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Original Article

Impact of a Chronic Disease Management Program on Hospital Admissions and Readmissions in an Australian Population with Heart Disease or Diabetes

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Abstract

Chronic disease management programs (CDMPs) were introduced in Australia to reduce unnecessary health care utilization by the growing population with chronic conditions; however, evidence of effectiveness is needed. This study evaluated the impact of a comprehensive CDMP, My Health Guardian (MHG), on rate of hospital admissions, readmissions, and average length of hospital stay (ALOS) for insured individuals with heart disease or diabetes. Primary outcomes were assessed through retrospective comparison of members in MHG (treatment; $n = 5053$) to similar nonparticipating members (comparison; $n = 23{,}077$) using a difference-in-differences approach with the year before program commencement serving as baseline and the subsequent 12 or 18 months serving as the program periods. All outcomes were evaluated for the total study population and for disease-matched subgroups (heart disease and diabetes). Statistical tests were performed using multivariate regression controlling for age, sex, number of chronic diseases, and past hospitalization status. After both 12 and 18 months, treatment members displayed decreases in admissions (both, $P \leq 0.001$) and readmissions (both, $P \leq 0.01$), and ALOS after 18 months ($P \leq 0.01$) versus the comparison group; magnitude of impact increased over time for these 3 measures. All outcomes for both disease-matched subgroups directionally mirrored the total study group, but the diabetes subgroup did not achieve significance for readmissions or ALOS. Within the treatment group, admissions decreased with increasing care calls to members (12 and 18 months, $P < 0.0001$). These results show that MHG successfully reduced the frequency and duration of hospital admissions and presents a promising approach to reduce the burden associated with hospitalizations in populations with chronic disease. (*Population Health Management* 2012;XX:XXX–XXX)

Introduction

Chronic disease accounts for over 70% of Australian disease burden, measured by disability-adjusted life-years, and is expected to increase to 80% by 2020.[1] Cardiovascular disease (CVD) and diabetes represent 2 of the most prevalent chronic diseases affecting Australians today. According to the 2007–2008 National Health Survey, 3.4 million (17%) and 898,800 (4%) Australians have CVD and diabetes, respectively.[2,3] Appropriate cost-effective approaches are needed to mitigate the impact of the anticipated increased burden of chronic conditions on health care utilization and costs.[1]

Recent evidence demonstrates that prevalence of disease in Australia is associated with high health care utilization and increasing medical expenditures. Of the 7.8 million hospital separations in Australia in 2007–2008, CVD was the primary cause for 475,000 hospitalizations and played a secondary role in another 797,000 hospitalizations.[4,5] According to 2004–2005 data, diabetes was the principal cause of 74,490 hospitalizations and was a contributing cause in up to 7 times that many (531,069).[6] In addition, over the period of 2000–2001 to 2004–2005, a 35% increase in the rate of diabetes-related hospitalizations was observed.[6] As health care utilization increased, Australia also experienced a more than 2-fold increase in health expenditure over 10 years, from $52.6 billion in 1999–2000 to $121.4 billion in 2009–2010.[7] For CVD, more than half of all expenditures ($3 billion) were for patients admitted to the hospital.[5]

However, evidence suggests that patients with effective self-management skills make better use of health care

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professionals' time and enhance self-care,[8,9] possibly reducing the likelihood of hospitalizations. This evidence underscores the urgency of more effective support of self-management, in collaboration with primary care, as a means to mitigate costly, avoidable health care utilization.

In Australia, since 2007, health funds have been permitted to offer what is termed "broader health cover" (BHC), which refers to services that prevent, are part of, or substitute for hospital-based services and, by regulatory definition, include chronic disease management programs (CDMPs). In its recent annual report, the industry regulator—the Private Health Insurance Administration Council—noted the rollout and adoption of CDMPs was initially slow but expanded quickly—the number of insurers offering CDMPs doubled in 2009–2010, but leveled to a growth of only 2% during 2010–2011. It is expected that participation in CDMPs will continue to grow as the benefits of such programs are more widely accepted.[10]

As more is invested in CDMPs, it is critical that there be support for these programs with evidence of their effectiveness. Although there has been some published work,[11] this study represents one of the first (and largest) studies to be completed on an Australian health fund CDMP for multiple diseases. My Health Guardian (MHG), a health and well-being program, provides health fund members with behavior change tools for a healthy lifestyle as well as a comprehensive CDMP for improved self-management among members with chronic conditions. In the current study, the authors evaluated the impact of the MHG program on hospital admissions, readmissions, and average length of stay (ALOS) for individuals diagnosed with heart disease or diabetes.

Study Data and Methods

Study design and outcomes

Although a randomized study is often desired, operational considerations do not always permit randomized studies in the context of a population of health plan members. To best study the population of interest, a retrospective quasi-experimental design was selected to evaluate the impact of the MHG program on hospital utilization outcomes of members with heart disease or diabetes. The outcomes of interest were change in (1) the rate of hospital admissions, (2) rate of hospital readmissions, and (3) ALOS in the hospital. MHG commenced on May 1, 2009; the year preceding program commencement was defined as the base period for the study. Two intervention periods were evaluated: the first 12 months and 18 months of the program.

My Health Guardian Program

The MHG program provides personalized online health support for all members and includes health assessments, health action plans, education, and health behavior tracking. Additional telephone support by registered nurses is provided for members who demonstrate, via health care claims or self-reported health status, a need for more intensive support in the management of their condition because of propensity for hospital admission. Outbound call frequency is driven by a balance of factors including the member's current disease severity, health status, and unique individual needs for improved self-management skills.

Study participants

Individuals eligible for this study were 18 years of age or older, diagnosed with diabetes or heart disease (coronary artery disease or heart failure), and continuously enrolled with The Hospital Contributions Fund of Australia (HCF) throughout the study period. Patient diagnoses were determined from hospital and medical claims dating to 2003 that included *International Classification of Diseases, 10th revision* diagnosis codes, Commonwealth Medicare Benefits Schedule procedure coding, and diagnosis-related groups hospital payment coding. The intervention group comprised 5053 members who consented to enroll in the MHG program within 6 months of program commencement and who maintained enrollment throughout the 18-month intervention period (May 2009 to October 2010). The comparison group comprised the 23,077 members who met MHG eligibility requirements but were either never contacted or did not enroll. The groups were compared on demographic factors, baseline admission rates and ALOS, and severity measures (admission during 24 months pre-base and comorbidity) to ensure that selection bias was a minimal concern.

As this study involved negligible risk and used only existing nonidentifiable data, it was exempt from review based on the Australian National Statement on Ethical Conduct in Human Research, chapter 5.1.22, as well as Institutional Review Board exclusion criteria outlined in the US Code of Federal Regulations.

Assessment of hospital utilization outcomes

All outcomes were calculated as the change from base to intervention period (12 or 18 months). Statistically, changes at the individual level in each group were evaluated, as will be described. Descriptive results for hospital admissions and readmissions were reported as the annualized rate per 1000 participants. ALOS was total bed days over total admissions during the specified period. Treatment effect magnitude was calculated as the difference-in-differences, or the difference between the groups with respect to the change in each measured outcome. Treatment group results also were stratified by the number of care calls completed to evaluate the relationship between calls and the change in admission rate. It was hypothesized that more intensive support via telephone calls would generally improve outcomes among individuals with the chronic conditions evaluated. However, given that outbound call frequency is a function of clinical severity, which varies in the population across time and has a direct effect on admissions, the analysis was not intended to define optimal call frequency. Analyses were conducted using the entire treatment and comparison groups and using disease-matched groups (diabetes or heart disease), which were not mutually exclusive.

Sensitivity analyses of admissions were conducted that excluded members with extreme changes in admissions (increase or decrease of more than 3 admissions) to determine if outliers were a primary driver of overall study results. Sensitivity analyses of members with either no change or an increase in admissions were performed to determine if the treatment mitigated the disfavorable trend in this group. The purpose of this analysis was to ensure that regression to the mean was not a primary driver of measured program effect.

Statistical analyses

The Chow test of structural equality between data sets[12] was used to evaluate whether study groups were sufficiently similar for balanced comparison. The null hypothesis was that the 2 study groups have coefficients of similar magnitude, variance, and sign in regressions incorporating the independent variables age, sex, admissions in the prior 24 months (y/n), and number of core conditions. Failure to reject the null hypothesis using the criteria $P \geq 0.01$ indicates the 2 groups are comparable.

Multivariate logistic regression analyses tested whether the intervention was a statistically significant determinant of change (increase or no change compared to decrease) in admissions and readmissions while controlling for differences in age, sex, number of chronic diseases, and past hospitalization status as variables that influence study outcomes. This approach also was used in the evaluation of the relationship between calls and changes in admissions. Multivariate general linear regression was used in the analysis of ALOS using the same control variables. Data manipulation and analysis was performed using SAS 9.2 (SAS Institute Inc., Cary, NC).

Results

Evaluation of study group comparability

The Chow test of comparison and treatment members failed to reject ($P \geq 0.01$) for the total study population ($P = 0.032$) and for the disease-matched subgroups (diabetes, $P = 0.053$; heart disease, $P = 0.139$). These results indicate statistical comparability between the treatment and comparison groups. Additionally, most demographic and baseline characteristics were similar between comparison and treatment members within the study groups (Table 1). Thus, the Chow test indicates that these groups are statistically comparable. Even though the Chow test indicated statistical comparability, differences between the 2 groups were still apparent. To address these additional differences, the authors included the available needed covariates (age, sex, hospital admission in prior 24 months, number of chronic conditions) in multivariate modeling in obtaining significance testing P values to help control for the remaining differences between selected study groups. Furthermore, sensitivity analyses were conducted in subgroups less susceptible to regression to the mean to confirm that the conclusions were not affected by this phenomenon.

Impact of MHG interventions on hospital utilization

The percent change in hospital utilization outcomes within and between study groups is shown in Table 2. For the total population and each disease subgroup, hospital admission rates were significantly more likely to improve at 12 and 18 months for the treatment group relative to the comparison group and the magnitude of effect increased at 18 months ($P \leq 0.01$).

The treatment group demonstrated a significantly higher likelihood of reduced readmissions than the comparison group for the total study population and the heart disease study subgroup ($P \leq 0.01$). The diabetes treatment subgroup also displayed a relative decrease in readmissions; however, these results did not achieve statistical significance. The magnitude of the treatment effect seen with readmissions was greater than that noted for all admissions. ALOS increased for the treatment group at a relatively lower rate than for the comparison group in the overall study population and both disease subgroups. Program impact on ALOS increased over time and reached statistical significance after 18 months for the total study population and the heart disease study subgroup ($P \leq 0.01$).

Sensitivity analyses and regression to the mean

Because regression to the mean is bidirectional (low utilizers in the base year tend to increase and high utilizers in

Table 1. Baseline Characteristics of Total Study Population and Disease-Matched Subgroups

	Total Study Population		*Diabetes Group*		*Heart Disease Group*	
	Treatment	*Comparison*	*Treatment*	*Comparison*	*Treatment*	*Comparison*
N	5053	23,077	2161	9259	3547	16,363
Avg age	66.4	64.6	66.1	65.0	66.9	64.9
% female	43.7%	40.3%	47.4%	44.1%	40.5%	37.4%
% with admission in 24 months pre-base	77.5%	72.3%	77.3%	73.2%	78.8%	73.0%
Avg number of chronic conditions (SD)	1.24 (0.51)	1.21 (0.49)	1.42 (0.63)	1.37 (0.61)	1.31 (0.57)	1.27 (0.54)
% with Diabetes	42.8%	40.1%	100%	100%	18.5%	15.6%
% with CAD	68.9%	69.4%	29.4%	26.6%	98.2%	97.9%
% with CHF	4.1%	4.1%	2.9%	2.9%	5.8%	5.8%
% with COPD	1.8%	1.4%	1.8%	1.3%	2.1%	1.7%
% with asthma	1.9%	1.9%	1.9%	1.8%	2.1%	2.0%
% with CKD	2.0%	1.8%	3.1%	2.5%	1.9%	2.0%
% with ESRD	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
% with depression	0.06%	0.04%	0.05%	0.05%	0.06%	0.05%
% with cancer	1.9%	1.6%	2.0%	1.9%	1.9%	1.4%
Base admission rate (per 1000)	539.3	419.6	494.2	398.4	602.5	464.5
Base readmission rate (per 1000)	59.6	47.3	41.2	43.8	71.9	54.2
Base ALOS (days)	5.6	5.9	6	6.6	5.4	5.7

ALOS, average length of stay; Avg, average; CHF, chronic heart failure; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; ESRD, end-stage renal disease; SD, standard deviation.

Table 2. Percent Change in Hospital Admissions, Readmissions, and Average Length of Stay

	Hospital Admissions		*Hospital Readmissions*		*Average Length of Stay*	
	% Change		*% Change*		*% Change*	
	12 months	*18 months*	*12 months*	*18 months*	*12 months*	*18 months*
Diabetes						
Comparison	−2.2%	6.1%	30.5%	51.9%	9.9%	16.2%
Treatment	−10.0%	−7.3%	24.7%	31.8%	5.9%	11.8%
Difference in % Change	−7.8%**	−13.4%*	−5.8%	−20.1%	−4.0%	−4.4%
Heart Disease						
Comparison	−18.7%	−13.5%	−12.6%	0.2%	10.9%	17.5%
Treatment	−25.9%	−25.5%	−26.7%	−25.5%	4.1%	4.9%
Difference in % Change	−7.2%**	−12.0%*	−14.1%*	−25.7%*	−6.8%	−12.6%*
Total Population						
Comparison	−13.9%	−8.3%	0.0%	14.3%	12.4%	19.1%
Treatment	−20.0%	−19.6%	−14.3%	−11.4%	4.4%	7.6%
Difference in % Change	−6.1%**	−11.3%**	−14.3%*	−25.7%*	−8.0%	−11.5%*

Statistical significance of the intervention effect was tested using multivariate logistic regression for the difference-in-difference change (increase or no change versus decrease from baseline to 12- or 18-month program period) in hospital admissions and readmissions, and multivariate general linear regression was used in the analysis of average length of stay. All statistical tests controlled for age, sex, number of core diseases, and hospitalizations in prior 24 months (y/n).

* $P \leq 0.01$, ** $P \leq 0.001$.

the base year tend to decrease), 2 sensitivity analyses were conducted to assess the potential impact of regression to the mean on the observed results. The first analysis focused on a core group with a change of 3 or fewer admissions; outliers with greater magnitude changes were excluded. Using these criteria, it was found that for both treatment and comparison, 2% and 3% were excluded from each disease group in the 12- and 18-month analyses, respectively, indicating an even distribution of outliers. A significant treatment effect ($P \leq 0.01$) was observed at 12 and 18 months for both disease study subgroups (Table 3). In a 1-sided analysis, all HCF members who had a decrease in admissions, for whom any regression to the mean would manifest as an apparent larger program impact, were excluded. The increase in admissions for the remaining treatment group was less than that for the comparison group at both 12 and 18 months; however, only the diabetes group achieved significance ($P \leq 0.01$ at 12 months; $P \leq 0.05$ at 18 months; Table 3). Sensitivity analyses of disease-matched subgroups confirmed that results were not driven primarily by outliers with extreme changes in admissions or by the natural tendency of groups to move toward average health care utilization/expenditure (regression to the mean).

Impact of intervention intensity on hospital admissions

The relationship between the number of completed care support telephone calls received by treatment group members and their change in admissions is shown in Table 4. The number of calls, while controlling for other covariates, is a

Table 3. Evaluation of Sensitivity of Results to Outliers (Core Group Analysis) and Regression to the Mean (One-Sided Analysis)

	Core group (admit count change of −3 to +3)				*One-sided (admit count change of ≥0)*			
	12 Months		*18 Months*		*12 Months*		*18 Months*	
	N	*Admission rate change*	*N*	*Admission rate change*	*N*	*Admission rate change*	*N*	*Admission rate change*
Diabetes								
Comparison	9095	−7.3%	8945	−10.7%	7553	308.1%	7800	204.3%
Treatment	2121	−13.5%	2097	−18.0%	1664	274.2%	1739	155.4%
Difference		−6.2%***		−7.3%**		−33.9%**		−48.9%*
Heart Disease								
Comparison	16099	−21.1%	15895	−24.8%	12739	273.0%	13207	172.2%
Treatment	3475	−26.0%	3448	−31.3%	2597	223.4%	2732	127.0%
Difference		−4.9%***		−6.5%**		−49.6%		−45.2%

Statistical significance of the intervention effect was tested using multivariate logistic regression for the difference-in-difference change (increase or no change versus decrease from baseline to 12- or 18-month program period) in hospital admissions and readmissions, and multivariate general linear regression was used in the analysis of average length of stay. All statistical tests controlled for age, sex, number of core diseases, and hospitalizations in prior 24 months (y/n).

* $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$.

Table 4. Percent Change in Treatment Group Hospital Admission Rates by Total Number of Calls

Total Calls During Treatment Period	Diabetes		Heart Disease		Total Population	
	% Change		% Change		% Change	
	12 months*	18 months**	12 months**	18 months**	12 months**	18 months**
1	11.0%	19.5%	−10.5%	3.8%	−3.2%	9.5%
2 – 3	2.4%	4.4%	−21.4%	−25.8%	−14.4%	−17.5%
4 – 5	−6.4%	−25.2%	−26.6%	−35.2%	−19.0%	−30.5%
6 – 7	−17.9%	−6.5%	−28.6%	−24.9%	−20.4%	−22.9%
8 – 10	−21.5%	−4.8%	−43.0%	−24.8%	−39.0%	−12.3%
11+	−24.2%	−6.7%	−8.7%	−23.4%	−15.2%	−19.4%

Statistical significance of the effect of number of calls was tested using multivariate logistic regression for the difference-in-difference change (increase or no change versus decrease from baseline to 12- or 18-month program period) in hospital admissions controlling for age, sex, number of core diseases, and hospitalizations in prior 24 months (y/n).

*$P < 0.001$, ** $P < 0.0001$.

significant predictor of the directional change in admission rate at both 12 and 18 months ($P < 0.001$).

Discussion

MHG proved to be an effective means to reduce the likelihood and duration of hospitalizations for individuals with diabetes and heart disease. In this study, the MHG program demonstrated a consistent effect; treatment group members had reduced admissions, readmissions, and ALOS relative to comparison group members, supporting the hypothesis that MHG reduces the occurrence, frequency, and severity of hospital utilization. Furthermore, the magnitude of effect increased over time demonstrating the importance of a sustained program for maximizing impact.

CDMPs, such as MHG, have a goal of empowering individuals to adopt a healthy lifestyle and become proactive in managing their health-proven approaches for reducing avoidable hospital admissions.[13–15] However, the need for effective, scalable strategies to augment primary care beyond community-based efforts, such as additional support for a doctor's plan of care, have surfaced in response to the chronic disease trends in Australia.[1,3,7] The provision of BHC that includes CDMPs supports solutions that fill this need by offering programs aimed at improving prevention and patient self-management.[10] This study provides initial evidence for the impact of a health fund-sponsored CDMP.

A challenge inherent in retrospective outcomes studies is the potential for confounding differences between study groups. To address this concern, the Chow test was used, which relies upon statistical criteria to determine whether attributes are similar between groups.[12] Results indicated comparability of the treatment and comparison groups in the entire study population and, meeting more stringent criteria ($P \leq 0.05$), in disease-matched subgroups, allowing for a valid evaluation of treatment effect. Further, remaining differences in age, sex, number of core diseases, and past hospitalization status were controlled for in the analysis to determine if the intervention was a significant determinant of the change in hospital utilization.

Although the directional change in outcomes was consistent across all measures, there was some variation by disease. A significant impact was demonstrated across both disease groups and time periods for hospital admissions; however, the treatment effect on readmissions and ALOS did not achieve significance during the study period for the diabetes group, although the result was directionally favorable at 12 months and improved further at 18 months. Failure to achieve conventional levels of statistical significance may stem from variability in how quickly members with diabetes respond to improved self-management with respect to these measures. A previous analysis of a CDMP in Germany found that the diabetes group had a sizable reduction in admissions after the first year that was insignificant, and although ALOS and readmissions were not measured, this outcome supports the hypothesis that level of initial impact on diabetics by CDMPs may be more variable across this population than for other conditions.[14] The comparison also indicates that MHG was more effective at creating an early reduction in admissions among participants with diabetes than the CDMP in Germany. Future analysis is needed to determine if the favorable trend shown here achieves statistical significance in subsequent years of the program. Although it is possible that regression to the mean could be biasing results in the heart disease cohort, the sensitivity analyses helped to rule out this possibility.

The relationship observed between the total number of calls treatment members received and change in admission rates revealed that care support telephone calls can impact health care utilization, a finding consistent with earlier studies of clinical process measures and admissions.[13,14,16,17] Similar to these studies, a plateau in reduction in admissions was observed after 6–7 calls delivered over 18 months. Although there may be a point of diminishing returns with respect to the value of additional calls that varies according to severity and risk level, we did not have sufficient clinical detail to statistically adjust for changes in risk during the course of the program and thus cannot draw conclusions about optimal call frequency. The plateau in results as the number of calls increased above 8 argues against the idea that regression to the mean is the primary driver of the results reported in this analysis. We do not believe that this result can be used to attribute number of calls directly to the level of effect; however, we think it provides supporting evidence that calls contributed to the treatment effect reported in other study analyses. Reduced likelihood of hospital admission is a more distal outcome of the personalized telephonic interactions that more directly impact behaviors

such as medication adherence, healthy eating and physical activity, and maintaining/achieving normal blood glucose and cholesterol levels. Higher risk members with more such issues typically require more calls and time to stabilize the disease and reduce the likelihood of admissions.

This is the first study of an Australian CDMP for multiple diseases using a large insured population and results should prove informative to ongoing policy initiatives. Notable policies previously established in 2005, such as the National Chronic Disease Strategy, National Service Improvement Framework, and the Blueprint for Chronic Disease Surveillance, are indicative of Australia's awareness of the need to focus on chronic disease prevention and management.[2,18,19] Subsequent adoption of BHC and, concomitantly, CDMPs created more specific guidelines for insured populations. However, the overall uptake of CDMPs in Australia was initially low, perhaps because self-management activities typically are not integrated into primary care or endorsed by health care professionals.[18,20] The pace of adoption picked up in 2009–2010, but flattened in 2010–2011; to maintain the energy around these programs, evidence for their effectiveness is needed.[10] The positive results achieved through the MHG program, which is designed to supplement and enhance primary care, likely will provide needed support to sustain and increase CDMP implementation and uptake in Australia.

Limitations

As in any retrospective analysis, limitations were acknowledged and minimized to the extent possible. To mitigate the effect of selection bias, comparison and treatment members were matched by disease and intergroup comparability was confirmed analytically. Regression to the mean is often a problem in nonrandomized studies; however, the increased magnitude of treatment effect after 18 months provides support that regression to the mean, which tends to occur shortly after patient identification,[21] was not a confounding factor. To verify, sensitivity analyses were performed on specific subpopulations less likely to be affected by regression to the mean and outliers. These analyses revealed a similar trend in outcome (eg, relative decrease in hospital admissions), further corroborating the study findings and earlier results.[13,14]

Future studies

Future research should extend upon these findings to explore additional outcomes achieved by the MHG program, both clinical and patient satisfaction measures, and other subpopulations of interest. Additionally, as the program progresses, additional research should evaluate the sustained impact of the MHG program.

Conclusions

Prior to this study, evidence of successful implementation and delivery of CDMP interventions in Australia has been limited. The findings reported here demonstrate the initial success of a CDMP for individuals with diabetes and heart disease. The MHG program reduced the burden of frequent and lengthy hospital admissions for patients, with increased impact over time. Overall, the results are consistent with the MHG program goals to offer an effective, scalable solution to the burden associated with chronic conditions.

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Author Disclosure Statement

Drs. Hamar, Rula, Wells, Coberley, and Pope are employees of Healthways, the provider of the disease management services under study and the sponsor of this research. Dr. Larkin is an employee of Hospital Contributions Fund, the health insurance company that offers the disease management services under study.

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