The Promise of Remote Patient Monitoring: Lessons Learned During the COVID-19 Surge in New York City

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Abstract
The coronavirus pandemic catalyzed a digital health transformation, placing renewed focus on using remote monitoring technologies to care for patients outside of hospitals. At NewYork-Presbyterian, the authors expanded remote monitoring infrastructure and developed a COVID-19 Hypoxia Monitoring program—a critical means through which discharged COVID-19 patients were followed and assessed, enabling the organization to maximize inpatient capacity at a time of acute bed shortage. The pandemic tested existing remote monitoring efforts, revealing numerous operating challenges including device management, centralized escalation protocols, and health equity concerns. The continuation of these programs required addressing these concerns while expanding monitoring efforts in ambulatory and transitions of care settings. Building on these experiences, this article offers insights and strategies for implementing remote monitoring programs at scale and improving the sustainability of these efforts. As virtual care becomes a patient expectation, the authors hope hospitals recognize the promise that remote monitoring holds in reenvisioning health care delivery.

Keywords
digital health, remote monitoring, COVID-19, care delivery

COVID-19 has rapidly reshaped how hospitals interact with patients, making digital and telehealth interactions a vital part of the delivery model.1 The current crisis has accelerated the transition to a hybrid care delivery environment, in which virtual care exists on equal footing with in-person patient interactions. Although consumer demand and provision of telehealth services have grown exponentially, recent analysis by McKinsey and Company suggests that the opportunity for virtualization remains vast. That research estimates that up to 24% of all outpatient encounters can be virtualized, leveraging digital health tools to reimagine the office visit and redesign home health services.2

NewYork-Presbyterian (NYP) is a comprehensive integrated academic health care system with 10 hospital campuses across the Greater New York area including Manhattan, Queens, Brooklyn, Westchester, and Putnam counties. NYP is affiliated with 2 academic medical centers, Weill Cornell Medical Center, and the Columbia University Vagelos College of Physicians and Surgeons, and has >200 primary and specialty care clinics and medical groups providing an array of telemedicine services.

At NYP, virtual visits represented 53% of all outpatient interactions at the peak of the COVID-19 crisis, up from 2% before the pandemic (unpublished data; NYP internal weekly digital health volume reports from July 2016 to April 2020). Remote monitoring, in particular, became a core component of the COVID-19 patient management strategy. Remote patient monitoring (RPM) is a mode of health care delivery that gathers and integrates patient data...
outside of traditional health care settings, allowing providers to track, assess, and engage patients regardless of location. Remote monitoring programs were a critical means through which care teams could closely follow discharged COVID-19 patients and assess changes in health status, enabling the organization to maximize inpatient capacity at a time of acute bed shortage. Emergently, expanding remote monitoring has focused on equipping patients with new tools in their homes while providing infrastructure for care teams to respond to the information gathered. As we look to the future, robust remote monitoring programs will require equipping health systems with an expanded capacity to manage care remotely and integrate remote monitoring within the broader continuum of care. NYP significantly expanded and integrated remote monitoring within the broader strategy to make RPM more accessible to patients, regardless of their health literacy and circumstances.

Maturing Existing RPM Programs at NYP

Before COVID-19, NYP successfully built remote monitoring into digitally oriented care delivery models for heart failure and hypertension. Both programs leveraged a mix of in-home devices and asynchronous communication with nurses and physicians to manage exacerbations.

Development of these RPM programs hinged on the ability to optimize device management, standardize escalations protocols, and develop a coordinated escalations infrastructure. Inventory management was an early-stage priority, determining the appropriate types of devices needed, creating device support resources, and monitoring device security and connectivity to ensure proper use of these technologies. As RPM programs expanded across sites, the second-stage efforts focused on developing standardized escalations protocols to ensure appropriate clinical criteria were met and all teams understood how and when escalations should take place. Finally, maturing RPM at NYP required investing in centrally housed teams and the infrastructure to manage high escalations volume across the system.

Addressing RPM Challenges During the COVID-19 Pandemic

RPM programs across the enterprise faced numerous challenges at the outset of the pandemic. The system was in the midst of transitioning to a single electronic medical record (EMR) across all 10 campuses at the start of the pandemic, hindering initial progress toward integration of medical records and building a centralized escalation model in which a designated team of providers managed system-wide alerts and escalations across campuses. In the heart failure RPM program, there was a renewed need to manage acute exacerbations outside of the hospital during the pandemic. Enterprise leadership met early on to standardize clinical escalation protocols for all providers seeing these patients. Cross-EMR permissions were established and an “escalation physician” was designated to streamline the reporting infrastructure and manage all nurses and physician assistants communicating with patients remotely. Standardization and leadership buy-in allowed for a more efficient and scalable program that was able to continue offering services during the significant disruption of the pandemic.

Device management was another challenge across RPM programs. Although NYP partnered with device vendors to manage inventory and deliver devices, there was considerable progress to be made in integrating the device ordering and inventory within the organization’s own EMR. In scaling these programs during the pandemic, device visibility and availability were paramount concerns. To better address this issue, an order was created in the Epic health record to directly link device provision on discharge, simplifying the workflow for providers and increasing the ability to track and manage device inventory in-house.

Finally, RPM programs also faced inherent health equity challenges, exacerbated by the isolation of some patient communities during the pandemic. The requirement for a reliable and secure internet connection to operate devices and share information can be a major barrier for some patients. Variable familiarity with these devices can make RPM implementation more challenging in particular patient populations. To that end, patient education, translation of materials into multiple languages, and the provision of Bluetooth-enabled devices that did not require an internet connection to share information became part of the broader strategy to make RPM more accessible to patients, regardless of their health literacy and circumstances.

Although COVID-19 accelerated the pace of change in RPM, the goal remained to develop an infrastructure for real-time monitoring while creating a seamless care environment spanning home and hospital for all patients. Learnings were taken from the expansion of existing RPM programs—improving centralized escalation, creating seamless device deployment orders, and creating solutions for patients with limited access to internet and other devices—to
design the COVID-19 Hypoxia Monitoring Program, a novel approach to COVID-19 patient management utilizing the RPM infrastructure.

**Designing and Deploying the COVID-19 Hypoxia Monitoring Program**

During the COVID-19 crisis, the potential benefits of remote monitoring quickly became clear. As NYP hospitals began responding to high volumes of COVID-19 patients, a significant concern was the potential for rapid deterioration of seemingly stable patients. However, maintaining and expanding hospital capacity to respond to the influx of COVID-19 patients also meant ensuring appropriate and timely discharge from inpatient units and the emergency department (ED). To preserve patient safety, RPM efforts were refocused to respond to the needs of discharged COVID-19 patients by quickly prototyping and implementing a COVID-19 Hypoxia Monitoring Program at scale.

Specifically, COVID-19 patients discharged from the ED and inpatient wards, as well as those from outpatient clinics who did not require immediate ED referral, were carefully assessed for clinical acuity and potential risk of decompensation. Depending on symptomatology and degree of hypoxia, patients were discharged with pulse oximeters and, if clinically appropriate, oxygen concentrators to facilitate recovery at home in a monitored setting (Table). In the midst of the crisis, a diverse team, including nurses and nurse practitioners, physician assistants, care managers, and volunteer medical and nursing students, was organized to monitor patient oxygen readings remotely and assess any worsening symptoms. Physician assistants and medical students conducted daily follow-up calls to enrolled patients for a 14-day period, monitoring COVID-19 symptoms, pulse, temperature, and oxygen saturation. Designated escalation physicians were alerted of any concerning readings, and directed patients to additional assessments via telemedicine or, if needed, readmission to the ED. A detailed workflow and clinical assessment criteria can be found in Figures 1 and 2, respectively. During the initial surge, >2000 patients from the ED and >3650 inpatients and outpatients were monitored through this program (Figure 3). Early data from the largest volume inpatient and outpatient sites are promising—of the patients monitored in the inpatient and outpatient programs, 21 were sent to the ED for monitoring and 33 patients were readmitted after monitoring.

**Impact of the COVID-19 Hypoxia Monitoring Program**

Rather than simply converting an in-person encounter into a virtual encounter, the COVID-19 Hypoxia Monitoring Program and other RPM efforts represent the second generation of digital health initiatives, providing patients with longitudinal care beyond the visit-oriented delivery model. Creating these programs during a time of crisis when many providers were idle because of the cessation of elective services allowed for new members of the clinical team to take on a critical role in management while conserving capacity and improving the targeting and delivery of scarce care resources. It brought together inpatient, outpatient, and ED teams in a coordinated effort to develop standardized workflows and algorithms for remote monitoring, examining data, and responding in real time. Ultimately, improving the integration of these services within clinical workflows was critical to their scale and success, allowing conservation of personal protective equipment, improved patient safety, and increased capacity of key services without compromising patient care.

However, as these programs grow, the organization recognizes the ongoing need to address usability concerns and ensure that devices are relaying accurate information to providers while also addressing the challenge of building the infrastructure needed to deliver data to physicians in an actionable and centralized manner across all remote monitoring programs. Ultimately, progress is being made toward a future in which remote monitoring programs are integrated within digitally oriented care models, expanding the scope of the patient–provider relationship.

**Lessons Learned**

In scaling and building programs during the peak of the epidemic, the approach to RPM was able to be tested and modified, leveraging the strengths of both clinical providers and automated systems to deliver optimal patient care. Based on this experience, the following recommendations are offered for health systems seeking to build on the virtual visit and expand remote monitoring beyond the current pandemic.
Effective Integration Allows Technology to Do the Work

Remote monitoring services should be embedded within the care model. Rather than approaching remote monitoring as a separate modality with a disparate management structure, it can become an integral part of the care continuum, informing and connecting patients and providers across care settings. Early efforts of NYU’s heart failure and other home monitoring programs demonstrated the challenges of managing these programs separately; an overreliance on in-person follow-up visits with nurse practitioners and disjointed enrollment and escalation processes...
made coordination across programs challenging. RPM programs must be designed thoughtfully to provide relevant streams of data, work with a leaner in-person workforce, and provide timely information to providers in the medical record. The benefits of remote monitoring can be fully realized when RPM data do not simply replace an in-person touch point, but when these data are used as part of the treatment plan and data trends can inform patient care. Integration will require building in postdischarge workflows, automated escalations infrastructure, and device delivery protocols that are standardized and centrally managed. As the EMR increasingly becomes a shared tool between patients and providers, RPM data will not only deliver insights to providers about how patients’ conditions change over time but it also will empower patients to use this information to coproduce health.

Coordination Across Providers Boosts Engagement

Remote monitoring is a powerful tool for diverse care settings, including transitions of care and outpatient chronic disease management. Making coordination across providers a priority—informing and involving primary care teams in escalations management and follow-up alongside specialists—improves the value of these services. Engaging social work teams, care managers, and community health workers in follow-up significantly broadened the reach and ensured that the care team was familiar with local resources while significantly reducing care fragmentation. Coordinating providers was achieved, in part, by shared accountability for training, education, and program management. Rather than creating implementation silos, the most successful remote monitoring programs ensured that all stakeholders were engaged and trained to maximize the utility of the data. As the RPM programs achieve scale, NYP seeks to further centralize staffing to improve the efficiency and sustainability of these programs.

Centralize Device Management and Support

The maturity of remote monitoring programs hinges on the development of a centralized device management plan. To appropriately and efficiently deliver, monitor, and recoup devices from patients enrolled in these programs, hospitals will need to develop protocols for enrolling patients, tracking devices, and ensuring privacy and security of patient information. NYP has recognized that inventory management requires strong vendor partnerships, and a clear delegation of responsibility for device recovery. Device management also will require working internally and with vendors to provide technical support, servicing, and education to patients to ensure data accuracy and ease of use.

Identifying Populations Who Benefit Most Requires Equity-Centered Design

As remote monitoring programs scale, identifying populations for whom RPM will deliver value is critical to its success. Ideally, remote monitoring programs can build on existing devices in patients’ homes; however, these programs run the risk of exacerbating existing disparities if equity is not considered in program design. Delivering devices to patients most in need and addressing logistical issues like access to Wi-Fi can help ensure these programs address barriers to care access. Digital literacy should not be a determinant of RPM success—rather, provider organizations must recognize and meet the needs of patients who require additional support. To ensure equity and value of these programs, reaching out to all stakeholders, applying user-centered design to understand barriers, and clearly communicating program motivations can foster uptake by physicians and patients. Given the cost of device management, effective targeting and a clear understanding of how RPM data can influence clinical decision-making will maximize the impact of these resources on patient outcomes.

Sustainability Depends on a Supportive Policy Environment

The sustainability and scale of remote monitoring programs is partly contingent on a reliable reimbursement infrastructure. The Centers for Medicare & Medicaid Services recently expanded the physician fee schedule to include billable codes for remote
monitoring services, spurring considerable growth in the delivery of RPM services. However, variability in RPM reimbursement in the private sector persists and considerable uncertainty remains about qualifying parameters, devices, and types of data. Disparate coverage policies can complicate the administration of these programs and impact patient communication and experience. As RPM becomes a mainstay of virtual care, reimbursement should be informed by further characterization of how RPM delivers value and impacts preventable admissions, ED visits, and chronic care management. Appropriate reimbursement policy that accommodates the diversity and evolution of remote monitoring programs will be critical to future growth.

Conclusion
When the dust settles from COVID-19, there will be an enormous opportunity to identify which remote monitoring services and technologies deliver the most value to patients and providers. Even when the capacity burden is lifted, hospitals should recognize that the ground beneath them has shifted. Many predict that virtual care enabled by RPM tools will become an expectation as patients become more familiar with the full range of telemedicine services that can be offered. Hospitals should build on the learnings of this crisis to evolve and recognize the promise that remote monitoring programs hold in reenvisioning health care delivery.

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Conflicts of Interest
The authors have no conflicts of interest to disclose.

Author Contributions
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