A Cluster Randomized Trial of an Enhanced eGFR Prompt in Chronic Kidney Disease

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Summary

Background and objectives Despite reporting estimated GFR (eGFR), use of evidence-based interventions in CKD remains suboptimal. This study sought to determine the effect of an enhanced eGFR laboratory prompt containing specific management recommendations, compared with standard eGFR reporting in CKD.

Design, setting, participants, & measurements A cluster randomized trial of a standard or enhanced eGFR laboratory prompt was performed in 93 primary care practices in Alberta, Canada. Although all adult patients with CKD (eGFR <60 ml/min per 1.73 m²) were included, medication data were only available for elderly patients (aged ≥66 years). The primary outcome, the proportion of patients with diabetes or proteinuria receiving an angiotensin converting enzyme inhibitor (ACEi) or angiotensin receptor blocker (ARB), was assessed in elderly CKD patients.

Results There were 5444 elderly CKD patients with diabetes or proteinuria who were eligible for primary outcome assessment, irrespective of baseline ACEi/ARB use. ACEi/ARB use in the subsequent year was 77.1% and 76.9% in the standard and enhanced prompt groups, respectively. In the subgroup of elderly patients with an eGFR <30 ml/min per 1.73 m², ACEi/ARB use was higher in the enhanced prompt group. Among 22,092 CKD patients, there was no difference in the likelihood of a composite clinical outcome (death, ESRD, doubling of serum creatinine, or hospitalization for myocardial infarction, heart failure, or stroke) over a median of 2.1 years.

Conclusions In elderly patients with CKD and an indication for ACEi/ARB, an enhanced laboratory prompt did not increase use of these medications.

Introduction

An estimated GFR (eGFR) <60 ml/min per 1.73 m² (1) identifies the presence of CKD and is associated with a significantly higher risk of death, most commonly due to cardiovascular disease (2–4). Patients with CKD often do not receive optimal therapy (5–7), perhaps because physicians do not recognize earlier stages of CKD or are unaware that CKD confers elevated cardiovascular risk. This is particularly important given that treatments have been shown to delay or prevent ESRD and improve cardiovascular outcomes (8–13).

One strategy for transferring evidence from research into practice has been to combine clinical practice guidelines with point-of-care physician reminders (14,15). Similar to conditions such as dyslipidemia (for which information to aid physicians with interpretation often accompanies laboratory results), there has been widespread enthusiasm for the use of laboratory prompts to facilitate recognition of CKD (16). Accordingly, many jurisdictions have implemented eGFR reporting, meaning that eGFR is also reported when a provider requests serum creatinine measurements (16,17). A recent systematic review noted that eGFR reporting increases the rate of nephrologist referrals (16), but only a minority of studies assessed whether eGFR reporting influences the use of medications modulating the renin-angiotensin-aldosterone system (16), with the largest time-series analysis showing no change in use (17). No prior randomized studies have examined the effect of eGFR reporting on process-based outcomes (i.e., appropriate medication use) or clinical outcomes.

Despite the lack of evidence to support eGFR reporting on its own, there is considerable interest in adding additional information on optimal management of patients with CKD to the eGFR laboratory prompt to increase uptake of beneficial therapies and perhaps improve outcomes (18–20). However, no prior studies have evaluated the effect of an enhanced management-based eGFR prompt. Moreover, whether point-of-care reminders improve processes of care and clinical outcomes is uncertain (21–23).

We conducted a cluster randomized trial testing the effect of an enhanced laboratory prompt for patients with CKD managed by primary care physicians compared with a standard eGFR laboratory prompt.

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Materials and Methods

Data Sources
We used a provincial repository of laboratory data to identify patients with CKD, defined as eGFR <60 ml/min per 1.73 m² (24). Available data included the test result as well as the ordering physician, allowing patients to be randomized and analyzed within clusters. Provincial administrative data were used to determine nephrology visits, hospitalization, and vital status. Because drug coverage is only provided for Albertans aged >65 years by the provincial health ministry, medication use outcomes, including our primary outcome, could only be assessed in elderly individuals (defined as those aged ≥66 years, allowing 1 year to accrue baseline drug status). Other outcomes including all-cause mortality and cardiovascular outcomes could be assessed for all participants, regardless of age. Ethics approval was obtained from the institutional review boards of the Universities of Calgary and Alberta (trial registration no. ISRCTN26610787).

Patient Population
The primary study population included all elderly CKD patients with diabetes or proteinuria because our primary outcome, use of an ACE inhibitor (ACEi) or angiotensin receptor blocker (ARB), could only be assessed in elderly patients and because use of these medications in patients with diabetes or proteinuria is recommended by clinical practice guidelines (25,26). Secondary outcomes not requiring medication data were assessed in all CKD patients aged >18 years. Patients were identified as having CKD during the 1-year enrollment period, on the basis of an outpatient eGFR requested by primary care physicians in eligible practices that was <60 ml/min per 1.73 m². Eligible practices were located in three Alberta Health Regions and included those with ≥2 full-time primary care physicians who worked at a single practice, reducing the risk of physicians being exposed to both the control and intervention laboratory prompt across multiple practices. On the basis of availability of laboratory data, the enrollment period varied by health regions: June 15, 2006 to June 15, 2007 in two regions, and January 1, 2007 to January 1, 2008 in the third. One region was largely urban (population serviced approximately 1 million), whereas the two others (populations serviced approximately 70,000 and 160,000) were a mixture of urban and rural communities. Subgroups considered included those in whom eGFR was <30 ml/min per 1.73 m² (a group at higher risk of complications due to CKD in whom primary care physicians may be reluctant to prescribe an ACEi or ARB), and those with incident CKD (defined as absence of documented eGFR <60 ml/min per 1.73 m² in the prior 2 years).

Control and Intervention Prompts
To reduce the risk of contamination between physicians co-managing patients with CKD, randomization occurred at the level of the group practice using a computer-generated randomization sequence and concealment. Physicians in the control group who ordered serum creatinine measurements continued to receive the standard eGFR prompt for patients with an eGFR <60 ml/min per 1.73 m² (Supplemental Appendix 1). For physicians randomized to the enhanced eGFR prompt, additional education about the significance of CKD and specific management suggestions were reported in addition to eGFR. These suggestions included guideline-based (25,26) recommendations to measure urine albumin/creatinine ratio, prescribe an ACEi or ARB in patients with diabetes or albumin/creatinine ratio >35 mg/mmol, reduce BP to <130/80 mmHg, reduce LDL cholesterol to <2.5 mmol/L, and target hemoglobin A1C to <7% in patients with diabetes (Supplemental Material).

Outcomes
The primary outcome was the proportion of elderly CKD patients with diabetes or proteinuria who filled a prescription for an ACEi or ARB within 1 year of the first prompt being received by the physician (index eGFR measurement), irrespective of baseline ACEi/ARB use. We chose this primary outcome because ACEi or ARB delays progression to ESRD in those with proteinuria (11–13), improves survival (in those with diabetes) (11), is recommended by practice guidelines, and was explicitly recommended by the enhanced prompt. Secondary outcomes, measured in patients with CKD regardless of age, represented markers of good quality care, or relevant clinical outcomes for patients with CKD (Supplemental Material).

Other Variable Definitions
Demographic and baseline clinical data were determined from provincial administrative data during the 2-year period before the index eGFR measurement. We used validated algorithms to define hypertension (27) and diabetes (28), with other comorbid conditions based on the Deyo classification of Charlson comorbidities (29). The presence of proteinuria varied based on the laboratory testing that the patient had, but was defined by quantitative assessment of proteinuria (i.e., measured proteinuria or albuminuria >300 mg/d if available or by urine dipstick results if quantitative testing was unavailable (≥1+ proteinuria on urine dipstick), using the testing done within 6 months of the index eGFR measurement (24).

Sample Size
Our sample size was estimated using a variety of assumptions based on the formula for cluster randomized trials with a binary outcome (30). On the basis of clinical expert consensus and for consistency with other studies, we deemed a 10% absolute increase in ACEi/ARB use to be the minimally important difference for this intervention. Because we had no a priori information on the intracluster correlation coefficient (ICC), we estimated power using ICC estimates of 0.01, 0.05, and 0.10. We estimated that we would have 75%–99% power to detect a 10% difference in the primary outcome with ICCs varying from 0.01 to 0.10. In post hoc analyses, given observed average cluster sizes of 58, an ICC of 0.02, and 90 primary care practices, we had >99% power to detect a 10% difference and 84% power to detect a 5% difference between groups.

Statistical Analyses
We designed, conducted, and reported this trial according to published guidelines (31). We used a cluster randomized design in which the unit of observation was the
patient, and the unit of randomization was the primary care practice. Randomization was concealed and stratified on the basis of the health region and whether the practice was located in a center with a population of <25,000 or >25,000. All analyses were intention to treat. Relative risk estimates were obtained using generalized estimating equations and binomial regression with a log-link function (30,32). The ICC was obtained from a random-intercept logistic regression model (33). To simultaneously control for individual-level and cluster-level covariates, we also estimated adjusted relative risks to obtain a more accurate variance associated with the odds of success for bivariate equations and binomial regression with a log-link function (33). To simultaneously control for individual-level and cluster-level covariates, we also estimated adjusted relative risks to obtain a more accurate variance associated with the odds of success for bivariate outcomes (30). The variables included were at the following levels: individual (age, sex, baseline kidney function, diabetes, congestive heart failure, cardiovascular disease), physician (sex, years in practice), and cluster (urban/rural, health region, and number of physicians per cluster). We conducted subgroup analyses for each outcome in patients in whom eGFR was <30 ml/min per 1.73 m² on first measurement, and in those with incident CKD. We used Stata software (version 11; Stata Corp, College Station, TX) for all analyses.

Results
Baseline Characteristics
The majority of primary care physicians and patients with CKD in the three health regions were included (Figure 1 and Supplemental Figure 1) and baseline characteristics of physician clusters were similar across study groups (Supplemental Table 1). Patients with CKD allocated to the enhanced prompt clusters were similar to those allocated to the standard prompt—both for elderly patients with diabetes or proteinuria, and for all patients aged ≥18 years (Table 1).

Primary Outcome
ACE or ARB Use in Elderly CKD Patients with Diabetes or Proteinuria. Of the 5444 elderly CKD patients with diabetes or proteinuria who were eligible for assessment of the primary outcome (irrespective of baseline ACEi/ARB use), 483 had eGFR<30 ml/min per 1.73 m². ACEi or ARB use was 77.1% and 76.9% in the standard and enhanced prompt groups, respectively (relative risk [RR], 1.00; 95% confidence interval [95% CI], 0.96–1.04) (Table 2). We noted no difference in ACEi or ARB use between the standard and enhanced prompt groups when we repeated the analysis considering only patients who were not using an ACEi or ARB at baseline, or when we considered the subgroup of patients with significant proteinuria in whom ACEi or ARB use could be considered standard of care. When we considered the subgroup of 5055 elderly CKD patients with diabetes or proteinuria who had two eGFR measurements <60 ml/min per 1.73 m², in whom the diagnosis of CKD was confirmed according to clinical practice guidelines (1), we also noted no difference in ACEi or ARB use (RR, 1.00; 95% CI, 0.96–1.04).

We noted a significant interaction between the intervention (i.e., standard and enhanced prompt groups) and severity of CKD (eGFR 30–60 versus <30 ml/min per 1.73 m²) (P=0.015). Among patients with an eGFR<30 ml/min per 1.73 m², ACEi or ARB use was 13% higher (RR, 1.13; 95% CI, 1.03–1.24) in the enhanced compared with the standard prompt groups (Table 2). We found no difference between groups in the proportion of patients receiving ACEi or ARB in the subgroup with incident CKD.

For all outcomes, adjusted and unadjusted results were similar. No differential response to the enhanced prompt was noted for female and male physicians, or for physicians practicing for <10 years or ≥10 years.

Secondary Outcomes
Elderly CKD Cohort. Among elderly CKD patients, there was no difference in the proportion of patients in whom a prescription for a cholesterol-lowering drug or an additional antihypertensive medication from a different therapeutic class was filled in the subsequent year between the two groups (Figure 2).

All Adults with CKD. Among all patients aged ≥18 years with no measure of proteinuria in the prior 6 months, albuminuria was measured during the 6 months after randomization in 7.4% and 6.3% of patients in the enhanced and standard prompt groups, respectively (RR, 1.29; 95% CI, 1.03–1.62) (Figure 3). Among those with an eGFR <30 ml/min per 1.73 m², corresponding proportions were 14.7% and 10.2%, respectively (RR, 1.50; 95% CI, 1.02–2.22). Results were similar when other measures of proteinuria (i.e., protein/creatinine ratio, urine dipstick) were considered. There were no differences between groups in the proportion of patients who had LDL cholesterol subsequently measured or the proportion of patients with diabetes who had hemoglobin A1C measured (Figure 3). Among patients with a baseline hemoglobin A1C >7.0%, we also noted no difference in the proportion of patients who had hemoglobin A1C of <7% during the observation period in the enhanced (35.5%) and standard (37.7%) laboratory prompt groups, respectively (RR, 0.94; 95% CI, 0.81–1.09). Finally, among the
subgroup of patients with incident CKD, we found no difference between groups in the above measures (Supplemental Figure 2).

There was no difference in the proportion of patients with an eGFR <30 ml/min per 1.73 m² who were seen by a nephrologist between the two groups (Figure 2). Results were similar when we considered referrals to internal medicine specialists. We also assessed whether the different prompts might result in referral of different types of patients (i.e., referral of more high-risk patients with proteinuria, or low-risk patients with an eGFR 30–60 ml/min per 1.73 m² without proteinuria) but found no differences in the types of patients referred to nephrologists (Figure 2).

During a median follow-up of 2.1 years, there was no difference in the likelihood of a composite clinical outcome (death, ESRD, doubling of serum creatinine, or hospitalization for myocardial infarction, heart failure, or stroke) for patients receiving the enhanced prompt (14.0%) compared with the standard prompt (13.3%), overall (RR, 1.00; 95% CI, 0.89–1.12) or in subgroups (Figure 4).

**Discussion**

eGFR reporting has been advocated based on its potential to improve the recognition and management of CKD by primary care physicians (16). A logical extension to

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**Table 1. Demographics and clinical characteristics of participants**

<table>
<thead>
<tr>
<th>Baseline Characteristic</th>
<th>Elderly Patients with Diabetes or Significant Proteinuria (Primary Analysis) (n=5444)</th>
<th>All CKD Patients Aged ≥18 yr (n=22,092)a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr), mean (SD), years</td>
<td>78.2 (7.0)</td>
<td>71.7 (12.7)</td>
</tr>
<tr>
<td>Female sex, n (%)</td>
<td>1400 (55.9)</td>
<td>6907 (64.5)</td>
</tr>
<tr>
<td>Baseline eGFR (ml/min per 1.73 m²), mean (SD)</td>
<td>46.5 (10.7)</td>
<td>49.7 (9.4)</td>
</tr>
<tr>
<td>Baseline eGFR, n (%)</td>
<td>45.0–59.9</td>
<td>50.0–59.9</td>
</tr>
<tr>
<td>45.0–59.9</td>
<td>1572 (62.8)</td>
<td>8060 (75.3)</td>
</tr>
<tr>
<td>30.0–44.9</td>
<td>710 (28.3)</td>
<td>2156 (20.1)</td>
</tr>
<tr>
<td>&lt;30.0</td>
<td>223 (8.9)</td>
<td>491 (4.6)</td>
</tr>
<tr>
<td>Significant proteinuria, n (%)b</td>
<td>1426 (56.9)</td>
<td>6447 (60.2)</td>
</tr>
<tr>
<td>no</td>
<td>608 (24.3)</td>
<td>820 (7.7)</td>
</tr>
<tr>
<td>yes</td>
<td>471 (18.8)</td>
<td>3440 (32.1)</td>
</tr>
<tr>
<td>Diabetes, n (%)c</td>
<td>2108 (84.2)</td>
<td>2816 (26.3)</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>2265 (90.4)</td>
<td>8084 (75.5)</td>
</tr>
<tr>
<td>Comorbidities, n (%)</td>
<td>286 (11.4)</td>
<td>8917 (81.1)</td>
</tr>
<tr>
<td>cerebrovascular disease</td>
<td>210 (8.4)</td>
<td>210 (7.7)</td>
</tr>
<tr>
<td>peripheral vascular disease</td>
<td>304 (12.1)</td>
<td>1011 (8.9)</td>
</tr>
<tr>
<td>myocardial infarction</td>
<td>573 (22.9)</td>
<td>1637 (14.4)</td>
</tr>
<tr>
<td>congestive heart failure</td>
<td>377 (15.1)</td>
<td>1348 (11.8)</td>
</tr>
<tr>
<td>cancer</td>
<td>587 (23.4)</td>
<td>2453 (21.6)</td>
</tr>
<tr>
<td>chronic obstructive pulmonary disease</td>
<td>386 (15.4)</td>
<td>533 (4.7)</td>
</tr>
<tr>
<td>diabetes with end organ damage</td>
<td>1427 (57.0)</td>
<td>2638 (23.2)</td>
</tr>
<tr>
<td>diabetes without end organ damage</td>
<td>2664 (90.6)</td>
<td>8782 (77.1)</td>
</tr>
<tr>
<td>Number of comorbidities, median [IQR]</td>
<td>2 [1,3]</td>
<td>1 [0,2]</td>
</tr>
<tr>
<td>Baseline medication use, n (%)</td>
<td>ACEi 1352 (54.0)</td>
<td>3157 (42.1)</td>
</tr>
<tr>
<td>ACEi or ARB</td>
<td>829 (33.1)</td>
<td>2110 (28.1)</td>
</tr>
<tr>
<td>cholesterol-lowering drug</td>
<td>1924 (76.8)</td>
<td>4820 (64.3)</td>
</tr>
<tr>
<td>cholesterol-lowering drug</td>
<td>1448 (57.8)</td>
<td>3416 (45.6)</td>
</tr>
<tr>
<td>RR, relative risk; eGFR, estimated GFR; 95% CI, 95% confidence interval; IQR, interquartile range; ACEi, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker.</td>
<td>RR, relative risk; eGFR, estimated GFR; 95% CI, 95% confidence interval; IQR, interquartile range; ACEi, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker.</td>
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</tr>
</tbody>
</table>
eGFR reporting is providing additional information to the prompt with the goal of enhancing risk prediction and management. In this cluster randomized trial, we found that an enhanced eGFR laboratory prompt did not improve specific elements of care processes or clinical outcomes in patients with CKD.

Clinical decision support has been shown to change physician practice in many randomized trials, across a wide range of conditions and interventions (34,35), although only 7 of 52 studies included in a meta-analysis of clinical decision support noted an improvement in patient outcomes (34). Recent systematic reviews have shown that three features are strongly associated with effective clinical decision support: routinely providing guidance as part of clinician workflow, providing guidance at the time and location of decision making, and providing a recommendation rather than an assessment (21,35). In both the intervention and control groups of our study, guidance was provided as part of clinician workflow and recommendations were provided to the enhanced prompt.

### Table 2. ACEi or ARB use among elderly CKD patients with diabetes or proteinuria

<table>
<thead>
<tr>
<th>Cohort</th>
<th>n</th>
<th>Standard Prompt, n (%)</th>
<th>Enhanced Prompt, n (%)</th>
<th>Intraclass Correlation Coefficient (P Value)</th>
<th>Relative Risk (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>eGFR &lt; 60 ml/min per 1.73 m²</td>
<td>5444</td>
<td>1932 (77.1)</td>
<td>2260 (76.9)</td>
<td>0.020 (&lt;0.001)</td>
<td>1.00 (0.96–1.04)</td>
</tr>
<tr>
<td>eGFR &lt; 30 ml/min per 1.73 m²</td>
<td>483</td>
<td>161 (72.2)</td>
<td>208 (80.0)</td>
<td>&lt;0.001 (0.497)</td>
<td>1.13 (1.03–1.24)</td>
</tr>
</tbody>
</table>

Percentages represent patients with outcome out of the number of patients in the subgroup of interest, irrespective of baseline ACEi/ARB use. ACEi, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; eGFR, estimated GFR.

### Figure 2. Secondary outcomes among all CKD patients receiving standard and enhanced prompts.

- Percentages represent patients with outcome out of the number of patients in the subgroup of interest.
- Defined as use of a cholesterol-lowering drug (defined as any statin, fibrate, or ezetimibe prescription).
- RR, relative risk; 95% CI, 95% confidence interval; eGFR, estimated GFR.
prompt group, although not at the time and location of decision making.

Why was the enhanced laboratory prompt not effective at improving processes of care in the management of CKD? It is possible that no further improvement in the primary outcome was possible, given the high baseline use of ACEi and ARB in both groups (approximately 77%). Alternatively, it is possible that the enhanced prompt was simply no more useful than an already effective standard prompt—physicians in the standard prompt group could access further information (including management recommendations) by visiting a website suggested in the laboratory report. However, because prior research suggests that eGFR reporting increases referral but does not seem to change prescribing of ACEi or ARB medication (16,17), we do not think that this would completely account for our findings.

The enhanced eGFR prompt may have been too complex because it combined physician education on identification and significance of CKD with management suggestions. Because the enhanced laboratory prompt may have been more effective in patients with an eGFR <30 ml/min per 1.73 m², we speculate that primary care physicians may not have considered all patients with an eGFR 30–60 ml/min per 1.73 m² to require specific management of CKD. Finally, it is possible that physicians were overwhelmed with the number of patients receiving a prompt, because >10% of patients in whom serum creatinine was ordered had eGFR <60 ml/min per 1.73 m².

Regardless of the explanation, our results suggest that adding clinical decision support to a laboratory prompt aimed at improving the identification and management of CKD does not provide meaningful benefit to patients (16,17). Data are urgently needed to clarify how routinely incorporating information on eGFR into routine care could improve outcomes rather than simply increasing physician workload. Because the effect of treatment recommendations delivered at point of care may be increased by accompanying them with endorsements from respected local physicians (22,36), future use of automated reminders should consider incorporating opinion leaders as signatories or other enabling strategies such as patient activation mechanisms and the involvement of allied health professionals (37).

Although it may have been more effective to provide the laboratory prompts within a functioning electronic medical record, which could prompt a physician to change practice during the clinical encounter), integrated electronic medical records are not yet widely available in Alberta. Indeed, <5% of American primary care physicians have access to electronic records with such advanced functionality (38) and the modality by which evidence prompts are delivered (computer-based versus paper-based) does not seem to influence effectiveness (39). Therefore, the interventions in our study were consistent with the usual mode of eGFR reporting throughout much of the world.

Our study had several limitations that should be considered. As noted, the high baseline ACEi/ARB use (approximately 77%) in our study participants may have affected our ability to detect a change in medication prescribing after exposure to the enhanced laboratory prompt. Not all patients are able to tolerate angiotensin blockade due to medication intolerance and adverse events, including hyperkalemia. However, it is important to note that in patients with an eGFR <30 ml/min per 1.73 m² in whom baseline use was similarly high and adverse events might be expected to be

<table>
<thead>
<tr>
<th>Outcome</th>
<th>N</th>
<th>Standard Prompt, n (%)</th>
<th>Enhanced Prompt, n (%)</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urinary albumin measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall cohort with eGFR&lt;90mls/min/1.73m²</td>
<td>17465</td>
<td>550 (6.3)</td>
<td>645 (7.4)</td>
<td>1.29 (1.03-1.52)</td>
</tr>
<tr>
<td>Subgroup with eGFR&lt;30mls/min/1.73m²</td>
<td>881</td>
<td>42 (10.2)</td>
<td>69 (14.7)</td>
<td>1.50 (1.02-2.22)</td>
</tr>
<tr>
<td><strong>Lipid measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall cohort with eGFR&lt;90mls/min/1.73m²</td>
<td>6954</td>
<td>720 (20.7)</td>
<td>754 (21.7)</td>
<td>1.07 (0.94-1.21)</td>
</tr>
<tr>
<td>Subgroup with eGFR&lt;30mls/min/1.73m²</td>
<td>578</td>
<td>50 (18.3)</td>
<td>56 (18.4)</td>
<td>1.00 (0.76-1.33)</td>
</tr>
<tr>
<td><strong>A1C measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with diabetes and eGFR&lt;60mls/min/1.73m²</td>
<td>1365</td>
<td>245 (37.9)</td>
<td>259 (35.9)</td>
<td>0.92 (0.78-1.09)</td>
</tr>
<tr>
<td>Subgroup with diabetes and eGFR&lt;30mls/min/1.73m²</td>
<td>131</td>
<td>19 (31.6)</td>
<td>20 (37.8)</td>
<td>1.16 (0.74-1.81)</td>
</tr>
</tbody>
</table>

Figure 3. | Proportion of CKD patients with a subsequent measurement of urine albumin, lipids, and hemoglobin A1C (in patients with diabetes) among patients who had no measure in the prior 6 months. Percentages represent patients with outcome out of the number of patients in the subgroup of interest. RR, relative risk; 95% CI, 95% confidence interval; eGFR, estimated GFR.
higher, we were able to document a 13% increase in ACEi/ARB use, suggesting that high baseline use did not solely account for the lack of change in the primary outcome. Second, because we relied on pharmacy prescribing records, we do not know to what extent patient noncompliance led us to underestimate the efficacy of our intervention; however, it is unlikely that noncompliance occurred differentially. Third, we did not collect data on the acceptability of the enhanced laboratory prompt to primary care physicians, and thus cannot determine how this might have influenced our results. Although the outcomes assessed are clinically relevant, we did not have any information on changes in other cardiovascular risk factors such as BP, weight, or smoking status.

In elderly patients with reduced eGFR and an indication for ACEi or ARB medication, an enhanced laboratory prompt neither increased the use of either agent, nor improved clinically relevant outcomes among a broader cohort of CKD patients. These data suggest that enhanced management-based laboratory prompts cannot currently be recommended for routine use in all patients with CKD. The higher use of angiotensin blockade noted in patients with an eGFR <30 ml/min per 1.73 m² who received the enhanced prompt requires confirmation. Future studies should examine the effects of using clinical decision support to target patients at higher risk of complications associated with CKD, including those with an eGFR <30 ml/min per 1.73 m² or patients with proteinuria.

Acknowledgments

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Figure 4. The occurrence of a clinically relevant composite endpoint¹ among CKD patients receiving standard and enhanced prompts.

¹Defined as death, ESRD, doubling of serum creatinine, and hospitalization for myocardial infarction, heart failure, or stroke. Percentages represent patients with outcome out of the number of patients in the subgroup of interest. RR, relative risk; eGFR, estimated GFR; 95% CI, 95% confidence interval.

None of the funding organizations had a role in the conception or design, conduct, analysis, interpretation, or reporting of the study, and none had access to the data.

Disclosures

B.C. became an employee of Baxter Healthcare after this study was designed. K.G. became an employee of Abbott after this study was designed. Baxter Healthcare and Abbott provided no funding for the study, no input into the analysis or interpretation of the results, and no input into the drafting of the paper. The remaining authors have no financial conflicts of interest to report.

References


<table>
<thead>
<tr>
<th>Outcome</th>
<th>N</th>
<th>Standard Prompt, n (%)</th>
<th>Enhanced Prompt, n (%)</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall cohort with eGFR&lt;60mls/min/1.73m²</td>
<td>22092</td>
<td>1424 (13.3)</td>
<td>1590 (14.0)</td>
<td>1.00 (0.99-1.12)</td>
</tr>
<tr>
<td>Subgroup with eGFR&lt;30mls/min/1.73m²</td>
<td>1096</td>
<td>189 (38.5)</td>
<td>222 (38.7)</td>
<td>0.96 (0.80–1.14)</td>
</tr>
<tr>
<td>Elderly patients with eGFR&lt;60mls/min/1.73m² and diabetes or proteinuria</td>
<td>5444</td>
<td>631 (25.2)</td>
<td>691 (23.5)</td>
<td>0.94 (0.93–1.05)</td>
</tr>
</tbody>
</table>


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