Detection of Chronic Kidney Disease With Laboratory Reporting of Estimated Glomerular Filtration Rate and an Educational Program

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Background: Serum creatinine concentration is an inadequate screening test for chronic kidney disease, especially in elderly patients. We hypothesized that laboratory reporting of estimated glomerular filtration rate (GFR) accompanied with an educational intervention would improve recognition of chronic kidney disease (CKD).

Methods: We conducted a before-and-after study at an outpatient family medicine practice. Patients 65 years or older for whom a Cockcroft-Gault GFR could be calculated from their medical record were included. The intervention consisted of automatic reporting of estimated GFR by the hospital laboratory along with an educational intervention directed toward the primary care physicians. The primary outcome was the recognition of CKD (defined as a Cockroft-Gault GFR \[<60 \text{ mL/min [<1.0 mL/s]}\]) by the primary care physician. Factors associated with the recognition of CKD were also determined.

Results: The study population comprised 324 patients. Prior to the study intervention, 22.4% of patients with CKD were recognized, which increased to 85.1% after the intervention. Before the intervention, recognition was more likely in male subjects (odds ratio, 4.3; 95% confidence interval, 1.9-9.8) and patients with diabetes (odds ratio, 3.4; 95% confidence interval, 1.6-7.6). These associations were no longer statistically significant after the intervention.

Conclusion: Laboratory reporting of estimated GFR coupled with an educational program markedly improves the recognition of CKD in the primary care setting.

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Chronic kidney disease (CKD) is increasingly recognized as a significant population health issue. In 1999, there were 239,836 patients undergoing dialysis in the United States, and this number is predicted to exceed 520,000 by 2010. A recent analysis of data from the Third National Health and Nutritional Examination Survey (NHANES III), a large community-based health survey in the United States, revealed that 58% of adult Americans had a glomerular filtration rate (GFR) below 80 mL/min (<1.33 mL/s) per 1.73 m². The prevalence of low GFR increases with age, and elderly patients are the fastest growing segment of the dialysis population. Serum creatinine concentration is currently the most widely used screening test for the detection of renal impairment. However, it has been shown to be a poor screening test, particularly in elderly patients. Such patients tend to be referred to a nephrologist late and this has been associated with an increase in health care costs, morbidity, and mortality inpatients starting renal replacement therapy.

To address this problem, the US National Kidney Foundation has recently published practice guidelines dealing with CKD. The guidelines recommend the use of prediction equations, such as the Cockcroft-Gault (C-G) and Modification of Diet in Renal Disease (MDRD) formulas, to estimate GFR. They further propose that clinical laboratories should report this estimated GFR directly to physicians. However, we could not find any published data that reporting of GFR improves the detection of CKD by primary care providers. Moreover, primary care physicians are not yet familiar with the interpretation of the GFR as a screening test for CKD.

We conducted a before-and-after study to determine whether laboratory reporting of estimated GFR, accompanied by an educational intervention, would increase the detection of CKD in a cohort of elderly patients from a primary care population.
GFR less than 60 mL/min (K/DOQI guidelines have subsequently categorized CKD as attributable to normal aging alone. However, the National Kidney specialist. Recognition was also considered to have occurred if the clinician had indicated on the laboratory results that he or she acknowledged renal impairment. A random sample of medical charts was reaudited by one of the investigators (A.A.) to determine the accuracy of the documentation of the primary outcome.

DATA ANALYSIS

Comparisons were made of the proportion of patients recognized as having CKD by their primary care physicians before and after the intervention. Logistic regression was performed to identify which characteristics were associated with the recognition of CKD. P < .05 was considered statistically significant. Data analysis was performed using SPSS for Windows, version 11 (SPSS Inc, Chicago, Ill).

METHODS

STUDY POPULATION

Swedko et al have identified a cohort of patients 65 years or older from an academic family medicine practice in whom a C-G GFR could be calculated from their medical records. A subset of these patients who met all of the following criteria were included in this study: (1) the C-G GFR could be calculated over the 3 years before the intervention (August 1, 1997, through August 1, 2000); (2) patients did not have severe renal impairment, defined as C-G GFR < 30 mL/min (< 0.5 mL/s), and were not currently receiving renal replacement therapy; (3) patients had a serum creatinine test performed at the hospital laboratory during the intervention period (March 15, 2001, through March 15, 2002); and (4) patients had a follow-up visit to their family physician after the laboratory results were available.

INTERVENTION

The intervention to increase recognition of CKD comprised 2 components. The first component was the automatic reporting of the C-G GFR by the hospital laboratory when the physician requested a serum creatinine test. For the duration of this study, the on-site phlebotomist weighed patients at the time the serum sample was drawn for serum creatinine testing. This weight along with the sex and age of the patient was submitted to the laboratory, and the C-G GFR was calculated by the laboratory and reported along with the serum creatinine concentration to the physician.

The second component was an educational intervention. This comprised two 1-hour didactic teaching seminars and facilitation visits. During the initial 6 weeks of intervention, facilitation was provided by a foreign medical graduate. She met with each staff physician and resident individually to educate them regarding GFR and distributed an on-screen slide show and a 1-page summary of the recommended standard approach to the management of a low GFR, based on applicable clinical practice guidelines. After the initial 6-week period, a nephrologist was available during office hours to answer questions about the interpretation and management of reduced GFR. Informal conversation among the coinvestigators who work at the clinic and the other physicians occurred frequently and served as an additional reinforcement of the educational intervention.

OUTCOME MEASURES

The primary outcome was the proportion of patients recognized by their primary care physician as having CKD before and after the intervention. Chronic kidney disease was defined as a C-G GFR less than 78 mL/min (< 1.3 mL/s), since we believed that it was a value of GFR that was not likely to be attributable to normal aging alone. However, the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines have subsequently categorized CKD as a GFR less than 60 mL/min (< 1.0 mL/s) in patients 65 or older. We have therefore analyzed our outcomes with the K/DOQI cutoff values, as well as those designated when the study was designed. The recognition of CKD was defined as any written evidence in the medical record that a physician had recognized impaired kidney function. Recognition was considered to have occurred if the physician wrote in the progress notes that renal impairment was an issue, ordered diagnostic investigations for renal impairment, or referred the patient to a kidney specialist. Recognition was also considered to have occurred if the clinician had indicated on the laboratory results that he or she acknowledged renal impairment. A random sample of medical charts was reaudited by one of the investigators (A.A.) to determine the accuracy of the documentation of the primary outcome.

RESULTS

Of the 854 patients from the original cohort, 324 met the inclusion criteria. The patients were excluded for the following reasons: (1) The C-G GFR could not be calculated within the 3 years prior to intervention (n = 134), (2) C-G GFR was less than 30 mL/min (< 0.5 mL/s) (n = 39), (3) serum creatinine concentrations were not measured at the hospital laboratory during the intervention period (n = 322), or (4) the patient did not return for subsequent follow-up during the intervention period (n = 15). The characteristics of the study cohort are summarized in Table 1 and Table 2.

RECOGNITION OF RENAL IMPAIRMENT

Prior to the study intervention, 223 of 324 patients had a C-G GFR of 30 to 77 mL/min (0.5-1.29 mL/s); only 31 (13.9%) were recognized as having CKD by their primary care physicians (Table 3). During the intervention period, 251 patients had a C-G GFR less than 78 mL/min (< 1.3 mL/s), 174 (69.3%) of whom were recognized. When a GFR cutoff value of 60 mL/min (1.0 mL/s) was used, 29 (22.4%) of 129 patients were recognized prior to intervention, which increased to 126 (85.1%) of 148 patients after intervention.

FACTORS PREDICTING THE DETECTION OF CKD

In the preintervention period, the detection of CKD by the primary care physician was more likely in male patients and patients with diabetes mellitus (Table 4). However, in the postintervention period there was no significant association between the detection of CKD and sex or diabetes.

PROGRESSION OF CKD

We defined a clinically significant change in the C-G GFR to be a 20% change from baseline value. A significant decline in C-G GFR was noted in 20.7% of the study population, whereas only 4.2% experienced a clinically significant improvement in C-G GFR during the study period. Table 5 demonstrates the proportion of patients before and after the intervention by degree of renal function.
These data demonstrate that when serum creatinine concentrations are measured in elderly patients, the laboratory reporting of calculated GFR along with a targeted educational intervention can vastly improve detection of CKD by the primary care physicians. In addition, our intervention eliminated the effects of 2 factors, sex and presence or absence of diabetes, both of which previously influenced the detection of CKD. Chronic kidney disease was also common in this elderly population, and there was significant deterioration in the kidney function of a substantial number of patients during the course of the study.

We observed that higher serum creatinine concentration and lower GFR were associated with the detection of CKD both before and after the study intervention (data not shown), and this is consistent with previous studies. However, we also observed that detection of CKD before the study intervention was inversely associated with female sex. Previous authors have addressed the issue of sex bias in the detection of renal disease and in referral to dialysis. One potential explanation for underrecognition of CKD in women is that serum creatinine concentration, the most commonly used screening test for renal disease, is related to muscle mass and hence is lower in women, especially elderly women. It is therefore not surprising to find the association of sex with detection of CKD disappearing when estimated GFR is used as a marker of renal function. This confirms that the use of a serum creatinine test alone is a cause of significant bias against elderly women in the detection of CKD.

Our findings become increasingly important when the population health implications of CKD are examined. The dialysis population in the United States and Canada is expanding at an alarming rate. The costs of care for patients requiring renal replacement therapy in the United States are staggering, reaching $US 17.9 billion in 1999, an increase of 7.2% from the previous year. Several interventions have been proven to slow the rate of progression of CKD, such as the aggressive control of hypertension and the use of angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers. These interventions are most effective when instituted early in the course of disease, necessitating an early diagnosis of CKD by primary care providers. Similarly, early referral to a nephrologist or multidisciplinary nephrology team has been associated with improved outcomes for patients starting dialysis. Early detection of CKD in a larger number of those at risk could lead to improved patient outcomes and may be cost-effective.

The prevalence of reduced GFR in elderly populations is now recognized to be much higher than previously suspected. We found that 45.2% of our study cohort had a C-G GFR less than 60 mL/min (<1.0 mL/s), a figure similar to that found by Clase and colleagues in their analysis of NHANES III data. Yet the natural history of low GFR in this population is not well defined. Previous studies suggest that patients with low GFR have progressive loss of kidney function, regardless of the initial cause of the low GFR. However, the prevalence of end-stage renal disease (patients requiring dialysis or transplantation) is substantially lower than would be expected from the prevalence of low GFR. Several explanations for this discrepancy are plausible. It is possible that a low GFR in some older people may not be associated with the same risks for progression as may be seen in younger individuals. Another possible explanation is that these older patients are not referred for dialysis, perhaps because the severity of their kidney disease is not appreciated, or because they have significant comorbidities. Such patients might expire before reaching end-stage renal disease. This is an area that warrants further study.

From our study we cannot determine the individual effects of the laboratory reporting of GFR and the
education component of our intervention. An educational component was used because we were concerned that widespread adoption of laboratory reporting of GFR without an accompanying educational program would lead to an added referral burden of a magnitude sufficient to overwhelm the nephrology specialty services in this area. To prevent this situation, it became clear that the family physicians would need to improve their skills in the initial management of CKD; an appropriate educational intervention was particularly important in this regard. We chose an outreach facilitation program because it has been well documented that educational programs that stress physician knowledge alone, such as traditional Continuing Medical Education courses, are insufficient to change practice behavior.38,39 There is also agreement that interventions such as an outreach facilitation program that attend to many guideline adoption factors and that use 2 or more strategies in an intensive combined fashion are more likely to result in improvement of practice behavior compared with single strategy interventions.40-51

We chose the formula of C-G17 to estimate GFR. This formula has been well validated,52-55 is easy to use, and has been recommended by K/DOQI.16 The disadvantage of this formula is that it requires the patient's weight, which might not be easily available in the laboratories. The physicians could provide this information on the requirement for serum creatinine concentration at the time the test was ordered. Alternatively, laboratories can use the MDRD study equation56 to calculate GFR. This equation does not require the weight, has been validated, and is also recommended by K/DOQI. Before the laboratory reporting of estimated GFR from prediction equations could be widely applied, efforts must be made to standardize the calibration of serum creatinine assays in clinical biochemistry laboratories.16 Serum creatinine results can vary widely between clinical laboratories that use different assays. In the study by Coresh et al,36 this resulted in a bias of 25% in estimating GFRs in the range of 100 mL/min, with lesser bias occurring at lower levels of GFR. In the present study, serum creatinine measurements obtained during the intervention period were analyzed in a single laboratory, using 2 well-correlated assays. However, most primary care physicians receive laboratory results from multiple sources. Thus, the serum creatinine results obtained from each laboratory must be comparable in order to accurately diagnose CKD from estimated GFR.

### Table 4. Factors Predicting the Detection of Renal Impairment by Primary Care Physicians*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Preintervention</th>
<th>Postintervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex</td>
<td>4.3 (1.9-9.8)</td>
<td>1.2 (0.7-2.0)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>3.4 (1.6-7.6)</td>
<td>1.5 (0.8-2.9)</td>
</tr>
<tr>
<td>Serum creatinine ≥1.4 mg/dL (≥125 μmol/L)</td>
<td>67.2 (17.6-256.7)</td>
<td>7.8 (1.8-33.6)</td>
</tr>
</tbody>
</table>

*Data are given as odds ratio (95% confidence interval). Male sex and diabetes mellitus were associated with the detection of chronic kidney disease in the preintervention period but were no longer significant factors after the intervention.

### Table 5. Deterioration of Glomerular Filtration Rate Between Subsequent Measurements*

<table>
<thead>
<tr>
<th>C-G GFR, mL/min</th>
<th>Preintervention</th>
<th>Postintervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30</td>
<td>0†</td>
<td>8 (2.5)</td>
</tr>
<tr>
<td>30-59</td>
<td>129 (39.8)</td>
<td>140 (43.2)</td>
</tr>
<tr>
<td>60-77</td>
<td>77 (23.8)</td>
<td>103 (31.8)</td>
</tr>
<tr>
<td>≥78</td>
<td>118 (36.4)</td>
<td>73 (22.5)</td>
</tr>
<tr>
<td>Total</td>
<td>324 (100)</td>
<td>324 (100)</td>
</tr>
</tbody>
</table>

Abbreviation: C-G GFR, Cockroft-Gault estimated glomerular filtration rate.

*Data are given as number (percentage) of patients. Compared with the preintervention period, fewer people had normal C-G GFR (>78 mL/min) in the postintervention period. The pattern of change suggests overall deterioration in the renal function of the study population over time.

†We excluded all patients with a preintervention C-G GFR lower than 30 mL/min as part of the study design.

In conclusion, we have demonstrated that CKD detection in ambulatory elderly patients can be dramatically improved in the primary care setting with the use of estimated GFR along with serum creatinine concentration. The laboratory reporting of estimated GFR along with serum creatinine concentration should be the preferred screening test for CKD, and targeted outreach facilitation intervention should be initiated to educate primary care providers to this new screening method.

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