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Building a Real-Time Remote Patient Monitoring Patient Safety Program for COVID-19 Patients

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Abstract

Coronavirus disease 2019 (COVID-19) pandemic has forced providers to rapidly adopt telehealth tools to reduce staff exposure to ill persons, preserve personal protective equipment, and minimize impact of patient surges on facilities. Remote patient monitoring (RPM) can be used to monitor high-risk patients from their homes and open up hospital bed availability. The authors describe a pilot program to evaluate the impact of RPM in postdischarge monitoring of COVID-19 patients. High-risk patients discharging from the hospital received a wearable vital sign monitoring device to be worn for 8 consecutive days, allowing real-time data transmission to a virtual health center (VHC), which had been established prior to the pandemic, via a smart phone application. The data were monitored 24 hours a day by a VHC tech with built-in escalation protocols to a nurse and/or an attending physician if needed. Eighty patients were enrolled, 48% women with an age range of 19–83 years. Languages included Spanish (49%), English (47%), Burmese (2%), and Swahili (1%). The most common comorbidities included hypertension (48%) and diabetes mellitus (48%). Oxygen was the most common addressed need; 8% requiring new oxygen and 8% benefitting from oxygen-weaning during the RPM time period. Ten percent patients had emergency department (ED) visits and 4% were readmitted within 30 days of discharge. The authors built and deployed an RPM program for postdischarge monitoring of high-risk patients. RPM can be quickly deployed to support COVID-19 patients postdischarge and assist with hospital capacity. RPM can be rapidly and successfully deployed during the COVID 19 pandemic to aid in transitions of care.

Keywords

interdisciplinary care, patient safety, remote patient monitoring, telehealth

Introduction

While telehealth technology is far from new, widespread adoption among health care providers and patients beyond simple telephone correspondence has been historically slow to develop.[1–3] The coronavirus disease 2019 (COVID-19) pandemic has rapidly disrupted the incentives around telehealth; accordingly, telehealth has taken a forefront role, forcing providers and patients alike to rapidly adopt telehealth tools to reduce staff exposure to ill persons, decrease utilization of personal protective equipment, and minimize the impact of patient surges on facilities.[4] Telehealth, has, in fact, been considered a virtually "perfect tool" during this pandemic.[5]

Health care systems have also had to adjust the way they triage, evaluate, and care for patients using methods that do not rely on traditional in-person care models. With the mass scale needed for COVID-19 patient management, remote patient monitoring (RPM), coupled with telemedicine, can be an important lever in caring for this growing population.[6] RPM uses digital technologies to collect health data from individuals in one location and electronically transmit that information securely to health care providers in a different location for assessment and recommendations. Health professionals can then act on the information received as part of the treatment plan. This type of service allows a provider to continue to track health care data for a patient once released to home or a care facility with the intent to improve patient safety and reduce readmission rates. The Center for Medicare and Medicaid Services (CMS) made several changes to RPM policies in response to the COVID-19 public health emergency (PHE), including waiving requirements for establishing in-person physician/patient relationships prior to RPM, clarifying that

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RPM can be used for acute and/or chronic conditions and confirming that RPM services can be furnished under general supervision rules.[7]

RPM can be used for close monitoring of COVID-19 patients, especially since this patient population can manifest with an unpredictable postdischarge course. Additionally, with increasing surges of COVID-19 patients, hospitals can anticipate higher volumes of patient censuses and admission rates. RPM can be deployed as part of a tiered approach to open up bed availability in hospitals; this approach extends the walls of the hospital virtually and allows earlier discharge of patients with continued virtual monitoring. The authors describe a feasibility pilot program to evaluate the impact of RPM in the postdischarge monitoring for COVID-19 patients.

Materials and Methods

Study Setting and Participants

The pilot program took place from April 15, 2020, to June 6, 2020 with the inpatient medicine services caring for COVID-19 patients at the University of Colorado Hospital (UCH), a 690-bed tertiary care academic hospital in Aurora, Colorado, part of UCHealth, a 12-hospital system in Colorado.

The program participants were patients with COVID-19, discharging from UCH who were considered to be high risk for clinical deterioration. The high-risk category was determined by a work-group comprised physicians including hospital medicine, family medicine, pulmonary/critical care (PCCM), and infectious disease (ID). High risk was defined as age greater than or equal to 55, immunocompromised state due to illness or medications or HIV with CD4 less than or equal to 200, pregnant or those having two or more of the following comorbidities: diabetes mellitus, hypertension, coronary artery disease, underlying lung disease, chronic kidney disease, or morbid obesity. Additionally, patients had to have decision-making capacity and a smart phone to transmit data from the smart phone application (app) to facilitate monitoring.

Device and RPM Protocol

On the day of discharge, if the patient met high-risk criteria for RPM, the inpatient medicine team placed an order in the electronic medical record (EHR), in addition to the usual discharge care and instructions. This populated the patient into a list for RPM enrollment evaluation. The nurse team member then met with and enrolled the patient and if they met the technological requirements, placed a wearable vital sign monitoring device on the patient. The program utilized the Masimo Radius PPG, a bracelet-like device placed on the wrist, which monitors respiratory rate, heart rate, and pulse oximetry. Due to the bracelet-like design, this device was well tolerated. This allowed for vital sign monitoring with real-time data transmission from the app to a Health Insurance Portability and Accountability Act (HIPAA) compliant cloud accessed at the VHC. These data were monitored 24 hours a day, 7 days a week over an 8-day period by a VHC technician trained for this role (not licensed) with built-in escalation protocols to a nurse and/or attending physician located within the VHC if needed (Figure 1). The authors chose an 8-day monitoring period as most high-risk patients had an average hospital length of stay of 4–5 days and an 8-day postdischarge monitoring would account for approximately 14 days of monitoring. The VHC team placed a call to the patient's house the evening of enrollment to ensure a smooth transition of care and subsequently made daily phone calls to patients with a standardized script, including symptom tracking.

Education

Multimodal communication, led by the physician champion, was employed to educate frontline COVID-19 providers on the high-risk criteria as well as the RPM pilot. This included electronic mail, virtual meetings with physician leadership to cascade information to frontline providers as well as direct virtual meetings with the frontline providers. This included a summary of the RPM program, the details on how to enroll their patient and how to escalate concerns; a frequently asked questions (FAQs) summary was also provided to frontline providers. Additionally, there was communication with COVID-19 unit nursing leadership to cascade to frontline nurses which included the FAQs. Since the VHC was established before the onset of the pandemic, this was already established within nursing and provider work flow. Last, a regular communication on institutional updates on COVID-19 from the UCHealth leadership sent to all employees and physicians also included this updated information.

RPM workflow education at the VHC included one-on-one orientation for technicians and nurses cross-trained for the RPM program, led by the nurse Director for the VHC; no additional staff was hired. Furthermore, video recordings of the workflow, created during the one of one orientation sessions, were made available virtually for further education. Last,

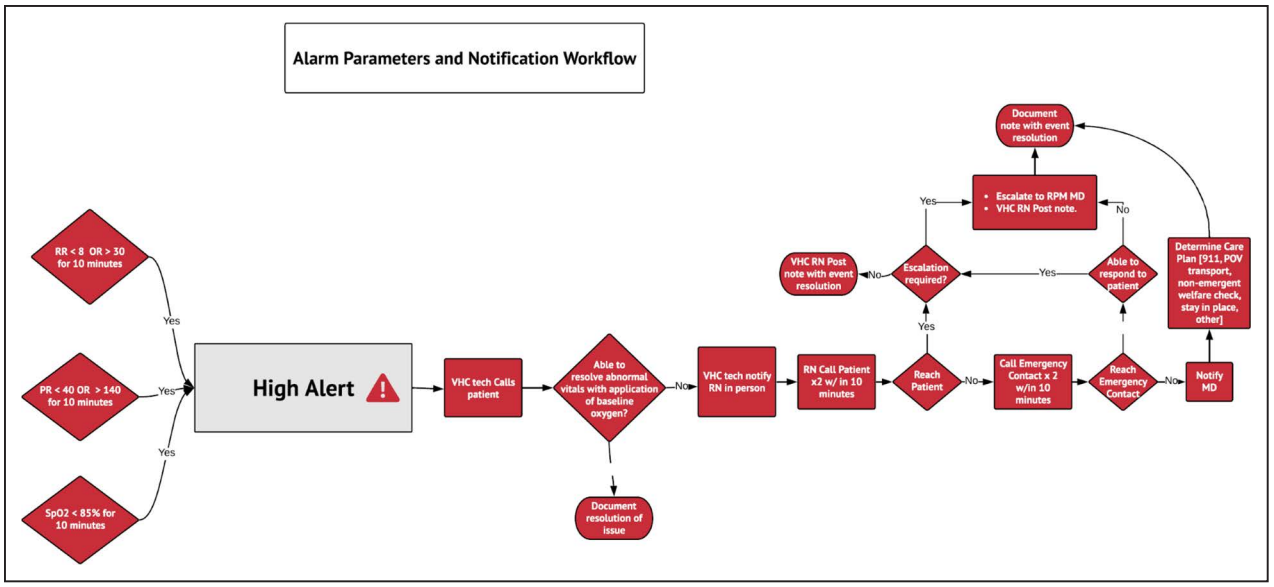

Figure 1. Escalation pathway for deteriorating patients at the virtual health center Abbreviations: PR, pulse rate; RN, registered nurse; RPM, remote patient monitoring; RR, respiratory rate; SpO2, oxygen saturation; VHC, virtual health center.

RPM staff had direct access to VHC leadership for questions or concerns.

Process Change

Starting in Early April 2020, the clinical leaders for RPM and Division of Hospital Medicine, began formal efforts centered on streamlining transitions of care for COVID-19 patients. The authors established the role of an RPM Physician Champion, a physician with operations experience in the inpatient setting. This physician champion partnered with the VHC leadership who have experience with RPM, bringing their expertise together to establish and implement the RPM program in the inpatient setting. This RPM physician champion, in conjunction with the inpatient medicine services quality improvement team, built a preliminary discharge pathway to restructure discharge efforts for all COVID-19 patients discharging from UCH. This pathway was subsequently integrated into the EHR, Epic, and edited to reflect the high-risk criteria built by the interdisciplinary team of physicians and escalated to the UCHealth system.[8] An order for RPM was also built directly into the pathway for ease of use localized to UCH.

Audit and Feedback

On the first day of the pilot, the physician champion reached out directly to each frontline COVID-19 provider team to re-educate on the pilot, the high-risk criteria and discuss potential patients for enrollment. The COVID-19 discharging patient census was reviewed daily by either the physician champion or nurse team for candidates during the first week to help frontline providers build a regular workflow around the pathway and pilot. After the first 2 weeks, the census was reviewed only when there were no orders for RPM enrollment. A regular weekly email communication was sent to remind frontline providers on the enrollment criteria, discharge pathway, and RPM enrollment opportunities.

In addition to seeking patients for daily enrollment during the first two weeks, the physician champion solicited feedback daily on the discharge pathway, RPM enrollment process as well as any other process improvement opportunities. This allowed real-time RPM process improvement.

At the VHC, the core RPM team, comprised the Medical and Nursing Director for the VHC, the information technology (IT) team at the VHC, the physician champion for RPM and the project manager, met daily to address any concerns, or questions and to problem-solve any real-time barriers with the discharge pathway, RPM ordering process, the cloud service or to build real-time processes to address medical conditions that were frequently coming up such as need for home oxygen. This was particularly important as RPM was a new program for UCH.

Data Collection

In this descriptive study, the authors collected demographic information on all COVID-19 patients,

underlying medical comorbidities, primary spoken language, as well as ED and re-admissions within 30 days of discharge related to an index COVID-19 admission and payor source (although patients were not charged). This study was classified as exempt by a local institutional review board (COMIRB 19-2104) as it was considered a feasibility pilot study. Patients were consented at time of registration.

Results

Study Participants

There were a total of 406 patients with COVID-19 who were discharged from the hospital medicine service during the pilot time frame of April 15 and June 6, 2020, at UCH. Of these patients, 19 (5%) patients were readmitted and 38 (9%) returned to the ED within 30 days of discharge after an index COVID-19 admission to the hospital medicine service. Of the 406 patients with COVID discharged from UCH, the focus was on high-risk patients and 80 of these patients were enrolled in the postdischarge pilot RPM program. The authors elected to limit RPM to high-risk patients which would allow a manageable enrollment number for a feasibility pilot program. This would allow correction of any concerns in real time without compromising care. The demographic and clinical characteristics of the patients enrolled in the pilot are described in Table 1.

Table 1. Characteristics of COVID-19 Patients Enrolled into Remote Patient Monitoring Program.

Characteristic	Pilot (N = 80)
Age, mean	52
Gender	
Male (%)	52
Female (%)	48
Insurance (%)	
Medicare	17
Medicaid	27
Private	29
Uninsured	8
Other	1
Unavailable	18
Language (%)	
English	49
Spanish	47
Burmese	2
Swahili	1
Comorbidities (%)	
Diabetes mellitus	50
Hypertension	50
Chronic lung disease	23
Obstructive sleep apnea	10
Coronary artery disease	11
Liver disease	10
Chronic heart failure	6
HIV	4
Immunosuppression	3
End-stage renal disease	1
Congenital heart disease	1

Patient Issues

The most commonly addressed need while enrolled in RPM centered on providing or modifying home oxygen orders, with 7 (8%) patients requiring new oxygen prescription and 7 (8%) patients benefiting from oxygen-weaning during the RPM time period. Eight (10%) patients had emergency department (ED) visits and 3 (4%) patients were readmitted within 30 days of discharge. The reasons for readmission included chest pain or worsening symptoms including shortness of breath and persistent fever. Of the ED visits, the diagnoses included new onset of emesis, tachycardia, pneumonia, thrombosis at previous IV site, and running out of oxygen while at home and the home oxygen unable to deliver oxygen in a timely manner.

Discussion

The authors' goal was to understand if it was feasible to rapidly implement a pilot RPM program to help with care for patients with COVID-19. They describe a successful implementation of a pilot RPM program deployed for postdischarge monitoring of high-risk patients with COVID-19. RPM, along with telemedicine, can be deployed in multiple arenas for care of COVID-19 patients. Importantly, RPM can be quickly adjusted in the circumstance of rapidly rising patient census to mitigate strain on hospital resources and account for postdischarge patient needs in real time.

The authors built and deployed an RPM program within weeks of recognition of community spread of COVID-19; this occurred through multidisciplinary collaboration, allowing integration of clinical guidelines with postdischarge monitoring for high-risk patients. The rapidity with which the team was able to institute this innovation was made possible by several factors: already existing VHC and IT infrastructure, high urgency, institutional buy-in, stakeholder engagement, and open feedback channels for improvement. Subsequent changes were made quickly to both RPM and its IT components, allowing the program to serve as a trustworthy mode of monitoring. Since the solution was fluidly integrated into the EHR, providers could easily build this into their daily workflows. Hospitals without preexisting telemedicine resources could implement similar systems using off-the-shelf, commercially available hardware, such as pulse oximeters with heart rate capability, a possibility made even more feasible by the loosening of HIPAA constraints during the current pandemic.[9]

Over the course of the pilot RPM program, the team learned several important operational lessons which are worth disseminating. While this is a descriptive study, the authors have attempted to contextualize these lessons within the available demographic and readmission data. As has been previously reported, COVID-19 disproportionately affects minority populations.[10] The authors certainly observed this within their RPM cohort, where 51% of patients had limited English proficiency. This was similar to the larger COVID-19 cohort not enrolled in RPM. The authors found that integrating translator services into their workflows was critical for operational success. Furthermore, they added additional education for patients' families as needed to ensure understanding of the program and discuss any possible cultural or language nuances that may arise. The authors also observed that a significant proportion of their RPM patients were either uninsured or had Medicaid coverage (which does not reimburse for RPM). While codes are available for RPM reimbursement, the authors made the operational decision to not bill for these services given that cost could represent a significant disincentive to participate in the program. Additionally, most RPM codes require a minimum of 14 consecutive days for monitoring and the 8-day program would not have allowed the authors to bill.

It is worth noting that the age range in the RPM cohort was highly variable from 19 to 83 years old. Anecdotally it is worth noting that the technical support required for RPM was more challenging than video visits. If vital sign signal was lost, devices and apps would often have to be rebooted or reinstalled, sometimes multiple times. The team anecdotally observed that elderly patients could require more technical support than younger patients. While it remains to be seen if this level of support is scalable, it is certainly feasible. Put another way, RPM should not be limited to those who are technologically savvy, as this greatly reduces RPM's relevance. However, health care systems should anticipate the need for technical support resources with tools specifically catered to an elderly population and incorporating family members into their care. The authors' observations support previous work where a lower level of digital illiteracy has been identified as a barrier to implementing remote monitoring on a broader scale.[11]

The authors observed that most of their clinical "saves" centered around home oxygen. In several instances they recognized postdischarge hypoxemia via RPM vital signs and were able to deliver home oxygen without a subsequent emergency department (ED) visit or readmission. They observed early in the pilot that home oxygen companies were unable to deliver oxygen in a timely way, leading to ED visits. Monitoring this trend early in the pilot allowed us to partner more effectively with home oxygen companies to ensure timely delivery. Despite the fact that patients enrolled in RPM were pre-identified as higher risk, the authors observed a similar rate of readmission between those receiving RPM and potentially lower risk patients who were discharged without RPM. More rigorous controlled study is required to determine whether RPM can be relied upon as a tool to reduce readmission rates.

The main programmatic challenge the authors experienced centered on consolidating efforts. Building an RPM program de novo required coordination of multiple stakeholder groups under one venture, including clinical staff, care management, nursing staff, as well as technological requirements and staff. It was also particularly challenging to navigate the daily

Table 2. Considerations for Building a Remote Patient Monitoring Program

Topic	Considerations
Technology	Choosing and purchasing monitoring devices Smart phone accessibility
	VHC infrastructure including HIPAA compliant cloud to capture vital sign monitoring
Infrastructure	Staffing for recruitment and enrollment of patients who do not have clinical responsibilities, separate from bedside staff with active clinical duties
	Establishing VHC staffing to monitor vital signs and make daily phone calls
	Translator services for patients with limited English proficiency
	Establishing a daily huddle early in the program to ensure concerns and issues are addressed in real time and celebrate early wins
	Establishing care management partnership to build processes to address issues in real time such as home oxygen and follow-up appointments
	Electronic medical record infrastructure changes including electronic orders, patient lists, and communication with frontline nursing and physician teams
	Data monitoring to understand trends
Communication and change management	Initial communication on the program, including vision, specifics on the program and a frequently asked questions section
	Regular communication about the program through electronic mail and virtual and in-person meetings
	Establishing communication channels with frontline staff including physicians and nurses to address concerns in real time as well as share updates on the program
	Updating primary care physicians on enrollment and specifically addressed issues
	Case review processes to address any patient safety concerns

Abbreviation: VHC, virtual health center.

changing face of this novel global pandemic relying on rapid cycle improvement based on provider experience and rapid technological brainstorming for any arising issues. Additionally, the authors' device required a smart phone app for data transmission, which limited some patient enrollment as not all patients had this capability. Considerations for building an RPM program have been summarized in Table 2.

Interestingly, the authors initially had difficulty with getting buy-in from frontline staff. This was centered around the requirement for a smart phone application for data transmission as not all patients had smart phones. There was a perception that this was a large proportion of patients that was resulting in disparity in care when in fact this occurred rarely. To account for this, the authors embarked on an educational campaign comprised of one-on-one meetings, emails, and virtual meetings to share data on the actual occurrence as well as the importance of continuing with the pilot. Furthermore, they were able to secure some donations of smart phones to provide for patient use to overcome this hurdle. This allowed greater engagement and buy-in from the frontline teams.

There are several limitations to this study. Sustaining results in an academic environment with rapid staff turnover is challenging and requires continuous education around standard protocols, as well as regular audit and feedback efforts to sustain the gains. This is especially pertinent to academic medical institutions where learners may rotate through multiple hospitals and therefore unable to keep up with all initiatives. This process is resource dependent, requiring a dedicated team of providers, nurses, and support and improvement specialists. In addition, improvement efforts were time consuming with regularly scheduled daily meetings to account for any frontline and technology challenges. Integrating the recruitment, registration, and device setup were time intensive and would not easily integrate into the bedside staff role; this would require someone dedicated to this role away from other patient care responsibilities. Last, wearable vital sign monitoring devices can be expensive to adopt as part of a large program if there is no existing infrastructure that is already in place. At the authors' institution, the already existing VHC allowed them to build a program without additional cost by restructuring internal resources.

The authors' initiative demonstrates the successful adoption of a rapidly deployed, fully integrated RPM program during the crisis situation of the COVID 19 pandemic to aid in transitions of care. Institutions should consider utilizing a similar approach for adoption of RPM programs.

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Conflicts of Interest

The authors have no conflicts of interest to disclose.

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