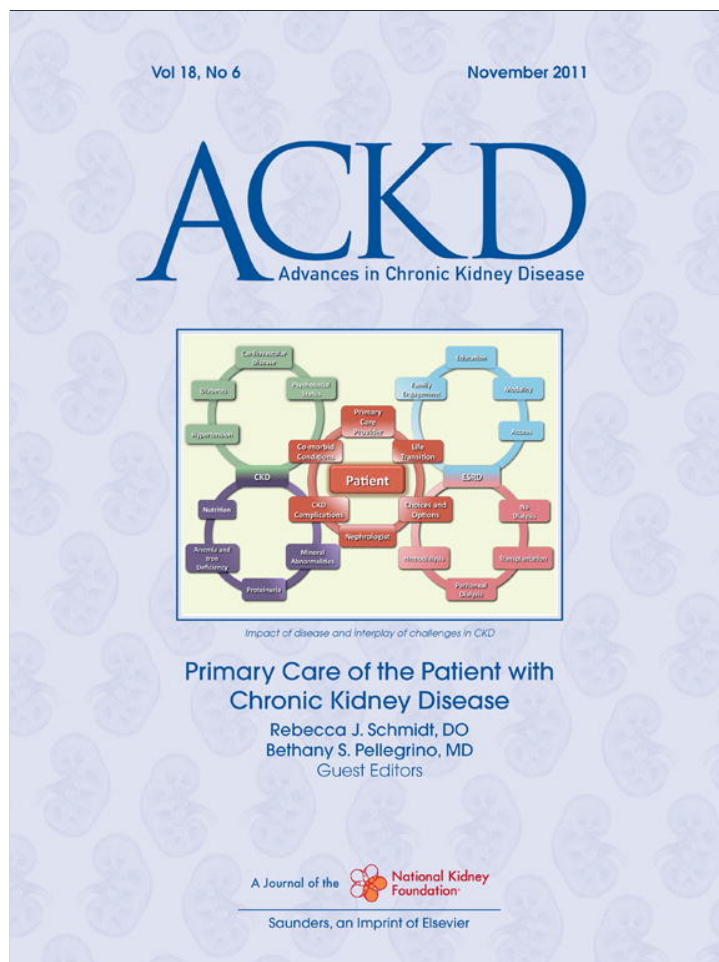


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Improving Blood Pressure Control Among Adults With CKD and Diabetes: Provider-Focused Quality Improvement Using Electronic Health Records

Bernadette Thomas

Current evidence demonstrates poor provider knowledge and compliance to clinical practice guidelines (CPGs) for CKD screening, blood pressure (BP) goals specific to people with diabetes mellitus (DM) and CKD, and underutilization or incorrect drug selection for antihypertensive therapy. This 12-week provider-focused quality improvement project sought to (1) increase primary care provider (PCP) adherence to CPG in the treatment and control of BP among adults with CKD and DM by using electronic health records (EHRs) and patient-level feedback (scorecards); (2) increase PCP delivery of basic CKD patient education by using EHR-based decision support; and (3) assess whether electronic decision support and scorecards changed provider behavior. The project included 46 PCPs, physicians, and nurse practitioners, in a statewide federally qualified health center that operates 12 comprehensive primary care sites in Connecticut. There were 6781 DM visits, among 3137 unique, racially diverse patients. There was a statistically significant increase in CKD screening, diagnosis, and use of angiotensin-converting enzyme inhibitor/angiotensin-receptor blocker. There was a statistically, but not clinically, significant increase in CKD basic education and ancillary service provider use when the provider was aware of the diagnosis or used EHR enhancements. EHR decision support and real-time provider feedback are necessary but not sufficient to improve uptake of CPG and to change PCP behavior. © 2011 by the National Kidney Foundation, Inc. All rights reserved.

Key Words: Scorecards, Electronic health records, CKD, Primary care, Clinical practice guidelines

In the United States and worldwide, CKD is a prevalent “risk multiplier” for those at risk for coronary vascular disease.¹⁻⁶ Fueled by the diabetes mellitus (DM) pandemic, DM accounts for 30% of incident and prevalent CKD and 40% of ESRD; National Health and Nutritional Examination Survey data estimates that of those with CKD, 33.8% also had DM and 43% had both DM and hypertension (HTN).⁷⁻⁹ The Centers for Disease Control and Prevention estimates 16.8% of US adults aged >20 have CKD, with prevalence being greater among those with DM, cardiovascular disease (CVD), and HTN.¹⁰ The United States Renal Data System (USRDS) refers to CKD as a multiplier of both poor health outcomes and healthcare costs.⁵ Those with CKD have greater risk for cardiovascular morbidity and mortality, including heart failure, acute myocardial infarction, stroke, peripheral arterial disease, and revascularization.^{5,11} While those with CKD are more likely to be affected by CVD than ESRD, patients with DM and CKD make up a large proportion of those who move on to ESRD: in 2006, this was 48,157 people, which was 4.6% greater than that in 2005, and 17.2% greater than that in 2000.⁵

Recent data demonstrate that the prevalence of comorbid conditions increases as the urine albumin-to-creatinine ratio (UACR) increases and as the eGFR decreases, especially HTN, DM, and CVD.⁵ Factors such as race and socioeconomic status have been associated with later diagnosis, greater likelihood to progress to ESRD, poorly controlled HTN, proteinuria, and greater risk for death.^{5,6,12-18}

Antihypertensive therapy reduces the risk for morbidity and mortality, specifically, stroke by 35% to 40%, myocardial infarction by 20% to 25%, and heart failure by more than 50%, and is the single most critical intervention to reduce the incidence and progression of CKD among people with type 2 DM.^{11,19-22} Numerous studies demonstrate poor provider knowledge and compliance to clinical guidelines, specifically to the blood pressure (BP) goals for patients with DM and CKD.²³⁻³⁰ Other studies demonstrate that antihypertensive therapy is underutilized or the wrong drug is selected.^{26,31-34} The literature also describes a failure by the primary care provider (PCP) to perceive the increased risk associated with CKD as well as a failure to intensify BP therapy as a means to mitigate that risk.^{26,27,34-37}

While those with CKD are at greater risk for morbidity and mortality related to coronary artery disease, peripheral artery disease, cerebral vascular disease, heart failure, and ESRD; their medical expenses are also greater.^{1,5,11} Among Medicare recipients, CKD accounts for 28% of all expenditures, including 39% of spending on DM and 32% of spending on CVD.⁵ With respect to ESRD, per patient per month costs reached \$16,140 in 2006, while costs for those with private insurance were 2.2 times greater.⁵ Inpatient and outpatient costs were

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5.2 times higher for patients with CKD, DM, and CVD compared with those with CKD and DM alone.⁵

Local Problem

Community Health Center, Inc. (CHCI) has been particularly concerned about chronic disease management and outcomes within its population, which, similar to other low-income populations, has documented challenges with clinical outcomes, process outcomes, and health disparities. In 2009, nearly 5000 patients with type 1 or type 2 DM received care at CHCI, 25% of whom have HbA1C >9%, and Hispanics account for more than one-half of the diabetic patients with poor glycemic control.

At CHCI, providers often fail to adequately screen, diagnose, educate, and treat patients with CKD. Of those patients with DM seen in 2009, 71% had an eGFR measured, 43% had a UACR measured, and only 40% had both recommended tests^{38,39} done, despite the availability of testing free of charge for the uninsured.

These findings are not unique to CHCI and, in fact, are representative of challenges to providing evidence-based care for CKD in high-risk populations. With respect to BP control, the Joint National Committee VII, American Diabetes Association, NKF, and International Society on Hypertension in Blacks universally recommend a BP goal of 130/80 for patients with DM and CKD.^{19,38-40} Although almost 70% of CHCI's DM patients have a coexisting diagnosis of HTN, in 2009, only 39% of patients achieved this goal.

These failures, well described in the literature as clinical or therapeutic inertia, are evident for the chronic diseases prevalent in primary care.⁴¹⁻⁴⁴

Intended Improvement

This 12-week provider-focused quality improvement (QI) project had 3 aims: (1) to increase PCP adherence to evidenced-based, clinical practice guidelines (CPGs) in the treatment and control of BP among adults with CKD and DM by using electronic health records (EHRs) and patient-level feedback (scorecards); (2) to increase PCP delivery of basic CKD patient education by using EHR-based decision support; and (3) to assess whether electronic provider decision support and scorecards changed provider behavior.

Project Question

This QI project aimed to determine whether weekly provider feedback in the form of individualized provider ac-

tion lists (scorecards) and EHR enhancements (decision supports) would increase provider awareness of CKD, improve screening rates among people with DM, and improve recognition and treatment as well as the delivery of CKD basic education, known as the Four Key Concepts for Kidney Disease Education from the National Kidney Disease Education Program (NKDEP, <http://www.nkdep.nih.gov>).

No potential risks or harms were identified for providers or patients, and Institutional Review Board waivers were received from CHCI, ID 1002, and Johns Hopkins University, NA_00037785.

Setting

This QI project was implemented at CHCI, a statewide primary care organization consisting of 12 federally qualified health centers in Connecticut, an early adopter of EHRs, where all providers were trained previously in eCW version 8 (eClinicalWorks, Westborough, MA). All patient care occurs within the EHRs, and the decision support created for this project was embedded within

it. Electronic feedback in the form of provider-patient action lists was delivered weekly, by secure interoffice e-mail.

Planning and Intervention

To determine baseline diagnosis data from 2009, International Classification of Diseases (ICD)-9 codes for CKD were extracted from

the practice management system, whereas lab data extraction was used to determine the initial scope of the problem and the discrepancy between provider diagnosis and laboratory evidence of disease. The weekly action lists used for this project were populated by data extracted directly from the EHRs.

Providers received 2 passive education sessions in the form of American Academy of Family Physicians-approved continuing medical education in July 2009 and October 2010. These companywide "Grand Rounds" were developed by the project author and delivered via live teleconference. Grand Rounds focused on the classification and treatment of CKD, as well as the QI project, and EHR enhancements aimed at improving PCP practice, including embedded NKDEP patient education.

During the 12-week study period, data extracted from the EHRs included all patients with DM seen during the week, their BP, use of angiotensin-converting enzyme inhibitor (ACEI)/angiotensin-receptor blocker (ARB), last eGFR, and last UACR. These data were imported into SPSS version 18 (SPSS, Armonk, NY), where data coding

CLINICAL SUMMARY

- Scorecards increase provider screening and diagnosis of CKD among patients with diabetes.
- Scorecards increase the use of ACEI and ARB among patients with CKD and diabetes.
- Electronic health record decision support is necessary, but not sufficient to increase delivery of CKD basic education and increase utilization of ancillary service providers.

and transformations were used to generate patient visit lists meeting the criteria for inclusion in the action lists and chart reviews.

Chart reviews were performed on all patients with DM, laboratory evidence of CKD, and an elevated BP ($n = 1051$). Charts were examined for provider action on an elevated BP. Provider action included HTN or CKD education, referral to ancillary service provider, or modification or reinforcement of medication regimen. Two weekly action lists were created for each provider. The CKD action list included patients seen in the past week with laboratory evidence of CKD and suggested actions. The DM action list included patients seen in the past week with DM who had not been screened for CKD, as well as suggested actions. Suggested actions included confirm diagnosis, refer to clinical pharmacist (PharmD) or certified diabetes educator (CDE), recall for BP check with registered nurse, and recall for eGFR or UACR.

Action lists were emailed to providers, the primary care nurse, and the on-site PharmD, if one existed. Each week's email included a brief "tips" sheet, which included reminders on CKD screening and diagnosis, evidence-based guidelines, and EHR enhancements to improve patient care. Providers were not "mandated" to use the action list in any specific way, although suggestions were made on a weekly basis on how to incorporate the members of the patient care team, including the receptionist, the medical assistant, and the primary nurse.

Analysis

Post hoc power analysis with a β of 20% and an α of 0.5%, with a moderate effect size (0.5), would have called for a sample size of 3341 patient visits, suggesting the QI project was sufficiently powered, with the caveat that significant findings could be explained by the large sample size. Chi Square was performed in SPSS version 18.

Outcomes

Quality Improvement Intervention: Action List Generation

All full- and part-time PCPs on staff at CHCI, who treat adults, were included, as were all patients with diabetes presenting for care during October 2010 to December 2010. The diagram below depicts how the action lists were created after data were extracted from the EHRs (Fig 1).

Descriptive Findings

Provider Characteristics

All full- and part-time adult and family practice providers were included in this QI project. This included

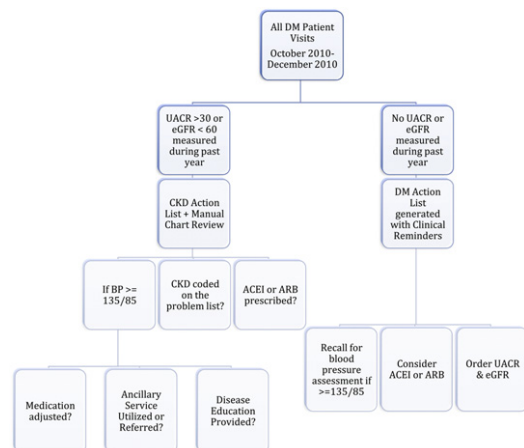


Figure 1. Abbreviations: DM, diabetes mellitus; UACR, urinary albumin creatinine ratio; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; BP, blood pressure; ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker. Ancillary Service (CDE, PharmD, RN, Nutritionist).

46 providers, 15 of which were nurse practitioners. All CHCI patients with DM seen during October to December 2010 were included in the intervention; 5327 visits (79%) were with physician providers. During this 12-week period, on average, each provider saw 146 patients with DM and 119 patients with a codiagnosis of HTN. The overall average patient panel size was 1019 (standard deviation [SD] 481), the average percentages of patients with DM and HTN were 7% and 5%, respectively, both with an SD 3%. To determine if a provider's behavior was influenced by a "comfort" with managing diabetes, providers were designated to low-, medium-, and high-acuity categories, depending on the percentage of their patient panel that comprised DM patients, seen during the 12 weeks: 2777 visits (41%) were from medium-acuity panels, and more than a third (33.4%) were from high-acuity panels.

Patient Characteristics

There were 6781 DM patient visits, which represented 3137 unique patients; 56% were female, 44% Hispanic, 35% White, and 13% African American. The mean age of patients seen was 53 years (range, 18-92); patient age was normally distributed.

Patients living in urban towns represented 78% of patient visits (5289). Visits with Hispanic and African American patients accounted for 50% of all visits (3390), and patients were from these same urban towns.

BP was controlled at 54% of patient visits (3702). Control was defined as $\leq 135/85$, to account for measurement error and variation in PCP clinical decision making. Mean systolic BP was 132 (SD = 20), and mean diastolic BP was 79 (SD = 11). With respect to measures of kidney function and damage, the mean eGFR, which was measured in the past year among 78% of patients with

diabetes, was 57 (SD = 8); the urinary albumin creatinine ratio (UACR), which was measured in the past year among 58% of patients with diabetes, was 70 (SD = 204), excluding values greater than 2000. Forty-six percent of patients seen during this project had both tests performed within the last year.

Intervention Analysis

Action Lists and Electronic Enhancements

Using retrospective practice management and laboratory data from 2009 (the 2009 DM Cohort was 4453; the QI DM Cohort was 3137), CKD diagnosis increased on ICD-9-coded problem lists from 472 to 615 ($\chi^2(1) = 55.81, P = .000$), and CKD screening rates increased from 38% to 46% ($\chi^2(1) = 3.88, P = .049$); however, only 32% of patients who met laboratory diagnosis of CKD were diagnosed during the intervention. We also hypothesized that weekly provider action lists and embedded clinical practice reminders would increase provider action. Clinical practice reminders included how often to screen for CKD, which tests to order, and the periodicity for monitoring. Provider action is defined as reinforcing regimen through education, increasing a drug, adding a drug, or referring to ancillary services when a patient's BP was above goal. During the intervention, there were 1051 visits wherein a patient had DM, CKD, and an elevated BP. Providers accessed EHR enhancements at only 4% (43) of those visits; of the 308 times a provider took action on an elevated BP, EHR enhancements were used at 14 (5%) of those visits ($\chi^2(1) = 2.23, P = .135$). However, action lists did appear to influence the use of ACEI/ARB among patients with CKD, increasing the ACEI/ARB use from 74% to 77% ($\chi^2(1) = 15.02, P = .007$). Weekly provider feedback also increased use of ACEI/ARB among our patients with DM, when compared with 2009 retrospective data, from 63% to 67% ($\chi^2(1) = 16.19, P = .000$). Basic CKD education, which was embedded in the "history of present illness" and "treatment plan" of the EHR, was "counted" if it was documented. Education delivery improved if the provider was aware of the diagnosis, which was defined as CKD appearing on the ICD9 problem list. An electronic enhancement was used in 17 (26%) of 65 instances of education delivery ($\chi^2(1) = 119.38, P = .000$). Although CKD education did improve, education rates were nonetheless low; education delivery was not recorded at 676 visits. Electronic enhancements also appeared to increase ancillary service provider use and were accessed at 5 referrals or visits, but though statistically significant, this does not represent a clinically significant change ($\chi^2(1) = 7.0, P = .01$). Ancillary service providers included the clinical pharmacist, certified diabetes educator, nutritionist, or registered nurse.

Visit Frequency

Patient visits ranged from 1 to 12 visits, with a mean of 2.2 visits per patient: 41.1% attended only 1 visit; 28%, 2 visits; and 16%, 3 visits during the 12-week period. Patients who attended more frequently did not have superior BP control, or early stage kidney disease as measured by eGFR and UACR. Moreover, there was no significant correlation with the frequency of visits and provider behavior with respect to ACEI or ARB use, recognition of CKD diagnosis, or delivery of basic CKD education.

Disease Recognition

PCPKD recognition rates are historically low, not unique to CHCI providers. At the beginning of this 12-week QI project, CKD was coded on 472 patient problem lists, whereas CHCI claims nearly 5000 patients with diabetes. For this data analysis, CKD was presumed based on an eGFR <60 mL/min/1.73 m² and/or a UACR >30 mg. An eGFR or UACR was "counted" if it was ordered, performed, and "resulted" in the EHR. There are numerous reasons why a laboratory result may not be resulted in an EHR, including the following ones: the provider orders the test, but the patient fails to present for the test to be done; the test is performed, but due to computer interface error, the result is not returned to the EHR; and finally, whilst Quest Diagnostics is our preferred laboratory, and results are directly transmitted into CHCI's EHRs, at several centers, patients prefer the local hospital laboratory, in which case, though the provider may have ordered the test, and the patient may have performed the test, there is no result in the EHR, and therefore, the result is not counted. Among the 1051 patients with DM, CKD, and an elevated BP providers took action 30% of the time (317 visits), referred or used ancillary services 19% of the time (103 visits), and documented CKD or HTN appropriate education 9% of the time (68 visits).

During the course of this QI project, providers used the EHR enhancements 43 times. EHR enhancement use was determined by chart review (n = 1051), which represented patients with a laboratory diagnosis of CKD and BP above target. A PCP or ancillary service provider was deemed to have used an enhancement if they used some sort of automation, which included basic CKD education talking points, CPGs, or self-management goal setting. When an enhancement was used, a significant relationship was found among patients who received basic CKD education and ancillary service provider use (Table 1).

Discussion

Summary

This 12-week provider-focused QI project sought to increase provider adherence to the CPGs for screening and improve the treatment of BP for those with DM

Table 1. EHR Enhancements: DM and CKD Patient Visits October-December 2010 N = 1051*

Number (%)	Yes	No	χ^2 (df)
Provider behavior			
ACEI or ARB (yes)	16 (3)	576 (97)	2.7 (1)
ACEI or ARB (no)	8 (5)	141 (95)	
Diagnosed (yes)†	11 (4)	237 (96)	1.7 (1)
Diagnosed (no)†	13 (3)	480 (97)	
Patient education (yes)†	17 (26)	48 (74)	119.4 (1)
Patient education (no)†	7 (1)	669 (99)	
Ancillary service (yes)†	5 (6)	79 (94)	7.0 (1)¶
Ancillary service (no)†	6 (1)	426 (99)	
Blood pressure action (yes)‡	14 (5)	294 (96)	2.2 (1)
Blood pressure action (no)‡	10 (3)	387 (98)	
Screened (yes)	16 (3)	455 (97)	0.1 (1)
Screened (no)	8 (3)	262 (97)	

Abbreviations: ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin-receptor blocker; df, degrees of freedom.

*Represents patients with DM, laboratory diagnosis of CKD, and an elevated blood pressure at the visit. Urinary albumin-to-creatinine ratio was measured among 58% of patients and eGFR, in 78% of patients.

†Represents patients screened for both urinary albumin-to-creatinine ratio and eGFR and met laboratory criteria for diagnosis of CKD. Percentages may not total 100 because of rounding.

‡Increased or added medication, reviewed medication regimen, referred to ancillary service, or other specialist.

¶ $P < .01$.

|| $P < .001$.

and CKD. This intervention made use of both EHR embedded clinical decision support as well as weekly provider feedback in the form of provider action lists. The project is particularly relevant for both meaningful use of EHR (MU) and the patient-centered medical home (PCMH). The acquisition of such knowledge is essential with the growing burden of obesity, and subsequent chronic illnesses, including HTN, diabetes, and CKD.⁴⁵ Furthermore, the primary care office is continually asked to provide more high-quality services and demonstrate efficacy and improved patient outcomes. Primary care redesign vis-à-vis the patient-centered medical home requires that PCPs work in teams, providing "proactive, population-based approach, especially for chronic care and preventive services."⁴⁶

This project was strengthened by the timeliness of provider feedback, as weekly action lists enabled PCPs and their teams to address patient needs in real time. Additionally, weekly action lists keep CKD and the evidence-based CPG in the PCP's "radar," increasing the likelihood the PCP will remember CKD screening and the use of ancillary services to improve disease management.

At the end of this 12-week QI intervention, there was a statistically significant increase in CKD diagnosis, screening, and ACEI/ARB use. There was also a statistically significant increase in basic CKD education and ancillary service provider use when the provider was aware of the diagnosis or used EHR enhancements; however, the delivery of basic CKD education and ancillary service

provider use did not increase among the DM patient population in general, which represents the people most at risk for developing CKD. Although statistically significant, the later results may not be clinically significant, as they only represent a small percentage of patients with both CKD and DM.

Limitations

There are several limitations threatening internal validity of this QI project. First, at locations where patients did not use the preferred laboratory, the accuracy of CKD prevalence and screening rates could not be guaranteed. Second, CKD diagnosis was based on laboratory evidence during the course of this project, which may have under- or overstated the true prevalence of CKD. Finally, no specific survey or interview was conducted among participating PCPs, and therefore, it is impossible to know if the effects observed during the course of this project were due to the action lists and clinical reminders or due to the Hawthorne effect.

There are also several limitations threatening the external validity of these findings. CHCI provides on-site laboratory services, and it is able to provide free laboratory services to its uninsured patients with incomes <200% of the federal poverty limit, which may improve screening rates relative to populations without such access. Such services are not available in all primary care offices or to all uninsured patients. CHCI serves a large number of Hispanic patients, and in this project, Hispanics represented nearly 50% of patients visits, which is not representative of most other community health centers or of the general population seeking care in the primary care setting.⁴⁷

Future Directions: Implications for Primary Care

There are many promising positive and negative findings described here that lend themselves to further expanding on the use of real-time provider feedback, the use of primary care teams, and increasing the uptake of the innovations of EHR to improve PCP adherence of CPGs and ultimately improve patient care and health outcomes. These results suggest that PCPs may require one-on-one training in the utility of action lists or scorecards, as well as group training on working in teams to both capitalize on existing resources and improve disease management. Finally, workflow redesign, which would reassign tasks to other members of the care team, must be considered to increase use of both ancillary service providers and EHR enhancements.

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