THE ROLE OF VIRTUAL CAPABILITIES IN CHRONIC DISEASE HOSPITAL AT HOME PROGRAMS

What remote patient monitoring (RPM) technologies are organizations using to support a chronic disease–focused hospital at home program? What are key considerations for selecting appropriate technologies?

Overview

While the adoption of hospital at home programs had been gradually increasing in recent years, the COVID-19 pandemic has greatly accelerated the shift to home health and virtual care. With half of families now more likely to choose in-home care for their loved ones than they were prior to the pandemic, with almost half of physicians using virtual health technologies to treat patients, and considering the renewed emphasis on safety and convenience, the home is now seen as an effective site of care, particularly for chronically ill patients. A successful chronic disease hospital at home program is not solely driven by technological capabilities; however, the rapid advancement of remote monitoring technology indicates that it will be an integral component of such programs.

Landscape: Technology-Driven Hospital at Home Offerings

The hospital at home model, designed to deliver inpatient care in the home, was developed at Johns Hopkins Medicine in the 1990s. Application of the model led to lower mortality rates and up to 30% cost savings for inpatient treatment of at-home patients compared to similar patients treated within the walls of a hospital. The program's structure was built on the use of a personalized care team, educational materials and remote patient monitoring tools, among other components.

When the model was introduced, as a patient received hospital at home care, remote monitoring devices often required the patient to manually report data readings from a peripheral device to a web server. The data were then reviewed in bulk during a follow-up in-person visit. Self-reporting the information required a high level of patient interaction with and adherence to the technology without the benefit of real-time monitoring and treatment adjustments. With remote monitoring devices rapidly evolving over the past 20 years, health systems have enhanced the role of remote monitoring technologies in their hospital at home programs to better manage a patient's home care plan.

Today, especially with the advent of the COVID-19 pandemic, the need to decant inpatient admissions coupled with the availability of RPM technology capable of real-time reporting and analysis has driven many organizations to focus on acute chronic diseases in a hospital at home program. Currently, most hospital at home programs rely on remote monitoring technologies that manage chronic illnesses such as diabetes, heart disease or chronic obstructive pulmonary disease. Understanding the capabilities of devices that are commonly used to monitor these diseases has become an important aspect of developing an effective chronic disease hospital at home program.

Remote Monitoring Devices Used in Hospital at Home Programs

This section presents the current capabilities of devices that are available to be adopted by health systems and addresses technological adaptations for consideration as they become available in the future.

Software Platforms

Current Platforms

Advanced remote monitoring platforms currently offer 2-way communication between patients and providers, as well as a streamlined process for transmitting patient health data. Third-party vendors have developed platforms that integrate with existing clinical workflows, often providing the hardware to operate the platform, such as a tablet. Increasingly, remote platforms can receive autonomously uploaded health data from Bluetooth-enabled peripheral devices, minimizing the need for patient intervention.

A 2020 National Health Service Trust case study in the United Kingdom shows that when a platform supporting connectivity with several peripheral device partners was used during a hospital at home intervention program, unnecessary emergency department visits declined by 87%. Such sophisticated platforms support real-time data transmission from peripheral devices directly to the provider, a capability that will expand as the technology advances.

Future Platforms

Emerging remote monitoring platforms will focus on customization of the platform experience for both the patient and provider. Data reports, alert systems and communication methods will differ by patient and disease. Some vendors already allow customization of various platform settings to address patient-specific illnesses, an indicator of the anticipated push to develop features that will enhance efficacy and patient satisfaction within the hospital at home program. Sg2's 2019 National Health Care Consumerism and Insurance Coverage Survey found that only 38% of patients are likely to allow providers to access data supplied by a remote monitoring device. Efforts to evolve remote monitoring software platforms toward creation of an individualized experience will increase patient adoption of these technologies.

RPM Devices

A wide range of remote patient monitoring devices are used by patients and providers every day to manage chronic illnesses in a hospital at home setting. This section highlights evolving RPM technologies that are, or will be, frequently used in hospital at home programs to support chronic disease patients.

Continuous Glucose Monitoring Devices

Current Devices

Currently available continuous glucose monitoring (CGM) devices transmit data to a software platform or mobile device via Bluetooth technology. Real-time reports can be viewed by a patient, family member or provider to proactively avoid an adverse event. Organizations that have developed Bluetooth-enabled diabetes monitoring programs have reported increased access to care and improvement of blood glucose levels among participating patients. While some CGM device companies only allow Bluetooth-enabled connection of their devices to their own software platforms, other CGM companies have formed partnerships with existing hospital at home platforms to increase interoperability. New CGM devices now include integrated insulin pumps; however, fully automated and interoperable insulin-controlling devices have only recently been approved by the FDA.

Future Devices

Future developments will target the physical size of CGM technology, an effort driven by consumer desires expressed across the remote monitoring device market. Coupling size with a fully functional insulin distribution pump that mimics the functionality of a pancreas will become the standard for future CGM devices. A quarter-sized insulin patch that autonomously distributes insulin into the body is currently in clinical trials, introducing the development of a closed loop insulin delivery system. Hospital at home programs would be able to monitor the readings provided by the Bluetooth-enabled CGM device within the system, allowing the patient's care team to take additional action beyond that provided by the CGM technology.

Heart Rate Monitoring Devices

Current Devices

Current ECG monitoring devices, known as mobile cardiac telemetry monitors, are worn externally on the patient's body as a patch or clothing clip. Most devices send ECG readings as well as respiration and motion patterns to a software platform operated by the patient. Advanced devices share this information via Bluetooth connection in real time to a provider for active monitoring and care adjustments. The technology has demonstrated improved accuracy in arrhythmia diagnosis for patients and increased cost savings for health care organizations. Recent ECG monitoring devices have enhanced ergonomic features, and some monitoring technology is now built into some wearable devices with expanded capabilities, such as the recently released version of the Apple Watch, which can detect irregular heartbeat and trigger atrial fibrillation warning notifications.

Future Devices

Further development of mobile cardiac telemetry monitors will target the size of the wearable device. The cardiac monitoring market has already transitioned from the bulky Holter monitor to smaller, wireless wearable devices, and that trend is expected to continue. Creating additional connectivity between the technology and several different providers and family members as well as manufacturers' ability to automatically update a device's software through the cloud are features that can be expected as these technologies evolve.

Pulse Oximeters

Current Devices

Remote pulse oximeters currently on the market feature either a reusable fingertip clip design or a single-use adhesive sensor. The oximeter wirelessly connects via Bluetooth to a software platform that analyzes and displays saturation and respiratory trends on patients' smart devices. Advanced pulse oximeters that are compatible with sophisticated software platforms transmit readings to care providers for further evaluation. During the COVID-19 pandemic, home-based pulse oximetry monitoring has helped identify the need for hospitalization among initially nonsevere COVID-19 patients; it also has reduced unnecessary ED visits. Several organizations that have scaled hospital at home programs during the COVID-19 pandemic supplied patients with a pulse oximeter to provide oxygen saturation data to their clinical team.

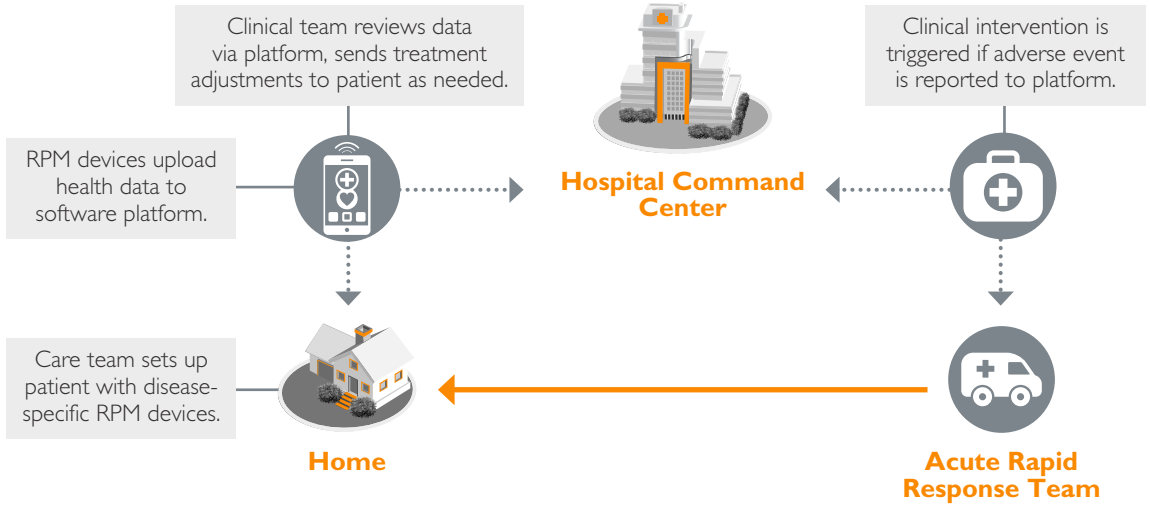
Future Devices

The hardware of the pulse oximeter is subject to change in the coming years. With tech giants such as Apple and Fitbit unveiling new wearable devices with the ability to measure blood oxygen saturation, the current stand-alone device may soon be deemed obsolete. Currently, such wearables are not labeled as medical devices, and the technology they use to measure oxygen saturation is not as accurate as the traditional pulse oximeter. However, consumer expectations will shift toward a wearable device with additional features outside of recording blood oxygen saturation levels.

Technological Attributes and Characteristics

Once a health system has chosen its desired type of hospital at home RPM technology, it must understand the capabilities of related devices and how similar devices stack up against each other. This section highlights key attributes of hospital at home technologies that should be considered when evaluating a remote monitoring device and discusses potential barriers to leveraging features. The inclusion of these attributes and characteristics can support and streamline rapid RPM data transmission to improve treatment response (see Figure 1).

FIGURE 1. RAPID RPM DATA TRANSMISSION DRIVES TREATMENT RESPONSES



EHR Integration

Integrating remote patient monitoring data into an EHR maximizes the value of health information gathered from the patient by creating new clinical insights within an already existing workflow. Remote monitoring platforms that support EHR integration have achieved high net promotor scores and strong adoption rates due to data being conveniently accessible from a single, centralized location. However, advanced levels of implementation are required. Such an endeavor involves thoughtful planning, as IT teams are typically understaffed. Furthermore, any additional integration services provided by a vendor can inflate costs. If executed and monitored correctly, stakeholder communication and overall response time to adverse events are improved by the enhanced system.

Bluetooth Connectivity

Not all remote monitoring devices transmit health information directly to a software platform via Bluetooth. Some devices require patients to self-monitor using a display built into the device, such as a traditional glucose monitor, whereby patients track their own blood sugar levels before reporting the results to a provider or software platform. Devices with Bluetooth connectivity to a software platform allow providers to intervene in real time when an adverse event is taking place. Bluetooth-enabled device setup is a more complex process than that for non-Bluetooth devices. However, patient intervention with the monitoring process is minimal once the technology is integrated with the platform.

Interoperability

Remote monitoring platforms are not compatible with all peripheral devices. When selecting the appropriate platform for a hospital at home program, the platform must integrate with the selected peripheral devices to maximize functionality. Platforms that support integration from several third-party devices often yield strong outcomes. A recent *Journal of General Internal Medicine* study shows that when a platform supporting connectivity from several peripheral device partners was used during a hospital at home intervention program, readmission rates decreased by 25%. Understanding the interoperable capabilities of software platforms is required to build a system that transforms data from multiple peripheral devices into one actionable report.

Platform Customization

Consumers prefer personalization of online software platforms. Modifiable threshold alerts, individualized provider recommendations and choice in the visual layout of the platform dashboard are all factors that can help drive patient engagement with the care team. A 2020 study in the *Israel Medical Association Journal* shows that the use of a customizable RPM platform significantly improved exercise capacity during a 6-month virtual cardiac rehabilitation program. Customizing the software platform requires additional effort by the care team to understand a patient's needs and preferences when using the device. An individualized experience with the platform enhances consumer engagement and encourages sustainability of the overall program.

Device Size and Ease of Use

The development of smaller, sleeker products to improve discretion and privacy will align with patient expectations and improve the quality of clinical data gathered. Cumbersome, uncomfortable designs can directly or indirectly impact the physiological readings recorded by the devices. The use of discreet, minimally invasive monitoring devices supports patient activation and accurate data collection in a hospital at home program.

Similarly, easy-to-use functionality and simplicity across all digital components improve adoption and utilization for patients and providers. While consumers support incorporating remote patient monitoring technologies into their treatment plans, they struggle with the usability and interoperability of these devices once they have adopted them. Balancing sophistication with simplicity among devices drives adherence and patient satisfaction in a hospital at home program.

PROGRAM EXAMPLE

Atrium Health Virtual Hospital

Atrium Health, headquartered in Charlotte, NC, established its Atrium Health Hospital at Home (AH-HaH) as a part of the organization's broader Transition Services program. AH-HaH serves patients who have been discharged but pose a high risk for readmission. It is designed as 2 triaging "floors": a low-acuity virtual observation unit and a high-acuity virtual acute care unit. Additional information about the high-acuity AH-HaH program follows, including its structure, digital components and early results during the COVID-19 pandemic.

STRUCTURE

- Patients who test positive for COVID-19 but do not require intensive care receive a monitoring kit delivered to their home.
- Readings from the monitoring devices are submitted to a software platform for the care team to review.
- Daily questionnaires integrated with the EHR are sent to the patient to gather qualitative information and determine case progression.

DIGITAL COMPONENTS

- Pulse oximeter, blood pressure cuff, thermometer
- Remote monitoring software platform
- Remote data collection supportive of EHR integration
- Two-way synchronous video capabilities

RESULTS

- 160 inpatient beds saved
- IP admission avoided for 87% of participants
- 0 deaths, even among those later admitted to the hospital

Sg2 Perspective

On its own, the use of advanced RPM technology will not be the determining factor in the success and viability of a hospital at home program. However, when the optimum technologies are deployed alongside a well-designed and effectively structured hospital at home program, they elevate the connectivity, breadth of services and sustainability of such programs. Once a type of technology has been chosen, several strategic elements should be evaluated before selecting a specific model or vendor. Remember the following suggestions as you enter the final stages of the selection process:

- **Consider compatibility and capability.** Ensuring that devices operate in conjunction with each other is as important as vetting the capabilities they provide. Select devices that support both compatibility and capability to improve costs and clinical outcomes.
- **Match the sophistication of the device to the needs of the organization.** Maximize the return on investment by avoiding expensive devices with features that offer no additional value to the hospital at home program.
- **Minimize the manual activity needed by a patient to be remotely monitored and treated through targeted clinical interactions.** Selecting autonomous technologies and workflows drives simplicity of the program and encourages adherence of the devices in use.
- **Personalize the set of devices administered to hospital at home patients.** Select clinically relevant technologies that can be used properly by all stakeholders to improve the patient's health.
- **Identify devices that have evolved alongside consumer expectations.** Devices that have adapted to changing consumer preferences will demonstrate longer clinical relevance due to higher patient satisfaction, decreasing the frequency at which equipment is replaced.

Sources: Donlan A. Long-term care decision-makers more likely to choose home care in COVID-19 aftermath. *Home Health Care News*. June 3, 2020; Harris Poll. Telehealth: the coming 'new normal' for healthcare; Johns Hopkins Medicine. Hospital at Home®: home-based care for older adults; Current Health. Imperial College Healthcare NHS Trust: Supporting care homes during a pandemic. September 11, 2020; Sg2 National Health Care Consumerism and Insurance Coverage Survey, 2019; Bottomley E. Technology allows patient in Southern California to remotely submit glucose levels. Permanente Medicine. January 3, 2018; Faulkner S. Glooko touts patient outcomes for remote diabetes care tech. *Drug Delivery Business News*. March 14, 2018; Business Wire. Current Health partners with Dexcom to offer healthcare providers continuous, remote glucose monitoring of patients. July 23, 2020; FDA. FDA authorizes first interoperable, automated insulin dosing controller designed to allow more choices for patients looking to customize their individual diabetes management device system [news release]. December 13, 2019; Best J. Diabetes management: how researchers are looking at new approaches from insulin patches to an artificial pancreas. ZDNet. May 11, 2020; Tsang J-P and Mohan S. *Med Devices (Auckl)*. 2014;7:1–5; Apple. Heart health notifications on your Apple Watch. November 5, 2020; Varma N et al. *J Am Coll Cardiol*. 2020;76(11)1363–1374; St Luke's University Health Network. St Luke's one of first in world to pilot remote patient monitoring for COVID-19 patients [news release]. April 7, 2020; Shah S et al. *Acad Emerg Med*. 2020;27(8):681–692; O'Carroll O et al. *Eur Respir J*. 2020;56(2):2001492; Ker D and Sherr I. Apple Watch Series 6 now measures blood oxygen, but it's not a medical device. CNET. September 16, 2020; Pearson A. Should you trust the new Apple Watch on blood oxygen readings? MedPage Today. September 21, 2020; Twistle. Lessons from behind the frontline: rapid deployment of tele-home monitoring of COVID-19 patients; University Hospitals. Clinical study shows TempTraq® wearable, Bluetooth® continuous temperature monitor detects fevers quicker than the current standard-of-care method in hospitals [news release]. June 14, 2017; Levine DM et al. *J Gen Intern Med*. 2018;33(5):729–736; Conduent. Annual Xerox EHR survey: Americans open to viewing test results, handling healthcare online [news release]. December 16, 2014; Nabutovsky I et al. *Isr Med Assoc J*. 2020;22(6):357–363; Malasinghe LP et al. *J Ambient Intell Humaniz Comput*. 2019;10:57–76; Cassagnol D. CTA survey finds high demand for remote patient monitoring devices [news release]. Consumer Technology Association. April 11, 2019; FDA. List of patient preference–sensitive priority areas. October 7, 2020; Sg2 Analysis, 2020. All websites accessed December 2020.