Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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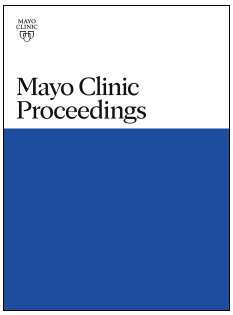

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PII: S0025-6196(22)00607-3

DOI: https://doi.org/10.1016/j.mayocp.2022.10.016

Reference: JMCP 3979

To appear in: *Mayo Clinic Proceedings*

Received Date: 21 October 2022

Accepted Date: 24 October 2022

Please cite this article as: Gunderson M, Melton GB, Ambulatory Remote Patient Monitoring Beyond COVID-19: Engagement and Sustainment Considerations", *Mayo Clinic Proceedings* (2022), doi: https://doi.org/10.1016/j.mayocp.2022.10.016.

Ambulatory Remote Patient Monitoring Beyond COVID-19: Engagement and Sustainment Considerations”

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Care delivery innovations in response to the COVID-19 pandemic, particularly digital health solutions, have been wide ranging and impactful. The spectrum of such innovations include, for example, the use of technology-based screening tools, EHR-based protocols, rapid provider onboarding and education, clinical decision support and diagnostics, large scale data collection with real time dashboards for tracking and surveillance to monitor outcomes and hospital capacity, and the rapid adoption and expansion of telehealth services and remote monitoring to improve safe access to healthcare and optimize resource utilization (1). The novel nature of SARS-CoV-2 infection and rapid evolution of healthcare delivery during the pandemic require robust evaluation of these implementations. In particular, we continue to face a number of evidence gaps in the optimal role and deployment of virtual care services including telehealth and remote patient monitoring (RPM) programs for COVID-19 and beyond.

In this issue of *Mayo Clinic Proceedings*, Haddad and authors (2) present their retrospective matched cohort analysis of a high intensity RPM program in SARS-CoV-2 test positive patients with one or more CDC defined risk factors for severe COVID-19 illness. The digital care solution collected vital sign measurements and symptom assessments using questionnaires several times per day using standardized care pathways. Alerts were generated by the technology using the care pathways and were reviewed by a team of RNs, who also had access to a COVID-19 care team of advanced practice providers and physicians for escalation of care, as needed.

The authors evaluated outcomes among those enrolled in the RMP who did and did not engage with the program defined by submission of at least one set of vital signs through the provided digital solution. Of 5,796 patients evaluated, 80% of patients engaged with the RPM program technology. While sex, race, ethnicity and primary language were similar between cohorts, non engaged patients were generally older, had more comorbidities and were diagnosed with COVID-19 while inpatient. Patients engaged in the RPM program had significantly lower rates of hospitalization, hospitalization of 7 or more days, and ICU admission when compared to non engaged patients. Additionally, engaged patients had significantly shorter hospital length of stay and lower overall 30 day costs of care, as well as lower all cause 30 day mortality rates. While rates of at least one emergency department visit were similar between groups, engaged patients were more likely to have 2 or more visits compared to those that were non-engaged, perhaps indicating that these patients had clinical worsening which required seeking and receiving additional care.

The study has as strengths its use of a large well matched cohort and its real world nature which did include minority, elderly, and rural populations. Limitations of this report include its retrospective nature and its lack of a true comparable control group managed without RPM and associated risk of participation bias given the inability to perform intention to treat analysis. How a particular patient may lack engagement in a RPM program may reflect a lack of engagement with healthcare more generally or other factors which were not evaluated.

Overall, the experience and outcomes with COVID-19 and RPM share similarities to the reported experience of others with a range of RPM programs as well as some distinctions. Similar to other groups, RPM for COVID-19 is feasible and acceptable to patients, but demonstrates variable rates of engagement (3–5). Haddad and authors similarly demonstrate a reduction in healthcare utilization associated with RPM including reduced length of stay (4) and less intensive care use and lower hospitalization (6). Optimizations to increase the benefits and minimize the risks of RPM programs require refining the target population. For example, Lupei and authors (7) developed and implemented a machine learning prognostic model triaging patients with increased risk for COVID-19 severity. While this algorithm was aimed to support emergency department physicians' clinical decision making, utilizing such a model for precise identification of patients who could benefit from an RPM solution such as this or may need tailoring of resources should be considered.

Interestingly, when considering equitable access and reducing barriers to access for RPM, the authors found that racial and ethnic minority populations were as likely to engage with the RPM program as non Hispanic white populations. Studies in other populations with COVID-19 and RPM have demonstrated more nuanced findings regarding engagement with preferences for telephone over app-based monitoring among black, male, older patients, as well as those from disadvantaged neighborhoods or with chronic medical conditions (8). Similarly, in another study with type 2 diabetic patients enrolled in a RPM program, a larger share of black patients and those over 65 years of age demonstrated regular engagement, while those with lower incomes had less engagement (9).

The experience of Haddad and authors contributes to our understanding of RPM feasibility as well as its potential as an adjunct to traditional clinical care. It is clear that RPM programs such as these will continue to mature over time, as will our understanding of patient engagement, digital technology and care delivery design, and ultimately sustainability of these solutions.

REFERENCES

1. Reeves JJ, Pageler NM, Wick EC, Melton GB, Tan YHG, Clay BJ, et al. The Clinical Information Systems Response to the COVID-19 Pandemic. Yearb Med Inform. 2021 Aug;30(1):105–25.
2. Haddad TC, Coffey JD, Deng Y, Glasgow AE, Christopherson LA, Sangaralingham LR, et al. Impact of a High-risk, Ambulatory COVID-19 Remote Patient Monitoring Program on Utilization, Cost, and Mortality. Mayo Clin Proc. In press.
3. Annis T, Pleasants S, Hultman G, Lindemann E, Thompson JA, Billecke S, et al. Rapid implementation of a COVID-19 remote patient monitoring program. J Am Med Inform Assoc JAMIA. 2020 Aug 1;27(8):1326–30.
4. Grutters LA, Majoor KI, Pol-Mattern ESK, Hardeman JA, van Swol CFP, Vorselaars ADM. Home-monitoring reduces hospital stay for COVID-19 patients. Eur Respir J. 2021 Nov 1;58(5):2101871.
5. Oliver J, Dutch M, Rojek A, Putland M, Knott JC. Remote COVID-19 patient monitoring system: a qualitative evaluation. BMJ Open. 2022 May 4;12(5):e054601.
6. Crotty BH, Dong Y, Laud P, Hanson RJ, Gershkowitz B, Penlesky AC, et al. Hospitalization Outcomes Among Patients With COVID-19 Undergoing Remote Monitoring. JAMA Netw Open. 2022 Jul 1;5(7):e2221050.
7. Lupei MI, Li D, Ingraham NE, Baum KD, Benson B, Puskarich M, et al. A 12-hospital prospective evaluation of a clinical decision support prognostic algorithm based on logistic regression as a form of machine learning to facilitate decision making for patients with suspected COVID-19. PloS One. 2022;17(1):e0262193.
8. Fritz BA, Ramsey B, Taylor D, Shoup JP, Schmidt JM, Guinn M, et al. Association of Race and Neighborhood Disadvantage with Patient Engagement in a Home-Based COVID-19 Remote Monitoring Program. J Gen Intern Med. 2022 Mar;37(4):838–46.
9. Kirkland EB, Marsden J, Zhang J, Schumann SO, Bian J, Mauldin P, et al. Remote patient monitoring sustains reductions of hemoglobin A1c in underserved patients to 12 months. Prim Care Diabetes. 2021 Jun;15(3):459–63.