OPEN

Workplace Outreach Program Improves Management of Chronic Kidney Disease

Olga A. Iakoubova, MD, PhD, Carmen H. Tong, MS, Charles M. Rowland, MS, Andre R. Arellano, BS, Lance A. Bare, PhD, Maren S. Fragala, PhD, and Charles E. Birse, PhD

Objective: Assess whether an employee outreach program improved management of chronic kidney disease (CKD). **Methods:** Participants with suspected CKD (eGFR <60 mL/min/1.73m^2) identified in employee health assessments in 2017 and 2018 were contacted by phone and offered physician consultation. Subsequent nephrologist visits at 11 months of follow up were compared between those who were (outreach group) and were not (control group) successfully contacted. **Results:** Most CKD risk factors at baseline were similar in outreach and control groups. At the end of the follow-up, outreach participants had more than 2-fold greater incidence of visiting a nephrologist compared with controls (HR = 2.3; 95% CI 1.2–4.2, $P = 0.01$), after adjusting for potential confounders. **Conclusions:** Employee outreach program increased utilization of nephrologist care.

Keywords: chronic kidney disease, prevention, utilization of outpatient nephrologist services, workplace outreach program

Chronic kidney disease (CKD) affects 16.8% of the US adult population and constitutes a substantial health and cost burden.[1–3] Medicare spent $36.6 billion on patients with end stage renal disease (ESRD) or kidney failure in 2018, an amount comprising approximately 7% of the costs of total Medicare claims.[4] CKD is classified into five stages (G1 through G5), based on assessment of kidney function (estimated glomerular filtration rate [eGFR]) and kidney damage (albuminuria).[5,6] Overall health, quality of life, and cost burden worsen as CKD progresses.[7] Progression from stage G3 to stage G4–5 is associated with up to a 4-fold increase in annual health care costs.[8] Annual costs associated with ESRD range from $20,110 to $100,593 per patient.[8]

CKD is often asymptomatic and may not be recognized or treated until the disease is at an advanced stage.[9] Fewer than 10% of patients with stage G3 CKD, and less than 50% at stage G4, are aware of their disease.[10,11] Even among individuals with two to four risk factors for CKD, 84% are unaware of their disease.[11] Among patients with CKD stages G3 to G5, only 14% are identified by primary care physicians.[12–14] Consequently, referrals to nephrologists are delayed leading to increased length of hospital stays and increased mortality.[15]

Timely referral to outpatient nephrology care can slow progression of CKD, improve outcomes, and reduce treatment costs.[16–20] Nephrologist care may include interventions aimed at slowing CKD progression such as lifestyle modifications; treatment with angiotensin-converting enzyme inhibitors (ACEIs), angiotensin receptor blockers (ARBs), and sodium-glucose transporter 2 inhibitors; and control of glucose levels and anemia.[21–31]

We designed an employer-sponsored workplace CKD outreach program with the goal of improving management of CKD and slowing disease progression. The outreach was prompted by annual laboratory testing that includes measuring serum creatinine, which is used to calculate eGFR. To assess whether the workplace program facilitates improved management of CKD, we used health insurance claims data to prospectively evaluate incidence of outpatient nephrologist care.

METHODS

Study Population

Employees participating in an annual health assessment program were tested for kidney function (eGFR) and assessed for key risk factors for CKD progression. Those with suspected CKD based on confirmed eGFR <60 mL/min/1.73m^2 in 2016 and 2017 were eligible for the CKD outreach program ($n = 398$), which was directed toward 2017 and 2018 annual health assessment participants. In 2017, the outreach did not include participants with previously diagnosed CKD (prior CKD) whereas in 2018 some participants with prior CKD (n = 104) were included. All participants were enrolled in an employer's health plans.

A program coordinator made up to three attempts to contact each eligible employee by phone. If successful, the coordinator provided an explanation of CKD risk and recommended that the participant discuss results further, either with their primary care physician, or through a physician tele-consultation offered as part of the program. Referrals for care, with a primary care physician or a nephrologist, were provided by the consulting physician with urgency based on the CKD stage and the presence of risk factors for CKD progression, or by participants' primary care physician. The outreach group ($n = 156$) comprised participants who accepted the phone call. Participants who were not reached by phone (n = 242) served as the control group. Both groups were followed for incidence of nephrologist visits during the 11 months after outreach.

Study participants comprised individuals from 34 states with a diverse range of job functions, including laboratory operations, patient services, sales, analytics, specimen processing and software engineering.

This study was conducted in accordance with the HIPAA Privacy Rule (Title 45 Code of Federal Regulations, Section 164.514e), which governs research conducted by Covered Healthcare Entities and allows retrospective analysis using a limited data set without requiring an Institutional Review Board approval.

From the Department of Quest Diagnostics, San Juan Capistrano, California (Dr Iakoubova, Ms Tong, Mr Rowland, Arellano, Dr Bare, Dr Fragala, and Dr Birse).

The authors received no specific funding for this work.
The authors report no conflicts of interest.
OAI, CHT, CMR, ARA, LAB, MSF, CEB disclosed employment by Quest Diagnostics. OAI, CMR, LAB, MSF, CEB disclosed ownership of stock by Quest Diagnostics

Clinical significance: An outreach program in a work-force population was effective in improving the management of the chronic kidney disease through increased utilization of nephrologist care, an important factor for slowing progression to end stage renal disease.

Address correspondence to: Olga A. Iakoubova, Quest Diagnostics, 33608 Ortega Highway, San Juan Capistrano, CA 92675 (Olga.A.Iakoubova@questdiagnostics.com).

DOI: 10.1097/JOM.0000000000002475

Data Collection

Kidney function was assessed with eGFR using the CKD-EPI creatinine Eq. (2009).[32] CKD stages were defined according to KDIGO guidelines as follows: stage 3, eGFR 59 to 30 mL/min/1.73m^2; stage 4, eGFR 29 to 15 mL/min/1.73m^s; or stage 5, eGFR <15 mL/min/1.73m^2.[33] Additional measurements performed annually on all study participants included body weight, waist circumference, BMI, systolic and diastolic blood pressure, creatinine, fasting glucose, HbA1C, triglycerides, total cholesterol, LDL cholesterol, HDL cholesterol, complete blood count, uric acid, total iron, and cotinine. Risk factors for CKD progression were defined as high blood pressure (systolic ≥130 mm Hg or diastolic ≥80 mmHg), presence of diabetes (fasting glucose ≥126 mg/dL, hemoglobin A1c ≥ 6.5%, treated with anti-glycemic medication), dyslipidemia (LDL cholesterol >130 mg/dL), smoking status (cotinine positive), uric acid >6 mg/dL, anemia (hemoglobin: <13.0 g/dL in men; <12.0 g/dL in women, ferritin <30 ng/mL mean corpuscular volume < 80 fL) and a rapid and substantial annual eGFR decline >5 mL/min/1.73m^2.[34–37] Laboratory testing was performed by Quest Diagnostics.

Study Outcomes

Incidence of nephrologist care was assessed from claims data. For outpatient nephrologist care we prospectively explored association of the outreach during an 11-month follow-up period. As scheduling a visit for a specialist physician in the US typically takes 24 days,[38] nephrology visits were counted between days 25 and 365. An annual eGFR decline of >5 mL/min/1.73m^2 was assessed from an eGFR measurement at the subsequent annual health assessment.

Statistical Analysis

Cox proportional hazard models adjusted for age, sex, BMI, and change in outreach participation status were used to estimate the effect of outreach, which was assessed by a follow-up time within 11 months for the first visit of the participant to a nephrologist. In the Cox models, prior CKD, year of engagement, and outreach status (outreach or control group) were time-dependent covariates to account for a subset of participants (n = 12) who were in the control group in 2017 and in the outreach group of 2018. In all other analyses, this subset of participants was treated as independent subjects appearing in both the outreach and control groups. Analyses stratified by prior CKD were presented as unadjusted estimates. Logistic regression models that adjusted for age, sex, BMI, and participation status were used to estimate the association of the CKD outreach with annual changes in eGFR levels >5 mL/min/1.73m^2.

Model 1 was adjusted for the presence of prior CKD and for the change in outreach participation status. Model 2 was adjusted for demographic variables (age and sex) in addition to those used in Model 1. Model 3 used an additional adjustment for BMI, a variable that was identified as a potential confounder in both 2017 and 2018.

Kaplan–Meier (K-M) curve analysis was performed to estimate cumulative incidence of the nephrologist visits during the follow-up period. Analyses were performed using SAS version 9.4. Student's t test and Chi square tests were used to assess differences between clinical characteristics of outreach and control groups.

RESULTS

Baseline Characteristics of Study Participants

The demographic and clinical characteristics at baseline were similar between outreach and control participants in both 2017 and 2018 (Table 1). However, there were fewer males in the control groups ($P < 0.05$ for both) and individuals in the control groups had greater body mass index (BMI) than those in the outreach groups: +3 kg/m^2 in 2017 and þ2 kg/m^2 in 2018 ($P < 0.05$ for both). Most participants (97%, n = 386) had stage G3 CKD, 2% (n = 7) had stage G4 CKD, and 1% (n = 4) had stage G5 CKD. In both groups, HbA_{1C} levels consistent with diabetes (about 16%) and prediabetes (about 30%) were observed, about 49% of participants were obese

TABLE 1. Baseline Characteristics of Eligible Participants in 2017 and 2018: Outreach Compared with Control Groups

	2017			2018		
Characteristic Mean ± SD, or (IQR)	**Outreach (n = 81)**	**Control (n = 79)**	***P***	**Outreach (n = 75)**	**Control (n = 163)**	***P***
Age, years	58.7 ± 9.0	58.7 ± 6.6	0.99	60.1 ± 8.5	57.8 ± 9.2	0.06
Body mass index, kg/m^2	30.6 ± 5.9	33.8 ± 9.7	0.01	29.2 ± 6.2	31.2 ± 7.7	0.03
Waist circumference, inches	38 ± 5	40 ± 7	0.03	37 ± 6	38 ± 6	0.30
Blood pressure- diastolic, mmHg	79 ± 12	77 ± 9	0.19	77 ± 9	78 ± 11	0.44
Blood pressure- systolic, mmHg	132 ± 18	127 ± 18	0.09	126 ± 15	129 ± 18	0.19
Glucose, mg/dL	102 ± 29	98 ± 21	0.26	103 ± 29	101 ± 26	0.52
HbA1c, %	5.7 ± 0.9	5.8 ± 1.0	0.51	5.9 ± 1.2	5.9 ± 1.3	0.99
LDL cholesterol, mg/dL	105 ± 32	112.3 ± 35.3	0.20	110 ± 37	111 ± 38	0.73
eGFR (in 1st year), mL/min/1.73m^2	53 ± 8	53 ± 6	0.40	48 ± 9	48 ± 10	0.79
Change in eGFR (2nd year), mL/min/1.73m^2	–0.7 ± 4.8	0.2 ± 5.4	0.37	–2.6 ± 9.6	–0.7 ± 8.6	0.15
Uric acid, mg/dL	6.1 ± 1.6	6.5 ± 1.4	0.07	6.4 ± 1.6	6.5 ± 1.5	0.58
Hemoglobin g/dL	13.8 ± 1.8	13.7 ± 1.7	0.65	13.7 ± 1.5	13.3 ± 1.9	0.76
Red blood cell count, million/mL	4.7 ± 0.6	4.7 ± 0.6	0.47	4.7 ± 0.5	4.6 ± 0.6	0.15
Mean corpuscular volume, fL	88.6 ± 6.3	89.3 ± 5.6	0.43	87.6 ± 5.9	87.8 ± 6.7	0.10
Total iron, mg/dL	100 ± 38	87 ± 28	0.02	90 ± 30	85 ± 30	0.29
Education, College graduate or above	39 (51)	39 (49)	1.0	39 (53)	73 (45)	0.06
Sex, male	37 (46)	22 (28)	0.009	32 (43)	55 (34)	0.05
Smoking	9 (11)	8 (10)	0.2	8 (11)	15 (9)	0.20
CKD stages						
Stage 3 (eGFR 30–59 mL/min/1.73m^2)	80 (99)	78 (99)	0.11	73 (97)	152 (93)	0.40
Stage 4 (eGFR 15–29 mL/min/1.73m^2)	0 (0)	1 (1)		1 (1)	9 (5)	
Stage 5 (eGFR <15 mL/min/1.73m^2)	1 (1)	0 (0)		1 (1)	2 (1)	

Values are means ± SD.

eGFR, estimated glomerular filtration rate; HbA1c, hemoglobin A1c; HDL, high-density lipoprotein; LDL, low-density lipoprotein; NA, not applicable.

TABLE 2. Association of Outreach Program with CKD Disease Management

	Model 1		Model 2		Model 3	
Outcome	**Hazard Ratio (95% CI)**	***P***	**Hazard Ratio (95% CI)**	***P***	**Hazard Ratio (95% CI)**	***P***
Nephrologist visits	1.9 (1.1–3.5)	0.03	2.3 (1.2–4.3)	0.01	2.3 (1.2–4.2)	0.01
Nephrologist visits in those with prior CKD	1.8 (0.9–3.8)	0.11	2.4 (1.1–5.2)	0.02	2.3 (1.0–4.8)	0.04
Nephrologist visits in those without prior CKD	2.2 (0.7–6.6)	0.16	2.4 (0.8–7.5)	0.13	2.1 (0.7–6.4)	0.18
Annual eGFR decline >5 mL/min/1.73m^2*	0.6 (0.3–1.1)	0.09	0.6 (0.3–1.1)	0.09	0.6 (0.3–1.1)	0.12

Model 1: Adjusted for prior CKD and the year of engagement (change in outreach participation status).
Model 2: Model 1 plus age and sex.
Model 3: Model 2 plus BMI.
*Risk estimates are presented as Odds ratio determined at the next annual health assessment.

(BMI > 30 kg/m^2), and about 45% had hypertension (systolic BP ≥ 130 mmHg or diastolic BP ≥ 80 mmHg).

A total of 354 study participants were analyzed, including 144 individuals that were solely in the outreach group and contributed 43,156 days (1438 months) of follow-up, 198 individuals that were solely in the control group and contributed 70,932 days (2364 months) of follow-up, and 12 participants that participated in both the outreach and control in different years of the outreach and contributed 8064 days (134 months) of follow-up to both the outreach group and the control group.

Association of CKD Outreach with Utilization of Outpatient Nephrologist Care

At the end of the follow-up period, participants in the outreach group had had about 2-fold greater utilization of outpatient nephrologist care compared with controls. In the model fully adjusted for age, sex, BMI, prior CKD, and outreach participation status (Model 3), the hazard ratio (HR) for those in the outreach group was 2.3 (95% CI 1.1–4.2, P = 0.01), compared with the control group (Table 2, Model 3, Fig. 1). The estimates were similar in two other models: in Model 1 adjusted for prior CKD and change in outreach participation status and in Model 2 adjusted for age and sex, in addition to adjustments used in the Model 1 (Table 2, Model 1 and 2).

When considering only participants with prior CKD (n = 104), the rate of nephrologist visits was greater in the outreach group, compared with the control group: HR = 2.3 (95% CI 1.0–4.8, P = 0.04). In those without prior CKD (n = 294), HR = 2.1 (95% CI 0.7–6.4, P = 0.18), after adjusting for sex, age and BMI (Table 2, Model 3; Fig. 2).

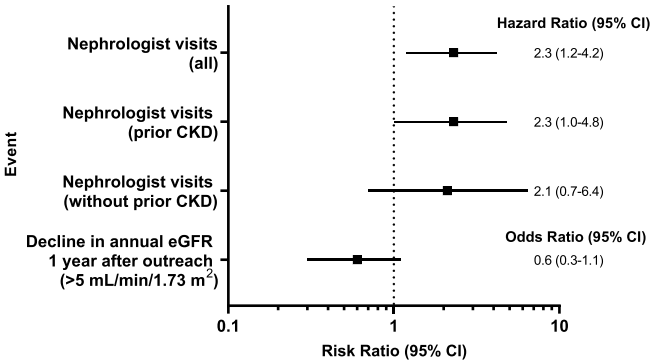

FIGURE 1. Association of the CKD outreach program with disease management. Risk estimates for nephrologist visits endpoint were assessed by Cox proportional hazard models. Risk estimates for annual eGFR decline endpoint were assessed by logistic regression models. For the analysis of all participants, models adjusted for the prior CKD, change in outreach participation status, age, sex, and BMI. For the analysis of strata of those with and without prior CKD, models adjusted for age, sex and BMI in the analysis.

At the end of the follow-up, the cumulative incidence of outpatient nephrologist care among those with prior CKD, was 38.7% (95% CI 24.1–58.0%) in the outreach group and 24.6% in the control group (95% CI 16.3–36.2%, Fig. 2A), while in those with newly identified suspected CKD, incidence of outpatient nephrologist care was 7.2% (95% CI 3.8–19.8%) in the outreach group and 3.0% (95% CI 1.3–7.1%) in the control group (Fig. 2B).

Outreach group participants had non-significant lower odds of having consistent annual decline in eGFR of >5 mL/min/1.73m^2, compared to controls: odds ratio (OR) 0.6 (95%CI 0.3–1.1, P = 0.12) after adjusting for potential confounders (Table 2, Model 3).

DISCUSSION

We analyzed the association between participation in a workplace CKD outreach program and utilization of the nephrologist care. Workplace participants who participated in the CKD outreach had about 2-fold greater utilization of the outpatient nephrologist care than those who were eligible but did not respond to requests to participate.

The 40% reduction in odds of having annual eGFR decline >5 mL/min/1.73m^2 did not reach significance in our study (P = 0.12). This may be due to the sub-optimal 42% power to detect the association of the program with annual eGFR decline with the observed effect size of 0.6. Extending the program to include more participants will improve the power for this endpoint and will likely to provide clarification on the impact of the program on annual decline in eGFR levels.

The 2-fold increase in referral to a nephrologist in response to outreach is clinically important. Delayed referral to a nephrologist has been shown to be associated with greater risk of ESRD and renal death.[20,39,40] In fact, late referral to a nephrologist is a major cause of unplanned urgent-start dialysis, a procedure associated with poor patient outcomes, frequent hospitalizations, and higher medical costs.[41,42] In contrast, timely referral to outpatient nephrology care slows CKD progression[18–20,39,40,43–45] and enables optimal-start dialysis in an outpatient setting, thus slowing CKD progression to ESRD, preventing CVD events and hospitalizations, and reducing medical costs.[39,41,42,46]

The observed association of employer-sponsored CKD outreach program with increased utilization of nephrologist care reported herein is supported by previous reports. Other health and behavioral counseling programs have been reported to reduce risk factors for chronic diseases, reverse metabolic syndrome, slow CKD progression, and reduce medical costs.[47–50] By increasing utilization of nephrologist visits, the outreach program demonstrates the importance increasing employees' engagement in health outreach programs.

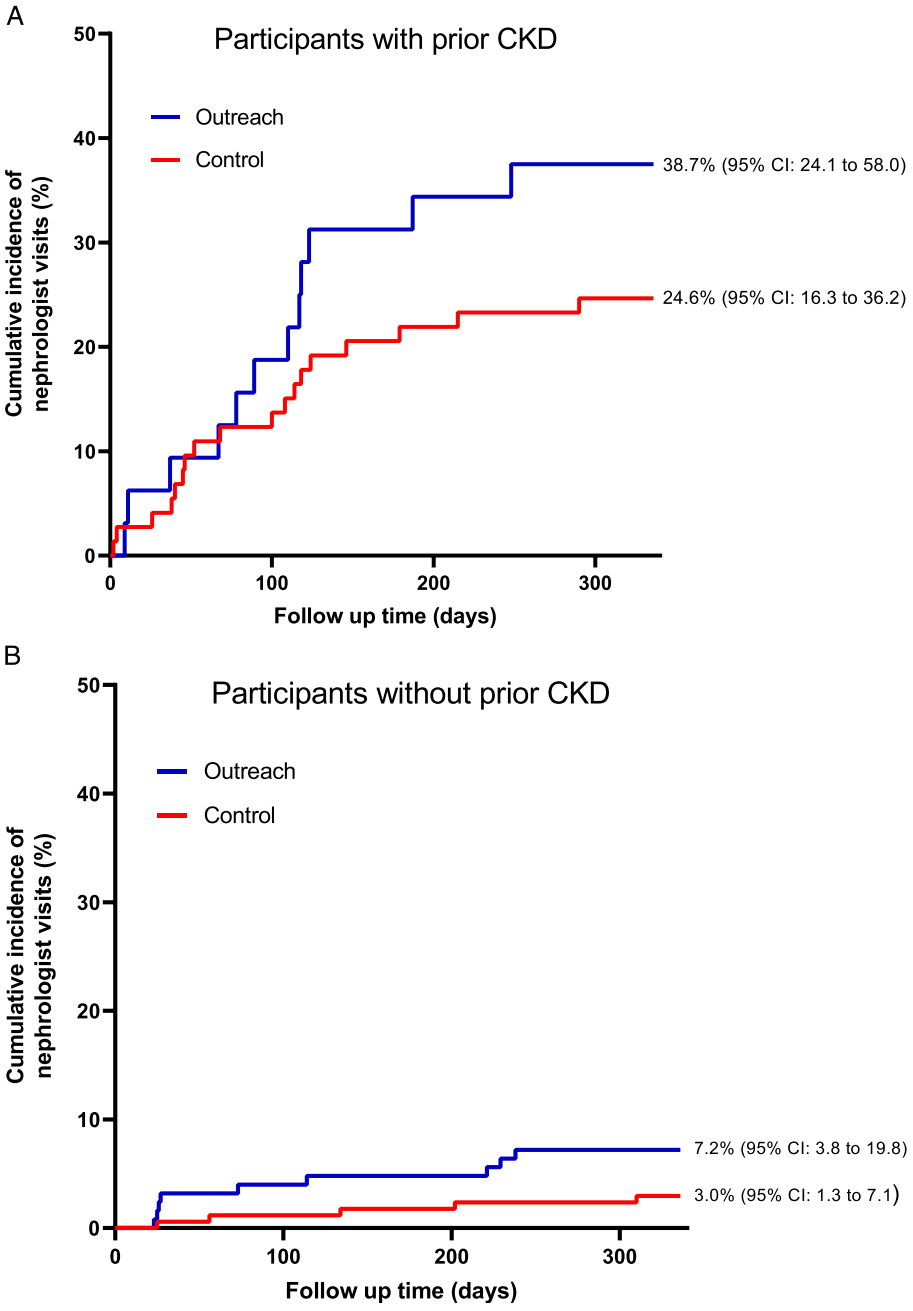

FIGURE 2. Cumulative incidence of nephrologist visits in the outreach and in control group.

Organizational senior leadership support for health promotion, communication of value of health programs, and broader organizational support for employee health and wellbeing, are important factors that improve employees' engagement in wellness programs, perceived job stress levels, and health behaviors.[51–54] In order to increase employee engagement in health programs, efforts directed at increasing leadership support are warranted. Ultimately, both the employee and organization benefit through improved employee health and reduced health care costs.

Limitations of the Study

Our study had two limitations. First, the nonrandomized nature of the outreach and control groups can introduce unobserved differences between the groups that can bias the result. For example, participants motivated to respond to the outreach may also be more inherently motivated to take charge of their healthcare and follow-up than the control group. Secondly, although efforts were made to offer the program to diverse employees, the study was underpowered for testing the association of the CKD outreach in different racial and ethnic groups.

CONCLUSIONS

A workforce CKD outreach program improved timely utilization of the nephrologist care. Efforts to engage more employees at risk of CKD progression are likely to be beneficial.

ACKNOWLEDGMENTS

The authors thank Jim Devlin, Dov Shiffman, Harvey Kaufman, Michael McPhaul, Wendi Mader, Tom Pela and Jeff Radcliff for their contribution to this work

REFERENCES

1. Centers for Disease Control and Prevention. Prevalence of chronic kidney disease and associated risk factors—United States, 1999–2004. *MMWR Morb Mortal Wkly Rep*. 2007;56:161–165.
2. Coresh J, Astor BC, Greene T, Eknoyan G, Levey AS. Prevalence of chronic kidney disease and decreased kidney function in the adult US population: Third National Health and Nutrition Examination Survey. *Am J Kidney Dis*. 2003;41:1–12.
3. Levey AS, Coresh J. Chronic kidney disease. *Lancet*. 2012;379:165–180.
4. Centers for Disease Control and Prevention. Chronic Kidney Disease Basics. Available at: https://www.cdc.gov/kidneydisease/basics.html. Accessed July 2, 2021.
5. Chapter 2: Definition, identification, and prediction of CKD progression. *Kidney Int Suppl (2011)* 2013;3:63–72.
6. Levey AS, de Jong PE, Coresh J, et al. The definition, classification, and prognosis of chronic kidney disease: a KDIGO Controversies Conference report. *Kidney Int*. 2011;80:17–28.
7. Nguyen NTQ, Cockwell P, Maxwell AP, Griffin M, O'Brien T, O'Neill C. Chronic kidney disease, health-related quality of life and their associated economic burden among a nationally representative sample of community dwelling adults in England. *PLoS One*. 2018;13:e0207960.
8. Elshahat S, Cockwell P, Maxwell AP, Griffin M, O'Brien T, O'Neill C. The impact of chronic kidney disease on developed countries from a health economics perspective: A systematic scoping review. *PLoS One*. 2020;15: e0230512.
9. Plantinga LC, Tuot DS, Powe NR. Awareness of chronic kidney disease among patients and providers. *Adv Chronic Kidney Dis*. 2010;17:225–236.
10. Plantinga LC, Boulware LE, Coresh J, et al. Patient awareness of chronic kidney disease: trends and predictors. *Arch Intern Med*. 2008;168:2268–2275.
11. Tuot DS, Plantinga LC, Hsu CY, et al. Chronic kidney disease awareness among individuals with clinical markers of kidney dysfunction. *Clin J Am Soc Nephrol*. 2011;6:1838–1844.
12. Guessous I, McClellan W, Vupputuri S, Wasse H. Low documentation of chronic kidney disease among high-risk patients in a managed care population: a retrospective cohort study. *BMC Nephrol*. 2009;10:25.
13. Ouseph R, Hendricks P, Hollon JA, Bhimani BD, Lederer ED. Underrecognition of chronic kidney disease in elderly outpatients. *Clin Nephrol*. 2007;68:373–378.
14. Tuot DS, Zhu Y, Velasquez A, et al. Variation in patients' awareness of CKD according to how they are asked. *Clin J Am Soc Nephrol*. 2016;11:1566–1573.
15. Chan MR, Dall AT, Fletcher KE, Lu N, Trivedi H. Outcomes in patients with chronic kidney disease referred late to nephrologists: a meta-analysis. *Am J Med*. 2007;120:1063–1070.
16. Israni A, Korzelius C, Townsend R, Mesler D. Management of chronic kidney disease in an academic primary care clinic. *Am J Nephrol*. 2003; 23:47–54.
17. Levin A, Lewis M, Mortiboy P, et al. Multidisciplinary predialysis programs: quantification and limitations of their impact on patient outcomes in two Canadian settings. *Am J Kidney Dis*. 1997;29:533–540.
18. Lonnemann G, Duttlinger J, Hohmann D, Hickstein L, Reichel H. Timely referral to outpatient nephrology care slows progression and reduces treatment costs of chronic kidney diseases. *Kidney Int Rep*. 2017;2:142–151.
19. McLaughlin K, Manns B, Culleton B, Donaldson C, Taub K. An economic evaluation of early versus late referral of patients with progressive renal insufficiency. *Am J Kidney Dis*. 2001;38:1122–1128.
20. Roubicek C, Brunet P, Huiart L, et al. Timing of nephrology referral: influence on mortality and morbidity. *Am J Kidney Dis*. 2000;36:35–41.
21. Adarkwah CC, Gandjour A, Akkerman M, Evers S. To treat or not to treat? Cost-effectiveness of ace inhibitors in non-diabetic advanced renal disease – a Dutch perspective. *Kidney Blood Press Res*. 2013;37:168–180.
22. Agodoa LY, Appel L, Bakris GL, et al. Effect of ramipril vs amlodipine on renal outcomes in hypertensive nephrosclerosis: a randomized controlled trial. *JAMA*. 2001;285:2719–2728.
23. Heerspink HJL, Stefansson BV, Correa-Rotter R, et al. Dapagliflozin in patients with chronic kidney disease. *N Engl J Med*. 2020;383:1436–1446.
24. Hogan TJ, Elliott WJ, Seto AH, Bakris GL. Antihypertensive treatment with and without benazepril in patients with chronic renal insufficiency: a US economic evaluation. *Pharmacoeconomics*. 2002;20:37–47.
25. Kuriyama S, Tomonari H, Yoshida H, Hashimoto T, Kawaguchi Y, Sakai O. Reversal of anemia by erythropoietin therapy retards the progression of chronic renal failure, especially in nondiabetic patients. *Nephron*. 1997; 77:176–185.
26. Lewis EJ, Hunsicker LG, Bain RP, Rohde RD. The effect of angiotensin-converting-enzyme inhibition on diabetic nephropathy. The Collaborative Study Group. *N Engl J Med*. 1993;329:1456–1462.
27. Patel A, Group AC, MacMahon S, et al. Effects of a fixed combination of perindopril and indapamide on macrovascular and microvascular outcomes in patients with type 2 diabetes mellitus (the ADVANCE trial): a randomised controlled trial. *Lancet*. 2007;370:829–840.
28. Saweirs WW, Goddard J. What are the best treatments for early chronic kidney disease? A background paper prepared for the UK Consensus Conference on early chronic kidney disease. *Nephrol Dial Transplant* 2007;22(Suppl 9):ix31–ix38.
29. Wong MG, Perkovic V, Chalmers J, et al. Long-term benefits of intensive glucose control for preventing end-stage kidney disease: ADVANCE-ON. *Diabetes Care*. 2016;39:694–700.
30. Xie X, Liu Y, Perkovic V, et al. Renin-angiotensin system inhibitors and kidney and cardiovascular outcomes in patients with CKD: a Bayesian Network Meta-analysis of Randomized Clinical Trials. *Am J Kidney Dis*. 2016;67:728–741.
31. Zhang Y, He D, Zhang W, et al. ACE inhibitor benefit to kidney and cardiovascular outcomes for patients with non-dialysis chronic kidney disease stages 3-5: a network meta-analysis of randomised clinical trials. *Drugs*. 2020;80:797–811.
32. Levey AS, Stevens LA, Schmid CH, et al. A new equation to estimate glomerular filtration rate. *Ann Intern Med*. 2009;150:604–612.
33. KDIGO. Clinical practice guideline for the evaluation and management of chronic kidney disease. *Kidney Int Suppl*. 2013;3:5–14.
34. Alicic RZ, Rooney MT, Tuttle KR. Diabetic kidney disease: challenges, progress, and possibilities. *Clin J Am Soc Nephrol*. 2017;12:2032–2045.
35. Chiu YL, Chien KL, Lin SL, Chen YM, Tsai TJ, Wu KD. Outcomes of stage 3–5 chronic kidney disease before end-stage renal disease at a single center in Taiwan. *Nephron Clin Pract*. 2008;109:c109–c118.
36. Tangri N, Stevens LA, Griffith J, et al. A predictive model for progression of chronic kidney disease to kidney failure. *JAMA*. 2011;305:1553–1559.
37. Tsai CW, Ting IW, Yeh HC, Kuo CC. Longitudinal change in estimated GFR among CKD patients: a 10-year follow-up study of an integrated kidney disease care program in Taiwan. *PLoS One*. 2017;12:e0173843.
38. Merritt H. Survey of physician appointment wait times and Medicare and Medicaid acceptance rates. Standalone Medicare's report;. 2017. Available at: https://www.merritthawkins.com/uploadedFiles/MerrittHawkins/Content/Pdf/mha2017waittimesurveyPDF.pdf.
39. Bastos MG, Kirsztajn GM. Chronic kidney disease: importance of early diagnosis, immediate referral and structured interdisciplinary approach to improve outcomes in patients not yet on dialysis. *J Bras Nefrol*. 2011;33: 93–108.
40. Minutolo R, Lapi F, Chiodini P, et al. Risk of ESRD and death in patients with CKD not referred to a nephrologist: a 7-year prospective study. *Clin J Am Soc Nephrol*. 2014;9:1586–1593.
41. Loeppke R, Nicholson S, Taitel M, Sweeney M, Haufle V, Kessler RC. The impact of an integrated population health enhancement and disease management program on employee health risk, health conditions, and productivity. *Popul Health Manag*. 2008;11:287–296.
42. Stack AG. Impact of timing of nephrology referral and pre-ESRD care on mortality risk among new ESRD patients in the United States. *Am J Kidney Dis*. 2003;41:310–318.
43. Winkelmayer WC, Owen WF Jr., Levin R, Avorn J. A propensity analysis of late versus early nephrologist referral and mortality on dialysis. *J Am Soc Nephrol*. 2003;14:486–492.
44. Crews DC, Jaar BG, Plantinga LC, Kassem HS, Fink NE, Powe NR. Inpatient hemodialysis initiation: reasons, risk factors and outcomes. *Nephron Clin Pract*. 2010;114:c19–c28.
45. Mendelssohn DC, Malmberg C, Hamandi B. An integrated review of "unplanned" dialysis initiation: reframing the terminology to "suboptimal" initiation. *BMC Nephrol*. 2009;10:22.
46. Smart NA, Titus TT. Outcomes of early versus late nephrology referral in chronic kidney disease: a systematic review. *Am J Med*. 2011;124(1073-1080):e1072.
47. Birse CE, Iakoubova OA, Arellano AR, et al. Digital diabetes prevention program reduces medical costs in the first 2 years of implementation in a workplace setting. *Circulation*. 2020;142(Suppl_3):13006.
48. Birse CE, Shiffman D, Satish A, et al. Impact of a digital diabetes prevention program on risk factors for chronic disease in a workforce cohort. *J Occup Environ Med*. 2020;62:1040–1045.
49. Mahdavi-Mazdeh M, Hatmi ZN, Shahpari-Niri S. Does a medical management program for CKD patients postpone renal replacement therapy and mortality? A 5-year-cohort study. *BMC Nephrol*. 2012;13:138.

50. Nakao YM, Miyamoto Y, Ueshima K, et al. Effectiveness of nationwide screening and lifestyle intervention for abdominal obesity and cardiometabolic risks in Japan: Themetabolic syndrome and comprehensive lifestyle intervention study on nationwide database in Japan (MetS ACTION-J study). *PLoS One*. 2018; 13:e0190862.
51. Crump CE, Earp JA, Kozma CM, Hertz-Picciotto I. Effect of organization level variables on differential employee participation in 10 federal worksite health promotion programs. *Health Educ Q*. 1996;23:204–223.
52. Grossmeier J, Castle PH, Pitts JS, et al. Workplace well-being factors that predict employee participation, health and medical cost impact, and perceived support. *Am J Health Promot*. 2020;34:349–358.
53. Hoert J, Herd AM, Hambrick M. The role of leadership support for health promotion in employee wellness program participation, perceived job stress, and health behaviors. *Am J Health Promot*. 2018;32:1054–1061.
54. Song Z, Baicker K. Effect of a workplace wellness program on employee health and economic outcomes: a randomized clinical trial. *JAMA*. 2019;321:1491–1501.

