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Improving the Efficiency of Telephone-Based Disease Management Programs: Getting the Population and the Timing Right Using Hospital Admission Data

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Abstract

Telephone-based disease management (DM) programs can improve health outcomes and provide a positive return on investment to funders. However, there is scant evidence about how to use hospital admission episode data to identify patients who are most likely to participate in a DM program. The objective of this study was to use hospital admission episode data held by health insurers to determine those factors that predict members with chronic disease joining and remaining in a DM program for at least 6 months. A multivariable logistic regression model was constructed to determine predictors of participating in a DM program for an insured population who had been admitted to hospital for congestive heart failure, coronary artery disease, or chronic obstructive pulmonary disease. The outcome variable was binary: did the member both opt into the DM program and remain in the program for at least 6 months? The study population included 9874 private health fund members. Time from a related hospital admission was a significant predictor, with those offered the program within 3 to 6 months being 71% more likely (95% confidence interval [CI]: 33%, 113%) to participate. The length of time from offer to commencement also was a significant predictor, with those commencing within 3 to 4 months being 75% (95% CI: 44%, 112%) as likely to remain in the program. It is possible to predict which individuals are most likely to participate in a telephone-based DM program using hospital admission episode data. Once individuals are identified, timely commencement of a DM program is an important predictor of success. (*Population Health Management* 2012;15:331–337)

Introduction

Disease management (DM) programs for people with chronic illness have become common practice in many health care settings. Rising costs associated with the increasing prevalence of chronic disease have provided an incentive to curb the cost impact on health funders[1] and encouraged the search for relatively low-cost postdischarge interventions aimed at improving the management of chronic disease in the community setting. The positive impact of DM programs on reducing health care episodes appears to be mediated by the effect on disease progression[1] of increasing the patients' knowledge about and behavior modification toward day-to-day management of their disease.[2,3]

In the United States, Medicare and Medicaid have been investigating the success of chronic disease management for their publicly insured members.[4] In the private sector, insurers, managed care organizations, and employers[1] have been providing DM interventions to their members over the last 2 decades.

Studies have shown that DM programs reduce hospital admissions,[3,5–8] length of stay,[5–7] emergency room visits,[5] hospital claims expense,[7,9] and improve quality of life[2,10] for people with chronic disease. There is also evidence of improved disease self-management,[11] a positive return on investment,[12] and cost-effectiveness[12,13] for people with cardiac failure and diabetes.[14] Programs that target multiple chronic conditions also have found that the return on

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investment of providing DM programs to insured members was positive for insurers.[12]

The advantage of telephone-based DM programs is that the delivery is via technology that is accessible to a broad range of the population across a large geographic area.[15] Telephone-based interventions have been described as being a moderate-intensity DM program with personal contact made with the patient.[16] A recent Cochrane Review of a structured telephone support DM program for people with chronic heart failure found that hospitalizations and costs were reduced and people reported improved quality of life.[17] When costs of delivery were included, 1 study found a net savings of 10% in a telephone-based DM intervention for heart failure.[4] A recent randomized controlled trial (RCT) of a telephone-based intervention also found that the intervention group experienced lower mean values for total claims and total costs (with intervention costs included) compared to the control group.[7] A telephone-based DM intervention for people with diabetes with a follow-up period of 18 months also found better control of diabetes.[18]

Despite evidence that DM programs can improve health outcomes and provide a positive return on investment to funders, there is little evidence about how to identify patients prospectively who are most likely to participate and remain in a DM program from hospital admission episode data. Factors found to affect any self-reported participation in a coronary artery disease (CAD) DM program included age,[5,19] diabetes as a comorbidity,[19] time since last "heart attack,"[19] higher than average utilization of health services prior to entering the program,[5] and severity of illness.[5] The importance of time since last "heart attack" in CAD[19] suggests that timing from a significant event might be relevant; however, no other studies have explored the influence of timing on participation in DM programs.

The lack of data to identify those patients most likely to participate in DM programs from existing patient information and billing systems is a potential obstacle to the broader implementation of these programs.[12,20] Health insurers and public funders that cover a large population base have integrated information systems that hold patient administrative and clinical information across different providers within the health care system. These information systems potentially enable the rapid identification of members who are likely to participate in and benefit from DM programs. This may be an important factor in reducing delivery costs by increasing the efficiency of DM programs through targeting individuals who are most likely to participate in the programs.

The objective of this study was to identify the factors that predict people with a chronic disease opting in and remaining in a telephone-based DM program for at least 6 months, using hospital admission episode data collected by health care funders or insurers.

Methods

This was a prospective cohort study that formed part of a larger RCT to estimate the return on investment of a telephone-based DM program for chronic disease from the perspective of a private insurer.[7] Monash University Human Research Ethics Committee granted approval for the study (CF07/0288-2007000019).

Study population

Privately insured members of Medibank Private were invited to participate in a chronic DM program for CAD, congestive heart failure (CHF), or chronic obstructive pulmonary disease (COPD). The cohort members were identified retrospectively from insurance claims between 2003 and 2009 as having had a hospital admission where CHF, CAD, or COPD was identified as a primary (ie, reason for admission) or secondary (ie, comorbidity associated with the admission) diagnosis. They were then randomized to either receive an invitation from Medibank Private to participate in a telephone-based DM program, or they were put on a waiting list to receive an invitation after 12 months. The DM program was provided by McKesson Asia-Pacific, a separate entity contracted by Medibank Private. Insured members were able to opt out to Medibank Private or to the DM provider prior to commencement or at any time after they had started the program.

Data sources

Medibank Private provided the case-level data pertaining to the diagnosis for hospital admissions leading up to the offer to participate in the DM program, the date the program was offered to each member, and demographic information and insurance claims data for hospital admissions and ancillary health services over the 12-month period of the DM program. McKesson Asia-Pacific provided case-level data relating to the date the individual member commenced the program, and the dates of 6- and 12-month assessments. Data from each source were cleaned and matched according to a unique identification number generated specifically for the study.

Outcome measure

The binary outcome variable indicated whether the insured member opted in and completed at least 6 months of the DM program from the date they started the program.

Statistical methods

Multivariable logistic regression models were used to estimate odds ratios (OR) and coefficients for a range of explanatory variables on the binary outcome. Statistical software packages Stata/MP 11.0 for Windows (StataCorp LP, College Station, TX) and IBM SPSS Statistics Version 19 (IBM, Chicago, IL) were used to analyze data. All confidence intervals (CI) are 95%.

The authors fitted models of the form:

logit(in program for at least 6 months) = f(sex, age group, disease group, hospital admissions over 12 months, time from date of the related hospital admission to program offer date, time from offer date to program start date).

Summary hospital admission variables for 15 months prior to and 3 months up to the program offer date were determined from insurance claims data. This meant that the 3-month lag in insurance claims data could be accounted for, while allowing a full 12-month picture of hospitalization to eliminate potential confounders such as seasonal variation. When a member did not have a claim for a hospital episode the hospital admission variable was given a value of zero. The variable was included in the model as a continuous variable.

The time interval between the date of the most recent related hospital admission and the DM program offer date was obtained from insurance claims data provided by Medibank Private. Six models were examined based on varying definitions of the "related hospital admission," including whether it was an overnight or a same-day admission and diagnostic information relating to the hospitalization. The admission diagnosis was varied from strict criterion (the primary admission diagnosis based on *International Classification of Diseases, 10th Revision* [ICD-10] was the same as the DM program offered), to less strict criteria (any primary or secondary diagnosis based on ICD-10 could be the same as any of the DM programs offered) and adjusted for overnight admission only, or same-day as well as overnight. This variable was divided into 7 categories, ranging from < 90 days to more than 3 years, to reflect the number of days between the related admission and offer date.

The time from date of program offer to commencement date in days also was calculated to estimate the effect of delayed entry on the risk of opting in and staying in the DM program. This was included in the predictive model as the insurer can have some control over the time interval between the offer and start dates. This variable was entered into the model as a categorical variable with 6 categories.

Results

Case numbers and model identification

There were 9874 eligible members with CAD, CHF, or COPD identified from the insurance claims data. Data were missing for 890 members (9%) of the 9874 eligible records. Missing data related to start date or offer date. The remaining 8984 members were included in the models to explore the best definition of related hospital admission. The Wald chi-square test was used to assess the performance of this factor in the model. Table 1 shows the case numbers and Wald chi-square values for each of the 6 models. Model (2A) with the highest chi-square value ($\chi^2 = 36.8$ (6df), $P < 0.001$) was chosen for the multivariable logistic regression.

Population characteristics

Twenty-six percent of the total sample of 8976 cases in Model 2A enrolled and remained in the program for at least 6 months; the remaining 74% did not start the program at all or ceased participation within 6 months of their start date. Table 2 shows the age group, sex, and disease group according to the risk of opting in and remaining in the DM program for at least 6 months.

Multivariable logistic regression model

The multivariable logistic regression model results for Model 2A are presented in Table 3. The results are expressed as an OR; from these the size of the contribution of that risk factor can be identified, controlling for other covariates in the model. Most covariates were significant with the exception of disease variables and sex. Table 3 also shows the reference group for each covariate where there was more than 1 group.

Findings suggest that people younger than 50 years of age were 40% less likely to remain in the program for 6 months compared to those aged 60–69 years. People aged between 50–59 years were 23% less likely, and people older than 80 years of age were 27% less likely to remain in the program for at least 6 months compared to people aged 60–69 years. We can conclude that patients aged 60 to 79 years old are more likely to remain in the program compared to other age groups.

Results for the time between the related hospital admission and the offer date were all significantly different compared to the baseline group of 2–3 years, with the exception of > 3 years. The results suggest that the best time to offer a DM program is within 3–6 months of a related hospital admission. However, even if the individual is offered the program between 6 and 12 months after the admission they still will be at least 33% more likely to participate and remain in the program compared to the baseline group. After 1 year, the relative likelihood increase falls to 20%.

Results for the time between the program offer and the actual commencement date were all statistically significant. If the time between the offer date and the commencement date is very short (< 30 days) or very long (more than 6 months), then people were less likely to remain in the program for

Table 1. Case Numbers and Varying Definitions of "Related Hospital Admission" for Each Model

Model	*Definition*	*Case numbers*	χ^2 *(6df)*	P *value*
Model 1A	Primary diagnosis is the same as the DM program diagnosis offered to the member for any admission (overnight or same day)	7928	25.5	< 0.001
Model 1B	Primary diagnosis is the same as the DM program diagnosis offered to the member for overnight admission only	7856	22.7	0.001
Model 2A	Any diagnosis (primary or secondary) is the same as the DM program diagnosis offered to the member for any admission (overnight or same day)	8976	36.8	< 0.001
Model 2B	Any diagnosis (primary or secondary) is the same as the DM program diagnosis offered to the member for overnight admission only	8904	31.9	< 0.001
Model 3A	Any diagnosis (primary or secondary) is the same as any of the DM program diagnoses[1] for any admission (overnight or same day)	8984	25.2	< 0.001
Model 3B	Any diagnosis (primary or secondary) is the same as any of the DM program diagnoses[1] for any admission for overnight admission only	8933	26.6	< 0.001

[1]DM program diagnoses included all of coronary artery disease, congestive heart failure, chronic obstructive pulmonary disease.
DM, disease management.

Table 2. Risk of Opting in and Remaining in the Disease Management Programs for At Least 6 Months

Population characteristic	*Risk*	*95% CI*	
Age Group			
Age <50 yrs	20%	15.6%	23.6%
Age group 50–59 yrs	24%	21.5%	25.9%
Age group 60–69 yrs	28%	26.7%	30.2%
Age group 70–79 yrs	29%	27.4%	30.6%
Age 80+ yrs	20%	18.3%	22.3%
Sex			
Female	24%	22.8%	25.9%
Male	27%	25.7%	28.0%
DM Program			
CAD	28%	26.7%	28.8%
CHF	21%	18.5%	23.0%
COPD	20%	17.3%	22.7%

CAD, cornary artery disease; CHF, congestive heart failure; CI, confidence interval; COPD, chronic obstructive pulmonary disease; DM, disease management.

6 months. The results demonstrate that the optimal time between the offer and commencement dates is 2–6 months, with the optimum likely to be achieved if the person commences within 3–4 months of the program offer.

The lagged variable for total hospital length of stay in the 12 months prior to the offer of a DM program was statistically significant, but the OR was close to 1 (0.994). Assuming a linear relationship, the result can be interpreted as: for each increase in length of stay by 1 day in the previous 12 months, the individual is 1% less likely to remain in the program for 6 months. If this result is calculated as length of stay in months instead of days, the OR can be recalculated as 0.84 (calculated as exp[30*log(0.9905784)] = 0.842), meaning that for each increase in length of stay by 1 month within a 12-month period there is a 16% decreased likelihood of remaining in a DM program for at least 6 months.

The model can be used to predict a positive outcome of program participation using known values of population characteristics from the coefficients of the parameters generated from the model. Table 4 predicts the probability of DM program participation using hypothetical values of

Table 3. Odds Ratio, 95% CI, *P* Value and Coefficient for Predictive Model (Model 2A)

Predictor Variable	*Odds Ratio (OR)*	*95% Confidence Interval for OR*		P *value*	*Coefficient*
Age Group					
Age <50 yrs	0.60	0.45	0.78	<0.0001	−0.52
Age 50–59 yrs	0.77	0.66	0.90	0.001	−0.26
Age 60–69 yrs	Reference Group				
Age 70–79 yrs	1.11	0.98	1.25	0.087	0.10
Age 80+ yrs	0.73	0.63	0.86	<0.0001	−0.31
Sex					
Male	Reference Group				
Female	0.96	0.86	1.07	0.456	−0.04
Disease Group					
CAD	Reference Group				
CHF	1.00	0.84	1.19	0.973	−0.003
COPD	0.92	0.75	1.13	0.420	−0.08
Total hospital length of stay in 12 months using 3-month lag from offer date	0.99	0.99	1.00	0.000	−0.005
Time from related hospital admission to program offer (days)					
<90 days (<3 months)	1.31	1.00	1.71	0.048	0.27
90–179 days (3–6 months)	1.71	1.33	2.13	<0.0001	0.53
180–364 days (6–12 months)	1.33	1.14	1.54	<0.0001	0.28
365–544 days (12–18 months)	1.20	1.03	1.40	0.019	0.19
545–729 days (18 months–2 yrs)	1.20	1.05	1.38	0.007	0.19
730–1094 days (2–3 yrs)	Reference Group				
>1095 days (>3 yrs)	0.88	0.73	1.06	0.188	−0.13
Time from program offer to commencement date (days)					
<30 days (1 month)	0.66	0.57	0.76	<0.0001	−0.41
30–59 days (1–2 months)	Reference Group				
60–89 days (2–3 months)	1.19	1.03	1.37	0.021	0.17
90–119 days (3–4 months)	1.75	1.44	2.12	<0.0001	0.56
120–179 days (4–6 months)	1.59	1.33	1.90	<0.0001	0.47
>180 days (>6 months)	0.49	0.39	0.63	<0.0001	−0.71
Constant				<0.0001	−1.01

CAD, cornary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

Table 4. Probability of Disease Management Program Participation Using Hypothetical Values of Population Characteristics and Other Model Parameters

Age	*Sex*	*Diagnosis*	*Length of stay over 12 months (days)*	*Time from related hospital admission to program offer*	*Time from program offer to commencement date*	*Probability of success*
70–79 yrs	M	CAD	6	3–6 months	3–4 months	54%
70–79 yrs	M	CAD	6	3–6 months	> 6 months	25%
70–79 yrs	M	CHF	6	3–6 months	3–4 months	54%
70–79 yrs	F	CAD	6	3–6 months	3–4 months	53%
70–79 yrs	F	CHF	30	3–6 months	3–4 months	50%
50–59 yrs	M	CAD	6	3–6 months	1–2 months	32%
50–59 yrs	F	CAD	6	3–6 months	1–2 months	31%
80 + yrs	F	CHF	6	3–6 months	1–2 months	30%
80 + yrs	F	CHF	6	12–18 months	1–2 months	23%
< 50 yrs	F	COPD	30	> 3 yrs	> 6 months	7%
< 50 yrs	F	COPD	6	> 3 yrs	> 6 months	7%
< 50 yrs	F	CAD	6	3–6 months	3–4 months	38%
< 50 yrs	M	CAD	6	3–6 months	3–4 months	39%

CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

model parameters. For example, in the best-case scenario, a male aged 70–79 years with CAD or CHF who is offered a DM program within 3–6 months of a related hospital admission and commences within 3–4 months of the program offer has a 54% probability of completing the program. However, if commencement of the program is delayed by at least 6 months, the probability of participation reduces to 25%. The worst-case scenario would give a female younger than 50 years of age with COPD who is offered a program more than 3 years after a related hospital admission and does not commence the program for at least 6 months only a 7% chance of opting in and completing the program.

Discussion

Insurers and funders can use the results presented in this model to predict which individuals with a chronic disease are likely to participate and remain in a telephone-based DM program for at least 6 months. The results demonstrate that people who are most likely to participate in DM programs can be identified by health insurers or funders using administrative data related to a hospital admission. Insurers can then offer a DM program within a defined time from the hospital admission to maximize participation.

The findings suggest an optimal time when people are most receptive to joining the program. A period of time that is either too close to or too distant from the relevant hospital admission reduces adoption. Insurers or funders can use this information to target individuals when they are most likely to be receptive to participating in a DM program. Likewise, once the offer has been made, there is an optimal time to commence the program. Insurers can then use this information to encourage participants to commence the program within an optimal time period from offer, or include incentives or penalties related to timing in contractual arrangements with third-party providers.

The finding that hospitalization prior to the offer is significant and supports results from other studies that also have reported that severity of illness and an event such as a heart attack are important predictors of participation in a DM program.[5,19] Severity of illness, however, is often difficult to determine from administrative data without supporting clinical information. Total length of stay in a preceding 12-month period may be a reasonable proxy for disease severity and is easily determined from administrative data.

The use of findings from large population-based probability models to determine which individuals are most likely to participate in DM programs has many advantages. Insurers or public funders with large enrolled populations can target people based on statistical probabilities from condition-based predictive models. The use of administrative data at a population level means that all individuals meeting the criteria can be offered the program; therefore, the decision to offer is consistent and transparent. This is in contrast to leaving the decision to individual clinicians where selection bias is a potential issue. Clinicians may choose patients who they believe will participate in and complete a program. It also avoids the influence of other barriers or financial incentives faced by individual providers.[21]

The cost of targeting individual patients can be reduced by using insurance data related to the hospital episode and a computer algorithm that incorporates the broadest possible evidence-based criteria. Funders can further realize economies of scale because they already have integrated information systems in place, and rely on health care providers to provide individual-level clinical and other administrative data as part of the billing process. In addition, with large enrolled populations, the funder can enter into contracts with specialist DM providers, thereby achieving some efficiency through a reduction in transaction costs.

This predictive model for participation in a telephone-based DM program has several limitations. First, the DM program participants were a privately insured population; it is likely that non-privately insured patients might have different characteristics and predictors. Second, data were limited to those available to private insurers, predominantly relating to hospital claims. Other data, such as demographic characteristics and socioeconomic status of patients, were not available. It is possible that demographic factors such as race,[22] income, household size, and education level might be important predictors. Likewise, psychosocial issues including dementia, behavioral health problems, and substance abuse may predict participation in a DM program, but are not available from administrative data. This is likely to limit the overall sensitivity of the model. Finally, the DM program offered to members was a telephone-based program; therefore, other factors that might have an impact on participation include willingness to talk on the telephone, capacity to communicate by telephone (eg, hearing impairment, language barriers), and living circumstances (eg, living alone, residential care).

The data were censored because the actual date of dropout was unknown, only whether the individual had undergone a 6-month assessment. In the RCT, as well as undertaking an intention to treat analysis, a *per protocol* evaluation was done based on those who had participated in the program for at least 6 months. The findings suggested a positive return on investment to the insurer for the telephone-based intervention.[7] Based on this, a binary outcome variable was used in the multivariate logistic regression model. However, whether 6-month participation is the "correct amount" is likely to depend on a range of factors, such as the design and intensity of the intervention. In conclusion, it is possible to predict which individuals are most likely to participate and remain in a telephone-based DM program using hospital admitted episode data collected by a health insurer or funder. The time between a related hospital admission and an offer to participate in a DM program is a significant predictor, but insurers also should be concerned that there is an optimal time period from offer to commencement. Better targeting of health fund members with chronic disease for DM programs is likely to reduce health insurance claims and hospitalizations. The efficiency of large-scale DM programs will be improved with the implementation of population-based criteria that are evidence-based, consistent, and transparent.

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Disclosure Statement

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