The Effects of a Nurse Case Manager and a Community Health Worker Team on Diabetic Control, Emergency Department Visits, and Hospitalizations Among Urban African Americans With Type 2 Diabetes Mellitus

A Randomized Controlled Trial

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Background: Although African American adults bear a disproportionate burden from diabetes mellitus (DM), few randomized controlled trials have tested culturally appropriate interventions to improve DM care.

Methods: We randomly assigned 542 African Americans with type 2 DM enrolled in an urban managed care organization to either an intensive or minimal intervention group. The intensive intervention group consisted of all components of the minimal intervention plus individualized, culturally tailored care provided by a nurse case manager (NCM) and a community health worker (CHW), using evidence-based clinical algorithms with feedback to primary care providers (eg, physicians, nurse practitioners, or physician assistants). The minimal intervention consisted of mailings and telephone calls every 6 months to remind participants about preventive screenings. Data on diabetic control were collected at baseline and at 24 months by blind observers; data emergency department (ER) visits and hospitalizations were assessed using administrative data.

Results: At baseline, participants had a mean age of 58 years, 73% were women, and 50% were living in poverty. At 24 months, compared with the minimal intervention group, those in the intensive intervention group were 23% less likely to have ER visits (rate difference [RD], −14.5; adjusted rate ratio [RR], 0.77; 95% confidence interval [CI], 0.59-1.00). In on-treatment analyses, the rate reduction was strongest for patients who received the most NCM and CHW visits (RD, −31.0; adjusted RR, 0.66; 95% CI, 0.43-1.00; rate reduction ↓ 34%).

Conclusion: These data suggest that a culturally tailored intervention conducted by an NCM/CHW team reduced ER visits in urban African Americans with type 2 DM.

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AFRICAN AMERICANS BEAR A disproportionate burden from diabetes mellitus (DM) and its complications.[1-3] Compared with their nonminority counterparts, African Americans are almost twice as likely to have DM, twice as likely to experience

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DM-related blindness, 1.5 to 2.5 times more likely to experience lower limb amputations, and 2 to 6 times more likely have kidney disease.[4,5] The risk of developing type 2 DM and its complications can be reduced through lifestyle modifications.[6,7] However, contributing factors to health disparities are multifactorial in nature and include patient behavior and characteristics (eg, adherence and health literacy), physician behavior (eg, treatment threshold and target), and health care system factors (eg, access to care and continuity of care).[8,9]

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Successful approaches to managing DM in this population are urgently needed to improve clinical care and self-management behaviors and, thereby, reduce complications and improve quality of life. Studies evaluating culturally tailored interventions for African Americans and other ethnic minority groups are few but

have been generally effective.[10-17] Because DM is a complex condition, especially in minority and lower-income groups, more work is needed to develop and implement multifaceted, comprehensive approaches that go beyond the traditional paradigm of medical care.

Case management interventions for people with DM have been implemented in recent years as an innovative approach to health care delivery that improves the coordination of care.[18] These interventions have generally been shown to be effective in improving glycemic control and provider (eg, physician, nurse practitioner, or physician assistant) monitoring of glycemic control. Likewise, community health workers (CHWs) (sometimes called lay health workers) have been used in various roles such as providing DM education and serving as liaisons between community members and the health care system.[19] Community health worker interventions have been shown to improve patient knowledge, physiological measures in some studies, and produce positive changes in lifestyle and self-care. Although these approaches to improve care are different, interventions that combine clinical and social (socioeconomic, family) aspects of life would be quite complementary. Few studies have taken this approach. Therefore, our intensive intervention combined individually tailored counseling by a nurse case manager (NCM) in the clinic and health education by CHWs in the home. Herein, we describe the effect of this intervention on our primary outcome, emergency department (ER) visits, in a randomized controlled trial (RCT), Project Sugar 2. Secondary outcomes (hospitalizations, hemoglobin A_{1c} [HbA_{1c}] levels), and subsidiary analyses (on-treatment) are also reported.

METHODS

STUDY SETTING AND PARTICIPANTS

Details of Project Sugar 2, including study design, randomization procedures, interventions, data collection procedures, comparison of participants and nonparticipants, and baseline characteristics of the study population are described elsewhere.[20] Briefly, the study was an RCT funded by the National Institutes of Health and conducted within a community, university-affiliated managed care organization (MCO) in Baltimore, Maryland. The MCO employed 100 primary care physicians in a staff-model practice at 19 sites, including 5 sites in the medically underserved areas of Baltimore that were used for recruitment in this study. This network of community physicians provided care to 80 000 capitated patients under multiple contracts and to an additional 40 000 fee-for-service patients. One other university-affiliated primary care clinic was also included in recruitment. African American patients 25 years or older, with type 2 DM, were eligible to participate. After identifying participants through administrative databases and screening by telephone, 542 participants (57% of eligible individuals) attended the required face-to-face visit consented to participate and underwent randomization (**Figure**). Recruitment was completed from November 2001 through May 2003.

INTERVENTIONS

A description of the interventions, including training of interventionists, has been previously published.[20,21] Prior to the development of the interventions, a literature review of published clinical practice guidelines, position statements, and expert opinions were reviewed by a team of health professionals, including an internist, endocrinologist, and certified DM educator. Only published guidelines and reports from appropriate organizations were used to develop the Project Sugar 2 interventions (ie, from the American Diabetes Association, American Heart Association, American Association of Diabetes Educators, and the National Cholesterol Education Program). The intervention was reviewed and updated on a yearly basis by the team of health professionals to accommodate any changes within the expert guidelines.

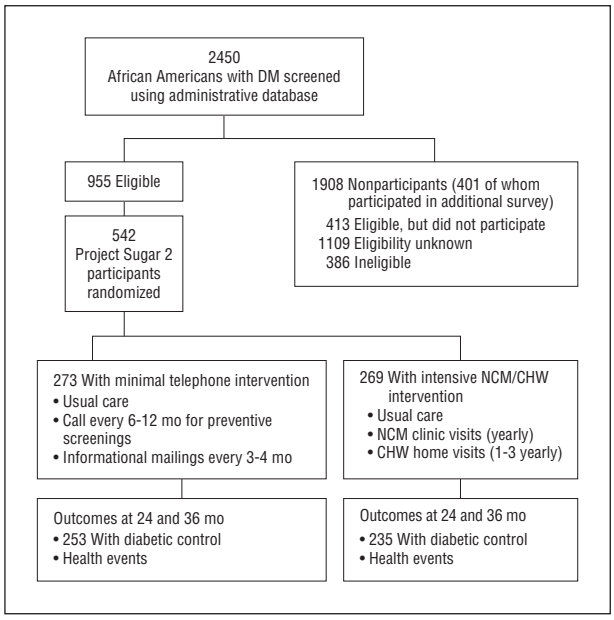

Figure. Flowchart of participants. CHW indicates community health worker; DM, diabetes mellitus; NCM, nurse case manager.

Participants were randomized to 1 of 2 intervention groups: (1) minimal intervention, a telephone-based intervention executed by a lay health educator, or (2) an intensive intervention, which used the education and follow-up services of an NCM and CHW team.

The minimal intervention consisted of telephone calls every 6 months to remind participants about preventive health screenings (HbA_{1c} tests, primary care and specialty visits). A written summary of their health care utilization was sent to the participant's primary care provider. Participants also received DM-specific information in the mail. In general, this minimal telephone-based intervention was aimed at prompting participants to become more involved in their health care.

Training for the intensive intervention (particularly for CHWs) was conducted over a period of 6 weeks and in 6 phases: phase 1, guidelines and practical information; phase 2, patient self-management education; phase 3, home-based assessment and education; phase 4, field experience; phase 5, skill reinforcement; and phase 6, maintenance and quality control. The intensive intervention used evidenced-based clinical algorithms and culturally tailored intervention action plans (IAPs) developed to address traditional cardiovascular risk factors (blood glucose, blood pressure, high-density lipoprotein cholesterol [HDL-C] levels, and behaviors) and nontraditional obstacles to optimal DM care and self-management (depression, socioeconomic problems, and caregiver concerns). The intervention was based on the PRECEDE-PROCEED conceptual framework.[22]

The clinical algorithms allowed interventionists to triage participants based on their level of control (optimal, suboptimal, poor, very poor) and guided frequency and intensity of follow-up (face-to-face vs telephone, weekly vs monthly, faxing

vs paging the provider). The algorithms also triggered specific IAPs. Finally, they served as documentation tools to track participants' progress and to facilitate intervention team discussions. For example, the blood glucose algorithm denoted a preprandial blood glucose of 350 mg/dL (19.4 mmol/L) as "very poor," leading the interventionist to call the provider to report the reading, counsel the patient to make an appointment with his or her provider within 7 days, plan to initiate follow-up in 1 week, and implement the appropriate IAP.

The IAPs consisted of culturally appropriate behavioral and educational interventions developed to be tailored for participants in the context of the PRECEDE-PROCEED conceptual framework: predisposing factors (eg, knowledge, beliefs), enabling factors (eg, skills, resources), and reinforcing factors (eg, provider support). The IAPs were also documentation tools to track interventionists' delivery of appropriate DM education and self-management training.

The IAPs focused on the following topics: nutrition, physical activity, medication adherence, appointment adherence, foot care, and socioeconomic issues. For example, when glucose control was judged to be "very poor," the interventionist would be prompted to initiate the medication adherence IAP and determine whether there was a problem with understanding the prescribed regimen, with obtaining the medication, or with lack of evaluation for possible adjustments by the physician. If misunderstanding the regimen was identified as a problem, the interventionist would discuss the indication for the medication with the participant and advise discussing its use with his or her provider. Furthermore, the interventionist would be prompted to initiate the nutrition IAP, allowing the patient to assess current meal choices along with facilitating possible changes.

The NCM scheduled visits at least once per year and focused on aspects of care that required nursing expertise (eg, providing education regarding medication management and prompting the physician regarding suboptimal care patterns). The CHWs scheduled visits a minimum of 3 times per year. The CHWs conducted home visits, during which they conducted a random blood glucose test, monitored blood pressure, and gave participants immediate feedback on the results. They then intervened on these factors by providing health education, problem solving, and follow-up implemented through the intervention action plans. In addition, CHWs focused on problems directly related to DM care as well as those not traditionally addressed by medical or nursing care (eg, difficulty understanding benefits and accessing the health care system, household problems interfering with medication adherence).[21] Both the NCMs and CHWs used clinical algorithms and IAPs and provided direct education and additional follow-up to participants. All information from the intensive intervention was fed back to the participant's primary care provider in a written or verbal manner depending on urgency. This feedback was designed to prompt provider behavior. Patients who needed further follow-up were scheduled for additional home visits. To ensure participant safety, CHWs performed duties with close nursing supervision and daily contact. The interventionists participated in weekly case conferences to discuss and implement a plan of care and also had access to physicians on the investigative team. It is important to note that the intensive intervention was designed to supplement on-going clinical care; therefore, all information was fed back to the participant's primary care provider in a written or verbal manner depending on urgency.

DATA COLLECTION

Participants attended baseline screening visits and 24-month follow-up visits at the Johns Hopkins Outpatient General Clinical Research Center, where they underwent standardized interviews, physical assessment, and laboratory testing. All data were collected by technicians who were masked to intervention assignment. The rate of follow-up was high, with 92% of participants completing the 24-month visit (488 of 528 [542 patients – 14 deaths]). Based on an earlier phase of our work and the experience of the investigative team, we used a number of strategies to ensure good retention. At our baseline visit, we collected tracking information on participants as well as contact information of 3 friends and/or family members who lived outside of the participant's home. We also provided flexible scheduling for data collection visits and made an effort to stay in contact with participants through periodic telephone calls, newsletters, and birthday and holiday cards. Deaths were balanced across intervention groups: 6 in the minimal group and 8 in the intensive group ($P=.06$). Although there were no deaths related to acute metabolic complications of DM (eg, diabetic ketoacidosis), the numbers of acute deaths (eg, from myocardial infarction and sepsis) were equal (n=3) in each group. Those who did not complete the study were similar to those who did for all demographic and clinical variables except that they had higher baseline diastolic blood pressure and HbA_{1c} values, but these differences were not evident between the intervention groups.

CLINICAL CHARACTERISTICS

Our main follow-up period occurred at 24 months. The HbA_{1c} level was measured using high-pressure liquid chromatography. The lipid profile (total and HDL-C) was measured using standard techniques. Blood pressure was assessed using a random-zero sphygmomanometer; the mean of 3 readings at 1 visit was used at baseline and again at follow-up. Height was measured using a stadiometer with the patient's shoes off, and weight was measured using a balance beam scale with the patient wearing light clothing.

HEALTH CARE UTILIZATION (ER VISITS AND HOSPITALIZATIONS)

Within the MCO, claims and encounters were captured for all health care utilization including ER visits and hospital admissions. Each claim was associated with the first, second, or third *International Classification of Diseases, Ninth Revision (ICD-9)*, diagnostic codes or Current Procedural Terminology procedure codes. For all participants, we also attempted to capture ER visits and hospitalizations that might have occurred outside of the MCO network by querying local hospitals. Each participant signed an authorization letter at the baseline and follow-up data collection visits granting us permission to obtain outside medical records. The follow-up period for health care utilization outcomes was determined a priori to be evaluated up to 36 months. Moreover, during telephone interviews conducted every 6 months, information was obtained about deaths. Verbal reports of death were confirmed by review of death certificates.

STATISTICAL ANALYSES

Baseline variables were compared by intervention group using *t* tests or χ^2 tests. Longitudinal analyses were performed by intention-to-treat. For continuous variables, within-group changes over 24 months were computed separately for both the minimal and intensive NCM/CHW groups using paired *t* tests. Between-group effects (whether differences from baseline to 24-month follow-up were statistically different between the 2 intervention groups) were compared using linear regression analysis adjusted for baseline values, age, and exact follow-up interval between baseline and follow-up visit. For analyses of ER visits and hospitalizations, Poisson regression with an

overdispersion parameter was used to account for multiple visits censored for death. Estimates are absolute rate differences (RDs) and ratios of utilization rates (RRs) in the intensive intervention group vs the minimal intervention group. In subsidiary analyses, we adjusted for baseline values, age, and insurance status and stratified according to intervention frequency. High frequency of visits with either an NCM or CHW was based on the mean number of visits at 24 and 36 months. For 24 months, high frequency was considered to be 2 or more visits with the NCM and 4 or more visits with the CHW. For 36 months, high frequency was considered to be 2 or more visits with the NCM and 6 or more visits with the CHW. All analyses were conducted using STATA statistical software (version 8.2; StataCorp LP, College Station, Texas).

RESULTS

BASELINE CHARACTERISTICS OF THE STUDY POPULATION

Baseline characteristics of the 488 participants who completed the 24-month visit are presented in **Table 1**. Nearly three-quarters were women, and their mean age was 58 years. On average, the group had 11 years of education and just over a third had yearly household incomes of $7500 or less. The population was socioeconomically disadvantaged, with half of participants living in poverty according to federal guidelines. The intensive intervention group was slightly older than the minimal group (59 vs 56 years; $P < .01$), otherwise, there were no statistically significant differences between the intervention groups at baseline.

Table 1. Selected Baseline Characteristics of 488 African Americans With Type 2 Diabetes Mellitus (DM) Who Completed a 24-Month Follow-up, by Assigned Intervention[a]

Characteristic	Intervention Group: Minimal (n=253)	Intervention Group: Intensive NCM/CHW (n=235)	Total Study Group (N=488)
Sociodemographics			
Age, y[b]	56 ± 11	59 ± 11	58 ± 11
Female sex	187 (74)	171 (73)	358 (73)
Education, y	11 ± 3	11 ± 2	11 ± 3
Yearly income ≤$7500	91 (36)	78 (33)	169 (35)
Living in poverty, %[c]	127 (50)	119 (51)	246 (50)
Insurance			
Medicaid	70 (28)	66 (28)	136 (28)
Medicare	45 (18)	41 (17)	86 (18)
Other capitated plans	107 (42)	99 (42)	206 (42)
Other fee-for-service plans	31 (12)	29 (12)	60 (12)
Marital status			
Married	74 (29)	85 (36)	159 (33)
Widowed/separated/divorced	118 (47)	106 (45)	224 (46)
Never married	61 (24)	44 (19)	105 (22)
Employment status			
Retired/disabled	137 (54)	147 (63)	284 (58)
Employed full- or part-time	92 (36)	66 (28)	158 (32)
Unemployed	11 (4)	12 (5)	23 (5)
Homemaker/attending school	13 (5)	10 (4)	23 (5)
Clinical characteristics			
First-degree relative with DM	137 (54)	122 (52)	259 (53)
HbA_{1c} level, %	8.0 ± 2.2	7.7 ± 2.1	7.8 ± 2.2
Cholesterol level, mg/dL	193 ± 53	190 ± 39	191 ± 47
HDL-C level, mg/dL	52 ± 15	51 ± 14	51 ± 14
Systolic BP, mm Hg	137 ± 20	137 ± 21	137 ± 20
Diastolic BP, mm Hg	80 ± 11	78 ± 11	79 ± 11
BMI	35 ± 8	34 ± 8	34 ± 8
Health care utilization (prior 12 mo)			
ER visit counts	130	112	242
ER rate/100 person-years	47.6	41.6	44.6
Hospitalization counts	57	61	118
Hospitalization rate/100 person-years	20.9	22.7	21.8

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BP, blood pressure; ER, emergency department; HbA_{1c}, hemoglobin A_{1c}; HDL-C, high-density lipoprotein cholesterol; NCM/CHW, nurse case manager/community health worker combined intervention.

SI conversion factors: To convert cholesterol and HDL-C to millimoles per liter, multiply by 0.0259; to convert HbA_{1c} to a proportion of total hemoglobin, multiply by 0.01.

[a] Results are shown as number (percentage) or mean ± SD.

[b] Statistically significant difference between groups ($P < .05$).

[c] Determined using US poverty thresholds for 2003 (data collected at 24-month visit).

EFFECT OF INTERVENTIONS ON CLINICAL CHARACTERISTICS AT 24 MONTHS

Mean (SD) within-group changes for the intensive group were favorable for HDL-C (1.2 [9.0] mg/dL increase; to convert to millimoles per liter, multiply by 0.0259) and diastolic blood pressure (–3.5 [13] mm Hg decrease) ($P < .05$ for both comparisons). No other significant within-group or between-group changes in clinical characteristics were observed (data not shown). When HbA_{1c} level was examined in relation to intervention frequency (**Table 2**), a nonstatistically significant decline (–0.69%; to convert to a proportion of total hemoglobin, multiply by 0.01) ($P = .06$) was shown for those who had a high number of visits (≥4) with a CHW, even if they had a low number of visits (<2 visits) with an NCM compared with the minimal group. Moreover, those who had more visits with a CHW and NCM had a statistically significant decline in HbA_{1c} level (–0.68%) compared with the minimal group ($P = .03$). This result was similar (–0.43% decline in HbA_{1c} level) but became nonsignificant ($P = .12$) after adjustment.

EFFECT OF INTERVENTIONS ON ER VISITS AND HOSPITALIZATIONS AT 24 MONTHS

At 24 months (**Table 3**), the intensive intervention group had fewer ER visits compared with the minimal intervention group (RD, –14.5; RR, 0.77; 95% CI, 0.59-1.00; rate reduction, ↓ 23%). Those who had a higher frequency of NCM and CHW visits had a significant reduction in ER visits compared with the minimal intervention group (RD, –31.0; RR, 0.66; 95% CI, 0.43-1.00; rate reduction, ↓ 34%). A similar trend was shown for hospitalizations; the intensive intervention group had an overall RD of –12.7 and RR of 0.91; 95% CI, 0.64-1.19; rate reduction, ↓ 9%, compared with the minimal intervention group. Those with higher intervention frequency, particularly CHW visits, had a lower rate ratio compared with the minimal intervention group. Results for hospitalizations were not statistically significant.

Table 2. Effect of Intervention on HbA_{1c} Level Over 24 Months by Intervention Frequency

Intervention[a]	Within-Group Mean±SD Change in HbA_{1c} Level Over 24 mo, %	Net Effect on HbA_{1c} Level, Mean±SE, %			
		Effect	*P* Value	Adjusted Effect[b]	*P* Value
Minimal	−0.08 ± 1.93	[Reference]		[Reference]	
Intensive (overall)	−0.20 ± 1.70	−0.07 ± 0.17	.66	−0.11 ± 0.14	.44
Low-frequency CHW + low-frequency NCM	0.11 ± 1.56	0.19 ± 0.26	.48	0.003 ± 0.23	.99
Low-frequency CHW + high-frequency NCM	0.21 ± 1.85	0.29 ± 0.26	.26	0.09 ± 0.23	.70
High-frequency CHW + low-frequency NCM	−0.49 ± 1.64	−0.69 ± 0.36	.06	−0.56 ± 0.31	.08
High-frequency CHW + high-frequency NCM	−0.48 ± 1.59[c]	−0.68 ± 0.32	.03	−0.43 ± 0.28	.12

Abbreviations: CHW, community health worker; HbA_{1c}, hemoglobin A_{1c}; NCM, nurse case manager.
SI conversion factor: To convert HbA_{1c} to a proportion of total hemoglobin, multiply by 0.01.
[a] High frequency indicates at least 2 visits for NCM and at least 4 visits for CHW.
[b] Adjusted for age, baseline HbA_{1c} level, and duration of follow-up.
[c] *P* value for within-group change over 24 months was statistically significant.

Table 3. Emergency Department (ER) Visits and Hospitalizations at 24-Month Overall and by Intervention Intensity

Intervention[a]	No.	Counts	Person-Years	ER/Hospital Rate per 100	RD per 100	Unadjusted RR (95% CI)	Unadjusted Rate Reduction, %	Adjusted[b] RR (95% CI)	Adjusted Rate Reduction, %
ER visits									
Minimal care	273	404	539.4	74.9	[Reference]	1.00	[Reference]	1.00	[Reference]
Intensive care (overall)	269	322	533.2	60.4	−14.5	0.81 (0.61-1.06)	↓19	0.77[c] (0.59-1.00)	↓23
No CHW and no NCM	18	19	31.6	60.1	−14.8	0.89 (0.39-2.02)	↓11	1.32 (0.61-2.85)	↑32
Low-intensity CHW + low-intensity NCM	64	131	127.7	102.6	27.7	1.36 (0.89-2.08)	↑36	1.14 (0.76-1.71)	↑14
Low-intensity CHW + high-intensity NCM	67	68	133.9	50.8	−24.1	0.67 (0.43-1.05)	↓23	0.59[c] (0.38-0.90)	↓41
High-intensity CHW + low-intensity NCM	46	39	92.0	42.4	−32.5	0.56[c] (0.33-0.96)	↓44	0.60[c] (0.36-1.00)	↓40
High-intensity CHW + high-intensity NCM	74	65	148.0	43.9	−31.0	0.58[c] (0.38-0.90)	↓42	0.66[c] (0.43-1.00)	↓34
Hospitalizations									
Minimal care	273	191	539.4	35.4	[Reference]	1.00	[Reference]	1.00	[Reference]
Intensive care (overall)	269	61	269.0	22.7	−12.7	0.94 (0.69-1.27)	↓6	0.91 (0.64-1.19)	↓9
No CHW and no NCM	18	15	31.6	47.5	12.1	1.55 (0.65-3.68)	↑55	1.88 (0.80-4.45)	↑88
Low-intensity CHW + low-intensity NCM	64	41	127.7	32.1	−3.3	0.88 (0.54-1.44)	↓12	0.86 (0.53-1.41)	↓14
Low-intensity CHW + high-intensity NCM	67	47	133.9	35.1	−0.3	0.96 (0.60-1.55)	↓4	0.98 (0.61-1.57)	↓2
High-intensity CHW + low-intensity NCM	46	32	92.0	34.8	−0.6	0.95 (0.55-1.66)	↓5	0.75 (0.42-1.33)	↓25
High-intensity CHW + high-intensity NCM	74	45	148.0	30.4	−5.0	0.83 (0.52-1.33)	↓17	0.86 (0.53-1.37)	↓14

Abbreviations: CHW, community health worker; CI, confidence interval; NCM, nurse case manager; RD, rate difference; RR, rate ratio.
[a] High intensity indicates 4 or more visits for CHW and 2 or more visits for NCM.
[b] Adjusted for age, baseline, and insurance.
[c] $P \leq .05$.

EFFECT OF INTERVENTIONS ON ER VISITS AND HOSPITALIZATIONS AT 36 MONTHS

At the 36-month follow-up (**Table 4**), the overall results for the intensive intervention group mirrored the 24-month follow-up results for ER visits and hospitalizations. Those who had a higher frequency of CHW visits, but not necessarily NCM visits, were significantly less likely to have ER visits and hospitalizations compared with the minimal intervention group: RD, −48.7; RR, 0.53; 95% CI, 0.36-0.80; rate reduction, ↓ 47% vs RD, −17.9; RR, 0.44; 95% CI, 0.27-0.73; rate reduction, ↓ 56%, respectively ($P < .05$ for both comparisons).

COMMENT

In this low-income, urban, African American population with type 2 DM, an NCM/CHW team reduced ER utilization by about 23%. Participants who received the most attention from the NCM/CHW team seemed to have the greatest benefit in terms of reduced utilization and improved HbA_{1c} levels. Strengths of our study that lend weight to this conclusion include its randomized controlled design; a high follow-up rate; blinded data collection away from the intervention site; and robustness after adjustment for baseline values, age, and follow-up time.

Our finding of modest changes in clinical characteristics for the entire NCM/CHW group was disappointing, particularly given the extensive implementation of clinical-based algorithms and protocols and action plans. Subanalyses indicated that those receiving a higher frequency of visits, particularly CHW visits, had better outcomes for HbA_{1c} levels. In addition, consistent with the high-risk approach, those who had higher baseline HbA_{1c} values, appropriately, received a greater frequency of visits (data not shown). Therefore, we feel confident that our intervention was suitable in providing the appropriate action for the corresponding participant risk status. We also conducted analyses among those in the intensive intervention group who had higher baseline HbA_{1c}

Table 4. Emergency Department (ER) Visits and Hospitalizations at 36 Months Overall and by Intervention Frequency

Intervention[a]	No.	Counts	Person-Years	ER/Hospital Rate per 100	RD per 100	Unadjusted RR (95% CI)	Rate Reduction, %	Adjusted[b] RR (95% CI)	Rate Reduction, %
ER									
Minimal intervention	273	811	800.8	101.3	[Reference]	1.00	[Reference]	1.00	[Reference]
Intensive intervention (overall)	269	665	791.1	84.1	–17.2	0.83 (0.64-1.07)	↓17	0.80 (0.62-1.03)	↓20
No CHW and no NCM	15	34	36.5	93.2	–8.1	1.17 (0.49-2.75)	↑17	1.97 (0.89-4.38)	↑97
Low-frequency CHW + low-frequency NCM	83	267	244.3	109.3	+8.0	1.06 (0.73-1.55)	↑6	0.94 (0.66-1.35)	↓6
Low-frequency CHW + high-frequency NCM	36	93	106.5	87.3	–14.0	0.84 (0.49-1.43)	↓16	0.92 (0.56-1.52)	↓8
High-frequency CHW + low-frequency NCM	69	123	207.0	59.4	–48.7	0.57[c] (0.37-0.87)	↓43	0.53[c] (0.36-0.80)	↓47
High-frequency CHW + high-frequency NCM	66	148	196.8	75.2	–26.1	0.73 (0.48-1.10)	↓27	0.67[c] (0.45-1.00)	↓33
Hospitalizations									
Minimal intervention	273	317	800.8	39.6	[Reference]	1.00	[Reference]	1.00	[Reference]
Intensive intervention (overall)	269	265	791.1	33.5	–6.1	0.84 (0.61-1.15)	↓16	0.79 (0.59-1.06)	↓21
No CHW and no NCM	15	16	36.5	43.9	+4.3	1.48 (0.51-4.31)	↑48	1.90 (0.75-4.83)	↑90
Low-frequency CHW + low-frequency NCM	83	90	244.3	36.8	–2.8	0.93 (0.59-1.47)	↓7	0.77 (0.51-1.18)	↓23
Low-frequency CHW + high-frequency NCM	36	40	106.5	37.6	–2.0	0.91 (0.48-1.74)	↓9	0.93 (0.52-1.66)	↓7
High-frequency CHW + low-frequency NCM	69	45	207.0	21.7	–17.9	0.52[c] (0.31-0.89)	↓48	0.44[c] (0.27-0.73)	↓56
High-frequency CHW + high-frequency NCM	66	74	196.8	37.6	–2.0	0.91 (0.55-1.50)	↓9	0.92 (0.58-1.44)	↓8

Abbreviations: CHW, community health worker; CI, confidence interval; NCM, nurse case manager; RD, rate difference; RR, rate ratio.
[a] High frequency indicates 6 or more visits for CHW and 2 or more visits for NCM.
[b] Adjusted for age, baseline, and insurance.
[c] $P \leq .05$.

values (≥ 8.0%) and found a statistically significant decline (–1.01%) over 24 months. Furthermore, those in the intensive group with HbA_{1c} values of 8.0% and a higher frequency of visits had an even larger decline in HbA_{1c} values, which was statistically significant (–1.44% for those with high frequency of CHW and NCM visits).

Again, our results for health care utilization indicated better outcomes for participants who received a greater number of CHW visits. We were surprised to see that the effect for NCM was not as strong. We also observed similar effects for the NCM/CHW team in our prior study, Project Sugar 1.[14] We attribute this finding to the significantly greater contact that the CHWs had with participants (mean of 6 visits with the CHW vs 2 visits with NCM at 36 months). Furthermore, the CHWs, who were part of participants' cultural group and spent time in participants' homes, received extensive training to enhance communication of shared experiences and personalization of interventions in their roles as educators and problem solvers,[21] which may have contributed to the findings. Studies of the use of CHWs in persons with DM, show positive changes[19]; CHWs have also been effective in a number of other disease settings.[23] Our study gives more evidence toward the use of CHWs as integral team members. Studies of NCMs show positive effects, particularly when they are given the authority to make independent treatment decisions.[24] The NCMs and CHWs had different, but complementary, roles that contributed to the success of the intervention.

Several limitations of the study deserve mention. First, staffing problems limited our ability to keep the same NCM present throughout the duration of the study, causing gaps in the continuity of that component of the intensive intervention. This could have influenced the results, particularly for the clinical characteristics. Moreover, the NCMs did not have the directive to change or increase dosages of medications and instead were dependent on the primary care provider to make the recommended changes. We abstracted current medications from participants' medical charts at baseline and 24 months and will be able to capture physicians' intensification of therapy in future analyses. Another contributor was the secular trends in HbA_{1c} levels that were observed in the MCO over time. For example, the mean HbA_{1c} level in phase 1 of our study, Project Sugar 1, conducted 5 years earlier, was 8.6% and the mean in this study was lower at 7.8%.

Previous intervention studies to improve quality of care in DM show a mean reduction in HbA_{1c} level of 0.42%.[25] Our study is comparable, with the reduction ranging from 0.2% overall to 0.68% for higher intervention frequency. A review of previous studies specifically focusing on disadvantaged populations concluded that culturally tailoring of interventions and using community educators or lay people among other strategies resulted in better outcomes.[26] Our study used these strategies as well as other unique approaches to improve care for this group of individuals at high risk of DM-related complications. Our work in this population has been included in 3 reviews and others as a promising approach to tackle this problem.[25-27] Furthermore, our study gives further support for the reduction in emergency department visits in minority and urban settings.[16,28] As such, this study indicates that an intervention using an NCM/CHW team approach is effective in enhancing some important aspects of DM care. The question of whether the reduction in ER visits were cost-effective awaits future economic analysis.

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