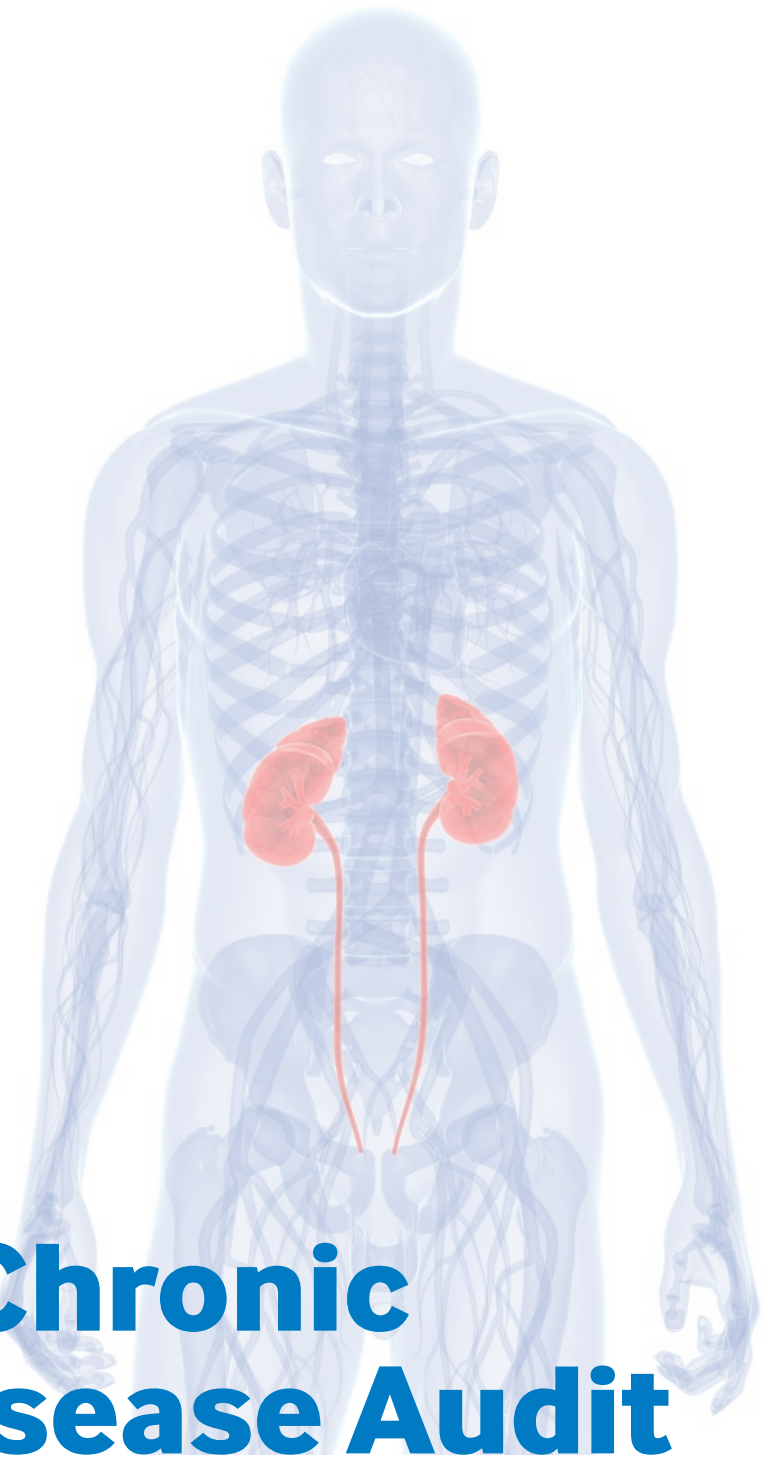
National CKDAudit

A quality improvement programme for chronic kidney disease



National Chronic Kidney Disease Audit

// National Report: Part 2 December 2017

Commissioned by: HQIP Healthcare Quality Improvement Partnership

Delivered by: Queen Mary University of London; London School of Hygiene & Tropical Medicine; UCL; Informatica Systems

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// Foreword by Fiona Loud

CKD Audit Part 2 – Mind the gap

The CKD Audit, the first of its kind in England and Wales, has some extremely relevant recommendations for patients and practitioners, showing that there is too much variation in the way CKD care is administered and that this has an adverse effect on our outcomes. We hope that by highlighting good practice more attention will be given to improving the care of people with CKD and to prevent or delay common complications such as heart disease and less common ones like kidney failure. Whilst many with CKD will have other problems and may be older, recognising the presence of CKD will deliver improved quality of care. The audit estimated a prevalence of 5.8% of the population having moderate to advanced CKD, with an average of 4.2% of the population being identified and recorded. The audit points to people in the gap having the worst outcomes.

From the patient viewpoint, knowing that you have chronic kidney disease gives a chance to do something about it; if your doctor knows (and lets you know) that you have CKD it makes it much more likely you will receive the information, advice and check-ups you need.

And if, as part of good, patient-centred care, a record of your condition(s), the medications, vaccinations and advice you are given is appropriately recorded this will prompt follow-up care.

Many with CKD do receive this care from their doctors, and it is supported by the recent CKD quality standards issued by NICE *https://www.nice.org.uk/guidance/qs5* which state clearly the importance of managing blood pressure and offering statins. However the Audit puts this into context, with data showing that a) recording or coding that people have CKD is not consistently implemented and b) that people with CKD which is not recorded (and therefore not known to all those who are caring for that patient) are more likely to have heart attacks and strokes, more likely to be admitted to hospital, more likely to develop Acute Kidney Injury and more likely to die than those who have been identified in advance.

The 1st audit showed that opportunities to identify and offer interventions to patients are missed in 673,000 people, or 1.2% of the population in England and Wales, this report shows the human cost. We know that primary care is stretched, we know that the NHS has cost pressures but it makes sense to use the information and opportunities that exist to look to do better for people with CKD. As we also know that **patients who are not coded for CKD are twice as likely to have an emergency hospital admission as patients who are coded for CKD. It is time to take action now**.

We are grateful to the CKD audit team for their hard work in delivering clear evidence to prompt improvement.

Fiona Loud

Policy Director Kidney Care UK (formerly known as the British Kidney Patient Association).
www.kidneycareuk.org

// Foreword

Dr Matt Kearney, GP and National Clinical Director for Cardiovascular Disease Prevention, NHS England and Public Health England.

Dr Kathryn Griffith previously RCGP Clinical Champion for Kidney Care and Chair of the National CKD Audit Project Board.

As Primary Care Doctors we welcome this second report of the HQIP national audit of chronic kidney disease (CKD) which focuses on kidney disease management in primary care. The majority of people with CKD will be cared for entirely by their general practice teams and this audit is the largest study of current practice in the world.

The detection and management of CKD is key to the prevention of cardiovascular disease (CVD), along with the detection and management of high blood pressure and diabetes mellitus, both important causes of CKD itself. CKD is also a major risk factor for Acute Kidney Injury (AKI). There is a robust evidence base that treatment of CKD is effective in reducing cardiovascular events and AKI.

The inclusion of CKD in the Quality and Outcome Framework did stimulate significant improvements in care, although for some clinicians there was initial confusion as to the significance of kidney blood tests, and concern about risks of over diagnosis and treatment.

The core value of audit is that it identifies good practice, evidence of suboptimal care and opportunities for improvement. The first report on the CKD Audit in January 2017 highlighted that there is wide variation in coding with some practices having large numbers of people with abnormal kidney function who have not been formally diagnosed with CKD. Without coding people are at high risk of not being monitored and receiving appropriate follow up, with potential increased risk of poor outcomes.

This second report examines outcomes for people with CKD. It shows that people with uncoded CKD have double the mortality rates of people whose CKD is coded in general practice. And there is a significant increase in unplanned hospital admissions and in rates of AKI.

Further work is needed to confirm whether there is a causal relationship between coding CKD in primary care and outcomes in hospital settings. Nevertheless, where the audit identifies local variation in coding, this should stimulate important questions about quality of care and outcomes for local clinicians and commissioners, and examination of systems for coding and follow up.

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// Executive summary

About Chronic Kidney Disease

Chronic Kidney Disease (CKD) is a long-term irreversible condition where the kidneys don't work as well as they should. CKD can be caused by many diseases but it is often found in patients who also have diabetes and high blood pressure. Moderate to severe CKD affects approximately 5.5% of adults and is more common in older people[1].

CKD is clinically important because it contributes to cardiovascular disease (CVD) and makes someone more susceptible to sudden worsening of kidney function (known as acute kidney injury or AKI) at times when patients are unwell for other reasons. People with more severe CKD have an increased risk of hospital admission and death2. Although only a small number of cases progress to end stage renal disease requiring dialysis (or, if possible, a kidney transplant), this reduces quality of life, is costly and difficult for patients and their families, and very costly for the health economy.

Most people with CKD do not have symptoms until it reaches an advanced stage, near to end stage failure. It is only detected by performing tests on blood and urine:

- The ability of the kidneys to 'clean the blood' can be assessed by measuring the levels of a waste product called creatinine in a patient's blood. The creatinine level can be used to estimate the rate at which the kidneys filter blood (the 'estimated glomerular filtration rate' or eGFR).
- Kidney damage can also be detected by measuring the leakage of a protein (albumin) into the urine, using a measure called the urinary albumin to creatinine ratio (or uACR).

Using a combination of blood and urine test results, the severity of CKD can be classified into stages 1-5. This report concentrates on moderate and severe CKD stages 3-5 – where the eGFR has fallen below a value of 60ml/min/1.73m^2.

For patients identified with CKD in primary care, it is advised that GPs record the correct classification (or 'CKD Read Code') for the stage of disease, and add those details to the patient's electronic health record. Coding for CKD is currently incentivised in England by the Quality Outcomes Framework.

Improving identification and coding in primary care delivers benefits for people with CKD[3-4]:

- Personalised information and education about CKD
- Opportunities to make lifestyle changes that will help maintain kidney health
- Regular review of kidney function (through creating patient lists for practice review using the CKD Read Codes)
- Improved management of blood pressure and cardiovascular risk
- Safer prescribing of medication (prescribing software may require a CKD Read code to recognise that a patient has reduced kidney function)
- Specialist care if and when necessary

This audit was designed to help GPs achieve these goals and the findings from the audit have been published as two reports.

The National Chronic Kidney Disease Audit

This National CKD Audit was commissioned by the Healthcare Quality Improvement Partnership (HQIP)* as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP), and was delivered by Informatica Systems in collaboration with London School of Hygiene & Tropical Medicine, University College London and Queen Mary (University of London). This national CKD audit has been supported throughout the planning and implementation stages by patient and patient charity representatives who have contributed fully as members of the audit board.

Originally designed to achieve full national coverage of general practices across England and Wales, the audit encountered technical challenges accessing primary care data. The audit reports the processes and care of outcomes for patients who were seen in primary care between April 2015 and June 2016. This report includes data linked from 1,005 practices representing approximately 75% of the Welsh practice population and 10% of the practice population in England. It has produced the largest sample of patients with CKD in primary care globally. The final dataset is broadly representative of English and Welsh populations in terms of age and sex, although those of White ethnicity and rural areas are overrepresented. From a total of more than 400,000 patients with kidney disease, there was a total of more than 250,000 years of follow-up.

The first part of the National Report, published in January 2017, focussed on the identification and management of CKD in primary care[4]. Recommendations included:

- Ensure that both blood tests AND urine protein tests are used in people at risk of CKD. On average GPs test 86% of people with diabetes for CKD (using annual eGFR), but only 54% have the relevant annual urinary albumin to creatinine ratio (uACR). For other groups (such as those with hypertension), uACR rates are below 30%
- Improve coding of people with CKD. There is considerable variation in coding for CKD between GP practices. The proportion of people with CKD stage 3-5 that were uncoded ranged from 0% to 80%
- For those people with identified (coded) CKD, effort should be focussed on regular review, blood pressure management and prevention of CVD. There was considerable variation in achievement of blood pressure control, with 70% of those at highest risk of poor outcomes not meeting recommended targets
- Patients with CKD are at increased risk of the consequences of infection. It was found that many patients with advanced CKD did not receive the recommended pneumococcal vaccination

This second part of the National Report has a focus on the outcomes for people with CKD with stages 3-5 for whom GPs are asked to keep a register according to the Quality Outcomes Framework as recommended by NICE[2]. Outcomes investigated included emergency hospital admissions, rates of death, and referrals from GPs to specialist kidney services. To do this, we linked data from the GP record with routine NHS datasets including the Hospital Episode Statistics database for England, hospitalisation data held at the NHS Wales Informatics Statistics and information on deaths from the Office for National Statistics.
We asked:

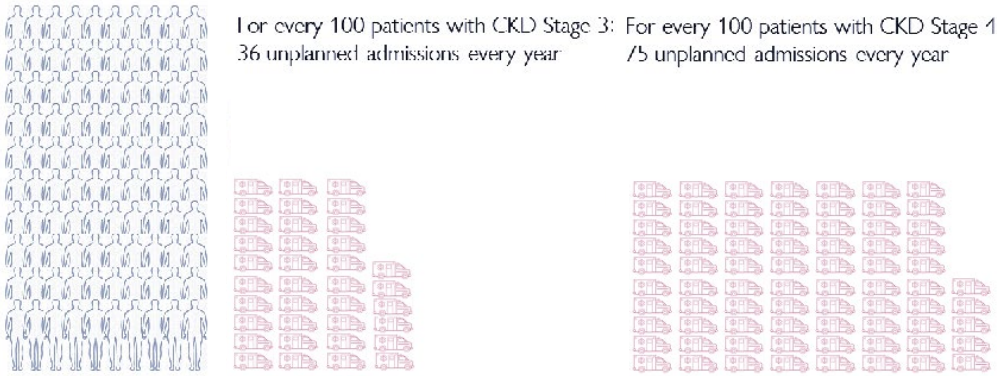
1. What are the rates of unplanned hospital admission for people with CKD?
2. For people with CKD who were admitted to hospital:
    - What are the rates of admission for acute kidney injury (AKI), for acute cardiovascular (CV) disease and to intensive care units (ICU)?
    - Do these rates vary by CKD severity and coding status?
3. What are the rates of death for people with CKD?
4. Are GP referrals for people with CKD being seen by a specialist within 18 weeks?

* HQIP is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing and National Voices. Its aim is to promote quality improvement, and in particular to increase the impact that clinical audit has on healthcare quality in England and Wales. HQIP holds the contract to manage and develop the NCA Programme, comprising more than 30 clinical audits that cover care provided to people with a wide range of medical, surgical and mental health conditions. The programme is funded by NHS England, the Welsh Government and, with some individual audits, also funded by the Health Department of the Scottish Government, DHSSPS Northern Ireland and the Channel Islands. The NCKDA is funded by NHS England and the Welsh Government.

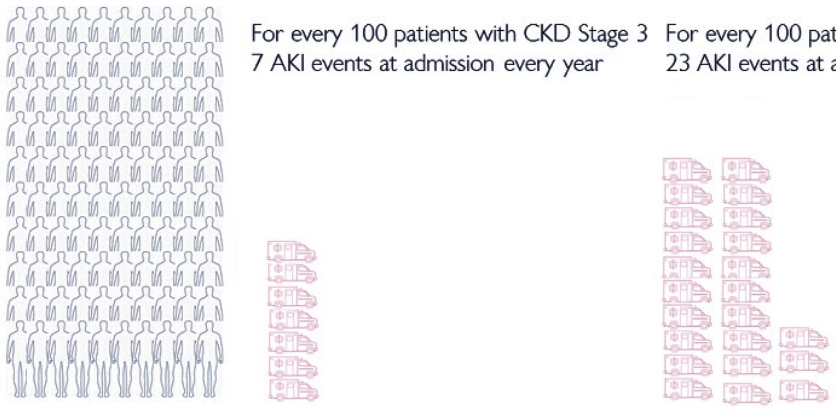
// Findings, Recommendations and Next Steps

Findings

Finding 1: Unplanned (Emergency) Hospital Admissions are common in people with CKD, and more likely as CKD worsens



Finding 2: Hospital admissions for specific events (Acute Kidney Injury (AKI), Cardiovascular Disease, Intensive care)

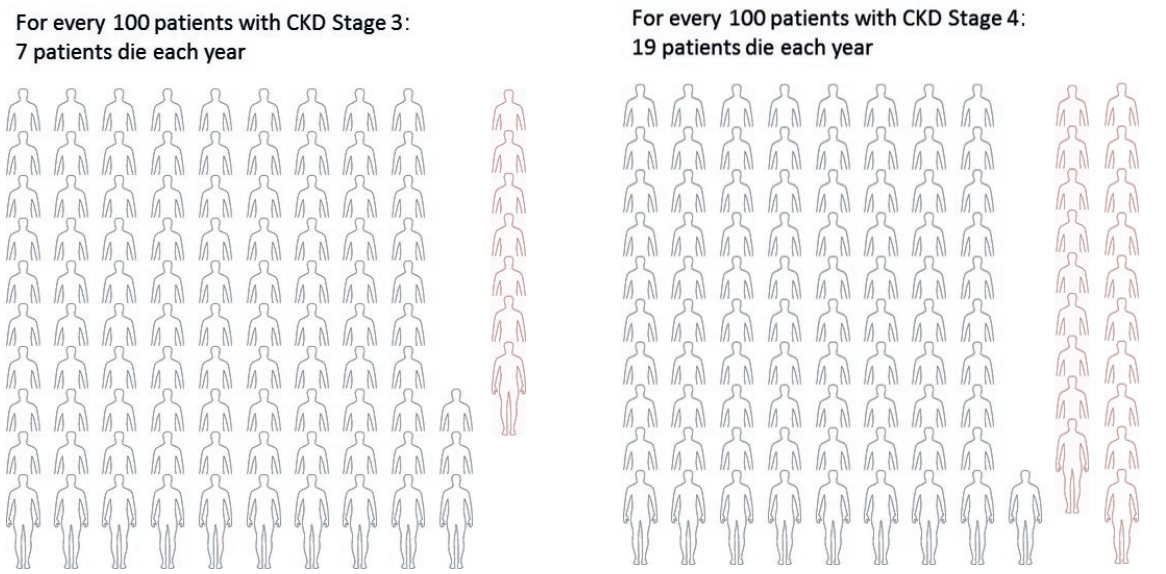


For every 100 patients with CKD Stages 3-5, there are

- 7 AKI events at time of admission per year
- 6 CV disease events per year
- 2 admissions to the ICU per year

As CKD worsens, these events are more common.

Finding 3: Rates of Death for People with CKD



Death is more common in people with more severe CKD.

Finding 4: Coding of CKD and patient outcomes

- Unplanned admissions are more likely among people with CKD that has not been coded in primary care compared to those who are coded. The magnitude of the difference between the rate of unplanned admissions for patients who are coded, compared with those who are not, increases as kidney function declines.
- AKI at hospital admission is more likely among people with CKD who have not been coded in primary care compared to those who are coded. The magnitude of this difference increases as kidney function declines.
- The figure on the next page demonstrates that death rates are approximately twice as high among people with CKD who have not been coded for CKD in primary care compared to those who have been coded. The magnitude of the difference in mortality rates for patients who are coded compared with those who are not also increases as kidney function declines.
- The differences in unplanned admissions, AKI and death rates for coded and uncoded patients are not explained by differences in age. Nor are they explained by whether the patients also had one or more of a defined group of medical conditions that are also known to affect the likelihood of these events happening.

How to read the graph below

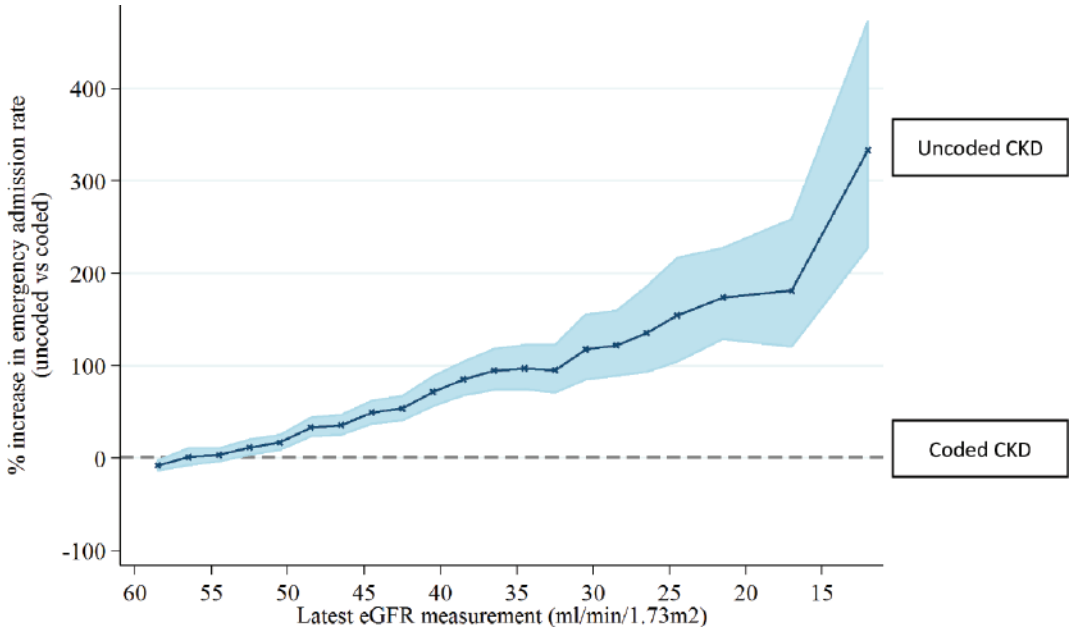
This type of graph shows the difference in outcomes for patients with reduced eGFR recorded with a code for CKD in their primary care record and those without. The vertical axis gives a measure such as the percentage increase in rate of hospital admissions or acute kidney injuries, and the horizontal axis shows the degree of loss of kidney function (estimated glomerular filtration rate, also known as eGFR).

The coded patients are represented by the dotted line. The other line on the graph shows the percentage difference for outcomes in patients who are not coded compared to those who are coded.

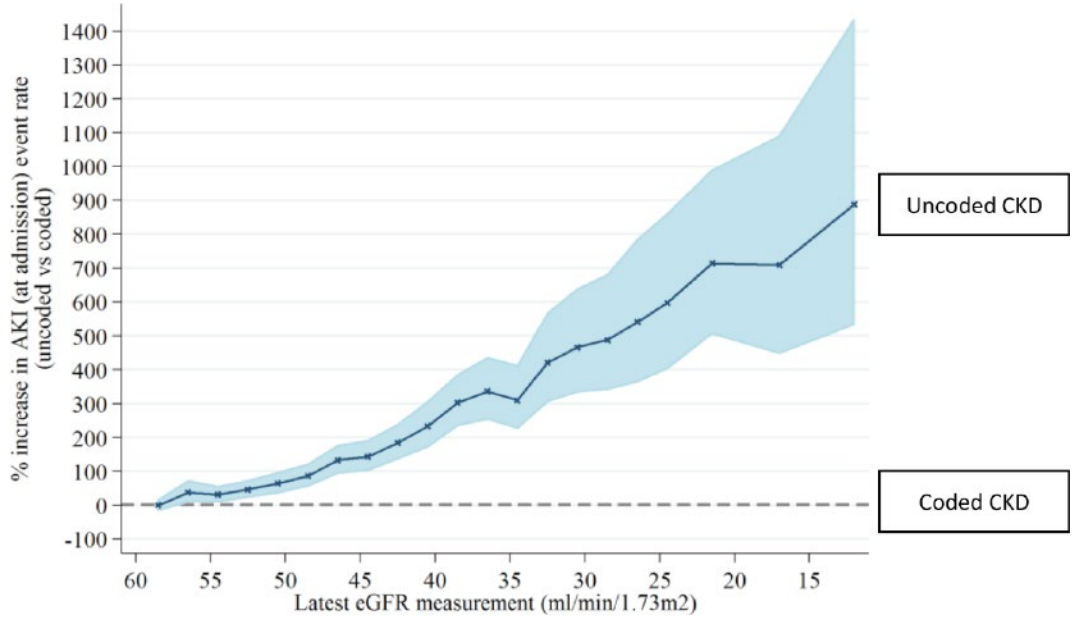
The blue background on the uncoded patients line represents statistical uncertainty for the estimated increase in rate, meaning the figure could range anywhere within the blue area.

The data in the graph takes in to account differences in age and sex between the coded and uncoded groups, as well as the presence of coded diabetes, hypertension, and CV diseases. However, there may be additional factors contributing to the percentage differences which we do not have data for, such as time since a patient's last eGFR measurement.

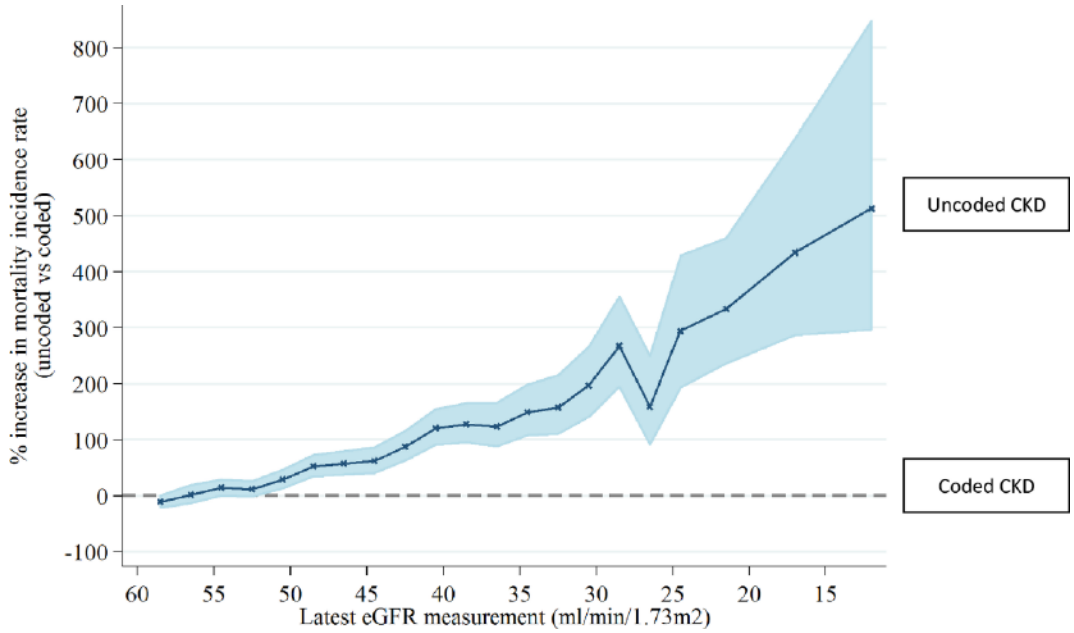
Comparison of unplanned admissions between uncoded and coded patients with biochemical CKD stages 3-5



Comparison of all first AKI events during hospitalisation between uncoded and coded patients with biochemical CKD stages 3-5



Comparison of deaths between uncoded and coded patients with biochemical CKD stages 3-5



The findings on coding need to be treated with caution as the NCKD audit data set can only take account of and adjust for a limited number of medical conditions and physical features that patients may have alongside their CKD. There are potentially a wide range of medical conditions and social circumstances that we are unable to capture reliably using the NCKD audit data, which in some cases might account for both the reason why a patient is not coded and why they have an emergency admission or an additional risk of death. Poor coding of other medical conditions in the GP record could also be a factor as it would result in missing data in the audit's adjustment calculations.

Further work is needed to establish a causal relationship between coding CKD in primary care (and the related actions when identifying and managing those patients) and outcomes in hospital settings.

Finding 5: Referrals from GPs to specialist renal services

- Following a GP referral to renal services we find that 95% of cases have a record of a nephrology outpatient appointment within the NHS delivery target of 18 weeks[5].

Recommendations

The audit recommendations from Part 2 of this audit report are directed at:

- General practices;
- Sustainability and Transformation Partnerships (STPs) and Clinical Commissioning Groups (CCGs) in England;
- Local Health Boards (LHBs) in Wales;
- Secondary care providers;
- Researchers.

They are also relevant to patients and patient support groups.

There are three key recommendations from the audit, which should be read in conjunction with the findings and recommendations from the Part 1 Report.

Recommendation 1: GPs should review the procedures in place to identify patients who have evidence of CKD stages 3-5 in order to improve the identification, coding and regular review of these patients.

- There is good evidence that coding in primary care is linked to increased rates of management activity recommended by NICE[2,3] such as treating blood pressure to target, measuring proteinuria and provision of CVD prevention medication[6,7].
- Admission and mortality rates appear lower among patients coded for CKD in the GP record compared to those who are not coded.
- Coding may be associated with increased clinical scrutiny and informed clinical decision making of these patients – who often have a range of other comorbidities, which will additionally increase their vulnerability to AKI and hospital admission.

Recommendation 2: Sustainability and Transformation Partnerships, Clinical Commissioning Groups and Local Health Boards should support constituent practices to consistently identify, code and manage patients with CKD in order to actively monitor and improve the quality of care delivered for this group.

- With retirement of CKD indicators from the Quality and Outcome Framework, which previously incentivised the monitoring and management of people with CKD in England, CCGs and Sustainability and Transformation Partnerships (STPs) need to ensure that practice CKD indicators are in place.
- CCGs can help monitor referral times and ensure that they do not fall outside of 18 weeks.
- Many GP practices already use audit tools to monitor and improve their performance. Other practices may need additional support or incentives to compare their performance with others. CCGs and LHBs have an important role in providing the tools and resources to support this activity, which will provide direct benefits for patient care, and is likely to result in a decrease in hospital admissions for those with CKD.

Recommendation 3: Further research is needed to investigate the nature of the association between CKD coding in the GP record and hospital admissions and mortality rates

The unplanned hospital admission and mortality data analysed for this report provide evidence of an association between absence of CKD coding in the GP electronic health record and increased rates of unplanned admissions, AKI and all-cause mortality.

At present, we cannot be sure of:

a. The strength of this association. A limited primary care dataset was used for the NCKDA analysis. There may be additional important differences in the accuracy of the codes that are obtained (e.g. for diabetes or cardiovascular disease), other coded comorbidities not collected by the audit (for example the presence of cancer or dementia diagnosis) or uncoded factors such as frailty – that reduce this association.

b. A causal link between recognition of CKD as evidenced with coding, and the resulting actions (e.g. blood pressure management, safer drug prescriptions, etc) that may result in improved patient outcomes.

Further research using the NCKD audit data and other sources of primary care data linked to hospital outcomes will be needed to address these questions.

In the meantime, the current evidence provides good reason to actively promote CKD diagnosis and coding. A slide deck is available from HQIP and LSHTM websites as a potentially useful resource to clinicians and service managers. Evidence suggests that there are improvements in management and prescribing in identified patients with CKD[6,7].

Report Key

Text in blue boxes summarise audit findings

Text in yellow boxes summarise quality improvement aspects

Text in green boxes provide additional information aimed at patients

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//1. Background and Aims of the National CKD Audit

Moderate to severe chronic kidney disease (CKD) affects approximately 5% of adults in the UK and increases with age[1]. It is often found in people who suffer from diabetes or high blood pressure. CKD is known to be associated with an increased risk of death, cardiovascular (CV) events, and hospitalisation, and this association is driven independently of known risk factors[2]. When patients are unwell for other reasons, CKD can contribute to CV disease as well as predispose people to acute kidney injury (AKI). A small number of people with CKD will progress to end stage renal disease, which then requires dialysis or kidney transplant. CKD is costly and burdensome on the healthcare system, and is difficult for patients and their families to cope with.

CKD is often asymptomatic until the later stages of the disease, but it is detectable using blood and urine tests[4]. Blood levels of creatinine are measured in order to estimate the rate at which the kidneys are able to 'clean the blood'. Creatinine provides an index of kidney function, or the estimated glomerular filtration rate (eGFR). Urine tests measure the amount of the protein (albumin) that leaks into the urine as a result of kidney damage, and are used to calculate a measure of kidney function called the urinary albumin to creatinine ratio (uACR). In 2008, the National Institute for Health Care and Excellence (NICE) issued guidance on the early identification and management of CKD and divided CKD into 5 stages using a combination of eGFR and uACR tests taken on two separate occasions, at least three months apart. CKD stages 3-5 are defined by an eGFR less than 60 ml/min/1.73m^2, and includes three uACR categories for each stage[4,8].

Most people with CKD are identified and managed by their general practitioner (GP). GPs are then able to use a number of computerised (Read) codes in practice computer systems in order to identify these patients, enabling regular monitoring and optimising treatment decisions. This step is likely to be crucial as optimising treatment of patients with CKD will improve later outcomes (heart disease, stroke, and risk of dialysis). Thus coding CKD will provide substantial health benefits.

Improving identification and coding in primary care delivers benefits for people with CKD

- Personalised information and education about CKD
- Opportunities to make lifestyle changes that will help maintain kidney health
- Regular review of kidney function
- Improved management of blodd pressure and cardiovascular risk
- Safer prescribing of medications
- Specialist kidney care if and when necessary

The National CKD Audit (NCKDA) was commissioned in England and Wales to review testing, identification and management of those with CKD in primary care, as well as their health outcomes. It has produced the largest sample of patients with CKD in primary care globally and has provided insights into data extraction and analysis using such large-scale data. The purpose of the NCKDA was to provide a snapshot of performance in primary care against NICE guidelines and quality standards and to measure variation between practices, clinical commissioning groups (CCGs), and local health boards (LHBs) in Wales[1].

The first part of the National CKD Audit report focused on how GPs are testing those at risk of CKD, identifying those with CKD and managing them in primary care. Based on the findings from the first part of this report, three recommendations were made in order to improve identification and management in primary care[1].

1. GPs should review practice to ensure that people at high risk of CKD (i.e. those with diabetes and hypertension) are getting routine blood tests for eGFR and urinary testing for uACR.

2. GPs should review practice to improve the coding of patients with CKD.
3. Once patients have been identified with CKD, GPs should then focus on regular review, management of high blood pressure, prescribing cholesterol lowering treatments, and performing relevant vaccinations as indicated (flu, pneumococcus) in order to improve health outcomes.

The aim of this second part of the National CKD Audit report is to describe how the burden of primary care CKD impacts secondary care. This report provides summary counts and rates with a median follow-up time of 15 months and includes the following outcomes in patients with CKD within the linked data:

1. Unplanned (non-elective, non-maternity) admissions
2. Acute Kidney Injury (AKI) events
3. Cardio Vascular (CV) events
4. Intensive care unit (ICU) admissions
5. All-cause mortality
6. The proportion of patients with CKD who have a GP referral code to a nephrologist and a corresponding HES outpatient appointment within 18 weeks.

//2. Audit Methods

Audit data from primary care

The audit aimed to recruit the majority of practices in England and Wales, however, it was only possible to enrol practices already using the Informatica Audit Plus software due to a delay with the implementation of the GP Systems of Choice (GPSoC) contract[1]. Practices that had a current version of the software installed were asked for their consent to take part[1]. Data were extracted from only those practices who signed up and consented and only from those patients who had not opted out of electronic data sharing (approximately 4% of patient records were not uploaded due to opting out).

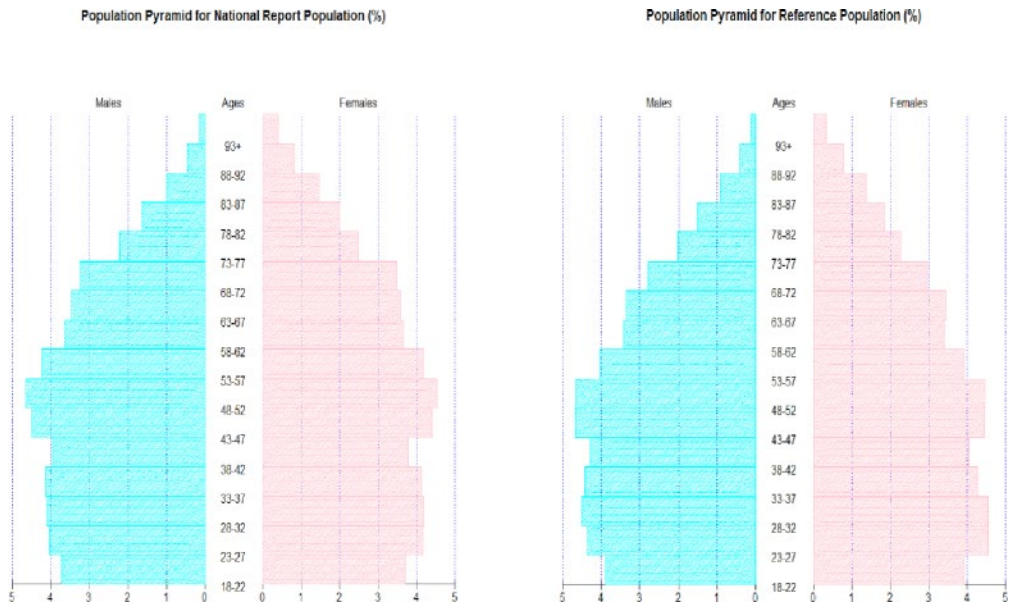
The first national report included 911 practices in total, covering approximately 8% of the population of England and 70% of the population of Wales. Since the first national report, additional practices were recruited into the audit, therefore GP data were extracted for a total of 1,039 practices. With follow-up outcome data available in 1,005 of these practices, this second national report covers approximately 10% of the practice population of England and 75% of the practice population of Wales. The total number of practices in England and Wales and the population covered by these practices are given in Table 1.

Table 1: Total number of practices with any follow-up for outcomes and the population coverage of these practices, overall and in England and Wales

	England	Wales	Overall
Practices with any patients followed up between round 1 extraction and follow up cap	670	335	1,005
Practices with list size data	670	280	950
Total *adult population* coverage for practices with list size data	4,293,690	1,660,215	5,953,905
Total *projected adult population* coverage	4,293,690	1,986,328	6,280,018

The Welsh government funded the Audit+ software, which is installed in all Welsh practices to enable audits across Wales. The practices in England, however, invested in the audit software themselves and voluntarily signed up for the audit. Hence, the English practices are a self-selected group who are likely to perform better than a random sample of practices. Regardless of this selection process, the first part of the national report showed that the Audit practice population is broadly representative of the English and Welsh population in terms of age and sex distribution (Figure 1), however those of White ethnicity and rural areas are overrepresented.

Figure 1: Population pyramid comparing National CKD Audit coverage population (right) with national data from England (Reference population, right)



Of the population extracted for the National CKD Audit[1], we only report on patients who had evidence of CKD or other renal codes at the first round of data extraction at practice recruitment between April 2014 and June 2016, including those with a diagnostic code for CKD as well as those who had biochemical evidence of CKD. Patients were placed into three groups (Table 2). More detail on the data extraction definitions used in this report are provided in Part 1 of the National Report: *www.hqip.org.uk/resources/national-chronic-kidney-disease-audit-national-report-part-1/*

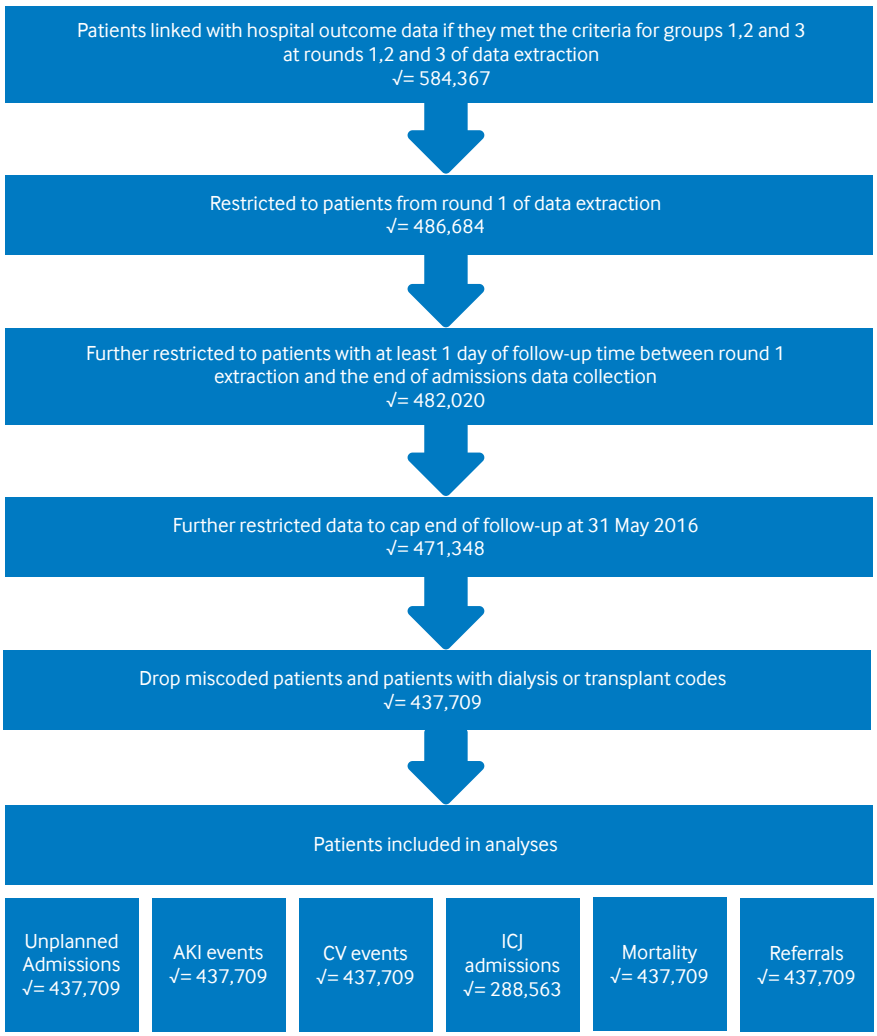
Table 2: Criteria for the three Audit group populations

Patients with coded CKD stages 3-5	Patients who had a read code for CKD stages 3-5 in the practice register, excluding those with miscoded CKD defined as: • 2 x eGFR ≥ 60ml/min/1.73m^2, at least three months apart, or • Last eGFR ≥ 60ml/min/1.73m^2, at least three months prior
Patients with uncoded CKD stages 3-5	Patients who were not on the CKD practice register but whose two most recent eGFR measurements are both <60 ml/min/1.73m^2 (measurements taken at least three-months apart with the most recent measurement in the last two years)
Patients with other renal codes	Patients who did not have a code for CKD stage 3-5 in the practice register and did not have two eGFR measurements <60 ml/min/1.73m^2 (measurements taken at least three-months apart with the most recent measurement in the last two years) but did have a renal Read code (excluding AKI), OR an uACR≥3 or PCR≥15, OR a Read code for CKD stage 1-2 in the practice register

Data linkage

Records for patients with CKD on any round of data extraction were linked with health records from hospitals to establish their subsequent outcomes (i.e. admissions, death). The total number of patients with linked data was 584,367 – including 386,253 patients from 696 GP practices in England, and 198,276 patients from 343 GP practices in Wales. For analyses the data had to fulfil further criteria to ensure high data quality (Figure 2). Below we describe the sources of data used for linkage in more detail.

Figure 2: Flow chart depicting the steps of restricting linked patients for use in National CKD Audit analyses



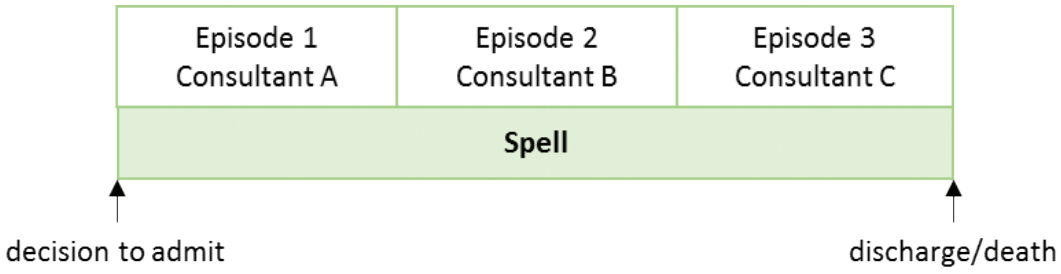
(note: total number of individuals analysed varies with the outcomes that are studied).

Admission data

Data on hospital admissions were derived from Hospital Episode Statistics (HES) for England and from NHS Wales Informatics Service (NWIS) in the Patient Episode Database (PEDW) for Wales. HES contains details of all admissions (both elective and unplanned) and outpatient appointments from NHS hospitals in England. Likewise, PEDW contains all inpatient and outpatient activity undertaken in NHS hospitals in Wales.

In both databases, records in the Admitted Patient Care (APC) databases are divided into hospital 'episodes' where each episode relates to a period of care for a patient under a single consultant. A 'spell' is a period of stay in hospital from admission to discharge and can be made up of one or more episodes of care (Figure 3). This means that each individual episode corresponds to the time a patient is managed by the same consultant during a hospital admission. An episode of care may last the whole of the patient's hospital admission (one episode=one spell) or patients may have multiple episodes of care during the same admission with a record for each episode (multiple episodes=one spell). In this report, the terms 'spell' and 'admission' may be used interchangeably.

Figure 3: Hospital episodes and spells



Each episode within the HES/PEDW dataset has one primary diagnosis and can also have up to 19 secondary diagnoses recorded[9]. HES APC data records up to 20 diagnoses in total; PEDW APC data records up to 14 diagnoses in total. The primary diagnosis is the main reason for admission or diagnosis during a relevant episode of in-patient care. The secondary diagnoses are any relevant comorbidities and external causes that have been identified. It is possible that the entire period of continuous care was not within one hospital – i.e. a patient may be transferred to another hospital within the same NHS trust or to another NHS trust such as a community hospital. It is common to label the entire length of the NHS admissions, including transfers, as 'super-spells'. This highlights the difficulty of describing overall patient experience and identifying unique outcome events when different stages of care are provided in different hospitals. More detail on this can be found here:

http://content.digital.nhs.uk/catalogue/PUB19124/hosp-epis-stat-admi-summ-rep-2014-15-rep.pdf

Duplicate data entry has been considered carefully in this report when identifying unique admissions and events to minimise the risk of double counting events. Complications in identifying unique admissions may arise, for example, where multiple episodes during an admission have the same or a similar diagnosis code. Further details of data handling conventions for identification of duplicates are provided in the Appendix.

Mortality data

The Office of National Statistics (ONS) collects information on the date and place of death (in or out of the hospital) from the death certificate all deaths in the UK. In future research and analyses, these data could potentially be used with admissions data to infer the cause of death (described in more detail in the source below). For the purpose of the audit, all-cause mortality and not cause-specific mortality is investigated.

http://content.digital.nhs.uk/hesonsmortality

Referral data

Referral data were derived from HES Outpatient (OP) data, a collection of individual records of outpatient appointments occurring in England. Records in the HES OP database are called "appointments" and relate to a period of care under a single consultant. Records include information on appointment dates, the main specialty under which the patient was treated, referral source, waiting times, and clinical diagnosis[10].

We anticipated that the quality of the referral data from general practices within the Audit would be poor. The Audit Plus software only extracts coded information in the GP record, however, referrals are often captured in free text (referral letters)[11]. Therefore, most of the relevant information may not have been recorded in practice systems in a way that the Audit software could extract. We focused on the small subset of patients who had a referral code recorded in primary care data.

Audit outcomes

This report includes the following outcomes for CKD patients using linked data:

1. **Hospital admissions:** Summary counts and rates of emergency hospital admissions (defined as non-elective, non-maternity admissions) by CKD Audit group (coded CKD stages 3-5; uncoded CKD stages 3-5; and individuals recorded other renal disease codes), country (England, Wales), calendar month, CCG, and by CKD stage /coding status, using both hospital in-patient data from England and Wales.
2. **AKI events:** Summary counts and rates of AKI events by CKD Audit group (coded CKD stages 3-5; uncoded CKD stages 3-5; and individuals recorded other renal disease codes), country, calendar month, and CKD stage and coding status, using both HES data from England and Wales. A first episode diagnosis of AKI is likely to have started prior to admission, but AKI can occur later in the hospital-stay as well. Because of this, we chose the following definition for AKI: AKI recorded (using N17 ICD-10 codes) in any diagnostic position (i.e. primary or any secondary diagnoses) of the first episode, indicating an AKI event occurring around the time of admission. Additional analyses investigated AKI recorded in any episode in any diagnostic position, indicating all AKI events occurring after admission to hospital (results in Appendix).
3. **Cardiovascular events:** Summary counts and rates of CV events (both emergency and elective admissions) by CKD Audit group (coded CKD stages 3-5; uncoded CKD stages 3-5; and individuals recorded other renal disease codes), country, calendar month, and by CKD stage and coding status, using hospital admissions data from England and Wales. CV events included: heart failure, ischaemic heart disease, cerebrovascular events, and peripheral artery and aortic disease (ICD10 codes in appendix). In contrast to AKI events, we were interested in acute rather than chronic CV diagnoses and so we chose to only look at events defined by codes recorded in the primary diagnostic position during the first episode of an admission, indicating that CV events were the main indication for hospital admission.
4. **ICU admissions:** Summary counts and rates of ICU admissions (both emergency and elective admissions) by CKD Audit group, calendar month, and CKD stage and coding status, using only the HES England dataset.
5. **Mortality:** Summary counts and rates of deaths by CKD Audit group, country, calendar month, CCG, and CKD stage and coding status, using linked ONS data from both England and Wales.
6. **Nephrology referral:** Proportion of patients with a GP referral code to a nephrology specialist who had a HES outpatient appointment within 18 weeks of being coded by CKD stage and coding status, using linked primary and secondary care data in England.

//3. Results

Rates of Audit outcomes are reported for all patients by Audit group (coded CKD stages 3-5; uncoded CKD stages 3-5; and individuals recorded other renal disease codes). In addition, rates are reported by country, calendar month, CCG and CKD stages, separately for CKD stages 3-5 and for patients with other renal codes. Since the focus of this report is on patients with CKD, results specific to patients with other renal codes are generally reserved for the appendix.

Crude rates are provided to demonstrate the burden of outcomes on patients and healthcare services. Additionally, we calculated age-sex standardised rates to allow comparisons of rates across populations within tables that may have different age and sex structures. The standard population used for each table represents the overall population covered in that table. Therefore, some tables cover all three patient groups combined, while others cover only patients with coded and uncoded CKD stages 3-5 or only patients with other renal codes.

It is important to note that age-sex standardised rates should only be compared directly within tables and across tables covering the same population. The selection of the standard populations also means that the rate estimates are only applicable to the population included in that table, and would not be directly comparable to rates in the general population. (See Data Handling Conventions in Appendix for further details).

3.1. Unplanned (Emergency) Admissions

By CKD Audit Group

When the patient population was split into those with CKD stages 3-5 (including those with and without coded CKD) and those with other renal codes, the crude emergency admission rate was 37.8 per 100 person years (pys) (95% CI 37.5-38.1) and 23.4 per 100pys (95% CI 23.0-23.8), respectively.

This means, for example, that for every 100 patients with stage 3-5 CKD there will be approximately 38 unplanned admissions each year. However, less than 38% of patients with CKD stages 3-5 will be admitted during this period because some patients will be admitted more than once (Appendix Table 21).

By CKD Stage and Coding Status

Overall, emergency admission rates increased sharply with CKD stage (Table 3). Those with more severe kidney function impairment had more emergency admissions than those with less severe kidney function. The emergency admission rate was also associated with whether the GP had coded a patient for CKD. In CKD stage 3 and CKD stage 5, patients who were coded with CKD have an emergency admission rate higher than those who were uncoded. However, in CKD stage 4, patients who were did not have a CKD code but had biochemical evidence of CKD stage 4 had an increased emergency admission rate than those who were coded, especially when data were age-sex standardised. These data do not take account other factors influencing admission rates, e.g. frequency of monitoring, or level of comorbidity. Further analysis is required to identify whether coding impacts on emergency admissions rates. Nevertheless, it is clear that admissions rates increase considerably with progressing disease, and effective primary care management may reduce the burden of emergency admissions in CKD patients, especially in those with CKD stage 4.

Table 3: Emergency admission counts and rates in people with coded and uncoded CKD stages 3, 4, and 5 defined by last eGFR measurement and by whether patients were coded or uncoded

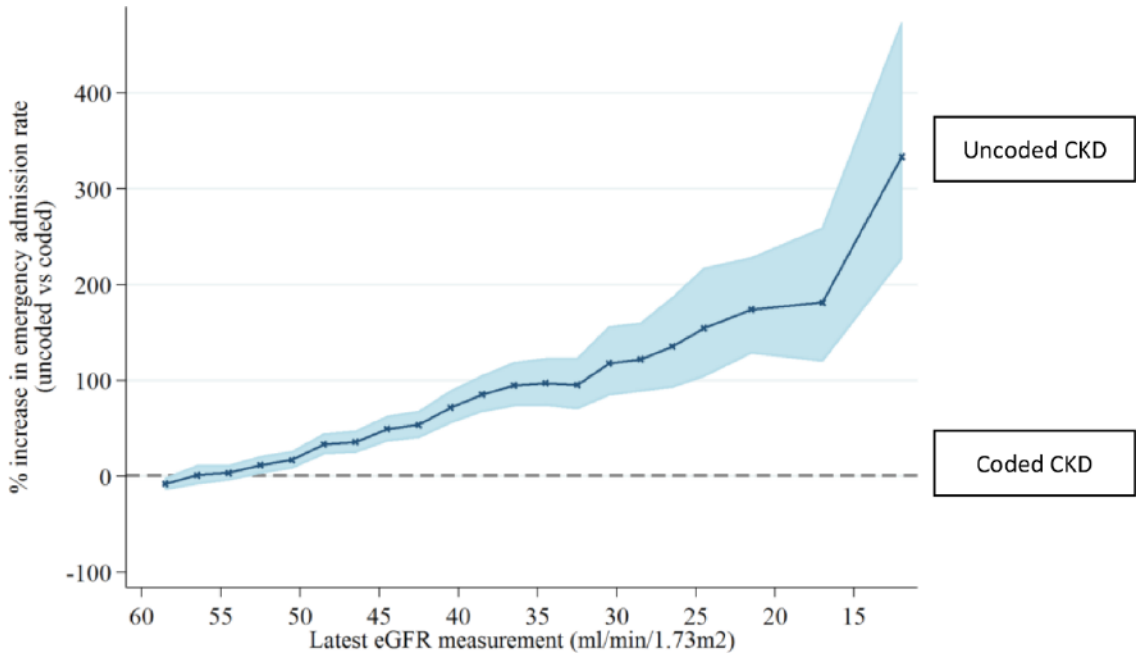
Coding group	CKD stage based on last eGFR measure	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
Coded CKD	3	62899	168717	37.28	36.86-37.71	33.18
Uncoded CKD	3	23359	68929	33.89	33.26-34.54	32.38
Coded CKD	4	10211	14321	71.30	69.31-73.36	66.27
Uncoded CKD	4	1189	1497	79.42	73.19-86.31	80.69
Coded CKD	5	2217	1949	113.73	107.06-120.91	113.02
Uncoded CKD	5	210	171	123.01	99.40-153.94	111.86

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

In Figure 4 on the next page, we calculated the rate ratio of patients with uncoded CKD stages 3-5 versus patients with coded CKD stages 3-5, taking into account differences in age, sex, diabetes, hypertension, and CV disease. This demonstrates an association between lack of CKD coding and emergency admission rates. In patients with confirmed biochemical CKD stages 3-5 (two most recent eGFR measurements before practice recruitment taken at least three months apart both <60 ml/min/1.73m^2), below an eGFR of 50 ml/min/1.73m^2 there is a clear increase in the rate ratios comparing uncoded to coded (Appendix Table 22). At about eGFR 40 ml/min/1.73m^2 (or roughly CKD stages 3b-4), patients who are not coded for CKD are twice as likely to have an emergency admission as patients who are coded for CKD.

Adjustment increases the magnitude of difference between the coding groups in CKD stage 4, which may suggest that the difference is driven by a reduction in kidney function rather than more diabetes, hypertension, or CV diseases in those with no CKD code recorded. Alternatively, these findings could be the consequence of higher rates of failure to code comorbidities (e.g. CVD or diabetes), or differential misclassification of eGFR due to less frequent monitoring in the uncoded group (i.e. those with uncoded CKD may have a slightly lower eGFR than our data suggest).

Figure 4: Comparison of emergency admissions (using rate ratios) between uncoded and coded patients with biochemical CKD stages 3-5



By Country

The crude rate of emergency admissions in patients with CKD stages 3-5 (coded and uncoded combined) was similar for England and Wales and the confidence intervals overlapped (Table 4). Age/sex-standardised rates were very close to that of the crude rates, suggesting that any comparisons between England and Wales, overall, were not confounded by the age-sex structure of the CKD populations studied.

Table 4: Emergency admission counts and rates by country, in people with coded and uncoded CKD stages 3-5

Country	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	75683	199161	38.00	37.59-38.41	38.44
Wales	38457	102660	37.46	36.93-38.00	37.98

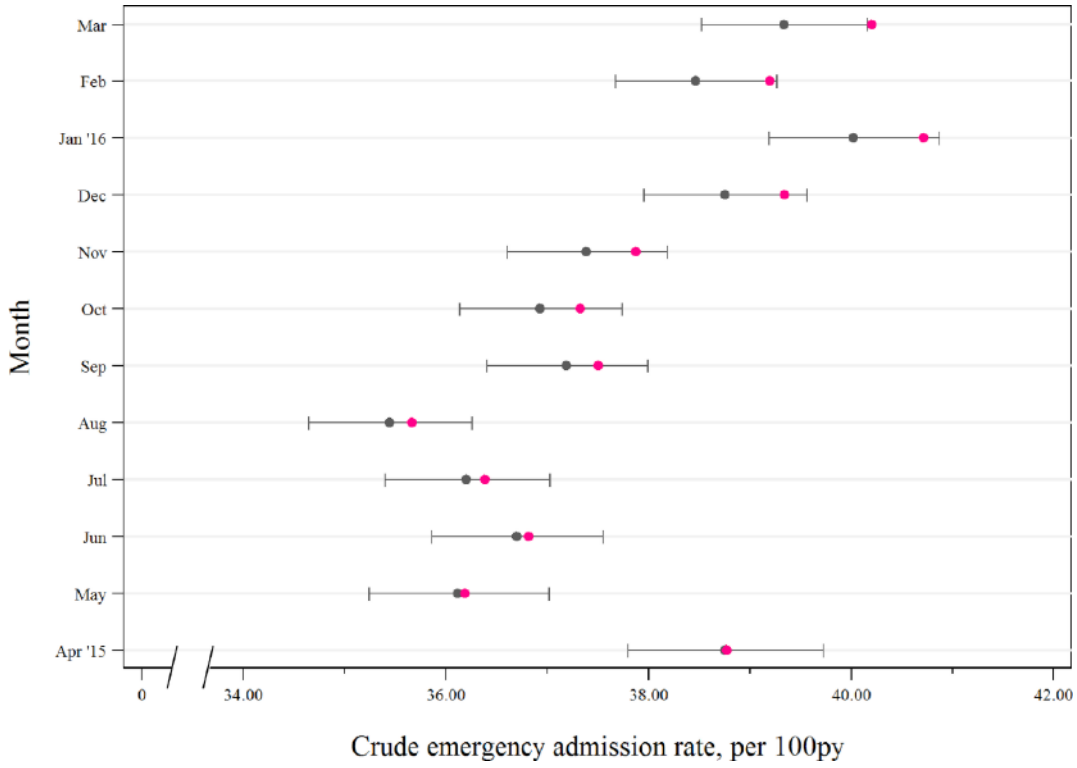
**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Amongst patients with other renal codes, there again was little evidence of a difference between England and Wales and no obvious confounding by the age/sex structure of the patient populations (Appendix Table 23).

By Calendar Month

Emergency admissions appeared to vary by season, in that rates, in general, were higher in colder months, and lower in warmer months (Figure 5, Appendix Figure 15).

Figure 5: Emergency admission rates by month in people with coded and uncoded CKD stages 3-5 (black dots represent crude rate), with pink dots representing age-sex standardised rates; not adjusted for comorbidity*

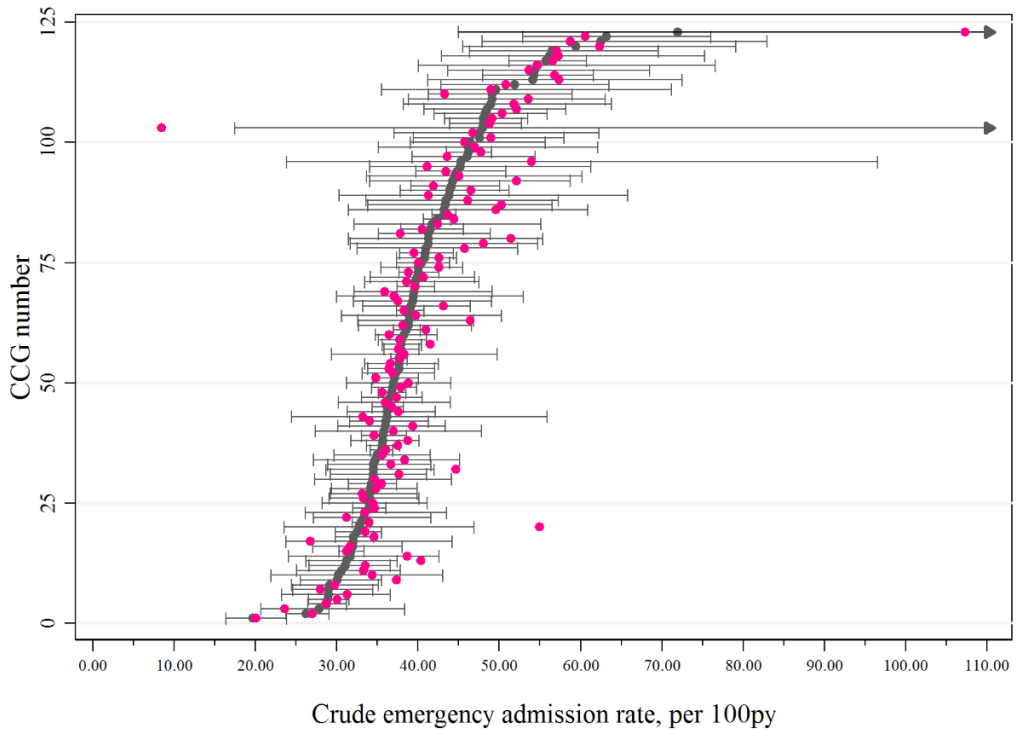


the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)

By CCG

There are 124 CCG/LHBs – including seven LHBs in Wales and 117 CCGs in England which were covered by the Audit (Appendix Table 26). Two CCGs located in England (#22 and #109) did not have any patient data and so were not included. The emergency admission rates in those with CKD varied substantially and confidence intervals were wide (Figure 6). The variation in rates did not seem to be explained by differences in age-sex structures across the different CCGs/LHBs examined, however there may be differences in either the calendar periods during which practices within CCGs submitted data or the burden of comorbidity among patients from certain geographical areas. Given the small number of participating practices in many CCGs, we have not been able to investigate the source of this variation in greater detail.

Figure 6: Emergency admission rates by CCG in people with coded and uncoded CKD stages 3-5, with pink dots representing age-sex standardised rates*



**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Unplanned Admissions

- For every 100 patients with chronic kidney disease and moderate to severe function impairment, there are 38 admissions per year.
- As kidney function worsens, there are more admissions per year. For every 100 patients with stages 4 CKD, there will be more than 70 admissions.
- Those who have severe CKD but do not have a Read code in the GP record have higher admission rates.

3.2. Acute Kidney Injury Events

The estimated frequency of AKI events depends on two things: whether the diagnosis was identified in the first episode of a spell or in any episode of a spell. This is because AKI recorded during the first episode of a spell is more likely to be related to what happened in the community before admission, i.e. within the remit of primary care. However, an AKI event recorded later in a hospital stay may be more likely to be related to what happened during the admission. The primary diagnosis is the main reason for hospital admission. However, there may be another acute illness that triggers AKI, and it is unclear whether the pneumonia that triggered the AKI event will be recorded before or after AKI in an episode of in-patient care. At a glance, the most common primary diagnoses where AKI occurred during hospitalisation were urinary system disorders, pneumonia, hypertension and diarrhoea/gastroenteritis.

We chose to report on the first episode of AKI in any diagnostic position, indicating an AKI event occurring around the time of admission. As an additional analysis we looked at any episode of AKI at any diagnostic level, indicating all AKI events occurring after admission to the hospital (results in Appendix). Of all admissions with AKI, 80% had a code recorded during the first episode, suggesting that most coded AKI exists at the time of admission or very early during the hospital stay.

By CKD Audit Group

The crude rate of AKI events occurring at admission was 7.04 per 100pys (95% CI 6.92-7.16) in patients with coded and uncoded CKD stages 3-5 combined and 2.08 per 100pys (95% CI 1.99-2.17) in patients with other renal codes (Appendix Table 28). In other words, for every 100 patients with CKD stages 3-5, there will be approximately seven AKI events each year.

By CKD Stage and Coding Status

Overall, the rates of AKI events occurring around the time of admission increased with CKD stage; patients with more severe kidney function impairment had more AKI events than those with less severe kidney function, regardless of whether the patient had been coded for CKD (Table 5).

The rate also appeared to be associated with whether the GP had coded a patient for CKD. Except in CKD stage 3 where rates were similar, uncoded patients had a higher crude rate of AKI events than coded patients and uncoded CKD stage 4 patients had the highest crude rate. This trend remained after age/sex standardisation.

There were very few AKI events in later stages of CKD. Presently, there is disagreement about whether an AKI event is possible in a patient with CKD stage 5, therefore, there is likely to be high variability in the coding of these patients. Consequently, it is unclear what these rates mean and cannot be compared directly. Also, these data do not take into account other factors that might influence differences in rates between patients, such as comorbidities. Nonetheless, the rates of AKI events at admission clearly increase considerably with more severe disease.

Table 5: Counts and rates of AKI events at admission in people with coded and uncoded CKD stages 3, 4, and 5 defined by last eGFR measurement and by whether patients were coded or uncoded

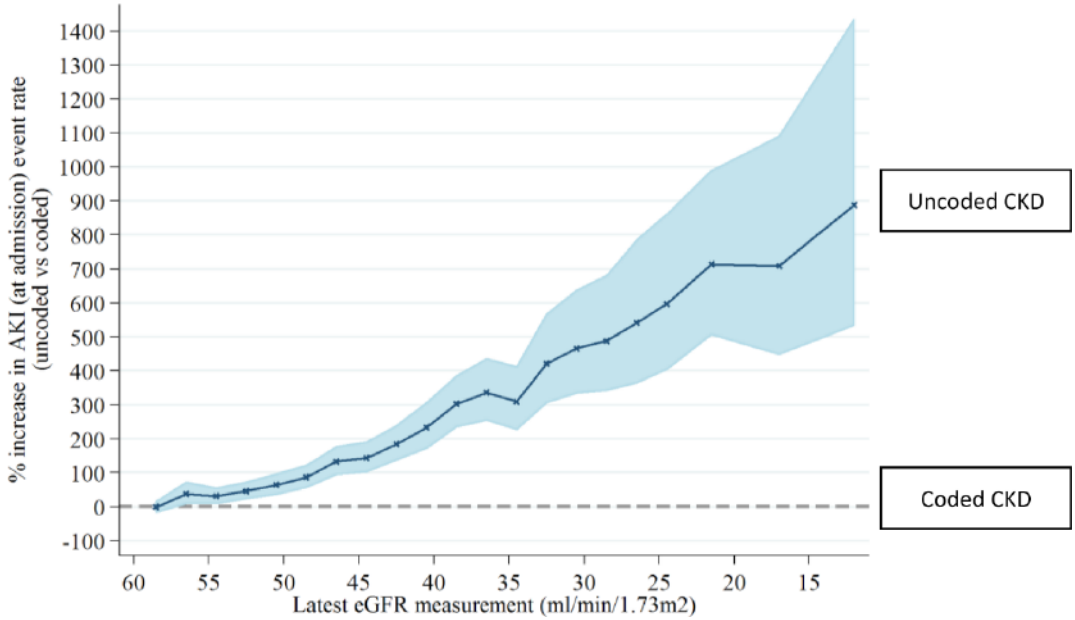
Coding group	CKD stage based on last eGFR measure	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rates per 100py*
Coded CKD	3	11514	168687	6.83	6.68-6.98	5.97
Uncoded CKD	3	4103	68919	5.95	5.73-6.19	5.72
Coded CKD	4	3034	14313	21.20	20.28-22.17	19.49
Uncoded CKD	4	375	1496	25.06	22.03-28.64	26.71
Coded CKD	5	372	1948	19.09	16.74-21.88	19.63
Uncoded CKD	5	45	171	26.38	18.63-38.56	25.44

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

In Figure 7 on the next page, we calculated the rate ratio comparing the rate of AKI events in patients with uncoded CKD stages 3-5 versus patients with coded CKD stages 3-5 (taking into account differences in age, sex, diabetes, hypertension and CV disease). There is a clear increase in AKI rate ratios as eGFR declines (Appendix Table 29). This means that as kidney function declines, patients who are not coded for CKD by their GPs are increasingly more likely to have an AKI event at admission compared with patients who are coded for CKD. For example, at eGFR 45, 35, 25 and 15 ml/min/1.73m^2, patients who are not coded for CKD are two times, four times, seven times, and ten times more likely to have an AKI event occurring around the time of admission than patients who are coded for CKD and in the same stage of kidney disease.

This adjusted model should be interpreted with care as these findings could be the consequence of higher rates of failure to code comorbidities (e.g. CVD or diabetes), or differential misclassification of eGFR due to less frequent monitoring in the uncoded CKD group (i.e. those uncoded for CKD actually have a slightly lower eGFR than our data suggest).

Figure 7: Comparison of AKI events at admission (using rate ratios) between uncoded and coded patients with biochemical CKD stages 3-5



By Country

In people with CKD stages 3-5 (coded and uncoded combined), the crude rate of AKI events in England was very similar to the crude rate in Wales (Table 6). Age and sex standardised rates were very close to crude rates, meaning any comparisons made between countries were not affected by the age or sex structure of the two countries. The same trend was seen in people with other renal codes (Appendix Table 30).

Table 6: Counts and rates of AKI events at admission by country, in people with coded and uncoded CKD stages 3-5

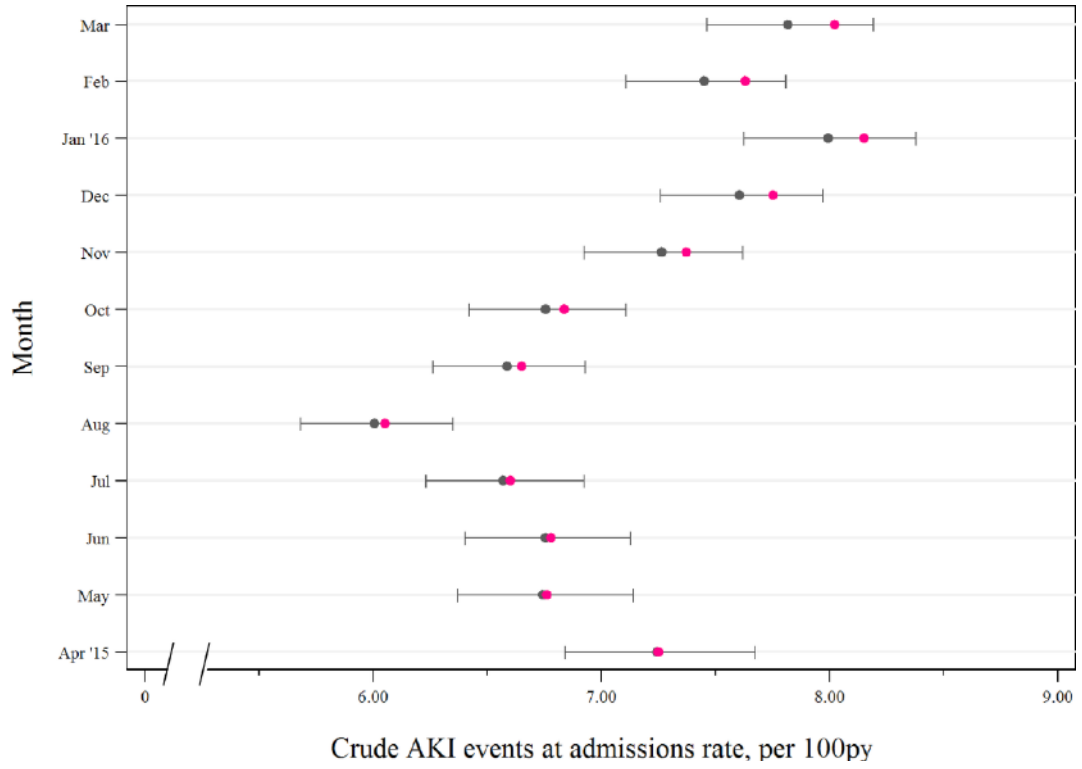
Country	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	14335	199124	7.20	7.06-7.34	7.30
Wales	6914	102642	6.74	6.54-6.94	6.85

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

By Calendar Month

AKI events at admission seemed to vary by season, with higher rates of AKI events at admission during winter months and lower rates during summer months (Figure 8, Appendix Figure 17).

Figure 8: Rates of AKI events at admission by month in people with coded and uncoded CKD stages 3-5 (crude rates = black dots), with pink dots representing age-and sex-standardised rates; not adjusted for comorbidity*



**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Acute Kidney Injury Events:

- For every 100 patients with chronic kidney disease and moderate to severe kidney function impaitment, there are 7 AKI events occurring around the time of admission per year.
- Patients with more severe kidney function impairment have more AKI events than those with less severe impairment, regardless of whether the patient has been coded for CKD.
- At eGFR 45, 35, 25 and 15 ml/min/1.73m^2 , patients who are not coded for CKD are two, four, seven and ten times more likely to have an AKI event occurring at admission than patients who are coded for CKD and in the same stage of kidney disease.

3.3. Cardiovascular Events

We were interested in acute rather than chronic CV diagnoses and so we included only hospitalisations due to heart failure, ischaemic heart disease, cerebrovascular events, or PAD/AAA as the primary diagnosis (i.e. main reason for admission). We report on both emergency (when the patient requires immediate admission and treatment) and elective admissions (when the patient's condition allows adequate time to schedule the admission) as any admission for these types of diseases is usually unavoidable, i.e. related to an acute event even when organised as an urgent elective admission. For example, some clinical pathways mean that patients with acute events are seen in an urgent outpatient clinic followed by elective admission. Counting only emergency (non-elective) admissions would mean missing patients who may be very ill but who are admitted electively for a CV intervention.

Event types

We chose to include heart failure, ischaemic heart disease, cerebrovascular, and PAD (shown separately in Appendix Tables 33 and 34) events. The majority of CV events (38%) were due to ischaemic heart disease, followed by cerebrovascular events (27%) and heart failure/volume overload (27%) (Table 7).

Table 7: CV composite events including both emergency and elective admissions, in people with coded and uncoded CKD stages 3-5

CV event type	Frequency	Percent
Acute and chronic ischaemic heart disease and its complications	6607	37.8%
Cerebrovascular disease / TIA	4794	27.4%
Heart Failure / Volume Overload	4744	27.1%
Peripheral and aortic artery disease	1339	7.7%
Total	**17484**	**100%**

By CKD Audit Group

When we split patients into those with CKD stages 3-5 (coded and uncoded combined) and those with other renal codes, the crude rate of CV events was 5.79 per 100pys (95% CI 5.68-5.91) and 3.45 per 100pys (95% CI 3.32-3.58), respectively (Appendix Table 35). This means that for every 100 patients with stage 3-5 CKD there will be approximately 6 CV events each year.

By CKD Stage and Coding Status

Overall, CV events increased sharply with deteriorating stage of CKD (Table 8); those with worse kidney function had more CV events than those with less severe impairment.

Except in CKD stage 5, where event counts were low, CV event rates between coded and uncoded patients were similar, with overlapping confidence intervals. This remained after taking into account differences in age and sex between the coding groups. Here we did not take into account other factors influencing CV event rates (such as comorbidities) and there were limited CV admissions in uncoded CKD stages 4 and 5, making it difficult to compare rates at between coded and uncoded individuals with stage 4 CKD and above. Nevertheless, it is clear that rates of CV events increase with progressing CKD, regardless of whether a patient has been coded with CKD by their GP.

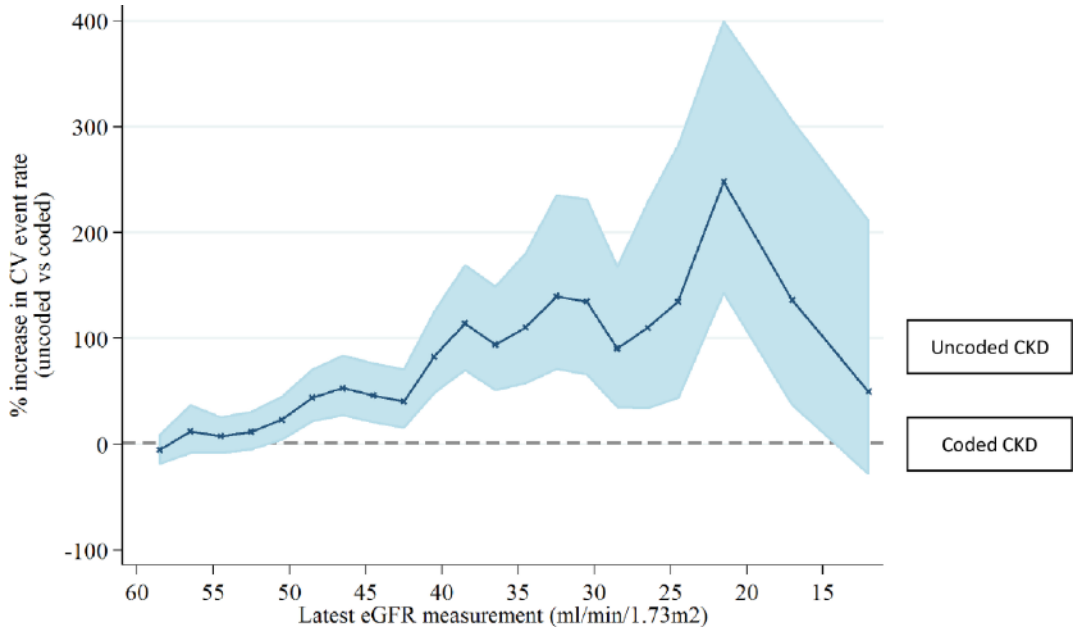
Table 8: CV composite event counts and rates in people with coded and uncoded CKD stages 3 4 and 5 defined by last eGFR measurement and by whether patients were coded or uncoded

Coding group	CKD stage based on last eGFR measure	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
Coded CKD	3	9761	168690	5.79	5.64-5.93	5.16
Uncoded CKD	3	3681	68921	5.34	5.12-5.57	5.04
Coded CKD	4	1626	14317	11.36	10.65-12.12	10.41
Uncoded CKD	4	174	1497	11.63	9.71-14.04	12.23
Coded CKD	5	333	1948	17.09	14.54-20.22	16.54
Uncoded CKD	5	16	171	9.37	5.42-17.69	8.69

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

In the graph below, we calculated the rate ratio comparing rate of CV events in patients with uncoded CKD stages 3-5 to patients with coded CKD stages 3-5, after taking into account differences in age, sex, diabetes, hypertension, and CV disease. In patients with confirmed biochemical CKD stages 3-5 (based on the two most recent eGFR measurements recorded at least three months apart where both were <60 ml/min/1.73m^2), rate ratios increased as eGFR declined until about 25 ml/min/1.73m^2 where rate ratios decreased as eGFR declined. Between about eGFR 35 ml/min/1.73m^2 and eGFR 25 ml/min/1.73m^2 (or roughly CKD stages 3b-4), patients who are not coded with CKD are two times more likely to have a hospital admission due to a CV event than patients who are coded for CKD (Appendix Table 36). This adjusted model should be interpreted with care as these findings could be the consequence of higher rates of failure to code comorbidities (e.g. CVD or diabetes), or other unmeasured factors.

Figure 9: Comparison of CV events (using rate ratios) between uncoded and coded patients with biochemical CKD stages 3-5



By Country

Among both patients with CKD stages 3-5 (coded and uncoded combined) and patients with other renal codes, the crude rate of CV events was similar for England and Wales with overlapping confidence intervals (Table 9, Appendix Table 37). Standardising by age and sex showed little difference, suggesting that any comparisons between England and Wales were not confounded by the age and sex distribution of the CKD populations studied.

Table 9: CV composite events counts and rates by country, in people with coded and uncoded CKD stages 3-5

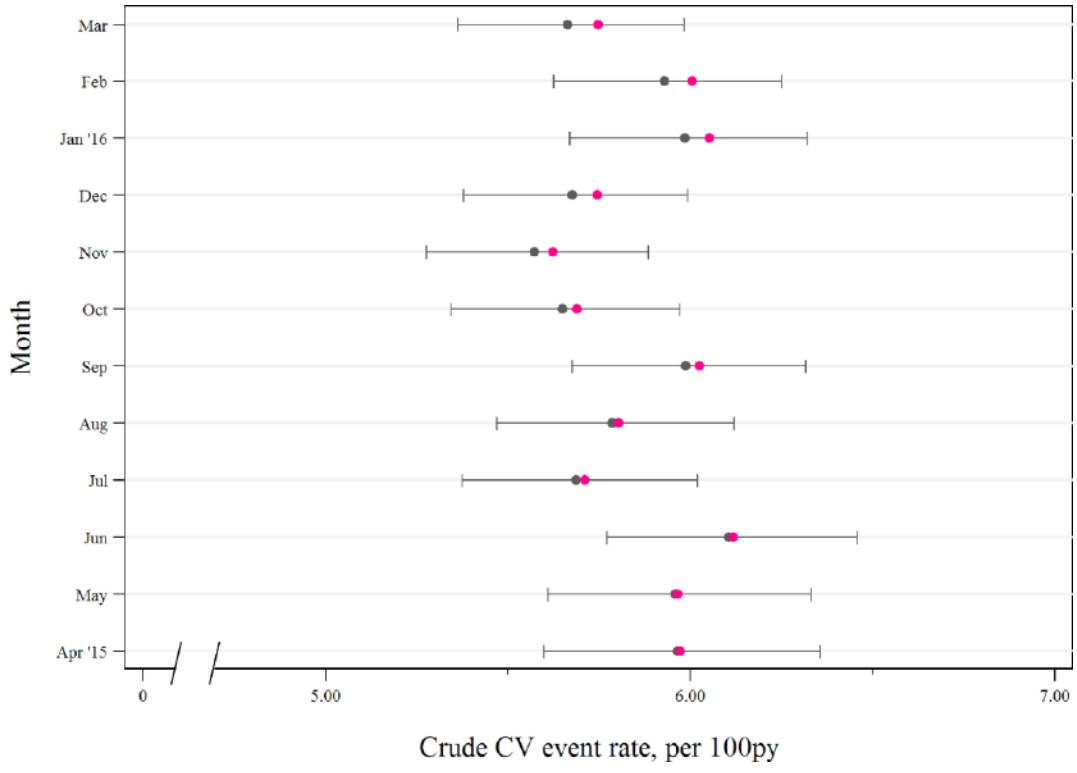
Country	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	11702	216186	5.41	5.29-5.54	5.48
Wales	6225	118153	5.27	5.10-5.44	5.31

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

By Calendar Month

Hospital admissions due to CV events seemed to vary little by season (Figure 10, Appendix Figure 18). However, CV event rates appeared to be higher in summer months and lower in winter months. We chose to include elective admissions as well as emergency admissions for both of these audit outcomes; this could be what drives higher CV event rates in warmer months and lower rates in colder months.

Figure 10: CV composite event rates by month in people with coded and uncoded CKD stages 3-5, with pink dots representing age- and sex-standardised rates; not adjusted for comorbidity*



**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Cardiovascular events:

- For every 100 patients with chronic kidney disease and moderate to severe function impairment, there are 6 CV events per year.
- Regardless of whether they have been coded for CKD, patients with more severe kidney function impairment have more CV events than those with less severe impairment.
- Between eGFR ml/min/1.73m^2 and eGFR 25 ml/min/1.73m^2, patients who are not coded for CKD are twice as likely to have a CV event as patients who are not coded for CKD.

3.4. Intensive Care Unit Admissions

Due to data quality issues with the Wales ICU admissions data, we have only reported results for English patients who received treatment in English critical care units. Patients who were not included in these results were: English patients who received care in Welsh critical care units; Welsh patients who received care in English critical care units; and Welsh patients who received care in Welsh critical care units. Patients receiving care in a critical care unit outside of their country are likely to have come from hospitals along the border of England and Wales.

Therefore, the reported rates may be an underestimate, since patients from English GP practices who were admitted to ICUs in Wales were not captured. More than half of ICU admissions were due to emergency admissions and more than a third were due to elective admissions (Appendix Figure 19). The mean duration of stay in ICU is 4.2 days and the median is 2 days. Patients with multiple ICU admissions (8% of patients) had a median of 30 days and a mean of 68 days between consecutive admission dates.

By CKD Audit Group

The crude rate of ICU admissions was 1.80 per 100pys (95% CI 1.73-1.86) among patients with coded and uncoded CKD stages 3-5, and 1.38 per 100pys (95% CI 1.30-1.47) among patients with other renal codes (Appendix Table 40). This means that, for every 100 patients with stage 3-5 CKD, there were approximately two ICU admissions (elective or unplanned).

By CKD Stage and Coding Status

Overall, ICU admission rates increased sharply with CKD stage; those with a worse reduction in kidney function had more ICU admissions than those with a less severe reduction (Table 10). This remained after taking into account differences in age and sex between coding groups. These data do not take into account other factors influencing admission rates, such as comorbidities, and there were very few ICU admissions in uncoded CKD stage 4 and 5, making it difficult to compare rates directly. However, it is clear that ICU admission rates increased with progressing CKD. Effective primary care management may reduce the burden of ICU admissions in CKD patients.

Table 10: ICU admission counts and rates in people with coded and uncoded CKD stages 3, 4, and 5 defined by last eGFR measurement and by whether patients were coded or uncoded

Coding group	CKD stage based on last eGFR measure	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
Coded CKD	3	1862	113076	1.65	1.57-1.73	1.61
Uncoded CKD	3	733	43909.31	1.67	1.55-1.81	1.67
Coded CKD	4	344	9328.134	3.69	3.19-4.29	4.96
Uncoded CKD	4	37	907.2745	4.08	2.95-5.81	5.42
Coded CKD	5	164	1275.515	12.86	10.74-15.52	12.04
Uncoded CKD	5	18	110.7625	16.25	9.60-29.68	14.05

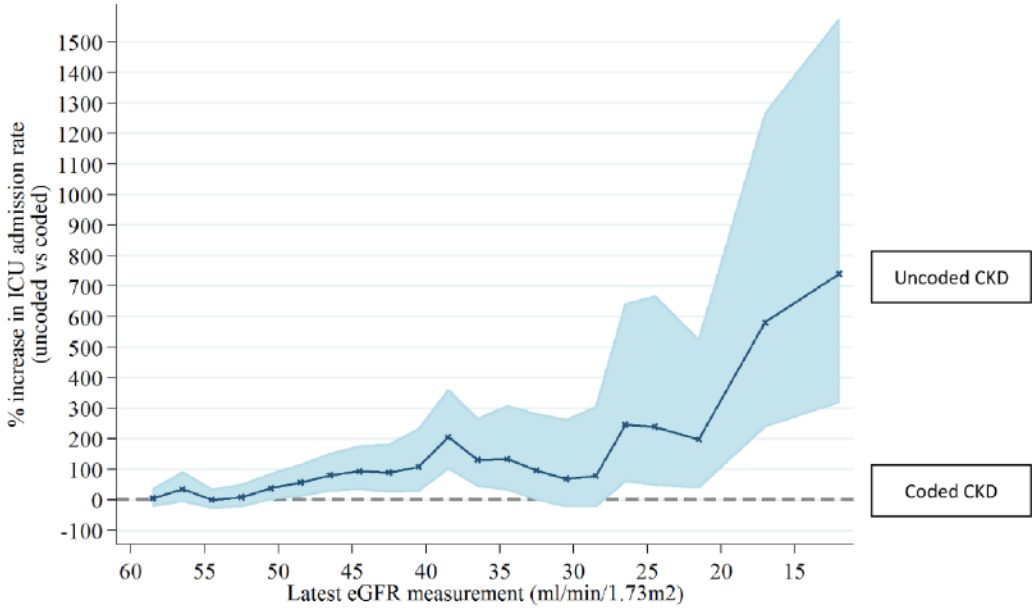
**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

***age-sex standardised rate could not be calculated due to low counts within strata leading to instability in the calculation of the age-sex standardised rate*

In Figure 11 below, we calculated the rate ratio comparing rate if ICU admissions in patients with uncoded CKD stages 3-5 to patients with coded CKD stages 3-5, taking into account differences in age, sex, diabetes, hypertension, and CV disease. In patients with confirmed biochemical CKD stages 3-5, the ICU admission rate ratios comparing the coding groups were approximately 1.0 (indicating no difference between group rates) until about eGFR 50 ml/min/1.73m^2 (Appendix Table 41). At about eGFR 40 ml/min/1.73m^2 (or roughly CKD stages 3a-4), patients with no recorded CKD code are two times more likely to have an ICU admission than patients with a CKD code. The rate ratios then level out slightly, until about eGFR 15 ml/min/1.73m^2 where uncoded patients have approximately eight times more ICU admissions compared to coded patients.

This adjusted model should be interpreted with care as these findings could be the consequence of higher rates of failure to code comorbidities (e.g. CVD or diabetes), or the presence of other severe comorbidities not captured in the Audit (e.g. lung diseases) that predispose to ICU admissions.

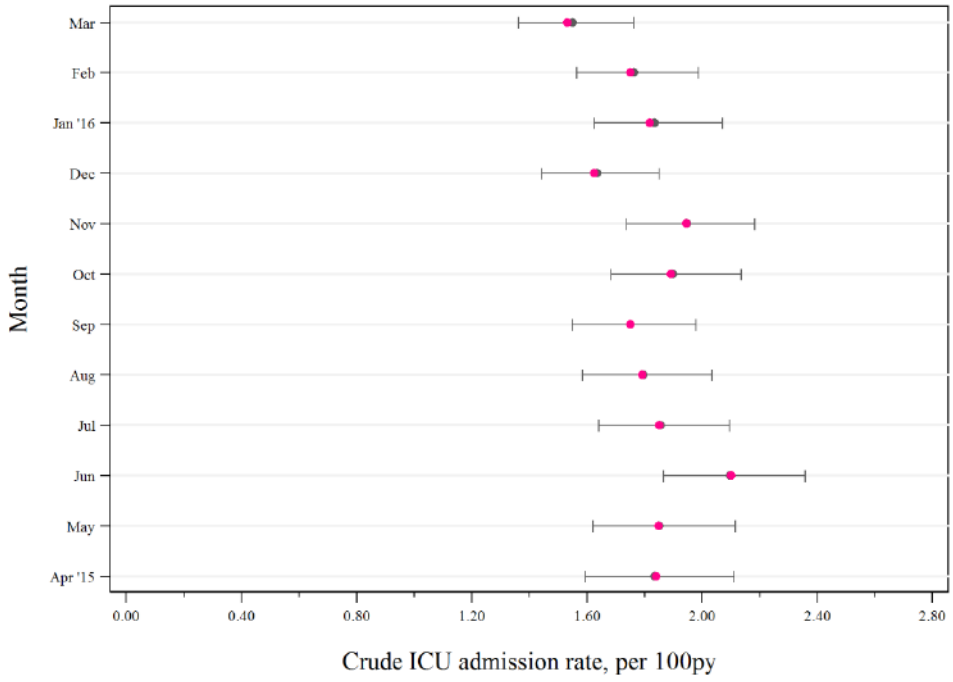
Figure 11: Comparison of ICU admissions (using rate ratios) between uncoded and coded patients with biochemical CKD stages 3-5



By Calendar Month

ICU admissions seemed to vary by season (Figure 12, Appendix Figure 20). However, unlike emergency admissions, rates appeared higher in warmer months and lower in colder months (although 95% confidence intervals overlapped).

Figure 12: ICU admission rates by calendar month, in people with coded and uncoded CKD stages 3-5, with pink dots representing age-sex standardised rates; not adjusted for comorbidity*



**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Intensive Care unit admissions:

- For every 100 patients with chronic kidney disease and moderate to severe kidney function impairment, there are 2 ICU admissions per year.
- As kidney function reduces, there are more ICU admissions per year. For every 100 patients with stage 4 CKD, there are 4 ICU admissions per year.
- Patients who do not have a Read code in the GP record might have higher ICU admission rates per year than patients with the same stage of kidney disease who do have a Read code.

3.5. Mortality

By CKD Audit Group

When the patient population was split into patients with coded and uncoded CKD stages 3-5 and patients with other renal codes, the crude death rate was 7.14 per 100pys (95% CI 7.04-7.23) and 2.59 per 100pys (95% CI 2.51-2.67), respectively (Appendix Table 45). In other words, for every 100 patients with stage 3-5 CKD, there were 7 deaths each year.

By CKD Stage and Coding Status

Mortality rates increased as CKD worsened, with higher mortality in later stages of CKD (Table 11). In addition, there was pronounced variation between those with and without a CKD code – at each stage of CKD, patients who were not coded for CKD had higher death rates compared to patients who with a CKD code.

Death rates were similar between coded and uncoded patients at CKD stages 3 and 5. After standardising by age and sex, the death rates remained similar, meaning that differences between coded groups at CKD stages 3 and 5 were largely due to age and sex. However, the age/sex-standardised rate among CKD stage 4 uncoded patients was nearly 50% higher than that in coded patients. This indicates that patients with biochemical evidence of CKD stage 4 but with no CKD code are dying at 1.5 times the rate of those with a CKD code (i.e. those at the same CKD stage, with the same age and sex, who have been coded for CKD by their GP). These data do not take into account other factors, such as comorbidities, that might influence death rates between patients. Nonetheless, it is clear that death rates increased with progressing CKD. Effective primary care management may reduce mortality in CKD patients, especially CKD stage 4.

Table 11: Death counts and rates in people with coded and uncoded CKD stages 3, 4, and 5 defined by last eGFR measurement and by whether patients were coded or uncoded

Coding group	CKD stage based on last eGFR measure	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rates per 100py
Coded CKD	3	11317	168718	6.71	6.59-6.83	5.43
Uncoded CKD	3	4188	68931	6.08	5.89-6.26	5.53
Coded CKD	4	2382	14321	16.63	15.98-17.31	12.27
Uncoded CKD	4	314	1497	20.97	18.78-23.43	18.31
Coded CKD	5	467	1949	23.96	21.88-26.23	25.14
Uncoded CKD	5	43	171	25.19	18.68-33.96	26.96

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

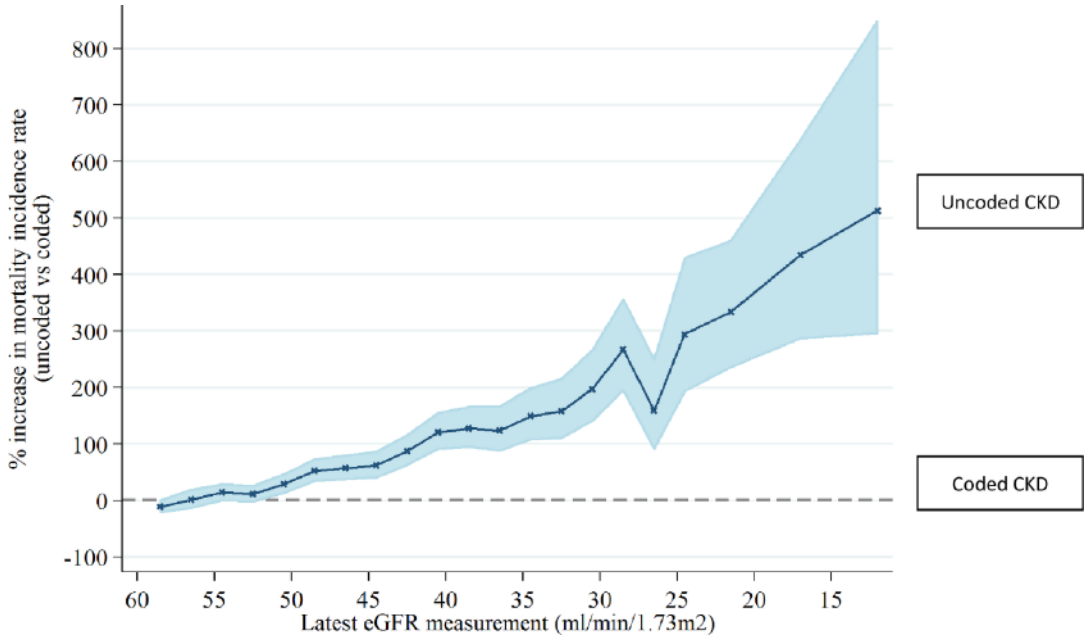
***age-sex standardised rate could not be calculated due to low counts within strata leading to instability in the calculation of the age-sex standardised rate*

In the graph below, we calculated the rate ratio of patients with uncoded CKD stages 3-5 versus patients with coded CKD stages 3-5 taking into account differences in age, sex, diabetes, hypertension, and CV disease on the association of lack of coding with death rates. In patients with confirmed biochemical CKD stages 3-5, the rate ratios comparing the those with and without CKD codes are approximately 1.0 (indicating no difference between group rates) until about eGFR 50 ml/min/1.73m^2. At about eGFR 40 ml/min/1.73m^2 (or roughly CKD stages 3a-4), patients who are not coded for CKD are two times more likely to die than patients who are coded for CKD (Appendix Table 46).

There is a dip in mortality rate ratios at about eGFR 20 ml/min/1.73m^2 and then rate ratios comparing those with and without CKD codes continued to increase.

This adjusted model should be interpreted with care as these findings could be the consequence of higher rates of failure to code comorbidities (e.g. CVD or diabetes), or the presence of other severe disease that is associated with a failure to code for CKD (e.g. dementia, metastatic cancer).

Figure 13: Comparison of deaths (using rate ratios) between uncoded and coded patients with biochemical CKD stages 3-5



By Country

In both patient populations, the crude rate of deaths is slightly higher in England compared with Wales (Table 12, Appendix Table 47). This means that the slight differences in death rates is not explained by the age- and sex-differences between the participating practice populations in England and Wales.

Table 12: Death counts and rates by country, in people with coded and uncoded CKD stages 3-5

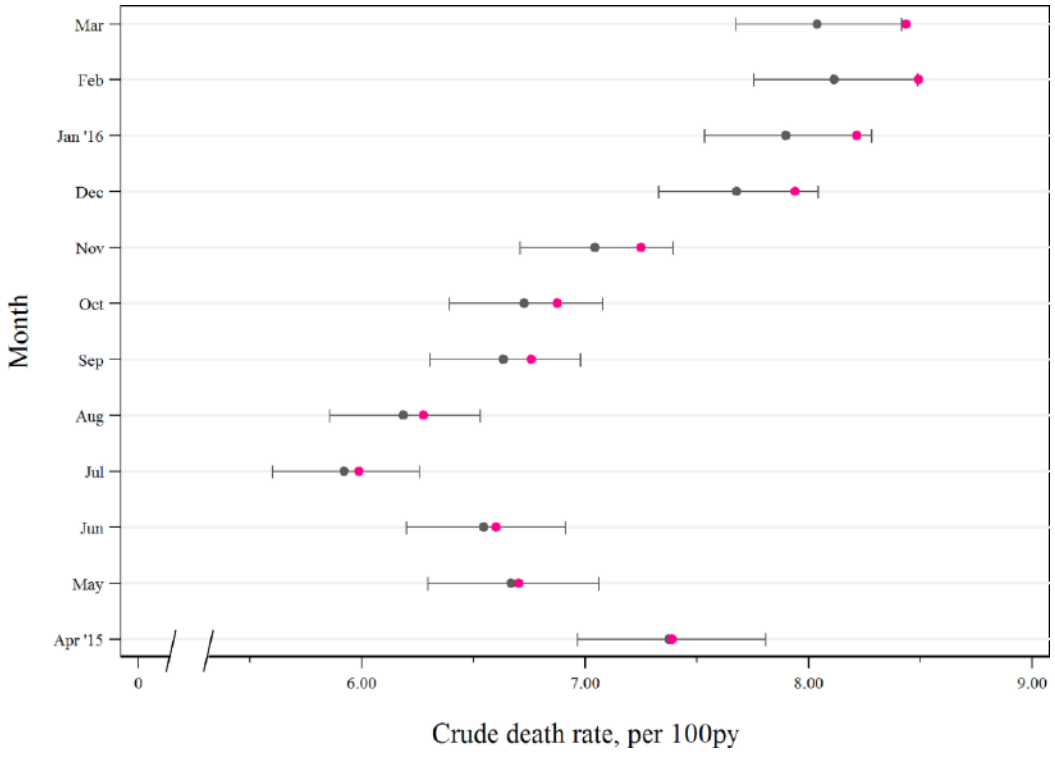
Country	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	14456	199163	7.26	7.14-7.38	7.44
Wales	7081	102661	6.90	6.74-7.06	7.15

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

By Calendar Month

Mortality appeared to vary by season, with high death rates in winter months and low death rates in summer months (Figure 14, Appendix Figure 21). This will need to be taken into account when reporting death rates in CCGs as the contribution of time will vary depending on the calendar month practices entered the audit.

Figure 14: Death rates by month in people with coded and uncoded CKD stages 3-5, with pink dots representing age-sex standardised rates; not adjusted for comorbidity*



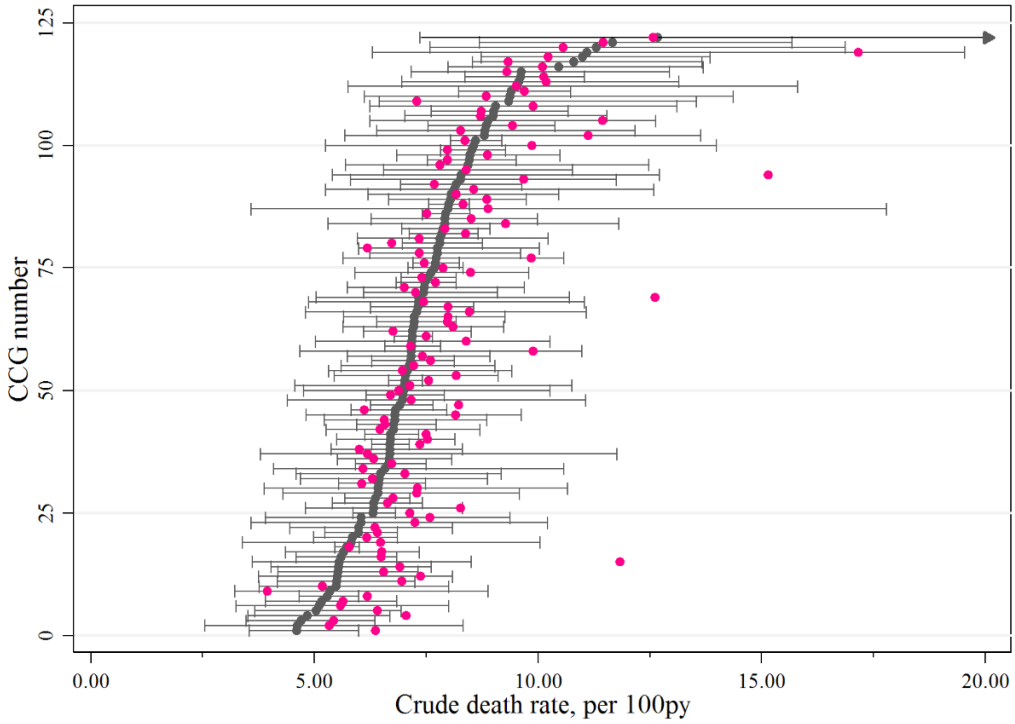
**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

By CCG

There are seven LHBs located in Wales and 118 CCGs located in England who contributed data to the Audit. Among people with coded and uncoded CKD stages 3-5, there were two CCGs (located in England) with less than ten deaths during the follow-up period, one of which had no deaths (Appendix Table 50). From the forest plot, confidence intervals overlap and there does not appear to be significant difference in mortality between CCGs/ LHBs (Figure 15, Appendix Figure 22).

Age/sex standardisation increased the magnitude of difference between mortality rates in coded versus uncoded CKD for each CCG. The variation in rates may be due to differences in either the calendar periods in which practices within CCGs provided data or the burden of comorbidity among patients from certain geographical locations. We were not able to investigate the cause of the variation due to the small number of practices within many of the CCGs.

Figure 15: Death rates by CCG in people with coded and uncoded CKD stages 3-5, with pink dots representing age-sex standardised rates; not adjusted for comorbidity*



**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Mortality:

- As kidney function worsens, the rates of death per year increase.
- For every 100 patients with stage 3 CKD, there are 7 deaths per year. For every 100 patients with stage 4 CKD, there are 19 deaths per year.
- Patients who have biochemical evidence of stage 4 CKD but do not have a Read code in the GP record are dying at 1,5 times the rate of patients in the same CKD stage with the same age and sex who do have a Read code.

3.6. Referrals

All patients with coded and uncoded CKD stages 3-5 from an English GP with a primary care nephrology referral code after January 2015 were followed up to identify whether they had a nephrology outpatient appointment within 18 weeks of the referral. Patients were only included if they had a minimum of 18 weeks of follow up between the referral date and the end of HES follow up (defined as end of May 2016).

In the group of patients who had a nephrology referral code recorded in their primary care record after January 2015, there were 5,176 patients with CKD stages 3-5 (both coded and uncoded).

The majority of CKD patients (coded and uncoded) with a GP nephrology referral code after January 2015 had a corresponding nephrology outpatient appointment recorded in HES within 18 weeks (Table 13). Only 5.2% of patients did not have a record of a nephrology outpatient appointment in the HES dataset. Further analyses need to establish whether these patients, who did not have a nephrology outpatient appointment within 18 weeks, were seen by other specialist clinics (e.g. diabetes, or urology). There were some patients (3.1%) with a referral corresponding to a nephrology outpatient appointment that were outside the recommended 18 weeks. The majority of patients without a nephrology outpatient appointment within 18 weeks had a record of a nephrology outpatient appointment that occurred before the date their GP coded the referral (up a maximum of approximately 3 years before referral record); these may represent previous referrals, where patients had been referred multiple times for continuation of care.

Table 13: The number and percent who have a matching GP nephrology referral code with HES nephrology outpatient appointments in people with coded and uncoded CKD stages 305 (people with coded and uncoded CKD stages 3-5)

	N (%)
Total CKD patients referred with minimum 18 weeks, post Jan 2015	5,176
GP referral and HES clinic dates match +/- 18 weeks	4,746 (91.7%)
GP referral and HES clinic dates differ by > 18 weeks	161 (3.1%)
GP referral date in absence of HES clinic date	269 (5.2%)

The majority of patients with CKD stages 3-5 (coded and uncoded) with a GP referral code had a corresponding nephrology outpatient appointment within 18 weeks of referral (Table 14). The number of successful referrals appeared to be highest in uncoded CKD stage 4 patients and lowest in uncoded CKD stage 3 patients compared with other groups.

Table 14: The number and percent who have a matching GP nephrology referral code with HES outpatient appointments in people with coded and uncoded CKD stages 3, 4, and 5 defined by last eGFR measurement and by whether patients were coded or uncoded

Coding group	CKD stage based on last eGFR measure	N	GP referral and HES clinic dates match +/- 18 weeks	GP referral and HES clinic dates differ by > 18 weeks	GP referral date in absence of HES clinic date
Coded CKD	3	1984	1,791 (90.3%)	46 (2.3%)	147 (2.3%)
Uncoded CKD	3	223	185 (83.0%)	6 (2.7%)	32 (14.4%)
Coded CKD	4	1852	1,748 (94.4%)	58 (3.1%)	46 (2.5%)
Uncoded CKD	4	66	63 (95.5%)	1 (1.5%)	2 (3.0%)
Coded CKD	5	639	592 (92.6%)	38 (6.0%)	9 (1.4%)
Uncoded CKD	5	21	19 (90.5%)	1 (4.8%)	1 (4.8%)

//4. Main Findings, Recommendations and Next Steps

This second national report of the NCKDA described the outcomes of patients with CKD managed in primary care using linked data from HES, PEDW and ONS. It represents the largest single analysis of outcomes among patients with CKD managed in primary care in the world. From a total of more than 400,000 patients with kidney disease, there was a total of more than 250,000 years of follow-up. The population studied is broadly representative of England and Wales in terms of age and sex, though those of White ethnicity and rural areas are overrepresented.

Previously, it has been shown that reduced eGFR is independently associated with increased risk of hospital admissions and all-cause mortality and there is evidence that demonstrates these risks of adverse events rise sharply when eGFR declines to 45 ml/min/1.73m^2.[2,12] This report has shown that, consistent with previous evidence, rates of adverse outcomes among patients with CKD stages 3-5 increase with reducing eGFR.

Findings

Finding 1. High burden of hospital admissions with increasing admissions as CKD worsens

We have demonstrated that patients with CKD in primary care experience very high rates of unplanned admissions to hospital. These analyses show a rate of 38 unplanned admissions each year for every 100 patients with CKD stages 3-5. Comparing this to the overall rate in England of 10 unplanned admissions for every 100 people[13] underlines the risk factors for poor health that many of this group live with alongside their CKD diagnosis, such as older age, diabetes and CV disease.

Finding 2. Coding is associated with a short-term reduction in unplanned admissions, including events due to AKI

AKI events were more likely among people with CKD that had not been coded in primary care compared to those with a CKD code and the magnitude of this difference increased as kidney function declined. In CKD stage 4 and 5, the crude rate of AKI events at admission was 1.2 and 1.4 times higher in uncoded patients compared with coded patients, respectively. This trend remained after age/sex standardisation, indicating that these rates were not confounded by the age-sex structure of the uncoded and coded CKD patient populations.

In stage 4 CKD, the magnitude of the difference in event rates between coded and uncoded patients was larger for AKI events than for CV events. In order to improve CV outcomes, several years of consistent primary care intervention may be needed, which this audit could not capture. In contrast, to prevent AKI, the importance may lie with the short-term secondary care provided to the patient during acute illness.

Finding 3. Presence of renal and other urological problems, as well as CKD stage 3-5, is associated with increased mortality

As kidney function worsens, the risk of dying increases. Overall, people with CKD stages 3-5 had death rates approximately three times that of people with other renal codes. However, after taking into account differences between the age-sex structure of the patient populations, people with other renal codes and an eGFR >60 ml/min/1.73m^2 had similar age/sex standardised death rates to those with CKD stages 3-5. This supports the notion suggested by previous research[8] that people with, for example, severe proteinuria and/or other structural renal problems, such as renal cancer, have an increased risk of death, even when they have preserved kidney function.

Finding 4. The vast majority of patients referred from primary to secondary care are seen within 18 weeks

Approximately 95% of patients with stage 3-5 CKD who had a GP nephrology referral code had a record of a nephrology outpatient appointment within 18 weeks. Some patients (3%) had a corresponding nephrology outpatient appointment that was outside the recommended 18 weeks referral-to-treatment (RTT) waiting time rules or did not have a corresponding appoint at all (5%)[14]. To ensure patients are seen as quickly as possible CCGs, in collaboration with GPs, need to monitor referral times to ensure they do not fall outside the 18 week threshold.

Recommendations

The audit recommendations from this Part 2 report are intended for GPs and SDTPs/CCGs/LHBs, as well as secondary care providers and researchers. CKD patients and patient support groups will also benefit from the findings of this report. These recommendations should be read in conjunction with the findings and recommendations given in the first part of the audit report.

Recommendation 1. GPs should review the procedures in place to identify patients who have evidence of CKD stages 3-5 in order to improve the coding and regular review of these patients.

Findings from the first part of the audit showed a wide variation in coding between GP practices; the proportion of patients with evidence of CKD stages 3-5 that were uncoded ranged from 0% to 80%[1]. There is good evidence that coding in primary care is linked to increased rates of management activity and improved disease management. as recommended by NICE[4].

This report has shown that patients with evidence of more advanced CKD stages 3-5 but who are not coded for CKD, are at a substantially increased risk of unplanned hospital admissions, particularly due to AKI events. As coded patients are on average older, with better documented severe kidney disease and a greater burden of comorbidity, it might be expected that the coded rather than the uncoded patients would have higher rates of admissions and deaths.

However, after taking into account differences in age and prevalence of comorbidities, it appears that those patients with no CKD code had even worse outcomes than those with the same level of kidney function but who were coded by their GP. This effect is observed whether we examined unplanned admissions, AKI events, CVD events, or mortality.

Recommendation 2. Clinical commissioning groups should put in place quality improvement tools and incentives to support and monitor the identification and care of patients with CKD within their constituent practices.

Although our analysis suggests patients with CKD who are coded in primary care have lower rates of adverse outcomes than similar patients with CKD who are not coded, we cannot conclude that the act of giving those uncoded patients a CKD code would improve those same outcomes. However, there are a number of mechanisms by which coding patients might improve their outcome. These include better control of risk factors such as blood pressure or cholesterol, closer monitoring of kidney function, and safer prescribing through automated patient identification via Read codes in GP systems.

GPs vary in their identification and decision making processes around CKD patients. Many GP practices already use audit tools to monitor and improve their performance while other practices still need incentives to compare their performance with others. CCGs play an important role in this activity. The tools and resources provided by the CCGs will in turn contribute direct benefits for patient care, and are likely to result in a decrease in hospital admissions for those with CKD. CCGs and LHBs need to ensure that practice CKD indicators are put in place to replace the retired CKD indicators in the Quality and Outcome Framework.

Recommendation 3. Further research is needed to investigate whether there the link between CKD coding in the GP record and hospital admissions and mortality rates is causal.

The unplanned hospital admission and mortality data analysed in this report provide evidence of an association between absence of CKD coding in the GP electronic health record and increased rates of unplanned admissions, AKI, and all-cause mortality. Presently, we cannot be sure of the strength of the association or of whether a causal link exists between coding and outcomes.

The association between coded CKD and better outcomes might be explained by either GP practice characteristics or by other patient characteristics that were not captured during data extraction for the NCKDA. For example, some GP practices may code patients more effectively or, alternatively, some uncoded patients may be very ill for other reasons. The primary care dataset used for the NCKDA analysis was limited in that it did not include information on comorbidities such as cancer, dementia, or serious mental illness. Furthermore the adjusted models we present should be interpreted with care as these findings could be the consequence of higher rates of failure to code comorbidities (e.g. CVD or diabetes), or differential misclassification of eGFR due to less frequent monitoring in the uncoded CKD group.

Further studies using the NCKDA data and other sources of primary care data linked with hospital outcomes will be needed to determine the strength of the association between coding and outcomes, and whether or not improvements to coding practice will result in better outcomes for CKD patients.

Those who are coded are more often getting indicated primary care interventions for CKD compared to those who are not coded. We cannot be sure whether some patients who were not coded would have benefitted from these interventions as well. Hence, in view of the evidence presented overall, we would encourage testing those at risk of CKD and coding for CKD in primary care in order to improve care and to prevent poor outcomes.

Summary findings of patient outcomes

Patients with chronic kidney disease and moderate to severe function impairment

1. For every 100 patients, there are **38 unplanned admissions per year.**
2. For every 100 patients, there are **7 AKI events occurring at time of admission per year.**
3. For every 100 patients, there are **6 CV events per year**.
4. For every 100 patients, there are **2 admissions to the ICU per year.**
5. For every 100 patients, there are **7 deaths per year.**
6. Approximately **95% of patients with CKD stage 3-5 who had a GP nephrology referral code** have a corresponding nephrology outpatient appointment within 18 weeks.

// Glossary and Abbreviations

AKI	acute kidney injury
APC	Admitted Patient Care activity
Average	A number to describe a series of observations. Depending on the pattern of these observations, the median/or mean will better describe the series.
CC	Critical care
CCGs	Clinical Commissioning Groups (England)
CI	Confidence interval
CKD	Chronic kidney disease
CKD Coding	Read codes given by primary care physicians to encode that a patient has CKD. A subset of CKD codes allows entry of the patient onto a QOF incentivised CKD practice register with payment to practices to maintain this information
CRG	Clinical Reference Group. This consists of representatives from partner organisations, and clinical experts, acting in an advisory capacity to the NCKDA project team
CV	cardiovascular
eGFR	Estimated glomerular filtration rate A calculation of the creatinine clearance rate filtered through the kidneys.
ED	Emergency Department
Elective	In this report this refers to the mode of hospital admission. The timing of elective care can usually be planned. In contrast, urgent/emergency care usually has to take place within very short timescales (hours)
GP	General practitioner
GPSoC	GP Systems of Choice
HES	Hospital Episode Statistics
HQIP	Healthcare Quality Improvement Partnership
HRA	Health Research Authority
HSCIC	Health and Social Care Information Centre
IQR	Interquartile range – the middle 50% of observations either side of the median
ICU	Intensive care unit
LHB	Local Health Boards (Wales)
Mean	Mathematical average
Median	Midpoint of all observations when ranked in order from smallest to largest (see average)

NHS	National Health Service
NCKDA	National CKD Audit and Quality Improvement Programme
NICE	National Institute for Health and Care Excellence
NWIS	NHS Wales Informatics Statistics
ONS	Office of National Statistics
OP	Outpatient data
Proteinuria	Presence of protein in the urine. The most common protein found in urine is albumin. NICE currently recommends using ACRs to quantify this, instead of the commonly used urine dipstick tests which are less sensitive
PEDW	Patient Episode Database of Wales
QOF	Quality and Outcomes Framework
QI	Quality improvement
Read Codes	Standardised set of codes given by primary care physicians for recording patient findings and procedures in health and social care.
STP	Sustainability and Transformation Plan
uACR	Urinary albumin to creatinine ratio

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//Appendix

Data Quality

Missing data

Although there were setbacks with the structure of the datasets and duplicate data, there was very little missing data in either APC dataset (Appendix Table 1). This is promising as it shows that patient data is being inputted into databases. Full APC datasets included admissions data from 2012 to 2016. The majority of data items had less than 1% of missing data. The primary diagnosis was missing 5% of the episodes in the Wales APC dataset. However, this data may not truly be missing as many of these primary diagnoses were coded 'Z' rather than missing. Data on the ethnicity of patients was missing in 7% of the HES dataset and in 67% of the PEDW dataset. These ethnicity data will be useful because, as described in the first part of the National CKD Audit Report the quality of the primary care ethnicity data was suboptimal in a subset of practices.

Appendix Table 1: Number of data items with missing data, separately for HES and PEDW APC datasets (based on full dataset prior to any restriction of follow-up)

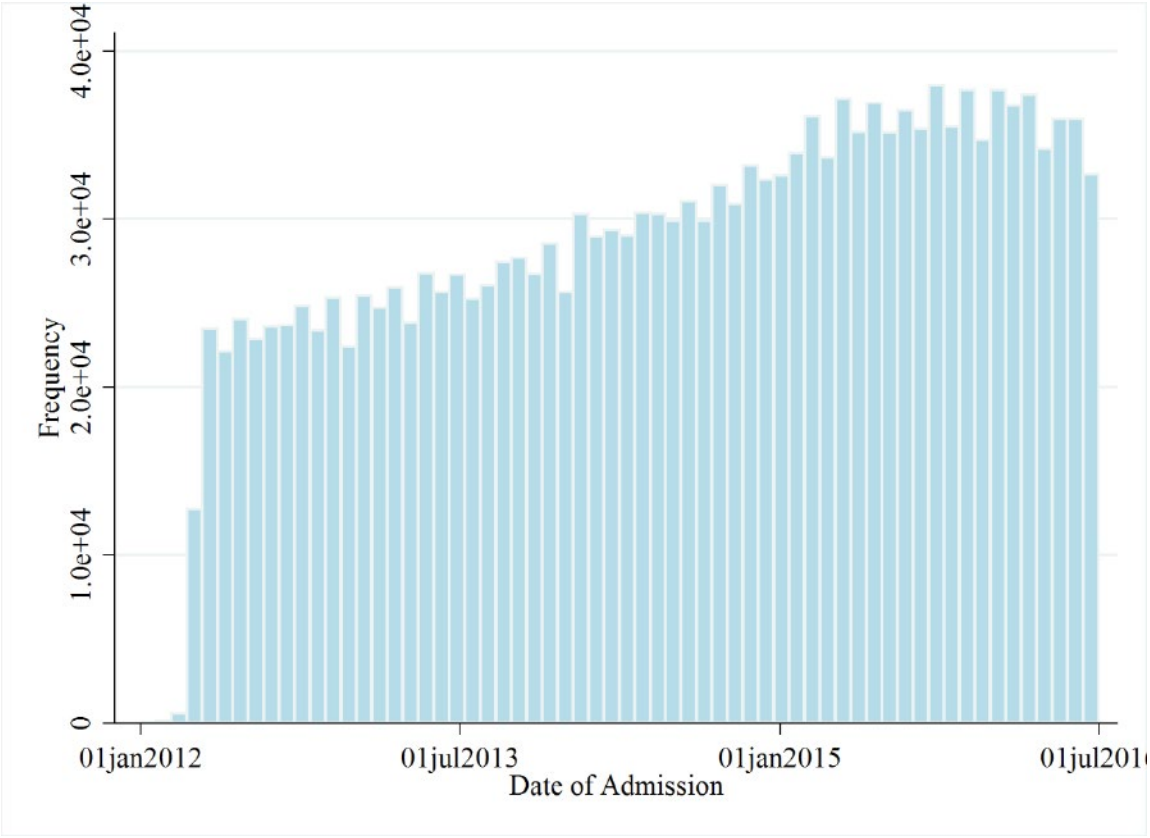
	HES England	PEDW Wales
Episode-level (N):	**1,761,897**	**749,180**
NHS number	0 (0)%	0 (0)%
Episode ID	0 (0)%	0 (0)%
Spell ID	993 (<0.1%)	1 (<0.001%)
Admission date	10 (<0.01%)	0 (0)%
Episode start date	10 (<0.01%)	7 (<0.001%)
Episode end date	801 (<0.1%)	0 (0)%
Primary diagnosis	151 (<0.01%)	36,092 (4.8%)
Current consultant specialty	4,938 (0.3%)	44 (<0.01%)
Main consultant specialty	506 (<0.1%)	84 (<0.1%)
Admission type	281 (<0.1%)	1 (<0.001%)
DOB	5 (<0.001%)	0 (0)%
Sex	0 (0)%	0 (0)%
Ethnicity	123,379 (7.0%)	500,779 (66.8%)
Patient-level:	**275,083**	**132,602**
DOB	1 (<0.001%)	0 (0)%
Sex	0 (0)%	3 (<0.01%)
Ethnicity	15,384 (5.6%)	87,644 (66.1%)

Admissions data

APC England

There were 1,761,897 unique episodes, 1,472,324 unique admissions, and 275,083 unique patients in the APC England dataset with all of the admissions matching patients that were requested for linkage (I.e. no admission or patients were incorrectly provided). Coverage of the APC dataset spanned 2012-2016 (Appendix Figure 1). 262,653 of patients in the HES APC dataset matched GP records from England (68% of England GP patients linked) while 12,494 of patients (3% of Wales patients linked) matched GP records from Wales (prior to any restrictions to follow-up). Of 1,761,897 unique records in the APC dataset, 142 were dated prior to Jan 2012 (<0.01%), and with a cut-off of June 30th 2016.

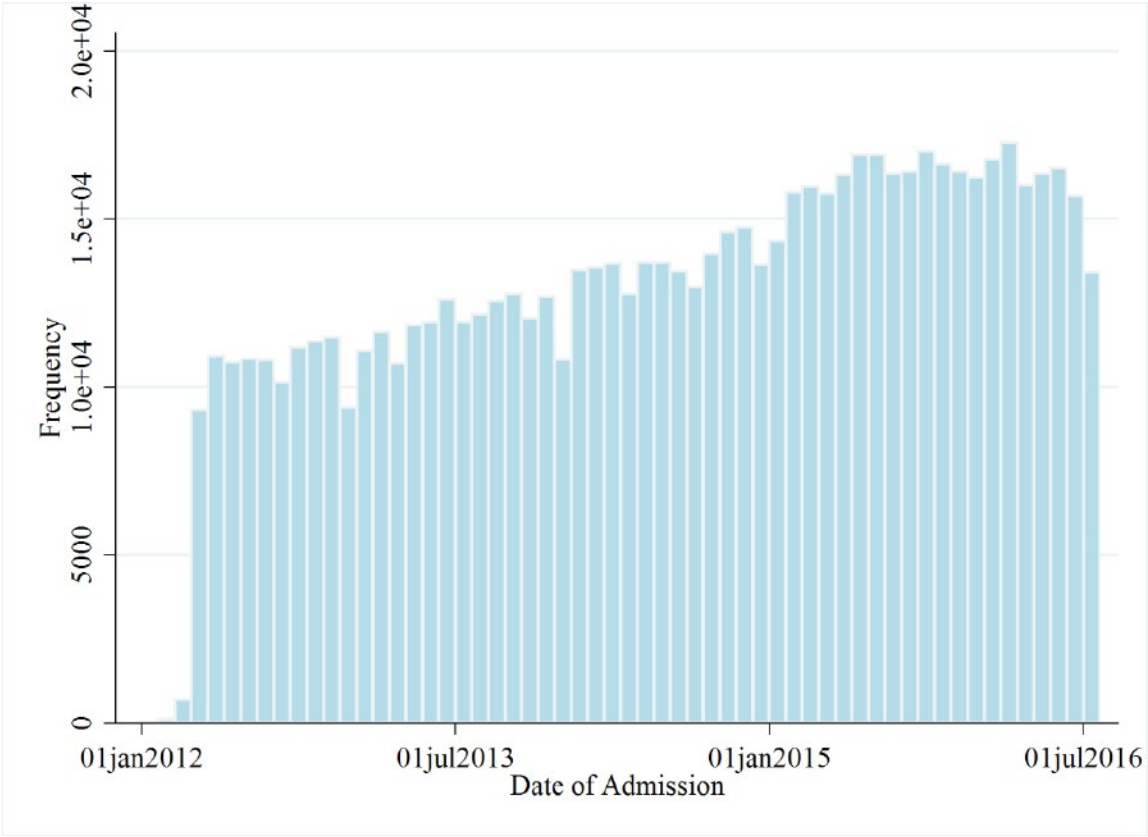
Appendix Figure 1: Admission dates for all records (episodes) in APC England dataset



APC Wales

In the APC Wales dataset there are 749,180 unique episodes, 595,416 unique admissions, and 132,602 unique patients. All admissions were matched with patients requested for linkage. As for APC England, coverage of the APC dataset spanned 2012-2016 (Appendix Figure 2). There were 131,342 patients in the HES APC dataset matching GP records from Wales (66% of 198,276 Wales patients linked) and 1,352 patients matching GP records from England (0.4% of 386,214 England patients linked). 106 episodes (0.01%) were dated prior to January 2012, and with a cut off of July 31st 2016. Note: This is a month extra compared to HES admissions data.

Appendix Figure 2: Admission dates for all records (episodes) in APC Wales dataset



As can be seen in both Appendix Figures 1 and 2, the number of admissions level off in the first half of 2016 in England and Wales. This is likely to be due to incomplete reporting or the data has not yet been filtered (HES says that there is a 6-month delay to reach good data quality). The follow-up periods for admission data from Wales and England are different.

Determining follow-up time

GP data extraction dates vary by practice as well as by country according to when they agreed to participate in the audit. This means that there may be differences in patient follow-up duration between practices and between countries. The first round of data extraction took place between 23rd March 2015 and 7th July 2016 and included 1,039 practices. The second round of data extraction started seven months later on 12 October 2015, ended 8 July 2016 and included 912 practices. Mortality data and admission data were also extracted from England and Wales databases at varying times.

HES admissions follow-up ended on 30 June 2016 with mortality follow-up ending on 18 July 2016 and PEDW admissions follow-up ended on 31 July 2016 with mortality follow-up ending on 19 September 2016.

Follow-up duration

England HES admission follow-up ended on 30 June 2016 while Wales PEDW admission follow-up ended on 31 July 2016. A total of 554,841 patients met the group criteria for linkage at rounds 1, 2 and 3 of data extraction with 501,050 patients meeting criteria at round 1 and 441,618 patients meeting criteria at round 2. Round 1 data provided longer follow-up time. The median follow-up time in patients from round 1 to the end of admissions data collection or death was 15 months (Appendix Table 2). At round 2 of data extraction, the median follow-up time was 8 months. Median follow-up was reduced slightly after application of a follow-up cap defined as 31st May 2016.

Appendix Table 2: Duration of follow-up from GP extraction to end of admissions follow-up or death (includes 0 duration follow-up)

	Round 1	Round 2
N	N = 501,050	N = 441,618
Mean	395	182
SD	127	93
Min	0	0
Q1	367	94
Median	455	244
Q3	465	249
Max	496	264

**duration of follow-up is reported for all patients requested for linkage, not only those with admissions data*

Data from both rounds provided follow-up data for 99% of patients linked (Appendix Table 3). 90% of patients linked from round 1 had at least 6 months of follow-up from extraction to end where only 70% of patients linked had this data in round 2. 75% of patient data extracted at round 1 provided at least 6 months of follow-up with a cut-off 6 months prior to the end of follow-up while round 2 provided no follow-up using this criterion. Although it was originally planned to use data from round 2 to allow practices the opportunity to improve CKD coding, only 5% of practices changed the CKD coding dramatically between rounds 1 and 2. Therefore, for the majority of practices there was not much change in the data quality, and in order to enable reporting on most practices in the audit, data from round 1 have longer and sufficient duration of admissions follow-up in many more patients. It was decided to use data extracted from round 1 to report on audit outcomes.

Appendix Table 3: Number of linked patients with admissions follow-up over specified time periods

	Round 1	Round 2
Total number of patients qualifying for linkage with data available	N = 501,050	N = 441,618
Patients with any follow up from extraction date to end of follow up	496,268 (99%)	437,894 (99%)
Patients with at least 6 months of follow up from extraction date to end of follow up	450,358 (90%)	307,786 (70%)
Patients with at least 6 months of follow up from extraction date to 6 months prior to end of follow up	375,887 (75%)	0 (0%)

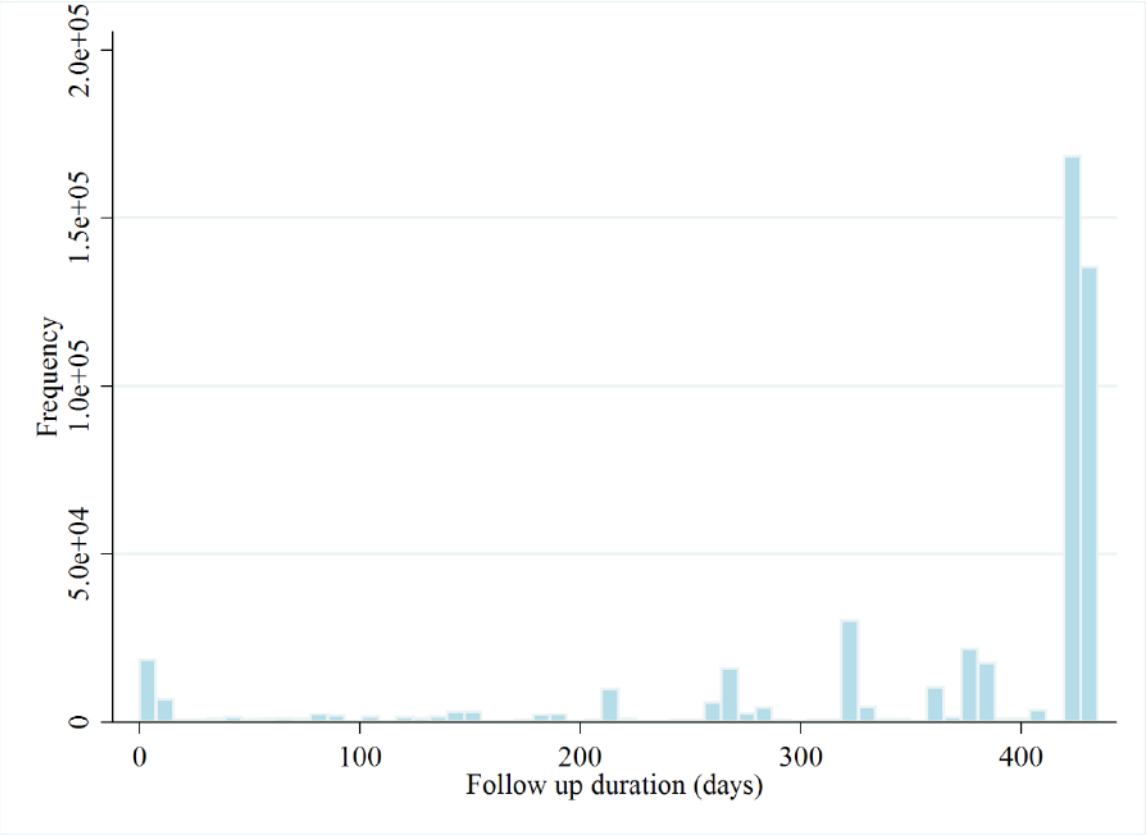
Patients were then further restricted to having any follow-up time between the round 1 extraction date and the end of admissions follow-up (excluding follow-up duration equal to zero). There was a total of 496,268 patients included with a median of 15 months' follow-up (Appendix Table 4). The distribution of the duration of follow-up for patients at round 1 is shown in Appendix Figure 3.

Appendix Table 4: Duration of follow-up from GP extraction to end of admissions follow-up or death (excludes 0 duration follow-up)

	Round 1	Round 2
N	N = 496,268	N = 437,894
Mean	399	183
SD	122	92
Min	1	1
Q1	382	94
Median	455	244
Q3	465	249
Max	496	264

End of follow-up was determined by inspection of the last dated admissions records in both HES APC and PEDW APC datasets. However, it is recognised that data completeness in the last few months of data collection may not be adequate. In order to accurately summarise admission rates as part of audit reporting, it was deemed necessary to cap follow-up before the actual end of data collection. The date of 31st of May 2016 was chosen after review, and Appendix Figure 2 shows the distribution of patient follow-up duration after applying the follow-up cap.

Appendix Figure 3: Follow-up duration (days) for all patients requested for linkage from round 1 extraction to end of May 2016



Emergency admissions

First, emergency admissions were assessed separately by HES and PEDW datasets because patients are more likely to be admitted to hospitals in the country in which their GP practice is located. However, due to a number of patients being admitted to hospitals across the border, datasets were combined. It is likely that these patients live adjacent to the border and were simply taken to the nearest hospital. In order to combine the datasets, we first derived the outcomes in each dataset, dropped the variables that were not needed, and appended the datasets. Emergency admissions were identified by using the admission method code (see Code Definitions in Appendix for further details).

In the HES dataset, there were 2,673 emergency admissions that occurred in 1,874 patients from GP practices in Wales. Equivalently in the PEDW dataset, there were 373 emergency admissions that occurred in 265 patients from GP practices in England. A total of 178,387 emergency admissions in 104,636 patients occurred in both England and Wales with 4541,962 patient-years of follow-up in all patients sent for linkage.

APC England

From England GP practices, 328,379 patients had at least 1 day of follow-up after round 1 extraction, of which 66,432 (20%) had an emergency admission (Appendix Table 5). In this dataset, there were 2,673 emergency admissions – covering 1,874 patients – in England hospitals for patients originating from GP practices in Wales.

Appendix Table 5: Emergency admissions since round 1 extraction for patients extracted form GP practices in England and Wales and admitted to hospitals in England only

	Total events in dataset	Number of patients with event
First episode of spell (England GP)	114,494	66,432
First episode of spell (Wales GP)	2,673	1,874

**variable patient follow-up*

APC Wales

There were 63,431 emergency admissions in Welsh hospitals covering 37,990 patients originally from GP practices in Wales while there were 373 emergency admissions covering 265 patients originally from GP practices in England (Appendix Table 6).

Appendix Table 6: Emergency admissions since round 1 extraction for patients from GP practices in Wales and England and admitted to hospitals in Wales only

	Total events in dataset	Number of patients with event
First episode of spell (Wales GP)	63,431	37,990
First episode of spell (England GP)	373	265

**variable patient follow-up*

AKI Events

HES England

When looking at primary AKI diagnoses only, there are 3,375 events covering 3,024 patients. 85% of these events were identified in the first episode of a spell. However, when looking at AKI diagnosis at any level, the number of events (N=21.859) and patients (N=17,242) increased dramatically (Appendix Table 7). There is an approximate 6-fold increase in AKI events at any diagnosis level compared to primary diagnosis only. Again, 85% of these diagnoses occurred in the first episode of a spell.

Appendix Table 7: AKI counts since round 1 extraction for patients extracted from GP practices in England and admitted to hospitals in England only (elective and emergency admissions)

Episode	Diagnosis level	Total events in dataset	Number of patients with event
First episode of spell	primary diagnosis only	2,854	2,575
Any episode of spell	primary diagnosis only	3,375	3,024
First episode of spell	any diagnosis level	18,624	14,952
Any episode of spell	any diagnosis level	21,859	17,242

**no apparent issue of incorrect AKI diagnosis for CKD patients receiving dialysis; "Any episode of spell" refers to any episode in a spell and includes the first episode*

PEDW Wales

Again, there is a substantial (6-fold) increase in the number of patients with an event and the total number of events in the APC Wales dataset when AKI is taken at any diagnosis level compared with AKI as a primary diagnosis only. There were 10,444 AKI events, covering 7,993 patients, diagnosed as any episode of a spell with 86% of these events diagnosed in the first episode of a spell (Appendix Table 8).

Appendix Table 8: AKI counts since round 1 extraction for patients extracted from GP practices in Wales and admitted to hospitals in Wales only (elective and emergency admissions)

Episode	Diagnosis level	Total events in dataset	Number of patients with event
First episode of spell	primary diagnosis only	1,601	1,408
Any episode of spell	primary diagnosis only	1,877	1,641
First episode of spell	any diagnosis level	8,932	6,960
Any episode of spell	any diagnosis level	10,444	7,993

CV Events

Stoke, myocardial infarctions, heart failure, peripheral artery disease and abdominal aortic aneurysm were used to describe CV events during hospitalisation. Similar to AKI diagnoses, the frequency of CV events depends on whether the diagnosis was only at the primary level or at any level and on whether the event was the first episode of a spell or any episode.

HES England

The number of CV events increases marginally by between 2%-10% when including CV diagnoses in any episode compared to in the first episode only (Appendix Table 9). As for AKI events, there is an approximate 6-fold increase in CV events when comparing diagnoses at any level to primary diagnoses only.

Appendix Table 9: CV counts since round 1 extraction for patients extracted from GP practices in England and admitted to hospitals in England only (elective and emergency admissions)

Episode	Diagnosis level	Total events in dataset	Number of patients with event
First episode of spell	primary diagnosis only	13,502	10,071
Any episode of spell	primary diagnosis only	14,810	11,022
First episode of spell	any diagnosis level	80,177	37,878
Any episode of spell	any diagnosis level	81,386	38,707

**includes heart failure, ischaemic heart disease, stroke/TIA, PAD/AAA*

PEDW Wales

Similar to CV counts from GP practices in England, the number of CV events increases marginally 2%-10% when including CV diagnoses in any episode compared to in the first episode only (Appendix Table 10). There is an approximate 5-fold increase in events when comparing diagnoses at any level to primary diagnoses only.

Appendix Table 10: CV counts since round 1 extraction for patients extracted from GP practices in Wales and admitted to hospitals in Wales only (elective and emergency admissions)

Episode	Diagnosis level	Total events in dataset	Number of patients with event
First episode of spell	primary diagnosis only	6,935	5,125
Any episode of spell	primary diagnosis only	7,625	5,571
First episode of spell	any diagnosis level	36,355	18,722
Any episode of spell	any diagnosis level	37,105	19,106

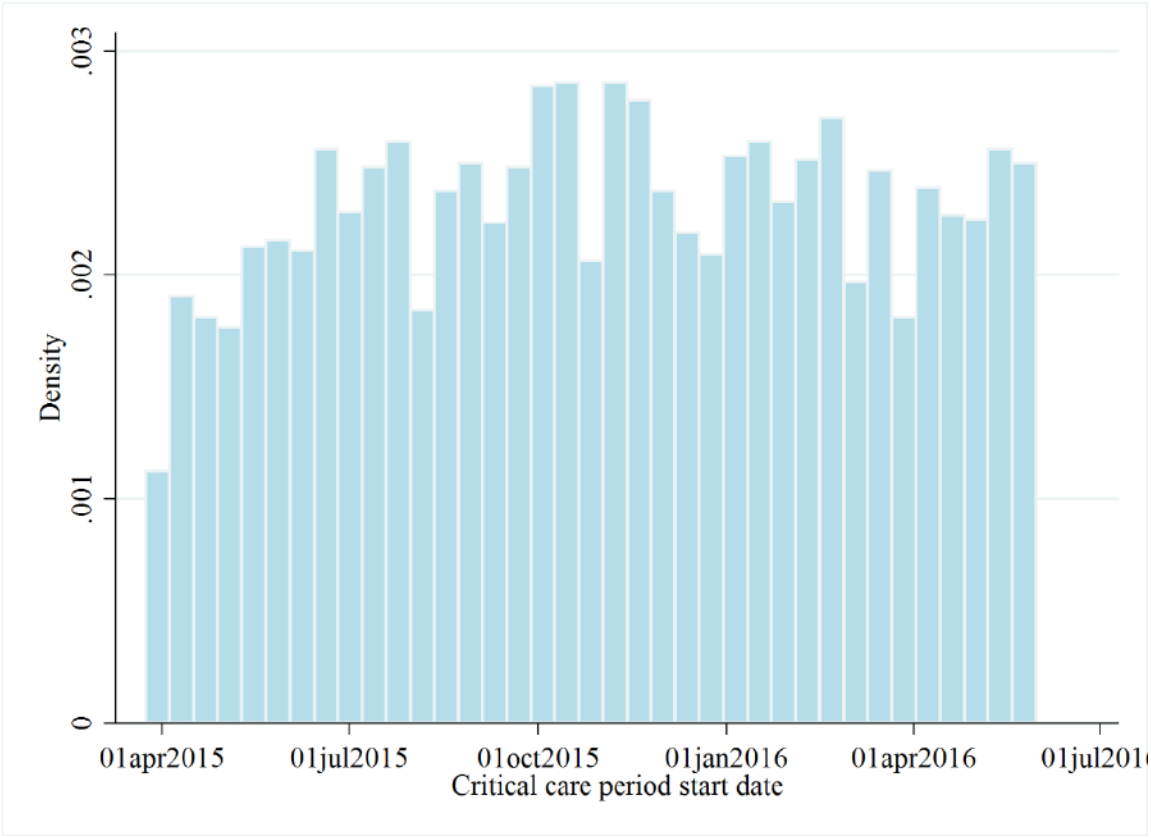
**includes heart failure, ischaemic heart disease, stroke/TIA, PAD/AAA*

ICU admissions

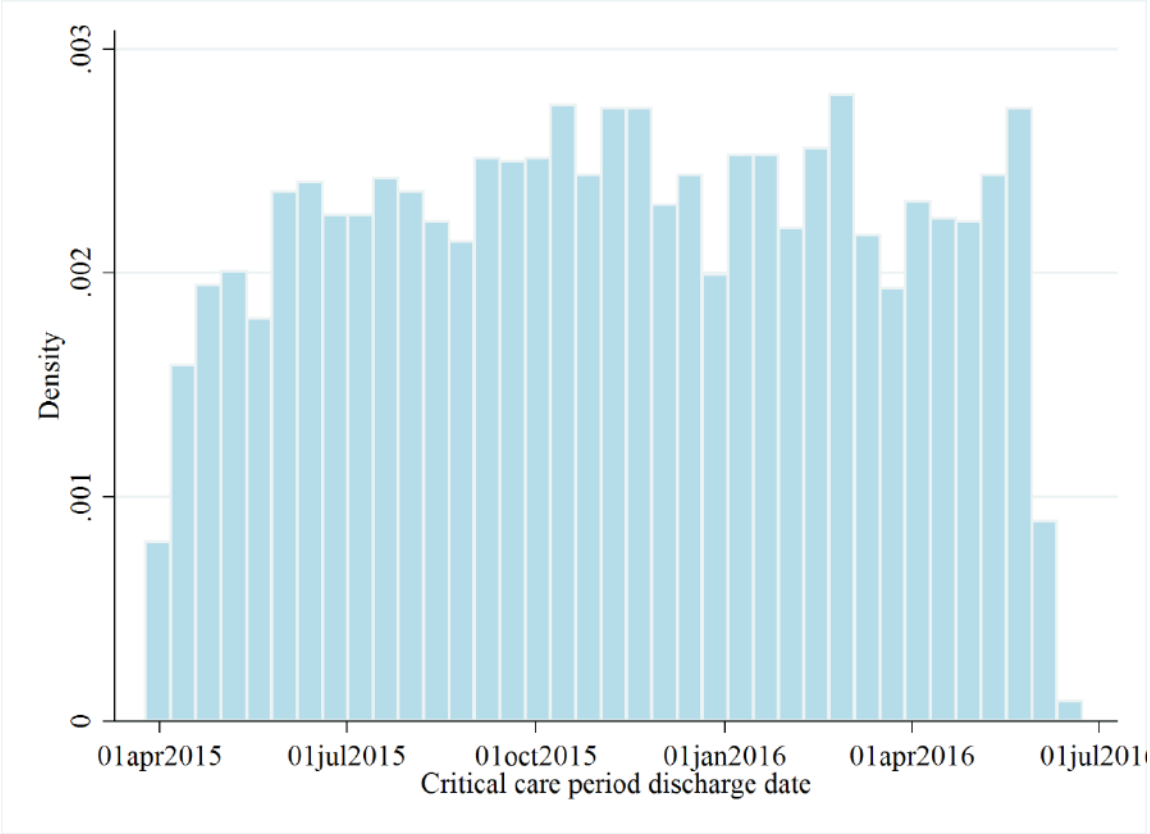
HES England

Admission dates ranged from 2 March 2012 to 25 May 2016 (Appendix Figure 4) and discharge dates ranged from 1 April 2012 to 30 June 2016 (Appendix Figure 5). ICU admission counts are from post-round 1 of data extraction. The range of time spent in ICU was between 0 days and 4.6 months, the mean was 3.7 days, and the median was 2 days. ICU records were combined in some cases where patients were shuffled in and out of ICUS, in order to accurately identify unique admissions and duration of stay. There were 172 duplicate ICU admissions, admissions that occurred on the same day, and there were no dates missing. ICU admission start and discharge dates are fairly uniform until about January 2014, when the number of recorded dates increases and becomes uniform again. In the last 6 months of follow-up, there appears to be a minor drop in ICU admissions.

Appendix Figure 4: ICU admission dates for all records in HES dataset (duplicates removed)



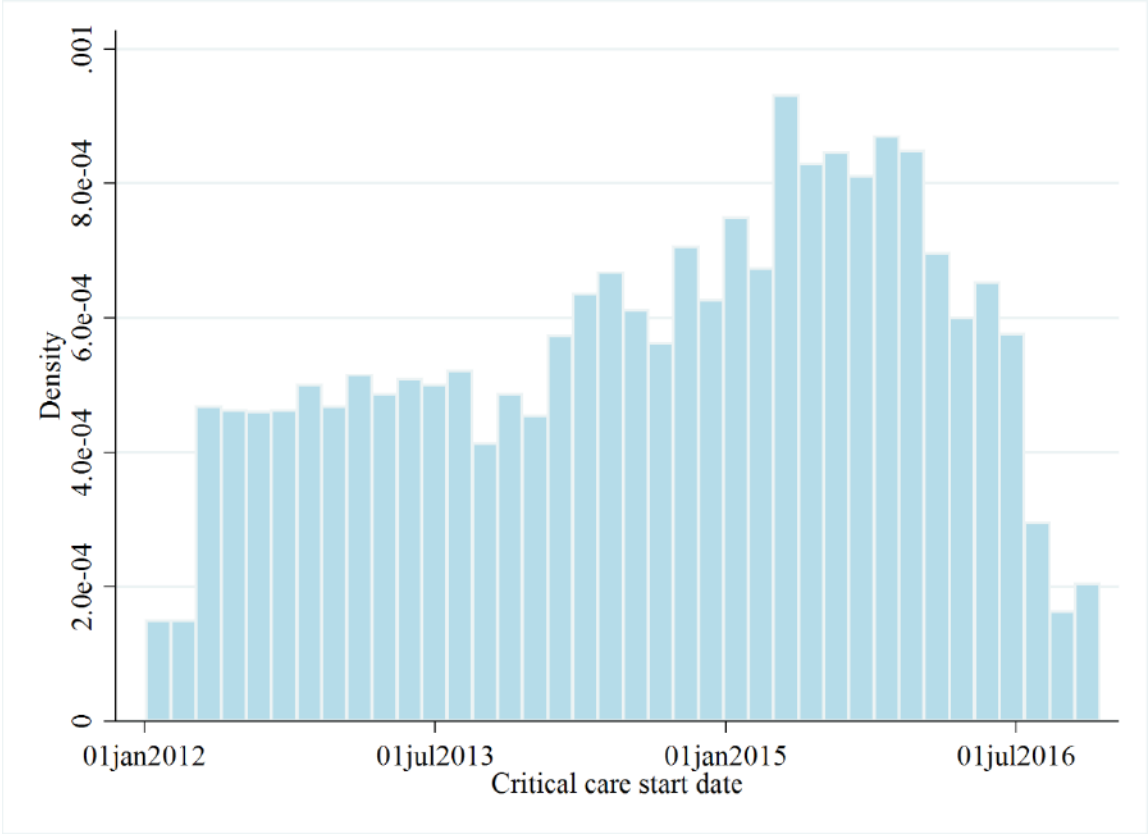
Appendix Figure 5: ICU admission discharge dates for all records in HES dataset (duplicates removed)



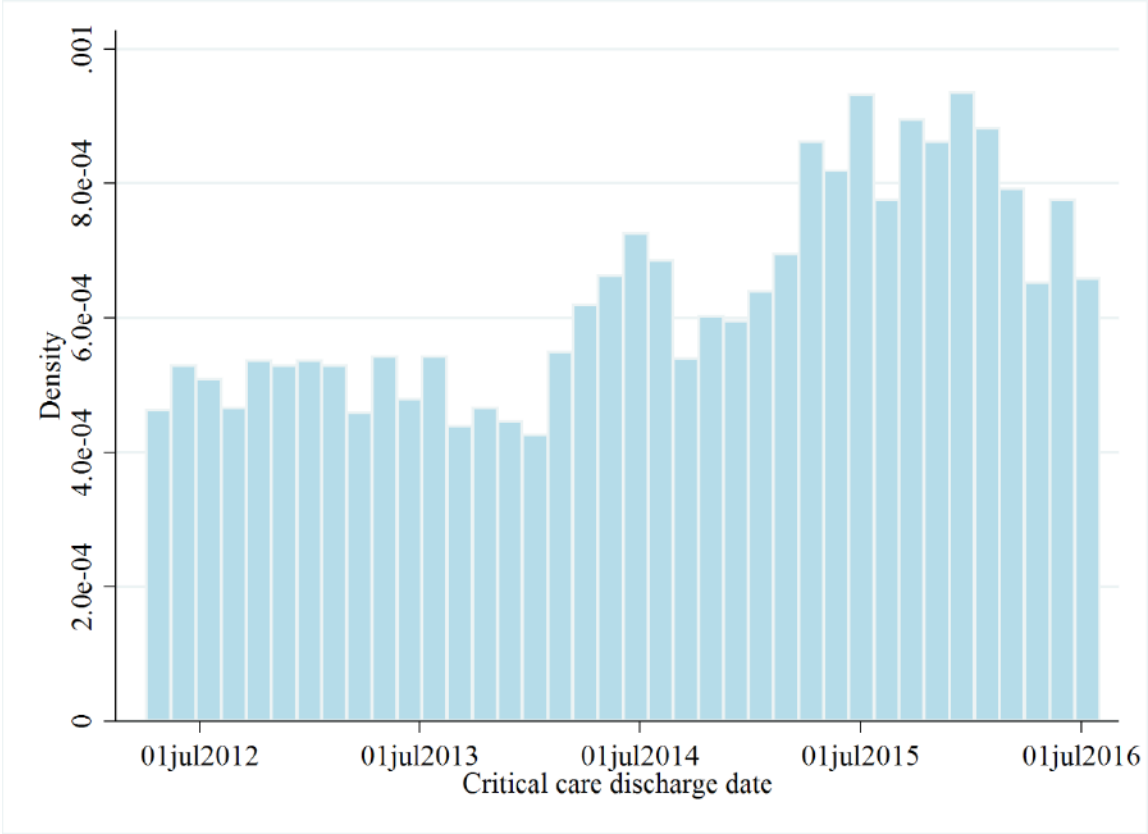
PEDW Wales

Start dates (Appendix Figure 6) for ICU admissions in the PEDW dataset ranged from 4 January 2012 to 7 December 2016 and discharge dates (Appendix Figure 7) ranged from 4 April 2012 to 2 August 2016. All admission counts are from post-round 1 data extraction. There were 2,203 ICU admissions in 2,007 patients in the PEDW dataset. 10 duplicate patient IDs were dropped and there were no start dates, but 9 discharge dates, missing. There is an issue in this dataset in that 24% of discharge dates occur prior to start dates. There is much more variation in the start and discharge dates in the PEDW dataset. Here, there is a substantial drop in ICU admissions in the last 6 months of follow-up. This may indicate that the quality of the data changed throughout the follow-up period.

Appendix Figure 6: ICU admission dates for all records in Welsh dataset (duplicates removed)



Appendix Figure 7: ICU admission discharge dates for all records in HES dataset (duplicates removed)



We found major data quality issues with the Welsh ICU admission data; a large number of discharge dates occur prior to start dates and data was missing for periods of time from some Welsh hospitals. Because of this, we will report results for ICU admissions only for English patients who end up in an England hospital. This means that rates will be based on following-up patients in England only and any overlap between England and Wales may not be captured. Thus, ICU admission rates for England may be underestimated due to excluding English patients ending up in Welsh hospitals.

According to the Protocol for Cross-Border Healthcare Services, patients resident in 5 areas of Wales bordering England and 8 CCGs bordering Wales who are registered with a GP on the other side of the border is the responsibility of that GP[16] and local commissioning for planning their healthcare is with the CCG or LHB of that GP16. However, among the general population in England, the Health & Social Care Information Centre (HSCIC) found nearly all critical care records (95%) in the HES dataset for the for the year April 2012-March 2013 had the source as the same NHS hospital site as the critical care unit[17]. Therefore, by excluding England patients who end up in Wales ICUs, our rates are likely to only be a slight underestimate.

For the HES provided data, only rows identified as "best match" were considered. "Best match" is a flag used to limit the data in instances where there is more than one row per critical care period. There were 6,966 HES critical care records in 5,546 patients with a start date post round 1 data extraction. There were no missing patient IDs, SUS record IDs, start dates or discharge dates in the dataset. The precise start time was missing for 16% of records but precise discharge time was not missing for any records. There were 757 duplicates (11% of all records) identified using the patient ID and SUS record ID and there were 172 duplicates (2% of all records) identified for patient ID on the same date. Any ICU admissions with a start date occurring within 48 hours of the previous start date are also considered duplicates. This is likely to be caused by patients being shuffled between various ICU departments. Duplicates ICU admissions were dropped from analyses.

There were low ICU admission counts and number of patient years in the last two months of data extraction. This is likely to be due to incomplete reporting by practices in the audit. For analysis if ICU admission rates, data will be cut-off at start dates from 31 May 2016 due to the drop-off observed in data collection. After dropping duplicate ICU admissions and restricting follow-up time, there were 5,813 records remaining in 5,275 patients (Appendix Table 11).

Appendix Table 11: Tabulation of the number of records per patient in HES

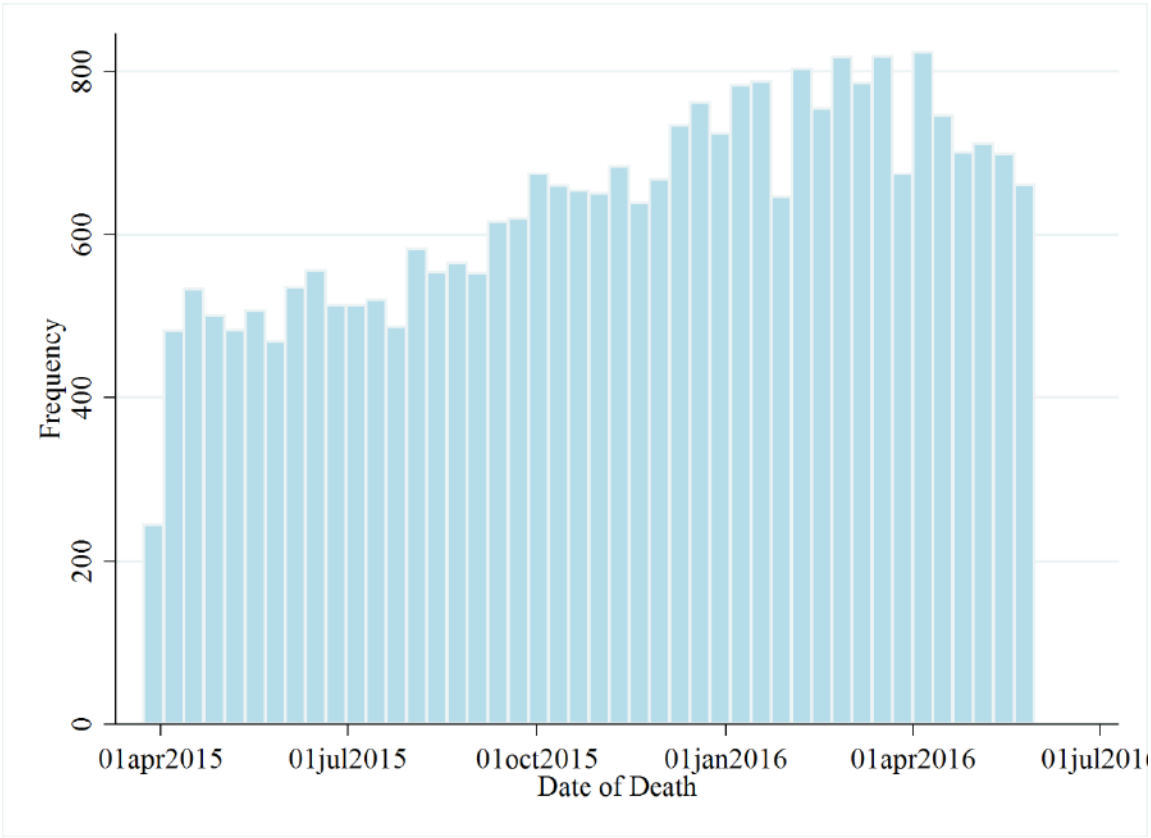
Number of records per patient	Frequency of Patients	Percent
1	4,841	91.80%
2	367	7.00%
3	47	0.90%
4	14	0.30%
5	5	0.10%
16	<5	0.02%
TOTAL	5,275	100%

Mortality data

A total of 499,562 patients were followed-up for deaths for a median duration of 16 months. 31,889 of patients followed-up for death died (6.4% of all patients followed-up).

Mortality data extraction for England ends two months prior to extraction for Wales (Appendix Figure 8). Because of this, there is a marked decrease in deaths after July 2016.

Appendix Figure 8: Dates of death post round 1 extraction



Of the total patients followed-up for deaths, 31,889 died (6.4% of all patients followed-up). There were 1,356 deaths in the ONS England dataset that matched GP records from Wales and 36 deaths in the ONS Wales dataset that matched GP records from England (Appendix Table 12).

Appendix Table 12: Death counts by country post round 1 extraction

Country	ONS England Deaths	ONS Wales Deaths	TOTALS
England GP	20,507	36	20,543
Wales GP	1,356	9,990	11,346
TOTALS	21,863	10,026	31,889

Follow-up duration

The dates of deaths for mortality data from England ranged between 16 May 1998 and 18 July 2016 while death dates for Wales mortality data ranged between 27 October 1999 and 19 September 2016. Notice that mortality follow-up ended after admissions follow-up and so duration of follow-up time for deaths will be slightly longer. When mortality follow-up time was restricted to between post round 1 extraction date to the end of mortality follow-up, 3,442 deaths (9.7% of total deaths) were excluded. A total of 499,562 patients were followed-up for a median duration of 16 months.

Referral data

The Department of Health mandated in 2008 that patients must not wait longer than 18 weeks for treatment from the date of the original referred[14]. From October 2015, this performance is measured solely on the incomplete pathway which states that "92% of patients should wait no longer than 18 weeks from referral to first definitive treatment"[14]. In people with biochemical CKD stages 3-5, 92% have a corresponding outpatient appointment in the HES dataset within 18 weeks of being coded for referral by their GP.

For patients with a GP nephrology referral code that corresponds to an HES outpatient appointment outside the recommended 18 weeks, the majority had an outpatient appointment prior to the corresponding referral code. It's possible that some of these referrals represent previous referrals in which the patient has been referred multiple times for continuation of care. According to the 18 week RTT waiting time rules, a patient who is referred for a continuation of care should not have a clock started and should be recorded as having had treatment previously[14].

We only looked at the cohort of patient with referral codes. It is well known that the coded referral data is an underrepresentation of the entirety of referrals. In practice, most of the relevant information on referrals in clinical care is in free text rather than as a code. In the UK, many GPs use a 'summary' code, a keyword representing the main body of consultation, and then add text under the code in the form of a referral letter [18]. The purpose of looking at GP nephrology referral data was to have a general data validation exercise for future data linkage. It is useful for future research to know that the HES dataset reflects GP nephrology referrals because the vast majority had matching HES outpatient nephrology appointment dates within the 18-week timeframe. Therefore, it is possible to use HES outpatient data as a proxy for GP referrals, without having to develop free text algorithms to detect referrals.

All AKI events occurring after admission to hospital

By CKD Audit Group

When the patient population was split into those with coded and uncoded CKD stages 3-5 and those with other renal codes the crude rate of all AKI events occurring during hospitalisation was 3.28 per 100pys (95% CI 8.15-8.41) and 2.43 per 100pys (95% CI 2.33-2.53), respectively (Appendix Table 13). This means, for example, that for every 100 patients with CKD stages 3-5, there will be approximately 3 AKI events occurring during hospitalisation.

Appendix Table 13: All first AKI events during hospitalisation: counts and rates, by audit group

Audit group	Event count	Patient years	Rate per 100pys	95%CI	Age-sex standardised rate per 100py*
Pts with coded CKD stages 3-5	19,531	225,154	8.67	8.52-8.83	7.81
Pts with uncoded CKD stages 3-5	5,456	76,601	7.12	6.89-7.37	7.13
Pts with other renal codes	3,431	141,076	2.43	2.33-2.54	3.75

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5 as well as people with other renal codes)*

By CKD Stage and Coding Status

All first AKI events during hospitalisation increase with increasing CKD stage (Appendix Table 14). This means that patients with more reduced kidney function have more AKI events during hospitalisation than those with less reduced kidney function. There also seems to be an association with the rate of all first AKI events during hospitalisation and whether a patient has been coded by their GP for CKD. As with AKI events at admissions, uncoded patients have a higher crude rate of all first AKI events during hospitalisation (except in CKD stage 3) and uncoded patients have the highest rate. Again, the trend remained after taking into account differences in the age and sex between coding groups.

Again, there were very few events in later stages of CKD which is likely to be due to high variability in the coding of these patients and to disagreement about whether an AKI event is possible in a patient with CKD stage 5. These data do not take into account factors such as comorbidities that might influence differences in rates between coded and uncoded patients. Still, it is clear that the rates of all first AKI events during hospitalisation increase with progressing disease.

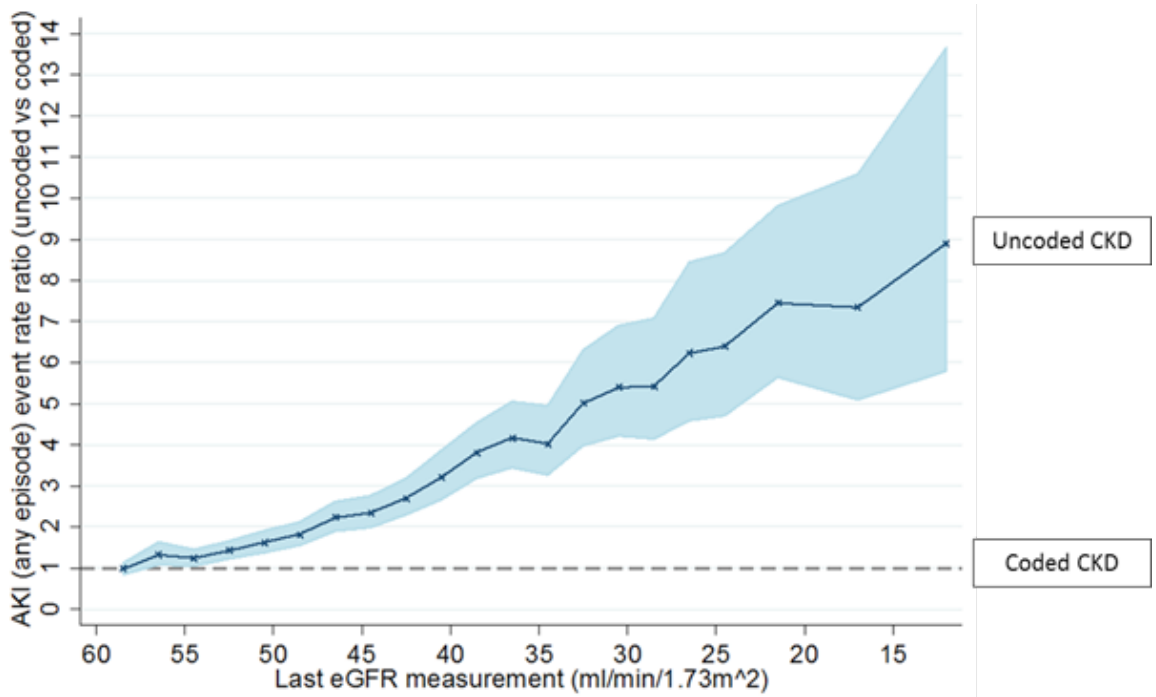
Appendix Table 14: All first AKI events during hospitalisation: counts and rates in people with coded and uncoded CKD stages 3, 4, and 5 defined by last eGFR measurement and by whether patients were coded or uncoded

Coding group	CKD stage based on last eGFR measure	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py
Coded CKD	3	14,417	185,878	7.76	7.60-7.92	6.77
Uncoded CKD	3	4,359	76,580	5.69	5.48-5.91	5.49
Coded CKD	4	3,713	15,717	23.62	22.68-24.62	21.69
Uncoded CKD	4	294	1,178	24.95	21.54-29.07	26.19
Coded CKD	5	443	2,134	20.76	18.44-23.46	21.41
Uncoded CKD	5	24	125	19.21	12.48-31.05	22.59

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Appendix Figure 9 shows the rate ratios of all first AKI events during hospitalisation in patients with uncoded CKD stages 3-5 versus patients with coded CKD stages 3-5, taking into account differences in age, sex, diabetes, hypertension, and CV disease between the populations. As we saw with AKI events at admission, the rate ratios are approximately the same (rate ratio=1.0) until about eGFR 60 ml/min/1.73m^2, and then increases sharply as eGFR declines. Then there is a clear increase in the rate ratios as eGFR declines (Appendix Table 15). This means that as kidney function declines, patients are not coded for CKD by their GPs are increasingly more likely to have an AKI event during hospitalisation compared with patients who are coded for CKD. For example, at eGFR 45, 35, 25 and 15 ml/min/1.73m^2, patients who are not coded for CKD are two times, four times, seven times, and ten times more likely to have an AKI event during hospitalisation than patients who are coded for CKD and in the same stage of kidney disease.

Appendix Figure 9: Comparison of all first AKI events during hospitalisation (using rate ratios) between uncoded and coded patients with biochemical CKD stages 3-5



Appendix Table 15: All first AKI events during hospitalisation rate ratios comparing rates in people with uncoded CKD stages 3-5 to people with coded CKD stages 3-5; adjusted for age, sex, diabetes, hypertension and CV diseases

Last GFR	Rate ratio (uncoded vs coded)	95% CI
58-59	0.98	0.85-1.14
56-57	1.33	1.08-1.63
54-55	1.24	1.06-1.46
52-53	1.43	1.23-1.67
50-51	1.63	1.39-1.91
48-49	1.82	1.56-2.13
46-47	2.23	1.90-2.62
44-45	2.35	1.99-2.77
42-43	2.7	2.30-3.18
40-41	3.22	2.68-3.86
38-39	3.81	3.20-4.54
36-37	4.17	3.45-5.05
34-35	4.03	3.27-4.95
32-33	5.01	3.98-6.30
30-31	5.4	4.22-6.90
28-29	5.42	4.15-7.08
26-27	6.23	4.59-8.45
24-25	6.39	4.71-8.67
20-23	7.45	5.65-9.82
15-19	7.35	5.10-10.58
0-14	8.9	5.80-13.67

By Country

In both patient populations, rates for all first AKI events during hospitalisation are similar between countries, although slightly increased in England (Appendix Tables 16 & 17). Age/sex standardised rates were very close to the crude, meaning any comparisons made between countries is not affected by the age or sex of the patient population.

Appendix Table 16: All first AKI events during hospitalisation: counts and rates by country, in people with coded and uncoded CKD stages 3-5

Country	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	16,904	199,116	8.49	8.33-8.65	8.61
Wales	8,083	102,639	7.88	7.66-8.10	8.01

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Appendix Table 17: Counts and rates of all first AKI events during hospitalisation by country, in people with other renal codes

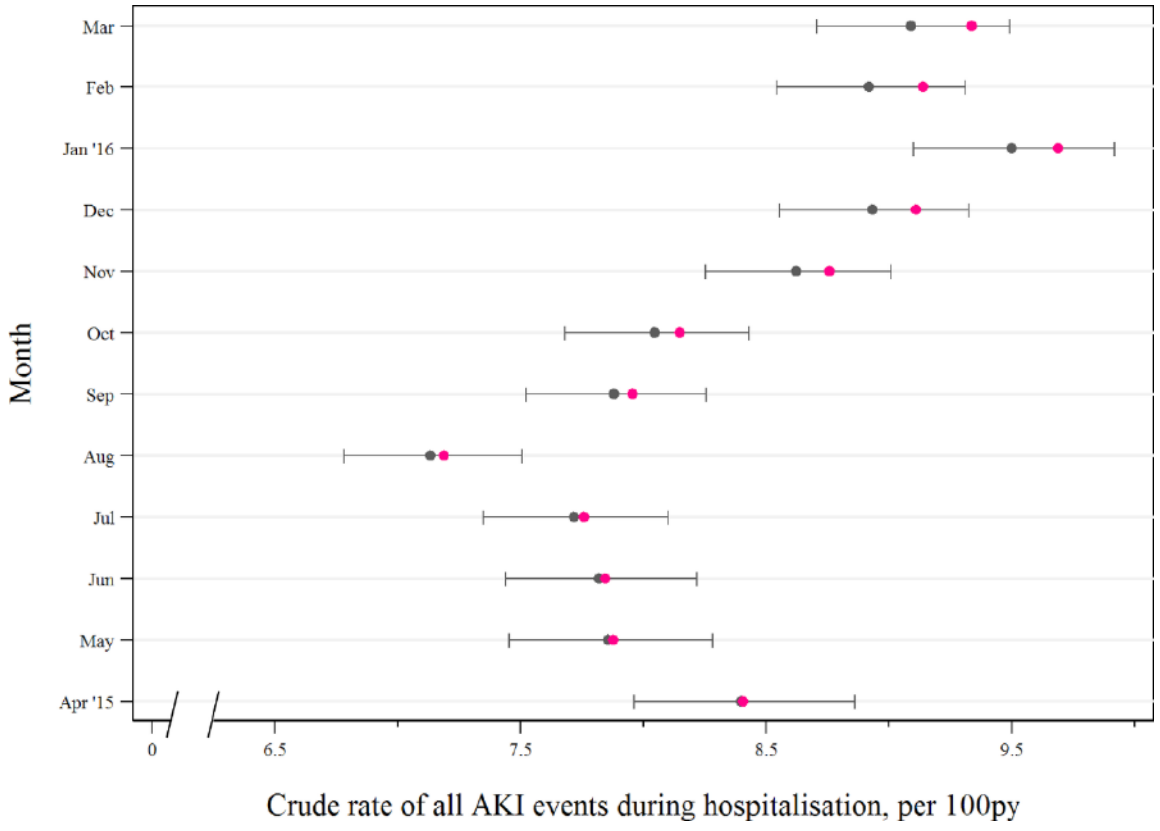
Country	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	2,327	89,834	2.59	2.46-2.72	2.66
Wales	1,104	51,242	2.15	2.01-2.32	2.15

**the standard age-sex population distribution reflects the population being reported on (people with other renal codes)*

By Calendar Month

All first AKI events during hospitalisation seem to vary by season. As with rates of AKI events at admission, the rates of all first AKI events during hospitalisation are highest in winter months and lowest in summer months (Appendix Figure 10, Appendix Table 18 & 19). Standardising by age and sex, seems to slightly increase the magnitude of the difference in rates between calendar months.

Appendix Figure 10: Rates of all first AKI events throughout hospitalisation by month in people with coded and uncoded CKD stages 3-5, with pink dots representing age- and sex-standardised rates; not adjusted for comorbidity*



**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

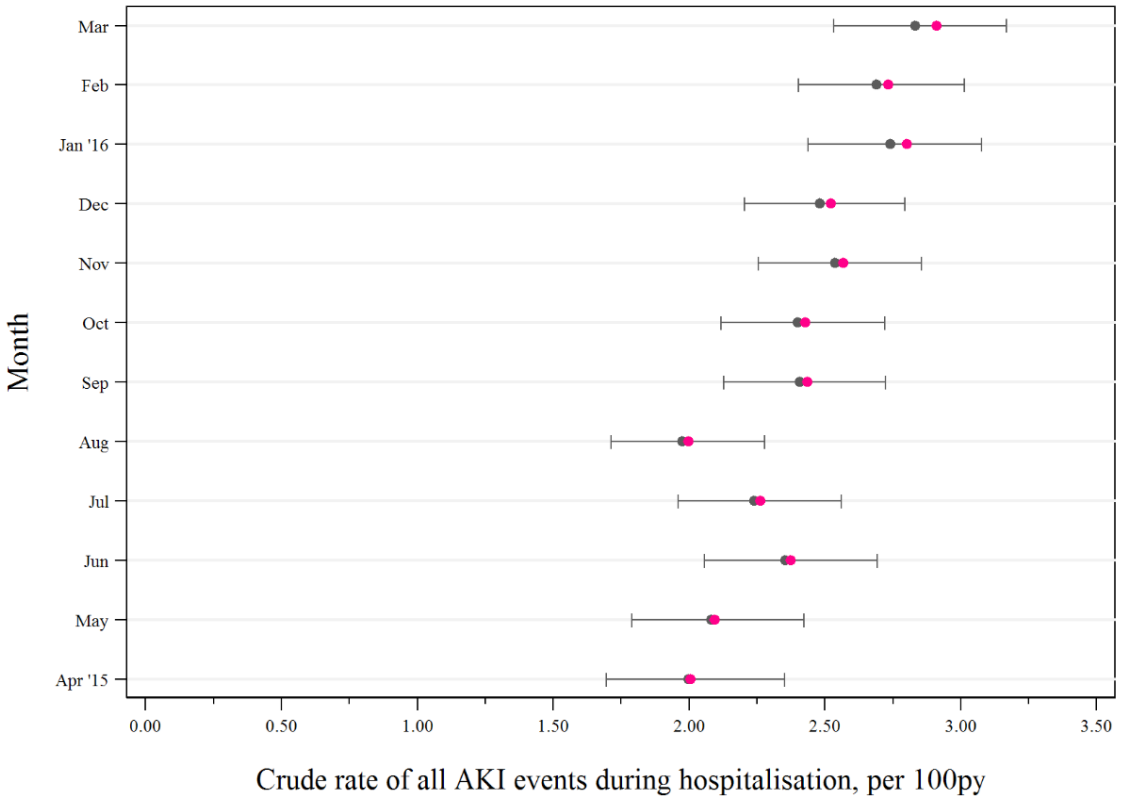
Appendix Table 18: Counts and rates of all first AKI events throughout hospitalisation by calendar month, in people with coded and uncoded CKD stages 3-5

Calendar month	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March	170	1,937	8.77	7.55-10.20	8.78
4 - April	1,340	15,957	8.40	7.96-8.86	8.41
5 - May	1,383	17,604	7.86	7.45-8.28	7.88
6 - June	1,552	19,852	7.82	7.44-8.22	7.84
7 - July	1,621	21,009	7.72	7.35-8.10	7.76
8 - August	1,493	20,931	7.13	6.78-7.50	7.19
9 - September	1,779	22,579	7.88	7.52-8.25	7.96
10 - October	1,776	22,074	8.05	7.68-8.43	8.15
11 - November	1,994	23,129	8.62	8.25-9.01	8.76
12 - December	2,067	23,142	8.93	8.56-9.33	9.11
13 - January 2016	2,069	21,784	9.50	9.10-9.92	9.69
14 - February	2,078	23,304	8.92	8.54-9.31	9.14
15 - March	2,057	22,631	9.09	8.71-9.49	9.34
16 - April	1,866	23,351	7.99	7.64-8.36	8.17
17 - May	1,640	22,678	7.23	6.89-7.59	7.42

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

***grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Figure 11: Rates of all first AKI events during hospitalisation by month in people with other renal codes, with pink dots representing age/sex standardised rates; not adjusted for comorbidity*



the standardised age-sex population distribution used reflects the population being reported on (people with other renal codes)

Appendix Table 19: All first AKI events throughout hospitalisation counts and rates by calendar month, in people with other renal codes

Calendar month	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March	18	835	2.16	1.36-3.42	2.21
4 - April	144	7,209	2.00	1.70-2.35	2.00
5 - May	167	8,020	2.08	1.79-2.42	2.10
6 - June	212	9,006	2.35	2.06-2.69	2.38
7 - July	215	9,594	2.24	1.96-2.56	2.26
8 - August	190	9,616	1.98	1.71-2.28	2.00
9 - September	251	10,428	2.41	2.13-2.72	2.44
10 - October	246	10,250	2.40	2.12-2.72	2.43
11 - November	276	10,875	2.54	2.26-2.86	2.57
12 - December	272	10,963	2.48	2.20-2.79	2.52
13 - January 2016	284	10,365	2.74	2.44-3.08	2.80
14 - February	299	11,114	2.69	2.40-3.01	2.73
15 - March	306	10,806	2.83	2.53-3.17	2.91
16 - April	283	11,196	2.53	2.25-2.84	2.58
17 - May	256	10,893	2.35	2.08-2.66	2.43

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

***grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Code Definitions

ICD-10 codes have been chosen as follows:

Audit outcomes	ICD-10 codes
Emergency admissions	admimeth = 21-28
AKI	diagnosis code = N17
CV outcomes	heart failure/volume overload (I50, I11.0, I13, I97.1)
	acute and chronic ischaemic heart disease and its complications (I20-I25, I51.6)
	cerebrovascular disease/TIA (I60-I69, G45-G46)
	peripheral arterial disease (I79.0, I79.2, I73.8, I73.9, I74.3, I74.4, I74.5, I70.2)
	abdominal aortic aneurysm (I71, I74.0)
Referrals	tretspef = 361 (nephrology)

Data Handling Conventions

Miscoded patients

Patients were considered to be miscoded if their last two eGFR measurements were >60 ml/min/1.73m^2 and they were given a code for CKD stage 3-5 in practice register or if they had a single eGFR >60 ml/min/1.73m^2, did not have a second eGFR measurement, and were given a code for CKD stage 3-5 in practice register. Miscoded patients were dropped from analyses.

Duplicate data

Detailed consideration of plausible duplicates has been done in this report. We considered the following to be duplicates: i) admissions occurring on the same day with the same diagnosis code (identified using the variable "first episode in spell", indicating patient was admitted twice), ii) elective admissions following an emergency admission (assumed planned), and iii) patients transferring from another hospital. These duplicate admissions were counted as a single admission. Admissions occurring on the same day but with differing diagnoses were retained.

We considered the following to be duplicate ICU admissions: i) records with the same patient ID, critical care start date and critical discharge date; ii) overlapping records; iii) records with a start date on the same day as the previous discharge date; and iv) records with a start date on the day following a previous discharge date. These duplicate ICU admissions were counted as a single admission and retained. Any records with a start date within 48 hours of the previous start date are considered duplicated and are dropped from analyses of ICU admissions.

Age/sex standardisation

Direct standardisation was used to derive age/sex standardised rates. 5-year age-bands were used except in younger patients where groups were wider to account for lower event counts in these patients. Rates were computed within age/sex strata and then weighted according to the population distribution of the population being standardised to.

For each table in this report, rates are standardised to the population being reported on in that table. For example, rates by audit group are standardised to the population of all patients followed-up in groups 1, 2, and 3. Conversely, rates by country, calendar month, and CKD stage are reported separately for the biochemical CKD stages 3-5 population (groups 1 & 2) and other renal codes population (group 3). This means that age/sex standardised rates can be compared within tables, but can only be compared across tables if the population is the same between those tables.

Follow-up time

In the last two months of data extraction there were low event rates (for all outcome events) which is likely to be due to incomplete reporting by practices in the audit. However, excluding these data may diminish statistical power. Anyone wishing to use HES and NWIS datasets for retrospective data should take this into account.

Appendix Table 20: Most common renal codes for patients in group 3 (other renal codes)

Other renal code	Frequency	Percent
CKD QOF code stage 2	38,860	27.30
ACR>3/PCR>15 in last year	36,215	25.44
Calculus of kidney code	13,624	9.56
Microalbuminuria code	8,769	6.16
CKD QOF code stage 1	7,138	5.01
Proteinuria code (4678)	4,596	3.23
Calculus of ureter code	3,578	2.51
Proteinuria code (R110)	2,901	2.04
Hydronephrosis code (K11)	2,849	2.00
Acquired cyst of kidney code	2,544	1.79
Type 2 DM + microalbuminuria code	2,160	1.52
Renal impairment code	3,578	2.51
Renal calculus NOS code	2,901	2.04
Bladder calculus code	1,249	0.88
Nephritis/nephrosis/nephrotic syndrome code	972	0.68

Appendix Table 21: Emergency admission counts and rates by audit group

Audit group	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
Pts with coded CKD stages 3-5	88,082	225,207	39.11	38.73-39.50	35.87
Pts with uncoded CKD stages 3-5	26,058	76,614	34.01	33.41-34.63	33.55
Pts with other renal codes	32,983	141,085	23.38	22.98-23.78	31.84

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5 as well as people with other renal codes)*

Appendix Table 22: Emergency admission rate ratios comparing rates in people with uncoded CKD stages 3-5 to people with coded CKD stages 3-5; adjusted for age, sex, diabetes, hypertension and CV diseases

Last GFR	Rate ratio (uncoded vs coded)	95% CI
58-59	0.92	0.87-0.98
56-57	1.01	0.92-1.11
54-55	1.04	0.96-1.11
52-53	1.12	1.04-1.2
50-51	1.17	1.09-1.26
48-49	1.33	1.24-1.44
46-47	1.36	1.25-1.47
44-45	1.49	1.37-1.62
42-43	1.54	1.41-1.68
40-41	1.72	1.56-1.89
38-39	1.85	1.68-2.05
36-37	1.95	1.74-2.18
34-35	1.97	1.75-2.22
32-33	1.95	1.71-2.23
30-31	2.18	1.85-2.56
28-29	2.22	1.9-2.6
26-27	2.35	1.93-2.86
24-25	2.55	2.05-3.17
20-23	2.74	2.29-3.27
15-19	2.81	2.21-3.59
Oct-14	4.33	3.28-5.73

Appendix Table 23: Emergency admission counts and rates by country, in people with other renal codes

Country	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	20,717	89,840	23.06	22.55-23.58	23.32
Wales	12,266	51,245	23.94	23.32-24.57	24.06

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

Appendix Table 24: Emergency admission counts and rates by calendar month, in people with coded and uncoded CKD stages 3-5

Calendar month	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	780	1,938	40.25	37.52-43.18	40.31
4 - April	6,185	15,960	38.75	37.80-39.73	38.77
5 - May	6,360	17,608	36.12	35.24-37.02	36.19
6 - June	7,287	19,856	36.70	35.87-37.55	36.81
7 - July	7,608	21,013	36.21	35.40-37.03	36.39
8 - August	7,420	20,935	35.44	34.65-36.26	35.66
9 - September	8,399	22,583	37.19	36.40-38.00	37.50
10 - October	8,154	22,079	36.93	36.14-37.74	37.33
11 - November	8,649	23,134	37.39	36.61-38.18	37.88
12 - December	8,970	23,147	38.75	37.96-39.56	39.34
13 - January 2016	8,721	21,789	40.02	39.19-40.87	40.71
14 - February	8,966	23,310	38.46	37.68-39.27	39.20
15 - March	8,904	22,636	39.34	38.53-40.16	40.20
16 - April	8,671	23,356	37.13	36.35-37.92	37.94
17 - May	8,731	22,682	38.49	37.69-39.31	39.39

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

***grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 25: Emergency admission counts and rates by calendar month, in people with other renal codes

Calendar month	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	207	835	24.79	21.63-28.40	24.89
4 - April	1,669	7,210	23.15	22.06-24.29	23.18
5 - May	1,772	8,020	22.09	21.09-23.15	22.16
6 - June	2,118	9,007	23.52	22.53-24.54	23.63
7 - July	2,194	9,595	22.87	21.93-23.84	22.98
8 - August	2,181	9,617	22.68	21.75-23.65	22.82
9 - September	2,498	10,429	23.95	23.03-24.91	24.09
10 - October	2,391	10,251	23.33	22.41-24.28	23.51
11 - November	2,322	10,875	21.35	20.50-22.24	21.52
12 - December	2,560	10,964	23.35	22.46-24.27	23.59
13 - January 2016	2,420	10,366	23.35	22.43-24.30	23.61
14 - February	2,640	11,115	23.75	22.86-24.67	24.07
15 - March	2,637	10,807	24.40	23.49-25.35	24.78
16 - April	2,614	11,197	23.35	22.47-24.26	23.72
17 - May	2,631	10,894	24.15	23.25-25.09	24.56

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

***grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 26: Emergency admission counts and rates by CCG, in people with coded and uncoded CKD stages 3-5 sorted by frequency of patient-years

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
1	11,097	29,444	37.69	36.70-38.71	37.85
2	6,243	18,916	33.00	31.89-34.17	33.96
6	5,363	15,105	35.50	34.17-36.90	36.07
4	6,484	15,017	43.18	41.72-44.70	43.71
90	6,341	14,977	42.34	40.71-44.05	44.45
45	3,507	11,034	31.78	30.32-33.34	31.24
3	4,155	10,765	38.60	36.97-40.32	41.00
12	3,911	10,633	36.78	35.12-38.54	35.61
7	3,851	9,873	39.01	37.35-40.76	38.32
115	2,808	7,753	36.22	34.34-38.23	36.76
93	2,908	7,670	37.91	35.87-40.10	37.61
88	2,846	7,176	39.66	37.45-42.03	39.61
63	2,537	7,118	35.64	33.71-37.72	37.52
35	2,160	6,362	33.95	32.00-36.06	34.71
94	2,478	6,190	40.03	37.68-42.57	38.82
10	2,056	5,421	37.92	35.57-40.47	41.49
121	2,359	5,109	46.17	43.51-49.04	47.72
61	1,488	4,635	32.10	29.86-34.56	34.61
29	1,700	4,602	36.94	34.30-39.83	37.94
125	1,190	4,144	28.72	26.48-31.20	28.75
44	1,403	3,778	37.14	34.48-40.06	34.86
5	1,264	3,540	35.71	33.07-38.62	34.64
72	1,208	3,525	34.27	31.47-37.39	35.52
32	1,012	3,500	28.92	26.54-31.57	30.07
76	1,338	3,307	40.46	37.35-43.91	40.09

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
16	1,348	3,296	40.90	37.78-44.35	39.55
123	1,060	3,258	32.53	29.88-35.49	33.51
52	1,186	3,124	37.96	35.16-41.04	37.78
36	1,109	2,670	41.54	37.91-45.61	40.49
91	683	2,601	26.26	23.75-29.10	27.02
111	988	2,418	40.86	37.38-44.76	42.61
54	1,298	2,330	55.70	51.21-60.69	56.61
89	889	2,320	38.32	34.75-42.37	36.49
66	780	2,132	36.58	33.09-40.55	37.40
46	1005	2,091	48.06	43.87-52.75	48.80
116	720	1,931	37.29	33.16-42.09	36.89
11	611	1,714	35.64	31.74-40.17	38.75
78	645	1,713	37.65	33.81-42.06	36.43
117	815	1,695	48.07	43.30-53.51	49.13
23	573	1,589	36.07	31.63-41.31	34.07
104	564	1,498	37.66	33.45-42.55	36.57
55	810	1,493	54.26	47.98-61.61	56.82
33	528	1,317	40.09	35.46-45.51	42.63
28	578	1,289	44.83	39.72-50.78	43.42
113	365	1,215	30.04	25.56-35.55	37.33
64	535	1,212	44.15	39.13-50.01	41.89
58	533	1,104	48.30	41.95-55.90	50.39
102	365	1,072	34.06	29.26-39.89	33.13
59	359	991	36.21	31.29-42.14	37.61
119	308	990	31.11	26.62-36.58	33.55
105	332	948	35.01	29.71-41.55	35.57
75	301	941	31.98	27.05-38.07	31.66

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
19	284	910	31.22	26.24-37.43	40.39
70	307	901	34.06	29.08-40.16	33.31
41	306	897	34.12	29.35-39.90	34.84
18	350	894	39.15	33.25-46.43	43.17
67	306	885	34.56	28.93-41.62	36.69
96	172	873	19.71	16.43-23.85	20.08
85	382	870	43.90	37.85-51.20	46.53
60	329	824	39.93	34.18-46.94	40.70
107	376	809	46.46	39.09-55.64	45.74
65	314	807	38.91	32.58-46.84	46.44
86	230	789	29.17	24.43-35.11	29.75
24	264	764	34.55	28.69-42.00	44.69
40	260	753	34.53	29.24-41.06	37.67
49	346	751	46.09	39.30-54.41	43.59
108	309	748	41.32	35.17-48.87	37.82
37	268	738	36.30	30.22-44.00	35.97
39	265	717	36.95	31.22-44.06	38.81
112	236	695	33.96	28.26-41.16	34.44
80	230	689	33.39	27.12-41.58	31.23
21	247	686	36.00	30.12-43.38	39.36
51	197	678	29.04	24.65-34.44	28.02
114	258	664	38.85	32.65-46.58	38.16
13	260	655	39.71	33.46-47.49	38.63
101	314	639	49.14	41.29-58.94	43.31
71	320	589	54.32	43.66-68.45	53.66
57	241	507	47.58	39.44-57.92	48.94
15	245	505	48.51	40.78-58.17	52.16

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
25	143	493	28.99	23.24-36.61	31.33
110	194	492	39.41	32.04-49.02	37.51
14	209	472	44.29	34.04-58.74	52.13
30	144	470	30.62	25.04-37.85	33.27
84	237	457	51.87	42.81-63.46	50.79
118	265	420	63.15	52.89-76.02	60.58
92	145	418	34.72	27.16-45.10	38.35
50	137	397	34.48	27.34-44.12	34.65
38	120	378	31.71	24.10-42.59	38.68
124	149	377	39.51	32.11-49.14	35.92
77	212	375	56.51	46.38-69.57	57.01
73	125	374	33.45	26.15-43.49	33.51
120	141	372	37.89	29.38-49.72	38.30
31	177	372	47.62	37.04-62.26	46.75
82	152	368	41.31	31.44-55.37	51.40
17	143	349	40.96	32.52-52.31	45.71
42	100	331	30.25	21.89-43.02	34.35
62	122	313	38.92	30.62-50.25	39.75
8	174	309	56.23	42.87-75.24	57.31
83	149	303	49.13	38.85-63.05	53.58
56	165	302	54.70	40.09-76.59	54.73
47	125	300	41.72	32.17-55.11	42.44
74	96	300	32.05	23.79-44.21	26.77
99	134	296	45.20	34.07-61.27	41.11
106	121	293	41.26	31.67-54.76	48.04
69	78	280	27.84	20.67-38.41	23.59
48	102	259	39.43	29.96-52.94	37.05

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
81	112	258	43.39	33.86-56.50	50.25
53	83	253	32.76	23.55-46.92	54.98
26	107	246	43.47	33.58-57.30	46.16
9	129	238	54.11	41.23-72.45	57.35
68	104	234	44.53	33.64-60.20	45.06
20	100	232	43.19	31.48-60.91	49.61
122	105	227	46.21	35.11-62.08	46.95
34	140	224	62.46	47.89-82.96	58.71
87	80	223	35.87	27.41-47.83	36.97
100	104	212	49.00	38.22-63.82	51.78
98	111	187	59.44	45.51-79.10	62.37
95	65	180	36.20	24.48-55.86	33.19
79	78	157	49.55	35.53-71.17	48.96
103	49	108	45.31	23.88-96.52	53.96
97	45	103	43.86	30.29-65.79	41.31
43	54	75	71.91	45.00-122.09	107.30
27	<5	8	47.98	17.51-181.94	8.46

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Appendix Table 27: Emergency admission counts and rates by CCG, in people with other renal codes sorted by frequency of patient-years

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
4	3,239	13,138	24.65	23.45-25.94	25.32
1	2,405	9,744	24.68	23.23-26.24	24.74
6	1,812	8,171	22.18	20.80-23.67	21.11
2	1,532	6,489	23.61	21.92-25.47	24.07
7	1,477	6,142	24.05	22.18-26.12	24.27
3	1,400	5,879	23.81	22.12-25.68	24.70
63	963	5,621	17.13	15.68-18.76	18.27
12	931	4,708	19.78	18.01-21.76	19.77
90	1,322	4,531	29.17	26.69-31.96	29.28
72	621	3,088	20.11	17.85-22.74	18.66
45	729	2,994	24.35	21.95-27.08	23.11
121	887	2,962	29.95	26.70-33.71	30.34
32	485	2,734	17.74	15.61-20.26	17.92
115	704	2,725	25.84	23.11-28.98	26.35
44	397	2,659	14.93	13.08-17.11	13.11
35	588	2,458	23.92	21.18-27.13	24.87
16	508	2,356	21.56	19.02-24.55	20.37
93	669	2,351	28.46	25.45-31.94	27.61
94	648	2,309	28.07	24.59-32.19	27.68
29	502	2,289	21.93	19.16-25.23	22.60
46	504	2,260	22.30	19.68-25.37	24.83
88	592	2,077	28.51	24.59-33.23	27.70
10	512	2,015	25.40	22.14-29.30	25.85
54	567	1,991	28.47	24.93-32.67	29.40
76	314	1,886	16.65	14.27-19.54	18.01
5	401	1,681	23.85	20.78-27.53	22.84

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
36	312	1,529	20.41	16.99-24.74	21.49
52	370	1,489	24.86	21.39-29.05	26.22
117	307	1,292	23.75	19.69-28.94	25.53
61	272	1,186	22.93	19.28-27.48	23.58
125	242	1,142	21.19	17.63-25.70	20.48
89	197	1,028	19.17	15.41-24.16	18.39
123	212	965	21.98	18.11-26.93	22.15
55	223	952	23.43	18.85-29.49	27.70
33	179	888	20.15	16.18-25.43	20.64
111	193	887	21.76	17.06-28.21	24.92
58	196	886	22.13	16.00-31.49	26.11
91	186	863	21.54	17.60-26.67	20.58
78	208	861	24.16	19.10-31.02	23.53
113	94	858	10.96	8.08-15.25	12.53
70	157	786	19.98	16.03-25.24	19.07
104	170	764	22.25	17.32-29.07	21.19
41	171	762	22.43	18.31-27.78	24.51
66	167	725	23.03	17.95-30.06	22.27
28	175	719	24.33	19.29-31.14	24.61
23	153	662	23.12	18.47-29.33	23.22
116	192	646	29.71	23.49-38.15	26.88
60	134	641	20.89	15.53-28.81	22.23
14	110	573	19.19	14.17-26.66	19.96
40	152	549	27.69	22.25-34.90	27.49
13	131	415	31.58	23.96-42.51	32.35
50	67	414	16.19	11.98-22.44	13.06
18	116	412	28.16	21.27-38.10	29.42

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
107	93	411	22.65	15.58-34.24	25.61
11	98	392	24.99	18.72-34.15	27.15
86	34	371	9.17	6.31-13.87	7.52
57	113	369	30.60	23.55-40.53	30.88
59	85	358	23.77	17.01-34.28	20.91
15	85	348	24.45	18.21-33.64	24.71
80	68	342	19.88	14.32-28.44	19.72
24	89	335	26.60	18.30-40.20	29.32
77	107	313	34.16	24.92-48.12	31.79
110	55	307	17.90	12.90-25.58	20.04
85	94	306	30.67	23.37-41.07	30.45
37	48	285	16.86	10.79-27.90	18.07
56	75	284	26.44	19.44-36.92	28.98
105	75	274	27.40	19.46-39.87	32.08
99	40	268	14.95	8.95-26.93	14.55
65	66	264	24.96	17.19-37.67	24.04
25	57	263	21.70	14.61-33.69	20.87
51	47	246	19.11	13.41-28.18	19.32
118	84	246	34.20	25.38-47.20	32.29
102	45	243	18.49	12.94-27.38	17.61
39	76	243	31.31	22.71-44.40	33.33
8	58	234	24.76	14.58-45.55	51.58
124	49	226	21.67	14.15-34.94	20.35
96	48	221	21.72	14.64-33.61	29.62
108	45	216	20.83	13.99-32.40	24.06
30	39	205	19.05	13.04-28.99	21.44
83	54	201	26.84	18.23-41.23	27.12

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
64	48	198	24.27	16.97-35.96	23.30
38	39	197	19.81	11.81-35.84	26.67
101	64	195	32.81	21.85-51.55	37.41
31	59	189	31.21	20.90-48.74	31.45
68	48	185	25.98	18.31-38.08	26.50
21	33	184	17.95	11.03-31.22	15.34
49	62	181	34.24	24.25-49.98	30.55
71	34	177	19.23	12.01-32.73	24.49
112	21	163	12.88	7.95-22.31	13.56
19	29	158	18.36	10.54-34.97	19.11
114	49	156	31.49	21.45-48.18	30.49
98	39	154	25.33	16.16-42.07	25.87
9	31	153	20.31	12.68-34.69	31.02
92	47	149	31.54	20.79-50.18	27.44
62	38	146	25.99	16.33-43.98	28.19
75	22	145	15.17	9.10-27.27	12.79
53	48	144	33.23	17.63-70.33	53.63
67	37	137	27.00	16.51-47.30	26.74
119	33	132	25.09	12.35-59.11	21.38
20	26	129	20.13	12.08-36.21	20.00
122	32	126	25.45	14.63-48.24	34.31
106	31	125	24.85	15.82-41.34	26.40
103	27	122	22.18	13.72-38.23	25.01
84	37	122	30.42	18.05-55.33	31.50
120	31	118	26.29	15.93-46.66	22.62
95	29	117	24.70	14.19-46.99	26.51
69	22	110	20.08	11.78-37.13	13.95

CCG Code	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
82	38	95	40.11	26.14-64.84	44.48
74	87	90	96.55	12.53-2567.30	160.85
17	26	89	29.19	19.32-46.28	31.26
26	28	86	32.61	20.19-56.19	31.77
47	9	82	10.95	3.67-47.04	7.27
79	14	82	17.09	8.92-37.02	16.48
87	30	82	36.78	22.51-64.33	26.83
34	19	81	23.40	11.00-58.76	21.65
48	22	79	27.99	13.05-71.23	24.70
42	27	62	43.73	22.80-94.83	40.26
73	7	53	13.28	6.01-35.40	17.03
43	10	47	21.34	9.32-60.08	17.73
81	14	44	32.04	13.03-100.61	28.20
100	6	35	17.37	4.91-102.24	9.87
97	6	25	23.99	9.24-83.04	11.11
27	<5	23	8.78	-	110.76

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

Appendix Table 28: Counts and rates of AKI events at admission by audit group

Audit group	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
Pts with coded CKD stages 3-5	16,577	225,163	7.36	7.23-7.50	6.65
Pts with uncoded CKD stages 3-5	4,672	76,603	6.10	5.88-6.33	6.14
Pts with other renal codes	2,937	141,077	2.08	1.99-2.18	3.13

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5 as well as people with other renal codes)*

Appendix Table 29: AKI events at admission rate ratios comparing rates in people with uncoded CKD stages 3-5 to people with coded CKD stages 3-5; adjusted for age, sex, diabetes, hypertension and CV diseases

Last GFR	Rate ratio (uncoded vs coded)	95% CI
58-59	0.99	0.86-1.16
56-57	1.38	1.10-1.73
54-55	1.31	1.10-1.55
52-53	1.46	1.24-1.72
50-51	1.64	1.38-1.95
48-49	1.86	1.57-2.2
46-47	2.33	1.96-2.77
44-45	2.44	2.04-2.91
42-43	2.84	2.39-3.39
40-41	3.33	2.73-4.06
38-39	4.03	3.36-4.85
36-37	4.37	3.56-5.36
34-35	4.1	3.28-5.12
32-33	5.22	4.08-6.67
30-31	5.67	4.36-7.37
28-29	5.89	4.44-7.81
26-27	6.42	4.65-8.85
24-25	6.97	5.06-9.6
20-23	8.14	6.08-10.89
15-19	8.09	5.50-11.9

Appendix Table 30: Counts and rates AKI events at admission by country, in people with other renal codes

Country	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py
England	2,004	89,835	2.23	2.12-2.35	2.29
Wales	933	51,242	1.82	1.69-1.97	1.82

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

Appendix Table 31: Counts and rates AKI events at admission by calendar month, in people with coded and uncoded CKD stages 3-5

Calendar month	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	142	1,937	7.33	6.22-8.64	7.34
4 - April	1,156	15,957	7.24	6.84-7.67	7.25
5 - May	1,187	17,605	6.74	6.37-7.14	6.76
6 - June	1,341	19,853	6.75	6.40-7.13	6.78
7 - July	1,380	21,010	6.57	6.23-6.92	6.60
8 - August	1,257	20,932	6.01	5.68-6.35	6.05
9 - September	1,487	22,580	6.59	6.26-6.93	6.65
10 - October	1,491	22,075	6.75	6.42-7.11	6.84
11 - November	1,680	23,130	7.26	6.92-7.62	7.37
12 -December	1,760	23,143	7.60	7.26-7.97	7.75
13 - January 2016	1,741	21,785	7.99	7.63-8.38	8.15
14 - February	1,736	23,305	7.45	7.11-7.81	7.63
15 - March	1,769	22,631	7.82	7.46-8.19	8.02
16 - April	1,600	23,352	6.85	6.52-7.20	7.00
17 - May	1,425	22,679	6.28	5.97-6.62	6.45

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

***grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 32: Counts and rates of AKI events at admission by calendar month, in people with other renal codes

Calendar month	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	14	835	1.68	0.99-2.83	1.71
4 - April	129	7,209	1.79	1.51-2.13	1.80
5 - May	148	8,020	1.85	1.57-2.17	1.86
6 - June	182	9,006	2.02	1.75-2.34	2.04
7 - July	187	9,594	1.95	1.69-2.25	1.97
8 - August	161	9,616	1.67	1.43-1.95	1.69
9 - September	217	10,428	2.08	1.82-2.38	2.11
10 - October	219	10,250	2.14	1.87-2.44	2.16
11 - November	240	10,875	2.21	1.94-2.50	2.23
12 -December	223	10,963	2.03	1.78-2.32	2.06
13 - January 2016	238	10,365	2.30	2.02-2.61	2.35
14 - February	247	11,114	2.22	1.96-2.52	2.25
15 - March	256	10,806	2.37	2.10-2.68	2.43
16 - April	242	11,196	2.16	1.91-2.45	2.21
17 - May	222	10,894	2.04	1.79-2.32	2.11

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

***grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 33: CV composite emergency admissions, in people with coded and uncoded CKD stages 3-5

CV event type	Freq.	Percent
Heart Failure/Volume Overload	4,109	34.0%
Cerebrovascular disease/TIA	3,774	31.2%
Acute and chronic ischaemic heart disease and its complications	3,652	30.2%
Peripheral and aortic artery disease	568	4.7%
TOTAL	12,103	100%

Appendix Table 34: CV composite elective admissions, in people with coded and uncoded CKD stages 3-5

CV event type	Freq.	Percent
Acute and chronic ischaemic heart disease and its complications	2,955	54.9%
Cerebrovascular disease/TIA	1,020	19.0%
Peripheral and aortic artery disease	771	14.3%
Heart Failure/Volume Overload	635	11.8%
TOTAL	5,381	100%

Appendix Table 35: CV composite event counts and rates by audit group

Table 15: Audit group	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
Pts with coded CKD stages 3-5	13,401	225,170	5.95	5.82-6.08	5.41
Pts with uncoded CKD stages 3-5	4,083	76,605	5.33	5.12-5.55	5.17
Pts with other renal codes	4,870	141,072	3.45	3.32-3.59	4.49

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5 as well as people with other renal codes)*

Appendix Table 36: CV event rate ratios comparing rates in people with uncoded CKD stages 3-5 to people with coded CKD stages 3-5; adjusted for age, sex, diabetes, hypertension and CV diseases

Last GFR	Rate ratio (uncoded vs coded)	95% CI
58-59	0.95	0.82-1.09
56-57	1.12	0.92-1.37
54-55	1.08	0.92-1.26
52-53	1.12	0.95-1.31
50-51	1.23	1.05-1.45
48-49	1.44	1.22-1.71
46-47	1.53	1.28-1.84
44-45	1.46	1.21-1.77
42-43	1.41	1.16-1.71
40-41	1.83	1.49-2.25
38-39	2.14	1.70-2.69
36-37	1.94	1.51-2.49
34-35	2.11	1.58-2.80
32-33	2.4	1.71-3.35
30-31	2.35	1.66-3.31
28-29	1.9	1.35-2.68
26-27	2.1	1.34-3.29
24-25	2.35	1.44-3.83
20-23	3.48	2.43-5.00
15-19	2.36	1.38-4.06
0-14	1.5	0.72-3.12

Appendix Table 37: CV event counts and rates by country, in people with other renal codes

Country	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	3,122	89,832	3.48	3.31-3.65	3.56
Wales	1,748	51,240	3.41	3.21-3.63	3.36

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

Appendix Table 38: CV composite event counts and rates by calendar month, in people with coded and uncoded CKD stages 3-5

Calendar month	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	125	1,938	6.45	5.41-7.69	6.45
4 - April	952	15,958	5.97	5.60-6.36	5.97
5 - May	1,049	17,605	5.96	5.61-6.33	5.97
6 - June	1,212	19,853	6.10	5.77-6.46	6.12
7 - July	1,195	21,010	5.69	5.37-6.02	5.71
8 - August	1,211	20,932	5.79	5.47-6.12	5.80
9 - September	1,352	22,580	5.99	5.68-6.32	6.03
10 - October	1,247	22,075	5.65	5.34-5.97	5.69
11 - November	1,289	23,131	5.57	5.28-5.89	5.62
12 - December	1,314	23,144	5.68	5.38-5.99	5.75
13 - January 2016	1,304	21,786	5.99	5.67-6.32	6.05
14 - February	1,382	23,306	5.93	5.63-6.25	6.00
15 - March	1,282	22,633	5.66	5.36-5.98	5.75
16 - April	1,253	23,353	5.37	5.08-5.67	5.44
17 - May	1,134	22,680	5.00	4.72-5.30	5.09

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

***age-sex standardised rate could not be calculated due to low counts within strata leading to instability in the calculation of the age-sex standardised rate*

****grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 39: CV composite event counts and rates by calendar month, in people with other renal codes

Calendar month	Event count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	31	835	3.71	2.61-5.28	3.79
4 - April	232	7,209	3.22	2.83-3.66	3.23
5 - May	243	8,020	3.03	2.67-3.44	3.05
6 - June	320	9,006	3.55	3.18-3.96	3.58
7 - July	347	9,594	3.62	3.26-4.02	3.64
8 - August	332	9,616	3.45	3.10-3.84	3.48
9 - September	381	10,428	3.65	3.30-4.04	3.68
10 - October	366	10,250	3.57	3.22-3.96	3.60
11 - November	380	10,874	3.49	3.16-3.86	3.52
12 - December	315	10,963	2.87	2.57-3.21	2.90
13 - January 2016	333	10,365	3.21	2.89-3.58	3.25
14 - February	371	11,114	3.34	3.02-3.70	3.38
15 - March	393	10,806	3.64	3.29-4.01	3.69
16 - April	433	11,196	3.87	3.52-4.25	3.93
17 - May	348	10,893	3.19	2.88-3.55	3.26

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

***age-sex standardised rate could not be calculated due to low counts within strata leading to instability in the calculation of the age-sex standardised rate*

****grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 40: ICU admission counts and rates by audit group

Audit group	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
Pts with coded CKD stages 3-5	2,743	150,226	1.83	1.75-1.91	1.97
Pts with uncoded CKD stages 3-5	835	48,929	1.71	1.59-1.84	1.78
Pts with other renal codes	1,242	89,838	1.38	1.30-1.47	1.56

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5 as well as people with other renal codes)*

Appendix Table 41: ICU admission rate ratios comparing rates in people with uncoded CKD stages 3-5 to people with coded CKD stages 3-5; adjusted for age, sex, diabetes, hypertension and CV diseases

Appendix Table 42: Last GFR	Rate ratio (uncoded vs coded)	95% CI
58-59	1.05	0.81-1.36
56-57	1.36	0.96-1.91
54-55	1	0.74-1.35
52-53	1.09	0.8-1.49
50-51	1.39	1.03-1.87
48-49	1.57	1.14-2.16
46-47	1.82	1.31-2.52
44-45	1.94	1.37-2.76
42-43	1.9	1.27-2.83
40-41	2.08	1.3-3.33
38-39	3.07	2.04-4.6
36-37	2.31	1.46-3.65
34-35	2.34	1.34-4.08
32-33	1.96	1.01-3.8
30-31	1.69	0.79-3.61
28-29	1.79	0.79-4.05
26-27	3.47	1.62-7.41
24-25	3.4	1.5-7.68
20-23	2.98	1.42-6.26
15-19	6.82	3.41-13.66
0-14	8.4	4.21-16.76

Appendix Table 42: ICU admission counts and rates by calendar month, in people with coded and uncoded CKD stages 3-5

Calendar month	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	25	1,560	1.60	1.08-2.37	1.61
4 - April	196	10,682	1.83	1.60-2.11	1.84
5 - May	217	11718	1.85	1.62-2.12	1.85
6 - June	279	13,306	2.10	1.86-2.36	2.10
7 - July	258	13,913	1.85	1.64-2.09	1.85
8 - August	248	13,814	1.80	1.59-2.03	1.79
9 - September	259	14,786	1.75	1.55-1.98	1.75
10 - October	273	14,392	1.90	1.68-2.14	1.89
11 - November	293	15,051	1.95	1.74-2.18	1.94
12 - December	247	15,111	1.63	1.44-1.85	1.62
13 - January 2016	262	14,287	1.83	1.62-2.07	1.82
14 - February	270	15,314	1.76	1.56-1.99	1.75
15 - March	231	14,907	1.55	1.36-1.76	1.53
16 - April	265	15,410	1.72	1.52-1.94	1.71
17 - May	250	15,037	1.66	1.47-1.88	1.65

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

***age-sex standardised rate could not be calculated due to low counts within strata leading to instability in the calculation of the age-sex standardised rate*

****grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 43: ICU admission counts and rates by calendar month, in people with other renal codes

Calendar month	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	12	666	1.80	1.02-3.17	1.85
4 - April	76	4,649	1.63	1.31-2.05	1.65
5 - May	69	5,101	1.35	1.07-1.71	1.37
6 - June	83	5,785	1.43	1.16-1.78	1.46
7 - July	89	6,160	1.44	1.17-1.78	1.47
8 - August	74	6,184	1.20	0.95-1.50	1.22
9 - September	117	6,635	1.76	1.47-2.11	1.78
10 - October	103	6,482	1.59	1.31-1.93	1.61
11 - November	90	6,828	1.32	1.07-1.62	1.34
12 - December	81	6,922	1.17	0.94-1.45	1.19
13 - January 2016	88	6,550	1.34	1.09-1.66	1.37
14 - February	98	7,031	1.39	1.14-1.70	1.42
15 - March	77	6,846	1.12	0.90-1.41	1.14
16 - April	89	7,111	1.25	1.02-1.54	1.27
17 - May	92	6,948	1.32	1.08-1.62	1.34

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

***age-sex standardised rate could not be calculated due to low counts within strata leading to instability in the calculation of the age-sex standardised rate*

****grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 44: Most common codes among patients with other renal codes who died

Code	Frequency	Percent
ACR>3/PCR>15 in last year	1,238	33.83
CKD QOF code stage 2	1,073	29.32
Microabluminuria code	255	6.97
CKD QOF code stage 1	138	3.77
Calculus of kidney code	126	3.44
Proteinuria code (4678)	93	2.54
Hydronephrosis code (K11)	93	2.54
Proteinuria code (R110)	64	1.75
Renal impairment code	58	1.59
Acquired cyst of kidney code	52	1.42
Type 2 DM + microalbuminuria code	45	1.23
Bladder calculus code	45	1.23
Renal cell carcinoma	44	1.20
Chronic renal failure	35	0.96
Calculus of ureter code	30	0.82

Appendix Table 45: Death counts and rates by audit group

Audit group	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
Pts with coded CKD stages 3-5	16,808	225,208	7.46	7.35-7.58	6.16
Pts with uncoded CKD stages 3-5	4,729	76,616	6.17	6.00-6.35	5.83
Pts with other renal codes	3,659	141,085	2.59	2.51-2.68	5.17

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5 as well as people with other renal codes)*

Appendix Table 46: Mortality rate ratios comparing rates in people with uncoded CKD stages 3-5 to people with coded CKD stages 3-5; adjusted for age, sex, diabetes, hypertension and CV diseases

Last GFR	Rate ratio (uncoded vs coded)	95% CI
58-59	0.89	0.79-1.00
56-57	1.01	0.86-1.19
54-55	1.14	1.01-1.29
52-53	1.11	0.98-1.26
50-51	1.29	1.14-1.46
48-49	1.53	1.35-1.73
46-47	1.57	1.38-1.8
44-45	1.62	1.41-1.87
42-43	1.87	1.63-2.16
40-41	2.21	1.91-2.55
38-39	2.28	1.95-2.66
36-37	2.24	1.88-2.67
34-35	2.49	2.08-2.98
32-33	2.58	2.11-3.15
30-31	2.97	2.42-3.66
28-29	3.67	2.95-4.56
26-27	2.59	1.92-3.5
24-25	3.94	2.94-5.29
20-23	4.34	3.36-5.6
15-19	5.34	3.87-7.38
0-14	6.13	3.96-9.49

Appendix Table 47: Death counts and rates by country, in people with other renal codes

Country	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
England	2,326	89,840	2.59	2.49-2.70	2.67
Wales	1,333	51,245	2.60	2.47-2.74	2.64

**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

Appendix Table 48: Death counts and rates by calendar month, in people with coded and uncoded CKD stages 3-5

Calendar month	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	132	1,938	6.81	5.74-8.08	6.82
4 - April	1,177	15,960	7.37	6.97-7.81	7.39
5 - May	1,174	17,608	6.67	6.30-7.06	6.70
6 - June	1,300	19,856	6.55	6.20-6.91	6.60
7 - July	1,244	21,014	5.92	5.60-6.26	5.99
8 - August	1,295	20,935	6.19	5.86-6.53	6.27
9 - September	1,498	22,584	6.63	6.31-6.98	6.76
10 - October	1,485	22,079	6.73	6.39-7.08	6.87
11 - November	1,629	23,134	7.04	6.71-7.39	7.25
12 - December	1,777	23,148	7.68	7.33-8.04	7.94
13 - January 2016	1,721	21,789	7.90	7.53-8.28	8.21
14 - February	1,891	23,310	8.11	7.75-8.49	8.49
15 - March	1,819	22,636	8.04	7.67-8.41	8.44
16 - April	1,799	23,356	7.70	7.35-8.07	8.12
17 - May	1,596	22,683	7.04	6.70-7.39	7.47

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

***grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 49: Death counts and rates by calendar month, in people with other renal codes

Calendar month	Admission count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
3 - March 2015	20	835	2.39	1.54-3.71	2.44
4 - April	192	7,210	2.66	2.31-3.07	2.68
5 - May	184	8,020	2.29	1.99-2.65	2.32
6 - June	210	9,007	2.33	2.04-2.67	2.36
7 - July	236	9,595	2.46	2.17-2.79	2.50
8 - August	211	9,617	2.19	1.92-2.51	2.23
9 - September	261	10,429	2.50	2.22-2.83	2.55
10 - October	285	10,251	2.78	2.48-3.12	2.85
11 - November	276	10,875	2.54	2.26-2.86	2.60
12 - December	315	10,964	2.87	2.57-3.21	2.96
13 - January 2016	271	10,366	2.61	2.32-2.94	2.70
14 - February	313	11,115	2.82	2.52-3.15	2.92
15 - March	297	10,807	2.75	2.45-3.08	2.87
16 - April	306	11,197	2.73	2.44-3.06	2.85
17 - May	282	10,894	2.59	2.30-2.91	2.71

**the standard age-sex population distribution used reflects the population being reported on (group 3)*

***grey rows indicate months where incomplete reporting is likely to contribute to low event rates; results are reported for a single year (April 2015-March 2016)*

Appendix Table 50: Death counts and rates by CCG, in people with coded and uncoded CKD stages 3-5, sorted by frequency of patient-years

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
1	1,687	29,445	5.73	5.46-6.01	5.78
2	1,330	18,916	7.03	6.66-7.42	7.56
6	1,087	15,105	7.20	6.78-7.64	7.51
4	1,201	15,017	8.00	7.56-8.46	8.33
90	1,002	14,977	6.69	6.29-7.12	7.35
45	850	11,034	7.70	7.20-8.24	7.46
3	680	10,765	6.32	5.86-6.81	7.13
12	843	10,633	7.93	7.41-8.48	7.51
7	849	9,873	8.60	8.04-9.20	8.36
115	596	7,753	7.69	7.09-8.33	7.87
93	578	7,670	7.54	6.95-8.18	7.41
88	515	7,176	7.18	6.58-7.82	7.15
63	477	7,118	6.70	6.13-7.33	7.50
35	475	6,362	7.47	6.82-8.17	7.72
94	527	6,190	8.51	7.82-9.27	7.98
10	375	5,421	6.92	6.25-7.65	8.22
121	401	5,109	7.85	7.12-8.66	8.39
61	245	4,635	5.29	4.66-5.99	6.19
29	293	4,603	6.36	5.68-7.14	6.75
125	276	4,144	6.66	5.92-7.49	6.74
44	295	3,778	7.81	6.97-8.75	6.74
5	247	3,540	6.98	6.16-7.91	6.71
72	211	3,525	5.99	5.23-6.85	6.41
32	253	3,500	7.23	6.39-8.18	7.97
76	224	3,307	6.77	5.94-7.72	6.58
16	279	3,296	8.47	7.53-9.52	7.97

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
123	233	3,258	7.15	6.29-8.13	7.60
52	246	3,124	7.87	6.95-8.92	7.92
36	172	2,670	6.44	5.55-7.48	6.06
91	152	2,601	5.84	4.98-6.85	6.17
111	153	2,418	6.33	5.40-7.41	6.63
54	219	2,330	9.40	8.23-10.73	9.69
89	158	2,320	6.81	5.83-7.96	6.12
66	156	2,132	7.32	6.25-8.56	7.99
46	201	2,091	9.61	8.37-11.04	10.13
116	139	1,931	7.20	6.10-8.50	6.76
11	96	1,714	5.60	4.59-6.84	6.49
78	140	1,713	8.17	6.92-9.64	7.69
117	150	1,695	8.85	7.54-10.38	9.43
23	106	1,589	6.67	5.52-8.07	6.32
104	135	1,498	9.01	7.61-10.67	8.74
55	100	1,493	6.70	5.51-8.15	7.53
33	106	1,317	8.05	6.65-9.74	8.86
28	96	1,289	7.45	6.10-9.09	7.27
113	56	1,215	4.61	3.55-5.99	6.36
64	81	1,212	6.68	5.38-8.31	6.01
58	79	1,104	7.16	5.74-8.92	7.41
102	83	1072	7.75	6.25-9.60	7.35
59	84	991	8.47	6.84-10.49	8.87
119	56	990	5.66	4.35-7.35	6.51
105	49	948	5.17	3.91-6.84	5.64
75	67	941	7.12	5.60-9.04	7.22
19	50	910	5.50	4.17-7.25	6.95

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
70	61	901	6.77	5.27-8.70	6.46
41	71	897	7.92	6.27-9.99	8.51
18	42	894	4.70	3.47-6.36	5.43
67	49	885	5.53	4.18-7.32	6.55
96	63	873	7.22	5.64-9.24	8.10
85	63	870	7.24	5.66-9.27	7.99
60	58	824	7.04	5.44-9.10	8.18
107	55	809	6.80	5.22-8.85	6.57
65	51	807	6.32	4.80-8.31	8.27
86	60	789	7.61	5.91-9.80	8.49
24	37	764	4.84	3.51-6.68	7.05
40	38	753	5.05	3.67-6.93	6.41
49	56	751	7.46	5.74-9.69	7.01
108	58	748	7.76	6.00-10.03	6.19
37	62	738	8.40	6.55-10.77	8.39
39	43	717	6.00	4.45-8.08	6.35
112	56	695	8.06	6.20-10.47	8.17
80	62	689	9.00	7.02-11.54	8.71
21	38	686	5.54	4.03-7.61	6.92
51	53	678	7.81	5.97-10.22	7.34
114	47	664	7.08	5.32-9.42	6.97
13	72	655	11.00	8.73-13.85	10.23
101	69	639	10.80	8.53-13.67	9.33
71	38	589	6.45	4.69-8.86	6.30
57	53	507	10.46	7.99-13.69	10.09
15	39	505	7.72	5.64-10.57	9.85
25	32	493	6.49	4.59-9.17	7.02

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
110	27	492	5.48	3.76-8.00	5.18
14	26	472	5.51	3.75-8.09	7.38
30	32	470	6.80	4.81-9.62	8.15
84	44	457	9.63	7.17-12.94	9.30
118	37	420	8.82	6.39-12.17	8.27
92	30	418	7.18	5.02-10.27	8.40
50	38	397	9.56	6.96-13.14	10.18
38	21	378	5.55	3.62-8.51	11.83
124	44	377	11.67	8.68-15.68	11.45
77	31	375	8.26	5.81-11.75	9.68
73	24	374	6.42	4.30-9.58	7.29
120	19	372	5.11	3.26-8.00	5.59
31	26	372	6.99	4.76-10.27	6.88
82	27	368	7.34	5.03-10.70	12.61
17	31	349	8.88	6.25-12.63	11.45
42	20	331	6.05	3.90-9.38	7.59
62	23	313	7.34	4.88-11.04	7.45
8	28	309	9.05	6.25-13.11	9.89
83	24	303	7.91	5.30-11.81	9.28
56	22	302	7.29	4.80-11.08	8.47
47	21	300	7.01	4.57-10.75	7.14
74	28	300	9.35	6.45-13.54	7.29
99	25	296	8.43	5.70-12.48	7.81
106	21	293	7.16	4.67-10.98	9.89
69	15	280	5.35	3.23-8.88	3.94
48	17	259	6.57	4.09-10.57	6.09
81	18	258	6.97	4.39-11.07	7.16
53	21	253	8.29	5.40-12.71	15.15

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
26	20	246	8.13	5.24-12.60	8.56
9	11	238	4.61	2.56-8.33	5.34
68	15	234	6.42	3.87-10.65	7.30
20	14	232	6.05	3.58-10.21	7.25
122	20	227	8.80	5.68-13.64	11.12
34	21	224	9.37	6.11-14.37	8.84
87	13	223	5.83	3.38-10.04	6.49
100	24	212	11.31	7.58-16.87	10.56
98	16	187	8.57	5.25-13.99	9.87
95	12	180	6.68	3.80-11.77	6.19
79	15	157	9.53	5.74-15.81	9.52
103	12	108	11.10	6.30-19.54	17.17
97	13	103	12.67	7.36-21.82	12.57
43	6	75	7.99	3.59-17.78	8.88
27	0	8	0	-	0

**the standard age-sex population distribution used reflects the population being reported on (people with coded and uncoded CKD stages 3-5)*

Appendix Table 51: Death counts and rates by CCG, in people with other renal codes, sorted by frequency of patient-years

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
57	11	13,138	2.98	1.65-5.38	2.85
118	11	9,745	4.48	2.48-8.09	3.97
111	12	8,171	1.35	0.77-2.38	1.55
80	13	6,489	3.80	2.21-6.55	4.00

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
70	14	6,142	1.78	1.06-3.01	1.86
55	16	5,879	1.68	1.03-2.74	1.92
23	17	5,621	2.57	1.60-4.13	2.46
104	18	4,708	2.36	1.48-3.74	2.06
78	19	4,531	2.21	1.41-3.46	2.26
41	19	3,088	2.49	1.59-3.91	2.95
66	19	2,994	2.62	1.67-4.11	2.47
58	20	2,962	2.26	1.46-3.50	3.00
61	23	2,734	1.94	1.29-2.92	2.18
123	23	2,725	2.38	1.58-3.59	2.41
33	24	2,659	2.70	1.81-4.03	3.49
28	27	2,458	3.75	2.57-5.47	3.67
116	28	2,356	4.33	2.99-6.28	3.17
117	31	2,351	2.40	1.69-3.41	2.76
89	32	2,309	3.11	2.20-4.40	3.58
91	34	2,289	3.94	2.81-5.51	3.32
76	35	2,260	1.86	1.33-2.58	2.18
46	37	2,077	1.64	1.19-2.26	2.20
36	41	2,015	2.68	1.97-3.64	3.05
88	47	1,991	2.26	1.70-3.01	2.30
29	48	1,886	2.10	1.58-2.78	2.37
52	50	1,681	3.36	2.55-4.43	3.70
125	50	1,529	4.38	3.32-5.78	3.86
5	55	1,489	3.27	2.51-4.26	2.76
54	59	1,292	2.96	2.30-3.82	3.27
32	61	1,186	2.23	1.74-2.87	2.39

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
35	66	1,142	2.69	2.11-3.42	2.80
16	71	1,028	3.01	2.39-3.80	2.65
44	75	965	2.82	2.25-3.54	2.32
94	76	952	3.29	2.63-4.12	3.37
72	81	888	2.62	2.11-3.26	2.33
115	82	887	3.01	2.42-3.74	3.02
10	83	886	4.12	3.32-5.11	4.12
93	84	863	3.57	2.89-4.43	3.05
121	86	861	2.90	2.35-3.59	3.04
45	88	858	2.94	2.38-3.62	2.58
90	105	786	2.32	1.91-2.81	2.38
63	115	764	2.05	1.70-2.46	2.42
12	126	762	2.68	2.25-3.19	2.71
7	146	725	2.38	2.02-2.80	2.40
3	148	719	2.52	2.14-2.96	2.97
2	184	662	2.84	2.45-3.28	3.10
1	215	646	2.21	1.93-2.52	2.26
6	255	641	3.12	2.76-3.53	2.78
4	330	573	2.51	2.25-2.80	2.72
40	9	549	1.64	0.85-3.15	1.56
13	10	415	2.41	1.30-4.48	2.71
50	9	414	2.17	1.13-4.18	11.67
18	<5	412	0.97	0.36-2.59	0.71
107	8	411	1.95	0.97-3.90	3.07
11	8	392	2.04	1.02-4.08	3.30
86	<5	371	0.81	0.26-2.51	1.12
57	11	369	2.98	1.65-5.38	2.85
59	5	358	1.40	0.58-3.36	0.94

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
15	5	348	1.44	0.60-3.46	1.72
80	13	342	3.80	2.21-6.55	4.00
24	5	335	1.49	0.62-3.59	2.75
77	9	313	2.87	1.50-5.52	2.75
110	6	307	1.95	0.88-4.35	2.17
85	8	306	2.61	1.31-5.22	3.35
37	<5	285	0.70	0.18-2.81	0.67
56	6	284	2.12	0.95-4.71	3.08
105	6	274	2.19	0.98-4.88	4.03
99	8	268	2.99	1.50-5.98	2.56
65	<5	264	0.76	0.19-3.02	0.87
25	<5	263	1.52	0.57-4.06	1.68
51	7	246	2.85	1.36-5.97	3.10
118	11	246	4.48	2.48-8.09	3.97
102	10	243	4.11	2.21-7.64	3.84
39	9	243	3.71	1.93-7.13	5.50
8	5	234	2.13	0.89-5.13	7.93
124	5	226	2.21	0.92-5.31	2.34
96	7	221	3.17	1.51-6.64	5.32
108	<5	216	1.39	0.45-4.30	1.53
30	<5	205	1.47	0.47-4.54	2.38
83	5	201	2.49	1.03-5.97	2.53
64	6	198	3.03	1.36-6.75	3.32
38	<5	197	1.02	0.25-4.06	0.97
101	9	195	4.61	2.40-8.87	7.21
31	<5	189	2.12	0.79-5.64	2.89
68	9	185	4.87	2.53-9.36	5.45
21	6	184	3.26	1.47-7.26	3.05

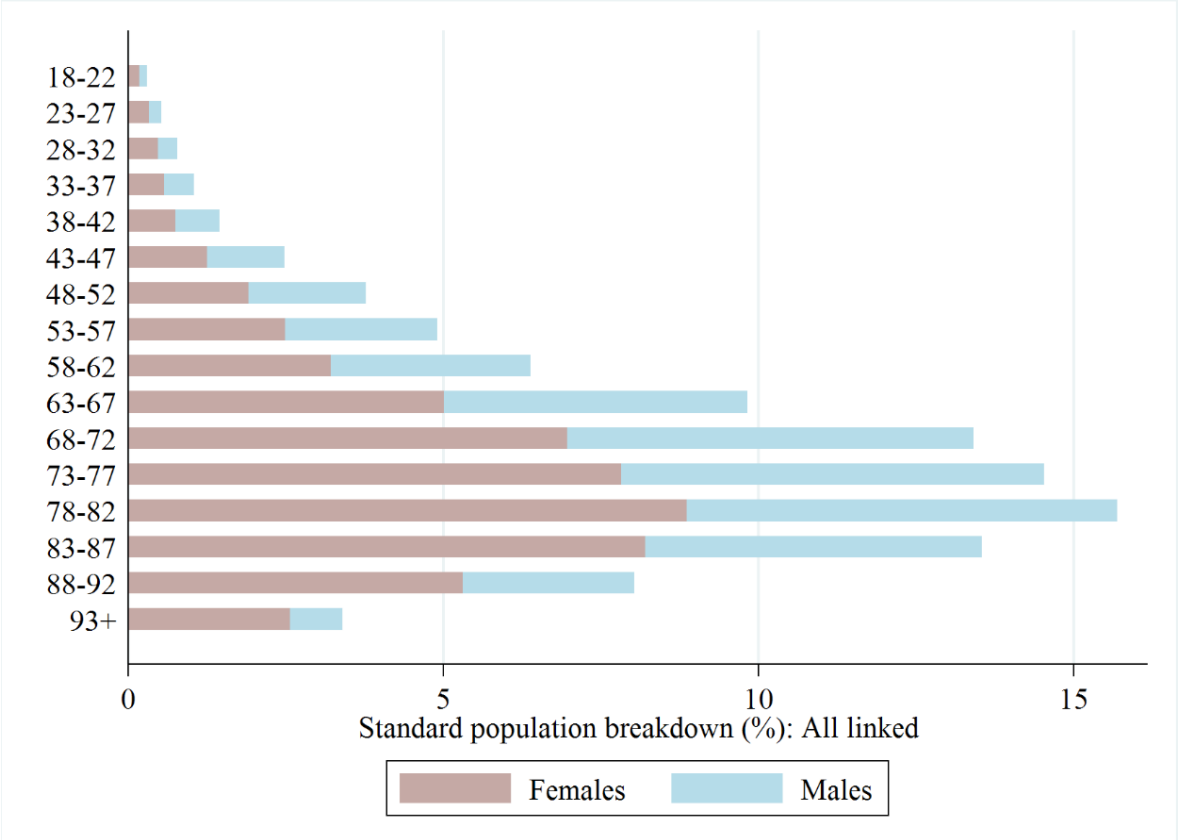
CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
49	6	181	3.31	1.49-7.37	3.01
71	9	177	5.09	2.65-9.78	8.12
112	5	163	3.07	1.28-7.37	3.70
19	<5	158	2.53	0.95-6.75	2.84
114	7	156	4.50	2.14-9.44	2.02
98	<5	154	1.95	0.63-6.04	2.12
9	<5	153	2.62	0.98-6.98	4.39
92	8	149	5.37	2.69-10.74	4.32
62	5	146	3.42	1.42-8.22	3.67
75	<5	145	0.69	0.10-4.90	0.37
53	<5	144	2.77	1.04-7.38	16.75
67	7	137	5.11	2.44-10.72	4.92
119	<5	132	0.76	0.11-5.40	0.45
20	<5	129	2.32	0.75-7.20	4.22
122	<5	126	2.39	0.77-7.40	3.76
106	<5	125	3.21	1.20-8.54	1.95
103	<5	122	2.46	0.79-7.64	2.56
84	5	122	4.11	1.71-9.88	3.77
120	<5	118	0.00	-	0.00
95	<5	117	0.85	0.12-6.05	0.95
69	5	110	4.56	1.90-10.96	3.55
82	4	95	4.22	1.58-11.25	4.38
74	<5	90	4.44	1.67-11.83	88.16
17	<5	89	4.49	1.69-11.97	2.93
26	<5	86	4.66	1.75-12.41	7.04
47	<5	82	1.22	0.17-8.63	1.26

CCG Code	Death count	Patient years	Rate per 100py	95% CI	Age-sex standardised rate per 100py*
79	<5	82	4.88	1.83-13.01	8.00
87	<5	82	1.23	0.17-8.70	0.61
34	<5	81	1.23	0.17-8.74	0.52
48	<5	79	0.00	-	0.00
42	<5	62	6.48	2.43-17.26	7.97
73	<5	53	1.90	0.27-13.47	8.20
43	<5	47	2.13	0.30-15.15	3.20
81	<5	44	4.58	1.14-18.30	2.05
100	<5	35	0.00	-	0.00
97	<5	25	0.00	-	0.00
27	<5	23	4.39	0.62-31.18	55.38

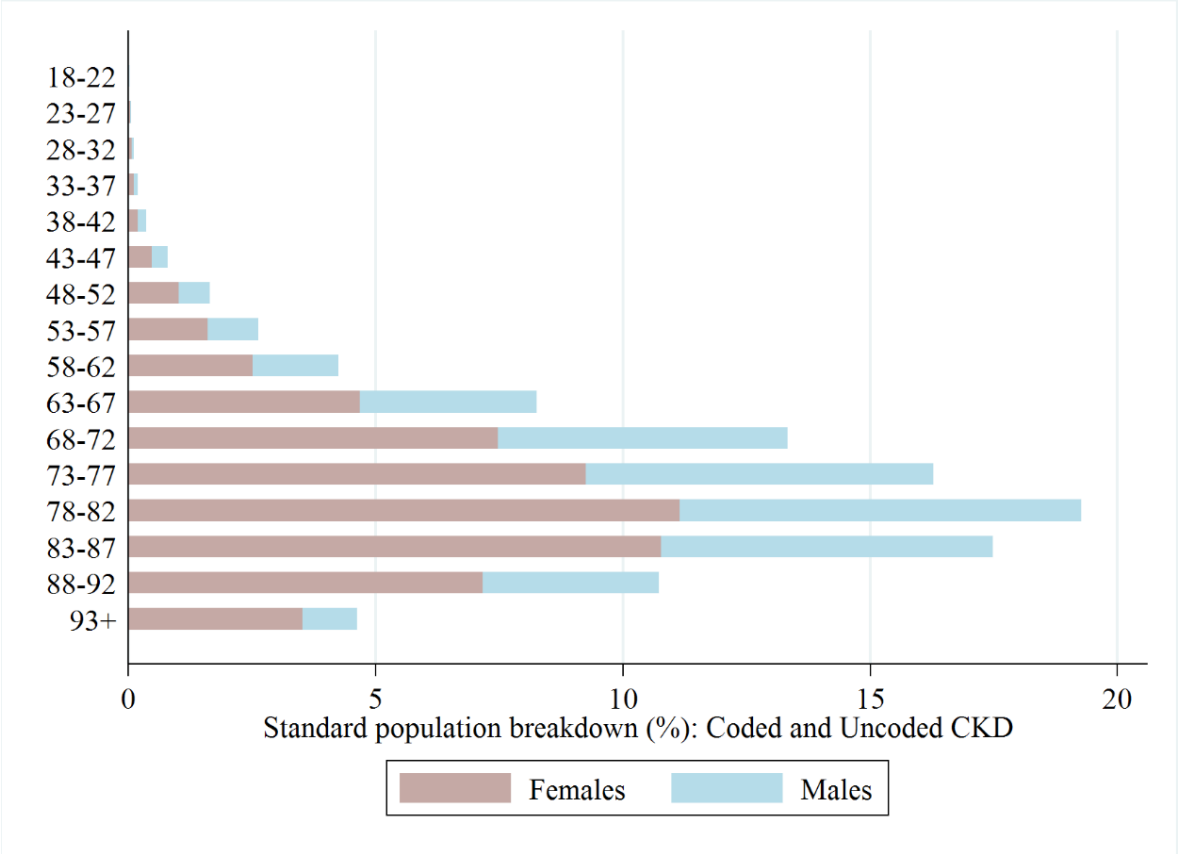
**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

// Appendix Figures

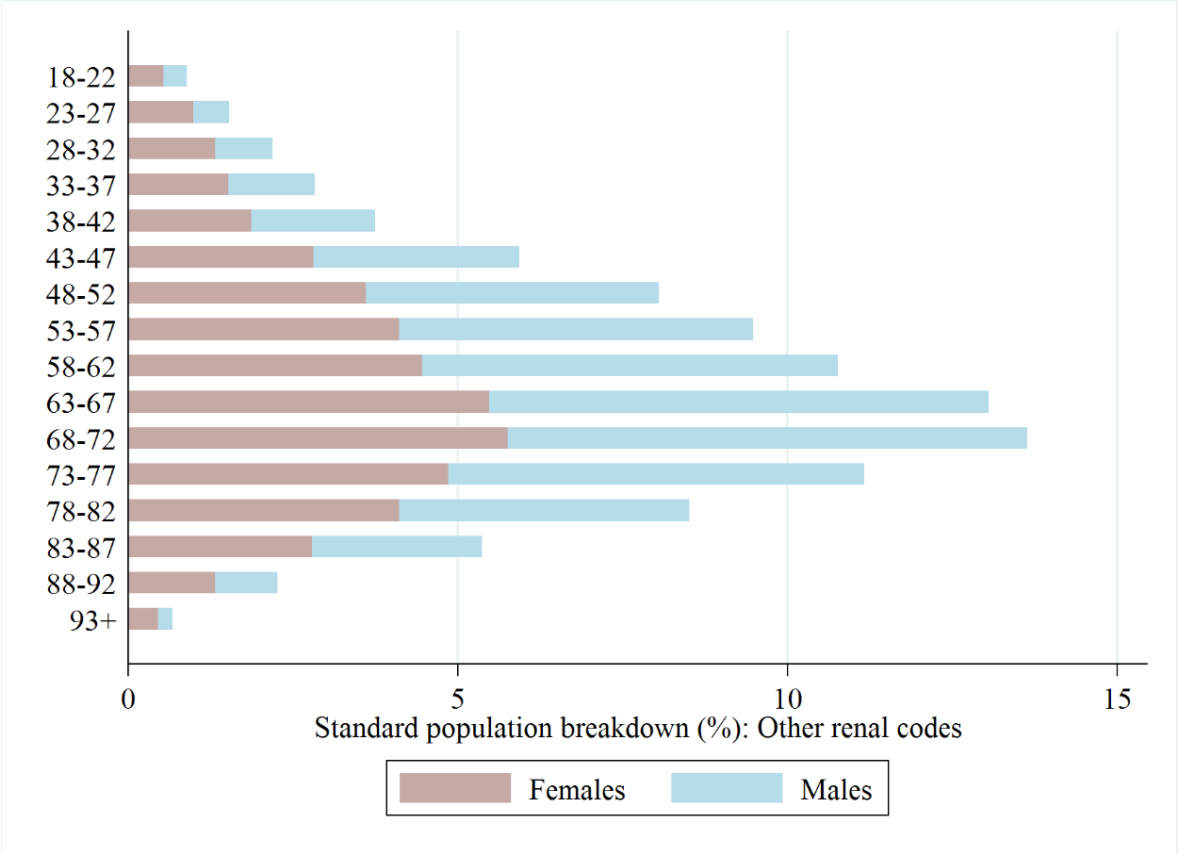
Appendix Figure 12: Breakdown of age of standard population (groups 1, 2, & 3)



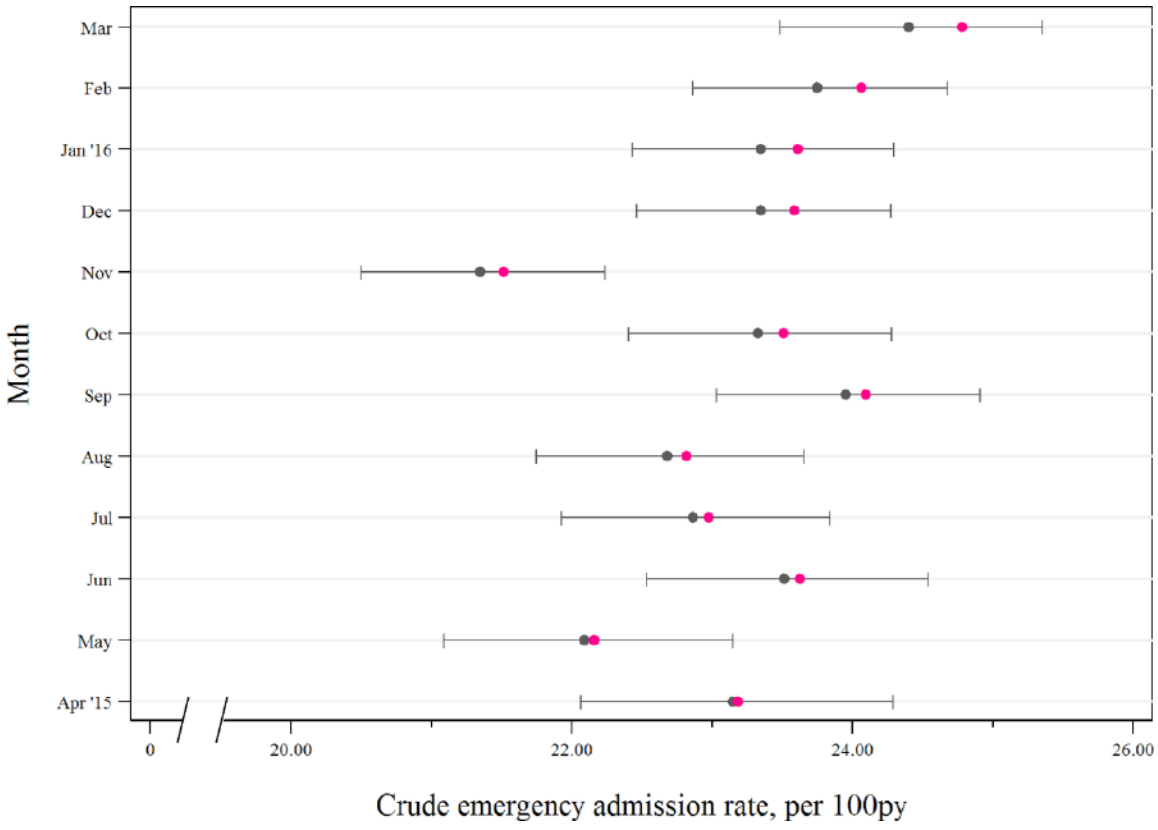
Appendix Figure 13: Breakdown of age of people with biochemical CKD stages 3-5 (groups 1 & 2, excluding miscoded)



Appendix Figure 14: Breakdown of age of people with other renal codes (group 3)

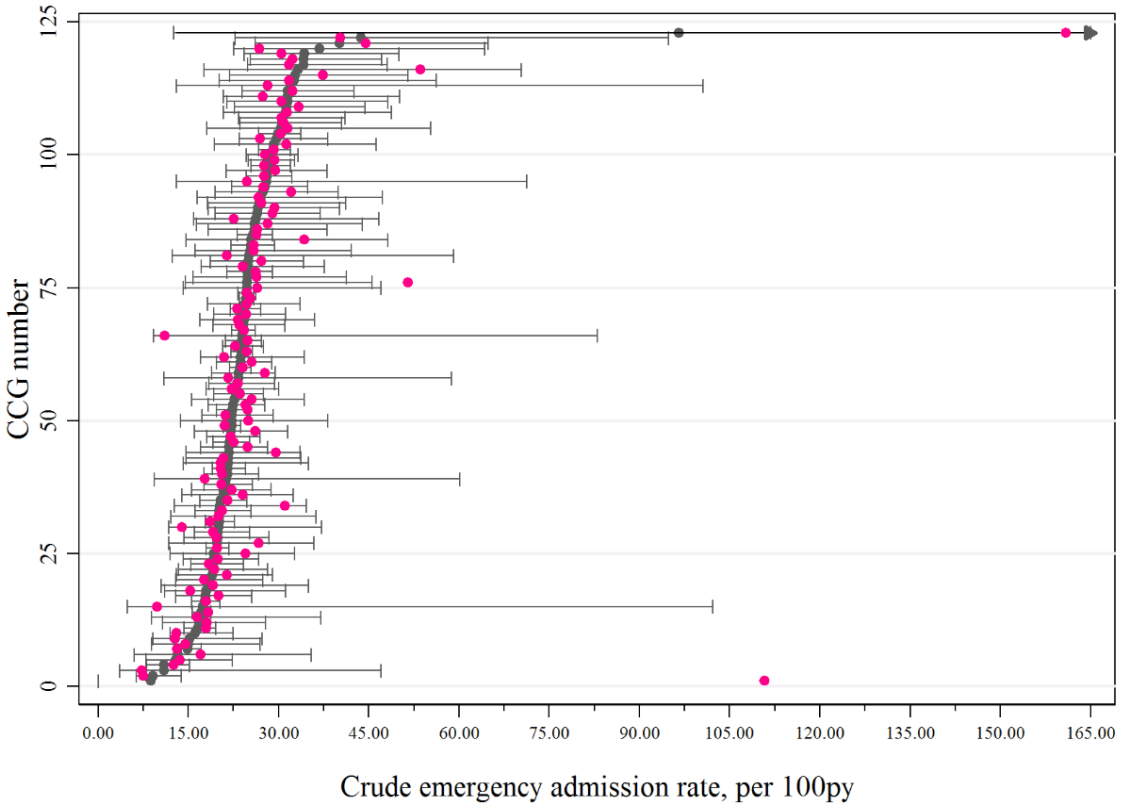


Appendix Figure 15: Emergency admission rates by month in people with other renal codes, with pink dots representing age- and sex-standardised rates; not adjusted for comorbidity*



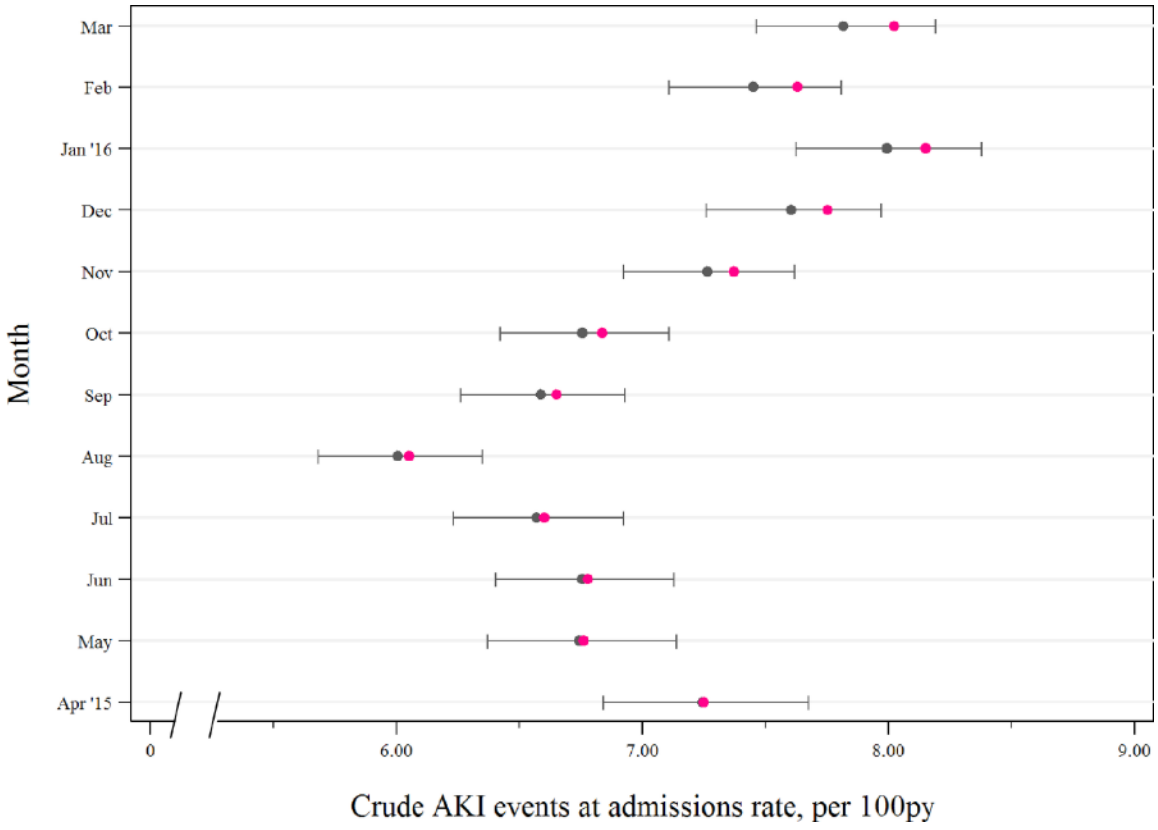
the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)

Appendix Figure 16: Emergency admission rates by CCG in people with other renal codes, with pink dots representing age-sex standardised rates; not adjusted for comorbidity*



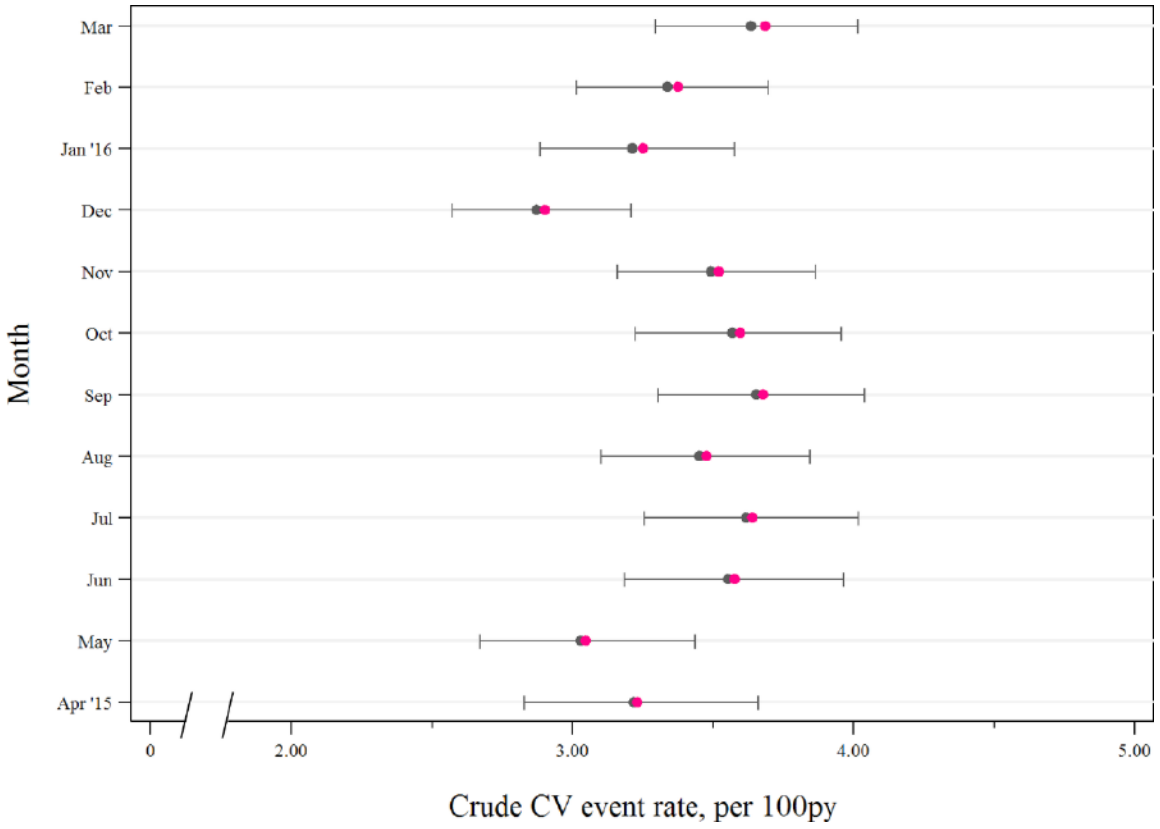
the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)

Appendix Figure 17: Rates of AKI events at admissions by month in people with other renal codes, with pink dots representing age/sex standardised rates; not adjusted for comorbidity*



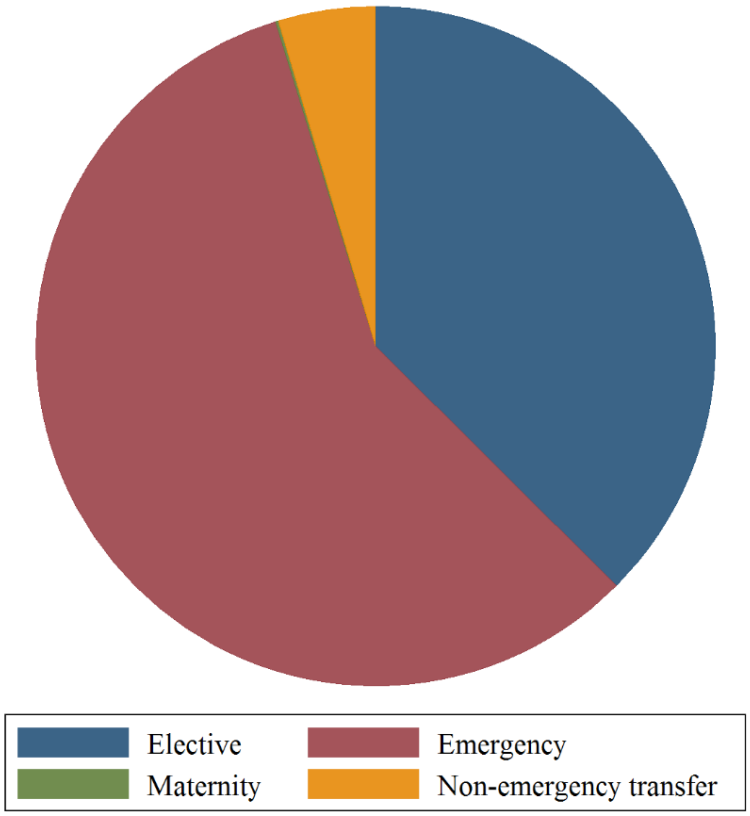
the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)

Appendix Figure 18: Rates of CV events by month in people with other renal codes, with pink dots representing age/sex standardised rates; not adjusted for comorbidity*

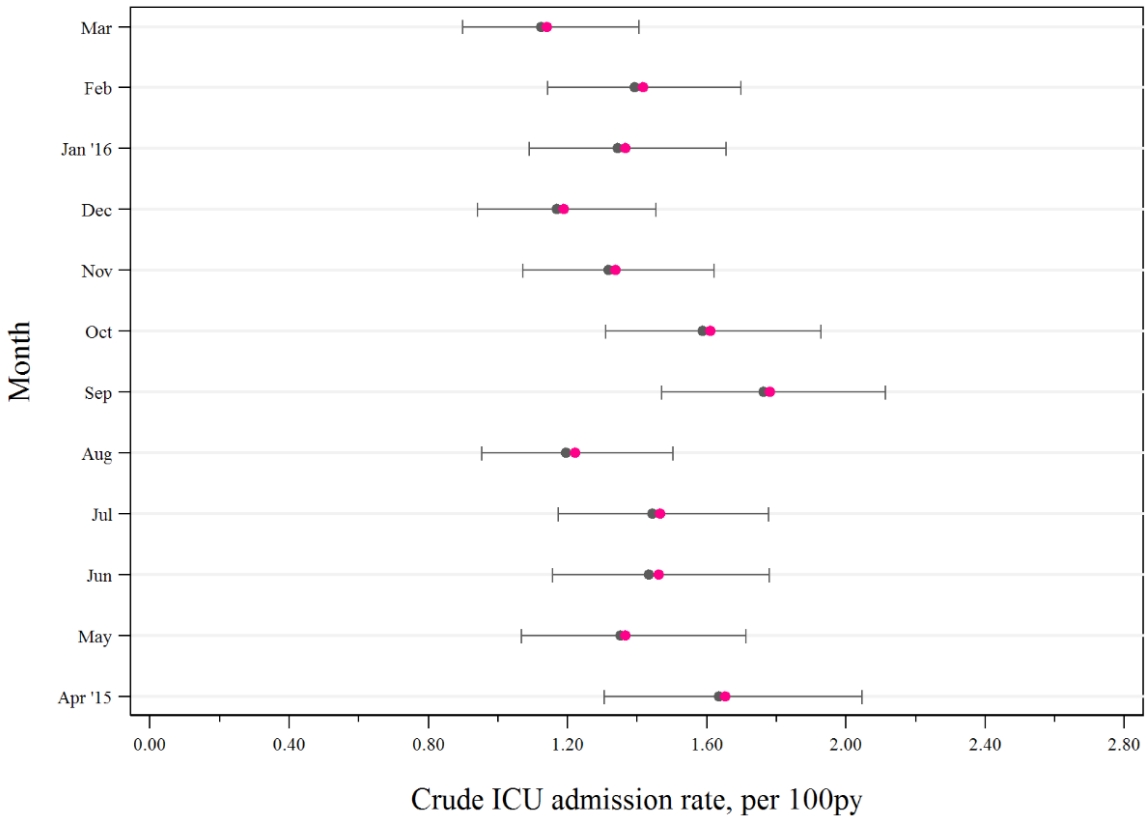


the standardised age-sex population distribution used reflects the population being reported on (people with other renal codes)

Appendix Figure 19: ICU admissions by admission method

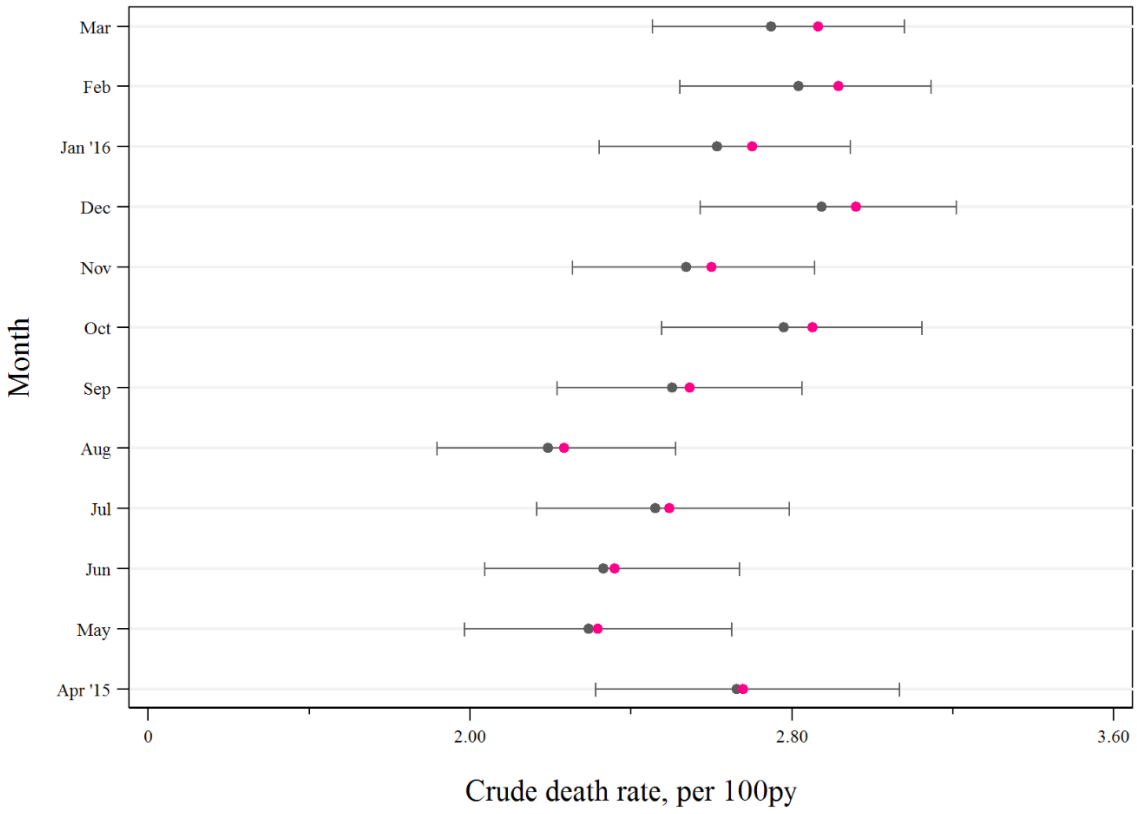


Appendix Figure 20: ICU admission rates by month in people with other renal codes, with pink dots representing age-sex standardised rates; not adjusted for comorbidity



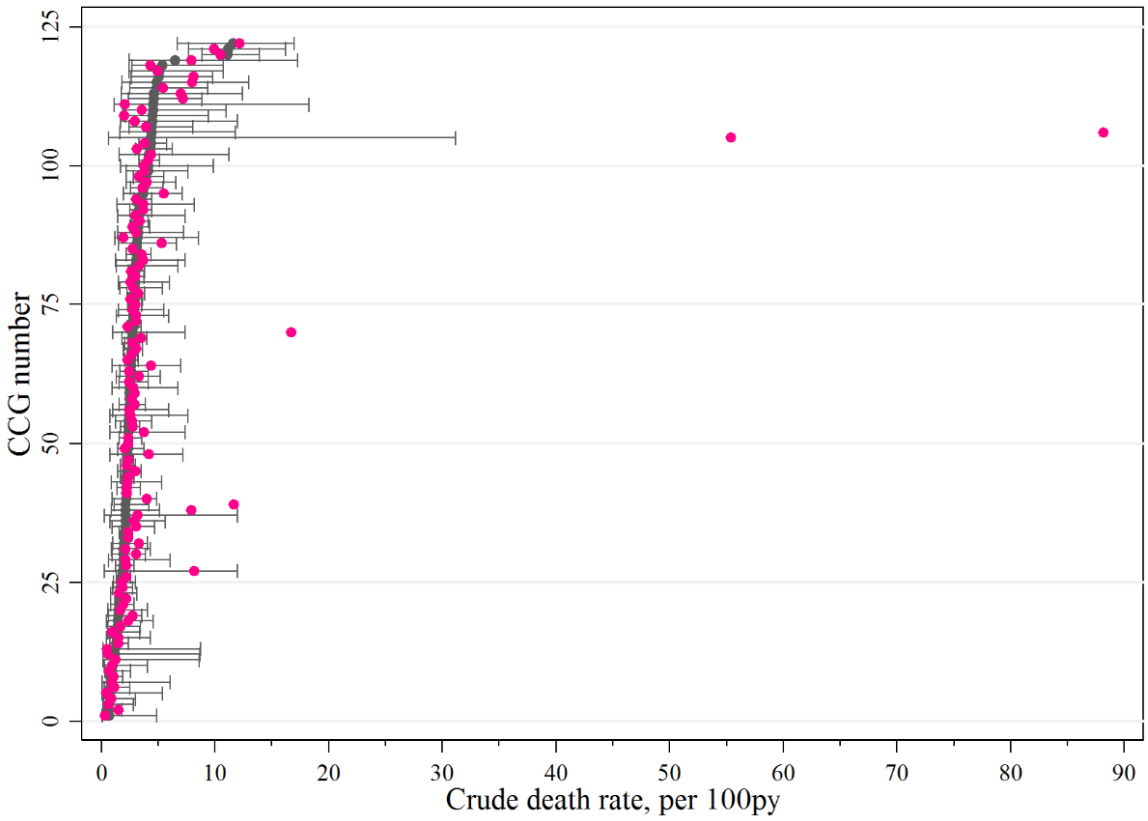
**the standard age-sex population distribution used reflects the population being reported on (people with other renal codes)*

Appendix Figure 21: Rates of death by month in people with other renal codes, with pink dots representing age/sex standardised rates; not adjusted for comorbidity*



the standardised age-sex population distribution used reflects the population being reported on (people with other renal codes)

Appendix Figure 22: Death rates by CCG in people with other renal codes, with pink dots representing age-sex standardised rates; not adjusted for comorbidity*



*the standardised age-sex population distribution used reflects the population being reported on (people with other renal codes)