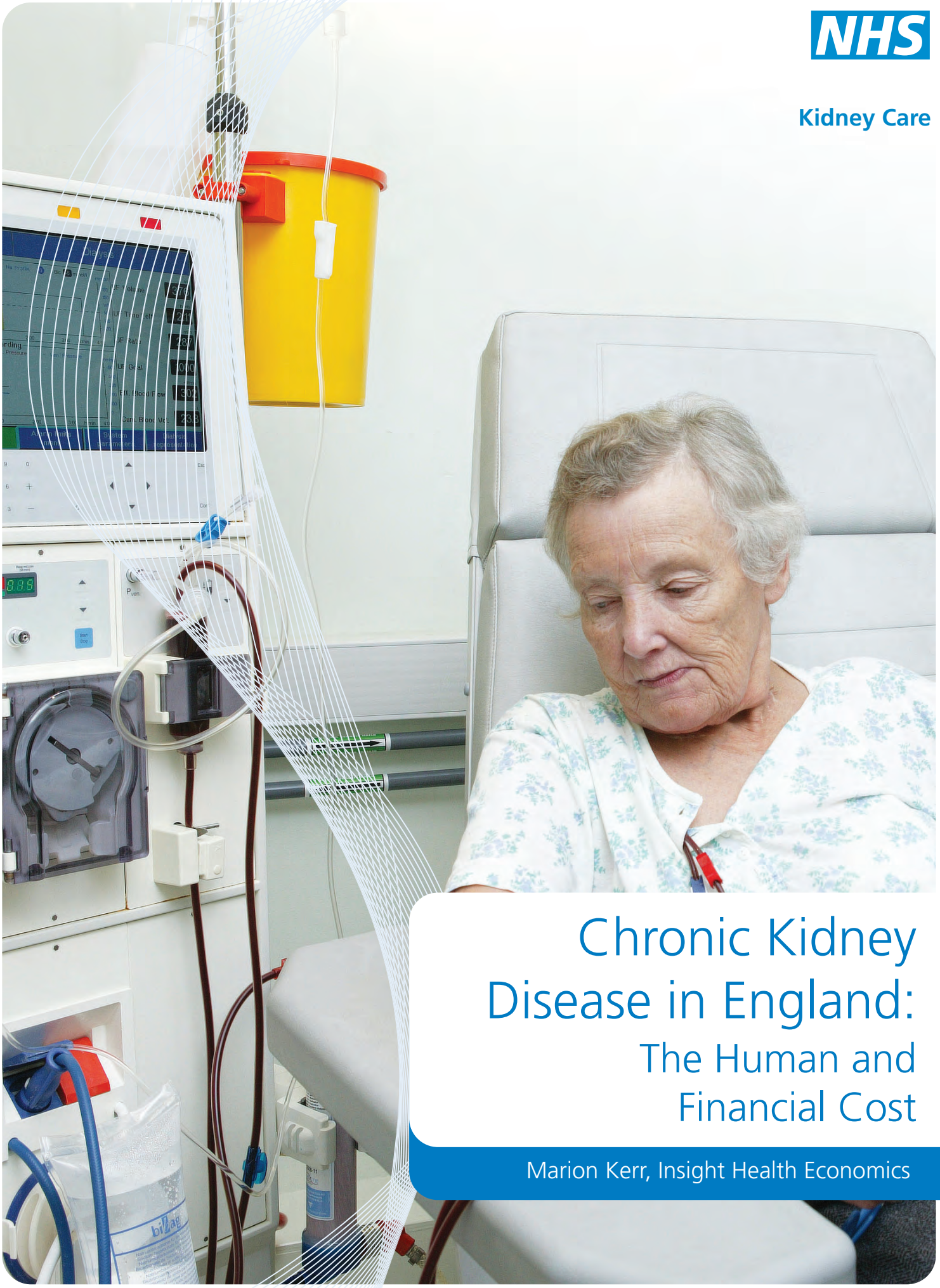
NHS

Kidney Care



Chronic Kidney Disease in England:

The Human and Financial Cost

Marion Kerr, Insight Health Economics

Better Kidney Care for All

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Acknowledgements

This paper was written for NHS Kidney Care by Insight Health Economics. We would like to thank the following individuals and organisations for their help (though any errors are the responsibility of the author):

Maria Alva, Health Economics Research Centre, University of Oxford

John Bradley, Consultant Nephrologist, Cambridge University Hospitals NHS Foundation Trust

Benjamin Bray, NHS Kidney Care

Matthew Brealey, UK Renal Registry

Fergus Caskey, UK Renal Registry

Clare Castledine, UK Renal Registry

Alistair Chesser, Consultant Nephrologist, Barts and The London NHS Trust

Simon de Lusignan, Professor of Primary Care and Clinical Informatics, University of Surrey

Chris Farmer, Consultant Renal Physician, East Kent University Hospitals NHS Foundation Trust

Alastair Gray, Director, Health Economics Research Centre, University of Oxford

Claire Hudson, Renal Audit Manager, Royal Sussex County Hospital

Rosemary Matheson, Prescribing and Primary Care, The NHS Information Centre for health and social care

Beverley Matthews, Director, NHS Kidney Care

James Medcalf, Consultant Nephrologist, University Hospitals of Leicester NHS Trust

Donal O'Donoghue, National Clinical Director for Kidney Care, Department of Health

Paul Roderick, Professor of Public Health, University of Southampton

Paul Stevens, Consultant Nephrologist, East Kent University Hospitals NHS Foundation Trust

Charlie Tomson, President, Renal Association

Abbreviations

ACEI: angiotensin-converting enzyme inhibitor
ACR: albumin:creatinine ratio
ARB: angiotensin II receptor blocker
CI: confidence interval
CKD: chronic kidney disease
eGFR: estimated glomerular filtration rate
EPO: erythropoietin
ESA: erythropoiesis-stimulating agent
ESRD: end-stage renal disease
GFR: glomerular filtration rate
HES: Hospital Episode Statistics
HR: hazard ratio
HRG: Healthcare Resource Group
HSE: Health Survey for England
KDOQI: US National Kidney Foundation Kidney Disease Outcomes Quality Initiative
MDRD: Modification of Diet in Renal Disease
MI: myocardial infarction
MRSA: meticillin-resistant Staphylococcus aureus
NEOERICA: New Opportunities for Early Renal Intervention by Computerised Assessment
NHANES: National Health and Nutrition Examination Surveys
ONS: Office for National Statistics
PCR: protein:creatinine ratio
PCT: primary care trust
QICKD: Quality Improvement in CKD
QOF: Quality and Outcomes Framework
RRT: renal replacement therapy

Executive Summary

1. More than 1.8 million people in England have diagnosed chronic kidney disease (CKD). In addition, there are thought to be around a million people who have the condition but are undiagnosed. CKD can substantially reduce quality of life, and leads to premature death for thousands of people each year.

2. People with CKD have a gradual loss of kidney function over time. The kidneys become less effective at filtering waste products from blood; water, waste and toxic substances therefore accumulate in the body. A minority of people with CKD suffer complete kidney failure, and require renal replacement therapy (RRT): dialysis or transplant. People with CKD are also at increased risk of stroke, heart attack, bone disease and other conditions.

3. CKD is classified in five stages, according to the level of kidney damage and function. The focus in this paper is on stages 3–5, which cover moderate to severe kidney disease. People with CKD are at greater risk of death than people of the same age and sex with healthy kidneys. The risk increases as the disease progresses, and is far greater than the risk of progression to RRT. It is estimated that there are 40,000–45,000 premature deaths each year in people with CKD. A large proportion of deaths in people with CKD are due to cardiovascular events such as strokes and heart attacks.

4. CKD is associated with reductions in health-related quality of life. A number of studies have reported that people receiving RRT experience significantly reduced quality of life, relative to those with normal kidney function. Less severe kidney disease also reduces quality of life.

5. The NHS in England spent an estimated £1.45 billion on CKD in 2009–10, equivalent to £1 in every £77 of NHS expenditure. This spending estimate covers both treatment directly associated with CKD (renal care and prescribing to prevent disease progression), and also treatment for excess non-renal problems such as strokes, heart attacks and infections in people with CKD. In the case of non-renal problems, costs are estimated only for excess events, over and above the expected number for people of the same age and sex who do not have CKD. The distribution of NHS spending on CKD is shown in Figure 1.

6. There were an estimated 7,000 extra strokes and 12,000 extra myocardial infarctions (MIs) in people with CKD in 2009–2010, relative to the expected number in people of the same age and sex without CKD. The cost to the NHS of health care related to these strokes and MIs is estimated at £174–178 million.

7. People with CKD have longer hospital stays than people of the same age without the condition, even when they go into hospital for treatments unrelated to CKD. We estimate that the average length of stay is 35% longer for people with CKD, and that the cost to the NHS of excess hospital bed days for patients with CKD was £46 million in 2009–10.

Executive Summary

8. Infections such as meticillin (methicillin)-resistant *Staphylococcus aureus* (MRSA) are more common in people with CKD, in particular in those receiving haemodialysis. The risk of MRSA is more than 100 times greater in people receiving haemodialysis than in the general population. The cost to the NHS of MRSA in haemodialysis patients is estimated at £1.4 million.

9. The costs in this paper cover only health care provision. In addition, there is likely to be considerable expenditure on social care services. It was not possible to produce robust estimates of most social care costs associated with CKD. In the case of excess strokes in CKD, social care costs have been estimated (see Appendix 2). The estimated cost of social care in stroke is more than 1.5 times the health care cost.

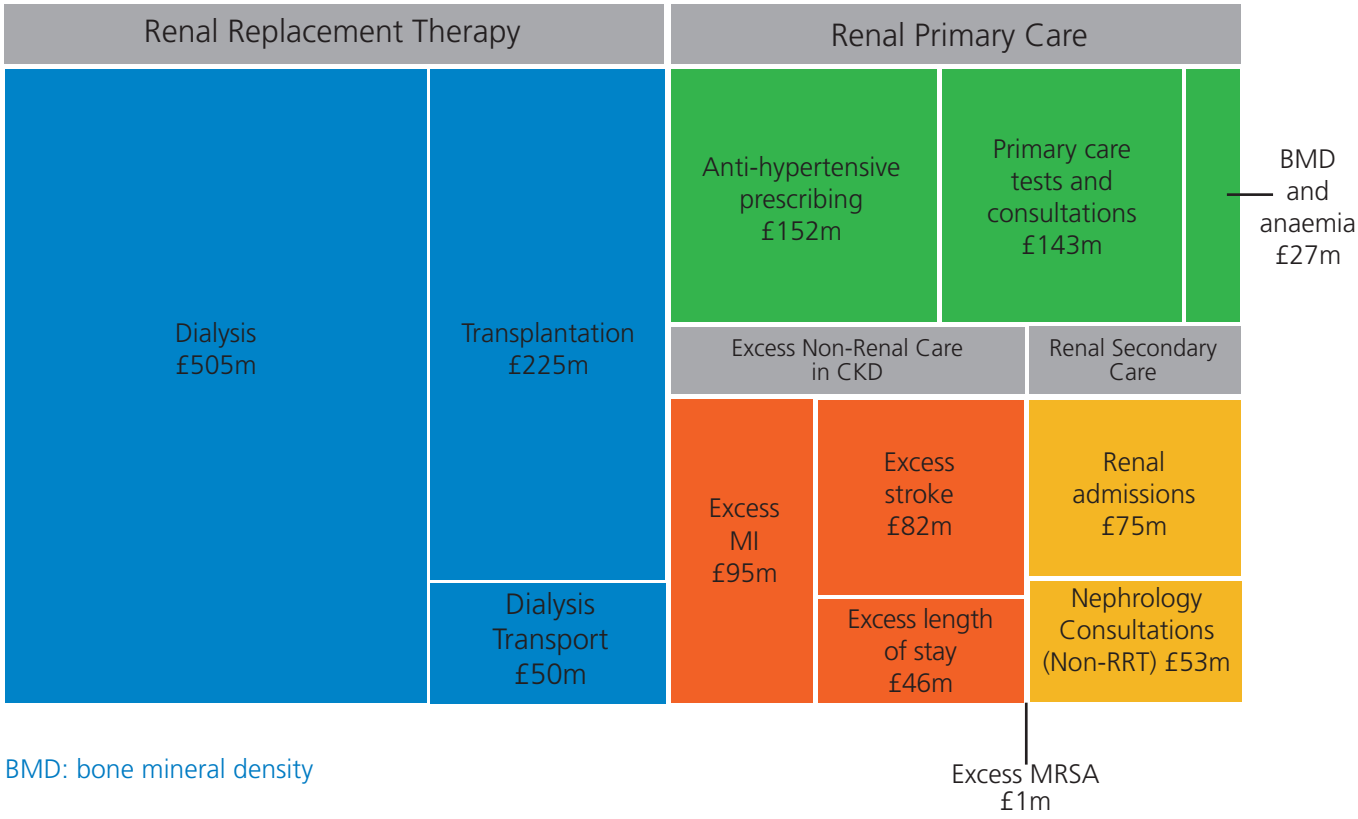
10. In addition to health and social care costs, CKD can place a financial burden on individuals with the disease and on their carers through lost working days and morbidity. These work and morbidity effects also entail costs to the public purse through reductions in tax revenue and increases in benefit payments. If all these impacts were taken into account the total cost of CKD, both to society and to the public sector, would be higher than the costs set out in this paper.

11. The estimate of total expenditure is more than twice the sum that would be produced by extrapolating from the figures in the 2002 Wanless report, *Securing our Future Health: Taking a Long-term View*. In that report, spending on kidney care in 2002–03 was estimated at £445 million (£580 million in 2009–10 prices). The number of people receiving RRT increased by 29% between 2002 and 2008. The total prevalence of CKD (diagnosed and undiagnosed) is also believed to be increasing.

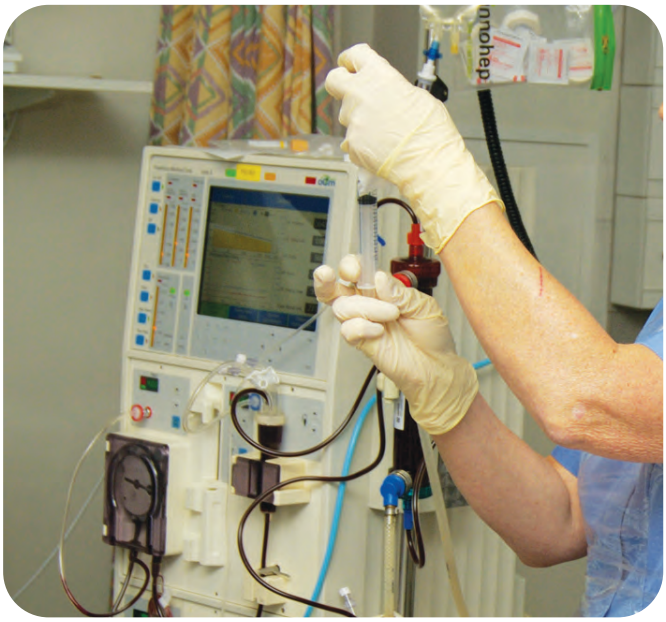
12. Programme Budgeting analysis by the Department of Health estimated total NHS expenditure on renal problems at £1.64 billion in 2009–10. However, the Programme Budgeting renal category is broader than CKD. The Programme Budgeting estimates therefore include expenditure on other renal conditions such as acute kidney injury. Programme Budgeting data on renal problems do not include indirect costs (which contribute £211–£225 million to the total estimated in this paper). The total direct costs estimated here are £1.23 billion.

13. In the Programme Budgeting data, 5% of PCT expenditure on renal problems was attributed to primary care and 95% to secondary care. The proportion of direct costs attributed to primary care in this paper is considerably higher (12% without prescribing costs, 26% if prescribing costs are included). There are a number of reasons for this: as indicated above, the renal category considered in this paper is narrower than that used for Programme Budgeting; some of the prescribing costs included here (such as those for anti-hypertensive therapies in CKD) are likely to be attributed to non-renal categories in Programme Budgeting; and a more detailed examination of primary care resource use for CKD has been undertaken here than is generally possible in the context of Programme Budgeting.

Figure 1. Direct and indirect NHS expenditure on CKD, England 2009–10



BMD: bone mineral density



Introduction

14. The purpose of this paper is to examine the impact of chronic kidney disease (CKD) and associated complications and comorbidities on quality of life, mortality and NHS costs in England.

15. The paper is divided into three sections: section I examines the prevalence of CKD and its impact on quality of life and mortality; section II examines expenditure on CKD; and section III discusses the implications of the study findings.

16. Costs are categorised here as direct and indirect. Direct costs are defined as those associated with the disease itself and its progression, including end-stage renal disease (ESRD). Indirect costs are defined as those incurred for non-renal care in cases where people with CKD have excess risk or consume excess health care resources relative to the non-CKD population. These indirect costs include those arising from excess adverse events (such as stroke) in people with CKD, from excess bed days in general hospital admissions and from excess infections.

17. CKD is classified in five stages, according to the level of kidney damage and the ability of the kidneys to filter blood. The glomerular filtration rate (GFR) measures the amount of blood that passes through the tiny filters in the kidneys, called glomeruli, each minute. As the disease progresses, the GFR falls.

18. The National Service Framework for Renal Services defines normal renal function as estimated GFR (eGFR) at or above 90 ml/min/1.73 m^2 with no evidence of kidney damage, and classifies CKD in five stages using the US National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) system. The National Institute for Health and Clinical Excellence (NICE) recommends sub-division of stage 3, as shown in Table 1. The focus in this paper is on stages 3–5 CKD, defined as GFR <60 ml/min/1.73 m^2 for at least 3 months.

Table 1. Definition and stages of CKD[1]

CKD stage[a]	GFR (ml/min/1.73 m^2)	Description
1	≥90	Normal or increased GFR, but with other evidence of kidney damage
2	60–89	Slight decrease in GFR, with other evidence of kidney damage
3A	45–59	Moderate decrease in GFR, with or without other evidence of kidney damage
3B	30–44	
4	15–29	Severe decrease in GFR, with or without other evidence of kidney damage
5	<15	Established renal failure
		[a] Use the suffix (p) to denote the presence of proteinuria when staging CKD

19. Stage 5 CKD is also known as ESRD. Most patients at this disease stage require renal replacement therapy (RRT): dialysis or transplant.

20. While the focus in this paper is on NHS spending, it is important to recognise that there are, in addition, substantial costs to individuals with CKD and to their carers through lost working days and morbidity. These work and morbidity effects also entail costs to the public purse through reductions in tax revenue and increases in benefit payments. If all these effects were taken into account the total cost of CKD, both to society and to the public sector, would be higher than the costs set out in this paper.

Section I:
Prevalence and Impact

Chapter 1 – Prevalence

21. The Quality and Outcomes Framework (QOF) register indicates that, in 2009–10, 1,817,871 adults in England had stages 3–5 CKD, a diagnosed prevalence rate of 4.3% of the population over the age of 18.[2] It is considered likely, however, that the total prevalence is higher, as there are thought to be a substantial number of undiagnosed cases.

22. Study evidence produces a range of estimates of total CKD prevalence. These are sensitive to the method used to detect prevalence and to the population on which the estimate is based. While CKD classifications are based on GFR levels over a 3-month period, most studies use only one measurement, thus tending to overestimate prevalence. Most recent studies estimate GFR from serum creatinine levels, adjusted for age, sex and ethnicity using a formula known as Modification of Diet in Renal Disease (MDRD). It is known, however, that this formula underestimates GFR in patients with normal renal function, thus also tending to overestimate prevalence.

23. The Health Survey for England (HSE) 2010 report estimated that 6% of men and 7% of women (aged ≥16 years) had stage 3–5 CKD, based on eGFR levels.[3] This was a nationally representative, population-based study on the prevalence of CKD in England using laboratory measures calibrated to allow use of MDRD to estimate GFR. The HSE 2010 report combines data from HSE 2009 and HSE 2010. By applying the HSE prevalence estimate to the 2009 population of England, as recorded by the Office for National Statistics (ONS), it is estimated that 2.71 million people have stage 3–5 CKD. If these estimates are accurate, they would suggest that only around two-thirds of people with CKD are included on QOF registers.

24. The New Opportunities for Early Renal Intervention by Computerised Assessment (NEOERICA) project estimated the age-standardised prevalence of stage 3–5 CKD in the UK adult population at 8.5% (10.6% for females and 5.8% for males).[4] It found, however, that only 1.6% of patients had a recorded renal diagnosis. The NEOERICA prevalence estimates were derived from an examination of primary care records covering 130,226 adults in Kent, Manchester and Surrey over a 5-year period ending in 2003. The eGFR was calculated from the MDRD equation using calibrated creatinine levels.

25. The NEOERICA age-standardised rates for the overall population were calculated with reference to the UK 2001 census population. Application of the NEOERICA prevalence findings, by age and sex, to the 2009 ONS population estimates for England suggests that approximately 3.6 million people are likely to have CKD stages 3–5. In the NEOERICA study, 95.5% of those with eGFR <60 ml/min/1.73 m^2 were at stage 3 CKD. The study did not produce separate prevalence estimates for stages 4 and 5. Unlike the HSE, the NEOERICA sample is not nationally representative with respect to socioeconomic and ethnic factors.

26. The Quality Improvement in CKD (QICKD) study recently estimated the prevalence of stage 3–5 CKD in 129 general practices in England, covering 930,997 patients with an age and sex distribution similar to the national average.[5] The prevalence was estimated at 5.41% of the entire (as opposed to adult-only) population (7.34% in females and 3.48% in males). In this study, the criterion for stage 3–5 CKD diagnosis was two consecutive laboratory-reported measurements, at least 3 months apart, of eGFR <60 ml/min/1.73m^2. The study argued that estimates based on a single eGFR reading tend to inflate CKD prevalence as they ignore the impact of creatinine fluctuation within individuals. Using these prevalence estimates it can be estimated that 2.81 million people have stage 3–5 CKD. Of the CKD population in this study, 97% were at stage 3 of the disease.

27. Estimates of the number of people with stage 3–5 CKD drawn from QOF, HSE, QICKD and NEOERICA are summarised in Table 2.

Table 2. Estimated prevalence and population numbers, CKD stages 3–5, based on QOF, HSE 2010, QICKD and NEOERICA[2-5]

Source	Denominator	Male	Female	All	Estimated CKD stage 3–5
QOF	18+			4.3%	1,817,871
HSE	16+	6%	7%		2,710,575
QICKD	Whole population	3.5%	7.3%	5.4%	2,817,104
NEOERICA	18+	5.8%	10.6%	8.5%	3,640,321

28. The estimates of total prevalence derived from the HSE, QICKD and NEOERICA studies indicate that there may be 900,000 to 1.8 million people in England who have undiagnosed stage 3–5 CKD.

29. The QICKD, NEOERICA and HSE estimates may be compared with estimates from international studies, though care must be taken when comparing results across studies because of differences in methodology. Age-standardised rates for CKD stages 3–5 from a population-based study in Iceland were estimated at 11.55% for women and 4.71% for men.[6] Prevalence estimates from other studies range from 5.84% in the Netherlands,[7] and 8% in Northern Ireland (published in abstract only),[8] to 11.2% in Australia.[9] Estimates for the US, based on the National Health and Nutrition Examination Surveys (NHANES), show 8.04% prevalence for stages 3 and 4 only.[10] The NHANES excluded people living in care homes, and the prevalence of CKD in the care home population may be higher than in the general population. If so, the NHANES prevalence is likely to be an underestimate.

Section I:
Prevalence and Impact

30. We do not have accurate time-series data on the prevalence of CKD in England, but it is likely that prevalence is rising. The population is ageing and a number of CKD risk factors – obesity, type 2 diabetes and hypertension – are increasing in prevalence. Comparison of data from consecutive US NHANES studies shows an increase in population prevalence of stages 3–4 CKD from 5.63% in 1988–94 to 8.04% in 1999–2004[10].

31. The diagnosed prevalence of CKD in England, as measured by QOF, has grown from 2.4% in 2006–07 to 4.3% in 2009–10. A substantial part of this observed growth, however, is likely to reflect increased detection rather than increased burden of disease.

32. When estimating the economic burden of CKD, reference is made both to diagnosed prevalence and to estimated total prevalence. In some contexts, diagnosed prevalence is the more appropriate denominator, while in others it is necessary to take account of the estimated total prevalence. For example, regular serum creatinine tests are likely to be provided for the majority of the diagnosed population, but are less likely to be provided for the undiagnosed group. When estimating expenditure on such tests, the QOF prevalence figure is likely to be the more appropriate denominator. The excess risk of adverse events such as stroke, however, is applicable to the entire CKD population. Indeed, the risk may be higher in an undiagnosed group than in a matched diagnosed group that is receiving preventive care. Therefore, estimated total prevalence is likely to be the more appropriate denominator when estimating expenditure on such excess adverse events.

Chapter 2 – Impact on Mortality and Quality of Life

33. People with CKD have a substantially increased mortality risk relative to the age-adjusted non-CKD population. The risk of death is far greater than the risk of progression to ESRD. A large proportion of deaths in the CKD population are due to cardiovascular events. The risk of cardiovascular events rises substantially as GFR falls.

34. A recent meta-analysis by the CKD Prognosis Consortium found that eGFR and albuminuria were associated with all-cause mortality and cardiovascular mortality independently of each other and of traditional cardiovascular risk factors (age, ethnic origin, sex, history of cardiovascular disease, systolic blood pressure, diabetes, smoking, and total cholesterol concentration).[11] The analysis included more than 100,000 individuals with albumin:creatinine ratio (ACR) measurements and 1.1 million people with dipstick measurements from 14 countries in Europe, North America, Asia and Oceania. Unlike some previous studies, this analysis suggested that mild to moderate reduction in eGFR was associated with adverse clinical outcomes.

35. A retrospective cohort study of all new cases of CKD from Southampton and South-West Hampshire Health Authority found that 69% of 1,076 individuals identified had died at the end of a mean follow-up period of 5.5 years.[12] (CKD was determined by a persistently increased serum creatinine level ≥1.7 mg/dl [≥150 µmol/l] for 6 months, identified from chemical pathology records.) The cause of death was cardiovascular in 46% of cases. Standardised mortality ratios were 36-fold in those aged 16–49 years, 12-fold in those aged 50–64 years, and more than twofold in those older than 65. Only 4% of the cohort had progressed to RRT by the end of follow-up.

36. A prospective cohort study of 3,240 individuals with a median GFR of 28.5 ml/min/1.73m^2 not known to renal services found that 39.5% died within a median follow-up period of 31.3 months.[13] The cause of death was cardiovascular in 39.7% of cases. Only 8.3% of the cohort experienced an annual decline in GFR >5 ml/min/1.73m^2 during the follow-up period.

37. A longitudinal US study of 1,120,295 adults found that a reduced GFR was associated with increased risks of death, cardiovascular events and hospital admission that were independent of known risk factors, a history of cardiovascular disease and the presence of documented proteinuria.[14] The adjusted HRs for adverse events increased sharply with an eGFR <45 ml/min/1.73 m^2.

38. ONS data indicate that, in 2008, chronic renal failure (another term for CKD) or hypertensive renal disease was shown as the underlying cause of death on 2,232 death certificates in England.[15] In addition, chronic renal failure was mentioned as a factor contributing to death on 13,895 death certificates. (Hypertensive renal disease was mentioned on 3,401 certificates, but multiple conditions are often cited as contributory factors so it is possible that some of these certificates also mentioned chronic renal failure.)

Section I:
Prevalence and Impact

39. It is possible, however, that official data substantially underestimate the contribution of CKD to premature mortality. In view of the prevalence of comorbidities in people with CKD, and the high risk of cardiovascular events in this population, it is likely that CKD is under-recorded on death certificates.

40. ONS mortality data for England in 2009 were used to estimate the number of deaths in a general population group of the same age and sex distribution as the CKD population (aged 16+), using HSE and QICKD estimates of CKD prevalence.[3,5,16] It was assumed that the proportion of the CKD population at each stage of the disease was as described in the QICKD population. Applying the HRs for death from any cause from a recent US study[14] to these populations, it is estimated that there were 40,000–45,000 more deaths in people with CKD in 2009, relative to the expected number for a population sample of the same size, age and sex without CKD, as shown in Table 3.

Table 3. Estimated deaths in the CKD population, and in a matched population without CKD, 2009

Source	Estimated CKD population	Expected deaths, non-CKD	Estimated deaths, CKD population	Estimated premature deaths, CKD
HSE	2,710,575	109,576	149,191	39,615
QICKD	2,816,710	125,060	170,273	45,213

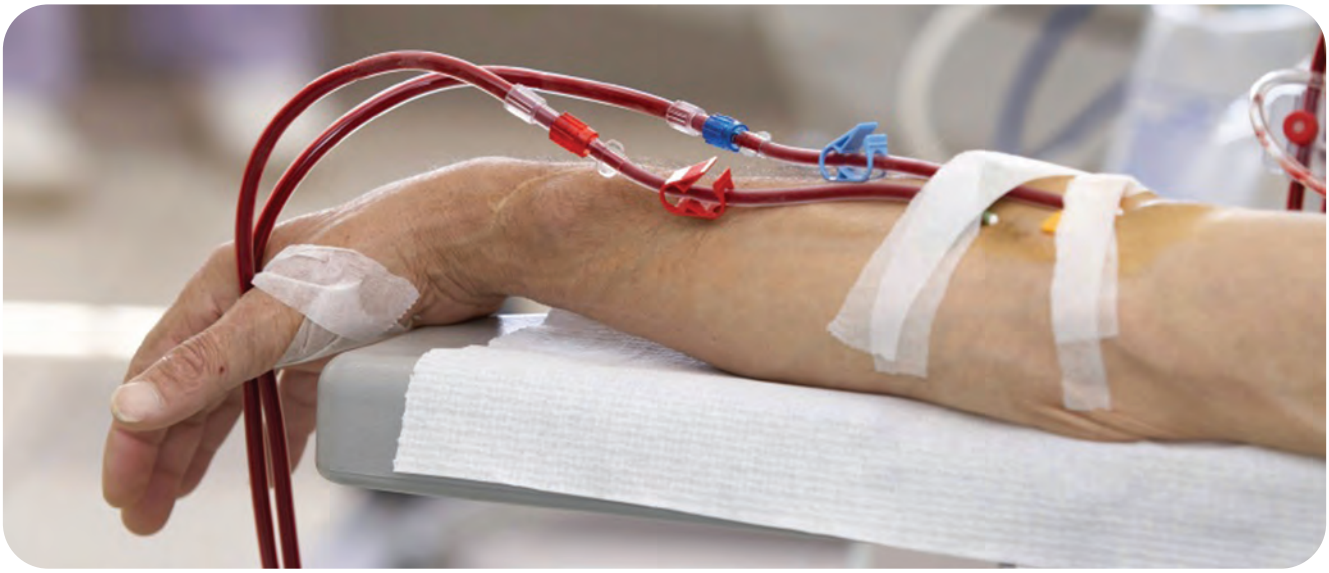
41. CKD is also associated with reductions in health-related quality of life. A number of studies have reported that people with ESRD experience significantly reduced quality of life relative to those with normal kidney function. Quality of life in CKD varies depending on disease stage, treatment modality and the presence of complications and comorbidities such as anaemia, diabetes and cardiovascular disease.

42. Many different questionnaires and interview techniques are used for the assessment of quality of life, and utility scores for individual health states can vary widely depending on the technique adopted. If cost-utility analyses are used to inform health care resource allocation decisions, it is important that there is comparability across the studies used. For this reason, NICE has specified that EQ-5D is the preferred measure for cost-effectiveness analysis in the NHS in England.[17] EQ-5D scores are derived from patient questionnaires covering five domains: mobility, pain/discomfort, anxiety/depression, ability to care for oneself, and ability to perform usual tasks. An index score between 0 and 1 is derived, with 1 representing perfect health, by attaching weights to each level in each domain. These weights are derived from valuations of health states in general population surveys.

43. A recent (2006) review of published utilities for health states associated with CKD identified two studies that were considered suitable for use in UK economic evaluation (as they used EQ-5D and a weighting system derived from UK population preferences).[18] Both of these studies focused on quality of life in patients with ESRD. Utility scores ranged from 0.62 to 0.81 for patients undergoing haemodialysis and from 0.55 to 0.81 for patients receiving peritoneal dialysis. Neither of these studies was based on delivery of care in the English NHS. The range in utility scores for both haemodialysis and peritoneal dialysis suggests that quality of life may be very sensitive to local conditions, including models of delivery of care. Care must therefore be taken in interpreting these results.

44. Quality of life scores for transplant patients are generally higher than scores for those receiving dialysis. The 2006 review of published utilities for health states in CKD identified two studies that used EQ-5D and population-based preference weights to measure quality of life in transplant patients.[18] A German study showed quality of life scores of 0.73 at 14 days after kidney transplantation, 0.78 at 1 month after transplantation and 0.88 at 2–20 years after transplantation.[19] This compared with 0.76 in the same study for patients with ESRD on dialysis. A Swedish study reported a score of 0.86 for kidney transplant recipients, compared with scores of 0.42 to 0.65 for patients receiving dialysis.[20] The review authors considered that these studies were not appropriate for UK economic evaluation as it was not clear whether the scoring mechanism was based on UK population preferences.

45. Quality of life in stages 3 and 4 CKD is less commonly studied. No studies using EQ-5D and UK population preferences have been identified. A recent Japanese study, however, estimated EQ-5D scores for stage 3–5 CKD patients using Japanese population weights. Measured quality of life scores were 0.88 for stage 3, 0.84 for stage 4, and 0.80 for stage 5.[21]



Section II
NHS Expenditure Attributable to CKD

46. There is considerable uncertainty as to the cost to the NHS of CKD. The 2002 Wanless report estimated spending on kidney care in 2002–03 at £445 million.[22] This is equivalent to £580 million in 2009–10 prices (adjusting for Hospital and Community Health Services (HCHS) pay and prices inflation). However, in the years since the Wanless report was produced there have been changes in CKD prevalence, detection and treatment, and in the real cost of care. Robust estimates of current costs cannot therefore be produced simply by updating the Wanless figures in line with health service inflation.

47. Programme Budgeting data from the Department of Health estimated total NHS expenditure on renal problems at £1.64 billion in 2009–10.[23] Approximately 5% of PCT expenditure on renal problems was attributed to primary care and 95% to secondary care. Prescribing costs relating to kidney problems were estimated at £43.5 million in 2009–10.[24] There is uncertainty, however, regarding prescribing costs as a number of medications can be prescribed for more than one condition and attribution is difficult. It should also be noted that the Programme Budgeting renal category is broader than CKD. The Programme Budgeting estimates are therefore likely to include expenditure on other renal conditions such as acute kidney injury.

48. The costing approach in this paper is based on routine data sets where possible, supplemented by modelling based on earlier costing exercises (for NHS Kidney Care, NICE and other bodies), data supplied directly by NHS organisations, academic literature and expert opinion.

49. In order to estimate NHS expenditure arising from CKD, both direct and indirect costs are examined. Direct costs are defined here as those arising from health events and health care needs directly associated with CKD and its progression. In the main, these are the costs of renal care. Indirect costs are defined as those arising from excess bed days in general hospital admissions and from non-renal conditions for which CKD carries increased risk. Costs are counted for excess cardiovascular events and infections occurring in the CKD population, relative to a comparable population without CKD. The nature of the relationship between CKD and cardiovascular disease is not fully understood. Estimations of expenditure on excess adverse events in the CKD population should not be taken as implying that these excess events are *caused* by CKD. (It is possible, for example, that a third factor increases the risks of both CKD and cardiovascular events.)

50. The focus in this paper is on health care costs. However, it is likely that CKD also entails additional costs for social care. In most areas of care it has not been possible to estimate expenditure on social care. In the case of excess strokes in CKD, social care costs have been estimated. These are shown in Appendix 2.

51. All costs are expressed in 2009–10 prices. Costs for activity that would take place in the absence of CKD are not included.

Chapter 3 – Direct Costs

52. This chapter focuses on the direct costs of CKD. These may be classified as arising from:

- primary care
- outpatient attendances
- inpatient care
- RRT (dialysis and transplant)

53. There is obviously some overlap between these areas. For example, dialysis patients incur some admitted patient costs for dialysis-related complications. Decisions about the classification of costs have been taken in a pragmatic way, according to data availability. Care has been taken not to double-count costs, so these classification issues do not have an impact on the overall expenditure estimates. If the focus is on cost by category, however, it will be important to recognise that the costs shown here for RRT do not represent the entire cost of care for patients receiving RRT.

54. It was not possible to produce robust estimates of the cost of conservative care, owing to uncertainties regarding patient numbers and unit costs. Illustrative figures are provided in Appendix 1.

Primary care

55. The QOF sets out management indicators for CKD, and NICE clinical guidelines 73 and 114 provide recommendations for treatment and care.[1,25] This section will estimate costs for routine tests recorded in the QOF, and for prescribing in primary care arising from the NICE guidelines.

56. The QOF contains four CKD management indicators. Underlying achievement and exception rates for these indicators in 2009–10 are set out in Table 4.

Table 4. QOF CKD indicators, achievement and exception rates, 2009–10 (The NHS Information Centre)

CKD management indicators		Underlying achievement	Exception rates
CKD 2	The percentage of patients on the CKD register whose notes have a record of blood pressure in the previous 15 months	97.6%	0.57%
CKD 3	The percentage of patients on the CKD register in whom the last blood pressure reading, measured in the previous 15 months, is 140/85 or less	73.9%	7.47%
CKD 5	The percentage of patients on the CKD register with hypertension and proteinuria who are treated with an angiotensin converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB) (unless a contraindication or side effects are recorded)	91.8%	9.28%
CKD 6	The percentage of patients on the CKD register whose notes have a record of a urine albumin: creatinine ratio (or protein:creatinine ratio) test in the previous 15 months	77.7%	4.51%

Section II:
NHS Expenditure Attributable to CKD

57. Annual costs have been estimated for the tests covered by the QOF CKD indicators for the 2009–10 diagnosed QOF population. It is assumed that patients with prevalent CKD who are recorded as having blood pressure tests have these tests once every 15 months at a single 20-minute consultation with a GP practice nurse. It is assumed that urine samples for ACR or protein:creatinine ratio (PCR) tests are taken at the same consultation. Therefore, no additional costs are estimated for urine tests. It is likely that many patients are tested more frequently than 15-monthly. These costs may therefore be underestimated.

58. It is also assumed that diagnosed CKD patients have two GP consultations a year in addition to those they would have in the absence of CKD.[26]

59. For newly diagnosed cases, it is assumed that there are two additional GP visits and that two additional ACR or PCR tests are performed in the year of diagnosis. In 2009–10 the QOF register of CKD prevalence showed an increase of 78,428 over the 2008–09 prevalence. Adjustments for mortality, based on mortality rates from a 2004 US study,[14] suggest that approximately 119,000 new cases were diagnosed in 2009–10.

60. Laboratory costs for ACR and PCR tests are taken from NICE,[1] and have been updated to 2009–10 prices. Unit costs for staff inputs are taken from the Personal Social Services Research Unit.[27] Costs are calculated for the percentage of patients who received the tests in 2009–10, as indicated by the QOF underlying achievement rates, adjusted for the exception rates. The underlying achievement rate for blood pressure testing in 2009–10 was 97.6%, with an exception rate of 0.57%. For ACR or PCR tests, the underlying achievement rate was 77.7% and the exception rate was 4.5%. Total expenditure on primary care tests and consultations for CKD is estimated at £143 million, as shown in Table 5. Expenditure would be higher if all patients with CKD received these tests and consultations.

Table 5. Expenditure on primary care tests and consultations for CKD, as specified in QOF, 2009-2010

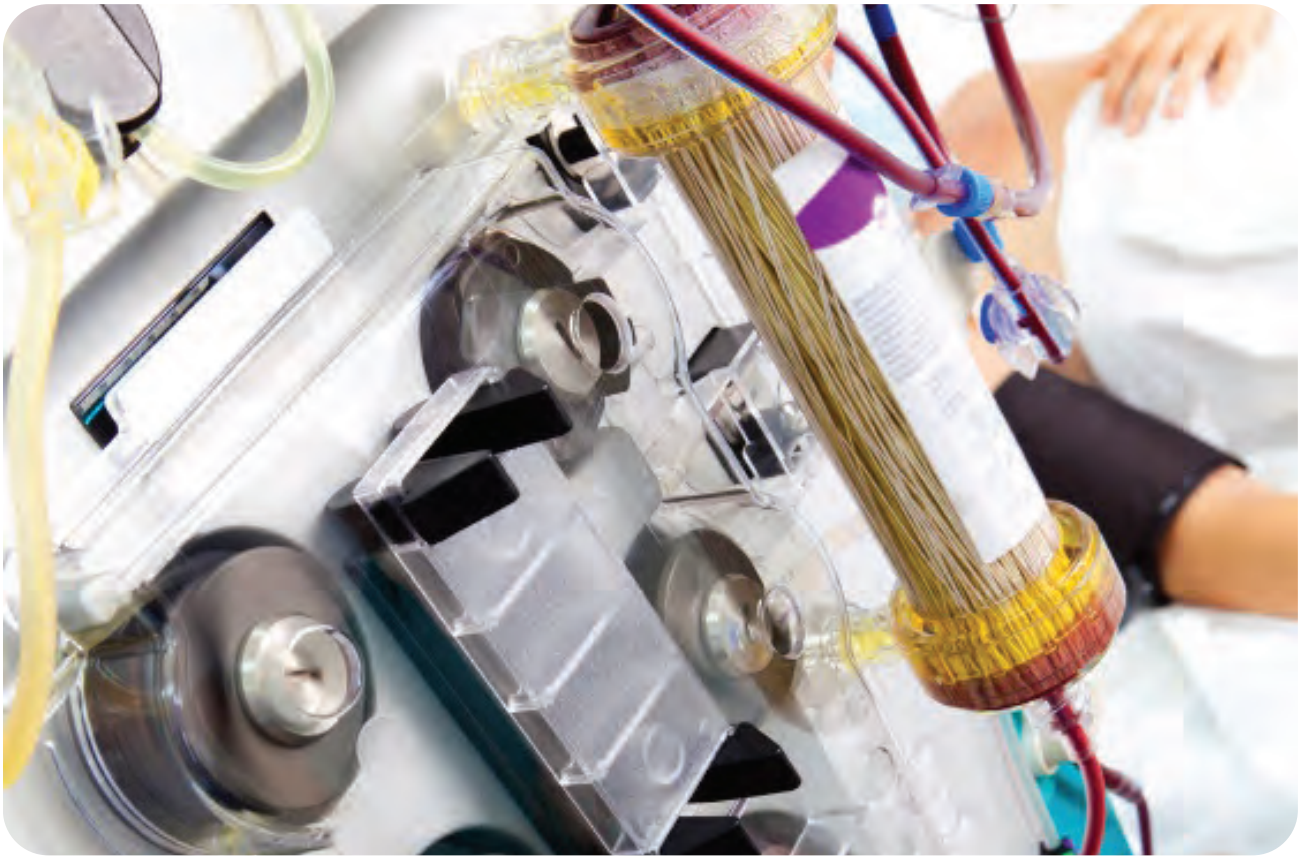
Intervention	Number of patients	Unit cost	Frequency	Annual cost
GP consultation	1,817,871	£32.00	6 months	£116,343,744
Additional GP consultations for newly diagnosed cases	119,359	£32.00	Two in first year	£7,639,004
Consultation with practice nurse	1,760,581	£10.00	15 months	£14,084,647
ACR or PCR laboratory test	1,347,584	£3.46	15 months	£3,730,112
Additional tests for newly diagnosed cases	119,000	£3.46	Two in first year	£823,480
				£142,620,986

Section II:
NHS Expenditure Attributable to CKD

61. Estimates of the cost of anti-hypertensive medications for people with CKD have been derived from a longitudinal population cohort study undertaken at East Kent University Hospitals NHS Foundation Trust.[28] This study found that 82.6% of 7,170 patients with CKD stages 3–5 were hypertensive in 2004–06, before the introduction of QOF points for CKD care; 91.2% of this group were hypertensive in 2006–08 and 89.4% of patients were hypertensive in 2008–10. Patients were considered hypertensive if they had a recorded mean blood pressure ≥140/85 mmHg or were prescribed anti-hypertensive medication.

62. The average annual cost of anti-hypertensive medications per hypertensive patient was estimated at £132 in 2008–10.

63. If the national prevalence of hypertension in CKD is similar to East Kent levels, it is estimated that 1.7 million people with CKD have hypertension (based on the diagnosed CKD population, as recorded through QOF). If anti-hypertensive medications are prescribed in the same quantities and proportions as for the East Kent cohort, the total annual cost for England is estimated at £215 million. (The East Kent CKD population is known to differ from the England population in certain respects. The average age is older in East Kent and the population is less ethnically diverse. However, expert opinion suggests that both the prevalence of hypertension and anti-hypertensive prescribing practices are likely to be similar to the CKD population in England.)



Section II:
NHS Expenditure Attributable to CKD

64. It is likely, however, that some of this expenditure would be incurred in the absence of CKD. Modelling suggests that expected hypertension prevalence in a non-CKD population with the age and sex profile of the CKD population is approximately 26%, based on HSE data.[29] Age and sex distributions are taken from the NEOERICA findings, as these are not available in QOF data.

65. Excess hypertension in the CKD population is therefore estimated at 63%. This suggests that around 1.2 million people in the CKD population are prescribed anti-hypertensive medications, over and above the number expected in a non-CKD population of the same age and sex profile. The cost of this excess prescribing is estimated at £152 million, as shown in Table 6.

66. This cost does not include any expenditure on anti-hypertensive medication for the 26% of people with CKD who are expected to have hypertension in the absence of CKD. Expert opinion suggests that the cost of anti-hypertensive medications is higher for those with both CKD and hypertension than for those with hypertension alone owing to greater use of ACE inhibitors in the CKD group. However, no robust comparative data on anti-hypertensive prescribing for matched populations with and without CKD has been identified. Therefore, no costs are counted for this group here.

67. It is important to note that hypertension is both a cause and a complication of CKD. In estimating excess hypertension in the CKD population it is not suggested that hypertension in this group is necessarily caused by CKD.

Table 6. Estimated numbers of people with CKD and hypertension, England, and costs of anti-hypertensive medications

Population	Prevalence	Number of patients	Annual cost
CKD patients with hypertension (estimate derived from Farmer C. *et al.*)	89.4%	1,625,260	£214,566,790
Expected hypertension without CKD	26.0%	472,369	
Excess hypertension in CKD	63.4%	1,152,890	£152,204,595

68. The number of people with CKD recorded in QOF as receiving hypertensive medications is very much lower than the numbers suggested by the East Kent study. QOF data show that, in 2009–10, 82,834 people on the CKD register with hypertension and proteinuria were treated with an angiotensin-converting enzyme inhibitor (ACEI) or angiotensin II receptor blocker (ARB).[2] This represents 4.6% of those on the CKD register. In the East Kent study, 36.7% of patients with CKD were prescribed ACEIs and 18.7% were prescribed ARBs in 2008–10 However, the QOF indicator covers only patients with proteinuria. (The QICKD study estimated the prevalence of proteinuria in stages 3–5 CKD at 4.0% to 10.1%, depending on the methods used to diagnose CKD and proteinuria.[5])

69. In addition to anti-hypertensive medications, NICE clinical guideline 73 recommends that vitamin D supplements should be prescribed for those with stages 3–5 CKD, according to need.[1] Data supplied by the NHS Information Centre indicate that expenditure on vitamin D supplements prescribed in primary care in England was £7.4 million in 2009–10. NICE recommends that erythropoiesis-stimulating agents (ESAs) should be offered to people with anaemia of CKD who are likely to benefit in terms of quality of life and physical function.[25] Expenditure on primary care prescribing of erythropoietin (EPO) and ESAs was £9.7 million in 2009–10. Phosphate binders are also frequently prescribed for people with CKD to prevent intestinal absorption of phosphate. Primary care expenditure on phosphate binders in 2009–10 was £9.4 million.[30]

70. These expenditure figures are based on estimates by The NHS Information Centre of the actual price paid (as opposed to the list price), allowing for any applicable discounts. While prescribing data are not available at disease level, expert opinion suggests that virtually all primary care expenditure on vitamin D supplements, EPOs/ESAs and phosphate binders is likely to be for people with stages 3–5 CKD. This expenditure is summarised in Table 7.

71. NICE recommends bisphosphonates for osteoporosis prevention in CKD, and iron supplements for those with functional iron deficiency.[1] However, these drugs are also prescribed for many patients who do not have CKD and it has not been possible discretely to identify expenditure for those with CKD. No costs are therefore included for bisphosphonates or iron supplements.

72. NICE also recommends diabetes management, smoking cessation and exercise programmes for people with CKD, according to need.[1] No costs are estimated here for these interventions as it is considered likely that in most cases eligibility for these treatments is determined by factors other than CKD status.

Table 7. Primary care prescribing of vitamin D, EPO/ESAs and phosphate binders, 2009–10 (The NHS Information Centre)

Product	Items	Primary care expenditure (£)
Vitamin D	662,006	7,420,039
EPO/ESAs	45,797	9,723,189
Phosphate binders	59,225	9,413,957
Total		**£26,557,185**

Section II:
NHS Expenditure Attributable to CKD

Outpatient care

73. NHS Reference Costs indicate that there were 679,538 nephrology outpatient consultations in 2009–10.[31] The total cost of this activity is estimated at £106 million (based on average unit costs in Reference Cost returns). Not all of these consultations relate to stages 3–5 CKD. Some are likely to be for stages 1–2 CKD and some for other renal conditions such as acute kidney injury and renal cancer. Owing to the lack of detailed coding in outpatients, it is not possible to identify discretely consultations for CKD in national datasets. Figures supplied by The North Bristol NHS Trust and University Hospitals of Leicester NHS Trust indicate that approximately 50% of nephrology outpatient consultations are for stages 3–5 CKD (excluding RRT, which is counted separately in the RRT section, below). Expert opinion suggests that this is a reasonable estimate of the national proportion. Costs for this proportion of activity are estimated at £53 million, as shown in Table 8.

Table 8. Activity and expenditure, nephrology outpatients 2009–10 (NHS Reference Costs) and estimated activity and expenditure for stages 3–5 CKD (excluding RRT)

	First attendances		Follow-up attendances		All
	Activity	Cost	Activity	Cost	Cost
All nephrology	84,305	£17,986,030	595,233	£88,341,995	£106,328,025
CKD 50%	42,128	£8,987,692	297,440	£44,144,851	£53,132,543

Inpatient care

74. A number of admitted patient Healthcare Resource Groups (HRGs) are specific to CKD or are likely to contain almost exclusively CKD activity. Together, these HRGs accounted for 63,504 hospital admissions in 2009–10, and expenditure of £75 million. Expenditure by HRG is shown in Table 9. It should be noted that the CKD HRGs may include some activity for patients with stages 1–2 CKD. No adjustment has been made as such admissions cannot be discretely identified and it is thought that activity levels for these patients are likely to be small. Cost estimates are based on average unit costs in Reference Cost returns.

Table 9. Cost of hospital admissions for CKD HRGs and dialysis-associated HRGs, NHS Reference Costs 2009–10, (Department of Health)

HRG v.4		Elective	Non-elective	Regular day/night admissions	All
LA08A	Chronic kidney disease with length of stay 2 days or more with major CC	£2,292,303	£13,472,983	£37,671	£15,802,957
LA08B	Chronic kidney disease with length of stay 2 days or more with intermediate CC	£6,089,497	£12,015,613	£13,381	£18,118,492
LAO8C	Chronic kidney disease with length of stay 2 days or more without CC	£3,882,167	£2,968,166	£6,021	£6,856,354
LAO8E	Chronic kidney disease with length of stay 1 day or less associated with renal dialysis	£2,225,771	£1,970,598	£2,424	£4,198,793
LAO8F	Chronic kidney disease with length of stay 1 day or less not associated with renal dialysis	£6,402,344	£4,079,259	£121,872	£10,603,475
LAO5Z	Renal replacement peritoneal dialysis associated procedures	£1,676,815	£702,318	£18,336	£2,397,469
QZ13A	Vascular access for renal replacement therapy with CC	£9,495,732	£3,636,710	£12,912	£13,145,355
QZ13B	Vascular access for renal replacement therapy without CC	£3,584,605	£175,882	£7,739	£3,768,226
Total		**£35,649,236**	**£39,021,530**	**£220,356**	**£74,891,121**

CC: Complications or comorbidities

Section II:
NHS Expenditure Attributable to CKD

Renal Replacement Therapy

75. The UK Renal Registry report for 2010 indicates that, in 2009, RRT prevalence was 40,962 in England.[32] Of this number, 47% were transplant recipients, 44% were receiving haemodialysis and the remainder were receiving peritoneal dialysis.

76. The costs of care for adult-recipient transplant were recently estimated by NHS Kidney Care.[33] A bottom-up costing exercise was conducted, covering costs relating to initial assessment, maintenance on the kidney transplant waiting list, the acute transplant episode, and post-transplant outpatient consultations. Overheads and capital charges were excluded. Immunosuppression costs were included for the first 12 weeks after transplantation only.

77. Table 10 sets out estimated expenditure related to kidney transplants, derived from the NHS Kidney Care analysis. Costs from NHS Kidney Care have been adjusted upwards by 15%, as an estimate of the impact of overheads. The number of patients receiving transplants in England is taken from NHS Blood and Transplant (2,329 in 2009–10), as is the number of patients on the waiting list for a transplant (6,178 in 2009–10).[34] The number attending initial assessment clinics has been estimated based on UK figures from a recent study by the NHS West Midlands Specialised Commissioning team.[35] (Of all UK transplants in 2009–10, 86% were in England, and 86% of people on the kidney transplant list were in England.[34] This proportion has therefore been used to estimate the number of UK initial assessments that occur in England.) The number of patients receiving ongoing post-transplant care (after year 1) is estimated from UK Renal Registry data. (The prevalence in England at the end of 2009 was 19,418.[32] Deducting 2,329 people who received their transplants in 2009–10, the number of patients receiving ongoing post-transplant care after year 1 is estimated at 17,089. No costs are counted for patients who died or experienced graft failure during the year.) Costs of immunosuppression beyond 12 weeks and of ongoing care are taken from a recent study by the NHS West Midlands Specialised Commissioning team.[35]

78. Donor costs were not included in the NHS Kidney Care estimates. NHS Reference Costs for 2009–10 record expenditure of £59,112 on live kidney donor screening, pre-transplantation work-up and post-transplantation examination.[31] It is likely, however, that this is a substantial underestimate. There are 81 episodes of live donor pre-transplantation work-up recorded in Reference Costs, nine donor screening episodes and seven post-transplant examinations. NHS Blood and Transplant figures indicate that more than 900 living donors gave kidneys for transplant in England in 2009–10.[34]

79. No cost estimates were available for the retrieval and transportation of kidneys from deceased donors. Therefore, these costs are excluded. The NHS Kidney Care costing exercise related to adult transplant recipients. It is recognised that costs for paediatric recipients are likely to be different. However, in the absence of detailed cost estimates for children, the estimates for adult care have been applied to all transplants. The total annual cost of transplant is estimated at £225 million.

Table 10. Estimated annual expenditure on kidney transplants, England

	Annual cost per patient	Patients	Annual expenditure
Initial assessment clinic	£2,537	2,531	£6,421,018
Waiting list clinic attendances (four times per year)	£2,971	6,178	£18,356,775
Acute transplant episode	£14,731	2,329	£34,307,984
Post-transplant outpatient visits, year 1	£12,884	2,329	£30,007,668
Immunosuppression after week 12 (year 1)	£4,810	2,329	£11,201,675
Ongoing care (after year 1)	£7,318	17,089	£125,050,287
Live donor costs (from 2009–10 Reference Costs)			£59,112
Total			**£225,404,520**

80. According to the 2010 Renal Registry report, 21,544 people were receiving dialysis in England at the end of 2009.[32] Of these, 18,191 were receiving haemodialysis and 3,353 were receiving peritoneal dialysis. NHS Reference Costs for 2009–10 show dialysis activity valued at £505 million. Of this sum, approximately £56 million was recorded for outpatient activity.[31]

81. Implied annual per patient costs are £24,043 for haemodialysis and £20,078 for peritoneal dialysis, as shown in Table 11.

82. In principle, NHS Reference Costs are calculated on a full cost absorption basis. The cost of drugs such as EPO should therefore be included if provided by the acute trust at the time of dialysis, at outpatient appointments or during a hospital admission. For this reason, no further costs are counted here for drugs provided to dialysis patients by acute providers. Expenditure on EPO and ESAs prescribed in primary care is estimated at £9.7 million, as shown in Table 7, above.

Table 11. Estimated expenditure on dialysis, 2009–10

	Haemodialysis	Peritoneal dialysis
Patients	18,191	3,353
Implied unit cost	£24,043	£20,078
Total cost	**£437,359,152**	**£67,321,076**
	All dialysis: £504,680,228	

Section II:
NHS Expenditure Attributable to CKD

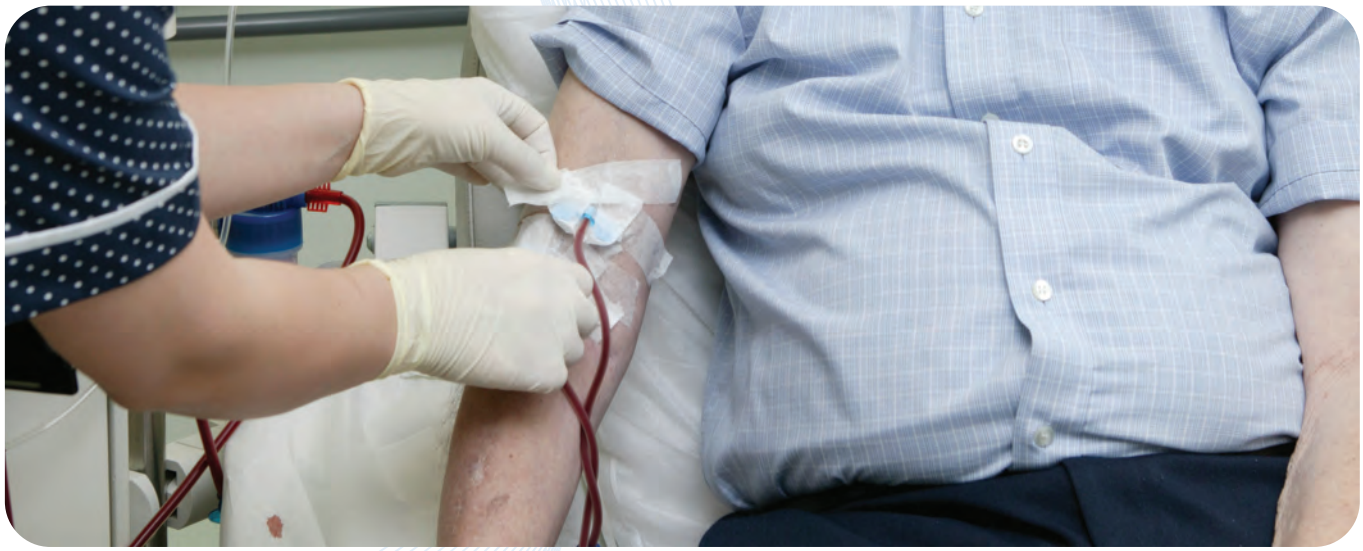
83. The implied annual cost per patient of haemodialysis may be compared with an estimated annual cost of £28,074, derived from estimates in the 2002 NICE report on home versus hospital haemodialysis.[36] (The figures in the NICE report have been updated to 2009–10 prices and a weighted average has been calculated, based on data from the Renal Registry on the proportion of haemodialysis patients treated in hospital, in satellite units and at home.)

84. Hospital admissions for complications arising from RRT are not included in these tables, though some at least of these costs are captured in Table 12 above. Of the expenditure in Table 9, £24 million is in HRGs specifically associated with RRT. It is likely that some of the remaining activity in Table 9 is also related to RRT.

85. Although expenditure on non-health areas, such as benefit payments, is not within the scope of this paper, it is important to recognise that it in many cases ESRD will significantly reduce an individual's mobility and ability to perform usual tasks. This is likely to entail both public and private costs. Public costs include both benefit payments and lost tax revenue. These costs are likely to vary considerably across RRT modalities.

86. The dialysis costs in Table 11 do not include patient transport costs. A 2010 audit found that NHS-funded transport was provided for 61% of patient journeys in England for hospital and satellite haemodialysis.[37] If these results are representative, they suggest that approximately 3.3 million NHS-funded journeys are taken each year for dialysis. This estimate is based on the assumption that the average patient travels to the dialysis centre three times a week, 52 weeks a year.

87. Costs of £50 million have been estimated for these journeys, using the average transport cost for a patient attendance from NHS Reference Costs 2009–10. This is equivalent to £2,792 for each haemodialysis patient, bringing the estimated annual mean cost of haemodialysis to £26,835 per patient. No transport costs are estimated for transplant or peritoneal dialysis patients.



Chapter 4: Indirect Costs

88. Indirect costs are counted for excess length of hospital stay in people with CKD and for excess adverse events occurring in the CKD population.

Excess length of hospital stay

89. Analysis of Hospital Episode Statistics (HES) data indicates that, in 2009–10, there were 86,488 ordinary hospital admissions (i.e. admissions in which the patient stayed in hospital for at least one night) for which a CKD diagnosis (ICD 10 N18) was recorded. This figure excludes the activity covered in CKD-specific HRGs, as outlined in Chapter 3. Maternity admissions and non-emergency hospital transfers were also excluded.

90. Generalised linear model regression was conducted to estimate the impact of CKD diagnosis on the length of stay in these admissions. Covariates were selected through pairwise analysis using $p<0.05$ as the benchmark. Covariates used in the regression were CKD diagnosis, patient age, sex, index of multiple deprivation decile, admission method (elective or emergency), and specialty type (surgical or non-surgical).

91. Six model specifications were tested: normal, gamma and inverse Gaussian using both identity and log links. Candidate models were ranked according to their Akaike information criterion (AIC) values. The model with the lowest information criterion was the log-gamma model. The log-gamma model results were therefore used to estimate parameters. The coefficient for CKD diagnosis in the log model was 0.298 (95% CI 0.286–0.310). The value of the exponentiated coefficient was 1.35 (95% CI 1.33–1.36).

92. Using the mean length of stay for patients without a recorded CKD diagnosis (6.78 days) as a baseline, the number of excess bed days in CKD was estimated at 203,625. The NHS Institute has estimated the cost of an inpatient bed day at £225.[38] Expenditure on excess bed days for people with CKD is estimated at £46 million. It should be noted, however, that the NHS Institute estimate is not specific to CKD patients. As many people with CKD have substantial healthcare needs, it is possible that the mean cost of an inpatient bed day for people with CKD is higher than the NHS Institute estimate. If so, expenditure on excess length of stay will be higher than the figure estimated here.

Section II:
NHS Expenditure Attributable to CKD

Stroke and Myocardial Infarction

93. CKD is associated with increased risk of cardiovascular disease. A number of studies have shown that stage 3–4 CKD is an independent risk factor for stroke, MI, fatal coronary heart disease and death.[14,39] The risk of cardiovascular events is greater in stage 5 CKD than at earlier stages.

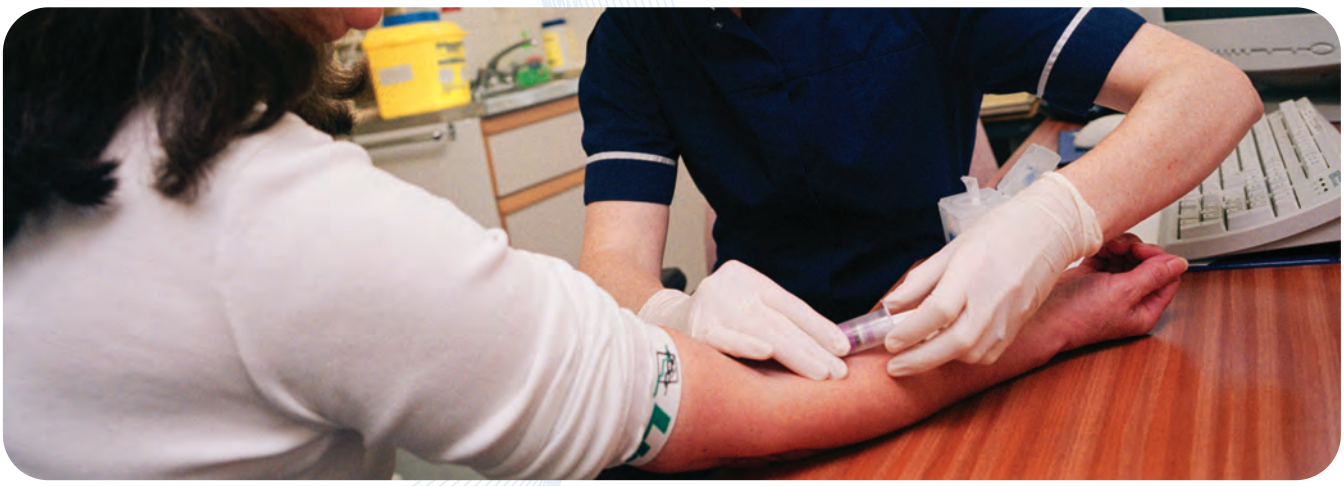
94. An economic model was constructed to estimate excess strokes and MIs in people with CKD. The model estimated the expected incidence of strokes and MIs in a non-CKD population with the age and sex distribution of the CKD population, and the incidence of strokes and MIs in the CKD population. Costs were estimated for strokes and MIs in excess of the number that would be expected in the absence of CKD. While costs are estimated here for excess adverse events in the CKD population, a causal relationship between CKD and these adverse events is not asserted.

95. Estimates of CKD prevalence derived from the QICKD study and from the HSE were used.[3,5] The estimated number of people in England with stages 3–5 CKD based on these prevalence estimates is higher than the number of people recorded with CKD on the QOF register, as shown in Chapter 1.

96. For the HSE, CKD was directly diagnosed by means of blood and urine samples from survey participants, thus identifying people with previously undiagnosed CKD. In the case of QICKD, the prevalence estimate was based on eGFR measurements in primary care records. However, the difference between prevalence estimates in this study and in QOF may suggest that not all of those who have recorded eGFR measurements indicating CKD stages 3–5 are recognised by GPs as having the disease.

97. QICKD and HSE prevalence estimates were used to estimate excess adverse events as it is considered likely that the risk of such events applies to the total CKD population. Indeed, the risk may be higher in the undiagnosed than in the diagnosed population, owing to the lack of risk-ameliorating treatment.

98. The age distribution of people with CKD was taken from the NEOERICA study.[4] The number of patients on dialysis in England was taken from the UK Renal Registry.[32] No excess strokes or MIs were estimated for the transplant population.



Stroke

99. A recent meta-analysis has found that stage 3–4 CKD independently predicts incident stroke with an adjusted HR of 1.22 (95% CI 1.02–1.44).[40] A Japanese study found a relative risk of stroke in people receiving dialysis of 5.2 ($p<0.001$).[41] This figure may be compared with the results of a US study which found an age-adjusted relative risk of stroke hospitalisation in people receiving dialysis of 6.1 (95% CI 5.1–7.1) for Caucasian males, 4.4 (95% CI 3.3–5.5) for African–American males, 9.7 (95% CI 8.2–11.2) for Caucasian females, and 6.2 (95% CI 4.8–7.6) for African–American females.[42] No estimate of relative risk for the English dialysis population has been identified. As the US study did not produce a CKD-population-level estimate of relative risk, the figure from the Japanese study is used here. It is recognised, however, that the estimate of excess strokes in people receiving dialysis is subject to uncertainty as the relative risk appears to vary with ethnicity. Excess strokes in the dialysis population represent 13-14% of all excess strokes estimated here.

100. The expected number of strokes in a non-CKD population of the same size as the CKD population, and with the same age and gender profile, was derived from WHO estimates of UK stroke incidence.[43] The number of strokes in the CKD population was estimated using the meta-analysis results for stages 3-4 and the Japanese study results for dialysis. The number of excess strokes was estimated by deducting the expected number from the CKD estimate.

101. The economic model estimates the incidence of stroke in a non-CKD population with the age and sex profile of the CKD population at 9.6 per 1,000 patient years. The incidence of stroke in the CKD population is estimated at 12.0 per 1,000 patient years. Using QICKD prevalence estimates for CKD, the number of excess strokes per year in the CKD population, relative to an age- and sex-matched population without the condition, is estimated at 6,734. Excess strokes are estimated for the population aged 25 and above. The number of excess strokes per year in the CKD population is estimated at 6,533, based on HSE prevalence.

102. The cost to the NHS of health care related to these strokes is estimated at £80 million to £82 million a year, as shown in Table 12. Costs are derived from the National Audit Office 2005 report on stroke care, and updated to 2009–10 prices.[44] Estimated social care costs for these strokes are shown in Appendix 2.

Section II:
NHS Expenditure Attributable to CKD

Myocardial Infarction

103. The adjusted HR for MI in people with stage 3–4 CKD is taken from a population-based study of 7,534 adults who took part in the World Health Organisation's MONICA Augsburg survey.[45] The adjusted HR for MI in women with stage 3–4 CKD, compared with those with eGFR ≥60 ml/min/1.73 m^2, was 1.67 (95% CI 1.07–2.61). The adjusted HR for men was 1.51 (95% CI 1.09–2.10).

104. The baseline population risk has been taken from the Oxford Record Linkage Study (data supplied to the British Heart Foundation).[46] Population risk is estimated for the population aged 35 and above. Excess MIs in the CKD population have therefore been estimated for this patient group only. No robust estimate of the excess risk of MI in people on dialysis was identified. The HR for stage 3–4 CKD has therefore been applied to this patient group. It is possible, therefore, that excess MIs are underestimated. No excess MIs have been estimated for transplant patients.

105. The economic model estimates the incidence of MI in a non-CKD population of the age and sex profile of the CKD population at 7.4 per 1,000 patient years (10.5 for men and 6.0 for women). The incidence for the CKD population is estimated at 11.9 (15.9 for men and 10.0 for women).

106. Using the QICKD prevalence estimate, the model suggests that 12,334 excess MIs a year occur in people with CKD. The number of excess MIs in CKD based on the HSE prevalence estimate is 12,189.

107. The first year cost of each MI is estimated at £7,734. This figure is derived from cost estimates produced by NICE, adjusted to 2009–10 prices.[47] The total cost to the NHS is estimated at £94–95 million, as shown in Table 12.

Table 12. Estimated excess strokes and MIs in the CKD population and associated expenditure, 2009–10

		QICKD		HSE	
	Unit costs	**Events**	**Expenditure**	**Events**	**Expenditure**
Stroke	£12,200	6,734	£82,155,382	6,533	£79,703,607
MI	£7,734	12,334	£95,391,156	12,189	£94,269,590

108. CKD also entails excess risk of other conditions, such as chronic ischaemic heart disease, heart failure and fragility fractures.[48] The cost estimates shown here are therefore likely to be an underestimate of total indirect costs.

Infection

109. Patients with CKD have an increased rate of infection compared with the non-CKD population. In England, the Health Protection Agency (HPA) collects data on MRSA infections in RRT patients. In 2008-09 there were 153 reported and verified cases of MRSA in haemodialysis patients.[63] (No episodes of bacteraemia were reported in people receiving peritoneal dialysis.) The median centre-specific rate of MRSA bacteraemia was 0.64 (range 0–3.49) episodes per 100 haemodialysis patients per year.

110. The total number of MRSA infections reported in England (among renal and non-renal patients) was 2,935 in 2008–09, or approximately 0.006 per 100 people. Given these figures, the expected number of infections in 17,349 people (the number of people receiving haemodialysis) is 0.98, so approximately 152 of the 153 reported cases among haemodialysis patients can be attributed to CKD. (This figure is not adjusted for age or comorbidity as MRSA data are not available by population sub-group. As it is known that the risk of MRSA increases with age and comorbidity, and CKD prevalence also increases with age and comorbidity, this attribution figure may be a slight overestimate. Sensitivity analysis was therefore conducted using the population aged 65 and over as the denominator to calculate MRSA incidence. If it were the case that all MRSA cases occurred in this age cohort, the expected number of infections in 17,349 people would be six. The number of cases in the haemodialysis population attributable to CKD would therefore be 147.)

111. The average cost of a bacteraemia infection is not known with confidence. A study conducted for the Department of Health estimated the hospital costs of a bloodstream infection at £5,397 in 1994–95 prices.[49] This is equivalent to £9,316 in 2009–10 prices. The total cost of 152 infections, at £9,316 per infection, is £1.4 million.

112. However, it is likely that MRSA infections related to haemodialysis are a relatively small proportion of total CKD-related infections. There is evidence that the incidence of a wide range of infections is greater for people with CKD than for those without CKD, and that this effect holds for the general CKD population (stages 3–5), not just for those receiving haemodialysis. The HPA does not report CKD status for patients who are not receiving dialysis. It is therefore not possible to estimate from these data the number of MRSA infections attributable to CKD in the non-dialysis population.

113. There is evidence that dialysis patients are at particular risk of *Clostridium difficile* infection.[50] A study in an Irish hospital showed that rates of *Clostridium difficile* were four times as high among patients in the nephrology unit (10.7 per 1,000 admissions) as in other areas of the hospital (2.7 per 1,000 admissions).[51]

114. The United States Renal Data System provides evidence that hospital admissions for bacteraemia/septicaemia, pneumonia and urinary tract infection are higher in patients with stage 3–5 CKD than in the non-CKD population.[52]

115. It was not possible to estimate the cost of CKD-related infections other than MRSA in haemodialysis as no robust data sources were identified.

Section II:
NHS Expenditure Attributable to CKD

Chapter 5: Summary of Costs

116. Total expenditure attributable to CKD in 2009–10 is estimated at £1.45 billion, as shown in Table 13. This is equivalent to 1.3% of NHS expenditure in England.

Table 13. Summary of CKD-associated expenditure, 2009–10

Category of care		Expenditure
Primary	Tests and consultations	£142,620,986
	Anti-hypertensive medications	£152,204,595
	Osteoporosis prevention and vitamin D supplements	£26,557,185
Primary		**£321,382,767**
Acute	Outpatient attendances	£53,132,543
	Admitted patient care	£74,891,121
Acute		**£128,023,664**
ESRD	Transplantation	£225,404,520
	Dialysis	£504,680,228
	Transport for dialysis	£49,521,157
ESRD		**£779,605,905**
Indirect costs	Excess length of hospital stay	£45,815,625
	Excess strokes	£79,703,607–£82,155,382
	Excess MIs	£94,269,590–£95,391,156
	Excess MRSA	£1,416,108
Indirect costs		**£221,204,929–£224,778,271**
		£1,450,217,265–£1,453,790,607

117. These costs are likely to be an underestimate of total NHS spending on CKD as there are a number of areas in which it has not been possible to estimate costs. No costs have been included for conservative care, or for prescribing in areas where it was not possible to identify discrete costs for the CKD population. Transplant donor costs are likely to be underestimated as they are under-reported in NHS Reference Costs and no robust alternative cost estimates were identified.

118. Where there is uncertainty regarding the level of costs, a conservative approach has been adopted. For example, it is assumed that primary care urine and blood pressure tests for the CKD population take place at 15-month intervals, as specified in the QOF, but it is likely that many patients are tested more frequently.

119. People with CKD have longer hospital stays than an age-matched population without the condition, and are at increased risk of adverse cardiovascular events and infections. Indirect costs are estimated for excess strokes, MIs and hospital bed days in the CKD population, and for excess MRSA infections in those receiving haemodialysis.

120. It is known that CKD is also associated with increased incidence of conditions such as heart failure and fragility fractures, which are not considered here.[48] There is also evidence that people with CKD are at increased risk of infections other than MRSA, and that this effect holds for the general CKD population (stages 3–5), not just for those receiving haemodialysis.[51]

121. All estimates are based on current practice rather than on optimal care.

122. The estimate of total expenditure is more than twice the sum that would be produced by extrapolating from the costs in the 2002 Wanless report, *Securing our Future Health: Taking a Long-term View*. Spending on kidney care in 2002–03 was estimated at £445 million (£580 million in 2009–10 prices).[22] Costing methodology was not set out in the Wanless report, so it is not possible to make a detailed comparison of our estimates with the earlier figures. However, a substantial rise in expenditure in recent years would not be surprising, as there have been significant increases in diagnosed prevalence and changes in the management of CKD and associated risks. The total prevalence (diagnosed and undiagnosed) is also believed to be increasing.

123. Programme Budgeting data from the Department of Health estimated total NHS expenditure on renal problems at £1.64 billion in 2009–10.[23] However, the Programme Budgeting renal category is broader than CKD. The Programme Budgeting estimates therefore include expenditure on other renal conditions. Programme Budgeting data for renal problems do not include indirect costs (which contribute £221–£225 million to the total estimated in this paper). Total direct costs estimated here are £1.23 billion.

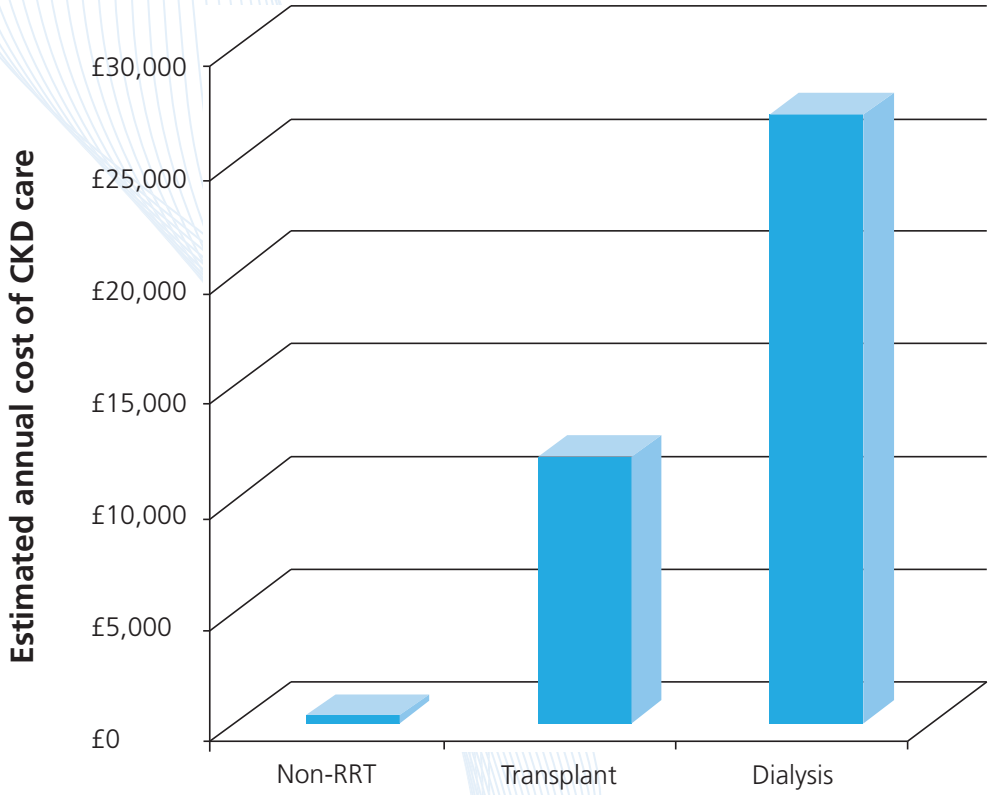
124. In Programme Budgeting data, 5% of PCT expenditure on renal problems was attributed to primary care and 95% to secondary care. The proportion of direct costs attributed to primary care in this paper is considerably higher (12% without prescribing costs, 26–27% if prescribing costs are included).

Section III:
Discussion

125. The evidence presented in this paper suggests that CKD leads to thousands of premature deaths each year, diminishes quality of life for many people and represents a significant financial burden for the NHS. The risk of death, the impact on quality of life, and the cost to the NHS are very much higher for people with advanced kidney disease than for those with moderate CKD.

126. More than half of total estimated expenditure on CKD is for RRT, although the RRT population comprises only one in 50 of the diagnosed CKD population. The mean annual cost of direct CKD care per patient receiving dialysis can be crudely estimated at £27,000, the cost per transplant recipient at £12,000 and the cost per patient not receiving RRT at £235, as shown in Figure 2.

Figure 2. Estimated annual cost of CKD care per patient, non-RRT, transplant and dialysis



127. Given the impact of ESRD on survival and quality of life, and the high level of expenditure on RRT, there is a need for further analysis on the potential for improved outcomes and cost savings through enhanced strategies to reduce progression rates to ESRD. For example, modelling based on the costs in this paper suggests that ACEI/ARB prescribing for patients with hypertension and proteinuria produces a mean annual net saving to the NHS of approximately £470 per treated patient over a 5-year perspective. This saving arises through reduced ESRD, stroke and MI risk.[53] QOF data indicate that, in 2009–10, 82,834 people with hypertension and proteinuria (6.1% of those who had an ACR or PCR test) were treated with ACEI/ARBs. The net annual saving for this group, over a 5-year perspective, is estimated at £39 million. Further details of this economic model are given in Appendix 3.

128. However, approximately 468,000 people on CKD registers did not have an ACR or PCR test in the 15 months before the 2009–10 QOF data collection. If the joint prevalence of hypertension and proteinuria were at the same level in the untested group as in the tested CKD population, there could be an additional 29,000 patients who would benefit from ACEI/ARB prescribing. The net annual saving from ACEI/ARB prescribing for a group of this size is estimated at £13 million over a 5-year perspective. (In 2010-11, there was an increase in the percentage of patients who received these tests. Based on 2010-11 data, it is estimated that there could be 26,000 patients who did not receive these tests and might benefit form ACEI/ARB prescribing). There may also be undiagnosed hypertension and proteinuria in the 900,000 to 1.8 million people who are believed to have undiagnosed CKD.[3,4,5]

129. There is also a need for further work on the relative costs and benefits of RRT modalities. The implied annual per patient cost for peritoneal dialysis presented in this paper is lower than that for haemodialysis. However, these figures are derived from NHS Reference Costs, and do not include the full impact of infections and complications. Most recent UK studies have found that mean costs are lower for peritoneal dialysis than for haemodialysis,[54-56] though one study reported that it may be more cost-effective to manage patients starting RRT with hospital haemodialysis than continuous ambulatory peritoneal dialysis, given the existence of the haemodialysis infrastructure.[57] Home haemodialysis may be less expensive than peritoneal dialysis.[56] There is also uncertainty regarding the relative clinical effectiveness of different modalities.[55]

130. Because of the paucity of data on resource use by people with CKD in the English NHS, cost-effectiveness and cost–benefit studies have often been based on international data. However, it is known that care delivery and associated expenditure vary substantially across countries. It is hoped that this paper will provide a robust foundation for cost analysis in future studies and for tackling questions such as the cost-effectiveness of screening for CKD and of strategies for early detection and disease management.

Appendix 1

Conservative Care

1. It is not known how many renal patients are receiving conservative care in England. Numbers are likely to vary from unit to unit depending on patient preferences and on local provision of conservative care. Estimates from one centre (Barts and The London NHS Trust) suggest that approximately 5% of those with renal failure choose conservative care rather than RRT.[58] A recent Renal Registry survey of all renal units in the UK found that the mean percentage of prevalent stage 5 CKD patients over the age of 75 said to be receiving conservative care was 16.7%.[59]

2. A 2009 retrospective cohort study of 396 stage 4 CKD patients in Scotland and Northern Ireland found that 89 commenced RRT while 20 chose conservative care.[60] Most patients died before being offered RRT. The percentage of the entire cohort opting for conservative care was 5.1%. The percentage of the combined RRT and conservative care group who chose conservative care was 18.3%. The study population was elderly, however, with 71.7% of patients aged ≥65, and it may be that preference for conservative care increases with age.

3. The cost per patient of conservative care provided by a renal unit has been estimated at £397 per month (£4,764 per year).[58] However, expert opinion suggests that not all conservative care patients are likely to receive such resource-intensive care. In the early stages of conservative care, resource use may be similar to that of a stage 3–4 CKD patient, with care (and expenditure) increasing over time with disease progression.

4. Survival rates with conservative care are estimated at 68% and 47% for 1 and 2 years, respectively.[61]

5. Using these cost and survival estimates (and assuming that 3-year survival is 25% and 4-year survival is 0), prevalence figures and costs have been estimated for three scenarios: 5% uptake of conservative care (of those choosing between dialysis and conservative care); 10% uptake; and 18% uptake. Annual expenditure estimates range from £3 million for the 5% scenario to £13 million for the 18% scenario, as shown in Table A1. The costs shown are only for renal units. It is possible that conservative care patients will also incur costs in primary and community care, in excess of those set out in Chapter 3.

Table A1. Estimated conservative care costs, for 5%, 10% and 18% uptake

Scenarios	Estimated conservative care prevalence	Annual renal unit cost
5% uptake	643	£3,061,990
10% uptake	1,363	£6,491,939
18% uptake	2,692	£12,825,537

Appendix 2

Social Care Costs

1. In most areas of CKD care it has not been possible to estimate social care costs. In the case of stroke, social care costs have been estimated.

2. The cost of stroke was derived from the 2005 report from the National Audit Office on stroke care, and updated to 2009–10 prices.[44] Annual stroke costs are shown here for health care and social care (Table A2), based on QICKD and HSE estimates of CKD prevalence. Social care accounts for more than 60% of stroke expenditure.

3. Unit costs are mean costs across the incident and prevalent stroke population. Total expenditure estimates cover both first year costs for incident strokes and long-term care costs for those whose strokes occurred in earlier years.

Table A2. Estimated health and social care costs of excess strokes in CKD, 2009–10

		Health		Social care		Total
CKD prevalence estimate	**Strokes**	**Unit cost**	**Expenditure**	**Unit cost**	**Expenditure**	**Expenditure**
QICKD	6,734	£12,200	£82,155,382	£19,435	£130,869,840	£213,025,222
HSE	6,533		£79,703,607		£126,964,272	£206,667,879

4. When the cost of social care for excess strokes in CKD is added to the health costs estimated in this paper, the total cost of CKD in 2009–10 rises to £1.66–£1.67 billion.

Appendix 3

Cost impact of ACEI/ARBs for hypertension and proteinuria

An economic model was created to estimate the cost impact of ACEI/ARB prescribing for people with CKD who have hypertension and proteinuria.

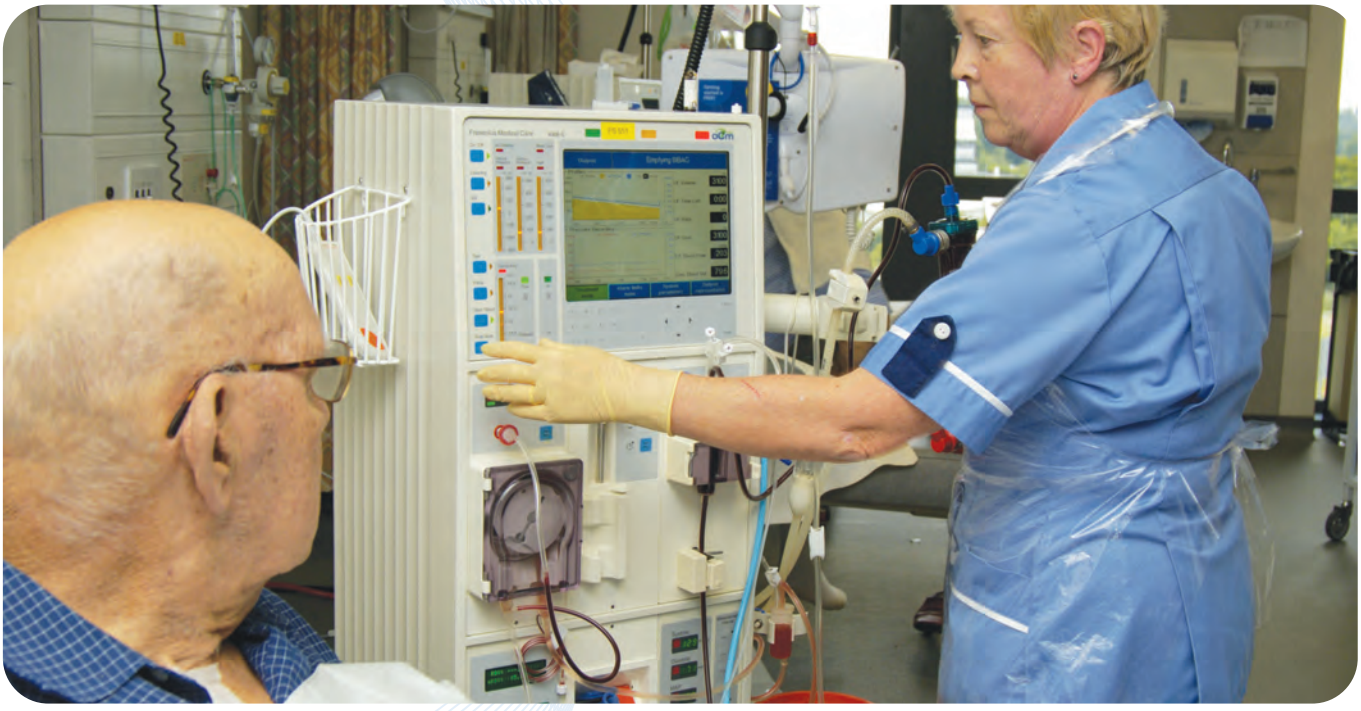
Annual transition rates to ESRD (hypertension and proteinuria untreated = 0.033, hypertension and proteinuria treated = 0.022) were taken from NICE[1].

The population is adjusted for annual mortality. The mortality rate for non-ESRD is calculated using ONS data on all-cause mortality, adjusted using hazard ratios for age and CKD stage[62] and the NICE estimate that the mortality rate for this group is reduced by 22% with ACEI/ARB therapy[1].

Transplant probabilities in ESRD are estimated based on Renal Registry and NHS Blood and Transplant data[32,34]. The costs of dialysis and transplant are taken from a recent report[35].

Annual graft failure and mortality rates for transplant recipients are taken from the Renal Registry[32]. It has been assumed that 62% of transplants are from deceased donors[34]. The renal transplant annual failure rate (2.9% in the UK in 2009) and death rate in prevalent patients (2.5 per 100 patient years) are taken from the Renal Registry 2010 report[32]. Dialysis mortality is estimated using data from the Renal Registry 2010 report[32].

The annual cost per patient of ACEI/ARBs is taken from a recent study at East Kent University Hospitals NHS Foundation Trust[28].



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