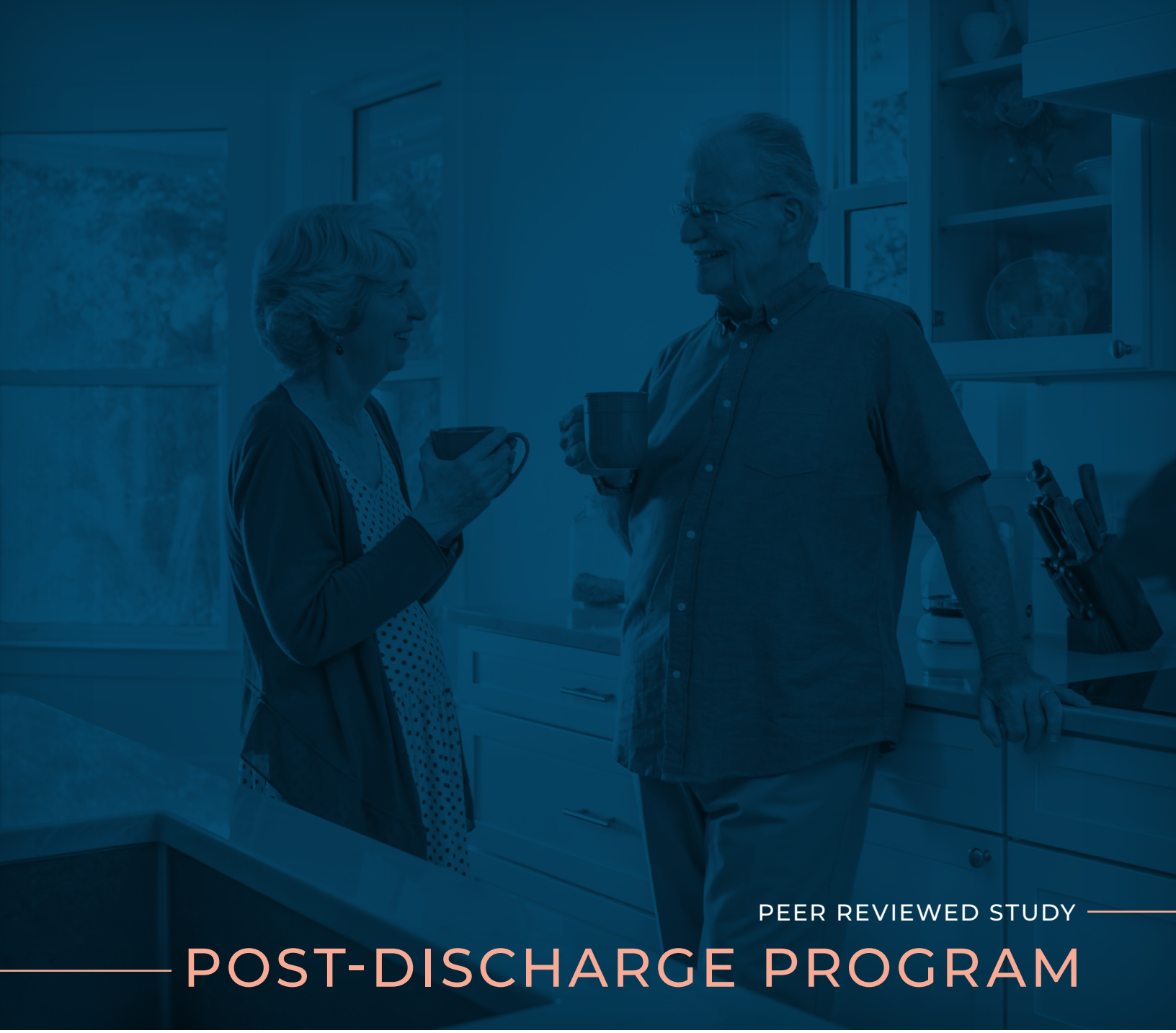

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ORIGINAL ARTICLE

Postdischarge Monitoring Using Interactive Voice Response System Reduces 30-Day Readmission Rates in a Case-managed Medicare Population

Jove Graham, PhD, Janet Tomcavage, RN, MSN, Doreen Salek, BS, RN, Joann Sciandra, BSN, CCM, Duane E. Davis, MD, and Walter F. Stewart, PhD, MPH

Background: Automated home monitoring systems have been used to coordinate care to improve patient outcomes and reduce rehospitalizations, but with little formal study of efficacy. The Geisinger Monitoring Program (GMP) interactive voice response protocol is a post-hospital discharge telemonitoring system used as an adjunct to existing case management in a primary care Medicare population to reduce emergency department visits and hospital readmissions.

Objectives: To determine if use of GMP reduced 30-day hospital readmission rates among case-managed patients.

Research Design: A pre-post parallel quasi-experimental study.

Methods: A total of 875 Medicare patients who were enrolled in the combined case-management and GMP program were compared with 2420 matched control patients who were only case managed. Claims data were used to document an acute care admission followed by a readmission within 30 days in the preintervention and postintervention periods (ie, before and during 2009). Regression modeling was used to estimate the within-patient effect of the intervention on readmission rates.

Results: The use of GMP with case management was associated with a 44% reduction in 30-day readmissions in the study cohort (95% confidence interval, 23%−60%, $P=0.0004$), when using the control group to control for secular trends. Similar estimates were obtained when using different propensity score adjustment methods or different approaches to handling dropout observations.

Conclusions: Investing in automated monitoring systems may reduce hospital readmission rates among primary care case-managed patients. Evidence from this quasi-experimental study demonstrates that the combination of telemonitoring and case management, as compared with case management alone, may significantly reduce readmissions in a Medicare Advantage population.

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The authors declare that they have no direct financial interests to disclose. Geisinger as a health system is a customer of, and has a financial interest in, AMC Health and may benefit if the company is successful in marketing its product(s) related to the research.

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Hospitalizations account for about one-third of the annual $2 trillion US cost of healthcare.[1,2] A total of 17.6% of all Medicare hospitalizations are due to 30-day readmissions at a cost of $15 billion.[3] Approximately 75% of re-hospitalizations are deemed to be avoidable or potentially preventable.[4] Notably, the 2010 Affordable Health Care Act directs CMS to track hospital readmission rates and implement payment penalties for targeted conditions.[5] We evaluated readmission rates for a case management model with and without support from an interactive voice response (IVR) protocol designed to facilitate the transition in care.

The 30-day readmission rate is recognized as a quality care indicator[6] as it reflects shortcomings in the current episodic, fragmented, and uncoordinated care model. Half of the Medicare fee-for-service patients who had a 30-day readmission did not visit an outpatient physician before the readmission.[7] Discharge planning is variable, and ineffective communication is thought to account for a significant share of readmissions. Communication gaps occur among providers (eg, medication prescriptions that are discontinued),[8] between the provider and patient (eg, lack of patient education on use of a treatment),[9] among providers in different healthcare settings (eg, receiving facility is not ready on the day of discharge), and, more generally, within a hospital or in transition between the hospital and community setting.[10]

A recent systematic review[11] indicates that in-hospital discharge planning for transition of patients to outpatient settings "probably brought about small reductions in length of hospital stay and readmissions." Other studies show significant reductions in 30-day readmission rates as well as cost savings associated with a variety of enhanced discharge processes, most of which used a combination of enhanced in-hospital communication, payment incentives, and multi-modal approaches to reducing readmissions.[12,13] At Geisinger, we evaluated whether a comprehensive case management model, when used with and without telemonitoring IVR support for care transitions, showed differences in 30-day readmissions rates.

METHODS

We provide an overview of the source population, the care processes, and finally the analytic methods used. The study was approved by the Geisinger Institutional Review Board.

Source Population

The Geisinger Health System (GHS) encompasses the Geisinger Health Plan (GHP) and Geisinger Clinic, among other healthcare entities. GHP serves 217,000 commercial and 52,000 Medicare Advantage members in central and northeastern Pennsylvania. GHP contracts with both the Geisinger Clinic and, separately, a network of non-GHS providers and 100 non-GHS hospitals. Geisinger Clinic, with nearly 200 primary care physicians in 38 community practice clinics and a total of 800 employed physicians, uses an electronic health record for all ambulatory and inpatient care.

For this study, we focused on the subpopulation of GHP MA members who had at least 1 hospital admission in 2009 and interacted with a nurse case manager. We compared 30-day readmission rates for members who did and did not use Geisinger's Monitoring Program (GMP), before and after the program was implemented.

Care Process Changes

Beginning in 2006, Geisinger Clinic implemented an advanced medical home model, known as ProvenHealth Navigator (PHN), in 2 clinics and later expanded it to 42 sites, including 5 non-Geisinger-owned clinics. The PHN model features GHP case managers embedded directly into ambulatory primary care sites to enhance coordination of care and interdisciplinary care management. This integrated team approach has been successful in managing high-risk patients for concerted follow-up and monitoring, especially during transitions of care, and has resulted in reductions in the overall hospital admission and readmission rates.[14,15] Case managers are generally Bachelor of Science in Nursing-trained and case management certified with at least 3 to 5 years of clinical experience. Turnover is low. Some experienced managers have been with the health system for over 10 years, providing training and mentoring to new staff.

Before 2009, GHP used an internally developed monitoring program as a tool for case managers to follow up patients after hospitalization. Patients were referred to this program by the case manager, and the program consisted of manual calls to the patient by Health Plan clerical staff incorporating a series of 8 or 9 questions depending on the patient's reason for hospitalization (eg, surgery vs. medical admission). Answers to questions that were flagged as a concern were elevated to nurse case managers for follow-up. The goal of this program was early identification of postdischarge complications and timely interventions to avoid emergency department visits and hospitalizations. Barriers to overall success, however, included the lack of scalability owing to the manual work required to support the program and notify nurses of patient issues. This program was discontinued.

Although other case management processes were unchanged, case managers were given access to a new tool in 2009, Geisinger Monitoring Program (GMP), a telemonitoring support system designed for postdischarge patients. GMP offered case managers a scalable solution for automated tracking of patient compliance to the program. IVR surveys were developed to support patients through the 30-day post-hospital transition period. Questions were asked about medication adherence and side effects, falls, pain, fever, gastrointestinal symptoms, shortness of breath, edema, neurological symptoms, psychosocial support, and incision site complications (for surgical patients). These calls did not replace or eliminate all contact from the case manager, as these nurses made the initial postdischarge contact and other follow-up contact as needed. The telemonitoring system, however, allowed the case manager to more easily prioritize patient contacts during each workday, increasing efficiency.

Patients were enrolled into the GMP program via the case manager, who made an initial outbound call to each patient within 24 to 48 hours of a hospital discharge. This initial call was made to all discharged patients receiving primary care from a medical home clinic site, regardless of diagnosis, and to all other patients after hospitalizations with diagnoses of heart failure, pneumonia, and/or chronic obstructive pulmonary disease. During this initial call, the case manager determined if each patient was clinically appropriate for the IVR program based primarily on case complexity, including a predictive modeling risk score and general readmission risk. The predictive modeling score, similar to the Hierarchical Condition Category risk score but calculated using externally developed software, factored in demographics, clinical condition, pharmaceutical use, and service location to calculate a risk level on a scale of 1 to 5 for each patient. A specific risk score was not required for GMP enrollment, as patients with lower risk scores could still be at risk for readmission and be appropriately managed with telemonitoring. Patients were excluded if they had severe hearing impairment, cognitive impairment, or were unable to receive planned phone calls. Regardless of whether or not the patient was enrolled in the GMP program, the nurse verified that the patient was aware of the medications they should take, ensured that a follow-up ambulatory care visit was scheduled with the patient's primary care provider and ensured that a patient-specific action plan was in place should problems arise. Patients with admissions for heart failure were managed through a separate telemonitoring program that included a weight monitoring component, and those patients were not considered in the present study.

Patients who enrolled in the GMP program received an IVR call once per week for 30 days for a total of 4 IVR calls. The IVR program, which cost approximately $25 per patient, did not replace all traditional contact but provided an additional service to extend the reach of the case manager to more patients in the postdischarge transitional period. Case managers could make additional calls or arrange to see the patient in the clinic, depending on need. In contrast to the earlier manual program that required clerical staff to spend approximately 30 minutes to fully complete a call, the IVR call took approximately 2 to 3 minutes to complete. The calls

had branching logic, which allowed questions to be tailored to the patient based on his/her current and previous responses. The IVR templates were designed to alert the case manager via the electronic health record system—in real time—of any areas that need further follow-up based on the patient's responses. Case management follow-up in response to an alert consisted of a review of the questions that prompted the alert, contact, and coordination with the primary care providers as indicated for follow-up appointments, and contact with the patient for medication management, care plan changes or reinforcement as necessary.

To support compliance or participation in the program, the IVR system was programmed to automatically retry calls at set intervals if there was no response to the scheduled call. A daily report for review by Case Managers profiled patients who did not answer the IVR call. Patients were discharged from the telemonitoring program after the fourth week. High risk patients with targeted conditions continued to stay in case management but did not receive continued IVR calls.

Statistical Analysis

We used a pre-post parallel quasi-experimental design to evaluate the impact of GMP on 30-day readmission rates. From an original population of 19,029 GHP members on the MA product, we assembled demographic information and medical claims data for paid services provided from January 1, 2007 through December 31, 2009 on 3772 members who had at least 1 hospital inpatient admission in 2009 and were case managed. Although the GMP program began in 2009, data from the prior 2 years were needed to establish baseline admission rates and calculate propensity scores for enrollment into GMP. From this population, we identified 1333 members who enrolled in the GMP program in 2009 and 2439 who never enrolled in GMP. Of the 1333 GMP enrollees, 888 had enrolled in GMP directly after their hospital discharge, whereas an additional 445 did not enroll until after a more complex transition from hospital to home (eg, via a skilled nursing facility). Because of concerns about identifying suitable controls for these 445 enrollees, we excluded them from analysis. Finally, 19 subjects from the control cohort and 13 subjects from the GMP cohort were excluded because they had no data (ie, were not enrolled in the GHP insurance plan) for the 12 months before their index admission. Therefore, a total of 3295 subjects (875 GMP, 2420 controls) were used in the final analysis. Figure 1 illustrates how patients were selected for the study and control cohorts.

Patients were not randomized. To adjust for potential selection bias by disease severity, we calculated a propensity score for GMP enrollment, based on the timeline illustrated in Figure 2. An index date was defined for each subject as either the date of his/her enrollment into the GMP program or the first case-managed hospital admission after January 1, 2009. The 12-month period before the index date was considered the baseline period. Each patient's sex, age, Hierarchical Condition Category risk score,[16] admissions, readmissions, mean and maximum medical costs per month, and history of chronic kidney disease, diabetes mellitus, and hypertension in those 12 months were used with a logistic regression model to calculate each subject's propensity score for enrollment into GMP.

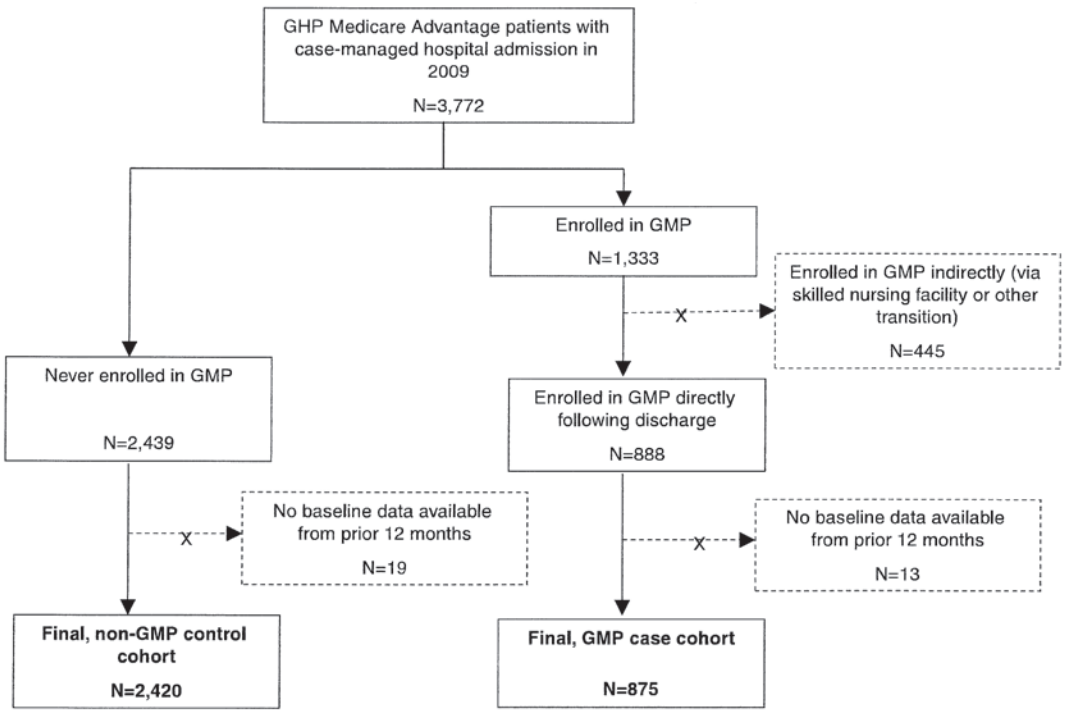

FIGURE 1. Diagram showing how patients were selected or excluded from study and control cohorts.

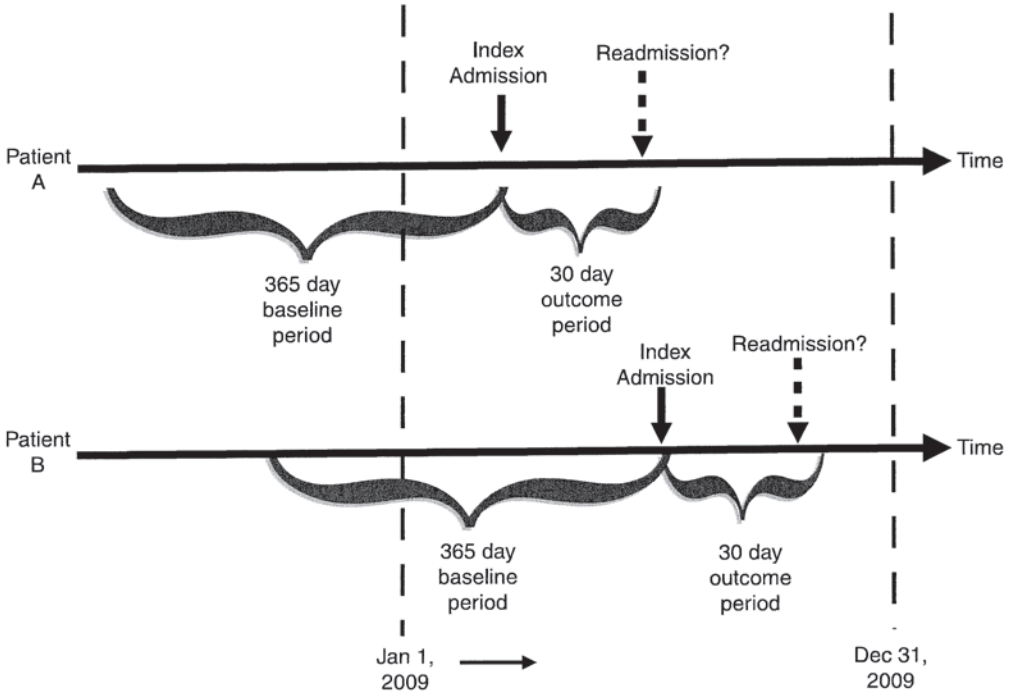

FIGURE 2. Diagram of key events and time periods for analysis of each subject. An index date was defined for each subject as their first case-managed admission in 2009. (For GMP subjects, this was also their first admission while enrolled in GMP.) Data from the 12 months before this index date were used to calculate propensity scores, and the 30 days after the index date were examined for hospital readmissions. Subjects could contribute multiple case-managed admissions in addition to their index admission.

For the analysis of 30-day readmission outcomes, each hospital admission for a given patient was the unit of analysis. Patients could contribute multiple admissions in addition to their index admission, before and after January 2009, but only if those admissions were case managed. Multivariate logistic regression was used to estimate the effect of GMP on the probability of a 30-day readmission after each admission. Models were adjusted for year and calendar month to capture yearly differences between the preintervention and postintervention periods as well as seasonal variation in admission rates. After the methods of Rosenbaum et al,[17] we estimated the within-patient GMP effect by stratifying subjects on propensity score quintiles and, in a separate model, by regression adjustment for propensity score as a continuous covariate.[18] Propensity score stratification and regression adjustment were 2 of the 3 propensity scoring methods proposed by Rosenbaum and Rubin.[18] We did not use propensity score matching in the current study because of the relatively small size of the control population from which to draw matches, and stratification is generally considered superior to regression because it does not require the assumption that the regression model has been correctly specified.[19] For the unadjusted and propensity-adjusted regression models, generalized estimating equation methods were used to cluster observations to account for repeated measures within subjects. All analyses used SAS statistical software (PROC GENMOD or PHREG, SAS 9.2, Cary, NC).

Because enrollment in the GMP program was not permanent but only lasted for 30 days, it was possible for a GMP patient to have additional admissions after they disenrolled from the GMP program. Our primary analysis reflected the actual GMP status at time of each admission. To address these "postdropout admissions," however, we also conducted 2 sensitivity analyses: intent-to-treat (treating postdropout admissions as if the patients were still enrolled in GMP), and by censoring any admissions that occurred after the patient disenrolled from GMP.

In all of the above models, GMP status was modeled after the approach of Berlin et al[20] as 2 components: (1) the percentage of admissions during which each patient was enrolled in GMP (ie, patient-exposure association) and (2) patient's current enrollment status (ie, a time-varying component). This 2-variable approach was used to further reduce confounding owing to patient selection and allow for estimates of the within-patient effect. The first variable is time invariant and thus cannot represent the effect of the intervention itself, but absorbs bias from nonrandom patient selection and nonuniform exposures. The second variable, in contrast, is time dependent and isolates the effect of the GMP program within an individual patient. The resulting odds ratios are estimates of the difference between readmission rates for active GMP participants versus their expected outcomes in the same 2009 time period if they had not been enrolled in GMP.

RESULTS

Table 1 shows how the demographics, utilization, and costs compare between the GMP and non-GMP cohorts in

TABLE 1. Comparison of Demographics and Utilization Between GMP and Propensity-matched Control Groups in the Baseline Period (ie, 12 mo Leading up to Index Admission)

Variable	GMP Patients (n = 875)	Control Patients (n = 2420)	*P* Before Propensity Adjustment	*P* After Propensity Adjustment*	Standardized Difference After Propensity Adjustment*
Male (%)	45.4	42.8	0.19	0.69	0.02
Age (mean, y)	75	78	< .001	0.07	0.06
HCC risk (mean)	1.35	1.75	< .001	0.97	< 0.01
% with chronic kidney disease	5	4	0.09	0.70	< 0.01
% with diabetes	11	15	< .001	0.78	0.03
% with hypertension	24	30	< .001	0.99	< 0.01
Admits per 1000 patient-months (mean)	44.1	46.7	0.76	0.89	0.03
Readmits per 1000 patient-months (mean)	14.0	13.4	0.90	0.91	0.02
Mean inpatient expenses per patient-month ($)	$338.93	$353.93	0.72	0.68	0.02
Mean total expenses (excluding prescriptions) per patient-month ($)	$1253.94	$1371.37	0.16	0.47	0.03

*P values >0.05 and standardized differences < 0.10 suggest adequate balancing of propensity scores.[25]

the 12 months leading up to their first hospital admission in 2009. The GMP group had a slightly lower mean risk score and lower prevalence of diabetes and hypertension, but a higher overall rate of readmissions in the baseline period than the control group. After adjusting for propensity score, the differences between cohorts in all of these variables were reduced to acceptable levels ($P > 0.05$, or standardized difference < 0.10). Although baseline information on admissions, readmissions, and costs are presented in Table 1, our study focused only on readmissions.

Of the 875 patients in the GMP cohort, only 34 (4%) failed to participate in the program for all 4 weeks. Four (0.5%) dropped out voluntarily; the others were disenrolled for other reasons (eg, hospitalization, transfer to nursing home, or goals met). The 3295 patients in the study had a total of 5766 case-managed hospital admissions from 2007 to 2009 and 1399 thirty-day readmissions for an overall readmission rate of 19.5%. Table 2 shows that patients in the GMP and control groups did not have significantly different readmission rates in 2007 (16.1% vs. 18.9%, $P = 0.43$) or 2008 (20.5% vs. 22.9%, $P = 0.38$), but they did differ significantly in 2009 (15.7 vs. 20%, $P < 0.0001$). More importantly, Table 2 shows the admissions and readmissions within the GMP cohort, before, during, and after active enrollment in GMP. Within the GMP cohort, admissions during GMP enrollment had a much lower readmission rate than admissions before or after GMP enrollment (10.1 vs. 27.1% and 18.8%, respectively, $P < 0.0001$).

Finally, Table 3 shows properly adjusted estimates of the within-patient effect of GMP enrollment on the probability of a hospital admission being followed by a readmission with 30 days. For the primary (ie, Per Protocol) analysis, unadjusted and propensity-score regression estimates were very similar (odds ratio 0.502 – 0.504, $P < 0.001$), whereas the propensity score stratified estimate was slightly more conservative (odds ratio 0.556,

TABLE 2. Unadjusted Numbers of Case-managed Admissions, Readmissions, and Readmission Rates (Readmission Per Admission) for GMP Versus Control Cohorts, by Calendar Year, and by GMP Active Status

	GMP Cohort (n = 875 Members)		Control Cohort (n = 2420 Members)		Comparison of GMP vs. Control		
	N, Admissions	N (%), Readmissions	N, Admissions	N (%), Readmissions	Absolute % Reduction in Readmissions	Relative % Reduction in Readmissions	*P*
By calendar year							
2007	155	25 (16.1)	657	124 (18.9)	−2.8%	−14.8%	0.43
2008	288	59 (20.5)	1171	268 (22.9)	−2.4%	−10.5%	0.38
2009	1329	209 (15.7)	3565	714 (20.0)	−4.3%	−21.5%	< 0.0001
Total	1772	293 (16.5)	5393	1106 (20.5)	−4.0%	−19.5%	< 0.0001
By GMP active status							
Pre-GMP	584	158 (27.1)	—	—	—	—	—
During GMP	1018	103 (10.1)*	—	—	—	—	—
Post- GMP	170	32 (18.8)	—	—	—	—	—

P values are based on simple χ^2 testing before propensity adjustment as is presented in Table 3.
*Represents a 15% absolute reduction, and a 60% relative reduction, in 30-day readmissions relative to the pre-GMP and post-GMP periods ($P < 0.0001$).

TABLE 3. Results of Logistic Regression Models Showing Within-patient Effect of GMP on the Odds of a Hospital Admission Being Followed by a Readmission Within 30 Days

Analysis Method	Odds Ratio	95% CI	*P*	Relative % Reduction in Odds of Readmission (95% CI)
Primary Analysis (Per Protocol)				
Unadjusted	0.502	(0.350, 0.720)	0.0008	50% (28-65%)
PS regression	0.504	(0.352, 0.723)	0.0002	50% (28-65%)
PS stratification	0.556	(0.401, 0.772)	0.0004	44% (23-60%)
Intent to treat analysis				
Unadjusted	0.596	(0.421, 0.843)	0.0035	40% (16-58%)
PS regression	0.596	(0.421, 0.844)	0.0035	40% (16-58%)
PS stratification	0.649	(0.483, 0.870)	0.0039	35% (13-52%)
Censoring dropout observations				
Unadjusted	0.438	(0.297, 0.647)	< 0.0001	56% (35-70%)
PS regression	0.441	(0.299, 0.650)	< 0.0001	56% (35-70%)
PS stratification	0.498	(0.351, 0.706)	< 0.0001	50% (29-65%)

In each row, GMP effect is expressed as odds ratios, that is, the odds of a readmission for a case-managed patient in GMP vs. a case-managed patient not in GMP. Column 1 indicates the different analysis methods and propensity-adjustment strategies used in each model. PS Regression used the propensity score as a continuous covariate, and PS Stratification estimated the effects of GMP within five quintiles based on propensity score and pooled these estimates into one overall GMP effect. Per protocol, intent-to-treat and censored analyses were performed to address 120 patients who had admissions after disenrollment from GMP: per protocol analysis reflected actual GMP status at time of each admission; intent-to-treat treated post-dropout admissions as if the patient were still enrolled in GMP; and censoring excluded all post-dropout observations.

$P = 0.0004$). This latter estimate corresponds to a 44% lower likelihood of readmissions for GMP patients than would be expected without the intervention (95% confidence interval, 23%–60%). For the intent-to-treat analysis (ie, treating postdropout admissions as if the patient were still enrolled in GMP), the estimates of GMP effect were slightly smaller (35% to 40% reductions in readmissions). When those postdropout admissions were censored, the estimates of GMP effect were slightly higher (50% to 56% reduction in readmissions). The comparison of results from these 3 sensitivity analyses suggest that patients who disenrolled from GMP did not permanently maintain the same level of reduced risk after leaving the program. However, all estimates were significant at the $P < 0.05$ level, and the consistency of results suggest that there was a robust, significant effect of the GMP program on 30-day readmissions.

DISCUSSION

These results demonstrate that, absent a change in the case management model, patients who were discharged from the hospital were approximately 44% less likely to have a 30-day readmission if they were case managed *and* participated in the GMP telemonitoring program than if they were case managed only. The robustness of these results was tested by applying a series of regression models using different propensity scoring methods and using different approaches to handling dropouts, none of which substantially changed the findings.

Our results differ from RCTs of remote monitoring systems (not necessarily automated systems) that have generated mixed and very limited evidence that these strategies reduce readmission, costs, length of stay, or quality of life. The methods employed in each of the studies included in the 2010 Cochrane review vary widely, making it difficult to generalize to any specific setting. There are no published RCTs specifically evaluating IVRs in a post-discharge setting, although observational studies have demonstrated feasibility and successful monitoring of potential adverse events. Recent RCT evidence indicates that telemonitoring did not improve outcomes for patients hospitalized for heart failure.[21] A telephone-based interactive voice response system was used to collect daily information about symptoms and weight that was reviewed by the patients' clinicians. The primary end point was readmission for any reason or death from any cause within 180 days after enrollment. This study employed a very similar, manually driven model that GHP was using before the GMP telemonitoring program. Patient dropout was a substantial concern in that study, as 14% of the participants who were randomly assigned to undergo telemonitoring never used the system and by the final week of the study period, only 55% of the patients were still using the system at least 3 times per week. The dropout rate from this study may suggest that there is an optimal balance among frequency of contact to evaluate patient status, patient burden, and patient engagement. As stated previously, only 34 of the 875 GMP patients included in our study (4%) failed to fully complete the 4 weeks of calls, and because these 34 patients were included in our analysis as GMP patients, we expect the potential for bias against the GMP program, not in favor of it. We believe that our automated GMP program effectively addressed issues of participation and compliance, a potentially important difference that may have reduced the risk of readmission.

Our results are more consistent with previous systematic reviews indicating that discharge and transition-related interventions can reduce readmissions. These findings are consistent for studies of CHF as well as studies that are not disease-specific. In these and other studies of apparently successful interventions, however, it is difficult to isolate which components of a discharge/transition-related intervention are responsible for reduction in readmissions. Parker et al[22] found evidence for a hierarchy of effect across heterogeneous interventions, with telephone-based interventions

appearing to be least effective, followed by home-based interventions. In contrast, those provided in the hospital or in the hospital and the home were most effective. The authors concluded that "doing something is better than nothing," and that interventions that span the hospital-community (ie, postdischarge) interface are more likely to favorably impact readmission. Mistiaen et al[23] reviewed different interventions and concluded that education reduced readmission and that interventions with both predischarge and postdischarge components are more likely to be successful. An implication of these findings is that no "gold-standard" intervention has emerged. In addition, no group has provided a system-level view of the value of home monitoring.

The conclusions of our study are tempered by several study limitations. First, the GMP intervention was introduced into a Medicare population with relatively little turnover, in an integrated health system that has long-standing use of an ambulatory electronic health record and where the provider and payer are part of the same corporate entity. In addition, the IVR technology was added on top of a very robust case management program that had already demonstrated impact on readmissions. The fact that our study specifically revealed what appears to be a substantial incremental benefit of the GMP program is significant. The fact that our study environment was already very accustomed to implementing novel case manager-based programs like GMP may have also contributed to the program's success and could therefore limit generalizability to other settings with less experience. Implementation experience, however, suggests that the key components of the program could be implemented outside of an integrated delivery model.

Although every effort was made to account for secular trends and confounding factors, including selection bias, our study is observational in nature and the usual caveats with regard to causal inference apply. Most importantly, we acknowledge that the role of the highly experienced case manager in selecting appropriate patients for the IVR intervention could be an important confounding factor. However, we have attempted to mitigate this concern through both the study design and analytic methods. The study design had several strengths, including our ability to analyze hospital readmissions for an entire population, all of whom received the same case management, before and after a subset of this population received the intervention. This design feature, together with the propensity scoring adjustment approach we have taken here, allows for relatively robust causal inference while minimizing the potential confounding from selection bias, regression to the mean and survivorship biases.[24] Finally, we acknowledge that, although our findings were statistically significant, the confidence interval around the estimated effect of GMP (23%−60%) was wide compared with other published results. Future work with larger populations or longer follow-up times should increase the precision of the estimated effects reported here.

In conclusion, the use of telemonitoring to monitor patients post-hospitalization can be implemented and used within a case management model outside of an integrated system as well as implemented within a hospital system with a defined staff dedicated to the safe and effective transition of their discharged patient population. At the core, a robust program of clinical staff dedicated to the follow-up of patients transitioning to the next site of care and the ability to intervene efficiently on identified patient issues in a timely manner is needed. Although the ability to implement this was expedited and enhanced within Geisinger's medical home model, the core components of trained clinical staff, effective communication tools and commercial telemonitoring systems such as AMC Health (New York, NY) can be implemented outside of Geisinger in innovative and creative provider models.

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