How do primary care doctors in England and Wales code and manage people with chronic kidney disease?

Results from the National Chronic Kidney Disease Audit

Lois G Kim[1,2], Faye Cleary[1], David C Wheeler[3], Ben Caplin[3], Dorothea Nitsch[1], Sally A Hull[4]

On behalf of the UK National Chronic Kidney Disease Audit

[1] Department of Non-communicable Disease Epidemiology, Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, Keppel St, London. WC1E 7HT.

[2] Cambridge Centre for Health Services Research, Department of Public Health and Primary Care, University of Cambridge, School of Clinical Medicine, Cambridge. CB2 0SR.

[3] Clinical Effectiveness Group, Centre for Primary Care and Public Health, Queen Mary University of London, Yvonne Carter Building, 58 Turner St, London. E1 2AB.

[4] Centre for Nephrology, UCL Medical School. Rowland Hill St, London. NW3 2PF.

Corresponding author:

Lois G Kim,

Cambridge Centre for Health Services Research,

Department of Public Health and Primary Care,

University of Cambridge,

School of Clinical Medicine,

Cambridge.

CB2 0SR.

T. 01223 761762

lois.kim@lshtm.ac.uk

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Summary:

In the UK, primary care records are electronic and require doctors to ascribe disease codes to facilitate efficient care and appropriate prescribing. The National CKD Audit assessed how many people in England and Wales with evidence for CKD stages 3-5 based on biochemical data were coded with CKD by primary care doctors. Patients who had biochemical evidence of CKD but were not coded as such were less well managed. In summary, further incentivising coding for CKD in UK primary care may improve outcomes for patients.

Abstract

Background

In the UK, primary care records are electronic and require doctors to ascribe disease codes to direct care plans and facilitate safe prescribing. We investigate factors associated with coding of chronic kidney disease (CKD) in patients with reduced kidney function and the impact this has on patient management.

Methods

We identified patients meeting biochemical criteria for CKD (two eGFRs <60ml/min/1.73m^2 taken >90 days apart) from 1039 GP practices in a UK audit. Clustered logistic regression was used to identify factors associated with coding for CKD and improvement in coding as a result of the audit process. We investigated the relationship between coding and five interventions recommended for CKD: achieving blood pressure targets, proteinuria testing, statin prescription, and flu and pneumococcal vaccination.

Results

Of 256,000 patients with biochemical CKD, 30% did not have a GP CKD code. Males, older patients, those with more severe CKD, diabetes, hypertension, or those prescribed statins were more likely to have a CKD code. Amongst those with continued biochemical CKD following audit, these same characteristics increased the odds of improved coding. Patients without any kidney diagnosis were less likely to receive optimal care than those coded for CKD (e.g. OR for meeting blood pressure target 0.78, 95% CI 0.76 to 0.79).

Conclusion

Older age, male sex, diabetes and hypertension are associated with coding for those with biochemical CKD. CKD coding is associated with receiving key primary care interventions recommended for CKD. Increased efforts to incentivise CKD coding may improve outcomes for CKD patients.

Introduction

Chronic kidney disease (CKD) has an estimated prevalence in the UK of around 5-7%[1, 2], based on creatinine measurements for stage 3-5 disease. The majority of CKD patients are diagnosed and managed by primary care physicians, rather than kidney specialists in secondary care settings. Early identification of people with CKD in primary care, particularly among populations with risk factors such as diabetes and hypertension, enables early management of high blood pressure and correction of adverse lifestyle factors. Progression of CKD can be delayed by such interventions[3], and the implementation of these interventions can be improved by use of quality improvement tools in primary care[4].

In the UK, primary care health records are computerised, with each condition given a diagnostic "Read code" to enable more systematic patient management and appropriate prescribing. The UK Quality and Outcomes Framework (QOF)[8] is an ongoing pay for performance system which incentivises aspects of primary care delivery. Coding for CKD based on two eGFR measurements below 60ml/min/1.73m^2 within 90 days has been incentivised in the QOF; however, there is evidence to suggest that this system does not capture all CKD cases meeting diagnostic criteria. It has been reported that only 55-70% of patients with biochemical evidence of CKD (stages 3-5) have an appropriate Read code in GP practice databases[5-7]. Practice-level prevalence of coded CKD (as captured in QOF) is positively associated with practice prevalence of diabetes, cardiovascular disease, and negatively associated with social deprivation[9]. The extent of this lack of coding varies widely by GP practice, even after accounting for practice-level differences in risk factors such as diabetes[6]. QOF registers are also subject to error relating to cases coded as CKD in the absence of biochemical evidence; recent data suggested that 11% of cases on QOF registers do not fulfil biochemical testing criteria, rising to 36% amongst those with black ethnicity[1]. It has further been shown that appropriate coding of CKD in the primary care electronic record may be associated with improved blood pressure management and urinary albuminuria testing, in comparison to those with uncoded CKD[5].

The National Chronic Kidney Disease Audit[6] (NCKDA) was set up to audit the testing, identification and management of CKD in primary care in the UK. The audit capitalised on the existence of computerised practice records, and used an automated extraction tool that directly extracted data from the electronic health record with automatic encrypted upload to a central data safe haven. The first round of data collection (round 1) provided an initial snapshot of the above outcomes for the practices enrolled in the audit. Practices were encouraged to make use of the electronic quality improvement (QI) tools for CKD which had been developed by the NCKDA team in collaboration with Informatica Systems as an integral component of the audit. The QI tools provided practice lists of people with risk factors who may need testing for CKD, people who may require CKD coding or coding removal, and prompts to support the management of those with coded CKD. In addition, consultation prompts alerting clinicians to people with uncoded CKD could be activated[1]. A second extraction of data was made (round 2) at least 90 days after round 1, to ascertain the impact of the QI aspect of the audit process.

We used individual patient data from the NCKDA to investigate the associations between individual patient characteristics and coding for CKD, amongst those with biochemical evidence of CKD based on creatinine measurements. We further sought to identify the characteristics associated with improvements in coding status at round 2. Amongst patients with biochemical evidence of CKD, we then investigated the relationship between coding and five key markers of primary care management of CKD[10]: (1) meeting blood pressure targets, (2) being offered statins for cardiovascular disease (CVD) prevention, (3) receipt of urinary albumin-to-creatinine ratio (ACR) or protein-to-creatinine ratio (PCR) testing, (4) receipt of flu vaccine, and (5) receipt of pneumococcal vaccine (for those with CKD stage 4-5 disease).

This work will help identify whether there are population sub-groups for whom coding for CKD requires improvement, and whether these same characteristics are associated with lack of coding improvement or receipt of primary care interventions aimed at improving patient outcomes.

Methods

Data source and study population

All practices in the England and Wales who were current users of the Informatica Audit Plus software were invited to participate in NCKDA between March 2015 and July 2016). NCKDA round 1 data were collected from all GPs in 1039 GP practices representing an underlying population of 8.24m over 18-year-olds in England and Wales. Coverage in England and Wales differed substantially as a result of technical difficulties and differential use of the software used to extract data for the NCKDA[1]; final coverage was approximately 76% of practices in Wales and 9% of practices in England. All Welsh practices had Audit Plus installed (funded by the National Health Service in Wales) whilst in England, practices actively purchased Informatica audit plus software to support better disease management[1]. Data on CKD coding, eGFR test results, and relating to CKD management were extracted for all patients with risk factor coding for CKD at least one year prior to data extract. A full list of risk factor codes and full details regarding the study population is available elsewhere[1]. Practices received an email feedback about the prevalence of biochemical, coded and uncoded CKD suggesting that they might use the QI software to improve coding.

Round 2 data were collected from 948 of these practices, with a median of 8 months from round 1 (range 3 to 20 months). Figure 1 shows patient progress from round 1 to round 2 by coding status. 65,661 patients with uncoded CKD at round 1 (i.e. no code for stage 3-5 CKD, but with biochemical evidence for CKD) for whom round 2 data confirming biochemical CKD were available, were included in an analysis of coding improvement.

Information about referrals to secondary care was available through (i) extraction of out-patient referral codes collected at round 1 from the GP record and (ii) linkage to out-patient records from Hospital Episode Statistics (HES) for England (data collected for the period 01/04/12 to 30/06/16) and NHS Wales Informatics Statistics (NWIS) (01/01/12 to 30/06/16).

Outcomes

Coding

Coding status for CKD (defined by the presence of a code for stage 3-5 CKD) was analysed for 256,433 patients with biochemical evidence of CKD (two MDRD-IDMS eGFR measurements <60ml/min/1.73m^2 at least 90 days apart). MDRD-IDMS measurements incorporating the ethnicity adjustment were derived from creatinine measurements and used for this analysis, as the majority of labs in the UK do not report the CKD-EPI eGFR.

Coding improvement

Amongst patients with uncoded CKD at round 1 and for whom round 2 data confirm biochemical CKD, coding improvers were defined as those who had a code for stage 3-5 CKD at round 2.

Referrals to secondary care

Referral to secondary care is defined as any nephrologist referral code collected at round 1 from the GP records or any nephrologist out-patient clinic code held in the HES database (see Appendix).

Primary care management of CKD

(a) Blood pressure management

Patients were considered to have met blood pressure targets if they had blood pressure measurements taken in the previous year and either (i) systolic blood pressure <130mmHg and diastolic blood pressure <80mmHg (for those with diabetes or proteinuria defined as last ACR≥70mg/mmol or last PCR ≥100mg/mmol) or (ii) systolic blood pressure <140mmHg and diastolic blood pressure <90mmHg (for everyone else). Those with blood pressure measurements taken more than one year earlier were not included as meeting targets, regardless of measurement. Only the single most recent blood pressure measurement was available from the GP record.

(b) Statins

As part of CVD prevention strategy, statin therapy is recommended for all individuals with CKD stage 3-5[11]. We report here for individuals for whom there was any previous recording of statin prescription collected at round 1 from the GP record.

(c) Proteinuria testing

It is recommended that testing for proteinuria is carried out at least once a year for all individuals with CKD stage 3-5 (increasing to 4 times a year for those at stage 5)[10, 11]. Proteinuria testing was considered as having been undertaken if patients had had an albumin-to-creatinine ratio (ACR) or

protein-to-creatinine ratio (PCR) test collected at round 1 that was from (i) the previous year or (ii) the previous two years, to provide some insight into the extent of deviation from testing guidelines.

(d) Flu vaccination

Guidelines state that all individuals with CKD stage 3-5 should be offered an annual flu vaccination unless contraindicated[10]. We report the percentage of patients receiving this vaccination in the previous year.

(e) Pneumococcal vaccination

For individuals with CKD stage 4-5, it is additionally recommended that pneumococcal vaccination is administered unless contraindicated, and that individuals are offered re-vaccination within five years[10]. We report the percentage of patients with stage 4-5 disease receiving this vaccination in the previous five years.

Amongst those with uncoded CKD, results are presented separately for those with and without a urological or renal diagnostic disorder code (a full list of corresponding read codes is available elsewhere[1]).

Predictors of coding and coding improvement

The following characteristics were considered as potentially being associated with coding and/or coding improvement:

(i) Age: categorised in 10-year age-bands (plus <50 and 90+ groups).
(ii) Index of multiple deprivation (IMD): categorised in approximate quintiles of the distribution for the study population, plus an additional category for those with missing IMD (these are all from Welsh practices; 93% of Welsh practices did not have any IMD data available).
(iii) Last known CKD stage: defined by categorising the last known eGFR measurement using standard definitions[10]: stage 3a (eGFR 46-59ml/min/1.73m^2), stage 3b (eGFR 31-45ml/min/1.73m^2), stage 4 (eGFR 16-30ml/min/1.73m^2) and stage 5 (eGFR<15ml/min/1.73m^2).
(iv) Diabetes: defined as any previously recorded diagnosis for diabetes (incentivised by QOF).
(v) Hypertension: defined as any previously recorded date for hypertension diagnosis (incentivised by QOF).
(vi) Statin prescription: defined as any previously recorded date on which statins were prescribed.
(vii) Country: indicator for Wales or England.

Statistical methods

Population-averaged logistic GEE models were fitted for having coded CKD (amongst those with biochemical CKD at round 1) and for coding improvement (amongst those with uncoded biochemical CKD at round 1 and biochemical CKD at round 2), allowing for clustering of patients within practices.

Use of five interventions for CKD was summarised amongst those with biochemical CKD according to CKD and renal disorder coding status. Odds ratios comparing the coding groups for each of these management outcomes were estimated using population-averaged clustered logistic GEE models adjusted for IMD group, sex, age group, country, last known CKD stage, diabetes, hypertension, CVD and statins (except for statins outcome).

Results

Predictors of coding for CKD

A breakdown of coding status by key characteristics is given in Table 1 for the 256,433 patients with stage 3-5 biochemical CKD, among which 78,156 (30%) did not have a read code for CKD. There was considerable inter-practice variation in the proportion of biochemical CKD cases that were coded, ranging from 4% to 100%.

Being male, being older, having later stage CKD, lower IMD (more deprived), diabetes, hypertension and being offered statins were all associated with increased odds of coding in unadjusted analyses. In a mutually adjusted analysis, all these associations remained except for IMD (Table 1). Belonging to an English practice rather than a Welsh practice also seemed to increase the odds of coding in both the unadjusted and adjusted analyses. There was evidence that the difference between males and females was only present in Wales (multivariable OR for males in Wales 1.11, 95% CI 1.07 to 1.14; in England, multivariable OR 1.01, 95% CI 0.99 to 1.04; p-value for interaction <0.0005).

Around half of those with uncoded stage 5 CKD (164 / 317) also had a renal disorder code (Table 2). Of the 153 who did not, 45 had either a dialysis or a transplant code, and a further 70 had a nephrologist referral code (either in the audit data or HES data). This left 38 / 3254 (1%) of patients with biochemical evidence of stage 5 CKD who were not coded for CKD, had no other renal code and who also had no referral, dialysis or transplant code.

Predictors of coding improvement at round 2

Amongst those with uncoded biochemical CKD at round 1 who also had biochemical evidence of CKD at round 2, 5,211 patients (out of 54,000; 9.7%) were found to have been coded at round 2 (Table 3).

After adjusting for other factors, those aged under 60 had a 15-20% reduction in odds of coding improvement compared to those aged 60+, although those aged 90+ also had a 15% reduction in odds of coding improvement compared to those aged 60-69 (OR 0.86 (0.79, 0.95)) (Table 3). Those with CKD stage 3b-5 all had a 1.5 to 2-fold increase in the odds of coding compared to those with biochemical evidence for CKD stage 3a. Furthermore, there was evidence of higher odds of coding improvement amongst males and those with diabetes, hypertension and on statins. There was no evidence of a difference in improvement by IMD.

Associations of coding with CKD management

Receipt of all primary care management interventions was highest in those who were coded for CKD (Table 4). The odds of receiving each intervention were greatest in those with coded CKD; the odds of intervention were comparatively reduced amongst those with uncoded CKD and a renal disorder code (except for statins, where the adjusted odds were similar to those with coded CKD), and reduced even further for those with uncoded CKD and no renal disorder code.

Blood pressure targets had only been met in the previous year in around 50% of patients with coded CKD; the odds of meeting the target were even lower in those with uncoded CKD, with a 15% reduction in those with a renal code and a 20% reduction in those without a renal disease code. Proteinuria testing was also low at around 50% of coded CKD patients in the previous year; this was considerably lower in those with uncoded CKD, with around a 50% and 80% reduction in odds for those with and without renal codes respectively. Around 70% of those patients with coded CKD had been offered a statin at some time in the past, with substantially reduced odds for those with uncoded CKD and no renal disease code. There was around a 20% reduction in odds of receiving both vaccinations for those with uncoded CKD and a renal code compared to those with coded CKD, and a 25% reduction in odds for those with uncoded CKD and no renal code.

Referrals to secondary care

Referrals recorded on either the GP record or hospital episode statistics (HES) databases accounted for 27.9% of those with uncoded CKD at round 1 with a renal code, but only 5.3% of those with uncoded CKD and no renal code (compared to 19.0% of those with coded CKD).

Discussion

Main findings

Younger patients, females, and those without major co-morbidities (diabetes, hypertension) who have biochemical evidence of CKD are least likely to have a CKD (3-5) code in their primary care record. Patients with biochemical CKD without a CKD code were less likely to be offered a statin, receive flu and pneumococcal vaccination, have their blood pressure controlled to target or have undergone proteinuria testing. Those who have biochemical evidence of CKD and a renal code were more likely to have received some interventions, but not to the same level as people with biochemical CKD who were coded.

Main findings in context

Among the 256,433 cases with biochemical evidence of CKD at round 1 of the national CKD audit, only 70% (178,277 / 256,433) are included on the QOF register as CKD stage 3-5. This compares to 72% reported by Jain et al[5] in a sample of similar size from 2005-9. Although broadly similar, some of the difference could be explained by the definitions of biochemical CKD used (we use two eGFRs at least three months apart, versus their two measurements seven days apart), and our use of re-calculated eGFRs.

Amongst those patients with biochemical evidence of CKD, males, older patients, those with lower eGFR (more severe CKD stage), diabetes, hypertension, receiving statins and in English practices had increased odds of being coded for CKD. Another study previously reported similar relationships with sex and co-morbidities, but not with age[12]. Our results suggest that even for patients with the same CKD stage and co-morbidities, younger patients have reduced odds of coding compared to older patients. Furthermore, we have shown that these same characteristics (except country) were associated with coding improvement following audit amongst those patients with uncoded biochemical CKD at round 1 who still had evidence of biochemical CKD at round 2. Although others have demonstrated that quality improvement tools can be useful in improving intervention outcomes[13], such studies have taken a more direct approach to improve specific interventions such as blood pressure control rather than through coding improvements, which may be more wide-reaching.

Our findings on management interventions for patients with coded CKD in primary care are also broadly similar to those reported elsewhere[14, 15], but we have also demonstrated the positive relationship between coding and patient management.

Interpretation and implication

There are many reasons why an individual with biochemical evidence of CKD may not have a corresponding code, including uncertainty about guidelines for testing and diagnosis and concern about medicalising a natural aging process[15]. However, the relevance of the absence of coding lies in its potential impact on a range of patient measures in primary care. Here, this is substantiated by the reported differences in the application of key management interventions between coded and uncoded groups with biochemical CKD. Amongst those with uncoded CKD, having a renal disorder code is associated with higher application of all these interventions, though not to the same level as those with a CKD code. We examined the possibility that the observed differences are, at least in part, due to differences in recording of these interventions and whether those with renal disorder codes may be managed in secondary, rather than primary care, with a corresponding lack of recording on GP databases. Investigation of referrals to secondary care suggests that although the difference in interventions in patients with coded CKD and those with uncoded CKD and a renal disorder may in part be explained by differences in referrals, there is no evidence that patients without a CKD or a renal disorder code are receiving interventions in secondary care. However, it is also possible that some referrals were not captured here for example, for joint specialist outpatient

clinics which may be coded under the non-nephrology speciality code in HES (e.g joint diabetic-renal specialist clinic, or joint urology-renal clinic).

Our findings suggest that practices and local health authorities should take a more active approach to ensuring CKD coding and resultant patient review for those with CKD, and that implementation is encouraged using active quality improvement techniques. In the UK, this is of particular importance as the renal QOF indicators have now been retired[16].

Strengths and limitations

We use data from a large, population-based study to investigate relationships between coding, patient characteristics and care. Although large and with good coverage of Welsh practices (76%), the study includes only 9% of English GP practices. It is likely that practices with higher ethnic minorities are under-represented in this sample (in England, the non-white population is around 9.1%, compared to 4.4% in Wales[17]). Previous work has suggested that CKD prevalence varies across ethnic minorities[18], but also that management outcomes may be reduced in these minority sub-groups[19]. Furthermore, participating English practices had chosen to install the audit software and therefore are more likely to have an interest in quality improvement. In light of this, for England, the underlying proportion of uncoded biochemical CKD cases may be even higher than we report, and management outcomes may be lower in some or all of the groups of patients with CKD.

Limitations of the audit include the use of routinely collected clinical data. There will inevitably be inaccuracies in the clinical dataset, and it is likely that there will be under-recording of at least some morbidities, however under-recording would mean that the GP also is not aware of the respective morbidity. The “missingness” in hypertension, diabetes and statin prescriptions is not known, since this would occur where there is an absence of a recorded date, making it indistinguishable from individuals without these events. However, as recording of hypertension and diabetes has been incentivised by QOF through a number of measures, there is little reason to assume that a majority of cases would have been missed.

Conclusions

Electronic quality improvement initiatives, which alert practitioners to uncoded CKD cases, with in-consultation prompts and patient lists requiring action, produce a small but important improvement in coding. However, this improvement tends to be focussed on older patients and those with well-established risk factors for CKD. Further efforts to improve coding for younger patients who have much to gain from regular CKD review, blood pressure and CVD risk management are needed.

Conflict of interest statement

DW has received honoraria from: Akebia, Amgen, AstraZeneca, Boehringer Ingelheim, Vifor Fresenius Medical Care, Janssen, Otsuka, ER Squibb.

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Table 1 Coding for CKD by patient characteristics, amongst those with biochemical evidence of CKD

	N with biochemical CKD at round 1	% of these who are coded for CKD	Univariable OR for coding (95% CI)	Multivariable** OR for coding (95% CI)
Sex				
Female	152,194	68.8%	1	1
Male	104,239	70.6%	1.09 (1.06, 1.11)	1.04 (1.02, 1.07)
Age				
<50	5,371	57.7%	0.82 (0.77, 0.87)	0.82 (0.78, 0.88)
50-59	12,612	55.9%	0.79 (0.76, 0.82)	0.86 (0.83, 0.89)
60-69	39,520	62.1%	1	1
70-79	82,776	69.7%	1.38 (1.34, 1.42)	1.23 (1.20, 1.27)
80-89	90,209	73.9%	1.69 (1.64, 1.75)	1.37 (1.32, 1.41)
90+	25,945	74.2%	1.72 (1.64, 1.80)	1.34 (1.28, 1.40)
IMD[$]				
<10000	41,051	71.4%	1	1
10000-14999	28,079	71.2%	0.98 (0.95, 1.02)	1.00 (0.97, 1.04)
15000-19999	30,222	70.4%	0.95 (0.92, 0.99)	0.98 (0.94, 1.02)
20000-24999	31,815	70.1%	0.94 (0.91, 0.97)	0.99 (0.95, 1.02)
25000+	40,230	70.1%	0.95 (0.91, 0.99)	1.01 (0.97, 1.05)
Missing	85,036	67.2%	0.86 (0.78, 0.95)	1.09 (0.96, 1.23)
Last known CKD stage*				
Stage 3a				
Stage 3b	160,100	60.8%	1	1
Stage 4	75,855	82.5%	3.01 (2.90, 3.12)	2.71 (2.62, 2.80)
Stage 5	17,224	89.7%	5.64 (5.25, 6.06)	5.03 (4.70, 5.38)
	3,254	90.3%	5.94 (5.22, 6.77)	5.81 (5.13, 6.58)
Diabetes				
No	187,716	67.5%	1	1
Yes	68,717	75.2%	1.45 (1.41, 1.49)	1.11 (1.08, 1.14)
Hypertension				
No	74,817	59.2%	1	1
Yes	181,616	73.8%	1.83 (1.79, 1.87)	1.50 (1.47, 1.53)
Statin offered				
No	84,885	62.0%	1	1
Yes	171,548	73.3%	1.64 (1.60, 1.67)	1.38 (1.35, 1.40)
Country				
Wales	85,308	67.1%	1	1
England	171,125	70.7%	1.25 (1.12, 1.40)	1.42 (1.18, 1.71)

* Based on last eGFR measurement. Stage 3a: eGFR 46-59ml/min/1.73m^2; stage 3b: eGFR 31-45ml/min/1.73m^2; stage 4: eGFR 16-30ml/min/1.73m^2; stage 5: eGFR<15ml/min/1.73m^2

** simultaneous adjustment for all characteristics in table

[$] Low IMD rank corresponds to higher deprivation

Table 2 Percentage of coding for renal disorder by CKD coding status and stage, amongst those with biochemical evidence of CKD at round 1 of the National CKD Audit

	CKD Coded		CKD not coded	
Last known CKD stage*	**N**	**% with renal disorder code**	**N**	**% with renal disorder code**
Stage 3a	97,352	13.7%	62,748	6.2%
Stage 3b	62,543	19.3%	13,312	12.0%
Stage 4	15,445	34.6%	1,779	27.7%
Stage 5	2,937	59.1%	317	51.7%

* Based on last eGFR measurement. Stage 3a: eGFR 46-59ml/min/1.73m^2; stage 3b: eGFR 31-45ml/min/1.73m^2; stage 4: eGFR 16-30ml/min/1.73m^2; stage 5: eGFR<15ml/min/1.73m^2

Table 3 ***Coding improvement amongst those with biochemical evidence of CKD at round 1 (uncoded) and round 2 of the National CKD Audit***

	N with biochemical evidence of CKD at R1 (uncoded) and R2	% of these coded at R2	Multivariable** OR for coding improvement at R2
Sex			
Female	32,661	9.0%	1
Male	21,339	10.7%	1.14 (1.09, 1.19)
Age			
<50	1,507	8.2%	0.83 (0.72, 0.97)
50-59	3,636	7.5%	0.85 (0.78, 0.94)
60-69	10,243	9.7%	1
70-79	17,844	10.4%	1.04 (0.99, 1.10)
80-89	16,537	9.6%	0.96 (0.90, 1.02)
90+	4,233	9.2%	0.86 (0.79, 0.95)
IMD[$]			
<10000	7,481	11.7%	1
10000-14999	5,286	11.8%	1.01 (0.92, 1.12)
15000-19999	5,816	13.0%	0.97 (0.87, 1.07)
20000-24999	6,514	10.8%	0.93 (0.85, 1.02)
25000+	8,088	10.9%	0.94 (0.87, 1.03)
Missing	20,815	6.6%	0.85 (0.63, 1.16)
Last known CKD stage*			
Stage 3a	42,405	8.7%	1
Stage 3b	10,085	12.5%	1.50 (1.42, 1.59)
Stage 4	1,302	16.9%	2.02 (1.78, 2.30)
Stage 5	208	13.9%	1.53 (1.08, 2.17)
Diabetes status			
No	41,934	9.0%	1
Yes	12,066	11.8%	1.21 (1.15, 1.28)
Hypertension status			
No	20,784	8.1%	1
Yes	33,216	10.6%	1.24 (1.17, 1.31)
Statin offered			
No	21,850	8.8%	1
Yes	32,150	10.2%	1.08 (1.03 1.13)
Country			
Wales	20,917	6.7%	1
England	33,083	11.5%	1.21 (0.81, 1.79)

* based on last eGFR measurement at R1. Stage 3a: eGFR 46-59ml/min/1.73m^2; stage 3b: eGFR 31-45ml/min/1.73m^2; stage 4: eGFR 16-30ml/min/1.73m^2; stage 5: eGFR<15ml/min/1.73m^2

** simultaneous adjustment for all characteristics in table

R1 = round 1; R2 = round 2

[$] Low IMD rank corresponds to higher deprivation

Table 4 Management outcomes for those with biochemical evidence of CKD at round 1, by coding status

	Coded CKD	Uncoded CKD with renal disorder code	Uncoded CKD without renal disorder code
N	178,277	6,176	71,980
Met blood pressure target in past year*			
% achieving outcome	51.5%	41.7%	46.8%
Adjusted OR (95% CI)[$]	1	0.83 (0.78, 0.87)	0.78 (0.76, 0.79)
Statins offered			
% achieving outcome	70.5%	69.2%	57.8%
Adjusted OR (95% CI)[$$]	1	1.04 (0.97, 1.11)	0.69 (0.67, 0.71)
ACR/PCR test in past year			
% achieving outcome	49.7%	32.7%	15.9%
Adjusted OR (95% CI)[$$$]	1	0.50 (0.45, 0.55)	0.20 (0.18, 0.22)
ACR/PCR test in past 2 years			
% achieving outcome	73.8%	49.4%	25.1%
Adjusted OR (95% CI)[$$$]	1	0.35 (0.32, 0.39)	0.12 (0.11, 0.13)
Flu vaccination in past year			
% achieving outcome	79.3%	72.9%	69.6%
Adjusted OR (95% CI)[$]	1	0.83 (0.77, 0.88)	0.75 (0.73, 0.77)
Pneumococcus vaccination in past 5 years, stage 4-5 only (based on last eGFR)[^]			
% achieving outcome	16.1%	15.5%	11.3%
Adjusted OR (95% CI)[$]	1	0.79 (0.63, 1.00)	0.73 (0.62, 0.86)

* measurements taken in past year and sbp<130mmHg and dbp<80mmHg (for those with diabetes or proteinuria) or sbp<140mmHg and dbp<90mmHg for everyone else

[$] adjusted for IMD group, sex, age group, country, last known CKD stage, diabetes, hypertension, CVD and statins offered.

[$$] adjusted for sex, age group, last known CKD stage, hypertension and CVD (due to model convergence).

[$$$] adjusted for age group and last known CKD stage only (due to model convergence).

[^] numbers in stage 4-5 in each coding category: coded CKD (n=19,076), uncoded CKD with renal code (n=755), uncoded CKD without renal code (n=1,739)

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