*MEDINFO 2023 — The Future Is Accessible*
*J. Bichel-Findlay et al. (Eds.)*


*doi:10.3233/SHTI231017*

# Post-Implementation Outcomes of a Remote Patient Monitoring Program After Emergency Department Discharge

Eric W. MAURER[a], Terrence ADAM[a], Lynn E. EBERLY[a], Ahmed ALSHARIT[b], Stephanie BILLECKE[b], Tucker ANNIS[b], Sameer BADLANI[b], Susan PLEASANTS[b] and Genevieve B. MELTON[a,b,1]
[a] *University of Minnesota, Minneapolis, USA*
[b] *Fairview Health Services, Minneapolis, USA*
ORCiD ID: Eric W. Maurer https://orcid.org/0000-0002-5337-1433, Terrence Adam https://orcid.org/0000-0002-8666-2587, Lynn E. Eberly https://orcid.org/0000-0003-4763-330X, Genevieve B. Melton https://orcid.org/0000-0001-5193-1663

**Abstract.** To better communicate and improve post-visit outcomes, a remote patient monitoring (RPM) program was implemented for patients discharged from emergency departments (ED) across 10 hospitals. The solution was offered to patients at the time of ED discharge and staffed by a group of care coordinators to respond to questions/urgent needs. Of 107,477 consecutive patients offered RPM, 28,425 patients (26.4%) engaged with the program. Activated patients with RPM were less likely to return to the ED within 90 days of their index visit [19.8% compared to 23.6%, p<.001]. While activation rates were modest, we observed fewer return visits to the ED in patients using RPM, with a 16.2% lower hazard of returning in the next year. Future research is needed to understand methods to improve RPM activation, any causal effects of RPM activation on return ED visits, and external validation of these findings.

**Keywords.** Remote patient monitoring, telehealth, emergency department

## 1. Introduction

Return visits to the emergency department (ED) are a well-described, persistent challenge with significant financial and care implications for patients, health systems, and payers [1,2]. Approximately 20% of patients return to the ED within 30 days, of which a number of these visits are preventable [3,4]. Major drivers for patients returning to the ED include fear and anxiety about their health condition, along with perceived convenience and expedited evaluation with EDs [5]. Results investigating the correlation of return ED visits to quality of ED (or hospital) care are mixed; however, ED return visit rate has been proposed as a quality of metric by payers [6]. As such, some health systems have implemented screening tools and predictive models, nurse or paramedic delivered care transition programs, telephone-based compliance programs, and patient education interventions aimed to reduce return ED visits [7-9].

[1] Corresponding author: Genevieve B. Melton, MD, PhD, Mayo Mail Code 450, 420 Delaware Street SE, Minneapolis, MN 55455, USA; email: gmelton@umn.edu.

Remote patient monitoring (RPM) has traditionally been used for chronic disease management in patient populations or for post-surgical care. Our health system previously reported our initial experience deploying a customizable RPM technology to manage patients with COVID-19 symptoms during the initial outbreak in Minnesota [10]. Globally, other health systems reported similar findings, in terms of patient experience and engagement, with implementation of RPM programs during the COVID-19 pandemic [11,12]. As our health system gained experience with use of RPM and is experiencing high rates of ED use, the RPM program and technology was customized and deployed to ED patients discharged to home system-wide. This manuscript provides an analysis of this RPM implementation, patients' subsequent use of healthcare and associated RPM program patient engagement.

## 2. Methods

This study took place at M Health Fairview (MHF) is an academic integrated health system with 10 hospitals having adult emergency departments based in greater Minnesota and western Wisconsin, United States. The ED discharge RPM technology solution (GetWell Loop; GetWellNetwork, Bethesda, MD, USA) was offered to patients as part of their discharge process with information included in the after-visit summary for enrollment. Patients needed either a mobile phone number or email listed in the electronic health record to receive the initial RPM registration message. Patients were excluded if they were already enrolled in a specialty RPM program (e.g., COVID-19 discharge from ED) or if they were enrolled in another transition program (e.g., nursing delivered telephone follow-up care for patients with Medicaid or behavioral health initiatives). During this study, the RPM program was only available in English, so patients who required an interpreter were also excluded. Healthcare utilization was measured as the counts of all office and telephone encounters for 90 days after the index ED visit extracted from the electronic health record (EHR).

Patients received an email or text message with instructions on how to activate the RPM program and asked to verify date of birth, create a log-in, and set user preference (mobile phone or email) for receiving messages for five days. The RPM messages (Table 1) contained three types of content: 1) check-in messages (either confirmations or surveys), 2) reminders, and 3) a checklist to confirm that any medications were picked up.

**Table 1.** Remote Patient Monitoring Program Components.

| Component Type | Schedule Start | Schedule Interval | Schedule Duration | Message Examples |
|---|---|---|---|---|
| Check-In Confirmation Surveys | Day 1<br>Day 5 | Daily<br>Daily | 5 days<br>Once | "Have you scheduled your follow-up visit(s) yet? |
| Reminders | Day 1 | Daily | Once | "Do you need to speak to us over the phone? Send us a message through GetWell Loop, and we'll get back to you." |
| Checklist | Day 1 | Daily | Twice | "If we prescribed any medicines, be sure to fill the prescriptions. Check this off once you've picked up your medicines, or if you have no medicines to pick up." |

Five of the check-in messages had responses that could contribute to an alert that would prompt a phone call from a registered nurse within six hours. Patients were asked to share details about any worsening problem as a free text comment response, which

helped prepare the nurse when interacting via phone or documenting in the EHR when calling the patient, thus saving valuable time.

All analyses were performed in IBM SPSS Statistics Version 27. Chi-square test and a Mann-Whitney U test were used for group comparisons. A Kaplan-Meier curve was plotted for mean days from index ED visit to next ED visit with a standard error (SE) with Mantel-Cox test for group comparisons. A Cox proportional hazard model, with stratification by hospital site, was fit for days to return to ED on RPM activation.

## 3. Results

Between October 19, 2020 to April 20, 2022, 107,477 consecutive ED patients (mean [range] age 50.48 [18-105] years, 62050 [57.7%] women) were offered the RPM program as part of their discharge process (Table 2). Overall, 28,425 patients (26.1%) activated the technology, with the mean count of RPM interactions was 1.43 (SD 0.856). Patients who activated the RPM were slightly older, 51.3 years (SD 19.6), compared to those who did not, 50.2 years (SD 20.9); $t(107,475) = 7.314$, $p<.001$. RPM activation for the ten hospitals with adult emergency departments ranged from 21.9% to 29.4% [$X^2$ (9, N=107,477) = 301.811, $p<.001$]. When comparing RPM activation (yes/no) on patients who returned to the ED within 90 days of the previous index visit, ED return was 19.8% in patients who activated compared to 23.6% in those who did not, $X^2$ (1, N=107,477) = 174.178, $p<.001$. In the 90 days after their index ED visit, patients who activated the RPM had a higher mean count (standard deviation (SD); 25th & 75th percentiles) of 1.46 (2.14; 0.00 & 2.00) office encounters compared to 1.19 (2.05; 0.00 & 2.00) office encounters for those who did not activate; Mann-Whitney U test, $z=26.676$, $p<.001$. Patients who activated also had a higher mean count of 1.92 (3.84, 0.00 & 2.00) telephone encounters compared to 1.83 (3.97; 0.00 & 2.00) telephone encounters; Mann-Whitney U test, $z=12.335$, $p<.001$.

**Table 2.** Sociodemographic, RPM and Clinical Characteristics of Patient Sample.

| Variable | Patient Distribution |
|---|---|
| Age (years) Mean (range) [Standard deviation] | 50.5 (18-105) [20.6] |
| Sex (Women, Men, Unknown) n (%) | 62,050 (57.7%), 45,392 (42.2%), 35 (0.0%) |
| Activated RPM (Yes, No) n (%) | 28,425 (26.4%), 79,052 (73.6%) |
| RPM interactions Mean (range) [Standard deviation] | 1.43 (1-12) [0.856] |
| Urgent Acuity (Yes, No) n (%) | 62,050 (58.2%), 44,977 (41.8%) |

A Kaplan Meier curve (Figure 1) was plotted for the number of days to the next emergency department visit after the index visit when the RPM application was offered. Patients who activated the RPM had a longer mean, 270.5 days (SE = 0.82) compared to 253.5 days (SE = 0.51), survival return time than patients who did not activate; Mantel-Cox $X^2$ (1, N=107,477) = 324.614, $p<.001$. We also fit a Cox proportional hazard model, with stratification by hospital (due to differences in activation rates). The event was a return ED visit (43,555 patients; 40.5%); patients without an event at the end of the observation window were right censored (63,922 patients; 59.5%). We observed that patients who activated the RPM had a 16.2% lower hazard of returning to the ED (hazard ratio = .838, 95% confidence interval = 0.820 - 0.857, $p<.001$) in the 12 months after their index visit.

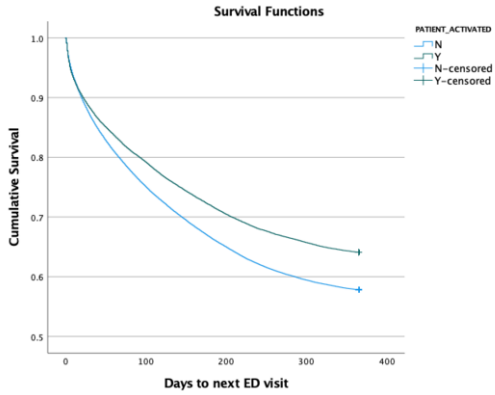


**Figure 1.** Kaplan Meier Curve.

## 4. Discussion

We evaluated a customized RPM program aimed to decrease return ED visits with a focus on patient activation. Preventing return ED visits can lower health care costs and reduce ED crowding [13]. Automated RPM programs, like those described here with technology solutions and virtual clinical support, offer a digital health alternative for reducing ED costs and potentially improving ED care delivery. We observed that patients who activated the RPM program were less likely to return to the ED within 90 days of their index visit. On multivariate modeling, there was a 16% lower hazard of returning to the ED in the 12 months after the index ED visit.

Our study had several limitations, which restrict our ability to generalize our findings or to better understand the potential causal relationship between RPM programs and return ED visits. These include the following:

- Despite customized RPM content and ED discharge processes integration, activation was relatively low at 26.4% (21.9% to 29.4% across hospitals)
- Our analysis lacks data from other health systems around patient utilization
- Lack of ED-specific clinical data (e.g., primary and secondary complaint)
- Medicaid (low income) patients were in a separate program and thus excluded

We expect future research directions to provide additional generalizability, insights on patient engagement, and understanding of patient factors. This research will help inform if RPM activation reduces ED utilization or, for example, is RPM activation is a marker of a patient's ability to navigate a health system. Improved study designs (e.g., step wedge implementation-effectiveness trial) would help to better understand causal relationships [14]. Strategies to increase and understand RPM activation, such as training/support for front-line healthcare teams, as well as integration of digital health literacy screening tools and patient feedback on the specific RPM program could be considered [15]. Finally, studies to better understand the cost effectiveness of RPM solutions in the ED setting would be particularly valuable.

## 5. Conclusions

Our evaluation of a customized RPM program for reducing return visits to the ED across

an integrated healthcare system provides proof-of-concept evidence for the role of similar technology in the ED setting. While demonstrating low rates of engagement, engaged patients had lower ED utilization.

## Acknowledgements

We would like to thank the efforts across *M Health Fairview*, including the expert technology, clinical care, care coordination, and patient education staff.

## References

[1] Sabbatini AK, Kocher KE, Basu A, Hsia RY. In-Hospital outcomes and costs among patients hospitalized during a return visit to the emergency department. JAMA. 2016 Feb;315(7):663-71, doi: 10.1001/jama.2016.0649.
[2] Tang N, Stein J, Hsia RY, Maselli JH, Gonzales R. Trends and characteristics of US emergency department visits, 1997-2007. JAMA. 2010 Aug;304(6):664-70, doi: 10.1001/jama.2010.1112.
[3] Keith KD, Bocka JJ, Kobernick MS, Krome RL, Ross MA. Emergency department revisits. Ann Emerg Med. 1989 Sep;18(9):964-8, doi: 10.1016/s0196-0644(89)80461-5.
[4] Lerman B, Kobernick MS. Return visits to the emergency department. J Emerg Med. 1987 Sep;5(5):359-62, doi: 10.1016/0736-4679(87)90138-7.
[5] Rising KL, Hudgins A, Reigle M, Hollander JE, Carr BG. "I'm Just a Patient": Fear and uncertainty as drivers of emergency department use in patients with chronic disease. Ann Emerg Med. 2016 Nov;68(5):536-43, doi: 10.1016/j.annemergmed.2016.03.053.
[6] Adams JG. Ensuring the quality of quality metrics for emergency care. JAMA. 2016 Feb;315(7):659-60, doi: 10.1001/jama.2015.19484.
[7] Sarasa Cabezuelo A. Application of Machine Learning Techniques to Analyze Patient Returns to the Emergency Department. J Pers Med. 2020 Aug;10(3):81, doi: 10.3390/jpm10030081.
[8] Mi R, Hollander MM, Jones CMC, DuGoff EH, Caprio TV, Cushman JT, Kind AJH, Lohmeier M, Shah MN. A randomized controlled trial testing the effectiveness of a paramedic-delivered care transitions intervention to reduce emergency department revisits. BMC Geriatr. 2018 Dec;18(1):104, doi: 10.1186/s12877-018-0792-5.
[9] Biese K, Lamantia M, Shofer F, McCall B, Roberts E, Stearns SC, Principe S, Kizer JS, Cairns CB, Busby-Whitehead J. A randomized trial exploring the effect of a telephone call follow-up on care plan compliance among older adults discharged home from the emergency department. Acad Emerg Med. 2014 Feb;21(2):188-95, doi: 10.1111/acem.12308.
[10] Annis T, Pleasants S, Hultman G, Lindemann E, Thompson JA, Billecke S, Badlani S, Melton GB. Rapid implementation of a COVID-19 remote patient monitoring program. J Am Med Inform Assoc. 2020 Aug;27(8):1326-30, doi: 10.1093/jamia/ocaa097.
[11] Aalam AA, Hood C, Donelan C, Rutenberg A, Kane EM, Sikka N. Remote patient monitoring for ED discharges in the COVID-19 pandemic. Emerg Med J. 2021 Mar;38(3):229-31, doi: 10.1136/emermed-2020-210022.
[12] Misra-Hebert AD, Ji X, Jehi L, Milinovich A, Pfoh ER, Kattan MW, Young JB. COVID-19 home monitoring after diagnosis and health care utilization in an integrated health system. JAMA Health Forum. 2021 May;2(5):e210333, doi: 10.1001/jamahealthforum.2021.0333.
[13] Kelen GD, Wolfe R, D'Onofrio G, Mills AM, Diercks D, Stern SA, Wadman MC, Sokolove PE. Emergency department crowding: the canary in the health care system. NEJM Catal Innov Care Deliv. 2021 Sep;2(5), doi: 10.1056/CAT.21.0217.
[14] Mdege ND, Man MS, Taylor Nee Brown CA, Torgerson DJ. Systematic review of stepped wedge cluster randomized trials shows that design is particularly used to evaluate interventions during routine implementation. J Clin Epidemiol. 2011 Sep;64(9):936-48, doi: 10.1016/j.jclinepi.2010.12.003.
[15] Nelson LA, Pennings JS, Sommer EC, Popescu F, Barkin SL. A 3-Item measure of digital health care literacy: development and validation study. JMIR Form Res. 2022 Apr;6(4):e36043, doi: 10.2196/36043.