HHS Public Access

Author manuscript

Int J Med Inform. Author manuscript; available in PMC 2021 November 01.

Published in final edited form as:

Int J Med Inform. 2020 November ; 143: 104267. doi:10.1016/j.ijmedinf.2020.104267.

The Effect of Remote Patient Monitoring on the Primary Care Clinic Visit Frequency among Adults with Type 2 Diabetes

Morgan Hampton Randall, MD[1], **Zachary Merle Haulsee, MD**[1], **Jingwen Zhang, MS**[1,2], **Justin Marsden, MS**[1,2], **MS William Patrick Moran, MD MS**[1], **Elizabeth Barnhardt Kirkland, MD MSCR**[1]

[1]Division of General Internal Medicine, Department of Medicine, Medical University of South Carolina, Charleston, SC, USA

[2]Section of Health Systems Research and Policy, Department of Medicine, Medical University of South Carolina, Charleston, SC, USA

Abstract

Aims: Healthcare organizations are increasingly using technology to assist in diabetes management based on telemedicine's proven ability to improve glycemic regulation, decrease cost, and overcome barriers to effective healthcare. Nevertheless, it remains unclear how telemedicine intersects with primary care. We aim to measure the impact of a remote monitoring program for diabetes on primary care delivery through analysis of primary care office visit frequency.

Methods: Patients eligible to participate in our institution's remote diabetes monitoring program were identified and classified as enrolled or not enrolled (i.e. "usual care"). The number of scheduled and completed primary care office visits in the 12 months prior to and after the index date were measured for both groups. The index date was the enrollment date or, for the patients who received usual care, the next available enrollment session after eligibility screen. Two-sample t-tests were used to examine the change in frequency of office visits prior to and after enrollment for participants, as well as the difference in visit frequency between enrolled patients versus patients receiving usual care.

Results: There was no statistical difference in the number of scheduled or completed primary care clinic visits before or after enrollment in telehealth. Furthermore, there was no difference in the number of scheduled or completed primary care visits between patients enrolled in telehealth versus those receiving usual care.

Conclusion: Participation in telehealth has been shown to be associated with significant HbA1c reductions in prior work, yet our data suggest that remote monitoring is not associated with a change in primary care office visit frequency. This suggests that telehealth may improve diabetes management independently of primary care visits.

Correspondence to: Elizabeth B. Kirkland, MD MSCR, Department of Medicine, Medical University of South Carolina, 135 Rutledge Ave, MSC 591, Charleston, SC 29425, kirklane@musc.edu, Phone: 843-792-5386, Fax: 843-792-7285.

Keywords

Telehealth; Telemedicine; Remote Patient Monitoring; Diabetes; Primary Care

I. Introduction:

Diabetes mellitus is estimated to affect around 30 million people in the United States and was the seventh leading cause of death nationally in 2015, amassing an estimated $245 billion dollars in total direct and indirect costs annually[1].

Telemedicine has emerged as a tool to improve glycemic management especially in type 2 diabetes. Evidence supports the implementation of technology, especially remote patient monitoring (RPM), to lower Hemoglobin A1c (HbA1c) compared to usual care[2, 3]. RPM has the potential to overcome barriers to effective health care delivery particularly in rural, underserved, and minority communities that are disproportionately affected by diabetes[4]. It is because of these positive effects that organizations are increasingly advocating for and using technology to assist in disease management[5].

In addition to clinical benefit in the form of HbA1c reduction, telemedicine has proven to be cost-effective[6, 7]. The reductions in cost are primarily due to decreased frequency of hospital admissions and shorter hospital stays for those participating in telehealth compared to controls. Data also suggest that improved preventative care can reduce complications, and by extension, downstream cost related to diabetes that is not optimally managed[8].

Although clinical outcomes data exist, it remains unclear how telemedicine intersects with primary care. Wasson et al suggested in 1992 that telephone care can serve as a replacement for in-person visits[9]; however, consistent confirmation of those findings among patients with diabetes managed with RPM is lacking. Further, electronic portal and telephone use alone has not been associated with changes in primary care office visit frequency[10,11].

In 2016, the Technology Assisted Case Management 2 (TACM2) program was established at the Medical University of South Carolina with the goal of improving chronic disease management for a diverse patient population, spanning across the state. The TACM2 program is an implementation program based on the success of the pilot study, TACM-DM, which demonstrated significant reductions in HbA1c and blood pressure at 6 months through the use of remote glucose and blood pressure monitoring with nurse case management oversight among patients randomized to the TACM intervention compared to controls[12]. The TACM2 program aims to improve health outcomes for low-income and rural patients in the state of South Carolina using this proven technology. At the time of this current study, nearly 100 patients were enrolled in the TACM2 program at our local clinic, with additional patients enrolled at partnering free clinics and community health centers across the state. In this setting of an ongoing successful telemedicine program, we examined the relationship between TACM2 participation and the frequency of primary care clinic visits.

Specifically, our objectives were 1) to compare the frequency of primary care clinic visits before and after enrollment among patients who participated in RPM and 2) to compare the

frequency of primary care clinic visits between those patients enrolled in TACM2 versus those who were eligible but not enrolled. Based on prior work[9] to suggest that telephonic care can substitute for in-person visits, we hypothesized that enrollment would be associated with fewer primary care visits post-enrollment compared to pre-enrollment and when compared to similar patients who received usual care.

II. Methods:

In accordance with the goals of our institution, we implemented the TACM2 program in our academic, primary care internal medicine clinic in 2017. This quality improvement program was configured to allow longitudinal prospective monitoring of a primary care population with type 2 diabetes through RPM. Eligibility criteria for enrollment include age ≥ 18 years and baseline HbA1c ≥ 8%. Exclusion criteria are a body mass index > 45 due to blood pressure cuff size, cognitive inability to check blood sugar (exception could be made if caregiver is willing and able to manage testing and medication administration), schizophrenia or other limiting mental disease, diabetes or hypertension medications managed by provider outside of our primary care clinic, or other medical condition which makes glucose and/or blood pressure lowering contraindicated.

Once patients were deemed eligible, they were offered enrollment into the TACM2 program. Eligible patients who did not participate received standard of care treatment in the primary care clinic. Those who participated first completed an informed consent. This group was then provided a FORA D40G 2-in-1 automated glucose meter and sphygmomanometer. Patients were instructed on device use and given testing supplies sufficient for 12 months of data collection. The devices are equipped with a SIM card that directly transmits data via 3G cellular connectivity to a secure web-based server maintained by ForaCare®. At enrollment, program nurses instruct patients to check glucose and blood pressure readings at least once a day. The nurses involved in this study were Registered Nurses (RNs), but not Certified Diabetes Care and Education Specialists (CDCEs). The secure server, which serves as a repository for patient data, was queried by resident physicians and program nurses regularly to evaluate for out-of-threshold measurements. Based on transmitted values, medication titration would occur exclusively through resident physicians under the supervision of a faculty physician up to every two weeks for any individual patient. All remote communication with patients was performed by the treating physicians via telephone. These phone calls commonly addressed assessment of factors that may affect recent monitoring habits or glucose values, concerns with medications, and instructions on any recommended medication titration. Program participants were asked to submit blood samples for HbA1c measurements at baseline, 6, and 12 months for comparison purposes, but there was no recommendation to alter usual clinic follow up based on participation.

In order to quantify the number of primary care office visits in relation to program participation, we first generated a list of TACM2-eligible patients using the screening database. Eligible patients were then classified as either enrolled or not enrolled (“usual care”). Each patient had a unique institutional medical record number which was then used to query the electronic health record. This search identified the number of scheduled and completed primary care provider (PCP) visits in the 12 months prior to and after the index

date. The index date was the enrollment session for participating patients. For those patients who had been deemed eligible but were not enrolled, the index date was designated as the next available enrollment session after identification.

The relationship between scheduled and completed PCP visits prior to and after enrollment was compared using a two-sample t-test. This analytic method was also used to examine the relationship between those patients enrolled in TACM2 versus eligible patients receiving usual care. Statistical analyses were performed using SAS version 9.4 and significance was determined at the 5% level. This work was deemed quality improvement, and thus the Internal Review Board advised that approval for human research was not required.

III. Results:

A total of 199 patients were identified as both eligible for enrollment and having at least 1 year of scheduling data before and after the index date. Of these patients, 91 had enrolled in TACM2, while 108 had not enrolled and therefore received usual care. There were no significant differences in patient demographics between the two groups at the index date (Table 1). Both groups had similarly high number of medical comorbidities with Charlson Comorbidity Index (CCI) scores of over five[13].

There was no significant difference in the average number of scheduled visits for enrolled patients in the 12 months prior to enrollment (8.5 ± 5.0) compared to the 12 months after enrollment (9.4 ± 4.7; p = 0.2168; Table 2). When comparing the number of completed visits in the 12 months prior to and after enrollment, the difference was, again, not statistically different (5.1 ± 3.2 and 5.0 ± 3.0, respectively; p = 0.7917).

The number of scheduled visits after the index date in patients enrolled in TACM2 was 9.4 ± 4.7 while those receiving usual care had 9.4 ± 5.9 visits in the 12 months after the index date (p=0.904). When comparing the number of completed PCP visits, there again was no difference with the enrolled patients having 5.0 ± 3.0 visits compared to the usual care group with 4.9 ± 4.0 (p=0.9310; Table 3).

IV. Discussion:

We hypothesized that the number of PCP visits would decrease after enrollment in telehealth and that patients enrolled in telehealth would have fewer PCP visits than those patients receiving usual care. Based on the data and analyses presented here, we fail to reject the null hypothesis of no difference. It is striking that in the setting of a successful telemedicine program, there is no difference in the frequency of primary care clinic visits. Our findings are consistent with a recent large database study which demonstrates that, over 4 quarters, in-person visit rates are no different for users and nonusers of virtual visits[14]. Our findings are further supported by existing literature which suggests that telemedicine may not reduce healthcare utilization in the short-term[10,11].

There are likely multiple reasons for the observed lack of difference in office visit frequency between and among groups. Patients were deemed eligible for enrollment by having diabetes that was not adequately managed (defined as HbA1c ≥ 8%) and on average had an

enrollment HbA1c upwards of 10%. Enrolled and usual care patients had a similarly high burden of medical comorbidities, as documented in Table 1, with no significant difference in the CCI among the two groups, but a markedly high CCI for both. We hypothesize that, while there was no observed difference in visit frequency, the content of the visits may have shifted to focus on other medical comorbidities. For example, improved management of diabetes and hypertension may allow the clinic provider to address heart failure in a more comprehensive manner.

Another possible explanation for our findings is that additional office visits may be scheduled that otherwise would not have occurred, balancing out any avoided visits. To illustrate, if remotely obtained values are identified to be out of range, a provider may encourage sooner or additional follow up visits. As further discussed below, the ability to confirm the rationale for appointment changes is logistically impractical in this retrospective study, representing and a limitation of this study.

A third potential explanation is that obtaining HbA1c values every 3 months is routine[16]. The average number of completed visits in all groups after the index date is only slightly more frequent than the expected 4 per year. Regular visits for disease monitoring are considered usual care and those patients enrolled in our telemedicine program received usual care in addition to being monitored remotely. Furthermore, the TACM2 program aims are focused on quality, accessibility, and expedience of care. There is no specific directive or goal to decrease in-office encounters.

A major limitation of this study is that we do not report or rigorously evaluate the primary diagnosis at each clinic visit due to inherent limitations of EHR data. Tracking of this information could confirm whether the focus of each visit was shifted to other disease states for patients engaged in TACM2 or whether remote data prompted additional visits. Ideally, one could measure the number of visits attributable to diabetes or hypertension and compare this with visits for other reasons; however, assessment of visit reason is challenged by inaccuracy of diagnosis coding in electronic medical record data and by conflicting data. For example, a patient may be called to schedule a visit based on remotely monitored hypoglycemia. Upon physical presentation, that patient may state a chief complaint of back pain, leading to a primary visit diagnosis of back pain rather than hypoglycemia. These inconsistencies in data entry fields threaten our confidence, particularly in utilizing this data to draw conclusions. Nevertheless, irrespective of primary diagnoses at each visit, our data show that the frequency of PCP office contact was unaffected.

While office visit frequency is not decreased among remote monitoring users, the benefits of remote monitoring and other forms of telemedicine may be seen in longer-term outcomes including the avoidance of downstream effects of sub-optimally controlled chronic medical conditions. For example, studies have shown reduced hospitalizations and mortality among heart failure patients receiving telemedicine services[,15]. The risk of telemedicine engagement is also minimal, rendering telemedicine a generally safe treatment option even if short-term benefit is not seen. These data, in conjunction with the data in our study, make a compelling case that benefits of an RPM program should be measured through long-term

outcomes such as sustained clinical benefit, improved mortality and avoidance of adverse outcomes of diabetes.

Overall, our findings suggest that RPM programs focused on outcomes may improve disease management independently of in-office visits. With increasing numbers of enrollees and expanding data, we hope to continue evaluating the relationship between telemedicine and PCP visits. Analysis of HbA1c outcomes is also underway. Longer follow up times as well as a larger sample size in our own clinic will further solidify our findings. Additionally, we plan to analyze visit frequency in non-academic, community health centers to augment external validity. Future work should also include cost-analysis, as proving financial benefit without changes in PCP visits would further support the conclusion that telemedicine is a supplement to primary care. Should this result occur, the synergistic relationship between primary care and telehealth would have health policy implications.

Telemedicine is a powerful and evolving tool that has a proven ability to improve outcomes for individuals with diabetes and overcome barriers to care. Our data provides evidence that primary care should use telemedicine as a tool to enhance the care delivered to patients.

ACKNOWLEDGEMENTS:

We thank Bill Barry for his dedication and time in patient outreach and care coordination. We thank Caroline Wallinger RN and Dawn Dericke RN for their management of the program and enrollment of patients. We thank the South Carolina Telehealth Alliance for support of the ongoing diabetes initiative, TACM2.

FUNDING SUPPORT

This publication was supported, in part, by the National Center for Advancing Translational Sciences of the National Institutes of Health under Grant Number UL1 TR001450 and by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (HHS) as part of the National Telehealth Center of Excellence Award (U66 RH31458). The content is solely the responsibility of the authors and does not necessarily represent the official views nor an endorsement, by NIH, HRSA, HHS or the U.S. Government.

References

1. CDC. National Diabetes Statistics Report, 2017. In: Centers for Disease Control and Prevention, ed. Atlanta, GA 2017.
2. Tchero H, Kangambega P, Briatte C, Brunet-Houdard S, Retali GR, Rusch E. Clinical Effectiveness of Telemedicine in Diabetes Mellitus: A Meta-Analysis of 42 Randomized Controlled Trials. Telemed J E Health. 2019; 25(7):569–583. [PubMed: 30124394]
3. So CF, Chung JW. Telehealth for diabetes self-management in primary healthcare: A systematic review and meta-analysis. J Telemed Telecare. 2018;24:356–364. [PubMed: 28463033]
4. CDC. Addressing Health Disparities in Diabetes. In: Services UDoHaH, ed. Atlanta, GA 2018.
5. Duffy S, Lee TH. In-Person Health Care as Option B. N Engl J Med. 2018;378:104–106. [PubMed: 29320653]
6. Warren R, Carlisle K, Mihala G, et al. Effects of telemonitoring on glycaemic control and healthcare costs in type 2 diabetes: A randomised controlled trial. J Telemed Telecare. 2018;24:586–595. [PubMed: 28814128]
7. Lee JY, Lee SWH. Telemedicine Cost-Effectiveness for Diabetes Management: A Systematic Review. Diabetes Technol Ther. 2018;20:492–500. [PubMed: 29812965]
8. Fritzen K, Basinska K, Rubio-Almanza M, et al. Pan-European Economic Analysis to Identify Cost Savings for the Health Care Systems as a Result of Integrating Glucose Monitoring Based Telemedical Approaches Into Diabetes Management. J Diabetes Sci Technol. 2019:1932296819835172.

9. Wasson J, Gaudette C, Whaley F, et al. Telephone care as a substitute for routine clinic follow-up. JAMA. 1992;267:1788–1793. [PubMed: 1545464]

10. Bergmo TS, Kummervold PE, Gammon D, Dahl LB. Electronic patient-provider communication: will it offset office visits and telephone consultations in primary care?. Int J Med Inform. 2005;74(9):705–710. doi:10.1016/j.ijmedinf.2005.06.002 [PubMed: 16095961]

11. North F, Crane SJ, Chaudhry R, et al. Impact of patient portal secure messages and electronic visits on adult primary care office visits. Telemed J E Health. 2014;20(3):192–198. doi:10.1089/tmj.2013.0097 [PubMed: 24350803]

12. Egede LE, Williams JS, Voronca DC, et al. Randomized Controlled Trial of Technology-Assisted Case Management in Low Income Adults with Type 2 Diabetes. Diabetes Technol Ther. 2017;19:476–482. [PubMed: 28581821]

13. Charlson ME, Pompei KL, Ales KL, et al.: A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chron Dis 1987;40:373–383. [PubMed: 3558716]

14. Shah SJ, Schwamm LH, Cohen AB, et al. Virtual Visits Partially Replaced In- Person Visits In An ACO-Based Medical Specialty Practice. Health Aff (Millwood). 2018;37:2045–2051. [PubMed: 30633681]

15. Hanlon P, Daines L, Campbell C, McKinstry B, Weller D, Pinnock H. Telehealth Interventions to Support Self-Management of Long-Term Conditions: A Systematic Metareview of Diabetes, Heart Failure, Asthma, Chronic Obstructive Pulmonary Disease, and Cancer. J Med Internet Res. 2017;19(5):e172 Published 2017 5 17. doi:10.2196/jmir.6688 [PubMed: 28526671]

16. Centers for Medicare and Medicaid Services. National Coverage Determination (NCD) for Glycated Hemoglobin/Glycated Protein (190.21).

Summary table:

What was already known	What this study has added
•Electronic portal use and telephone communication does not appear to affect primary care visit frequency.	•Remote monitoring of diabetes is not associated with change in office visit frequency.
•Remote monitoring has been associated with improved disease management metrics but its impact on office visit frequency is unknown.	•Telemedicine may supplement rather than replace in-person primary care.

Table 1.

Sample characteristics

Variable	Enrolled (n= 91)	Usual Care (n=108)	p-value
Age (years)	59.1 +/− 11.9	58.5 +/− 14.0	0.7689
Sex			0.5800
Male	36 (33.3%)	27 (29.7%)	
Female	72 (66.7%)	64 (70.3%)	
Race			0.3845
White	15 (13.9%)	9 (9.9%)	
Black	93 (86.1%)	80 (87.9%)	
Other	0 (0.0%)	2 (2.2%)	
BMI (kg/m^2)	32.9 +/− 8.1	32.2 +/− 6.6	0.5097
BMI>30	68 (63.0%)	59 (64.8%)	0.7842
Baseline A1c	10.3 +/− 2.1	10.5 +/− 2.1	0.4463
Charlson Comorbidity Index (Mean +/− STD)	5.1 +/− 3.0	5.5 +/− 2.9	0.3820
Comorbidities			
Myocardial infarction	4 (4.4%)	7 (6.5%)	0.5212
Congestive heart failure	14 (15.4%)	31 (28.7%)	0.0253
Peripheral vascular disease	16 (17.6%)	26 (24.1%)	0.2636
Cerebrovascular disease	18 (19.8%)	22 (20.4%)	0.9176
Chronic pulmonary disease	46 (50.6%)	48 (44.4%)	0.3901
Rheumatoid arthritis	12 (13.2%)	8 (7.4%)	0.1767
Peptic ulcer disease	4 (4.4%)	2 (1.9%)	0.4152
Diabetes[^]	90 (98.9%)	107 (99.1%)	1.0000
Hemiplegia	2 (2.2%)	6 (5.6%)	0.2937
Renal disease	31 (34.1%)	56 (51.9%)	0.0117
Cancer	17 (18.7%)	28 (25.9%)	0.2236
AIDS/HIV	7 (7.7%)	6 (5.6%)	0.5434
Liver disease	11 (12.1%)	12 (11.1%)	0.8300

[^]Inclusion criteria for enrollment was based on HbA1c value, rather than diagnosis code.

Table 2.

Number of PCP visits for enrolled patients before and after enrollment

TACM2 participants	# scheduled visits	# completed visits
12 months prior to enrollment	8.5 ± 5.0	5.1 ± 3.2
12 months after enrollment	9.4 ± 4.7	5.0 ± 3.0
p-value	0.2168	0.7917

Table 3.

Number of PCP visits during the 12 months after index date for enrolled and usual care patients

	# scheduled visits	# completed visits
Enrolled	9.4 ± 4.7	5.0 ± 3.0
Usual Care	9.4 ± 5.9	4.9 ± 4.0
p-value	0.9404	0.9310