

Remote Monitoring & Connected Care





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Remote monitoring enables caregivers to track and manage their patients' health beyond the hospital walls. Recent technological advances have resulted in a proliferation of sensors of all sorts. These advances allow for greater measurement, transmission, storage, and analysis of patient data. They have also enabled a paradigm shift: instead of checking in with patients on a regular schedule, care managers can engage and intervene based on device alerts. This report examines remote patient monitoring, the technology that drives it, and several leading solutions on the market today.¹

Why Remote Monitoring?

Healthcare costs are concentrated on the sickest patients, with the top 5% of patients accounting for 49% of all healthcare expenditures in the United States of America. Chronic conditions are a major driver for these patients, with 78% of total healthcare expenditures — trillions of dollars — spent on treating chronic conditions. Additionally, 47% of all healthcare costs go toward treating diabetes, hypertension, pulmonary conditions, heart conditions, and stroke.² This percentage is expected to rise in the coming years alongside an aging and increasingly obese population. Remote monitoring solutions have been understood to provide value since the early 1990s, with studies showing not only high patient compliance, but also positive effects on clinical outcomes, including decreases in ER visits, hospital admissions, and average length of stay.³

Considering these factors, the transition to value-based care, and decreasing costs of sensors and other technology, the market for remote patient monitoring is large and growing. Various estimates of the market size for remote patient monitoring place the global market between \$618 million and \$31.4 billion globally.⁴

From the provider's perspective, this market is substantial enough to support several major suppliers. Due to the wide range of chronic conditions managed and diversity of devices, providers should carefully evaluate the variety of solutions that exist in the market and select one that will best meet the organization's needs."

¹ <http://jamia.oxfordjournals.org/content/14/3/269.full>

² AHRQ - Medical Expenditure Panel Survey

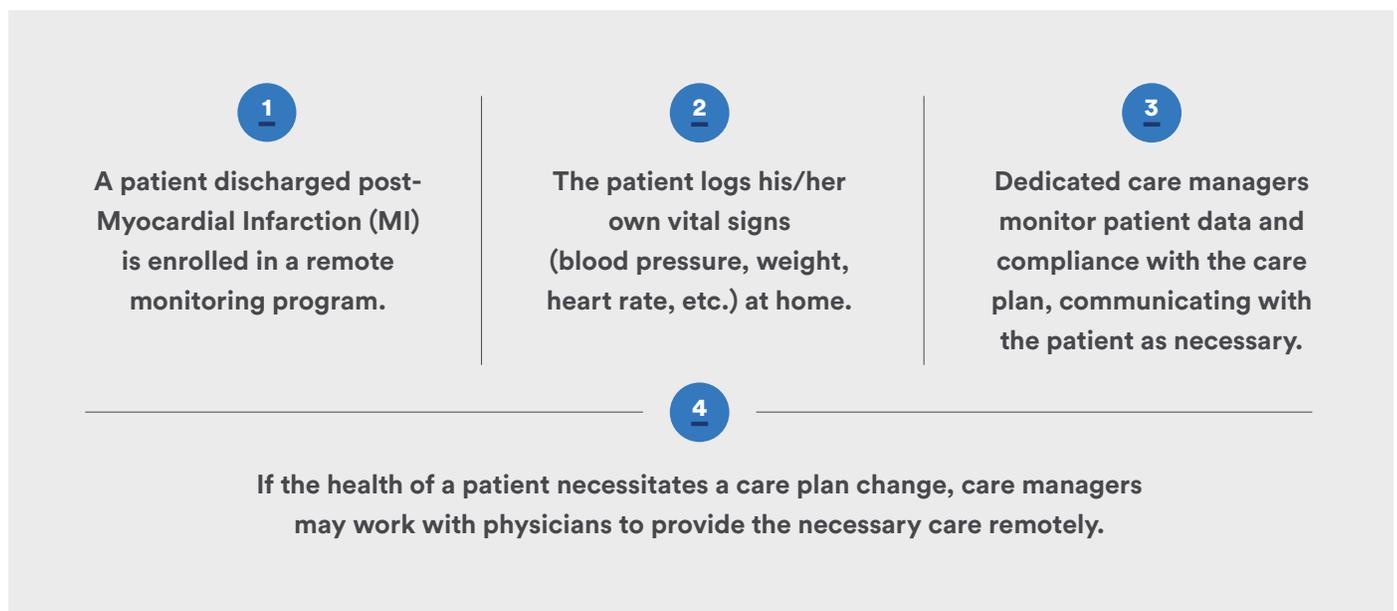
³ JAMIA, "Systematic Review of Home Telemonitoring for Chronic Diseases", May 2007, jamia.oxfordjournals.org/content/14/3/269.full

⁴ Healthbox analysis, Biotronik, Kalorama Information, Goldman Sachs, et al

What is remote monitoring and connected care?

Remote monitoring and connected care programs provide clinical or sub-clinical care to patients directly — regardless of location — reducing the need for physician visits while creating more effective in-person appointments. Additionally, these programs may utilize technology to improve the patient experience by providing more touchpoints with the clinical team, resulting in stronger patient engagement, empowerment, and clinical outcomes. In the simple case outlined below, communication with the patient can be made by telephone, electronic messaging, video-call, or any combination of the aforementioned.

Example scenario:



The value-adds of remote monitoring include:

1. “Just in time” application of care to match continuous variations in physiologic state (“more touch-points”).
2. Resource intensity scaled to patient acuity by allowing a technologically sophisticated, but relatively low-cost solution to replace a home nursing visit.
3. Patient engagement in self-management and disease/health awareness by providing the patient with access to medication lists, activity tracking, diet recommendations, and other features (“empowered engagement”).
4. Action or triage at a distance that conserves expensive professional services by providing care through a more cost-effective centralized site (“the nurse monitoring alerts center”).
5. Ability to use machine learning or other algorithmic techniques to filter out the non-clinically relevant information and identify the important data points that require intervention.

TYPES OF PROGRAMS

Remote monitoring programs are typically targeted toward one of four populations: post-acute, pre-chronic, and chronic, as defined in the report below. This report focuses on solutions primarily targeting the pre-chronic and chronic populations.

TARGET POPULATION	POST-ACUTE	PRE-CHRONIC ILLNESS	CHRONIC ILLNESS
RISK FOR ILLNESS	Already Ill	Moderate-High	Already Ill
OBJECTIVE	<ul style="list-style-type: none"> ✔ Provide more gradual transition in intensity of monitoring from hospital to home ✔ Permit earlier discharge from the hospital (shorter length of stay) by allaying fears of the unmonitored state by monitoring for condition in the home ✔ Reduce cost of care (reduced ER, hospital admissions, and readmissions) 	<ul style="list-style-type: none"> ✔ Patient engagement ✔ Enabling consumer to take control of healthcare ✔ Reduce risk of chronic disease ✔ Reduce cost of care 	<ul style="list-style-type: none"> ✔ Patient engagement ✔ Improve quality of life ✔ Reduce cost of care (reduced ER, hospital admissions, and readmissions) ✔ Reverse chronic disease during onset, if possible
SOLUTION REQUIREMENTS	<ul style="list-style-type: none"> ✔ Peripherals track key metrics ✔ Analytics to detect early deterioration ✔ Communication with care network ✔ Integration with clinician workflows 	<ul style="list-style-type: none"> ✔ Peripherals for tracking activity and metrics ✔ Clinician/care coordinator view of data ✔ Alerts and communication tools for care team and patients 	<ul style="list-style-type: none"> ✔ Peripherals track key metrics ✔ Analytics to detect early deterioration ✔ Communication with care network ✔ Integration with clinician workflows
PREREQUISITES	<ul style="list-style-type: none"> ✔ Purchaser bears risk for the individual ✔ Capitated Payment 	<ul style="list-style-type: none"> ✔ Purchaser bears risk for the overall health of the individual 	<ul style="list-style-type: none"> ✔ Purchaser bears risk for the individual ✔ Capitated Payment

Remote monitoring programs may be specific to a single chronic condition or may address the needs of a variety of chronic conditions. Each condition requires tracking multiple biometric readings.

BIOMETRICS TRACKED BY POPULATIONS SERVED	
CONDITION	BIOMETRICS TRACKED
Asthma (Chronic & Pre-Chronic)	Respiratory rate, respiratory rate interval, pulmonary function (spirometer), oximeter
CHF (Chronic & Pre-Chronic)	Heart rate, heart rate variability, weight
COPD (Chronic & Pre-Chronic)	Respiratory rate, respiratory rate interval, pulmonary function (spirometer), oximeter
Diabetes (Chronic & Pre-Chronic)	Blood glucose levels, weight, activity tracking
Frail/Elderly	Fall detection

Key Remote Monitoring Components & Success Factors

Remote monitoring programs include the following elements, each of which is crucial to successful implementation and for evaluating remote monitoring technologies:

- Patient and care manager friendly user interfaces
- Analytics
- Care management capabilities
- Education and coaching capabilities
- Device quality and management

Patient and Care Manager Friendly User Interfaces (UIs)

Remote monitoring solutions typically have two different UIs — one for care managers and one for patients. Each UI has distinct features that should be evaluated based on the below.



CARE MANAGER UI:

1. **Simplicity and intuitiveness:** Does the solution drive a care manager's enthusiasm about the product?
2. **Customizability:** Does the solution easily enable care managers (or administrators) to customize their own care pathways?
3. **Data visualization:** Does solution present patient data and alerts in an easy-to-understand fashion, limiting alarm fatigue and maximizing efficiency of a care manager's time?
4. **Population management:** Does the solution provide summary data visualization across a panel (for a care manager) or across a population (for the manager of the care manager) to prioritize interventions and optimize healthcare provider resource allocation?



PATIENT UI:

1. **Simplicity and intuitiveness:** Does the solution drive the patient's willingness to use the solution? Ideally, data transmission would occur with no intervention on the part of the patient.
2. **Accessibility:** Does the solution enable those with even little technical proficiency to access the data? A typical remote monitoring program services patients with an average age in the late-70s to early-80s and across groups of varying education levels, income levels, language proficiency, technical proficiency, and other factors. For those who have visual or hearing impairments, large fonts and special audio instructions may be necessary for effective use. If there are significant non-English-speaking populations in your area, consider the language needs beyond English that may be required for an effective program.

For both administrators and patients, a good user interface is key to program adoption.

Analytics Capabilities

With all the data that a remote monitoring program collects, analytics tools are critical to making clinical-sense of biometric signals. Analytics capabilities are essential to the success of a remote monitoring program because they direct the care team's attention to the most prescient information. Without analytics, much of the data produced is not easily actionable.

For those evaluating technologies to adopt, it is also important to consider the level of analytics capabilities, as “smarter” technologies could predict adverse effects or reduce staffing needs.

There are three tiers of analytic capabilities, listed in the order of increasing complexity and utility:

- 1. Identification of out-of-bounds measurements:** Provides varying levels of alerts based on how “far” out of bounds a biometric measurement goes and which type of biometric measurement went out of bounds. For example, if a patient records his/her body temperature and it is greater than one degree from the normal resting body temperature of 98.6 degrees Fahrenheit, then the analytics tool will alert a care manager. In another example, an out of bounds respiratory rate measurement would ideally prompt more immediate interventions than variations in blood pressure because respiratory rate is considered a more important biometric than blood pressure. Furthermore, the system should ideally be able to determine the relevance of the reading before alerting the care manager based on factors such as the number of data points measured and the state of the user (i.e. resting vs. active).
- 2. Trending analysis tool:** Analyzes trends in a patient's biometric signals. This tool may be critical in cases where a patient's weight is not out of bounds but they have steadily gained weight over the course of a few days, indicative of a patient retaining excess water, a condition that requires immediate attention. Again, this type of tool will provide different levels of alerts based on the severity of a trend and/or the type of biometric measurement that the tool has identified as a trend.
- 3. Artificial intelligence:** Identifies the early warning signs that indicate a patient's health deterioration — something that typically takes place over a matter of days. Rather than use a simple range or trend on a single metric, early deterioration algorithms may use factors such as range, directional trends, and variability across multiple biometric signals to detect a patient's deterioration up to several days before other symptoms manifest. The more advanced versions of these algorithms will also incorporate other elements, such as patient history and risk factors, to detect changes in a patient's condition. Small deviations or trends away from an individual's homeostasis will trigger alerts but only when they are clinically relevant. For example, some of these systems have been proven to detect cardiac events days in advance with a very high level of accuracy and specificity. This type of remote monitoring eliminates much of the care manager's routine data analysis, a difficult job given the large amount of data available for interpretation. Several companies are developing algorithms and gathering clinical evidence, but this tool is still nascent in the market.

Care Management Models

Remote monitoring solutions are often utilized to aid care managers in treating their chronic care population. When evaluating a solution, hospitals may consider three types of care management models to administer the remote monitoring.

1. Utilizing existing, in-house care managers to administer the solution:

Historically, insurers have provided care managers through a fee-for-service model; however, healthcare providers are now commonly providing care management services for patient populations in value-based payment models. This model of care management can suffer from drawbacks in that it is typically only available during business hours and may have limited bandwidth in the event that multiple patients need interventions.

2. Augmenting/supplementing in-house care management with outside care managers provided by the remote monitoring solution:

This model has the potential to eliminate the drawbacks mentioned above as there is always someone available for patients to interact with, including outside of standard business hours and on holidays and in the event that in-house care managers have limited bandwidth. In-house care management teams have expressed concerns over the handling of transfers to outside care management teams.

3. Utilizing outside care management teams provided by the remote monitoring solution:

Organizations that do not have existing care management programs might choose this option, as it eliminates the risk in hiring full-time employees. However, it is typically more expensive. Healthcare providers should conduct appropriate research into the quality standards and care models of the outsourced organization as part of solution diligence. Additionally, healthcare providers should consider potential communications issues when transferring patient care to outside care management teams.

Education & Coaching

Another important element to consider when evaluating remote monitoring programs is the education and coaching features. Similar how analytics make the output of a remote monitoring program actionable for the clinicians, education and coaching make the output of a remote monitoring program actionable for the patient. While a typical remote monitoring program only runs between 30 and 90 days, these programs aim to build healthy behaviors that will stay with the patient well beyond the length of the program. To achieve this goal, a remote monitoring solution may use several education tools such as teach-back quizzes, videos, educational content, gamified strategies, and SMS text reminders.

For example, when a remote monitoring program quizzes a patient and the patient answers a question incorrectly about healthy eating, the remote monitoring solution may present video or written content to educate the patient about healthy food choices. Ideally, the remote monitoring solution would customize content for the patient based on preferences and past information. Some remote monitoring programs offer education tools for all disease states while others only have education tools for a limited set of the most common comorbidities. A vendor may be able to add more videos or content at the healthcare organization's request. The depth and breadth of these education materials differentiate the various remote monitoring solutions on the market.

Device Quality & Management

Remote monitoring relies on devices collecting biometric signals. The best device for a healthcare provider will vary based on the needs and requirements of the remote monitoring program. It is critical that clinical-grade devices be used to capture data for the highest risk patients, whereas consumer-grade devices may be more appropriate for lower-risk patients, such as those who are healthy or have pre-chronic conditions.

Some companies provide their own proprietary devices, while others provide devices via third-party manufacturers that integrate with the remote monitoring solution. In both cases, devices are typically connected wirelessly so that data automatically flows to the remote monitoring system upon data collection. Wireless connections increase the reliability of data collected and the consistency of insight into a patient's condition. In either case, there are three main types of devices:

- 1. Peripheral devices:** Extend typical telemetry to the home, such as weight scales, blood pressure cuffs, and glucometers, among others. Patients are asked to use these devices to collect data on a regular schedule.
- 2. Bring-Your-Own-Device model (BYOD):** Allows patients to manually enter their vitals into a care platform using their own existing devices (or devices provided by payers/ healthcare providers).
- 3. Wearables:** Measure biometrics, such as single-lead ECG, heart rate, respiratory rate interval, heart rate variability, respiratory rate, skin temperature, body posture, fall detection, and physical activity, including steps, typically through a patch. Other wearables are able to track real-time changes in body chemistry. Wearable devices are often used continuously. Some vendors offer end-to-end device management, including setup, delivery, and logistics, while other vendors require health systems to manage the devices. When evaluating vendors, healthcare providers should consider human capital availability, both today and in the future, to identify whether device management should be outsourced or maintained in-house. Moreover, healthcare providers should determine whether or not the range of devices, which may include consumer-grade wearables, is acceptable for the goals of the program.



The Future of Remote Monitoring Devices

Wearables likely represent the future of remote monitoring as technological advances will allow for greater device adoption and integration into remote monitoring platforms. In the future, expect to see:

- The extension of wearables' battery lives to the full length of a remote monitoring program.
- A growing number of sensors in each wearable and additional data collected in real-time.
- Development of internal biomonitors, such as subcutaneous devices that track blood glucose instantaneously.

With this shift, care managers will be able to both spend more time interacting with patients and manage larger panels of patients, resulting in higher returns on the investment in human capital.

Example Remote Monitoring Program

While the starting point for each organization may differ, the diagram below offers one vision for how remote monitoring can improve the model of care.



Patient



Remote Monitoring Product



PCPs



Care Managers

Enrollment

One Time	Enrolled into Remote Monitoring Program	Educate patient about solution and equip them with necessary wearables and devices	PCPs enroll high-risk patients	CMs enroll patients post-discharge from hospital
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Care Management Program

BIOMETRIC	Daily	Patients measure their vitals with connected devices and wearables	Patients can see trends in their vitals and identify how changes in regimen affect their health Vital signs are automatically recorded . Data is analyzed and risk-scored.	PCPs are able to track real-time patient data	CMs are able to track real-time patient data
	Daily	Patients are engaged and educated by solution readily	Solution engages, educates and motivates patients readily with digital content	PCPs are able to track patient engagement	CMs are able to track real-time patient engagement
ENGAGEMENT	Ad Hoc	Patients communicate with their care team		Care team (PCP/CM) communicates with patient	
	Monthly	Patient visits PCP	2 Solution provides insight into patient health	PCP sees patient in office	Care managers are immediately made aware of any changes to the care plan and can be looped into the planning if needed
	Rarely	Deterioration of health status or lack of engagement	3 Solution identifies root-cause and recommends action		Care teams are alerted to patient status and provided with tools to intervene

Transition

One Time	Patients no longer considered high-risk , no longer receive intensive care management support	Patients who are still at a high-risk for deterioration remain enrolled in program	Options for lowering intensity monitoring are available	
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- 1 Communication between patients and the care team occurs through the preferred medium of choice (video call, phone call, or messaging.) Engagements are effective as care teams are equipped with personal and population insights to inform their clinical recommendations. PCPs are looped into conversations and are able to recommend regimen changes or prescription changes remotely.
- 2 PCP visits are effective and efficient as PCPs are armed with data giving them a complete picture of the patient's health changes between appointments. Any changes the PCP prescribes, the care manager is notified immediately.
- 3 In the event that the patient has an adverse health event, the solution identifies the issue and notifies the care team. Communication with the patient is quick and contains clear instructions. Questions and concerns that patient has are responded to immediately.

Key Questions

Determining the remote monitoring solutions that will be most successful within an organization depends on many idiosyncratic needs and conditions within that particular organization. The types of remote monitoring programs implemented by your organization may vary with the risk environment you operate in:



The following sets of questions will help establish the specific factors that should be considered when selecting a remote monitoring solution to implement.

TIME TO IMPLEMENT:

- How long will it take to design and implement this program?
- How much additional effort is required to add an additional patient to the program? An additional facility?
- What approval is required within the healthcare organization in order to use the remote monitoring devices with patients?

WORKFLOW CONSIDERATIONS:

- Which staff members will interact with this solution?
- How might workflows change if this solution is implemented?
- Are there any healthcare workers whose current roles may change dramatically or face elimination with the implementation of this solution? If so, how can those concerns be alleviated?
- Are the devices managed by the remote monitoring company?
- Can the solution's interface be integrated into the EMR? If not, how will this impact the care manager's workflow?
- How will target patients be enrolled in the program?

CLINICAL RELEVANCE:

- Which patient population(s) will you focus on? How will you identify these patients?
- What relevant data must be collected from patients in order to effectively monitor them and address their needs?
- What analytics are performed on the data collected?
- How is the data presented to care managers and clinicians? How and when are they alerted about concerning patient data?
- How accurate and reproducible are the measurements recorded by the device(s) in this program?

COST EFFECTIVENESS:

- What is the ROI potential for this solution?
- Are the benefits accruing to the same group that will be paying for the solution? If not, how might you align incentives?

PATIENT QUESTIONS:

- Does the solution interact directly with patients? What amount of additional effort do patients need to take in order to participate in the remote monitoring program?
- Does this solution require either an internet or cellular connection? If so, is that a problem for any of the participating population? Does the remote monitoring company provide a solution to this challenge?
- Is the user interface easy to navigate? What format is the interface (i.e. SMS texting, smartphone, desktop, tablet)?

Stakeholder Involvement

A wide range of stakeholders should be involved in the vetting and implementing of a remote monitoring solution. From administrators to clinicians to the EMR integration team, all stakeholders, including care managers and physicians, need to buy into the solution in order for it to achieve the desired results. Moreover, clinical sponsors should be involved from the initial conversations with short-listed vendors to help shape the metrics upon which the solution will be evaluated. The entire process should be structured and transparent so that everyone understands the purpose of a remote monitoring solution and how each solution will be evaluated.



Potential Metrics for Remote Monitoring Programs

- Rate of readmissions due to conditions monitored
- Length of stay
- Number of homecare visits
- Number of hospitalizations
- Number of ER visits
- Patient engagement
- Patient satisfaction scores
- Staff satisfaction scores
- Disease-specific outcomes (e.g., HbA1c)
- Ability to pursue usually daily activities, including employment

Conclusion

Seven out of the ten leading causes of death in the United States are related to chronic diseases and 86% of U.S. health expenditures are for people with chronic medical or mental health conditions. Remote monitoring programs present an opportunity to better understand and manage chronic diseases including diabetes, COPD, asthma, and chronic heart failure.

These technology-enabled programs allow healthcare systems to better and more efficiently serve patients by tracking them remotely and scaling resources to meet patients' needs. This increased frequency and reliability of data paves the way not only for improved condition management by patients and the care team, but also for increased accuracy and use of algorithmic diagnostic tools, driven by machine learning. Top vendors in the space are able to deliver high quality devices, well-designed user interfaces and experiences, useful analytics, care management capabilities, and education and coaching capabilities.

As the market continues to develop, we anticipate further reductions in the cost of sensors, smaller devices that fit more seamlessly into daily life, improved analytics to detect deterioration sooner. Combined, these innovations have the potential to deliver improved management of chronic conditions and quality of life for millions of people.



About Healthbox

Healthbox is a healthcare innovation services firm that leading organizations trust with decisions on when and how to build, buy, or partner. Founded in 2010, we were the first to combine investing experience and consulting services in a way that is strategic, objective, and actionable for providers, payors, and others across the industry. Our unique perspective and expertise drives innovation from inside organizations and out to to produce lasting impact with our partners. We are proud to work with healthcare leaders who share our passion for building, harnessing, and advancing solutions to empower the reinvention of healthcare.