

# Multidisciplinary Team Care May Slow the Rate of Decline in Renal Function

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## Summary

**Background and objectives** A multidisciplinary team (MDT) approach to chronic kidney disease (CKD) may help optimize care of CKD and comorbidities. We implemented an MDT quality improvement project for persons with stage 3 CKD and comorbid diabetes and/or hypertension. Our objective was to decrease the rate of decline of GFR.

**Design, setting, participants, & measurements** We used a 4-year historical cohort to compare 1769 persons referred for usual nephrology care *versus* 233 referred for MDT care within an integrated, not-for-profit Health Maintenance Organization (HMO). Usual care consisted of referral to an outside nephrologist. The MDT consisted of an HMO-based nephrologist, pharmacy specialist, diabetes educator, dietitian, social worker, and nephrology nurse. Both groups received usual primary care. The primary outcome was rate of decline of GFR. Secondary outcomes were LDL, hemoglobin A1c, and BP.

**Results** In multivariate repeated-measures analyses, MDT care was associated with a mean annual decline in GFR of 1.2 *versus* 2.5 ml/min per 1.73 m<sup>2</sup> for usual care. In stratified analyses, the significant difference in GFR decline persisted only in those who completed their referrals. There were no differences in the secondary outcomes between groups.

**Conclusions** In this integrated care setting, MDT care resulted in a slower decline in GFR than usual care. This occurred despite a lack of significant differences for secondary disease-specific measures, suggesting that other differences in the MDT population or care process accounted for the slower decline in GFR in the MDT group.

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## Introduction

It is estimated that >16 million adults in the United States have stage 3 or higher chronic kidney disease (CKD) as defined by a decrease in GFR of <60 ml/min per 1.73m<sup>2</sup> (1). In 2007, approximately 500,000 people were treated by means of renal replacement therapy (dialysis or transplantation) for ESRD in the United States (2), and the size of the prevalent ESRD population is projected to increase to 700,000 by 2015 and potentially to >2 million by 2030 (3). Therefore, it is important to identify strategies to delay the progression of CKD to ESRD.

Persons with CKD have a range of comorbid conditions. Some of these, such as hypertension and diabetes (DM), are risk factors for renal disease. Others, such as anemia, malnutrition, and metabolic bone disease are a result of CKD. Still others, such as coronary heart disease, are often co-prevalent because of shared risk factors. Comorbidities are a major cause of mortality among CKD patients (4). All of these comorbidities have been associated with adverse outcomes among patients with CKD (5–8), and optimal management of such comorbidities improves health outcomes of those with CKD (5,9–13).

There is evidence that treatment of common comorbid conditions improves health outcomes such as decreasing cardiovascular events and mortality in patients with CKD (14,15). However, care of complex CKD patients is often fragmented among specialists, primary care clinicians, and members of patient-education teams. As a result, a more cohesive multidisciplinary team (MDT) approach to CKD has been advocated as a means to optimize care of comorbidities and CKD, as well as to facilitate the transition to management of ESRD (16,17). Such team-based care is a foundation of the Chronic Care model, which calls for productive interactions between informed patients and proactive practice teams to improve health outcomes for persons with chronic medical conditions (18–20). However, it is unclear whether team-based approaches to CKD care offer definitive benefit. Although some comprehensive approaches to CKD have shown improved survival and stabilization or slowing of CKD progression, others have not changed the progression of CKD (21–24). Furthermore, the composition of MDT CKD care teams, the outcomes studied, and length of follow-up time all have been variable, limiting meaningful comparisons. This sug-

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gests that, although promising, MDT approaches to managing CKD deserve further investigation (15,25).

We report on the process and results of a quality improvement (QI) project designed to care for persons with stage 3 CKD. Our project differs from previous studies in that it assesses rate of change of renal function over time and secondary process outcomes for comorbid conditions managed by the MDT. In addition, we specifically targeted a population at risk because of comorbid diabetes and/or hypertension. The goal of the QI project was to decrease the rate of decline in GFR through comprehensive, integrated, multidisciplinary care. In this project, we compared usual care consisting of primary care plus nephrology referral, with enhanced care using primary care plus the MDT.

## Materials and Methods

### Project Setting and Population

The target population consisted of an historical cohort of community-dwelling members of a large, group model, integrated, not-for-profit Health Maintenance Organization (HMO) who were referred for nephrology care by their primary care physician during the period March 1, 2005 through June 1, 2009. Adult patients with stage 3 CKD and at least one of two specific comorbid conditions were eligible for inclusion. The required comorbid conditions included DM and/or hypertension; most participants had additional chronic conditions. Stage 3 CKD was defined as having at least two GFR values between 30 and 59 ml/min per 1.73 m<sup>2</sup> measured 90 or more days apart (26). We excluded those with dementia, age greater than 90, those enrolled in an intensive heart failure management program, and those in palliative or hospice care programs on the premise that they would be unlikely to actively participate in an MDT care program. The MDT program was only available in English. The Institutional Review Board of the participating institution reviewed and approved the project.

### Description of Usual Care and MDT QI Interventions

Usual care for CKD consisted of shared care between a primary care physician (PCP) and a consulting nephrologist outside of the integrated care plan. PCPs routinely managed the chronic conditions of diabetes, cardiovascular disease, and hypertension (among many others) using resources available through the integrated system including the option to access chronic care nurses such as diabetes educators and/or relevant specialty care providers. PCPs referred to one of three contracted nephrology specialty groups across the metropolitan area outside of the integrated system. The consulting nephrologist then mailed a visit summary to the PCP, which was scanned into the electronic medical record (EMR). These patients did not need additional referrals for subsequent nephrology care.

As part of the QI initiative, a multidisciplinary nephrology team was implemented within the integrated care plan. The MDT consisted of a nephrologist, renal clinical pharmacy specialist, diabetes nurse educator, renal dietitian, social worker, and nephrology nurse. Clinicians were hired to be part of the MDT based on experience in managing their area of expertise within CKD, as well as based on previous experience in team-based care, which is standard for chronic disease care within the integrated system. The MDT team then met weekly to review their ongoing

processes of care. The components of the team care included an educational class with review of patient-education materials on CKD, medication therapy management and medication reconciliation, nephrology consultation including medical recommendations for hypertension, DM, and CVD comorbidities, as well as metabolic abnormalities consistent with CKD such as anemia and bone and mineral metabolism, depression screen using the Patient Health Questionnaire (PHQ-9) instrument (with appropriate treatment and/or referral), and dietary assessment with recommendations. A comprehensive care plan based on input from all team members was developed for team use and also shared with patients. After an initial assessment, the MDT visits were individualized to meet patient needs because not all patients required all services offered within the team at each visit.

Patient self-management was specifically encouraged by the MDT team and included obtaining necessary laboratory tests, keeping home BP and/or home blood sugar logs that were called, faxed, or E-mailed (secure) to the renal nurse, and keeping appointments (follow-up appointment intervals routinely ranged from 1 to 6 months). Patients were contacted by phone or E-mail to adjust medications and review behavioral or lifestyle recommendations. Through the EMR, PCPs received electronic, same-time copies of MDT clinic notes and notification of any outstanding clinical issues.

Patients were assigned to either internal nephrology care with the MDT or usual care based on available internal clinic capacity and the zip code of their residence. At any given time, if there was capacity at the MDT clinic, persons referred for nephrology care who resided in zip codes closest to the MDT clinic were preferentially offered care at that site for patient convenience. Patients were also assigned to the most convenient external nephrology care sites by zip code for usual care. This patient allocation procedure set up a quasi-experimental design permitting comparison of outcomes between patients who attended the MDT clinic and those assigned to usual care.

### Analysis Plan

The primary outcome was change in GFR over time as a function of referral to the MDT program *versus* usual care. Secondary outcomes were adjusted final values of the disease-specific quality measures of LDL and hemoglobin A1c, as well as percent time at goal BP, as a function of referral to the MDT program *versus* usual care. There was some crossover in which approximately 7% of patients referred for external nephrology care also attended one or more MDT visits. The bias created by this crossover should decrease the observed effect of the MDT and thus our results are relatively conservative.

### Measures

GFR was estimated using the four-variable Modification in Diet and Renal Disease equation (27). Initial GFR was defined as the second of two GFR values of 30 to 59 ml/min per 1.73 m<sup>2</sup> measured 90 or more days apart. Final GFR was defined as the last GFR before either the end of the project period or being censored from the cohort. We censored participation in the cohort if a participant died,

disenrolled from the health care plan, or started renal replacement therapy. Diagnoses for initial inclusion criteria were based on manual chart review by the nephrology team. Morbidity scores were calculated using the Quan adaptation of the Elixhauser morbidity measure (28). Initiation of renal replacement therapy, if it occurred, was identified by a reimbursement claim for dialysis. Secondary outcomes were defined as follows: percentage of time at a goal BP of <130/80; final A1c adjusted for baseline A1c in the subsample of persons with diabetes; and final LDL adjusted for initial LDL measure. All values were measured closest to baseline GFR and closest to, but not exceeding, the final date of enrollment.

We described participants in terms of baseline GFR, demographic information, MDT care *versus* external nephrology care, morbidity score, initial body mass index, overall morbidity level, duration of nephrology care, and rate of hospitalization during the follow-up period. We then assessed bivariate associations between these characteristics and change in GFR over time. In an approximation of an "intention to treat" analysis, we in-

cluded all referrals for nephrology care—whether eligible for usual care or the QI intervention—in the analysis, regardless of whether the patient actually attended any visits at that site.

We used mixed effect modeling to assess both change in GFR and secondary outcomes as a function of participation in the QI program. Multivariate analyses were adjusted for baseline GFR, number of GFR measurements, number of primary care visits, visit to any nephrologist, amount of follow-up time, age, race, gender, morbidity score, and body mass index. All analyses were conducted using SAS version 9.1.3.

## Results

We identified 2002 HMO members who received a nephrology referral between March 1, 2005 and June 1, 2009, who met the enrollment criteria above. Mean age of participants was 68 years, on average they had 4.5 chronic conditions, and they were followed for an average of 2.0 years. Characteristics of the program population are listed in Table 1. The MDT and usual care patients were equiv-

**Table 1. Characteristics of study population**

	Total Sample	MDT Care	Usual Care	P <sup>a</sup>
N	2,002	233	1769	
Age, mean (SD)	68.22 (12.18)	67.62 (11.28)	68.29 (12.29)	0.2224
Female	888 (44.36)	111 (47.64)	777 (43.92)	0.2831
White	1,365 (68.18)	152 (65.24)	1,213 (68.57)	0.3259
African American	144 (7.19)	22 (9.44)	122 (6.90)	
Other/unknown race	493 (24.63)	59 (25.32)	434 (24.53)	
Hispanic	176 (8.79)	20 (8.58)	156 (8.82)	0.7296
Non-Hispanic	1,460 (72.93)	166 (71.24)	1,294 (73.15)	
Unknown	366 (18.28)	47 (20.17)	319 (18.03)	
Follow-up time in years, mean (SD)	1.95 (1.05)	1.95 (1.09)	1.95 (1.04)	0.9501
Loss to follow-up				
death	103 (5.14)	9 (3.86)	94 (5.31)	0.3459
dialysis	197 (9.84)	13 (5.58)	184 (10.40)	0.0202
health plan disenrollment	313 (15.63)	53 (22.75)	260 (14.70)	0.0015
MDT visit <sup>b</sup>				
any visit	345 (17.23)	219 (93.99)	126 (7.12)	<0.0001
annualized visit rate, mean (SD)	1.91 (1.78)	1.78 (1.89)	2.17 (1.54)	0.0004
Outside nephrology visit				
any visit	1,540 (76.92)		1,540 (87.05)	
annualized visit rate, mean (SD)	2.20 (2.11)		2.20 (2.11)	
Primary care visits				
any visit	1,939 (96.85)	229 (98.28)	1,710 (96.66)	0.1834
annualized visit rate, mean (SD)	5.69 (6.69)	4.29 (36.97)	5.88 (6.95)	0.0032
Hospitalizations				
any inpatient hospitalization	762 (39.56)	76 (32.62)	716 (40.47)	0.0211
annualized visit rate, mean (SD)	0.55 (1.18)	0.32 (0.85)	0.57 (1.22)	<0.0001
Number of chronic conditions, <sup>c</sup>	4.45 (2.73)	3.78 (2.19)	4.53 (2.78)	0.0002
mean (SD)				
Diagnosis of diabetes	878	114 (48.93)	764 (43.19)	0.0970
Baseline A1c value (%), mean (SD)	7.7 (1.7)	7.9 (1.9)	7.7 (1.7)	0.4252
Baseline GFR (ml/min per 1.73 m <sup>2</sup> )	40.51 (6.56)	40.89 (6.54)	40.46 (6.56)	0.3232
Baseline at BP goal (%)	47.6 (26.3)	43.1 (23.5)	48.2 (26.6)	0.6396
Baseline LDL (mg/dl)	95.6 (35.9)	91.5 (33.9)	96.0 (36.1)	0.1604
BMI, mean (SD)	29.83 (6.46)	31.39 (6.34)	29.63 (6.44)	<0.0001

<sup>a</sup>P values were obtained from  $\chi^2$  (categorical), or *t* test or Mann Whitney *U*-test (continuous) statistics.

<sup>b</sup>Approximately 7% of the usual care group attended one or more MDT group visits.

<sup>c</sup>Based on the Quan adaptation of the Elixhauser morbidity index.(28)

**Table 2. Unadjusted annual change in GFR: MDT versus usual care**

Referral Status	Estimated Change in GFR from					
	Total Sample		Completed Referral		Did Not Complete Referral	
	Estimate (SE)	P	Estimate (SE)	P	Estimate (SE)	P
Main effects, slopes						
MDT care	-1.12	0.0003	-1.09 (0.32)	0.0007	-1.64 (1.35)	0.2241
usual care	-2.47	<0.0001	-2.44 (0.12)	<0.0001	-2.78 (0.029)	<0.0001
Difference in slopes (MDT versus usual care)	1.35	<0.0001	1.34 (0.34)	<0.0001	1.13 (1.38)	0.4131

**Table 3. Adjusted annual change in GFR: MDT versus usual care<sup>a</sup>**

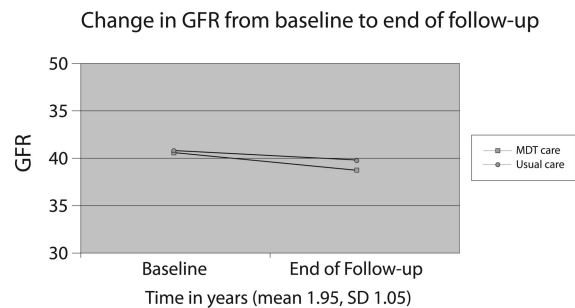
Referral Status	Estimated Change in GFR from Baseline					
	Total Sample		Completed Referral		Did Not Complete Referral	
	Estimate (SE)	P	Estimate (SE)	P	Estimate (SE)	P
Main effects, slopes						
MDT care	-1.17	0.0003	-1.15 (0.33)	0.0005	-1.79 (1.38)	0.1962
usual care	-2.52	<0.0001	-2.48 (0.12)	<0.0001	-2.83 (0.31)	<0.0001
Difference in slopes (MDT versus usual care)	1.35	<0.0001	1.33 (0.35)	0.0001	1.04 (1.41)	0.4625

<sup>a</sup>Adjusted for nephrology site, follow-up time, race, age, baseline GFR, gender, number of chronic conditions, body mass index, number of GFR measurements, and number of primary care visits.

alent in age, gender, race, ethnicity, length of follow-up, and biologic values (other than body mass index) at baseline. However, some significant differences were observed. Compared with usual care patients, MDT patients had on average fewer chronic conditions (although their average body mass index was significantly higher) and a lower rate of primary care visits, but were more likely to disenroll from the integrated care plan. In addition, fewer MDT patients initiated dialysis than did usual care patients, and they had lower rates of hospitalization during follow-up.

In both unadjusted and adjusted analyses, the rate of decline in GFR was lower in the MDT group (Tables 2 and 3). In multivariate repeated-measures analyses, referral to the internal MDT was associated with a mean decline in GFR of 1.2 ml/min per 1.73 m<sup>2</sup> compared with a mean GFR decline of 2.5 ml/min per 1.73 m<sup>2</sup> in members referred to the other three outside referral sites (P = 0.0001; Table 3; Figure 1). In stratified analyses of patients who completed their nephrology referrals and attended at least one visit with a nephrologist versus those who did not complete their referrals, the significant difference in decline in GFR between the MDT patients and usual care patients persisted in the completed referral group but not in the group who did not complete their referrals (Tables 2 and 3).

In adjusted analyses, there were no differences in the secondary outcomes of BP, A1c, or LDL between the MDT patients and the usual care patients (Table 4).



**Figure 1. | Change in GFR over time: MDT versus usual care (1).** \*Adjusted for nephrology site, follow-up time, race, age, baseline GFR, gender, number of chronic conditions, body mass index, number of GFR measurements, and number of primary care visits.

**Discussion**

This quality improvement initiative showed that, in an integrated care setting, comprehensive, team-based, multidisciplinary care for CKD and associated comorbidities was associated with a slower decline in GFR over time and a lower percentage of patients initiating dialysis than usual care consisting of PCP management using outside nephrology consultation. These results were observed despite a lack of significant differences for secondary process of care measures for diabetes, hypertension, and coronary artery disease.

These findings suggest that there may have been other inherent differences in either the MDT population or MDT

**Table 4. Adjusted model of disease-specific quality outcomes**

	Percent Time at Normal BP		Final LDL		Final A1C <sup>a</sup>	
	Estimate <sup>b</sup>	P <sup>c</sup>	Estimate <sup>b</sup>	P <sup>c</sup>	Estimate <sup>b</sup>	P <sup>c</sup>
Referral status						
MDT care	41.35	0.1600	88.87	0.4143	7.30	0.7848
Usual care	45.38		91.59		7.37	

<sup>a</sup>Diabetic subjects only.  
<sup>b</sup>Adjusted for multidisciplinary team visit counts, outside nephrology visit counts, race, age, follow-up time, gender, morbidity score, body mass index, primary care visit counts, and baseline values.  
<sup>c</sup>P value for final adjusted difference between MDT and usual care.

care process compared with the usual care subcohort that accounted for the slower decline in GFR in the MDT group. Both prescription of, and adherence to, a range of medications (such as angiotensin converting enzyme inhibitors, angiotensin receptor blockers, nonsteroidal anti-inflammatory agents, among others) may have differed across groups. Although control of diabetes and hypertension are primary predictors of change in GFR over time (29), the MDT care in this program also included assessment and management of multiple additional components of CKD care. For example, although there was no difference in prevalence of depression at baseline between the two groups, the team included a social worker who may have diagnosed and recommended treatment for additional incident cases of depression. Persons with CKD have a high prevalence of depression, which is independently associated with poor outcomes in CKD.(30,31) In addition the team provided coaching on details of self-management such as nutritional counseling—a missing piece for many patients with CKD (32).

There may also be intangible benefits to the informational continuity of care provided through an integrated system compared with receiving nephrology care at an outside site. Although outside nephrologists did have “read-only” access to patients’ electronic medical records, the MDT team had the ability to electronically dialogue with other clinicians (*e.g.*, cardiology, endocrinology, or primary care) and thereby address issues important to patients but not directly related to CKD care (*e.g.*, difficulty with exercising because of pain from osteoarthritis).

In addition to differences in care delivery content and process, there may have been patient-level differences between the MDT and usual care groups. Those patients interested in participating in a comprehensive care management strategy may be more likely to have a higher level of engagement with recommended lifestyle changes (*e.g.*, diet modification and medication adherence). The MDT group was also noted to have fewer comorbid chronic medical conditions at baseline—although this adjustment was incorporated into the analyses (see Table 1)—and lower rates of hospitalization during the program. Finally, there are multiple biopsychosocial factors that may potentially influence processes of self-care for complex patients including perceived disease burden, social support, level of physical functioning, and others (33–35). Such factors may also contribute to a relatively slower decline in GFR over time.

There have been calls for increasing integrated care for CKD patients to specifically include management of cardiovascular risk factors; shared care between specialists, primary care clinicians, and allied health workers such as dietitians and pharmacists; and an emphasis on patient self-management support (14,16,17). However, there is debate in the literature about the benefit of multidisciplinary team care for CKD patients. Different MDT interventions in different populations and settings have produced conflicting results (21–23). Our findings lend support to the concept of MDT care, although they do not clarify the specific components of that care that effect improvement in health outcomes.

There are several limitations to our quality improvement assessment. As mentioned above, it was conducted in an integrated care environment, and the results may be less generalizable to other settings. However, the MDT concept may become increasingly applicable across settings with the broader implementation of electronic medical records and of integrated care consistent with the Patient Centered Medical Home model. This project was designed as a quality improvement initiative and not a randomized clinical trial. Therefore, allocation of the patients to nephrology care was based on zip code of residence rather than true randomization, and to the extent that geographic location may be associated with socioeconomic status and health status, this practice may have biased the results. We attempted to account for this limitation by adjusting for patient level variables (*e.g.*, demographics and comorbidities) and by approximating an intention to treat analysis and including all patients referred for nephrology consultation regardless of whether or not they were actually seen by the consultant. Approximately 7% of the usual care group received one or more MDT visits; however, this crossover should bias our results toward the null and result in a more conservative estimate of the MDT program. In addition, there may have been provider practice variation within each of the external nephrology practices, whereas there was only one nephrologist in the MDT practice. Finally, other outcomes warrant consideration in a complete assessment of the effects of MDT care. Specifically, because of low rates of baseline proteinuria assessment in primary care before nephrology referral, we were unable to accurately assess changes in proteinuria over time as a function of enrollment in the MDT program. This important outcome should be assessed in future studies of MDT care, as should longer-term outcomes of renal re-

placement therapy, mortality, cardiovascular events, and formal cost-effectiveness analyses.

The population of persons with CKD is growing rapidly. Progressive CKD has negative effects on quality of life and on healthcare resources. Therefore, it is important to explore different mechanisms of delivering care to this complex patient population. Our findings suggest that specific groups of CKD patients may benefit from comprehensive MDT CKD care as manifested by delayed progressive decline in renal function and that these improved health outcomes may be facilitated within an integrated health care system. Furthermore, the benefit of slower decline in CKD did not seem to be completely mediated by improved control of hypertension or diabetes. Remaining challenges are to identify subsets of persons with CKD who are likely to benefit from such MDT teams and to determine the ideal components and duration of MDT care.

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#### Disclosures

None.

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