

Quality of Care of Patients with Chronic Kidney Disease in National Healthcare Group Polyclinics from 2007 to 2011

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Abstract

Introduction: Chronic kidney disease (CKD) is a major public health problem where majority of patients are managed in the primary care. The major risk factors are advanced age, hypertension and diabetes mellitus, and risk factors control is paramount to prevent progression to CKD. The objective of the study is to describe the epidemiology and quality of care of patients with CKD stages 3 to 5 at National Healthcare Group Polyclinics (NHGP). **Materials and Methods:** The study was carried out using data from National Healthcare Group (NHG) Renal Registry. Patients were included if they were identified to have CKD based on ICD-9-CM codes and laboratory results. **Results:** Overall, the number of CKD patients increased more than 2 fold from 4734 in 2007 to 10,245 in 2011. In 2011, the majority belonged to stages 3A (39.6%) and 3B (37.6%), had hypertension (98.2%), dyslipidemia (97.2%) and diabetes mellitus (68.7%). From 2007 to 2011, among those with hypertension, the use of angiotensin converting enzyme (ACE) inhibitors and/or angiotensin receptor blockers increased from 78.4% to 84.1%, and the percentage with good systolic blood pressure control (<130 mmHg) improved from 18.7% to 36.3%. Among those with dyslipidemia, the use of statins increased from 81% to 87.1%, and the percentage of patients with low density lipoproteins (LDL) <2.6 mmol/L increased from 40% to 54.7%. However, among those with diabetes mellitus, mean glycated haemoglobin (HbA1c) increased from 7.4% to 7.6%, and the percentage of patients with HbA1c ≤7.0% decreased from 44.5% to 39.4%. **Conclusion:** The number of CKD patients in NHGP has increased significantly from 2007 to 2011 at an average annual rate of 21.3%. Majority of patients the study conducted in 2011 were in stage 3A and stage 3B. Blood pressure and LDL control are encouraging but glycaemic control can be further improved.

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Introduction

Chronic kidney disease (CKD) is defined as either functional or structural kidney damage or a glomerular filtration rate (GFR) less than 60 mL/min per 1.73 m² for at least 3 months.¹ It is divided into 5 stages of increasing severity depending on GFR from stage 1 to 5, with stage 3 subdivided into stages 3A and 3B (Table 1). Worldwide, CKD is becoming a major public health problem with the median prevalence estimated to be 7.2% in persons aged 30 years or older but in persons aged 64 years or older, the prevalence of CKD varied from 23.4% to 35.8%.²

In 2010, the prevalence of renal impairment (CKD stages 3 to 5) among Singapore residents aged 18 to 69 years was 2.3%.³ Although the prevalence may appear low, the number of new patients with end-stage renal disease (ESRD) had

increased from 680 in 1999 to 1264 in 2009.⁴ The age standardised rate of new patients with ESRD had also increased from 194 per million population in 1999 to 254 per million population in 2009.⁴ With an ageing population, the burden of CKD is expected to increase exponentially.

The increasing trend is worrying, hence primary and secondary prevention are critical. Among patients with early or established CKD, it is important to emphasise optimal management to prevent or retard their progression to ESRD.⁵ It has been reported that primary care-based disease management of CKD, based on estimated GFR reporting, improves patient outcomes.⁶ It is therefore important to examine the management of CKD patients in primary care; optimal blood pressure, diabetic and lipid control, reducing the presence of proteinuria, the use of angiotensin

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Table 1. Stages of Chronic Kidney Disease

Stage	Glomerular Filtration Rate	Description
1	90+	Normal kidney function but urine findings or structural abnormalities or genetic trait point to kidney disease
2	60 to 89	Mildly reduced kidney function, and other findings (as for stage 1) point to kidney disease
3A	30 to 44	Moderately reduced kidney function
3B	45 to 59	
4	15 to 29	Severely reduced kidney function
5	<15 or on dialysis	Very severe, or endstage kidney failure

converting enzyme (ACE) inhibitors or angiotensin receptor blockers, and smoking cessation. Moreover, CKD appears to be associated with the development of cardiovascular disease⁷ and even the earliest stages of chronic kidney disease may be associated with excess risk of subsequent coronary heart disease.⁸

To date, little is known about the extent of CKD in primary care in Singapore. The objective of this study is to describe the epidemiology and quality of care of patients with CKD stages 3 to 5 at NHGP.

Materials and Methods

CKD patients with encounters in NHGP from 1 January 2007 to 31 December 2011 were identified using the National Healthcare Group (NHG) Renal Registry. A full description of the registry had been published⁹ earlier. It was enhanced to identify patients with CKD, i.e. patients who were at least 16 years old and fulfill any one of the following conditions:

1. Coded with CKD diagnosis (International classification of diseases codes, ninth edition 585);
2. Two estimated GFR <60 mL/min/1.73m² taken 90 days apart;
3. Two urine albumin creatinine ratio (ACR) ≥ 2.5 mg/mmol (male) taken 90 days apart for males, or ≥ 3.5 mg/mmol taken 90 days apart for females;
4. Two urine protein creatinine ratio (PCR) ≥ 20 mg/mmol taken 90 days apart;
5. Two urine protein ≥ 0.2 g/day taken 90 days apart;
6. Two urine ACR lab tests >30 mg/g taken 90 days apart; and
7. Two urine PCR lab tests >0.2 mg/mg taken 90 days apart.

Variables extracted from the renal registry for the study included demographics (age, gender and ethnic group), comorbidities (hypertension, dyslipidemia and diabetes mellitus), use of medications (angiotensin converting enzyme (ACE) inhibitor), angiotensin receptor blocker (ARB), statins, fibrates, insulin and oral hypoglycaemic agents), laboratory results [eGFR, urine ACR, urine PCR and total urine protein, lipid profile, glycated haemoglobin (HbA1c)] and physical findings (blood pressure).

Patients were classified as having overt proteinuria if they have ACR >30 mg/mmol, PCR >50 mg/mmol or urine total protein >500 mg/day. Patients were classified as having microalbuminuria if ACR was between 2.5 and 30 mg/mmol for males or between 3.5 and 30 mg/mmol for females. Serum creatinine was measured using an Isotope Dilution Mass Spectrometry (IDMS) traceable standard and eGFR was estimated using the abbreviated Modification of Diet in Renal Disease (MDRD) equation and standardised creatinine.

For CKD patients with diabetes mellitus, the target HbA1c should be less than or equal to 7.0%.¹⁰ For CKD patients

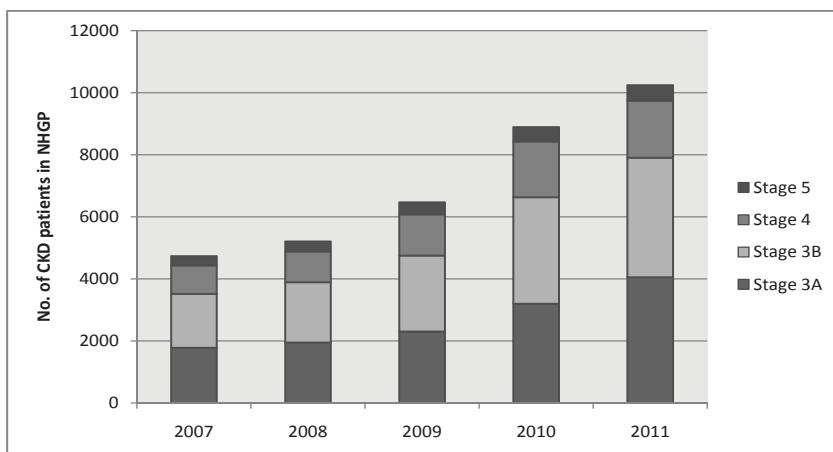


Fig. 1. Total number of chronic kidney disease patients in NHGP, 2007 to 2011.

with hypertension, the target blood pressure should be less than 130/80 mmHg and they should be all on ACEi or ARB.¹⁰ For CKD patients with dyslipidemia, the target low density lipoproteins (LDL) should be less than 2.6 mmol/L.¹⁰

Data were analysed and *P* value for test of trend was done using Stata /IC version 11.2 programme for Windows and *P* values of less than 0.05 were taken to be significant. The study was approved by the NHG's Domain-specific Ethics Board E.

Results

Overall, the number of CKD patients in NHGP increased 116% from 4734 in 2007 to 10,245 in 2011 (Fig.1).

Demographic Characteristics

Table 2 describes the characteristics of CKD patients in NHGP. There were more males, who were younger with a median age of 70.7 to 71.5 years compared to females (72.1 to 73.8 years). Ethnic distribution was similar to that of the Singapore population. Majority of the patients belonged to stage 3A and stage 3B and had at least 2 out of the 3 comorbidities (hypertension, diabetes mellitus and dyslipidemia). A significant number of patients had microalbuminuria or overt proteinuria. Stratifying by the number of comorbidities, the percentage use of ACEi/ARB was higher for those with all 3 comorbidities (diabetes mellitus, hypertension and dyslipidemia) than those with only 1 of these 3 comorbidities. Similarly the percentage use if ACEi/ARB was higher in those with diabetes mellitus compared with non-diabetic patients without hypertension (Table 3).

Table 2. Characteristic of Patients with Chronic Kidney Disease in NHGP, 2007 to 2011

	2007 n = 4734	2008 n = 5207	2009 n = 6469	2010 n = 8894	2011 n = 10,245
Age, Mean (SD)	71.5 (10.7)	70.9 (10.7)	71.0 (10.6)	71.3 (10.6)	71.8 (10.4)
Age, Median (Min, Max)	71.5 (26.4, 103.9)	71.6 (28.0, 109)	71.6 (18.5, 110.0)	72.0 (17.6, 109.8)	72.5 (27.6, 110.8)
Male, No. (%)	2610 (55.1)	2890 (55.5)	3591 (55.5)	4901 (55.1)	5517 (53.9)
Chinese, No. (%)	3534 (74.6)	3826 (73.5)	4651 (71.9)	6501 (73.1)	7487 (73.1)
Malays, No. (%)	763 (16.1)	882 (16.9)	1184 (18.3)	1546 (17.4)	1745 (17.0)
Indians, No. (%)	290 (6.1)	320 (6.1)	405 (6.3)	539 (6.1)	631 (6.2)
Others, No. (%)	147 (3.1)	179 (3.4)	229 (3.5)	308 (3.5)	382 (3.7)
Body Mass Index, kg/m ² , Mean (SD)*	25.9 (4.6)	26.0 (4.6)	26.2 (4.9)	26.2 (4.8)	26.2 (4.9)
Body Mass Index, kg/m ² Median (Min, Max)*	25.4 (10.1, 64.4)	25.5 (11.2, 69.9)	25.7 (10, 78.4)	25.6 (9.1, 66.8)	25.7 (12.2, 59.3)
Stage 3A, No. (%)	1782 (37.6)	1951 (37.5)	2306 (35.6)	3200 (36.0)	4056 (39.6)
Stage 3B, No. (%)	1736 (36.7)	1942 (37.3)	2447 (37.8)	3433 (38.6)	3851 (37.6)
Stage 4, No. (%)	915 (19.3)	991 (19.0)	1326 (20.5)	1794 (20.2)	1837 (17.9)
Stage 5, No. (%)	301 (6.4)	323 (6.2)	390 (6.0)	467 (5.3)	501 (4.9)
Hypertension or diabetes or dyslipidemia alone, No. (%)	274 (5.8)	229 (4.4)	216 (3.2)	211 (2.4)	254 (2.5)
Hypertension and diabetes only, No. (%)	63 (1.3)	59 (1.1)	52 (0.8)	41 (0.5)	52 (0.5)
Diabetes and dyslipidemia only, No. (%)	115 (2.4)	115 (2.2)	119 (1.8)	117 (1.3)	118 (1.2)
Hypertension and dyslipidemia only, No. (%)	1407 (29.7)	1463 (28.1)	1772 (27.4)	2414 (27.1)	2935 (28.6)
Hypertension, diabetes and dyslipidemia, No. (%)	2859 (60.4)	3322 (63.8)	4285 (66.2)	6094 (68.5)	6865 (67.0)
None of the above, No. (%)	16 (0.3)	19 (0.4)	25 (0.4)	17 (0.2)	21 (0.2)
Overt proteinuria, No. (%)	1192 (25.2)	1404 (27.0)	2382 (36.8)	2041 (22.9)	2752 (26.9)
Microalbuminuria, No. (%)	1096 (23.2)	1379 (26.5)	1670 (25.8)	2052 (23.1)	2133 (20.8)

*Patient records with missing values were omitted.

Table 3. Use of Angiotensin Converting Enzyme inhibitor (ACEi) and/or Angiotensin Receptor Blocker (ARB), Presence of Microalbuminuria, Overt Proteinuria

		2007 n = 274	2008 n = 229	2009 n = 216	2010 n = 211	2011 n = 254
Presence of 1 comorbidity (Diabetes Mellitus, Hypertension or Dyslipidemia)	ACEi and/or ARB, No. (%)	160 (58.4)	138 (60.3)	121 (56.0)	120 (56.9)	149 (58.7)
	Microalbuminuria, No. (%)	6 (2.2)	10 (4.4)	5 (2.3)	9 (4.3)	7 (2.8)
	Overt proteinuria, No. (%)	31 (11.3)	17 (7.4)	39 (18.1)	16 (7.6)	22 (8.7)
		2007 n = 1585	2008 n = 1637	2009 n = 1943	2010 n = 2572	2011 n = 3105
Presence of 2 comorbidities	ACEi and/or ARB, No. (%)	1058 (66.8)	1141 (69.7)	1412 (72.7)	1813 (70.5)	2314 (74.5)
	Microalbuminuria, No. (%)	115 (7.3)	125 (7.6)	112 (5.8)	130 (5.1)	89 (2.9)
	Overt proteinuria, No. (%)	163 (10.3)	188 (11.5)	465 (23.9)	267 (10.4)	387 (12.5)
		2007 n = 2859	2008 n = 3322	2009 n = 4285	2010 n = 6094	2011 n = 6865
Presence of 3 comorbidities	ACEi and/or ARB, No. (%)	2448 (85.6)	2911 (87.6)	3764 (87.8)	5411 (88.8)	6087 (88.7)
	Microalbuminuria, No. (%)	975 (34.1)	1267 (38.1)	1551 (36.2)	1911 (31.4)	2035 (29.6)
	Overt proteinuria, No. (%)	995(34.8)	1170(35.2)	1869(43.6)	1757 (28.8)	2341 (34.1)
		2007 n = 3047	2008 n = 3502	2009 n = 4460	2010 n = 6253	2011 n = 7041
Diabetic patients	ACEi and/or ARB, No. (%)	2579 (84.6)	3044 (86.9)	3898 (87.4)	5447 (87.1)	6211 (88.2)
	Microalbuminuria, No. (%)	1049 (34.4)	1338 (38.2)	1607 (36.0)	1964 (31.4)	2085 (29.6)
	Overt proteinuria, No. (%)	1038 (34.1(43.6))	1222 (34.9)	1946 (43.6)	1790 (28.6)	2388 (33.9)
		2007 n = 58	2008 n = 55	2009 n = 64	2010 n = 47	2011 n = 61
Non-diabetic patients without hypertension	ACEi and/or ARB, No. (%)	24 (41.4)	18 (32.7)	21 (32.8)	0 (0)	17 (27.9)
	Microalbuminuria, No. (%)	0 (0)	3 (5.5)	3 (4.7)	2 (4.3)	2 (3.3)
	Overt proteinuria, No. (%)	8 (13.8)	5 (9.0)	15 (23.4)	4 (8.5)	8 (13.1)

Table 4. Quality of Care Among Patients with Chronic Kidney Disease and Hypertension

	2007 n = 4551	2008 n = 5031	2009 n = 6282	2010 n = 8729	2011 n = 10,060	P value for trend†
ACEi, No. (%)	2700 (59.3)	2957 (58.8)	3656 (58.2)	4993 (57.2)	5505 (54.7)	0.018
ARB, No. (%)	1311 (28.8)	1622 (32.2)	2196 (35.0)	3131 (35.9)	3730 (37.1)	0.008
ACEi and/or ARB, No. (%)	3566 (78.4)	4094 (81.4)	5304 (84.4)	7344 (84.1)	8456 (84.1)	0.060
Systolic blood pressure, mmHg, Mean (SD)*	134.6 (12.1)	133.8 (17.8)	123.8 (16.7)	134.3 (19.3)	134.4 (18.8)	0.996
Diastolic blood pressure, mmHg, Mean (SD)*	76.5 (9.0)	72.7 (10.3)	65.6 (10.1)	70.3 (10.8)	69.8 (10.8)	0.261
Systolic blood pressure <130 mmHg, No. (%)*	853 (18.7)	1430 (28.4)	3474 (55.3)	3140 (36.0)	3653 (36.3)	0.388
Diastolic blood pressure <80 mmHg, No. (%)*	1351 (29.7)	2525 (50.2)	5048 (80.4)	6279 (71.9)	7541 (75.0)	0.075

ACEi: Angiotensin converting enzyme inhibitor; ARB: Angiotensin receptor blocker

*Patient records with missing values were omitted.

†Significance was set at $P < 0.05$.

Chronic Kidney Disease and Hypertension

The use of ACEi and/or ARB has increased from 78.4% in 2007 to 84.1% in 2011 (Table 4). There has been a decreasing trend in the use of ACEi and a corresponding increasing trend in the use of ARB. The percentage of patients with good systolic blood pressure control (systolic blood pressure <130 mmHg) has increased from 18.7% in 2007 to 36.3% in 2011 while the percentage of patients with good diastolic blood pressure control (<80 mmHg) has increased from 29.7% in 2007 to 75.0% in 2011.

Chronic Kidney Disease and Dyslipidemia

There has been an increasing trend in the use of statins and fibrates from 2007 to 2011 (Table 5). This is followed by a decreasing trend in total cholesterol and LDL and an increasing trend in the percentage of patients with good LDL control (LDL <2.6 mmol/L) from 2007 to 2011.

Chronic Kidney Disease and Diabetes Mellitus

There has been a decreasing trend in the use of oral hypoglycaemic agents (Table 6). Overall, mean HBA1c has increased from 7.4% in 2007 to 7.6% in 2011 and the percentage of patients with good glycaemic control (HBA1c ≤7.0%) has decreased from 44.5% in 2007 to 39.4% in 2011. However both trends were not statistically significant. The mean HBA1c in stage 5 CKD appears to be lowest among the different stages of CKD.

Discussion

The number of CKD patients in NHGP has increased at an average annual rate of 21.3% from 2007 to 2011. This alarming rate of increase could be attributed to several factors. Firstly, it is well established that diabetes mellitus is often underdiagnosed, as the majority of the population are asymptomatic and constitute 51.4% of persons aged 18 to 69 years.³ Tight glycaemic control is critical in slowing progression of diabetic nephropathy (DN)¹¹ and the increasing prevalence of diabetic kidney disease¹² may be a result of poor glycaemic control in patients with undiagnosed diabetes mellitus. Secondly, increased referrals from general practitioners (GPs) could have contributed to some of the cases. A recent survey among GPs found that 50% of GPs were confident of managing patients with CKD stage 1; while a lower 33% and 13% were confident in managing CKD stage 2 and stage 3, respectively.¹³ Finally, regular audits of process and laboratory indicators put in place at NHGP more than a decade ago has resulted in detection of new CKD cases, as exemplified by the higher proportion of CKD patients in the earlier stage 3 and lower proportion in the later stages 4 and 5 during the period 2007 to 2011 (Table 2). If this trend continues, the increasing load of

CKD will have enormous implications and strain on our public primary healthcare system, which will be further aggravated with our rapidly ageing population.

To address this, the Singapore Ministry of Health has taken steps to address the growing public health problem through its Chronic Disease Management Programme which started in October 2006; engaging the GPs to provide systematic, evidence-based chronic disease management programs (including diabetes mellitus), and allowing the use of Medisave (a portion of contribution towards the Central Provident Fund (CPF), a compulsory savings scheme in Singapore) to reduce the out-of-pocket cash payments for outpatient bills.¹⁴ The Ministry has also funded NEMO (Nephrology Evaluation Management Optimization) program which aims to stem the rising incidence of ESRD due to DN among patients with diabetes on follow-up at the primary care setting by:

1. Identifying diabetic patients with DN.
2. Increasing the number of DN patients receiving ACEi and/or ARB to reduce albuminuria.
3. Optimising the ACEi and/or ARB dose in diabetic patients who are already on ACEi and/or ARB in NHGP.

Evidence-based clinical practice guidelines and regular audits have also contributed to the improvement in management of CKD patients. As patients with CKD have a higher prevalence of dyslipidemia compared to the general population, it is imperative that these patients be identified early and treated.¹⁵ It is heartening that the majority of CKD patients with dyslipidemia in NHGP were on statins (81% in 2007 increasing progressively to 87% in 2011), which may help in reducing the risk of all-cause and cardiovascular mortality.¹⁶ The mean LDL in 2010 was also much lower (2.57 mmol/L) compared to 3.4 mmol/L in the National Health Survey 2010.³ The Study of Heart and Renal Protection (SHARP) trial demonstrated that a lipid-lowering strategy is both effective and safe.¹⁷ Unfortunately, lipid targets have not been established specifically for CKD patients and treatment strategies should be implemented in accordance with current recommendations for high-risk populations.¹⁸

As for hypertension, there has been an increasing proportion of CKD patients receiving ACEi and/or ARB (78% in 2007 increasing progressively to 84% in 2011), which have been shown to reduce proteinuria in CKD,¹⁹ and improved blood pressure control during the study period. This is comparable to a study done in Australia where 42% of patients with eGFR <60 mL/min per 1.73 m² are not recorded as having ACEi or ARB therapy.²⁰ The Singapore National Health Survey 2010 however, has found the prevalence of hypertension among adults aged 30 to 69 years to be 23.5%, and among those aged 60 to 69 years

Table 5. Quality of Care Among Patients with Chronic Kidney Disease and Dyslipidemia

	2007 n = 4423	2008 n = 4936	2009 n = 6215	2010 n = 8655	2011 n = 9958	P value for trend†
Statins, No. (%)	3581 (81.0)	4129 (83.7)	5395 (86.8)	7592 (87.7)	8674 (87.1)	0.037
Fibrates, No. (%)	518 (11.7)	635 (12.9)	890 (14.3)	1367 (15.8)	1640 (16.5)	<0.001
Total cholesterol (TC), mmol/L, Mean (SD)*	4.76 (1.02)	4.65 (1.02)	4.61 (0.98)	4.53 (0.97)	4.51 (0.94)	0.005
Triglyceride, mmol/L, Mean (SD)	1.66 (0.89)	1.69 (0.89)	1.65 (0.84)	1.63 (0.81)	1.64 (0.83)	0.20
High density lipoproteins (HDL), mmol/L, Mean (SD)*	1.21 (0.40)	1.21 (0.34)	1.20 (0.34)	1.23 (0.35)	1.27 (0.37)	0.11
Low density lipoproteins (LDL), mmol/L, Mean (SD)*	2.80 (0.85)	2.68 (0.84)	2.67 (0.80)	2.57 (0.77)	2.51 (0.76)	0.004
LDL <2.6 mmol/L, No. (%)*	1770 (40.0)	2321 (47.0)	2977 (47.9)	4557 (52.7)	5445 (54.7)	0.006

*Patient records with missing values were omitted.

†Significance was set at $P < 0.05$.

Table 6. Quality of Care Among Patients with Chronic Kidney Disease and Diabetes Mellitus

	2007 n = 3047	2008 n = 3502	2009 n = 4460	2010 n = 6253	2011 n = 7041	P value for trend†
Insulin use, No. (%)	791 (26.0)	949 (27.1)	1312 (29.4)	1855 (29.7)	2002 (28.4)	0.145
Oral hypoglycaemic agents, No. (%)	2353 (77.2)	2661 (76.0)	3329 (74.6)	4631 (74.1)	5199 (73.8)	0.008
Biguanide, No	1564	1768	2155	3034	3384	
Stage 3A, No.	757	862	1053	1487	1774	
Stage 3B, No.	585	680	819	1172	1250	0.018
Stage 4, No.	188	200	260	344	321	0.052
Stage 5, No.	34	26	23	31	39	0.031
Sulphonylureas, No.	1964	2173	2718	3802	4168	0.006
Stage 3A, No.	735	793	964	1353	1562	0.837
Stage 3B, No.	735	822	1022	1441	1579	0.149
Stage 4, No.	370	422	570	807	812	
Stage 5, No.	124	136	162	201	215	
HbA1c, %, Mean (95% CI)*	7.41 (7.36 – 7.46)	7.38 (7.32 – 7.42)	7.52 (7.48 – 7.57)	7.58 (7.54 – 7.62)	7.62 (7.58 – 7.65)	
Stage 3A, Mean (95% CI)*	7.39 (7.32 – 7.47)	7.35 (7.28 – 7.42)	7.50 (7.43 – 7.58)	7.57 (7.50 – 7.63)	7.55 (7.49 – 7.60)	
Stage 3B, Mean (95% CI)*	7.48 (7.39 – 7.57)	7.43 (7.35 – 7.52)	7.52 (7.45 – 7.60)	7.61 (7.54 – 7.67)	7.68 (7.62 – 7.74)	
Stage 4, Mean (95% CI)*	7.39 (7.26 – 7.51)	7.42 (7.30 – 7.53)	7.62 (7.52 – 7.72)	7.65 (7.56 – 7.74)	7.76 (7.67 – 7.85)	
Stage 5, Mean (95% CI)*	7.21 (7.01 – 7.42)	7.02 (6.83 – 7.21)	7.33 (7.15 – 7.50)	7.19 (7.02 – 7.36)	7.17 (7.02 – 7.32)	
HbA1c ≤7.0 %, No. (%)*	1356 (44.5)	1751 (50.0)	1954 (43.8)	2577 (41.2)	2777 (39.4)	

*Patient records with missing values were omitted.

†Significance was set at $P < 0.05$.

to be 53.4%. About 1 in 4 persons with hypertension was undiagnosed, among whom 1 in 10 had grade 2 hypertension and one third of persons with hypertension had suboptimal control of blood pressure. This is an important risk factor for CKD, accounting for 10.5% of all patients undergoing renal dialysis,²¹ and a cause for public health concern. On the other hand, blood pressure targets should be individualised according to age, co-existent cardiovascular disease and other comorbidities, risk of progression of CKD, presence or absence of retinopathy (in CKD patients with diabetes) and tolerance of treatment.²²

Besides the high rate of undiagnosed diabetes mellitus, glycaemic control in NHGP among CKD patients remains suboptimal with 39% of them achieving HBA1c less than or equal to 7.0%, a target believed to slow the progression of DN, including both the onset of microalbuminuria and progression to overt nephropathy.^{23,24} Although this is better than the 2010 National Health Survey of 34%, the trend during the study period has been declining, being more pronounced among the Indians and younger patients. These are important risk factors contributing towards CKD, a trend expected to increase if current situation remains.

Furthermore, HBA1c may be falsely low in patients with CKD stage 5²⁵ due to altered red blood survival and erythropoietin therapy, thus the lower HBA1c level in our CKD stage 5 patients may not be a true reflection of their glycaemic status.

Limitations

There are several limitations to the study:

1. The registry can only capture patients who are diagnosed with chronic kidney disease or had their creatinine measured in NHGP. There may be patients with undiagnosed chronic kidney disease in NHGP even though patients with hypertension and/or diabetes mellitus are recommended to have their creatinine measured yearly. Thus the findings may not reflect fully the extent of the problem in NHGP and may be an underestimate.
2. The findings may not fully reflect the quality of care of chronic kidney disease management in NHGP as the patients may be on concurrent follow-up with nephrologists in tertiary hospitals.
3. The drug allergies or adverse reactions of diabetic patients who were not given ACEi/ARBs were also not captured. If patients who could not tolerate ACEi/ARBs were excluded, the proportion of diabetic patients on ACEi/ARBs would be even higher.
4. Kidney Disease: Improving Global Outcomes (KDIGO) have recently published new CKD clinical practice guidelines for the evaluation and management

of CKD and there is now a new classification for CKD which includes cause of disease, GFR classification and albuminuria stages.¹⁸ However, this study was unable to use the latest classification as the cause of CKD was not captured and some of the patients, especially those in the earlier years may not have done urine test to test for albumin.

Conclusion

A population health approach of health promotion, primary and secondary prevention is urgently needed to prevent, screen and identify people at risk of CKD. Risk factor control and optimal management to reduce progression to CKD is critical from a system perspective due to the interconnectedness between the community and the hospital, and the private and public sector. Lifestyle changes such as avoiding high protein intake (>1.3g/kg/day) in adults with CKD at risk of progression, lowering salt intake to <2g per day, encouraging people with CKD to undertake physical activity compatible with cardiovascular health and tolerance, achieving a healthy weight and smoking cessation are helpful as well.¹⁸ Future epidemiological work to predict persons at risk of rapidly developing CKD will be useful to target and refer those at risk of rapid progression for specialists' management.

Despite the increase in the number of patients with CKD, the quality of care in NHGP has improved from 2007 to 2011 in terms of the use of blood pressure and lipid control, but more can be done in improving glycaemic control.

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