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Epidemiology of chronic kidney disease in Australian general practice: National Prescribing Service MedicineWise MedicineInsight dataset

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SUMMARY AT A GLANCE

This study described a large cohort of Australian general practice-based patients identified as having chronic kidney disease (CKD), utilizing data from MedicineInsight dataset, and aimed to compare this dataset against the Australian Bureau of Statistics' CKD prevalence estimates. The results provided important and interesting sociodemographic data of CKD in Australia, and might further assist general practitioners to optimize the prevention and care of CKD patients.

ABSTRACT:

Aim: **To describe sociodemographic characteristics and comorbidities of a large cohort of Australian general practice-based patients identified as having chronic kidney disease (CKD), using data from National Prescribing Service (NPS) MedicineWise's MedicineInsight dataset, and compare this dataset to the 2011–2012 Australian Health Survey's (AHS) CKD prevalence estimates.**

Methods: **This was a cohort study using deidentified, longitudinal, electronic health record data collected from 329 practices and 1 483 416 patients distributed across Australia, from 1 June 2013 until 1 June 2016. Two methods were used to calculate the CKD prevalence. One used the same method as used by the 2011–2012 AHS, based on one estimate of the estimated glomerular filtration rate (eGFR) or albumin/creatinine ratios (ACR). The other defined CKD more rigorously using eGFR or ACR results at least 90 days apart.**

Results: **In 2016, of 1 310 602 active patients, 710 674 (54.2%) did not have an eGFR or ACR test, while 524 961 (40.1%) had an eGFR or ACR test but did not meet AHS criteria for CKD. Age–sex adjusted rates of CKD (compared to AHS) were CKD 1–0.45% (3.9%), CKD 2–0.62% (2.5%), CKD 3a: 3.1% (2.7%), CKD 3b: 1.14% (0.6%), CKD 4–5: 0.41% (0.3%). The CKD cohort defined more rigorously using eGFR and ACR measures >90 days apart, had comorbidities of atrial fibrillation (30.5%), cardiovascular disease (25.0%), diabetes mellitus (17.1%) and hypertension (14.8%).**

Conclusion: **The MedicineInsight dataset contains valuable and timely information about Australian patients with CKD, and provides prevalence estimates similar to those from AHS data.**

Chronic kidney disease (CKD) is a worldwide health problem with an increasing incidence and prevalence, especially in developed countries, such as Australia.[1] It is usually associated with multimorbidity, even at moderate, stage 3 levels.[2] The current standard for estimating the prevalence of CKD in the Australian population is the Australian Bureau of Statistics (ABS) dataset, incorporating self-report surveys and based on a 2011–2012 sample of 31 937 Australians.[3,4] Due to the reliance on health literacy and recall, this approach may not produce the most accurate picture of the health of Australians.[5]

In the United Kingdom, the Clinical Practice Research Datalink (CPRD) national registry, comprising primary care data from almost 3 million patient electronic health record (EHR), has been shown to have good external validity for estimating the prevalence of reduced kidney function (glomerular filtration rate, GFR <60 mL/min per 1.73 m^2).[6] In contrast, large datasets from general practices in Australia have not previously been used, although the country now seems well suited to such an approach. While laboratories in only 18% and 8% of countries report routine estimates of

and proteinuria measures, respectively,[7] to assist in the recognition of CKD, Australian general practitioner (GP) have had access to routine GFR estimates for 10 years.[8] On average, 85% of Australians visit their general practitioner at least once in a year.[9] The details of these visits will typically be recorded electronically; by 2014 Australian GP were using EHR 98% of the time for prescribing and 70% reported a paperless office.[9] Paper-based GP recording of consultation details, using relatively small patient populations, has been previously used to extrapolate the prevalence of chronic conditions and multi-morbidity.[10] While the collection of cross-sectional de-identified data from Australian general practice EHR has been described, most studies to date have also used relatively small populations or been limited geographically.[11]

The National Prescribing Service (NPS) MedicineWise MedicineInsight dataset is the largest and most representative general practice/primary care clinical dataset yet developed in Australia[12,13]; it currently has over 650 recruited general practices, providing a database of over 3.6 million records of Australian patients. Since 2013, general practices and GP across Australia have been able to contribute their data. The dataset includes information from codable and free-text fields within an EHR, such as medication prescribed and vaccines given, biometrics, investigations ordered and conditions managed for each patient. Updating the data every 2–4 weeks provides a longitudinal picture for each person in the database[13] .

This study aimed to describe a large cohort of Australian general practice-based patients identified as having CKD, utilizing data from NPS MedicineWise's MedicineInsight dataset, and to compare this dataset against the ABS's CKD prevalence estimates.[4] The MedicineInsight dataset was also used to describe associated sociodemographic characteristics and comorbidities for Australians with CKD.

METHODS

The NPS MedicineWise's MedicineInsight data has been described elsewhere.[12] This dataset was collected from 329 participating practices representing 1 483 416 active patients from 1st June 2013 until 30th June 2016. Active patients are defined as those visiting the general practice at least three times over the previous 2 years.[14] We used two methods to calculate the prevalence of CKD in our population. In the first method, data collected from 01 January 2013 to 01 June 2016 was used to identify patients ≥18 years of age with probable CKD stages 1–5.[15] All staging was based on estimated glomerular filtration rate (eGFR) and/or urinary albumin-to-creatinine ratio (ACR) results, as per the ABS's CKD criteria.[4] CKD stage 1 classification depended on the presence an eGFR ≥90 mL/min per 1.73 m^2 and albuminuria of ≥2.5 for males or ≥3.5 for females (urine ACR mg/mmol). CKD stage 2 resulted from an eGFR of 60–89 mL/min per 1.73 m^2 and the same ACR finding. CKD stage 3a classification depended on finding an eGFR of 45–59 mL/min per 1.73 m^2, with CKD stage 3b on finding an eGFR of 30–44 mL/min per 1.73 m^2. CKD stages 4–5 depended on an eGFR of <30 mL/min per 1.73 m^2. We used each patient's first eGFR and first ACR in each calendar year to determine their stage of CKD, as per the Australian Health Survey (AHS).[3] Patients were only included in the dataset by the 30th of June in the nominated year if they had a general practice encounter or a pathology result within the previous year.

In the second method, CKD status was determined by two eGFR results <60 mL/min per 1.73 m^2 at least 90 days apart, and/or presence of albuminuria for >90 days of ≥3.5 mg/mmol for females, and ≥2.5 mg/mmol for males. We have labelled this cohort as 'Two eGFRs or ACRs CKD'. This method matches that recommended for the diagnosis of CKD in Australian general practice.[16]

Both CKD cohorts were determined using pre-calculated eGFR measurement results routinely sent to general practices as part of a pathology dataset. The modification of diet in renal disease (MDRD) equation had been used to calculate the eGFR in 85% of the pre-calculated eGFR results, while the remainder were based on the chronic kidney disease epidemiology collaboration (CKD-Epi) equation. To standardize the mix of MDRD and CKD-EPI calculations of raw data eGFR, all eGFR were recalculated using the CKD-EPI (2009) formula.[17] As data had been obtained in 5 years age groups from NPS MedicineWise MedicineInsight, the patient's age at the time of testing was calculated as the median age of their respective 5 years group minus the number of days prior to the end of the study period that the test results were provided. ACR measurements were a stand-alone pathology request.

The diagnoses of anxiety disorder, atrial fibrillation (AF), cardiovascular disease (CVD), CKD, diabetes mellitus (diabetes) and hypertension (HT) were recorded based on 'condition flags' provided by NPS MedicineWise MedicineInsight. Condition flags are devised using algorithms that analyse coded and free-text information in the fields of either 'encounter_reason', 'prescription_reason', or 'diagnosis_reason',[18,19] .

Statistical analysis

All data cleaning, data manipulation and statistical analysis were completed using the statistical and graphical computing language of R (https://www.R-project.org/). Pearson's χ^2 test of independence was used to determine differences in proportions between the CKD cohort and all active patients in the dataset.

Age–sex adjustment of raw prevalence rates, and their 95% confidence intervals (CI), were completed using the 'Age-standardization – direct method' described by Boyle and Martin.[20] Potential clustering by practice was not accounted for in the calculation of the 95% CI. The reference population for age–sex standardization was from the

Australian Demographic Statistics (June 2016) report from the Australian Bureau of Statistics.[21]

Rurality was based on Australian Bureau of Statistics' (ABS) Australian Statistical Geography Standard (ASGS) remoteness areas.[22] Socio-economic index was also based on patient postcode, using the socio-economic indexes for area (SEIFA) of relative socio-economic advantage and disadvantage decile. SEIFA is ranked from 1 (most disadvantaged area) to 10 (most advantaged)[23] .

RESULTS

The number of active patients varied over the three annual periods from 1 041 529 to 1 310 602, reflecting the increasing enrolment of general practices in the NPS MedicineWise MedicineInsight program over that period. As noted in Table 1, while the number of patients in the dataset grew each year from 2014 to 2016 the percentage of patients not tested with either a measure of eGFR or ACR, those who were tested but did not meet AHS criteria for CKD, and those who met criteria for CKD 1–5 remained relatively stable.

Table 2 describes the unadjusted prevalence of CKD for adult males and females, in 10 years age groupings in the year from 02 June 2015 to 01 June 2016. This year was the latest in the dataset. In Table 1, three annual time-periods from June 2nd to June 1st each year (2014–2016) were used to compare the age- and sex-adjusted prevalence for each CKD stage with the figures obtained from the AHS in 2011–2012.[3] Figure 1 demonstrates the selection process leading to the more rigorous definition of CKD.[16] Of 1 483 416 active patients, 524 430 (35%) did not have an eGFR or ACR measurement in the study period. Of the 958 986 patients with at least one eGFR or ACR, 893 682 (93% of those tested) did not have an eGFR <60 mL/min per 1.73 m^2, or an abnormal ACR. Of the 113 517 with results potentially classifying them as having CKD 3–5, only 61 102 (54%) had 2 measures at least 90 days apart on which to base a more accurate diagnosis of CKD 3–5.

Table 3 presents MedicineInsight data collected in the period 02 June 2015 until 01 June 2016 (denoted as 2016). Socio-demographic characteristics, smoking status and comorbidities of are presented as rows. As columns are: all 2016 MedicineInsight patients, described as current, who had either a general practice encounter, or any pathology result entered into their EHR during the time period; 'Two eGFRs and/or 2ACRs CKD' cohort as a percentage of all 2016 patients; patients who have ever had an eGFR as a percentage of all 2016 patients; patients who had an eGFR of <60 mL/min per 1.73 m^2 as a percentage of all 2016 patients; and patients who had an eGFR <60 mL/min per 1.73 m^2 as a percentage of those who had an eGFR in 2016. Each group with eGFR measures were then age- and sex-adjusted against ABS data.

Figure 2 is a Venn diagram illustrating the mix of comorbidities in patients from the 'Two eGFRs and/or 2 ACRs CKD' cohort.

DISCUSSION

The NPS MedicineWise MedicineInsight database provides a new tool for measuring the prevalence of CKD in the Australian population. Because the data is longitudinal with multiple pathology results per patient, it is possible to be more rigorous in defining a cohort of patients with CKD based on the requirement to more properly define CKD as having

Table 1 Comparison of yearly MedicineInsight data to Australian Health Study age and sex-adjusted results by the Australian Bureau of Statistics.

	2014†		2015†		2016†		Australian Health Study Data
	n (%)	Age–sex adjusted % (95% confidence intervals (CI))	*n* (%)	Age–sex adjusted % (95% CI)	*n* (%)	Age–sex adjusted % (95% CI)	Age–sex adjusted by ABS‡
No Indicators§	394 961 (37.9%)	35.65% (34.62–36.69)	502 554 (38.5%)	37.18% (36.14–38.22)	524 961 (40.1%)	38.83% (37.77–39.88)	81.6%
Stage 1	3802 (0.4%)	0.35% (0.22–0.48)	5430 (0.4%)	0.41% (0.27–0.55)	5876 (0.4%)	0.45% (0.30–0.59)	3.9%
Stage 2	5708 (0.5%)	0.47% (0.33–0.61)	6982 (0.5%)	0.49% (0.35–0.64)	8145 (0.6%)	0.58% (0.42–0.74)	2.5%
Stage 3a	33 015 (3.2%)	2.57% (2.27–2.87)	37 362 (2.9%)	2.57% (2.25–2.88)	40 666 (3.1%)	2.79% (2.46–3.11)	2.7%
Stage 3b	10 938 (1.1%)	0.84% (0.67–1.02)	13 482 (1.0%)	0.92% (0.73–1.11)	14 941 (1.1)	1.02% (0.82–1.22)	0.6%
Stages 4–5	3297 (0.3%)	0.26% (0.16–0.36)	4555 (0.3%)	0.32% (0.20–0.43)	5339 (0.4%)	0.37% (0.24–0.49)	0.3%
Not tested¶	589 808 (56.6%)	59.85% (58.81–60.89)	736 105 (56.3%)	58.11% (57.07–59.14)	710 674 (54.2%)	55.97% (54.93–57.02)	8.4%
Active during this year††	1 041 529	–	1 306 470	–	1 310 602	–	–

†Year is from June 2nd to June 1st the following year[1]. ‡Percentages are based on the Australian Health Study/Australian Bureau of Statistics definition of chronic kidney disease . §Had an estimated glomerular filtration rate and or albumin/creatinine ratios, but did not meet Australian Health Study/Australian Bureau of Statistics definition for chronic kidney disease . ¶Did not have a recorded albumin/creatinine ratios or estimated glomerular filtration rate in year. ††Patients were included in this analysis if they had a GP encounter or pathology measurement within that year.

Table 2 Prevalence of patients in 'two eGFRs and/or ACRs CKD' cohort by gender and age-group

Age-group	MedicineInsight		Two eGFRs and/or ACRs CKD cohort		Encounter in 2016	Australian Health Study CKD Stages based on 2016 Encounter Data			
Females	*n*	%	*n*	% of medicine Insight Dataset	*n*	Stage 3a n (%)[#]	Stage 3b *n* (%)[#]	Stage 4–5 *n* (%)†	Total*n* (%)†
20–29	150 334	17.73%	34	0.02%	127 038	27 (0.02%)	9 (0.01%)	11 (0.01%)	47 (0.04%)
30–39	166 953	19.69%	114	0.07%	144 268	117 (0.08%)	23 (0.02%)	30 (0.02%)	170 (0.12%)
40–49	152 374	17.97%	359	0.24%	135 390	386 (0.29%)	63 (0.05%)	63 (0.05%)	512 (0.38%)
50–59	140 668	16.59%	1291	0.92%	127 233	1222 (0.96%)	217 (0.17%)	151 (0.12%)	1590 (1.25%)
60–69	116 604	13.75%	4463	3.83%	107 376	3877 (3.61%)	726 (0.68%)	293 (0.27%)	4896 (4.56%)
70–79	71 472	8.43%	10 548	14.76%	67 061	7475 (11.15%)	2235 (3.33%)	658 (0.98%)	10 368 (15.46%)
80–89	39 084	4.61%	12 785	32.71%	36 372	7082 (19.47%)	3706 (10.19%)	1071 (2.94%)	11 859 (32.60%)
90+	10 542	1.24%	4351	41.27%	9377	1804 (19.24%)	1344 (14.33%)	494 (5.27%)	3642 (38.84%)
Total	848 031	100%	33 945	4.00%	754 115	21 990 (2.92%)	8323 (1.10%)	2771 (0.37%)	33 084 (4.39%)
Males									
20–29	93 259	14.71%	42	0.05%	76 025	46 (0.06%)	13 (0.02%)	14 (0.02%)	73 (0.10%)
30–39	114 061	17.99%	117	0.10%	95 280	78 (0.08%)	31 (0.03%)	43 (0.05%)	152 (0.16%)
40–49	116 040	18.30%	370	0.32%	100 486	338 (0.34%)	64 (0.06%)	100 (0.10%)	502 (0.50%)
50–59	113 395	17.88%	1274	1.12%	101 292	1232 (1.22%)	248 (0.24%)	180 (0.18%)	1660 (1.64%)
60–69	101 602	16.02%	4575	4.50%	93 247	3926 (4.21%)	880 (0.94%)	350 (0.38%)	5156 (5.53%)
70–79	62 713	9.89%	9551	15.23%	58 606	6889 (11.75%)	2084 (3.56%)	712 (1.21%)	9685 (16.53%)
80–89	28 110	4.43%	9136	32.50%	26 129	5275 (20.19%)	2586 (9.90%)	892 (3.41%)	8753 (33.50%)
90+	4844	0.76%	2087	43.08%	4331	892 (20.60%)	712 (16.44%)	277 (6.40%)	1881 (43.43%)
Total	634 024	100%	27 152	4.28%	555 396	18 676 (3.36%)	6618 (1.19%)	2568 (0.46%)	27 862 (5.02%)

[†]Number of patients meeting Australian Health Study criteria. Percentage of patients with a General Practitioner encounter or pathology result in 2016. ACR, albumin/creatinine ratios; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

eGFR that remain at or below cut-off points over a period of 90 days or more.[16] The resultant large cohort is then useful to view as a more specific group with which to investigate factors leading to disease stability or progression. This could form an important CKD research tool and offers the same benefits as a registry but across earlier stages of CKD.[24]

The age- and sex-adjusted prevalence rates with the MedicineInsight dataset compare favourably with AHS figures for CKD stages 3a to 4–5, while figures for CKD 1–2 show a lower prevalence compared to AHS data.[3] This is likely to reflect the reasons for ordering pathology tests in general practice. Patients who may be diagnosable as CKD 1–2 may be comparatively well, presenting less often to their GP and having fewer reasons to have an eGFR and/or ACR ordered, while those with, for example, cardiovascular disease and diabetes are likely to have their renal function monitored regularly as part of overall management.[16]

The MedicineInsight dataset showed a higher prevalence of CKD in Aboriginal and Torres Strait Islander (ATSI) populations (5.51%) than non-ATSI populations (4.22%). There was also a clear correlation between CKD prevalence and areas of socio-economic disadvantage, with prevalence increasing from 3.54% in the most advantaged quintile to 4.63% in the most disadvantaged quintile. These findings are consistent with patterns of CKD prevalence reported in the AHS.[1]

The AHS dataset has limitations, noting that the current sample is dated - have been collected in 2011–2012, and is based on a relatively small sample, with the data based on 10 391 of 27 636 Australians over the age of 12 years submitting to one estimate of their eGFR, and 11 267 of 30 329 over the age of 5 years submitting a urine sample for an ACR.[3] Although the AHS results were then weighted against population benchmarks chosen to reduce random and systematic errors, the judicious use of the NPS MedicineWise MedicineInsight dataset could form a very useful adjunct noting the benefits of being drawn from a large, well-distributed population of Australians, its timeliness and associated extra data such as comorbidity prevalence.

The finding that 88% of patients in the 'current' cohort had a GP encounter or pathology result during the period 02 June 2015 until 01 June 2016 (denoted as 2016) fits well with estimates that, on average, 85% of Australians visit their GP annually.[9] The higher percentage of patients with flagged conditions within the 'current' 2016 cohort reflects the expected higher engagement rates of these patients with their general practice. Hence, over a year 95.2% of patients with AF, 92.1% with anxiety disorder, 94.9% with CVD, 94.7% with diabetes, 94.9% with HT and 97.1% with CKD saw their GP or had recorded in their EHR a pathology result.

Age- and sex-adjusted MedicineInsight data suggests 40–45% of Australian patients had an eGFR estimate in 2016. We do not know why these tests were undertaken

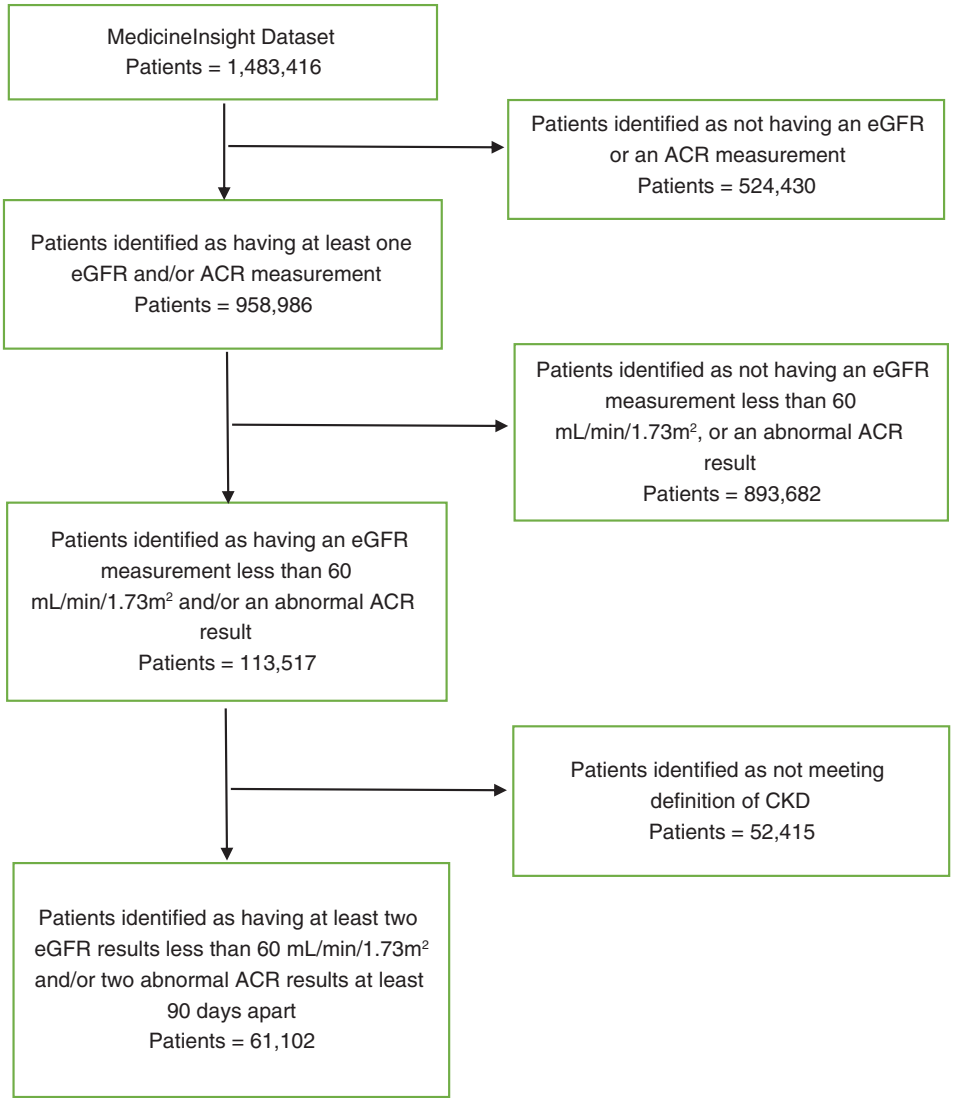

Fig. 1 Flow Chart of patient inclusions and exclusions.

but, appropriately, patients with a diagnosis of CKD had an eGFR at an annual rate of 87.3%, those with diabetes 67.7%, with CVD 58.8%, HT 58.4%, and AF 57.5%. Those with anxiety disorder, as an example of a disorder not noted as a CKD comorbidity, were only a little above the 40–45% rate at 49.6%. This suggests GP and their patients were aware of a need to check renal function in the face of known CKD or comorbidities of highest risk for the development, or progression of CKD.

The comorbidities of CKD patients managed by GP may be concordant conditions overlapping in pathophysiology and treatment goals such as HT and diabetes, or discordant with opposing management plans that may exacerbate CKD, such as arthritis and the use of non-steroidal anti-inflammatory drugs.[25] Further exploration of this dataset to investigate the use of medications in the management of concordant and non-concordant conditions is planned.

The NPS MedicineWise MedicineInsight dataset also has inherent limitations relating to its reliance on complete and accurate recording of data by GP, and the use of 'condition flags'. These limitations were partly illustrated by the finding that less than 25% of the patient with potentially diagnosable CKD had CKD documented as a 'condition flag' in their EHR. Comorbidities were recorded based on 'condition flags' provided by MedicineInsight, using an algorithm that analyses coded and free-text patient information; this algorithm has not been validated. Other limitations were the absence of 'condition flags' for haematuria, previous acute kidney injury, glomerulonephritis, or current renal replacement therapy, all factors of interest in describing the Australian population's CKD epidemiology.

Despite its limitations, the NPS MedicineWise MedicineInsight dataset could meet the call by researchers for the use of aggregated EHR data to evaluate primary care interventions,[26] while contributing to data-linkage studies that inform community-based needs assessment[27] and to drug post-marketing sentinel systems.[28] In the area of Australian patients with CKD, it is likely to provide a more

Table 3 Unadjusted and age/sex-adjusted percentages

	MedicineInsight data	Two eGFRs and/or two ACRs CKD cohort		Patients who had an eGFR in 2016		Had an eGFR < 60 mL/min per 1.73 m^2 in 2016		Had an eGFR < 60 mL/min per 1.73 m^2 in 2016	
	Current patients in 2016 [a] (% of category total)	n [b] (% of current patients in 2016*)	Age–sex-adjusted Prevalence (95% CI)	n [c] (% of current patients in 2016*)	Age–sex -adjusted % (95% CI)	n[†] (% of current patients in 2016*)	Age–sex-adjusted % (95% CI)	n[†] (% of patients who had an eGFR in 2016[‡])	Age–sex-adjusted % (95% CI)
n	1 309 511 (88.22%)	59 309 (59 309/1309511 = 4.53%)		597 332 (597 332/1309511 = 45.61%)		63 053 (63 053/1309511 = 4.82%)		63 053 (63 053/597332 = 10.56%)	
State									
NSW	374 969 (88.62%)	16 149 (4.31%)	3.65% (3.30–3.99)	173 670 (46.32%)	44.35% (43.29–45.41)	17 355 (4.63%)	3.94% (3.58–4.31)	17 355 (9.99%)	6.20% (5.81–6.58)
VIC	331 716 (88.30%)	15 343 (4.63%)	4.68% (4.27–5.09)	143 872 (43.37%)	43.38% (42.35–44.42)	16 341 (4.93%)	5.03% (4.57–5.43)	16 341 (11.36%)	7.58% (7.16–8.01)
QLD	238 418 (87.68%)	9703 (4.07%)	3.65% (3.29–4.00)	118 150 (49.56%)	47.03% (45.97–48.10)	10 397 (4.36%)	3.91% (3.54–4.27)	10 397 (8.8%)	5.83% (5.44–6.21)
WA	175 232 (87.29%)	7292 (4.16%)	3.87% (3.50–4.24)	72 079 (41.13%)	39.44% (38.41–40.47)	7768 (4.43%)	4.11% (3.72–4.48)	7768 (10.78%)	6.93% (6.52–7.33)
TAS	99 737 (92.46%)	6440 (6.46%)	4.93% (4.56–5.30)	48 324 (48.45%)	43.59% (42.54–44.65)	6454 (6.47%)	4.94% (4.56–5.31)	6454 (13.36%)	7.46% (7.03–7.89)
SA	45 899 (90.24%)	3209 (6.99%)	4.66% (4.32–5.00)	22 493 (49.01%)	43.67% (42.59–44.75)	3359 (7.32%)	4.95% (4.59–5.31)	3359 (14.93%)	7.58% (7.16–7.99)
ACT	21 084 (86.23%)	520 (2.47%)	3.25% (2.84–3.65)	9318 (44.19%)	45.78% (44.70–46.86)	630 (2.99%)	3.91% (3.46–4.35)	630 (6.76%)	5.99% (5.56–6.43)
NT	18 247 (81.53%)	518 (2.84%)	3.55% (3.12–3.98)	7787 (42.68%)	41.83% (40.76–42.91)	596 (3.27%)	4.03% (3.57–4.48)	596 (7.65%)	7.27% (6.78–7.76)
Rurality									
Major Cities	837 669 (88.00%)	35 256 (4.21%)	3.80% (3.44–4.16)	379 576 (45.31%)	44.02% (42.97–45.07)	37 928 (4.53%)	4.11% (3.73–4.49)	37 928 (9.99%)	6.35% (5.96–6.74)
Inner Regional	301 810 (89.64%)	15 486 (5.13%)	4.41% (4.03–4.78)	138 712 (45.96%)	43.19% (42.15–44.23)	16 153 (5.35%)	4.59% (4.21–4.97)	16 153 (11.64%)	7.12% (6.71–7.54)
Outer Regional	140 158 (88.29%)	7506 (5.36%)	4.76% (4.36–5.15)	66 301 (47.3%)	44.58% (43.53–45.64)	7810 (5.57%)	4.93% (4.53–5.34)	7810 (11.78%)	7.74% (7.29–8.18)
Remote	21 246 (86.49%)	765 (3.60%)	4.23% (3.80–4.65)	9062 (42.65%)	41.95% (40.89–43.01)	825 (3.88%)	4.47% (4.03–4.91)	825 (9.10%)	7.13% (6.68–7.59)
SEIFA quintile									
1	219 513 (89.59%)	12 766 (5.82%)	4.63% (4.26–4.99)	104 259 (47.50%)	44.35% (43.30–45.41)	13 430 (6.12%)	4.89% (4.50–5.27)	13 430 (12.88%)	7.54% (7.124–7.96)
2	201 115 (88.57%)	10 143 (5.04%)	4.37% (3.99–4.74)	95 788 (47.63%)	45.23% (44.19–46.29)	10 593 (5.27%)	4.56% (4.18–4.95)	10 593 (11.06%)	6.98% (6.57–7.39)
3	260 745 (88.40%)	12 389 (4.75%)	4.02% (3.66–4.38)	117 094 (44.91%)	42.60% (41.55–43.65)	13 172 (5.05%)	4.29% (3.91–4.69)	13 172 (11.25%)	6.89% (6.48–7.29)
4	263 761 (87.92%)	10 295 (3.9%)	3.99% (3.60–4.38)	120 516 (45.69%)	44.87% (43.83–45.92)	11 066 (4.20%)	4.27% (3.87–4.68)	11 066 (9.18%)	6.44% (6.03–6.83)
5	353 541 (87.89%)	13 370 (3.78%)	3.54% (3.18–3.89)	155 088 (43.87%)	42.98% (41.93–44.03)	14 405 (4.07%)	3.84% (3.47–4.21)	14 405 (9.29%)	5.97% (5.59–6.35)

Table 3 (Continued)

	MedicineInsight data	Two eGFRs and/or two ACRs CKD cohort		Patients who had an eGFR in 2016		Had an eGFR < 60 mL/min per 1.73 m^2 in 2016		Had an eGFR < 60 mL/min per 1.73 m^2 in 2016	
	Current patients in 2016 [a] (% of category total)	n [b] (% of current patients in 2016*)	Age–sex-adjusted Prevalence (95% CI)	n [c] (% of current patients in 2016*)	Age–sex -adjusted % (95% CI)	n† (% of current patients in 2016*)	Age–sex-adjusted % (95% CI)	n† (% of patients who had an eGFR in 2016‡)	Age–sex-adjusted % (95% CI)
Indigenous Status									
ATSI	21 110 (88.20%)	612 (2.90%)	5.51% (4.84–6.18)	9153 (43.36%)	46.67% (45.52–47.82)	632 (2.99%)	5.52% (4.85–6.18)	632 (6.90%)	8.99% (8.33–9.66)
Non-ATSI	916 086 (89.71%)	44 238 (4.83%)	4.22% (3.85–4.59)	431 361 (47.09%)	45.01% (43.96–46.06)	46 575 (5.08%)	4.45% (4.07–4.84)	46 575 (10.80%)	6.75% (6.34–7.15)
Missing	372 315 (86.20%)	14 459 (3.88%)	3.57% (3.21–3.93)	156 818 (42.12%)	40.75% (39.72–41.79)	15 846 (4.26%)	3.93% (3.55–4.30)	15 846 (10.10%)	6.48% (6.09–6.88)
	Current pin 2016 [a] (% of category total)	n [b] (% of current Patients in 2016*)	Age—adjusted prevalence (95% CI)	n [c] (% of current patients in 2016*)	Age–sex adjusted % (95% CI)	n† (% of current patients in 2016*)	Age–sex adjusted % (95% CI)	n† (% of patients who had an eGFR in 2016‡)	Age–sex adjusted % (95% CI)
Patients with	–	Unadjusted %	Prevalence of CKD in Patients with …	Unadjusted %	Percentage of patients with… who had an eGFR	Unadjusted %	Percentage of patients with… who had an eGFR less than 60	Unadjusted %	Percentage of patients with… who had an eGFR less than 60
Atrial fibrillation	29 969 (95.23%)	9137 (30.49%)	7.59% (6.84–8.34)	23 062 (76.95%)	57.49% (52.49–62.50)	8865 (29.58%)	7.71% (6.91–8.52)	8865 (38.44%)	10.35% (9.06–11.64)
No AF	–	–	3.81% (3.44–4.19)	–	43.57% (42.52–44.61)	–	4.11% (3.72–4.50)	–	6.49% (6.09–6.90)
Anxiety	177 380 (92.16%)	7818 (4.41%)	4.67% (4.22–5.12)	89 156 (50.26%)	49.62% (48.51–50.72)	7785 (4.39%)	4.66% (4.21–5.12)	7785 (8.73%)	6.58% (6.14–7.03)
No anxiety	–	–	3.98% (3.61–4.33)	–	42.92% (41.88–43.96)	–	4.28% (3.90–4.65)	–	6.72% (6.32–7.12)
CVD	93 314 (94.92%)	23 370 (25.04%)	7.95% (6.93–8.94)	70 117 (75.14%)	58.82% (54.59–63.05)	22 790 (24.42%)	7.71% (6.87–8.55)	22 790 (32.50%)	10.61% (9.19–12.01)
No CVD	–	–	3.33% (2.95–3.72)	–	42.86% (41.81–43.92)	–	3.70% (3.29–4.10)	–	6.06% (5.64–6.48)
Diabetes	109 036 (94.73%)	18 667 (17.12%)	7.65% (7.19–8.11)	83 564 (76.64%)	67.67% (65.77–69.57)	18 627 (17.08%)	7.71% (7.24–8.18)	18 627 (22.29%)	9.80% (9.19–10.41)
No Diabetes	–	–	3.40% (3.04–3.76)	–	42.09% (41.05–43.14)	–	3.72% (3.34–4.10)	–	6.03% (5.63–6.42)
Hypertension	315 555 (94.88%)	46 566 (14.76%)	6.24% (5.52–6.96)	215 781 (68.38%)	58.35% (55.53–61.16)	47 325 (15.00%)	6.41% (5.69–7.12)	47 325 (21.93%)	9.31% (8.13–10.48)
No Hypertension	–	–	2.18% (1.78–2.58)	–	39.99% (38.89–41.09)	–	2.60% (2.17–3.03)	–	4.74% (4.29–5.19)

Table 3 (Continued)

	MedicineInsight data	Two eGFRs and/or two ACRs CKD cohort		Patients who had an eGFR in 2016		Had an eGFR < 60 mL/min per 1.73 m^2 in 2016		Had an eGFR < 60 mL/min per 1.73 m^2 in 2016	
	Current patients in 2016 [a] (% of category total)	n [b] (% of current patients in 2016*)	Age–sex-adjusted Prevalence (95% CI)	n [c] (% of current patients in 2016*)	Age–sex -adjusted % (95% CI)	n [†] (% of current patients in 2016*)	Age–sex-adjusted % (95% CI)	n [‡] (% of patients who had an eGFR in 2016[‡])	Age–sex-adjusted % (95% CI)
CKD	59 309 (97.07%)	–	–	52 996 (89.36%)	87.26% (82.19–92.33)	45 231 (76.26%)	71.71% (65.38–78.04)	45 231 (85.35%)	82.15% (76.99–87.31)
No CKD	–	–	–	–	42.63% (41.58–43.68)	–	1.53% (1.26–1.81)	–	2.65% (2.34–2.97)

Age–sex adjustment of raw prevalence rates, and their 95% confidence intervals, were completed using the "Age-standardization – direct method" described by Boyle and Martin. The reference population for age–sex standardization was from the Australian Demographic Statistics (June 2016) report by the Australian Bureau of Statistics. *Patients were determined as 'current' and included in this analysis if they had a GP encounter or pathology measurement during 2016 (02 June 2015 to 01 June 2016). [†]Patients who had an eGFR measurement <60 mL/min per 1.73 m^2 during 2016 (02 June 2015 to 01 June 2016). [‡]Patients who had an eGFR measurement during 2016 (02 June 2015 to 01 June 2016). [§]Patients in the 'Two eGFRs and/or Two ACRs CKD cohort' who had a GP encounter or a pathology result during 2016 (02 June 2015 to 01 June 2016). ACR, albumin/creatinine ratios; CI, confidence interval; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

Fig. 2 Venn diagram of chronic kidney disease and key comorbidities.

valid source of information for pre-dialysis patients than current registries.[24] The relatively large group of patients comprising those with CKD stages 1–3 disease, as is compatible with guideline care, are managed by their general practice team.[16] It is likely the analysis of this dataset will assist the specialty of general practice to optimize the prevention of CKD and care of patients with CKD.

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