International statistical classification of diseases and related health problems coding underestimates the incidence and prevalence of acute kidney injury and chronic kidney disease in general medical patients

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Key words
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Abstract

Background: The international classification of diseases (ICD) code is frequently used to identify renal impairment in epidemiological research. However, Australian studies examining accuracy of this administrative data in coding kidney injury are lacking.

Aims: To compare the ICD 10 coding with the kidney disease: improving global outcomes (KDIGO) criteria in diagnosing acute kidney injury (AKI) and/or chronic kidney disease (CKD).

Methods: A retrospective study of 325 patients admitted to general medicine during January 2012 was performed. Sensitivity and specificity of ICD 10 in identifying AKI and CKD were calculated using KDIGO as gold standard.

Results: The sensitivities of ICD 10 in identifying AKI and CKD were low for both (59.5% and 54.1%), but the specificities were high (86.2% and 90.2%). Using KDIGO criteria, we identified 72 AKI (22%), 56 CKD (17%), 64 AKI on CKD (19%) and 133 controls (40%). Compared to the control group, patients with AKI and AKI on CKD had longer length of stay (3.2 vs 4.9 days and 3.2 vs 4.8 days, P = 0.20). Renal impairment groups had increased in-hospital mortality rate (5% control, 6% AKI, 10% CKD, 9% AKI on CKD) and re-admission rate within 30 days (13% control, 20% AKI, 25% CKD, 26% AKI on CKD). After adjusting for age, gender and comorbidities, the difference in outcomes was not statistically significant.

Conclusion: This study shows that ICD 10 fails to identify almost half of the patients with AKI (40.5%) and CKD (45.9%) in our cohort. A total of 60% had evidence of renal impairment as defined by KDIGO.

Introduction

Acute kidney injury (AKI) is defined as any of the following: increase in serum creatinine by (≥26.5 μmol/L) within 48 h or an increase in serum creatinine to ≥1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; or urine volume < 0.5 mL/kg/h for 6 h.1 Chronic kidney disease (CKD) is defined as abnormalities of kidney structure or function, present for >3 months, with implications for health. Kidney damage is identified by the presence of one of the following markers: albuminuria ≥30 mg/day, urine sediment abnormalities, electrolyte and other abnormalities due to tubular disorders, abnormalities detected by histology, structural abnormalities detected by imaging, history of kidney transplantation, glomerular filtration rate (GFR) < 60 mL/min/1.73 m².

Many patients admitted to general internal medicine units have renal insufficiency as defined above. Renal diseases are present in 17–30% of acute medical admissions.2–4 A reduced estimated GFR (eGFR) is associated with increased risks of death, cardiovascular events and hospitalisation that are independent of the known risk factors (age, sex, income, education, use of dialysis, history of ischaemic stroke, cardiovascular disease, peripheral arterial disease, diabetes mellitus, hypertension, dyslipidaemia, cancer, hypoalbuminaemia, dementia, cirrhosis, chronic lung disease, documented proteinuria and prior hospitalisations).5

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Australian public hospitals translate the diagnoses and procedures to codes, using the international statistical classification of diseases and related health problems, 10th revision, Australian Modification codes (ICD 10), which are reflective of documentation in the discharge summaries completed by the treating clinicians. The codes and the assigned DRG are transmitted to the Department of Health (DoH) and the hospital is funded accordingly. This funding is known as case-mix funding. It has previously been reported that up to 87% of admissions with renal insufficiency are not coded as having kidney failure.4 Therefore, we calculated the sensitivity and specificity of ICD 10 in identifying AKI and/or CKD using the kidney disease: improving global outcomes (KDIGO) criteria as the gold standard. We then evaluated the incidence of AKI and prevalence of CKD as per KDIGO criteria and their association with clinical outcomes.

Methods

Study site

The study was conducted at Western Health (WH), a tertiary-level health service with two major hospital campuses in Melbourne, Australia.

Inclusion and exclusion criteria

Data were extracted from 325 consecutive discharge episodes from the general internal medicine units at WH in January 2012. Patients with end stage kidney disease on dialysis and those with kidney transplant were not included in this study.

Data source

A database at WH records patient age, sex, discharge unit, country of birth, length of hospital stay (LOS) and detailed ICD 10 coding information ascribed to that patient during the admission. Additional data on medical history, discharge summary, clinical outcomes and laboratory results were obtained from the patients’ digital hospital records. The Charlson comorbidity index was used as a measure of comorbidities in patients.6

Definitions

Three approaches (KDIGO criteria, ICD 10 codes and discharge summary documentation) were used to identify four cohorts (control, AKI, CKD and AKI on CKD).

Kidney disease: improving global outcomes (KDIGO)

A baseline serum creatinine level and eGFR, from the 7 days to 12 months prior to admission, were available for 222 patients (69%). All 325 patients had serum creatinine and eGFR on admission and 303 (94%) on discharge. Patients with a rise in admission serum creatinine of ≥26.5 μmol/L or an increase to 1.5-fold from the baseline was classified as having AKI. Those with a fall in serum creatinine of ≥26.5 μmol/L from the admission to the discharge were also identified as AKI. Patients with documented CKD in medical history and/or those with baseline and admission eGFR < 60 mL/min/1.73 m² were defined as CKD. All other patients who did not meet the above criteria were included as the control group. Urine output criteria were not used as it was inconsistently documented.

International statistical classification of diseases and related health problems (ICD 10)

We identified the ICD 10 codes specific for AKI and CKD as per ‘Acute kidney injury in Australia: a first national snapshot’ report from the Australian Institute of Health and Welfare.7 The codes included for AKI were N17.0-9, N00, N10, E10.29, E11.29, E13.29 and E14.29. To identify CKD, N18.1-9, E10.2, E11.2, E13.2, E14.2, I12, I13, I15, N00-N07, N08, N11, N12, N14, N15, N16, N18, N19, N25-N28, N391, N392, E85.1, D59.3, B52 and Q60-Q63 were used. E10.29, E11.29, E13.29, E14.29 and N00 are overlapping codes for AKI and CKD. All other inpatient episodes without AKI and CKD codes were defined as the control cohort.

Discharge summary

All 325 discharge summaries were individually reviewed by SK and SV to identify documentation of AKI, CKD and AKI on CKD.

Outcomes

We pre-specified the following outcomes for each episode: the LOS, re-admission within 30 days and in-hospital mortality. Inpatient LOS was calculated in days from admission until discharge from the health service. Re-admission within 30 days was recorded as a binary variable. We included all cause hospital re-admissions to WH general internal medicine units within 30 days of discharge from the index admission.
Statistical analysis

Sensitivity and specificity were calculated with following equations: Sensitivity = true positive/(true positive + false negative), Specificity = true negative/(true negative + false positive). Continuous variables were described as mean ± standard deviation (SD) or median with inter-quartile range (IQR) if not normally distributed. Categorical variables were expressed as number (n) and percentage (%). Patients were separated into four groups as per KDIGO criteria (AKI, CKD, AKI on CKD and control/no renal impairment). Characteristics of these groups were compared with the Kruskal–Wallis H test for numerical variables and the Pearson Chi-squared test for nominal values. LOS was presented as both mean and median. Mean LOS was adjusted for age, gender, congestive cardiac failure, hypertension, diabetes mellitus and ischaemic heart disease with analysis of covariance. Logistic regression was used to examine the association of the groups with in-hospital mortality and re-admission within 30 days adjusting for the covariates as described above. Results of the regression analyses were displayed as odds ratio (OR) with 95% confidence interval (CI). Descriptive analyses were undertaken using Microsoft Excel (Microsoft Corp., Redmond, WA, USA); inferential analyses were performed using IBM SPSS Statistics software version 24.0 (IBM Corp., Armonk, NY, USA). A P-value of <0.05 was considered significant.

Ethics approval

Approval was obtained from the WH Low-Risk Human Research Ethics Panel (QA2013.15).

Results

Comparing ICD 10 with KDIGO

KDIGO criteria identified 72 AKI (22%), 56 CKD (17%), 64 AKI on CKD (19%) and 133 control (40%) out of 325 patients (Fig. 1). In contrast, using ICD 10 identifies 47 AKI (14%), 25 CKD (7%), 60 AKI on CKD (18%) and 193 as having no renal injury (59%; Fig. 2). The sensitivity and specificity of ICD 10 in diagnosing AKI were 59.5% and 86.2% respectively. In regard to identifying CKD, sensitivity was 54.1% and specificity was 90.2% (Table 1).

Comparing diagnoses of AKI/CKD in discharge summary with KDIGO

The sensitivity of discharge summary diagnosis of AKI was only 38.2%, but specificity was 92.5%. Similarly, the sensitivity of CKD was 43.3% and specificity was 97% (Table 2).
Baseline characteristics of four cohorts defined by KDIGO

The average age in the control group was 66 ± 18.3 years whereas it was significantly higher in AKI group (71.2 ± 15), CKD group (81.5 ± 8.1) and AKI on CKD group (81 ± 9.6). There was no significant difference in the number of males across all four groups. The mean eGFR on admission was 73.3 ± 16.6 mL/min/1.73 m² in the control group and it was significantly lower in AKI, CKD and AKI on CKD groups (55.5 ± 19.2, 39.6 ± 14.6 and 27 ± 12.1 respectively). The number of patients with congestive cardiac failure, ischaemic heart disease, diabetes mellitus and hypertension was significantly increased in all renal impairment groups. There was also a statistically significant difference in the Charlson index between the kidney injury groups and control group. Frequencies of the comorbidities are listed in Table 3.

Outcomes in four cohorts defined by KDIGO

The median LOS in the control group was 2.60 (IQR: 1.10–5.00) days (Table 4). Mean LOS were also shown in Table 4. None of the differences between groups was statistically significant.

Patients with renal impairment had higher rates of re-admission within 30 days, although, after adjusting for age, gender and comorbidities, statistical significance was not reached. The OR of re-admission within 30 days for the three renal impairment groups (AKI, CKD, AKI on CKD) compared with control group were 1.51 (CI: 0.68–3.36; P = 0.30), 1.40 (CI: 0.57–3.45; P = 0.45) and 1.59 (CI: 0.67–3.75; P = 0.29) respectively (Table 5).

In total, 24 deaths occurred during the admission out of 325 patients (7.3%). In-hospital mortality was increased in patients with kidney injury, particularly CKD (10%) and AKI on CKD (9%) compared to those without (5%). But, there was no statistical significance and the numbers of deaths were small (Table 6).

Discussion

To our knowledge, this is the first study to compare ICD 10 with KDIGO in identifying AKI and/or CKD in hospitalised general medical patients in Australian tertiary hospitals.
An estimated 1.7 million (10%) Australian adults, aged 18 years and over, had biochemical evidence of CKD, based on measured data from the Australian Bureau of Statistics 2011–2012 Australian Health Survey. Furthermore, after age 74, rates of CKD increased to 42%. The average age of patients with CKD in our study was 81.5 ± 8.1 years. Therefore, the proportion of patients with CKD identified by KDIGO (36.9%) reflects the epidemiological data more accurately than ICD 10 coding (26.1%).

In fact, our study of predominantly older patients with comorbidities, had a higher proportion of patients with reduced renal function than previously described in the literature (17–30%). This may be partly explained by the fact that the number and rate of hospitalisations due to kidney disease has been increasing in Australia. The number of hospitalisations for CKD as a principal diagnosis (excluding dialysis) increased by 12% from 2000–2001 to 2007–2008. During the same period, the number of hospitalisations where CKD was an additional diagnosis also increased by 48%. Similarly, aged standardised hospitalisations rates for AKI as a principal diagnosis have increased by 69% between 2000–2001 and 2012–2013.

Aitken et al. reported that in a 650-bed university teaching hospital in Glasgow, the median LOS for patients with AKI was 11.5 days and in-hospital mortality was 19%. In our AKI cohort of patients, median LOS was 4.1 days and mortality was 6%. LOS of patients with CKD (median 2.5 days) was similar to those without renal insufficiency (median 2.6 days). Furthermore, our study did not show statistically significant increase in mortality and re-admission within 30 days for both AKI and CKD groups. These findings in clinical outcomes may be due to the facts that we included patients admitted to general internal medicine units alone and that our sample size was small. Patients with end-stage kidney disease on renal replacement therapy are admitted under nephrology units in our institution. In addition, patients are admitted directly to medical units from emergency departments as there is no acute medical assessment unit. Thus, our cohort may include more low acuity admissions.

Previous studies have used administrative data to identify AKI and CKD. However, lack of coding and inconsistencies have been noted and another Australian study by Yong et al. reported that 87% of admissions with renal insufficiency were not coded. In comparison, 40% of AKI and 45% of CKD in our study were not coded. For patients without AKI, 13% were coded incorrectly as having AKI. Only 9% of those without CKD were coded as having CKD erroneously.

The poor sensitivity of ICD 10 could be due to under-diagnosis by medical staff, inadequate documentation in discharge summaries and/or inaccurate coding practice. To evaluate further, we analysed the comparison between discharge summary diagnoses and KDIGO criteria. Once again, sensitivities were low (38.2% for AKI and 43.3% for CKD). On the other hand, specificities were high (92.5% for AKI and 97.0% for CKD). This suggests that under-diagnosis of renal injury and

### Table 4 Length of stay (LOS)

|          | Median LOS | IQR | Mean LOS | 95% CI |
|----------|------------|-----|----------|--------|
| Control  | 2.600      | 1.200 | 4.800    | 3.208  | 2.016 | 4.400 |
| AKI      | 4.150      | 2.425 | 7.325    | 4.948  | 3.537 | 6.360 |
| CKD      | 2.500      | 1.100 | 5.000    | 3.342  | 1.969 | 4.714 |
| AKI on CKD | 3.800      | 2.225 | 5.900    | 4.852  | 3.564 | 6.140 |

P-value = 0.20. †Adjusted for age, gender, congestive cardiac failure, ischaemic heart disease, diabetes and hypertension. AKI, acute kidney injury; CI, confidence interval; CKD, chronic kidney disease; IQR, interquartile range.

### Table 5 Re-admission within 30 days

|          | Re-admission within 30 days, n (%)† | P-value | OR (95% CI)‡ |
|----------|------------------------------------|---------|--------------|
| Control  | 18 (13)                            |         |              |
| AKI      | 15 (20)                            | 0.30    | 1.51 (0.68–3.36) |
| CKD      | 14 (25)                            | 0.45    | 1.40 (0.57–3.45) |
| AKI on CKD | 17 (26)                            | 0.29    | 1.59 (0.67–3.75) |

†Four cases excluded as there was no data regarding re-admission. †Adjusted for age, gender, congestive cardiac failure, ischaemic heart disease, diabetes and hypertension. AKI, acute kidney injury; CI, confidence interval; CKD, chronic kidney disease; OR, odds ratio.

### Table 6 In-hospital mortality

|          | In-hospital mortality, n (%)† | P-value | OR (95% CI)‡ |
|----------|-------------------------------|---------|--------------|
| Control  | 7 (5)                         |         |              |
| AKI      | 5 (6)                         | 0.90    | 0.92 (0.24–3.46) |
| CKD      | 6 (10)                        | 0.41    | 1.74 (0.46–6.57) |
| AKI on CKD | 6 (9)                         | 0.53    | 1.51 (0.40–5.69) |

†One case excluded as there was no data regarding mortality. †Adjusted for age, gender, congestive cardiac failure, ischaemic heart disease, diabetes and hypertension. AKI, acute kidney injury; CI, confidence interval; CKD, chronic kidney disease; OR, odds ratio.
infrequent documentation in discharge summaries were mainly responsible for poor sensitivity of ICD 10 with significant implications, such as an impact on post-discharge medical care for the patients and loss of case-mix based funding for the hospitals.

The strength of our study is that we fully reviewed each patient’s electronic medical records and pathology results to identify patients with AKI and/or CKD as per KDIGO definitions and compared these results with ICD 10 coding in the same cohort. A single laboratory was used limiting inter-laboratory error and misclassification. We analysed a large, diverse and unselected hospitalised adult population with an array of comorbidities. Our main finding is of substantial importance given renal impairment has been linked to increased use of health-care services and expenditures.11

This study has several limitations. Generalisability of our results is limited by the fact that our study is based on a single health service and lacks long-term outcome data. The identification of an individual comorbid condition does not account for the severity of the condition in question. Other residual known and unknown confounders that were not accounted for in our analyses also might have affected the clinical outcomes. Furthermore, there might have been outcome misclassification due to the ascertainment bias of potential hospital readmissions to other acute-care facilities. For practical reasons, we used the Modification of Diet in Renal Disease (MDRD) study equation to estimate the GFR in identifying CKD. Calculating eGFR by MDRD equation has not been validated in Aboriginals, Pacific Islanders, Chinese ethnicities and we did not adjust the result for patients from African origin. Our study included three patients with Chinese ethnicity, two Pacific islanders and one African patient. Three patients had missing ATSI (Aboriginal and Torres Strait Islander) status. Like all other creatinine-based estimation equations, there are physiologic limitations of creatinine as a filtration marker. All estimates of GFR based on serum creatinine will be less accurate for patients at the extremes of muscle mass (including frail elderly, critically ill or cancer patients), those with unusual diets, and those with conditions associated with reduced secretion or extra-renal elimination of creatinine.

Conclusion

In summary, a large number of patients with kidney injury are admitted to our general internal medicine units. Using the administrative diagnostic codes to identify AKI/CKD in admitted general medical patients will result in an underestimation of true incidence and prevalence.

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