The Role Of Information and Communications Technology In Chronic Disease Management

January 2010

Report prepared by the Public Health Institute
# The Role Of Information and Communications Technology In Chronic Disease Management

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INTRODUCTION:
The Role Of Information And Communications Technology In Chronic Disease Management
A. INTRODUCTION

PROJECT OBJECTIVE

To assess the role of Information and Communications Technology (ICT) in the development of applications for the management of chronic diseases through providing overviews of the following:

– The current state and future prospects for ICT in chronic disease management with a focus on the market need, innovative approaches using ICT technology, potential benefits, and drivers and barriers to market adoption and diffusion

– Two promising technology areas suited to the delivery and management of chronic conditions: Remote Health Services and Mobile and Web Technologies. The emphasis is on remote patient monitoring, mobile communications technologies, health gaming, and social networking

– ICT-based care management innovations across two specific conditions – cardiovascular diseases and asthma – to reveal a high-value, high-leverage set of interventions that should be more visible to the policy and practice communities.

PROJECT GOAL

To create a credible vision of ICT-enabled innovation in chronic disease management through the following:

– Raising general awareness of the role of information and communications technologies in chronic disease management

– Highlighting specific technology areas that show the greatest promise for transformative change, including recent evidence and case studies

– Demonstrating successful applications of ICT for the management of specific conditions

– Identifying the key drivers and barriers of successful adoption and diffusion of technologies.

PROJECT DELIVERABLES

A series of five integrated publications that can be accessed as one document or as individual modules:

1. Overview of the current state and future prospects for ICT in chronic disease management
2. Technology profiles for Remote Health Services and Mobile and Web Technologies
3. Profiles of ICT-enabled innovations in chronic disease management for cardiovascular diseases and asthma.
The prevalence and incidence of chronic diseases continue to rise. Aging demographics and deleterious lifestyle behaviors are the two most significant contributing risk factors. The worsening chronic disease situation will not only affect an ever larger number of people, but also result in significant human and economic costs to hospitals, health systems, and society. The worsening chronic disease situation will also be accompanied by an increase in the number of conditions per individual. This will in turn create more unnecessary hospitalizations and healthcare resource utilization, complex care management needs, adverse drug events, duplicative tests, conflicting medical advice, and poor functional status.

The capacity of the current health care system to effectively manage this growth in chronic diseases will be seriously challenged, particularly by critical service infrastructure constraints in the form of a growing shortage of qualified professional caregivers. This challenging situation will impress upon key stakeholders the need for transformation of the health care delivery system, through innovative service delivery redesign and the deployment of enabling Information and Communications Technologies (ICT) to broaden self-management, caregiver roles and responsibilities, and sites of care. This is necessary in order to expand capacity and provide chronic care management at many levels (including hospital, community, and self).

This report assesses the role of ICT in the development of applications for the management of chronic diseases. Our goal is to raise general awareness of the role of ICT in the management of chronic diseases and to highlight the promise that two technology categories in particular – remote health services and mobile and web technologies – offer for transformative change. We selected these technologies on the basis of their ability to improve remote access to care services on a regular basis, to impact critical health care measures, and to improve outcomes. Furthermore, we believe that they can be readily adopted and diffused into chronic care practices. We will also examine recent evidence and case studies using ICT in the management of two leading chronic conditions, cardiovascular diseases and asthma. This will be balanced by an assessment of the key drivers and barriers to the successful adoption and diffusion of ICT into hospital-based practices.

This report profiles and discusses the role two broad categories of ICT, Remote Health Services (which include remote patient monitoring) and Mobile and Web Technologies (which include cell phones, social networks, and health games), can play in chronic disease management. We will also focus on two chronic disease areas, cardiovascular disease and asthma, to show how ICT can contribute to delaying disease progression and preventing unnecessary complications and hospitalizations. Improved health outcomes and cost savings can result from unifying diverse ICT components at the point of care to provide patients with integrated, informed and continuous care over time.
Our approach to the work has been as a single research effort with a common methodology through assembling, reviewing and summarizing all previous HealthTech research and products on the subject to both establish baseline content and identify key subject matter experts. We conducted secondary research to identify emerging issues of interest to technology research and application development, and interviewed subject matter experts on emerging trends related to technology and market adoption. Project deliverables include five integrated publications that can be accessed as one report or as individual modules:

• Overview of the current state and future prospects for ICT in chronic disease management
• Technology profiles for the Remote Health Services and Mobile and Web Services categories
• Profiles of ICT-enabled innovations in chronic disease management for cardiovascular diseases and asthma.
CHRONIC DISEASE MANAGEMENT

CURRENT DRIVERS
Chronic diseases exert significant human and economic costs on the health-care system and the chronic disease burden is likely to continue to increase over time:

- Almost half of the U.S. population has at least one chronic condition, with approximately 25% having multiple conditions
- Chronic diseases account for high costs in terms of lost productivity, treatment expenditures, and health care resource utilization
- A shortage of qualified professional caregivers is placing even more emphasis on the need to ‘downshift’ care management responsibilities and sites of care.

EMERGING TRENDS
Reengineering of care management communications and interventions is leading to care that is more coordinated, proactive and patient-centric through the following:

- “Downshifting” service capacity and the workforce in chronic care processes to provide effective levels of care management
- Designing chronic care management models that are coordinated, incorporate self-management, and can span multiple age groups and conditions
- Deploying technology-enabled processes that support evidence-based and coordinated care, patient-provider communications, and self-management.

IMPLICATIONS FOR CHRONIC CARE MANAGEMENT
The integration of ICT with chronic care management processes or frameworks can promote a technology-enabled, systematic approach to chronic disease prevention and control, and support critical care coordination, provider-patient interaction, and self-management functions across systems, populations, and conditions. Key functional elements include the following:

- Frequent and reliable communication between patient and provider
- Real-time decision making at the point of care
- Customized patient guidance and education to support self-care
- Clinical information exchange to facilitate care coordination
- Adherence to evidence-based practices to support ongoing quality improvement
- Performance accountability by reporting program and organizational outcomes.

ICT ADOPTION AND DIFFUSION IN CHRONIC CARE MANAGEMENT
The widespread deployment of ICT in chronic care management requires overcoming a mix of policy, business and end-user issues that currently act as barriers:
• Lack of third-party reimbursement and a solid evidence-base that supports the business case for the sustained use of ICT in chronic disease service delivery
• Poor frameworks for matching individual patients’ needs and capabilities to specific chronic care management technologies
• Limited direct consumer demand for technologies to manage chronic diseases
• Technologies that lack broad appeal due to poor usability and functionality
• Challenges associated with integrating ICT into provider workflow due to a mix of organizational, technical and operational factors.

The Current State and Future Outlook for Chronic Diseases

Chronic disease conditions are defined as any health condition requiring ongoing care activities and response from the patient, caregivers, and the health care system and in which patient self-care efforts are significant. Such conditions currently exert a significant human and economic cost on the health system. The identification of strategies for their effective management is perhaps the most pressing and challenging long-term clinical issue facing the U.S. health care delivery system. The “perfect storm” of an aging population, increasing disease incidence, and a shortage of qualified caregivers is creating an urgent need for more robust models of chronic care management that are cost-effective and coordinated, that incorporate self-management techniques, and that can span multiple conditions and age groups.

Today, nearly half of all Americans have at least one chronic condition, while a quarter have multiple chronic conditions. In 2005, 133 million people lived with at least one chronic condition. The prevalence of multiple chronic conditions is particularly high among older adults, with over 80% of people over the age of 65 having more than one condition. The number of people with chronic conditions is expected to increase by nearly 30% between 2005 and 2030 to 171 million. The medical care costs of people with chronic diseases account for more than 75% of $2 trillion in total national health spending, and the rising prevalence of treating chronic diseases between 1987 and 2007 was the single greatest cause of rising health care spending in the U.S, accounting for approximately two-thirds of the increase or $453 billion.

All chronic diseases combined had an estimated economic impact of $1.3 trillion in 2003, with the majority associated with lost economic output (approximately $1 trillion) and the remainder with treatment expenditures ($277 billion). In assessing the overall economic impact from chronic diseases in 2003, cardiovascular diseases (hypertension and heart disease) were the single most significant chronic disease group. Based on the current chronic disease trajectory, the economic impact from chronic diseases is estimated to rise to close to $4 trillion by 2023, with the vast majority of costs still being attributed to lost economic output. An analysis by the Milken Institute suggests that the United States could save $1.1 trillion by 2023 ($805 billion from gains in productivity and $218 billion from reduced spending on treatment) through improvements in chronic care management and prevention efforts.

Among chronic diseases affecting adults, cardiovascular diseases currently account for both the highest prevalence and the leading cause of mortality. Other common chronic conditions affecting Americans include pulmonary conditions, mental disorders, diabetes, and cancer. Today’s chronic disease profile is continually evolving to reflect the significance of risk-inducing lifestyle behaviors, the degenerative nature of many of the conditions which disproportionately affect a growing number of elderly, and clinical advances in diagnostic and therapeutic interventions that allow people to live longer with chronic conditions. According to the Milken Institute report referenced above, cancer is projected to have the largest single increase among chronic conditions in the number of cases from 2003-2023. Mental disorders and diabetes are projected to be the next fastest-growing groups, followed by cardiovascular conditions. All major chronic illnesses are projected to increase at a rate faster than population growth during this time period.
Chronic Disease Management: Populations, Goals, and Technologies

Treatment of all the major chronic diseases, with the exception of depression and arthritis, indicate a gradual shift in the site of care away from hospitals as the primary site of care and an increase in ambulatory care visit rates. An analysis of utilization patterns of chronic care services confirms that the majority of chronic care service delivery is currently taking place through primary care practices. The trend in “downshifting” the site of care will continue as the prevalence of chronic diseases continues to rise and technology enables the delivery of care services to extend beyond primary care practices to other community-based sites of care, including the home. Shifting to an interdisciplinary primary care team-based care model is also viewed as necessary in order to provide effective care management capacity in response to patient care needs, projected labor shortages, and the growth in chronic disease cases. However, demand for services will be so great that a caregiver shortage is still projected despite expected growth in unlicensed professional caregivers and family caregivers.

Figure 2 highlights the varying levels of resource use and intensity of interventions associated with care settings and caregivers relative to the required chronic disease management goals and actions across systems, populations and stages of disease.

Figure 2: Chronic Disease Management Process

<table>
<thead>
<tr>
<th>Target Population</th>
<th>Healthy</th>
<th>At-Risk</th>
<th>Minimal-Moderate Disease</th>
<th>Significant Disease</th>
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<tr>
<td>Intervention Goal</td>
<td>Keep population healthy</td>
<td>ID at-risk patients</td>
<td>Delay disease progression</td>
<td>Minimize complications &amp; costs</td>
</tr>
<tr>
<td>Intervention Approach</td>
<td>Population health management</td>
<td>Candidate selection and enrollment</td>
<td>Personal health management</td>
<td>Acute clinical care</td>
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Figure 2: Chronic Disease Management Process

Figure 3 illustrates how chronic disease management reflects a complex mix of populations, care settings, caregivers and technologies. The role of technology-enabled innovation is to effectively “downshift” service capacity to the community and other less resource intensive sites and to incorporate patients, their families and caregivers in care processes.

Figure 3: Chronic Disease Management Process: Target Populations
Figure 4 highlights how such a technology-enabled framework allows us to move chronic disease interventions that incorporate prevention and management goals focused on healthy and at-risk populations “upstream” in order to slow if not reduce future “downstream” demand for services at traditional sites and from professional caregivers.

Figure 4: Chronic Disease Management Process: Intervention Goals
Figure 5 illustrates how each system- and population-level has a wide array of ICT options available to support provider-patient interactions and self-management interventions.

Figure 5: Chronic Disease Management Process: Technology Options
Communication and the design of chronic disease interventions, particularly the ability to provide patients with integrated care over time (supported by coordinated and relevant information and actions), can have the most significant impact on outcomes. Figure 6 illustrates a model that supports core chronic care management functions using ICT. However, progress in technology-enabled chronic disease management processes will rely not only on technical developments in the core ICT technology areas but also, and perhaps more importantly, enabling regulatory and market developments such as reimbursement policy that promote widespread adoption and sustained use:

**Figure 6: Technology-Enabled Chronic Care Management Functions**

![Image of Figure 6: Technology-Enabled Chronic Care Management Functions](source: Canada Health Infoway)
An Integrated Framework for Chronic Care Management

The professional literature provides a number of frameworks for understanding chronic disease management. One of the best recognized and most robust models is the Chronic Care Model (CCM) developed by Dr. Edward Wagner. CCM relies on electronic disease registries, evidence-based guidelines, patient self-management support, and decentralized on-site consultation. It builds on the inter-relationships between six evidence-based elements that lead to improved clinical quality through proactive, planned and population-based chronic disease management:

1. Delivery system design  
2. Decision support  
3. Clinical information systems  
4. Self-management support  
5. Community  
6. Organization of health care

It also relies on primary care teams focused around patient panels and using multidisciplinary team members. The model is illustrated in Figure 7:

Figure 7: The Chronic Care Model

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Approximately 1,500 medical practices nationwide are using CCM today. User organizations tend to be integrated delivery systems that have also invested more heavily as organizations in IT support in the form of electronic patient records and supporting clinical information systems. Evidence from chronic care management programs based on CCM and integrated with primary care demonstrates a sustainable, quality-improvement approach to the management of chronic diseases. Multi-component practice changes in four key areas have been found to contribute to the greatest improvements in health outcomes:

1. Increasing providers’ expertise and skill
2. Educating and supporting patients
3. Making care delivery more team-based and planned
4. Making better use of registry-based information systems

A summary of evidence on the effectiveness of CCM is provided in Table 1:

**Table 1: Effective Chronic Care Model Interventions**

<table>
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<tr>
<th>Component</th>
<th>Interventions shown to be effective</th>
<th>Outcome measures affected</th>
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| Patient self-management support | • Patient educational sessions  
                             | • Patient motivational counseling  
                             | • Distribution of educational materials                          | • Physiological measures of disease  
                             | • Patient factors: quality of life, health status, functional status, satisfaction with service, risk behaviour, knowledge, service use, adherence to treatment |
| Delivery system design         | • Multidisciplinary teams                                  | • Physiological measures of disease  
                             | • Professional adherence to guidelines  
                             | • Patient service use                                      | • Physiological measures of disease  
                             | • Professional adherence to guidelines  
                             | • Physiological measures of disease                                      |
| Decision support               | • Implementation of evidence-based guidelines  
                             | • Educational meetings with professionals  
                             | • Distribution of educational materials among professionals         | • Professionals adherence to guidelines  
                             | • Audit and feedback                                          | • Physiological measures of disease                                      |
| Clinical information systems   | • Little published experimental evidence                   | • Professionals adherence to guidelines                          |
| Health care organization       | • Little published experimental evidence                   |                                                                 |
| Community resources            | • Little published experimental evidence                   |                                                                 |

Source: Canada Health Infoway

The evidence on the effectiveness of CCM dovetails with key findings from a technology assessment report from the Agency for Healthcare Research and Quality (AHRQ). In particular, the report focused on studies of interactive consumer health IT and factors influencing the use, usefulness, and usability for the elderly, chronically ill, and underserved populations. The review concluded that ICT has the greatest positive effect on patient care processes and outcomes when a feedback loop is provided between physician recommendations and patient actions through the following functions:

- Monitoring current health status
- Interpretation of data in light of established, often individualized treatment goals
- Adjustment of the care management plan as needed
- Communication back to the patient with tailored recommendations or advice plus repetition of this cycle at appropriate intervals

Evidence on the cost-effectiveness of CCM is just beginning to emerge, and more research is needed to understand the actual costs and benefits to practices, payers, and patients. Preliminary findings from the experiences of early collaborative participants have demonstrated that although redesigning practices along the lines of the CCM costs practices money in the short term (an extra $6–$22 per patient in the first year in one study), lowered risks from reducing complications of blindness, end-stage renal disease, and coronary artery disease led to an increase in quality-adjusted life-years at a price considered to be cost-effective from a societal perspective.

A recent survey was conducted of 15 Medicare Coordinated Care Demonstrations, six of which used home telemonitoring devices for daily transmission of physical readings and symptom reports. According to the survey, for the sites shown to be effective in reducing hospitalizations and costs over four years, six key components were critical to their success and could indicate how to sustain effective outcomes and cost savings over the long term. However, the review cautions that it is not simply the presence of program components but how well they are integrated that will determine the success of an intervention:

1. Targeting of those patients at ‘substantial’ risk of hospitalization in the coming year
2. In-person contact with patients
3. Access to timely information on hospital and emergency room admissions shortly after they occur
4. Close interaction between care coordinators and primary care physicians and using the same coordinator for patients of a given primary care physician
5. Providing a range of services that include assessing, care planning, educating, monitoring, and coaching patients on self-management
6. Staffing that supports coordinator and team-based roles

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Our proposed framework for the management of chronic diseases relies on the integration of ICT with the CCM model to promote a technology-enabled, systematic approach to chronic disease prevention and control, the integration of the critical care management elements and, most important, the ability to downshift caregiver roles and responsibilities and sites of care. Key functional elements of this ICT-enabled model include the following:

- Frequent and reliable communication between patient and provider
- Customized patient guidance and education to support self-care
- Clinical information exchange to facilitate care coordination
- Adherence to evidence-based practice to support continuous quality improvement
- Performance accountability by reporting outcomes of programs and organizations

A viable technology-enabled model for chronic care management will select from a broad array of ICT tools to support providers in coordinating and delivering quality care. It will also support patients in gaining confidence and competence in self-managing their chronic care. In particular, the application of ICT within the CCM framework will support the ultimate goal of facilitating productive communications and interactions between informed activated patients (with the information, motivation, skills and confidence necessary to make decisions about their care) and prepared, proactive practice teams (with the patient information, decision support, and other resources needed to deliver quality care).

The use of ICT will lead to improved health outcomes and reduced costs by focusing on the following:

- **Evidence-based Practice Guidelines** – An integrated system of electronic communication devices, decision-support tools, and clinical databases will ensure and monitor the implementation of evidence-based practice guidelines to increase quality of care and reduce medical errors.

- **Collaborative Practice Models** – Electronic or Internet-based technologies integrated with clinical information tools will facilitate the management of relevant clinical and patient information, support the coordination of care interventions and communications between providers and their patients.

- **Patient Empowerment Strategies** – Internet-based, in-home, or personal communication technologies will provide personalized patient guidance and education to guide patients and enable self-assessment and self-care education.

**ICT in Chronic Care Management**

Health care is a data-rich, information-dependent, fragmented process where the management of information is central to optimizing resource utilization and achieving process efficiencies that will lead to cost-effective, quality care and improved health outcomes. ICT is increasingly viewed as a viable technological means for bridging gaps in the health system’s current approach to facilitating and managing the flow of information related to the growing number of chronic disease patients. In addition, ICT offers the ability to provide chronic care management programs with a scalable approach for optimizing resource utilization and building capacity into the care management process while supporting the downshifting of caregiver roles and responsibilities as well as sites of care.
Information and communications technologies (ICT) is an umbrella term that covers a broad range of technologies involved in the capture, storage, processing and communication of information. ICTs provide the enabling technology components for an integrated and coordinated electronic health information infrastructure of chronic care interventions and communications that will provide timely, relevant, reliable, and secure health care information and services. In the remote delivery of chronic care services, specific enabling technologies used in application development include video phones, messaging and reminder systems, measurement and monitoring, and personal computing devices, many of which allow connection to peripheral medical devices that automatically capture and facilitate the transmission of physiological data and images.

Figure 8 illustrates the convergence of ICT to support chronic disease management:

**Figure 8: ICT Convergence in Chronic Disease Management**

Source: Canada Health Infoway
ICT can address broad challenges presented to delivery systems in chronic disease management, namely in data management, workforce and care processes, and business sustainability, through the following functions:

- **Data Management** improvements will result from more structured and automated data collection, analysis and display methods. This will in turn lead to reduced errors, improved accuracy and quality of data, enhanced data access and exchange capabilities, and the ability to process and display data for more effective decision support.

- **Workforce and Care Process** efficiencies will result from improved coordination, communication and decision support capabilities across care settings and care teams, interactive and continuous feedback between the patient and provider, building in trust and accountability mechanisms, and automation of repetitive care tasks.

- **Business Sustainability** will result from streamlining care processes and creating economies of scale for chronic disease management across large populations. This in turn will lead to greater cost reductions for data management and communication and improved care process efficiencies through optimizing provider resource utilization and activating patients in self-management practices.

The basic ICT infrastructure includes networking hardware and software, enterprise and personal data storage and security systems, monitoring devices that integrate sensor, communications and data storage capabilities, and artificial intelligence capabilities in the form of intelligent software agents linked to the network to provide more predictive and customized decision support. Current application developments in the electronic delivery of clinical health care services include tools that perform the following tasks:

- Offer evidence-based practice guidelines (such as electronic patient records and physician-order entry systems)

- Support collaborative practice models (such as computerized disease registries allowing for team-based care and remote patient monitoring tools to engage patients more actively in their care), and

- Promote patient empowerment (such as mobile personal communications systems that extend personal care services to individuals and that assist in self-management support).

CCM proposes that improving the health of people with chronic conditions requires transforming the delivery system from one that is essentially reactive to one that is proactive through a series of interactive, coordinated, patient-centric communications and interventions. Our proposed framework for the management of chronic conditions relies on the integration of the CCM model with ICT that we have identified as promising in promoting the core features of a transformational, technology-based chronic care model based on evidence. We believe that improvements in health outcomes are greatest when implemented as an integrated strategy of multi-component practice changes in several areas:
• **Make better use of registry-based information systems** to organize patient- and population-level data to facilitate efficient and effective care. A comprehensive clinical information system can enhance the care of individual patients by providing timely reminders for needed services, with the summarized data helping to track and plan care. At the practice population level, an information system can identify groups of patients needing additional care as well as facilitate performance monitoring of practice teams and the care system and the identification of targeted quality improvement efforts.

• **Make care delivery more team-based and planned** to increase the capacity and options for chronic care, and to provide the information and shared decision making that many primary care physicians lack the time to offer on an individual basis. The panel management approach uses medical assistants trained as patient panel managers to systematically review the chronic disease registry, to contact patients to come in for overdue routine services, and to help physicians intensify medications more rapidly. This approach also leverages the HIT infrastructure of organizations to offer a systemized process for coordinating physician and team activities in population-level chronic care management. In addition, tele-training and tele-education programs can help improve provider skill and expertise.

• **Using evidence-based medicine** to promote clinical care practices that are based on explicit, proven guidelines that are consistent with the latest scientific evidence and considerate of patient preferences. Evidence-based guidelines should be discussed with patients to encourage their active participation in their own care plan. Those who make treatment decisions need ongoing training to stay current on the latest evidence, using new models of provider education that improve upon traditional continuing medical education. To change practice, guidelines must be integrated through timely reminders, feedback, standing orders and other electronic communication methods that increase their visibility at the time that clinical decisions are made.

• **Educate and support patients** to enable them to participate more fully in managing their health through effective self-management support that includes the use of proven programs that provide basic information, emotional support, and strategies for living with chronic illness. Self management support also relies on a collaborative approach where providers involve patients more actively in defining problems, setting priorities, establishing goals, creating individual care plans, and continuously monitoring progress and outcomes. Using ICT to involve patients in the management of their conditions tends to be most effective when providing a complete feedback loop, allowing for frequent interactions with a clinician and involving the participation of a multidisciplinary health care team.
Figure 9 illustrates the past, present and desired future for chronic care management. The bottom-left quadrant illustrates the traditional resource-intensive approach characterized by disease management services’ call centers. This system of care coordination is now being increasingly delivered through programs organized by providers themselves, as represented by the upper left quadrant. To the lower right is a technology-leveraged care model that is continuous and proactive but organized outside of the traditional care model. The key to realizing improved health outcomes and cost savings will require operational designs that employ ICT in unifying disease registry functionality, care coordination services, and remote patient monitoring technology at the point of care, the Value Quadrant of Healthcare Reform, to simultaneously provide the following:

- Tracking of chronic care management progress and targeting interventions to the right individuals within a population
- Raising the level of awareness of the status of individuals with chronic disease and keeping them in better contact with their care team
- Providing care coordination staffing infrastructure, training and performance management
- Organizing provider systems to have chronic care physician oversight and incentives to deliver chronic care management

Figure 9: The Universe of Chronic Care Management

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ICT-enabled remote health services are being integrated into traditional primary care-home care management to identify patients at risk for early readmission and to enhance traditional primary care-home care strategies and the quality of care delivered. Potential applications include patient follow-up, screening, reminders, after-hours access, and counseling by telephone. Patients can use an array of peripheral devices such as vital sign monitoring equipment, weight scales, pulse oximetry, and stethoscopes, as well as systems for menu planning, compliance reminders, educational resources, and program critical pathways. *Table 2* (next page) highlights the array of ICT options for tech-enabled chronic care management messaging, monitoring, and disease management applications:
Table 2: ICT Along The Chronic Care Management Continuum

<table>
<thead>
<tr>
<th>Patient Environment</th>
<th>Communications</th>
<th>Provider Environment</th>
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<tr>
<td><strong>ICT ENABLING DATA MANAGEMENT AND CARE PROCESSES:</strong></td>
<td><strong>ICT ENABLING DATA COMMUNICATIONS, EXCHANGE, AND MANAGEMENT:</strong></td>
<td><strong>ICT ENABLING DATA MANAGEMENT, AND WORKFORCE AND CARE PROCESSES:</strong></td>
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<tr>
<td>SELF CARE RESOURCES AND EDUCATION</td>
<td>REMOTE MONITORING SERVICES</td>
<td>COLLABORATIVE CARE SOLUTIONS</td>
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**Untethered Personal Health Record:** An electronic record of health-related information on an individual that can be drawn from multiple sources while being managed, shared, and controlled by the individual. The record is not formally linked to any institution, allowing patients to connect to information in other health management systems or devices.

**Remote Patient Monitoring:** Home-based telehealth monitoring and management devices that measure and capture a biological or chemical analyte or a physical stimulus (such as pressure). Typically a device that a patient has on, in or around the body to measure, track adherence to care guidelines, and detect variations in status.

**Personal Communications Devices:** Available formats include the Plain Old Telephone System (standard telephone service that most homes use); Cell Phone (mobile, wireless personal communication device); and Smart Phone (mobile phone offering advanced capabilities, often with PC-like functionality)

**Structured Clinical Messaging:** Allows the exchange of clinical information between patients and clinicians using Internet-enabled devices and structured communications

**Text Messaging/ Short Message Service:** SMS is a communication service standardized in mobile communications allowing the interchange of short text messages between mobile telephone devices.

**Health Information Exchange:** The electronic movement of health-related information among organizations according to nationally recognized standards

**Geographic Information Systems:** An information system that captures, stores, analyzes, manages, and presents data that is linked to physical location

**Electronic Health Record:** An electronic record of health-related information on an individual that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization.

**Electronic Medical Record:** An electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization.

**Tethered Personal Health Record:** PHR that is sponsored by an organization like a provider, payer or employer (when sponsored by a provider they are usually an extension of an EMR) that allows patients to communicate with care team members and manage aggregated care information and care needs.
### Table 2: ICT Along The Chronic Care Management Continuum

<table>
<thead>
<tr>
<th>Patient Environment</th>
<th>Communications</th>
<th>Provider Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICT ENABLING DATA MANAGEMENT AND CARE PROCESSES:</strong></td>
<td><strong>ICT ENABLING DATA COMMUNICATIONS, EXCHANGE, AND MANAGEMENT:</strong></td>
<td><strong>ICT ENABLING DATA MANAGEMENT, AND WORKFORCE AND CARE PROCESSES:</strong></td>
</tr>
<tr>
<td>SELF CARE RESOURCES AND EDUCATION</td>
<td>REMOTE MONITORING SERVICES</td>
<td>COLLABORATIVE CARE SOLUTIONS</td>
</tr>
<tr>
<td>Electronic Health Games: Interactive media platform that offers the user a set of challenges and tasks to complete and provides feedback about the user’s skills and performance</td>
<td>Data Communications Networks: Available services range from the simple dial-up modem to more advanced data bandwidth services like DSL, wireless cable, and mobile broadband.</td>
<td>Disease Registries: Hospital- and population-based chronic disease management systems that track and manage disease-specific information for individual patients and populations to support evidence-based proactive patient care and population management, and provider performance</td>
</tr>
<tr>
<td>Patient Portals: Healthcare-related online applications, sometimes linked to an EHR, which allow patients to interact and communicate with their healthcare providers, such as physicians and hospitals.</td>
<td>Store and Forward Systems: The collection and storage of clinical data or images digitally which is later forwarded for interpretation at a time distant from a face-to-face clinical encounter.</td>
<td>Electronic Prescribing: Handheld electronic devices loaded with software that enhance workflow productivity and improve care quality at the point of care</td>
</tr>
<tr>
<td>Social Media: The use of web-based communication tools (including blogs, wikis, podcasts, social networks, instant messaging, and video) to connect to health information, share knowledge, provide personal support, and collaborate with other users online</td>
<td>Interactive Care Communications : Collaborative space that allows consumers to consult with doctors, nurses, and therapists (including behavioral health care providers) via secure e-mail; renew prescriptions; schedule and cancel appointments; review detailed lab test results; view immunization histories as well as receive reminder communications on preventive and chronic care service needs, specific chronic health resources and evidence-based care guidance as a result of claims analysis.</td>
<td>Clinical Decision Support: Evidence-based information management systems that identify gaps or opportunities to improve individual patient care.</td>
</tr>
<tr>
<td>Virtual Worlds: Simulated environment, which may or may not be based on a real environment that users explore and possibly interact with others.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Barriers to ICT Adoption and Diffusion in Chronic Care Management

While numerous technology applications and pilots in chronic disease management currently exist, information and communications technologies have yet to see widespread adoption despite their many proven benefits. Much of the current adoption has been limited to small-scale pilots scattered throughout the United States, or to large health systems (such as the VHA or Kaiser Permanente) which assume full risk for costs of care and therefore have the incentive to fund the deployment of these technologies. Obstacles still remain though in terms of the future development and wider adoption of these technologies, and the ubiquitous use of these technologies remains a long way off. Some of these obstacles include the following:

- **Lack of funding and reimbursement leading to poor provider uptake:** Currently, there is very little direct reimbursement from third parties for the use of remote health, mobile, and web technologies. Technology vendors frequently cite this as the largest barrier to adoption, as there is little incentive for a provider to adopt a technology when the financial benefit is more likely to be realized by payers. The exception to this is the Veterans Health Administration and integrated provider-based health plans, such as Kaiser Permanente and Group Health of Puget Sound, which have an incentive to deploy such technologies because they can translate cost and utilization savings into direct economic benefits.

- **Technology Implementation:** Challenges in technology implementation and the associated change management requirements result in significant barriers to technology adoption. Even if a provider were able to support a web, mobile, or remote technology application in chronic care management, it is often difficult to integrate the technology into the provider’s workflow and provide the staffing and other resources necessary to support the technology.

- **Proof of both ROI/business case and clinical outcomes:** While some technologies have been able to demonstrate an ROI and improved clinical outcomes, greater adoption of these technologies will require the development of a larger evidence base and models of implementation to draw experience from. Without such an evidence base, providers will focus on the upfront cost rather than potential long-term benefits that result from their deployment, which limits the adoption of these technologies.

- **Lack of patient self-actualization relating to their own health:** At present, the level of demand from patients and consumers for these technologies for the purposes of self-directed care is not substantial. A minority of patients are motivated and educated with regard to their own health to the extent where they would directly demand a technology for disease management. In addition, many patients view any technology relating to the management of chronic illness as being the responsibility of the provider or health plan, rather than the responsibility of the individual patient.

- **Technologies still lack usability and functionality:** While many web, mobile, and remote technologies are currently available and these offerings have made great strides in functionality and interface design, further improvements in the technologies themselves will be an important part of future adoption and deployment. In order to have the broadest appeal possible to providers as well as consumers, technologies would benefit from being less expensive, more reliable, more user-friendly, and easier to incorporate into workflow processes.
The future adoption of ICT will initially be driven by employers and fully-integrated provider-based health plans, as they have the greatest benefits to be derived from the cost savings associated with improved chronic disease outcomes, as well as the greatest interest in broadly deploying technologies for the purposes of better population health management. As these technologies become more established in chronic care management processes, integrated healthcare delivery systems and health plans will represent the next level of adoption, especially when coupled with increased quality and outcome mandates. Direct-to-consumer offerings are expected to be the last level of adoption, and will require a shift in the way that patients view disease management responsibilities.

The population with chronic illnesses and the needs they face for medical and social support services is very diverse. Figure 10 reflects the continuum of need for support among Medicare beneficiaries in improving adherence and coordination of medical care and social services relative to the severity and complexity of the chronic conditions patients have. Patients with a greater number of chronic conditions and therefore at a higher risk for rehospitalization due to the severity and complexity of their conditions are likely to be further to the right and therefore in greater need of coordination in their care. On the other hand, those patients at the upper level of the chart do not necessarily have major medical problems but will rely on social services to support them.

**Figure 10: Care Support Needs of Medicare Beneficiaries with Chronic Illnesses**

Source: Mathematica Policy Research
Once an organization has decided to adopt a technology, effectively matching technologies with individual patients relative to their needs and capabilities is the next challenge. VHA (Veterans Health Administration), which uses remote health technologies in the delivery of non-institutional care services to chronically ill individuals and populations, has developed a patient classification system to help categorize patients on the basis of complexity of their care and an algorithm to then assign remote health technologies accordingly.9 (Figure 11, next page) The algorithm uses indicators related to physical and cognitive abilities, such as manual dexterity and literacy level. Patients are reassessed on a quarterly basis. Care coordinators attribute high levels of patient satisfaction and compliance with its technology-enabled non-institutional care services to the algorithm. In effect, patient clinical need and ability, not the type or brand of technology, drives the algorithm. The technology selection in the algorithm includes videophones, messaging devices, biometric devices, digital cameras, and telemonitoring devices.

The Role of Information and Communications Technology in Chronic Disease Management

Figure 11: Chronic Care Management Technology Assignment

Source: Veterans Health Administration

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Given the considerable potential and promising evidence currently available for these technologies to improve clinical outcomes, to support treatment adherence and health management behaviors, and to generate care-related cost savings, overcoming the obstacles is critical for realizing their full benefit for chronic disease management. In order for this to happen, actions must be taken at a policy level as well as on the part of the technology companies, and specific incentives must be created for providers and/or patients to encourage more widespread use of these technologies. Policy initiatives that are expected to have a positive effect on technology adoption include the following:

- **Explicit reimbursement for technologies**: Establishing reimbursement to providers directly for using web, mobile and remote self-management and monitoring technologies will help overcome financial barriers. Currently, many providers are reluctant to adopt these technologies, as financial benefits from decreased healthcare utilization are usually passed along to insurance companies, while the providers themselves may not recoup their initial investment. Reimbursement for these technologies through insurance companies, government, or other third parties would speed the adoption of these technologies.

- **Implicit reimbursement through mandates or non-payments for unacceptable outcomes**: The alternative to direct, explicit reimbursement for these technologies is policy initiatives that mandate certain outcomes, which will in turn promote technology adoption. Some initiatives are already underway, such as non-payment for “never events” and hospital readmissions within 30 days of original discharge for certain conditions. As the policy focus on healthcare outcomes and cutting healthcare costs continues, such mandates and payment adjustments will only become more common. These changes will align financial incentives to support providers’ adoption of technology.

- **Increased standards and certifications**: Creating standards and certification processes for chronic disease technology applications (or health-related technology applications in general) would increase the functionality and interoperability of these technologies. Currently, most of these technologies are relatively limited with respect to their interoperability with other information systems, such as electronic medical records, and sharing data across settings, such as non-provider settings. Standards and certifications that increase interoperability and other data sharing functionalities would make a stronger case for these technologies to be adopted widely.

- **Employer or health plan-provided incentives for better health**: Incentives to manage and improve health status can also boost wider use of these technologies. At present, such initiatives are provided through employers or health plans, as these entities bear many of the associated costs, and as a result see the most benefit for improved health of their workers and health plan members. In the future, these incentives are expected to become more widespread, which will likely encourage people to look for additional solutions to manage their health, either from providers or the market directly.
A report sponsored by Better Health Care Together, *Vital Signs via Broadband: Remote Health Monitoring Transmits Savings, Enhances Lives*, finds that public policy adjustments that reduce barriers and promote accelerated adoption and use of remote monitoring tools can lead to savings of $197 billion over the next 25 years for the U.S. health care system.\(^\text{10}\)

In particular, policy changes around reimbursement and continued investment in broadband infrastructure will boost savings in four chronic disease areas — congestive heart failure ($102.5 billion), chronic pulmonary disease ($24.1 billion), chronic skin ulcers and wounds ($16 billion), and diabetes ($54.4 billion) — compared with continuation of the current policy baseline over the same time period.

In addition to these policy initiatives, the technology companies themselves should continue to generate and publish evidence supporting improved health outcomes, ROI, and other beneficial measures that result from using a particular technology. This information will help create a stronger business case for the sustained use of these technologies, thereby overcoming one of the largest barriers to adoption. Technology companies should also continue to work on improving the functionality and accessibility of their technologies to create products that are as usable and streamlined as possible.

Technology Profile:
Remote Health Services
C. TECHNOLOGY PROFILE: REMOTE HEALTH SERVICES

SUMMARY

Remote Health Services (RHS) are defined as patient care interactions where patient and provider are physically separate but virtually connected through telecommunications, information technology, and sensor technology. RHS facilitate data collection and transmission to improve care coordination and communications and to support patient care applications.

Remote patient monitoring (RPM), a specific technology platform application development within RHS, facilitates data collection and transmission to improve chronic disease care coordination processes, reduce unnecessary resource utilization, and improve care outcomes:

- Available technologies provide messaging, monitoring and measurement, and interactive communications functions to support triage, remote consultation, early diagnosis, disease treatment, and continuous monitoring and assessment applications.
- RPM is a disruptive technology. Its use relies on a reorganization of care processes involving newly defined roles, a disruption of existing business models, and a reduction in the use of and revenue for traditional hospital-based care services.
- The Veterans Health Administration (VHA) and through many small trials at Kaiser Permanente and Group Health of Puget Sound, has found that fully-integrated provider-based plans have demonstrated the greatest success to date in adopting and deploying RPM-enabled programs for chronic disease management.
- The VHA attributes the rapidity and robustness of its implementation to the “systems approach” taken to integrate the elements of the program. Key to the success of the systems approach was VHA’s standardization of the clinical, educational, technical, business, and organizational elements of the program. In addition, VHA’s integrated EMR has been critical in aiding its deployment of RPM technologies.
- Technology developments will continue to evolve as key functions advance from desktop to mobile applications, care management processes shift focus from place-based to person-based solutions, and technologies that facilitate remote health management become a part of a broader technology ecosystem to support independent living through health and safety applications.
REMOTE HEALTH SERVICES

Remote health services (RHS), which represent both an approach to care and a class of technology, are defined as patient care interactions where patient and provider are physically separate but virtually connected by telecommunications, information technology, and sensor technology. From a clinical perspective, remote health services are often used to improve patient outcomes through patient monitoring and disease management applications. Key benefits provided through remote health services include improved availability of and accessibility to care services and specialists, with a reduction in the travel burden on home health staff. Remote health services can also produce improvements in workforce efficiency and quality of care, and offer the potential to drive care-related operating efficiencies and to decrease costs.

Such services are an increasingly important component of care for patients with chronic diseases and patients in home care settings. Progress in the development of remote health services continues to rely on advances in enabling technologies and their successful deployment in supporting patient care applications such as triage, remote consultation, early diagnosis, disease treatment, and continuous monitoring and assessment. The enabling technologies range from telephones and videoconferencing equipment and structured clinical messaging to more sophisticated sensors for monitoring physiological parameters and software for computer-assisted diagnosis. Devices can communicate synchronously, or in real-time, and asynchronously. Among early adopters are the Veterans Health Administration, Kaiser Permanente, and Partners Healthcare.

Table 3 illustrates the ability of RHS to facilitate data collection and transmission to improve care coordination processes, reduce unnecessary resource utilization, and improve care outcomes in chronic disease management applications.

Table 3: Overview of Remote Health Services in Chronic Care Management

<table>
<thead>
<tr>
<th>Patient Interacts With the Telehealth Device</th>
<th>Patient Information is Collected and Transmitted</th>
<th>Patient Information is Used in Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Collected Includes:</td>
<td>Data Transmitted Over:</td>
<td>Results Include:</td>
</tr>
<tr>
<td>Vital signs (blood pressure, glucose meters, pulse oximeters, weight, etc.)</td>
<td>Video over low-bandwidth POTS (Plain Old Telephone System)</td>
<td>Improvement in care coordination and caregiver support</td>
</tr>
<tr>
<td>Physical and emotional well-being assessment</td>
<td>Video over IP LAN/WAN Broadband</td>
<td>Reduction in unnecessary emergency care visits and hospitalizations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve in medication compliance and treatment outcomes</td>
</tr>
</tbody>
</table>
RHS address several specific challenges within healthcare related to labor shortages, the aging population, and the high proportion of expenditures on patients with chronic diseases. This is achieved by improving accessibility to care, enabling collaboration between care providers, and offering the potential to address the medical needs of patients with both single and multiple chronic conditions by providing continuous monitoring and disease management in a convenient, efficient, and flexible manner. The discussion of RHS in this report primarily focuses on clinical applications involving interaction between providers and patients (excluding the more professional clinical applications involving doctor-to-doctor interactions) along the care continuum. Available devices provide messaging, monitoring and measurement, and interactive communications functions to support triage, remote consultation, early diagnosis, disease treatment, and continuous monitoring and assessment applications.

The functions of RHS differ depending on whether the user is a patient or provider. Table 4 highlights the key benefits to providers as a result of the ability to continuously monitor patients and support productive communications and interactions between informed activated patients and prepared, proactive practice teams.

Table 4: Functions and Benefits of RHS in Patient and Provider Communications

<table>
<thead>
<tr>
<th>PATIENT FUNCTIONS</th>
<th>PROVIDER BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect patient info</td>
<td>Diagnose early</td>
</tr>
<tr>
<td>o Remote collection of patient information, whether physiological or emotional, using a device. May include video or phone interaction. May collect specific vital signs manually or automatically.</td>
<td>o Use remote information to diagnose patient early</td>
</tr>
<tr>
<td>Send alerts</td>
<td>Intervene early</td>
</tr>
<tr>
<td>o Sends alerts to patients on changes in health status, medication reminders, upcoming appointments, or motivational statements. Sends alerts to caregivers and providers on changes in health status and/or warning signs.</td>
<td>o Inform providers of changes in health status and intervene early to prevent hospitalizations.</td>
</tr>
<tr>
<td>Educate</td>
<td>Improve resource allocation</td>
</tr>
<tr>
<td>o Built-in patient education programs allow patients access to information on their specific condition(s), medications, symptoms, etc.</td>
<td>o Help providers make the most efficient use of limited resources.</td>
</tr>
<tr>
<td>Advise</td>
<td>Improve care coordination</td>
</tr>
<tr>
<td>o Two-way video and phone conferencing allow for live advising.</td>
<td>Support caregivers</td>
</tr>
</tbody>
</table>
RHS technologies are best defined by their mode of communication and the type of care interaction model employed during the remote interaction. As the field of RHS develops, technology applications use either an asynchronous or a real-time, synchronous mode of communication (Table 5):

**Table 5: Remote Health Services: Communication and Care Interaction Model**

<table>
<thead>
<tr>
<th>Mode of Communication</th>
<th>Remote Health Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Synchronous Communication</strong>&lt;br&gt;Often requires coordination in time and/or scheduling by the parties involved in the care interaction</td>
<td>Physiological monitoring – real-time monitoring of biologic indicators, such as ECG, EEG, blood pressure, etc., that transmit data as they are acquired. Live, interactive audio/visual – videoconferencing with or without peripheral devices. Multimedia transfer – technologies capable of transferring images, audio and video in real time.</td>
</tr>
<tr>
<td><strong>Asynchronous Communication</strong>&lt;br&gt;Does not require coordination in time and/or scheduling by the parties involved in the care interaction</td>
<td>Clinical messaging – scripted communication with a dedicated device, structured email. Physiological monitoring – technologies that are capable of subjective and/or objective information capture and transfer, e.g., spirometers for COPD, glucose meters for diabetes, scales for CHF and other patient query tools.</td>
</tr>
</tbody>
</table>
As RHS diffuse more broadly in chronic disease management, they will promote thinking about not only how care is delivered, but also where and by whom. The care interaction models typically fall into two categories: those that utilize direct communication between the provider, caregiver or patient, and those that facilitate a collaborative approach to the provision of care interventions and communications between provider, caregiver and patient. As access to the patient is broadened, the definition of “care provider” will expand to include a variety of individuals, such as dieticians and personal trainers, friends, family, and the patient. The networking and integration of a widely dispersed care team (that includes the patient) will demand care coordinators to interact with the patient and the clinician team to coordinate interventions and communications between each stakeholder. In the most advanced operational model of RHS, the patient becomes his or her own primary care provider (Table 6).

**Table 6: Interactive Care Models Using Remote Health Services**

<table>
<thead>
<tr>
<th>Type of Care Interaction</th>
<th>Interactive Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>Patient + Primary Clinician (e.g., nurse, physician, or PA)</td>
</tr>
<tr>
<td></td>
<td>Patient + Ancillary Care Provider (e.g., nutritionist)</td>
</tr>
<tr>
<td></td>
<td>Caregiver (e.g., family member) + Primary Clinician or Ancillary Care Provider</td>
</tr>
<tr>
<td>Collaborative</td>
<td>Patient + Primary Clinician + Specialist</td>
</tr>
<tr>
<td></td>
<td>Patient + Ancillary Care Provider + Primary Clinician or Specialist</td>
</tr>
<tr>
<td></td>
<td>Primary Clinician + Specialist</td>
</tr>
<tr>
<td></td>
<td>Patient + Patient (e.g., support group/network)</td>
</tr>
</tbody>
</table>
REMOTE PATIENT MONITORING

Overview

Remote Patient Monitoring (RPM) is a significant application development within RHS, which encompasses the use of technology that serves as an intermediary between the clinician and patient to enable remote clinical monitoring, evaluation and management of a range of health conditions. RPM is particularly beneficial in serving the health care needs of the chronically ill who have difficulty accessing health services on a regular basis; significantly improving or maintaining patient health while reducing the costs of care; relieving pressure on the workforce; and being readily available for adoption and diffusion. Further, RPM facilitates coordinated and evidence-based chronic care management, providing essential support for the coordination of care, behavior change, and evidence-based decision support for patients and providers.

RPM is a disruptive technology, as its use relies on a reorganization of care processes involving newly defined roles for clinical and non-clinical providers, a disruption of existing business models involving a shift of some responsibility to the patient and non-clinical providers, and a reduction in the use of and revenue for emergency departments and hospitals. Managing patient care as such includes the integration of several care components such as patient history, physical examination, monitoring medications and biosignals, diagnostic testing, and home health assessments and therapy. Historically, clinicians provided this continuum of care through in-person patient interaction. The growing use of information technology in medicine continues to improve the clinician’s ability to manage such care remotely.

Point-of-care (e.g., including at-home) monitoring devices, such as weight scales, glucometers, and blood pressure monitors, may be used as standalone devices to collect and report health data, or they may become part of a fully integrated health data collection, analysis, and reporting system that communicates to multiple nodes of the health system and provides alerts when health conditions decline. The technology may serve as an intermediary in several types of interactions, including communication between patients, primary care providers, specialists, ancillary service providers, or psychiatric service providers. The following list includes several examples of remote patient management technologies:

• A glucometer with a phone line/modem connection to relay patient blood glucose readings from a home-based setting to a nurse or primary care provider (monitoring function).

• The use of a digital camera during a primary care visit to record a patient’s dermatological lesion. Photos are then emailed to a dermatologist for remote review and diagnosis (diagnosis function).

• Software applications that analyze sensor-derived patient health measurements in acute care settings and trigger action, enabling enhanced monitoring capabilities of multiple patients (active patient monitoring/decision support in acute care).
Several health care organizations are now using and trialing RPM-enabled programs for chronic disease management. Broadly deployed within the Veterans Health Administration and in many small trials including Kaiser Permanente and Group Health Cooperative of Puget Sound, RPM has been shown to support patient self management, shift responsibilities to non-clinical providers, reduce the use of emergency department and hospital services, and improve patient and provider satisfaction. Early adopters identify six components of chronic care management that are facilitated by these technologies:

1. Early intervention: to detect deterioration and intervene before unscheduled and preventable services are needed;
2. Integration of care: exchange of data and communication across multiple co-morbidities, multiple providers, and complex disease states;
3. Coaching: motivational interviewing and other techniques to encourage patient behavioral change and self-care;
4. Increased trust: patients’ satisfaction and feelings of “connectedness” with providers;
5. Workforce changes: shifts to lower-cost and more plentiful health care workers, including community health workers and social workers; and
6. Increased productivity: decreased home visit travel time and automated documentation.

These findings suggest that RPM technologies can play six functional roles in chronic disease management as outlined in Table 7:

Table 7: Roles and Benefits of RPM in Chronic Disease Management

<table>
<thead>
<tr>
<th>Functional Role</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Warning System</td>
<td>Prompts early intervention when health status deteriorates</td>
</tr>
<tr>
<td>Care Integrator</td>
<td>Integrates a complex web of caregivers that might not otherwise communicate and collaborate for the health of an older adult.</td>
</tr>
<tr>
<td>Scorekeeper</td>
<td>Promotes evidence-based health care and self-care. Reduces duplication of health services.</td>
</tr>
<tr>
<td>Confidence Builder</td>
<td>Reinforces self-efficacy and confidence that selected health behaviors will lead to selected health goals.</td>
</tr>
<tr>
<td>Capacity Builder</td>
<td>Increases the capacity of individuals (patients and lower-skilled informal and formal caregivers) to provide more highly skilled care. Enables less centralized and more distributed care.</td>
</tr>
<tr>
<td>Productivity Amplifier</td>
<td>Increases the ability to do more with less and to avoid duplication of services.</td>
</tr>
</tbody>
</table>

Source: Adapted from Coye et al, Health Affairs 28, no. 1 (2009): 126-135
Figure 12 illustrates the wide range of applications enabled by RPM along the chronic disease continuum to support care coordination processes, reduce unnecessary resource utilization, and improve health outcomes.

Figure 12: Remote Patient Monitoring Applications

<table>
<thead>
<tr>
<th>Target Population</th>
<th>Healthy</th>
<th>At-Risk</th>
<th>Minimal/Moderate Disease</th>
<th>Significant Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Patient Monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RPM applications</td>
<td>Physiological monitoring and assessment</td>
<td>Patient-based functional assessment</td>
<td>Care plan compliance</td>
<td>Professional assessment and observation</td>
</tr>
<tr>
<td></td>
<td>Early id of at-risk and intervention design</td>
<td>Care communication and coordination</td>
<td>Interactive Consultation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patient health education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Health management coaching</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self care</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RPM solutions have demonstrated considerable success in improved outcomes for patients with congestive heart failure, chronic obstructive pulmonary disease and diabetes. Early adopters of remote patient monitoring solutions tend to be capitated managed care organizations having fiscal responsibility for their patients across the continuum of care. According to a recent market study, an estimated 97% of healthcare organizations using RPM rely on RPM to improve clinical outcomes for critically ill patients who are at the greatest risk of re-hospitalization and/or unnecessary trips to the emergency department. Health care organizations may also receive benefits through improving patient outcomes, reducing health care delivery costs, and increasing access to care for patients living in rural/remote areas.¹¹

Table 8: Selected Home Telehealth Study Findings

<table>
<thead>
<tr>
<th>Study</th>
<th>N=</th>
<th>Survival/Mortality</th>
<th>Decrease in Hospitalization</th>
<th>Decrease in ED Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans-European Network Homecare Monitoring Study</td>
<td>426</td>
<td>15% increase in survival</td>
<td>34%</td>
<td></td>
</tr>
<tr>
<td>Roanoke Chowan Community Health Center</td>
<td>40</td>
<td>--</td>
<td>71%</td>
<td>69%</td>
</tr>
<tr>
<td>Specialized Primary and Networked Care in Heart Failure II</td>
<td>188</td>
<td>No statistical Difference</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td>Meta Analysis – Health Buddy</td>
<td>238</td>
<td>69% decrease in mortality</td>
<td>--</td>
<td>69%</td>
</tr>
</tbody>
</table>

Source: New England Healthcare Institute

RPM has been shown to be effective in enhanced care and support during care transitions in which patients are first engaged by a care coordinator while in the hospital to prepare for the transition from the hospital to the home or other community setting and then followed intensively immediately after discharge with the goal of reducing avoidable hospitalizations. In the Institute of Healthcare Improvement’s (IHI) survey of the published evidence, a large body of evidence exists with regard to the effect of various remote monitoring strategies, with a large number of those studies focusing on patients with heart failure. However, because RPM interventions are often but one element of a comprehensive strategy, it is difficult to assess the isolated effect on reducing rehospitalization rates, with the total effect ranging from a low of 14% to a high of 80% reduction.  

Barriers faced in the adoption of remote clinical technologies include the following:  

- A lack of business models that support reimbursement of providers for use of remote health service technologies in patient care  
- A lack of experience among providers and delivery systems with the technology, and few models of implementation to reliably draw experience from in terms of best practices and to ensure sustainable operation  
- A low prioritization for the adoption of RPM among hospital-based health systems for technical (preoccupation with EMR implementation and interoperability barriers), business (stand to lose volume of admissions and ED visits), and organizational (lack of experience in work process redesign and adoption of similar technologies) reasons  
- A general lack of information, models and recommendations for consumers as to the availability and benefits to be derived from the use of remote health service technologies such as RPM in their care.

Applications

The evidence base for RPM is building and, through demonstrating decreases in emergency department (ED) visits and hospital admissions for pulmonary and cardiac disease, indicates essential support for the coordination of care, behavior change (of providers as well as patients), and evidence-based decision support for patients. The Veterans Health Administration has evaluated, piloted, reevaluated, and deployed RPM technologies on a scale that stands in stark contrast to other providers. Analyzing data from the remote monitoring program at the VHA, as well as other smaller programs, an October 2008 report, *Vital Signs via Broadband: Remote Health Monitoring Transmits Savings, Enhances Lives*, finds the U.S. health care system could reduce costs by nearly $200 billion during the next 25 years if remote monitoring tools were utilized in congestive heart failure, diabetes, chronic obstructive pulmonary disease (COPD), and chronic wounds or skin ulcers much more widely.

In addition to the expected decreases in ED, hospital, and nursing home use, VHA reports improvements across a wide range of metrics from the use of health informatics, disease management and home telehealth technologies to provide routine non-institutional care (and chronic care management services) to veteran patients with diabetes, congestive heart failure, hypertension, posttraumatic stress disorder, chronic obstructive pulmonary disease and depression. In particular, the use of preventive services and medication adherence increased, as did patients’ understanding of their condition, confidence in self-management, communications with physicians and nurses, feeling of connectedness to the care team, sense of security, and health related quality-of-life scores.

The New England Healthcare Institute’s (NEHI) analysis of home telehealth technologies reports that despite the large volume of potential patient beneficiaries and technology offerings, the installed base of such devices remains small. The total number of deployed devices is estimated in the tens of thousands. Table 9 profiles selected devices with remote monitoring capabilities with a summary overview of the key features offered and targeted applications:

---

Table 9: Selected RPM Product Offerings

<table>
<thead>
<tr>
<th>Technology</th>
<th>Key Features</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Buddy</td>
<td>Simple four-button device with no audio or video</td>
<td>With more than 30 health management programs to choose from, the Health Buddy system can address a broad range of health applications that include chronic disease management, weight loss programs, diabetes management, cardiac monitoring, and clinical trials. An average of 27,000 patients connect daily to their care providers using the system. The VA deploys the technology nationwide. The technology is also being used in the Medicare High Risk Demonstration Project with approximately 1,000 patients in California. An ongoing study comparing Health Buddy system users to a control group saw an 85% daily utilization rate, resulting in a 40% drop in acute hospital days, 68% fewer nursing home days and a 3.75% overall net reduction in medical costs for the Health Buddy group.</td>
</tr>
<tr>
<td>(Bosch)</td>
<td>Central server connects units to authorized health professionals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connecting peripherals include stethoscope, scale, blood pressure and glucose meters, peak flow meter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reports can be generated for patients or health care professionals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Web-based decision support tools and content development tools</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Key Features</td>
<td>Comments</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>Genesis DM (Honeywell HomMed)</td>
<td>User interface comprises voice and text prompts to guide patients through health assessments. On-demand patient management modules provide symptom-specific assessment and patient information by diagnosis or disease state Peripherals include stethoscope, scale, blood pressure meter, glucose meter, pulse oximeter, thermometer, PT/INR meter, peak flow meter Device forms part of Honeywell LifeStream Telehealth Ecosystem which provides a unified application platform for remote patient monitoring and management</td>
<td>Over 40,000 monitors in use worldwide in the remote management of a variety of chronic conditions, such as congestive heart failure, chronic obstructive pulmonary disease, coronary artery disease, diabetes and hypertension.</td>
</tr>
<tr>
<td>Health Guide PHS6000 (Intel)</td>
<td>Video-capable touch screen Two-way audio and video Peripherals include blood pressure, glucose meter, ECG, scale, peak flow meter</td>
<td>Received 510(k) market clearance from the U.S. FDA in July 2008 and has been available since the end of 2008. Among pilot partners and customers are insurance company Aetna, provider Providence Medical Group in Oregon, Erickson Retirement Communities, Medicare Advantage plan SCAN Health Plan, and the VA's Rural Resource Center Western Region.</td>
</tr>
<tr>
<td>TeleStation (Philips)</td>
<td>Two-way transmission of vital signs data and interactive communication Peripherals: scale, blood pressure meter, glucose meter, pulse oximeter, rhythm strip recorder Web-based clinical review software for prioritizing clinical intervention based on objective vital signs data and/or subjective survey responses</td>
<td>Philips telehealth services target disease management firms, home care agencies and healthcare providers to provide remote monitoring of chronic diseases and send patients short health status surveys to make more timely care decisions and help prevent unnecessary hospitalizations. Banner Health reported telehealth services to more than 550 patients with heart failure and other chronic diseases in the past three years achieved a readmission rate of 3.8 percent for patients on telehealth versus a national readmission rate of 29 percent for Medicare-certified home health agencies.</td>
</tr>
<tr>
<td>Technology</td>
<td>Key Features</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>LifeView</td>
<td>Video-capable touch screen</td>
<td>American TeleCare claims to have installed more than 95 percent of all video-based home telehealth programs nationwide.</td>
</tr>
<tr>
<td>(American Telecare)</td>
<td>Two-way audio and video</td>
<td>Centura Health at Home, Colorado’s largest health care system, is currently offering home telehealth services to 167 Medicare members with heart failure, COPD, and diabetes. Pilot study results found a 100 percent reduction in ED visits over a 6-month period.</td>
</tr>
<tr>
<td></td>
<td>Peripherals: stethoscope, scale, blood pressure meter, glucose meter, pulse oximeter, thermometer, PT/INR meter</td>
<td></td>
</tr>
<tr>
<td>Ideal LIFE Pod</td>
<td>Inexpensive system of communications hub and peripherals</td>
<td>Applications targeting congestive heart failure, hypertension, asthma, and chronic obstructive pulmonary disease (COPD). Ideal LIFE products are currently available through select insurers, physician groups, and home care agencies. The company expects to have its products and services available in retail outlets by 2010.</td>
</tr>
<tr>
<td>(Ideal Life)</td>
<td>Open platform that allows devices to easily integrate with cell phones, telephone lines, and the Internet.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No audio or video</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All interactive capability is contained in peripherals: blood pressure meter, glucose meter, scale pulse oximeter, peak flow meter, pedometer, chair</td>
<td></td>
</tr>
<tr>
<td>Viterion 200</td>
<td>“Text to speech” feature for the visually impaired</td>
<td>Applications for management of diabetes, congestive heart failure, and chronic obstructive pulmonary disease.</td>
</tr>
<tr>
<td>(Bayer HealthCare)</td>
<td>Creation of automated advise messages and questions in response to vital signs data to promote self-management</td>
<td>A recent study amongst CHF patients showed that the rate of rehospitalization was 45% in the “routine care” group, whereas it reduced sharply to 20% in the group monitored with Viterion telemonitors.</td>
</tr>
<tr>
<td></td>
<td>Peripherals include Blood Pressure and Pulse; Blood Oxygen level; Weight; Blood Glucose; Pain; PT/INR; Temperature; Asthma; Fluid Level and Peak Flow</td>
<td></td>
</tr>
</tbody>
</table>

Source: New England Healthcare Institute

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Results from VHA’s Care Coordination / Home Telehealth program as of 2006 and 2007 show the following superior benefits relative to traditional care models: 25% reduction in bed days of care; 20% reduction in numbers of admissions; and 86% mean satisfaction score rating. The majority (85%) of technology utilized was messaging/monitoring services, 11% video-telemonitors and 3% videophones. The net cost was $1,600 per patient per annum versus $13,121 for VHA’s home-based primary care services (and $77,745 for market rate nursing home care). Since VHA implemented its program, a total of 43,430 patients have been enrolled. VHA plans to increase its non-institutional care (NIC) services 100% above 2007 levels to provide care for 110,000 patients by 2011, representing 50% of its projected NIC needs.

The VHA’s experience recommends use of a systems approach for successful implementation of home telehealth programs. Implementation centers around reengineering of existing processes coupled with a strong IT infrastructure and a commitment to training. The VHA attributes the rapidity and robustness of its implementation to the “systems approach” taken to integrate the elements of the program. Wherever possible, VHA incorporated existing business processes to reduce the program’s overhead costs and increase efficiency. Key to the success of the systems approach was VHA’s standardization of the clinical, educational, technical, business, and organizational elements of the program based upon experience gained from piloting it prior to widespread deployment. Clinical process reengineering is necessary to create the clinical, quality, educational, business, logistic, and organizational systems necessary to support implementation on an enterprise scale.  

CMS demonstrations of improvements in chronic care management recently expanded and extended three successful programs, including one involving the use of Health Hero Network’s Health Buddy device on the basis of each one demonstrating over three years improvements in outcomes. The Health Buddy project at medical groups in Wenatchee, Washington, and Bend, Oregon, is a partnership with the American Medical Group Association. The program has been extended to January 31, 2012 and will also potentially be allowed to expand to one additional site in the second year of the extended program. Using the Health Buddy, a system also employed by the VHA, 2,500 patients with congestive heart failure, diabetes, or chronic obstructive pulmonary disease, at high risk of hospitalization, received the appliance to monitor symptoms and physical status, coach about condition-specific knowledge, and transmit risk-stratified results back to multi-specialty medical groups.  

The Future

RPM is growing rapidly, bringing convenience and simplifying care for patients and healthcare professionals. In the future, remote patient monitoring is expected to expand not only in terms of adoption, but also in terms of the variety of applications and offerings. For example, medication management is being integrated with RPM systems to provide a more integrated health management solution for chronic health conditions. Despite market and regulatory obstacles to deployment in chronic disease management, there is enormous potential for RPM to aid in improving access to care, improving home management of chronic diseases, providing more real-time interactive health services for health consumers, and reducing costs and improving workforce efficiency. In particular, chronic disease patients in underserved areas are likely to see the largest benefit.

Provider-based plans and home health agencies may well prove to be the most effective entities driving the adoption of RPM. The business model for hospital-based delivery systems has historically been poorly aligned with chronic care innovations and the RPM technologies that support them. After some early experimentation with RPM technologies, many health plans have come to rely upon disease management (DM) contractors to identify opportunities to use RPM in chronic care management. But whether RPM is used by DM companies, health plans or homecare providers and senior living communities, a great deal still remains to be learned about the most effective means of compensating providers for their use.

Although RPM can produce improvements in workforce efficiency and quality of care, leading delivery systems to achieve significant ROI, limited insurance coverage can make achieving financial gains a challenge. Other obstacles to adoption include sometimes complex and costly technologies to operate, low consumer awareness of available devices and benefits, malpractice issues, regulatory issues such as provider licensing and supervision, and data interoperability concerns. States are currently varied in their telemedicine adoption (sometimes dramatically) due to a number of complex policy, funding, and technology barriers.

As the prevalence of this technology increases, medical facilities will encounter new challenges in preparing and training adequate personnel to deploy and effectively enhance the quality of the patient-provider interaction. The cost structures of medical facilities will change as capital investments in medicine respond to growing demand for remote health services. Technology developments will continue to evolve as key functions advance from desktop to mobile applications, care management processes shift focus from place-based to person-based solutions, and technologies that facilitate remote health management become a part of a broader technology ecosystem to support independent living through health and safety applications. But given the enormous potential to transform chronic care management, remote patient monitoring will continue its rapid growth, playing a large role in the future of medicine and treatment.

Technology Profile: Mobile And Web Technologies
D. TECHNOLOGY PROFILE: MOBILE AND WEB TECHNOLOGIES

SUMMARY

Mobile and web technologies represent a class of technologies that improve chronic disease care through facilitating self-management (including medication adherence, health education, and health information access). These technologies rely on ubiquitous mobile and Internet infrastructure. Mobile and web technologies include cell phones, health games, social networking, and personal health records.

Cell phones rely on a technology infrastructure that is ubiquitous and offers users convenient access and ease of use. As cell phone capabilities continue to advance, the potential of cell phones to supplement the delivery of health-care services will continue to grow and lead to more sophisticated and personalized applications.

- Cell phone technology is a rapidly expanding platform for chronic disease management, given its ability to facilitate remote patient monitoring
- Mobile-enabled platforms have demonstrated promising results such as improved medication adherence, health outcomes, and reduced costs
- Cell phone-related applications are expected to increase in number and sophistication as the underlying technology continues to improve.

The development of health games has been driven by trends in a broad range of computing and communications technologies. Game platforms and formats include traditional video games on game consoles, handheld players, computers and the Internet. The market is growing rapidly and offers games targeted at chronic diseases:

- Health games involve the use of interactive multi-media gaming platforms that support self-management and self-efficacy across a broad range of health conditions, fitness, and wellness
- Key gaming functions target self-assessment, self-management, education, treatment adherence; some games are especially designed for specific chronic diseases such as asthma or diabetes

Social networking services connect patients with other patients as well as to other stakeholders in the care process. Social networking is especially useful for the chronically ill and others with special healthcare conditions, to enable patients to find others with similar healthcare needs and concerns:

- Social networking allows communities of patients to connect, share knowledge with, and provide support to other patients and with their care providers, and collaborate with other users online
- Web-based social networks utilize a variety of means to facilitate communication among patients and providers including discussion groups, chat, messaging, email, video, and file-sharing.
Personal Health Records (PHRs) may include clinicians’ visit notes, laboratory results and imaging reports, a narrative summary of events, and other health information. Early adoption of PHRs has occurred as part of chronic disease care.

- PHRs refer to a set of technologies through which patients can access and manage their own health information and can include clinicians’ visit notes, laboratory results and imaging reports.
- PHRs can be tethered (connected to an EMR) or untethered (managed and information entered directly by the patient).
- PHRs are especially useful for chronic disease patients and have seen the most adoption by this group. They are particularly useful for coordinating care from different sources and clinicians, and providing constant access to information.
MOBILE AND WEB TECHNOLOGIES

Mobile and Web technologies include cell phones, health gaming, social networking, and personal health records. As a technology class, cell phones, mobile services and web technologies have been transformative in how people work, play, and relate to each other, and are increasingly expected to expand rapidly in chronic disease management. Overall, mobile connectivity is becoming a powerful differentiator among technology users.

Mobile and Web technologies have already demonstrated benefits in managing chronic diseases, through improved patient adherence to treatment regimens, patient satisfaction, care coordination, and quality of care at a reduced cost. For example, in a pilot study of young asthma users, a mobile technology platform from BeWell Mobile showed increased adherence and patient satisfaction, as well as a decrease in healthcare utilization and missed school days. In the future, the health needs of consumers will determine the degree to which they perceive the need to receive care services using the traditional and formal health care infrastructure, and the degree to which alternative technology-supported care and lifestyle models will emerge and downshift care.

Healthcare has increasingly become recognized as a key area of social impact of the Internet and one that continues to evolve. Recent research from the Pew Internet Project reveals that Americans today have very different behaviors from just a few years ago, related to access to and the sharing of information, learning, solving problems, and looking for social support. This difference in behaviors is a result of the availability of new information and communication tools, such as mobile and web technologies, and broadband and wireless communications protocols:

- 74% of American adults go online, 61% of American adults look online for health information, and 57% of American households have broadband connections
- 59% of e-patients have consulted blog comments, hospital reviews, doctor reviews, and podcasts about health and health care
- 20% of e-patients have posted comments, reviews, photos, audio, video or tags related to health care

However, Pew’s Social Life of Health Information reports lower levels of broadband adoption and Internet usage among the chronically ill compared with the general population. For example, 5 in 10 people living with a chronic condition have Internet access compared with 8 in 10 among the general population. Pew tracking data also indicate lower use of social media among people with chronic conditions: 1 in 3 internet users with a chronic condition read blogs, while 1 in 4 use social networks. While this suggests that this population is less sophisticated in technology use, people in their social networks are likely to be online and active users on their behalf. Over half of online inquiries are on behalf of someone other than the person making the inquiry.
Table 10: Generational Differences in Online Activities

<table>
<thead>
<tr>
<th>Online Teens (&lt;12)</th>
<th>Gen Y (13-32)</th>
<th>Gen X (33-44)</th>
<th>Younger Boomers (45-64)</th>
<th>Older Boomers (65-74)</th>
<th>Silent Generation (75+)</th>
<th>All Online Adults**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Go online</strong></td>
<td>93%</td>
<td>87%</td>
<td>82%</td>
<td>78%</td>
<td>70%</td>
<td>56%</td>
</tr>
<tr>
<td><strong>Teens and Gen Y are more likely to engage in the following activities compared with older users:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Play games online</td>
<td>78</td>
<td>50</td>
<td>38</td>
<td>26</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Watch videos online</td>
<td>57</td>
<td>72</td>
<td>57</td>
<td>49</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>Get info about a job</td>
<td>30±</td>
<td>64</td>
<td>55</td>
<td>43</td>
<td>36</td>
<td>11</td>
</tr>
<tr>
<td>Send instant messages</td>
<td>68</td>
<td>59</td>
<td>38</td>
<td>28</td>
<td>23</td>
<td>25</td>
</tr>
<tr>
<td>Use social networking sites</td>
<td>65</td>
<td>67</td>
<td>36</td>
<td>20</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Download music</td>
<td>59</td>
<td>58</td>
<td>46</td>
<td>22</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Create a SNS profile</td>
<td>55</td>
<td>60</td>
<td>29</td>
<td>16</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Read blogs</td>
<td>49</td>
<td>43</td>
<td>34</td>
<td>27</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>Create a blog</td>
<td>28</td>
<td>20</td>
<td>10</td>
<td>6</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Visit a virtual world</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Activities where Gen X users or older generations dominate:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get health info</td>
<td>28</td>
<td>68</td>
<td>02</td>
<td>74</td>
<td>81</td>
<td>70</td>
</tr>
<tr>
<td>Buy something online</td>
<td>38</td>
<td>71</td>
<td>50</td>
<td>58</td>
<td>72</td>
<td>56</td>
</tr>
<tr>
<td>Bank online</td>
<td>*</td>
<td>57</td>
<td>65</td>
<td>53</td>
<td>49</td>
<td>45</td>
</tr>
<tr>
<td>Visit govt sites</td>
<td>*</td>
<td>55</td>
<td>64</td>
<td>52</td>
<td>63</td>
<td>60</td>
</tr>
<tr>
<td>Get religious info</td>
<td>26±</td>
<td>31</td>
<td>38</td>
<td>42</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td><strong>And for some activities, the youngest and oldest cohorts may differ, but there is less variation overall:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use email</td>
<td>73</td>
<td>94</td>
<td>83</td>
<td>90</td>
<td>91</td>
<td>70</td>
</tr>
<tr>
<td>Use search engines</td>
<td>*</td>
<td>80</td>
<td>53</td>
<td>50</td>
<td>55</td>
<td>70</td>
</tr>
<tr>
<td>Research products</td>
<td>*</td>
<td>84</td>
<td>84</td>
<td>82</td>
<td>70</td>
<td>73</td>
</tr>
<tr>
<td>Get news</td>
<td>63</td>
<td>74</td>
<td>76</td>
<td>70</td>
<td>69</td>
<td>56</td>
</tr>
<tr>
<td>Make travel reservations</td>
<td>*</td>
<td>65</td>
<td>70</td>
<td>69</td>
<td>66</td>
<td>69</td>
</tr>
<tr>
<td>Research for job</td>
<td>*</td>
<td>51</td>
<td>59</td>
<td>57</td>
<td>48</td>
<td>33</td>
</tr>
<tr>
<td>Rate a person or product</td>
<td>*</td>
<td>37</td>
<td>35</td>
<td>29</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Download videos</td>
<td>31±</td>
<td>38</td>
<td>31</td>
<td>21</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>Participate in an online auction</td>
<td>*</td>
<td>26</td>
<td>31</td>
<td>27</td>
<td>26</td>
<td>16</td>
</tr>
<tr>
<td>Download podcasts</td>
<td>19</td>
<td>25</td>
<td>21</td>
<td>19</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>


* Most recent teen data for these activities comes from the Pew Internet & American Life Project Teens and Parents Survey conducted Oct.-Nov, 2004. Margin of error is ±4%.

* No teen data for these activities.
In addition, as illustrated in Table 10, there are also generational differences in online activity and health information behaviors. The vast majority of online adults from all generations use email and search engines, but older generations typically do not engage in online activities beyond e-commerce applications, whereas the majority of younger people frequently use social networks and other social media tools. However, usage trends suggest that the generational gap is closing, and that Baby Boomers are increasingly active and sophisticated users of social networking technologies. For example, in February 2009, Facebook reported that women over 55 years old were their fastest-growing user segment.

Generational differences and related trends in technology adoption and use, such as social networking and SMS messaging, will impact strategies for interacting and communicating with specific audiences. This is particularly true when considering chronic disease management approaches for different diseases and will depend on the demographics of the populations most affected by a specific disease.

Mobile and Web Technology Framework

The various components of mobile and web technology can serve a variety of functions for patients in the various stages of chronic disease, as shown in Figure 13. This framework contains some of the major applications that web and mobile technologies can provide for patients at four different stages of the chronic disease continuum: healthy, at-risk, minimal-moderate disease, and extreme disease.

Figure 13: Mobile and Web Applications
Many technology applications span multiple disease categories, and the at-risk and minimal-moderate disease areas are currently the most relevant target users for applications. This is due to the fact that these disease categories lend themselves most to self-management techniques that many web and mobile technologies facilitate, and such techniques are instrumental in preventing or delaying the progression to extreme disease. Web and mobile technology applications are less useful for extreme disease as much of the care associated with chronic diseases at this step is intensive and inpatient in nature, negating the need for self-management.

The sections that follow discuss in greater detail applications related to several mobile and web platform technologies: cell phones, health games, social networking, and personal health records.
CELL PHONES

Overview
Cell phone technology comprises a combination of hardware, software, wireless network, and communications standards to offer health services for patient education, wellness, and chronic disease management. Companies have been quick to see the opportunity for health applications on a technology infrastructure that is ubiquitous and offers users convenient access and ease of use. As cell phone capabilities continue to advance through developments in microprocessors, communications protocols, and network standards, the potential of cell phones to supplement the traditional delivery of health-care services will continue to grow and lead to more advanced and personalized applications. As evidence to demonstrate that cell phones can improve health outcomes grows (for example, studies done in the United Kingdom on asthma management via mobile platforms show an increase in adherence and patient satisfaction\(^{20}\)), there will be many new opportunities for their use in healthcare.

Cell phone use has grown dramatically since the first devices were introduced in the 1980s. The industry association, CTIA, estimates that approximately 79% of all teens in the United States (17 million) have a mobile device, 15% of whom own a smart phone.\(^{21}\) Applications have tended to focus primarily on communication, information, and entertainment. The use of the cell phone for text messaging is growing faster than two-way calling. Technological advances have increased the platform’s functionality to include a broader and richer set of personalized, lifestyle-oriented, mobile, interactive, and intelligent applications.

Recent surveys indicate that nearly one out of every six American homes only has a wireless telephone service, and that a growing number of homes, one out of every eight, received all or almost all calls on wireless telephones despite having a landline in the home. The increasing prevalence of cell phone coverage in the United States and the consequent substitution of cell phones for landlines highlight the growing need for cell phone mediated intervention and communication strategies, especially among younger and more transient populations, particularly those who will benefit from regular messaging, monitoring, and reporting functions in support of their health management needs.

Applications
Cell phones currently offer a platform that can facilitate the delivery of a range of electronic health services to a large number of users, especially young people. To date, early decision support and disease management applications have focused on two chronic diseases, asthma and diabetes, as well as other health applications including dermatology, and healthy behavior applications such as diet and weight management, smoking cessation, and sexual activity.

\(^{20}\) Ron Neville, Alexandra Greene, John McLeod, Andrew Tracy, and John Surie. Mobile phone text messaging can help young people manage asthma. BMJ. 2002 September 14; 325(7364): 600.

Table 11: Mobile Device Functions and Applications

<table>
<thead>
<tr>
<th>Mobile Device Function</th>
<th>Application Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal health management</td>
<td>Appointment Booking</td>
</tr>
<tr>
<td></td>
<td>Access to Dietary Information</td>
</tr>
<tr>
<td></td>
<td>Electronic Diary</td>
</tr>
<tr>
<td></td>
<td>Health Monitor</td>
</tr>
<tr>
<td></td>
<td>Personal Health Record</td>
</tr>
<tr>
<td></td>
<td>Chronic Disease Management</td>
</tr>
<tr>
<td></td>
<td>Substance Abuse/ Addiction</td>
</tr>
<tr>
<td></td>
<td>Behavioral Health</td>
</tr>
<tr>
<td></td>
<td>Fitness</td>
</tr>
<tr>
<td></td>
<td>Health Device Data Capture</td>
</tr>
<tr>
<td>Personal decision support</td>
<td>Appointment Reminder</td>
</tr>
<tr>
<td></td>
<td>Medication Reminder</td>
</tr>
<tr>
<td></td>
<td>Health Coaching</td>
</tr>
<tr>
<td></td>
<td>Self-diagnosis</td>
</tr>
<tr>
<td></td>
<td>Allergy Alert for Asthmatics</td>
</tr>
<tr>
<td></td>
<td>Peer-to-Peer Support</td>
</tr>
<tr>
<td></td>
<td>Patient Education</td>
</tr>
<tr>
<td></td>
<td>Crisis Helpline</td>
</tr>
<tr>
<td>Patient care management</td>
<td>Care information for family</td>
</tr>
<tr>
<td></td>
<td>Patient Location Tracking</td>
</tr>
<tr>
<td></td>
<td>Child Monitor</td>
</tr>
<tr>
<td>Professional care management</td>
<td>Patient Paging</td>
</tr>
<tr>
<td></td>
<td>ePrescribing</td>
</tr>
<tr>
<td></td>
<td>Patient Record Access</td>
</tr>
<tr>
<td></td>
<td>Positive Patient Identification</td>
</tr>
<tr>
<td></td>
<td>Medication Adherence</td>
</tr>
<tr>
<td></td>
<td>Remote Patient Management</td>
</tr>
</tbody>
</table>

Cell phone applications have demonstrated promising results for chronic disease management in many early-stage studies. For example, the mobile management technology for asthma Think Positive was featured in several clinical studies in the UK. Results indicate that the majority of patients felt that the solution helped them improve their asthma symptoms, decrease their use of inhalers, and improve compliance with monitoring their symptoms and physiological measurements, including peak flow\(^\text{22}\). Further studies on the outcomes associated with these technologies will be an important step toward wider deployment of mobile technologies in chronic disease management.

In particular, short message services (SMS or text messaging) have proven to be a popular approach to reach health consumers on a large scale. Message length can be up to 160 characters in length and can use non-text based messaging formats. In the context of chronic disease management, many technologies employ alerts to improve medication compliance and thus produce better health outcomes. Table 12 shows several examples of mobile/text-based chronic disease management applications:

**Table 12: SMS Application Examples**

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>airTEXT</td>
<td>airTEXT is an innovative UK-based program that is designed to provide text alerts on poor air quality. airTEXT goals include the ability to enable patients to self-manage symptoms and reduce exposure, to reduce acute impacts of air pollution, and to improve patient quality of life. A 2006 pilot found that the majority of users found the technology to be useful and thought that airTEXT helped them better manage their symptoms and change their behavior. <a href="http://www.airtext.info">www.airtext.info</a></td>
</tr>
<tr>
<td>BeWell Mobile</td>
<td>BeWell Mobile is a mobile technology application that uses a cell phone platform to help patients manage their health. The technology has been applied to both asthma and diabetes, demonstrating promising results in pilot studies such as increased adherence and a decrease in school days missed. Users of BeWell Mobile self-monitor their symptoms with mobile technology, which also provides them with feedback, a regimen plan, and connection to their health providers. <a href="http://www.bewellmobile.com">www.bewellmobile.com</a></td>
</tr>
<tr>
<td>Think Positive Medical</td>
<td>Think Positive Medical is the leading supplier of mobile phone technologies for chronic disease management in the UK. The technology is currently used for asthma, diabetes, COPD, and cardiovascular conditions and has multiple components (including a mobile assistant, clinical management and monitoring center, and member center). The technology has demonstrated promising outcomes in clinical trials, including improving medication compliance and patient satisfaction. <a href="http://www.tplusmedical.co.uk/positive/">www.tplusmedical.co.uk/positive/</a></td>
</tr>
<tr>
<td>Application</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Avalis Telemedicine</td>
<td>Avalis Telemedicine is a Swiss company that offers a number of interactive chronic disease solutions, including a mobile platform to manage asthma, GoAsthma. An Internet-enabled mobile phone and a peak flow meter are the only requirements for the program, where patients track their lung function and manage their treatment plan online. The website associated with the technology also helps patients keep track of medications.  <a href="http://www.go-asthma.ch/index_e.html">http://www.go-asthma.ch/index_e.html</a></td>
</tr>
<tr>
<td>Confidant</td>
<td>Confidant provides a series of solutions designed to assist chronic disease management, with initial solutions available for diabetes and weight management. The solutions are cell phone-based applications that collect patient information and help facilitate treatment feedback, self-management options, and provider communication. <a href="http://www.confidantinc.com">http://www.confidantinc.com</a></td>
</tr>
<tr>
<td>mCare</td>
<td>The U.S. Military is currently conducting pilots on text messaging services for some of its members, using a cell phone platform to push out information about appointment reminders, as well as health and education resources. This study leverages soldiers' existing cell phones to minimize the learning curve, and the major cell phone service providers (AT&amp;T, Verizon, T-Mobile, and Sprint) have agreed to provide services at no cost to patients for the purposes of the study. The information sent is coordinated by a case manager, with some messages customized according to patients' needs. Pilot results demonstrate increased compliance with appointments, user satisfaction, and a belief that the texts were helpful. In addition, it has been found that many younger patients prefer only text messages, over alternative options such as email and voicemail. This IRB-approved study currently involves a population of 100 patients and future plans are to expand test sites and hopefully eventually cover the entire army. The study also has possibilities in the future to incorporate social networking and increased family involvement.</td>
</tr>
</tbody>
</table>
Smart phones will enable new applications that support more advanced and customized health management services (Table 13).

**Table 13: Smart phone application examples**

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anvita Health</td>
<td>Anvita Health developed a new free mobile viewer for Google Health. It allows for an on-demand and real-time view of patient medical records and provides for more flexibility when visiting physicians, pharmacists, and other care providers.</td>
</tr>
<tr>
<td>Ringful</td>
<td>Ringful has designed a number of applications for asthma patients, including an Asthma Journal that is linked to a smart phone. The Asthma Journal provides access to personal health information, and allows sharing of the information with others, including providers through Google Health. General information on prevention and news is also provided, and the application can be linked to Facebook as well. In addition, Ringful is working on other similar applications for cardiovascular disease and general health and wellness. Due to significant overlap with PHR technologies, this technology can also be classified under PHR-related technologies.</td>
</tr>
<tr>
<td>iTMP Technology</td>
<td>iTMP Technology has developed a wireless bridge that collects data from distributed health and fitness sensors such as heart rate monitors and cycling sensors. The data is sent to the iPhone and users can track their fitness data.</td>
</tr>
<tr>
<td>ZumeLife</td>
<td>ZumeLife’s iPhone application helps users remember to do various health-related activities and to record those activities, such as medication management, exercise and nutrition, as well as common biometrics and symptoms. A web site allows for review of continuous health patterns and the interrelationships among different activities, and to respond quickly to changes in health.</td>
</tr>
<tr>
<td>Voxiva</td>
<td>Voxiva offers multiple health solutions built on the mConnect Services Platform for smartphones, and interactive mobile health solutions exist for diabetes, HIV/AIDS, weight control, smoking, flu, immunization, and pregnancy through its Health Connect suite. This suite allows patients to receive reminders, health education, assessments, and access to personal health portals.</td>
</tr>
</tbody>
</table>
The Future
A major barrier to the advancement of cell phones in healthcare is the lack of evaluation and evidence of improved outcomes. More studies on the effects of such technologies on chronic disease management are needed, as studies to date have mostly been early stage with a small sample size. Also, Health Care Unplugged, a 2008 California Health Care Foundation report, identified additional barriers to broader diffusion, such as lack of reimbursement, slow uptake by healthcare systems, data privacy and security concerns, and the affordability and maintenance of services.

Health applications will continue to build on convenient consumer technology infrastructures such as the cell phone. Over the next five years, direct-to-consumer cell phone services for health and wellness applications in nutrition and fitness will continue to grow. Applications of cell phone technology to support self management in chronic diseases will rely on involvement by formal health service providers, and will likely be considerably slower than health and wellness applications.

In general, diffusion will be slower than direct-to-consumer services because ROI is critical for healthcare service providers to make investment decisions. Although text messaging will drive applications, smart phone platforms will enable a new generation of applications that support integration with personal health records, multi-media data, gaming, and social networking services.

HEALTH GAMES

Overview

Health games involve the use of interactive multi-media gaming platforms that support self-management and self-efficacy across a broad range of health conditions, fitness, and wellness. Key gaming functions target self-assessment, self-management, education, and physical conditioning with a goal of healthier behaviors and skill building. Health games have also been designed for chronic disease management, in order to provide education, improve treatment adherence, and remove stigma associated with certain diseases. To date, the development of health games has been driven by trends in a broad range of computing and communications technologies. Game platforms and formats include traditional video games on game consoles, handheld players, computers and the Internet.

Health games are a relatively new market phenomenon that has grown quickly in number and variety in recent years. Consumers and some traditional health services (e.g. health insurers, service providers) have adopted and in some instances have driven the development of such games. The primary drivers of market demand are the convergence between consumer and social trends, advances in user interface technologies, and an increase in the incidence and prevalence of obesity and chronic diseases.

Industry analysts estimate that the market currently offers over 300 games focusing on specific chronic diseases, wellness, fitness, and a variety of conditions and treatments that include smoking cessation, pain management, and rehabilitation and occupational therapy. The Robert Wood Johnson Foundation’s Health Games Research is a national program with $8.5 million supporting research to enhance the quality and effectiveness of interactive games to improve health.
Applications
Health games target a broad range of consumer needs across all age groups, many of them related to chronic conditions such as asthma and obesity:

<table>
<thead>
<tr>
<th>Targeted Need</th>
<th>Health Game Example</th>
<th>Targeted Outcome</th>
</tr>
</thead>
</table>
| Treatment Self-management                   | Re-Mission (HopeLab) [http://www.hopelab.org/innovative-solutions/re-mission%26%2384%A2/]  
Quest for the Code (Starlight Children’s Foundation) [http://asthma.starlightprograms.org/]  
Packy and Marlon (Super Nintendo)  
Bronkie the Brontosaurus (Super Nintendo) | Improve treatment adherence through increased knowledge and self-efficacy for young patients with cancer (Re-Mission), asthma (Quest for the Code) and diabetes (Packy and Marlon). Bronkie the Brontosaurus’ goal is to reduce symptom days, emergency visits, and average daily doses of corticosteroids. |
| Healthy lifestyle behavior change           | Escape from Diab (Playnormous) [http://www.escapefromdiab.com/game1.html]  
Nanoswarm: Invasion from Inner Space (Playnormous) [www.playnormous.com]  
Food Fury (Playnormous) [www.playnormous.com] | Improve children’s healthy lifestyle behaviors in nutrition and physical activity. |
| Physical activity and fitness               | Dance Dance Revolution (Konami) [www.ddrgame.com]  
Wii Fit (Nintendo) [www.wiifit.com] | Increase physical activity and improve fitness for all age groups. |
| Mental health                               | Bejeweled 2 Deluxe (PopCap Games) [www.popcap.com]  
Bookworm Adventure (PopCap Games) [www.popcap.com]  
Peggle (PopCap Games) [www.popcap.com]  
| Cognitive function                          | InSight (Posit Science) [www.positscience.com]  
Brain Fitness (Dakim) [www.dakim.com]  
Crazy Taxi (PlayStation 2) [http://www.us.playstation.com/PS2/Games/Crazy_Taxi] | Reduce effects of age-related mental decline through exercising areas of memory, language and concentration. Measure executive function and assess visual attention by performance with cognitive speed and skills. |
Besides consumer interest in health games, health insurers and delivery systems have been quick to explore the potential of health games, as shown in Table 15 below.

**Table 15: Health Plan Games**

<table>
<thead>
<tr>
<th>Group</th>
<th>Initiative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humana</td>
<td>Humana Games</td>
<td>Portal offering a series of online health and wellness games for children (Horsepower Challenger) and older adults (Dancetown).</td>
</tr>
<tr>
<td>Inland Empire Health Plan</td>
<td>The Xrtainment Zone</td>
<td>Exer-gaming wellness weight-loss program targeting overweight 5-17 year olds who have been referred by a doctor.</td>
</tr>
<tr>
<td>Kaiser Permanente</td>
<td>Amazing Food Detective</td>
<td>Game-based activities that promote healthy eating behaviors among children aged 9-10.</td>
</tr>
</tbody>
</table>

Other place-based strategies that involve the use of health games are listed in Table 16 below.

**Table 16: Place-based health games**

<table>
<thead>
<tr>
<th>Location</th>
<th>Initiative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools</td>
<td>WV Games For Health</td>
<td>Initiative to place the Dance Dance Revolution video game into West Virginia K-12 schools.</td>
</tr>
<tr>
<td></td>
<td><a href="http://wvgamesforhealth.wvu.edu">http://wvgamesforhealth.wvu.edu</a></td>
<td>Initiative to place the Dance Dance Revolution video game into West Virginia K-12 schools.</td>
</tr>
<tr>
<td>Fitness clubs</td>
<td>American Council on Exercise</td>
<td>Organization is conducting research on exer-gaming activities such as Wii Sport and Dance Dance Revolution and how to incorporate the games into personal trainer sessions.</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.acefitness.org">www.acefitness.org</a></td>
<td>Organization is conducting research on exer-gaming activities such as Wii Sport and Dance Dance Revolution and how to incorporate the games into personal trainer sessions.</td>
</tr>
<tr>
<td>Senior living communities and centers</td>
<td>International Council on Active Aging</td>
<td>A November 2008 survey reports that 61% of more than 350 senior-living and older-adult centers intend to purchase some form of computer-generated or Wii-type game in the next two years. Another 38% were considering buying brain fitness software.</td>
</tr>
</tbody>
</table>
The Future

Despite the strong consumer interest in health games, the evidence base to validate and support the broad use of health games to deliver measurable health benefits (particularly for chronic diseases) is limited but emerging. For example, the American Council on Exercise confirmed in a study that interactive exer-gaming improves players' endurance, speed, hand-eye coordination and balance, as well as helps to increase energy expenditure and burn calories\(^{24}\).

The high cost and complexity required for clinical outcomes research represents a barrier to market development for unvalidated health games. Some clinical studies are underway for a number of chronic health conditions, including asthma, cancer, diabetes, and cystic fibrosis. The development of an outcomes evidence base will support effective design strategies in future game development. However, clinical evidence, while very important to providers and health plans, may not be as crucial to consumers, many of whom have adopted health games without particular concern for the evidence base for benefits.

Games will continue to introduce greater context-awareness, socialization, and augmented reality as capabilities in mobile and networked computing devices, context-sensitive programs, and immersion technologies advance. This will create mixed reality gaming environments and games that are more predictive of improved outcomes through their ability to monitor, assess, and provide customized feedback. Games will also provide social connections and support for players with their peers.

Future digital game play need not necessarily be screen-based, and can increasingly involve mobile components. Children’s digital games might take place face-to-face and involve information from cell phones as one component of the game, but not as its focus. For example, the game Geocaching is an activity that uses a GPS system and the web via a cell phone to post clues for people to hunt for buried items in the physical world (http://www.geocaching.com/).

SOCIAL NETWORKING

Overview

Web-based social networking services use software to allow communities of patients to connect, share knowledge with, provide support to other patients and with their care providers, and collaborate with other users online. These web-based social networks utilize a variety of means to facilitate communication among patients including discussion groups, chat, messaging, email, video, and file-sharing. Social networking services connect patients with other patients as well as with other stakeholders including clinicians, researchers, health plans, and even suppliers.

Social networking is especially useful for the chronically ill and others with more acute health conditions, to enable patients to find others with similar healthcare needs and concerns. In addition to social networking applications, general informational websites are also a commonly used resource for chronic disease management and education. Though not as interactive as the newer social media applications, general informational websites provide many chronic disease patients with helpful information and can be used in a more “passive” way than social media applications. However, many such websites may also contain a social networking component through message boards, blogs, listservs, and other interactive features or components of an online community.

In 2007, 56 percent of American adults used the Internet to look for health information. Their activities ranged from seeking opinions on medications and treatments and getting emotional support, to researching conditions or treatments, learning self-management skills, and receiving education to manage a condition. The benefits of providing support and exchanging knowledge, especially for patients with chronic conditions, are well studied. Web-based online social networking has emerged as a way to connect peers, independent of geography.

Before web-based social networking services existed, in-person peer groups like the Chronic Disease Self-Management Program have recognized the effect of sharing experiences, exchanging knowledge, and providing support to improve health outcomes for patients with various chronic conditions. The combination of patient-centered knowledge exchange and support, independent of geographical location, makes social networking a very powerful platform in changing the way that healthcare is delivered.

Children and teens in particular are among the more active users of social media and are attracted by the ease and simplicity by which they can communicate. In many instances, the use of social media is already a central part of teen culture and personal lifestyle. Specific areas of social media where young people are active include blogging and social networking sites to communicate and stay in contact with friends (e.g., MySpace, Facebook). Teens, particularly girls, are also active in the creation of content.

A major benefit of online social media (and what may explain its popularity) is the unique experiences created through virtual networking. Patient-centered knowledge exchange and support make online social media a very powerful healthcare platform that can transform the manner in which patients access information and can influence the design, development, and delivery of future healthcare services.

Applications
Social networking sites provide services that connect patients with other patients as well as to other stakeholders in health care (e.g., clinicians, researchers, health plans, vendors). Patients have used web-based social networking services to exchange knowledge and share experiences on the management of their conditions. Clinicians and researchers have also used social networks to educate and promote preventive health and to respond to their patients’ needs. Health plans and suppliers can utilize the information gained from patients, whether by tracking adverse side effects or collecting patient opinions, to improve their products and offerings.

Table 17 below shows some networking examples involving social media for chronic disease management applications.

Table 17: Social Networks in Health

<table>
<thead>
<tr>
<th>Targeted Need</th>
<th>Social Media Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children with life threatening illnesses</td>
<td>Starbright World <a href="http://www.starlight.org/starbrightworld">www.starlight.org/starbrightworld</a></td>
<td>A site for seriously ill teens and their teen-aged siblings. Whether from home or the hospital, members are able to get to know other teens from around the world that are going through similar experiences.</td>
</tr>
<tr>
<td>Families with sick children</td>
<td>Sophia’s Garden <a href="http://www.sophiasgarden.org">www.sophiasgarden.org</a></td>
<td>A site that combines the richness of real-life collaboration with online learning to help families of children with life-threatening and chronic conditions harness the power of community to address all of their needs.</td>
</tr>
<tr>
<td>Parenting and prevention</td>
<td>iParent Network <a href="http://www.iparentnetwork.org">www.iparentnetwork.org</a></td>
<td>A broad based community coalition of parents, professionals and other community members from three small towns. The mission is to equip parents with the tools to be prevention experts so today’s youth develop in healthy and safe ways.</td>
</tr>
<tr>
<td>Patient support groups</td>
<td>PatientsLikeMe <a href="http://www.patientslikeme.com">www.patientslikeme.com</a></td>
<td>A more effective way to capture valuable results and share them with patients, healthcare professionals, and industry organizations that are trying to treat specific (and often rare) diseases.</td>
</tr>
<tr>
<td>Storytelling</td>
<td>Center for Digital Storytelling <a href="http://www.storycenter.org">www.storycenter.org</a></td>
<td>Organization assisting people in using digital media to share stories from various facets of their lives, such as education, health, and family.</td>
</tr>
<tr>
<td>Mental health</td>
<td>Real Mental Health <a href="http://www.realmentalhealth.com">www.realmentalhealth.com</a></td>
<td>The online community includes individuals, their family members, loved ones and friends who want to easily and interactively obtain knowledge about mental health symptoms and treatments in a supportive community environment.</td>
</tr>
</tbody>
</table>

Due to the plethora of general informational websites that exist regarding health, it is important for patients to choose information from reputable sources. A good starting point is often a government-sponsored website, such as the Centers for Disease Control and Prevention or AHRQ.
The Future

Social networking is rapidly evolving, with new players still joining and transforming the field. In addition, the number of general informational websites on chronic health and other health conditions is increasing rapidly, providing many options for patients seeking health information online.

However, three main barriers prevent rapid development and broad dissemination of social networking for health. The first barrier involves conflicts of interest between stakeholders and users. It is oftentimes unclear how a patient’s information will be used by health plans and suppliers. The second barrier involves patient privacy concerns. Social networking for health relies on the open sharing of patient information. Within a hospital, a patient’s privacy is protected by HIPAA. Outside of the hospital, privacy issues become a concern. It is uncertain how the judicial system will deal with violations of privacy as well as how they will provide for protection of this information. Lastly, the organizational culture of traditional healthcare is largely controlling of the information, or the message, they send to patients. Since content on social networking is mostly patient-generated, traditional healthcare is concerned how this will affect their message.

One primary theme underlying the future of these online social networking services is integration and connectivity with other ICT applications. Social networks are just beginning to incorporate applications such as search and personal health records (PHRs). Websites that integrate search with social networking allow patients to search for health information and see both their Web search results as well as a list of patients that may be suffering from similar conditions related to the search. Additionally, websites that integrate PHRs with social networking give the patients the ability to view their medical information data as well as to share it with whom they wish.

The overlay of intelligent algorithms onto both applications gives patients the ability to receive customized information about their health that they could then use to proactively manage their health in a more personalized manner. Algorithms also facilitate the ability to look at patient data in aggregate to identify patterns, understand behaviors, and ultimately use that wisdom to improve care. As patients demand different ways to manage their health outside of the traditional healthcare model, these powerful new additions will play a large role in advancing online social networking for health.

Traditional healthcare stands to benefit considerably from the addition of social networking services. Over the long term, social networking can provide benefits in a number of ways including “integrating patient care and enabling community, enhancing patients’ compliance with therapies, building goodwill in communities, providing useful health information to people who opt-in to receive it, and averting costs that would be incurred in acute settings.”

Social networking services have the potential to form a more collaborative model of healthcare and deliver more effective and efficient care, particularly for chronic disease management applications.

PERSONAL HEALTH RECORDS

Overview

Personal Health Records (PHRs) refer to a set of technologies through which patients can access and manage their own health information. The contents of a PHR vary, but should include at a minimum diagnosis/problems, medications, allergies, and past medical history. The PHR may include the clinicians’ visit notes, laboratory results and imaging reports. Some PHRs allow the patient to keep a narrative summary of events, to record blood pressure and blood sugar levels, and to track medications, diet, and exercise. Most PHRs contain generic health content or links for references, and self-management. When discussed by source and relationship, a PHR may be referred to as either “tethered” or “untethered.”

• A tethered PHR is sponsored by a provider organization that is making available the patient’s personal health information. The record is automatically populated without the person having to enter information or arrange for the information to be transferred. The person may be able to add and/or correct the information. Tethered PHRs may have other functions such as secure messaging, appointment scheduling, or access to the person’s entire medical history. This may also be referred to as a patient portal.

• An untethered PHR is under the control of the person. The person controls access and must grant privileges to others for them to use the PHR. The person must enter all information or arrange for the information to be transferred from a specific source like a laboratory or pharmacy. The value of an untethered PHR is largely determined by a person’s willingness to manage and maintain their PHR information.

PHRs are especially useful for chronic disease patients and have seen the greatest traction among this group, as PHRs are useful for coordinating care from different sources and providing constant access to health information. Chronic disease patients are often more motivated to provide information and make the effort that PHRs often entail, as their care is more frequent and involves many more clinicians than the average patient. The PHR, when maintained properly, can be very useful for coordinating their care between these different clinicians.

The PHR has evolved over time from paper and pencil solutions, to simple word processing and spreadsheet implementations, and finally to specialized electronic systems. In the late 1990s, some large medical groups began to offer their patients a tethered PHR as a service. Two examples include MyChart at the Palo Alto Medical Foundation and Indivo at Boston Children’s Hospital. This was followed over the next several years by offerings from payers and commercial vendors. The payer systems were often limited in that they were interoperable only with the information systems of the organization that developed the system (e.g., the claims database and prescription information). The commercial vendors, whose systems were completely siloed, relied exclusively on the patient to enter health data.
The PHR market accelerated rapidly in late 2006 with the formation of Dossia (www.dossia.org), a non-profit organization formed by a consortium of large corporations to develop and host a comprehensive PHR. This was followed by PHR announcements from Microsoft, Google, large clinics, many hospital systems, online health information resources such as Revolution Health and WebMD, and many other smaller commercial vendors. These developments have coincided with an increasing focus on interoperability and information portability. For example, Google’s PHR integrates with a number of information sources such as commercial laboratories, pharmaceutical suppliers, and devices. Microsoft’s HealthVault is focusing more on connecting with traditional service providers like the Cleveland Clinic to provide a patient service. Both of these strategies are designed to populate the person’s record with some information from electronic sources, but still rely on the person to self-enter much of his/her information. Some large health systems such as Kaiser Permanente also currently offer tethered PHRs which usually do not rely on the person to self-enter information (such as Kaiser’s My Health Manager which is connected to their EPIC health record).

Currently, Project Health Design (www.projecthealthdesign.org) is a national program of the Robert Wood Johnson Foundation that designs next-generation PHRs through grant making activities. The program has funded a number of multi-disciplinary teams to work with users to design and eventually build prototypes of PHR applications. Two examples related to chronic disease include My-Medi-Health (Vanderbilt University Medical Center), which is a system that features a medication management assistant to help children with cystic fibrosis play a larger role in taking care of themselves; and a project from Stanford University and Art Center College of Design that uses a set of multimedia PHR tools to help adolescents with chronic illness communicate with their providers and others about their health as they transition to adulthood. Such initiatives are likely to continue the development of PHRs in the future, particularly for chronic diseases.

As PHRs advance, standards and certifications are beginning to emerge. Common across many of these systems is support for the Continuity of Care Record (CCR) as outlined by the American Society for Testing and Materials (ASTM; www.ccrstandard.com). The CCR is a core data set of the most relevant administrative, demographic, and clinical information facts about a patient’s healthcare and is becoming a de facto data standard across implementations. Functional, communication, and data standards for PHRs are emerging from the other major standards bodies. HL-7 (Health Level 7) released the Personal Health Record System Functional Model (PHR-S FM), which identifies a set of recommended functions and specifications for PHR’s. In addition, the Certification Commission for Healthcare Information Technology (CCHIT), the organization that certifies electronic health records, is currently developing a certification standard for PHRs.
PHRs also face a number of significant barriers to their continued progress:

- **Limited value**: People without special needs or chronic medical problems seldom need to access their health history and most are not inclined to regularly participate in structured wellness activities.
- **Privacy concerns**: Most patients guard their medical information as closely as their money. As more people use electronic systems to manage their money, they gain trust in systems for both functions. The one privacy area that remains a challenge is the right of a parent to access an adolescent’s PHR; thus most organizations with tethered PHRs do not currently provide PHRs for adolescents.
- **Limited interoperability**: Current standards do not allow information to flow easily from one health information system to another. This limits the usefulness of an untethered PHR to the small number of motivated persons willing to self-enter their important information.
- **Lack of funding**: At present there is no direct reimbursement for use of a PHR. Provider organizations that supply PHRs do so to project an image or because it improves their clinical performance. Currently, only the integrated, tethered PHRs that are an extension of a provider’s Electronic Medical Record (EMR) appear to improve an organization’s operating performance, as Kaiser Permanente has shown.

**Applications**

PHRs remain first and foremost a tool to engage individuals in their own health management. There are numerous applications of all types and they are constantly evolving. Current applications of PHRs tend to target the following key functions:

- Storage and viewing of parts or all of a person’s medical history
- Access to health information
- Assistance with chronic disease management
- Secure patient-provider communication
- A portable repository for the CCR
- Medication management
- Support for wellness activities
The Future

In the near-term, tethered PHRs with the functions of a patient portal will increase at a rate that follows the implementation of ambulatory EMRs. This adoption could be further accelerated if the U.S. Department of Health and Human Services were to include PHR adoption with their EMR incentive plan for supplemental reimbursement followed by reimbursement penalties. Untethered PHRs will struggle and will be used mostly by chronic disease or special-needs patients whose providers do not supply a tethered PHR, as well as the occasional person who is motivated to take the time and effort to self-enter their health information.

In the long term, all providers will likely have robust PHRs as an extension of their EMRs. Their EMR/PHRs will be able to accept CCR information from other providers on an automatic or on-demand basis. Even if an individual is healthy and receives only episodic care, he or she will have encounter information sent to a single site, most likely a primary provider. Most provider organizations will have added all of the portal functions to their PHR to provide improved access, self-service, continuity of chronic care, and remote care.

Major developments that will likely increase the adoption rate and importance of PHRs include:

- Increased standardization: CCHIT, HL-7, and other standards and certification bodies will be releasing formal requirements in the coming years. This increased standardization will accelerate interoperability and increase the utility of the PHR as a central health information hub.

- Increased openness of architecture: Vendors such as Google and Microsoft have published application program interfaces (APIs) for their systems to allow integration with other health IT systems, devices, and services.

- Inclusion in regional and national health information networks: Many of these organizations are considering incorporating Personal Health Records into their models as a point of contact for the patient as well as a portable information source for patient information on the network.

- Universal adoption of the ASTM CCR standard across PHR systems: The CCR may serve as a minimum data requirement of all PHRs both supporting interoperability and the utility of the PHR as a tool for clinicians.

- Increasing participation by large payers: The Center for Medicare and Medicaid Services (CMS) announced that, starting in early 2009, it would pilot four PHRs (Google Health, HealthTrio, NoMoreClipboard.com, and PassportMD) with its beneficiaries. If this program proves successful, CMS may roll out PHRs to millions of beneficiaries, dramatically increasing the adoption rate.

- Personalized health information: Health data in the PHR provides a unique opportunity to personalize health information and education materials with the application of intelligent agents.

- Device and Service Integration: The PHR will become the information and interface hub for a variety of wellness, remote health services, and disease management services and devices.
Chronic Disease Profile: Cardiovascular Diseases
SUMMARY

The most significant risk factor for cardiovascular disease (CVD) is age. Not only is CVD the leading cause of mortality, but CVD prevention and control achievements in recent years have led to a gradual decline in age-adjusted death rates, an increase in the average age of death, and a longer period of living with the disease after the initial onset of a CVD-related acute event. As a result, CVD affects a growing number of older adults. This development poses challenges to the health care system to continue to provide effective levels of care within the current delivery model and resource constraints.

Within CVD, congestive heart failure (CHF) is a disease of specific concern; its prevalence and incidence has increased in recent years as treatment has improved the survivability of acute events. An estimated 5.8 million people are affected by CHF in the United States. Approximately 550,000 new patient cases are reported annually, half of whom die within five years of the initial diagnosis. The cost of care for the CHF population alone constitutes two-fifths of Medicare costs and CHF is the most common diagnosis that leads to costly and often preventable hospital admissions and readmissions.

As a result, a new model of care is needed, comprising team-based care capabilities and collaborative care coordination strategies, as well as information and communication technologies that support patient transitions, remote care interventions to monitor and assess signs of potential complications, self-management, and patient-provider communications. This report discusses the ways that ICT can play a role in improving cardiovascular care processes and outcomes, and gives an overview of applications currently available or under development to treat CVD.

Context

The aging population, limited impact of prevention strategies in slowing disease onset, and suboptimal control by patients of risk factors could significantly exacerbate the future CVD burden unless a new model of care comprising team-based care capabilities and care coordination strategies supported by ICT emerges.

• Prevention and control achievements have led to a gradual decline in age-adjusted death rates, an increase in the average age of death, and a longer period of living with the disease after the initial onset of a CVD-related acute event
• Driving the escalating incidence and prevalence of disease in the United States are relatively new risk factors, namely aging and obesity which, when combined with the associated increase in diabetes, produce a larger population at greater risk for developing vascular diseases
• The resulting implications for health care services and related costs are enormous. Total hospital costs (inpatient, outpatient and emergency department patients) projected for 2009 are estimated at $150.1 billion, out of a total of $313.8 billion in direct health care costs
• A shift away from in-hospital and toward ambulatory care services is currently driving the organization and delivery of care services for CVD and a greater need for better care coordination and collaboration with the use of appropriate ICT and payment incentives.

**ICT for Chronic Care Management**

Elements of ICT that can be deployed along the intervention continuum to support collaborative and interactive remote care support services for CVD include clinical information systems, websites offering physician/patient education and personal health records, and self-management support tools.

• Pilot studies demonstrating improved outcomes and cost savings through the use of and high levels of patient acceptance and satisfaction with remote telehealth systems in CVD exist and will be critical in driving broader adoption

• The increasing ubiquity and low cost of broadband access has been a critical enabling technology in advancing the functionality of remote telehealth and is likely to continue to enhance interactive functionality and continuous connectivity

• The convergence of wireless technology, the Internet, mobile devices, and smart systems design are likely to also transform related developments in patient education and self-management support and multidisciplinary team management

• Personal health records are increasingly compatible with peripheral devices that connect to remote monitoring units to automatically upload data for storage and use by other web-based applications to help patients monitor progress, manage specific care management goals, share information, and receive customized and timely communications on health-care related topics.

**Implications**

Policy adjustments that reduce barriers and promote accelerated adoption and use of remote monitoring, particularly around reimbursement and investment in broadband infrastructure, will introduce significant cost savings for the U.S. health care system.

• Currently, adoption is largely driven by large private insurers or large employers that directly accrue benefits and justify the required investments in the technology infrastructure and services

• Broader adoption of remote telehealth systems requires larger studies evaluating financial and clinical outcomes to make a strong business case for investment and sustained use

• The availability of enterprise clinical information systems and technical staff to maintain and operate services will be critical to support the effective role for remote monitoring applications in the clinical care of patients

• Provider and patient acceptance and satisfaction with such technologies are also critical in driving adoption. Studies involving larger sample sizes will be required to validate user satisfaction on a broader scale.
CONTEXT

Among adults with one or more forms of CVD, the most prevalent conditions are hypertension or high blood pressure (74.5 million), coronary heart disease (17.6 million), stroke (6.4 million), and heart failure (5.8 million). CVD is also the number one cause of mortality, accounting for approximately one-third of all deaths. In addition to the standard “modifiable” (unhealthy diet, physical inactivity and tobacco use) and “intermediate” (the effects of modifiable risk factors such as raised blood pressure and raised blood lipids) risk factors underlying CVD and driving the escalating incidence and prevalence of disease in the United States are relatively new risk factors. These new risk factors include aging and obesity which, when combined with the associated increase in diabetes, produce a larger population at greater risk for developing vascular diseases.

Improvements in acute cardiac care and secondary prevention have resulted in people today living longer with the disease and an increase in the average age of death from CVD. In particular, advances in preventive measures, advanced diagnostic modalities, and improved treatment interventions have contributed to a decline of 50% over several decades in age-adjusted death rates. CVD and the need for effective levels of care management increasingly affect a larger number of patients as a result, particularly the middle-aged and elderly. Although advancing age is the most powerful risk factor for CVD, almost two-thirds of adults living with CVD are younger than sixty-five years of age. In particular, more than half of men and women ages 55–64 live with one or more forms of CVD.

A shift away from in-hospital and toward ambulatory care services is another major trend underway in the organization and delivery of care services for CVD. High blood pressure, acute and chronic heart failure, and chest pain are among the chief reasons for outpatient visits to physicians’ offices and emergency department (ED) visits. In 2006, there were over 72 million physician office visits, hospital emergency department visits and outpatient visits with a primary diagnosis of CVD. CVD also remains a leading cause of admissions or discharges from short-stay hospitals and nursing homes, with a quarter of nursing home residents aged 65 or older having CVD as a primary diagnosis at the time of admission.

In 2008, health-care spending and lost productivity from CVD resulted in a combined direct and indirect cost of $475.3 billion. Total hospital costs (inpatient, outpatient and emergency department patients) projected for 2009 for cardiovascular diseases and stroke are estimated at $150.1 billion, out of a total of $313.8 billion in direct health care costs. Costs of care for the heart failure population are reported to make up nearly two-fifths of Medicare costs, and a large share of those costs are avoidable through better care coordination and collaboration with the use of appropriate ICT and payment incentives. (Table 18)
Despite reductions in age-adjusted death rates and an increase in the average age of death, evidence suggests that rather than current interventions being effective in preventing vascular diseases, CVD is being made less lethal with the result that more people are surviving the acute presentation of the disease and returning to their communities in need of continuous chronic care management services. Sequelae of the disease—namely, disability and reduced quality of life—affect many survivors and almost all require numerous medications, increased care by medical specialists, recurrent testing, and, for some, recurrent hospitalizations and invasive procedures. The resulting implications for health care services and related costs are enormous.
A number of driving forces in CVD epidemiology exist with the potential to worsen this situation. Demographic shifts, and aging in particular, will have a major impact on the future prevalence and associated costs of CVD. Contributing to CVD epidemiology among U.S. adults is a documented increase in self-reported prevalence of CVD risk factors (high blood pressure, high cholesterol, diabetes, and obesity). Furthermore, current health issues affecting younger cohorts, particularly childhood obesity as well as obesity and Type-2 diabetes in young adults, represent major public health challenges that will increase the morbidity and mortality from CVD outside of the traditional patient cohort.

From a care management perspective, a significant opportunity to integrate mid-level providers or non-physician clinicians, such as nurses and physician assistants, into care models and build a more multidisciplinary team-based cardiovascular workforce exists. Such new care roles can help increase care capacity at a lower cost while contributing to maintaining levels of high-quality care and patient satisfaction. A March 2009 Cardiology Workforce report from the American College of Cardiology (ACC) found that mid-level providers create considerable value-added through their care and patient education roles, generating one third of the relative value units of a typical cardiologist with gross revenues three to four times greater than their actual incomes.33

The aging population, limited impact of prevention strategies in slowing disease onset, and suboptimal control by patients of risk factors could significantly exacerbate the future CVD burden unless a new model of care comprised of team-based care capabilities and care coordination strategies emerges. Elements of ICT that can be deployed along the intervention continuum to support such a model include clinical information systems for coordinated and collaborative care management, interactive patient communications, and self-management tools, including monitoring devices, medication adherence reminders, online educational and self-management resources, and home-monitoring devices that provide monitoring, measurement, coaching, and messaging functions that facilitate collaborative and interactive remote care services.

ICT IN CHRONIC CARE MANAGEMENT FOR CARDIOVASCULAR DISEASES

In CVD, new care delivery strategies are emerging comprised of team-based care capabilities and collaborative care coordination strategies and enabled by ICT to support patient transitions, remote care interventions, patient self-management, and patient-provider communications. ICT-enabled care management approaches in CVD involve the use of clinical information systems for coordinated and collaborative care management (such as disease registries and electronic health records with evidence-based guidelines), websites offering physician/patient education and personal health records, such as ACC’s CardioSmart, and self-management support tools that facilitate collaborative and interactive remote care support services.

A review of data from ten randomized clinical trials of heart failure care management programs to assess how program delivery methods, specifically delivery personnel and the communication method used, contribute to patient outcomes found that patients enrolled in programs using multi-disciplinary teams and in programs regularly using in-person (face-to-face) communication had significantly fewer hospital readmissions and readmission days than routine care patients and programs.\(^\text{34}\) No study that was reviewed, however, involved the use of a multidisciplinary team as well as communications involving telephonic or similar ICT, so it was not possible to evaluate whether in-person or ICT-enabled approaches were significantly more effective.

\(^\text{34}\) Sochalski et al. What Works In Chronic Care Management: The Case Of Heart Failure Health Affairs.2009; 28: 179-189.
However, the results are encouraging and highlight the strengths of the care delivery approach and potential ICT offers to support such a model. When combined, programs using multidisciplinary teams and in-person communication methods resulted in significant reductions in readmissions and days per month over routine care. These reductions were roughly 60 percent and 50 percent larger than those for programs using a single heart failure expert and in-person communication. Using published estimates of national hospitalization and readmission rates for the population of people with CHF, the study’s authors found that achieving a 2.9 percent reduction in hospital readmissions per month from implementing team-based care management programs could result in an annual reduction of 14,700–29,140 hospital stays nationally.

Table 19: Percentage Reduction in Hospital Readmissions Associated with Delivery Personnel and Method of Communication in Chronic Care Management Programs

<table>
<thead>
<tr>
<th></th>
<th>Percent reduction in readmissions per month</th>
<th>Percent reduction in readmission days per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery personnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single heart failure expert</td>
<td>0.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Multidisciplinary team</td>
<td>2.9***</td>
<td>6.4****</td>
</tr>
<tr>
<td>Method of communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telephonic</td>
<td>0.4</td>
<td>1.5</td>
</tr>
<tr>
<td>In-person</td>
<td>2.5***</td>
<td>5.7****</td>
</tr>
<tr>
<td>Delivery + communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single expert + telephonic</td>
<td>0.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Single expert + in-person</td>
<td>1.8^3</td>
<td>4.3^b</td>
</tr>
<tr>
<td>Team + in-person</td>
<td>2.9***</td>
<td>6.4****</td>
</tr>
</tbody>
</table>

**Source:** Authors’ analysis.

**Notes:** Figures in the exhibit represent authors’ conversion of log-transformed regression coefficients from linear mixed-model regressions adjusted for age, sex, history of hypertension, prior heart attack, and original trial. Routine care patients are the reference group in each comparison. N = 2,028.

^a p = 0.05.
^b p = 0.06.
***p < 0.001

Source: Health Affairs
The following section discusses specific ICT-enabled care interventions to illustrate the applications of ICT in supporting multidisciplinary team-based care capabilities and engaging patients themselves as part of the care team, and the reported outcomes.

**ICT Applications in Cardiovascular Disease Care Management**

The cost for remote patient monitoring, which comprises the cost of hardware, including the base unit and peripheral devices, and the fees associated with the service component, makes payers and providers the primary target market for vendors. The hardware cost varies considerably based on the degree of functionality provided. More sophisticated devices, such as Intel’s Health Guide and American Telecare’s LifeView devices, cost several thousand dollars each. Service fees typically cover the use of IT systems to store, manage and disseminate information, the provision of access to web-based tools, and the integration of data with electronic health records. The basic LIFE Pod, which is priced at approximately $100 per unit, has a monthly service fee of $20. VHA estimated the net cost for its home telehealth program was $1,600 per patient per annum.

A recent assessment of home telehealth systems by the New England Healthcare Institute (NEHI) reported that the majority of devices currently in use are part of pilot or demonstration projects. In addition to demonstrating improved outcomes and cost savings, patient acceptance and satisfaction with such technologies is also critical in driving adoption. The Health Buddy system from Bosch, which is currently in use by the Department of Veterans Affairs and in the Medicare High Risk Demonstration project with approximately 1,000 patients in California, reported that 90% of CHF patients in one study approved of the device and that patients found that the device contributed to improved diet and medication compliance and increased confidence in self-management of the disease. Using data collected through 42,460 surveys administered through home telehealth devices, the VHA found that, on average, patients reported an 86% satisfaction level with home telehealth services.

Improved clinical outcomes, as demonstrated through secondary outcomes such as reduced ED visits, hospitalizations, and length of stay and improved survival rates, have also been reported in pilots involving home telehealth. (Table 20) These secondary outcomes provide a strong business case to support the adoption of home telehealth on the basis of the resulting cost savings. The decreases in hospitalizations and emergency department visits reported with CHF patients using Health Buddy in its meta-analysis of three programs reduced average annual costs from $11,549 to $3,263. Home telehealth can also reduce the need for intensive home health service and institutional care services. VHA’s Care Coordination / Home Telehealth program indicated that the net cost was $1,600 per patient per annum versus $13,121 for VHA’s home-based primary care services (and $77,745 for market rate nursing home care).

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Table 20: Selected Home Telehealth Study Findings

<table>
<thead>
<tr>
<th>Study</th>
<th>N=</th>
<th>Survival/Mortality</th>
<th>Decrease in Hospitalization</th>
<th>Decrease in ED Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans-European Network Homecare Monitoring Study</td>
<td>426</td>
<td>15% increase in survival</td>
<td>34%</td>
<td></td>
</tr>
<tr>
<td>Roanoke Chowan Community Health Center</td>
<td>40</td>
<td>--</td>
<td>71%</td>
<td>69%</td>
</tr>
<tr>
<td>Specialized Primary and Networked Care in Heart Failure II</td>
<td>188</td>
<td>No statistical Difference</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td>VHA</td>
<td>17,025</td>
<td>--</td>
<td>19.74%</td>
<td></td>
</tr>
<tr>
<td>Meta Analysis – Health Buddy</td>
<td>238</td>
<td>69% decrease in mortality</td>
<td>--</td>
<td>69%</td>
</tr>
</tbody>
</table>

Source: New England Healthcare Institute

Given that approximately 20% of hospitalized CHF patients are not identified as such upon admission because unrelated acute symptoms are noted at that time, ICT has been shown to be effective in identifying such patients and in enhancing care and support during their care transitions. In particular, hospitals are deploying information systems (such as disease registries) that help identify hospitalized patients by flagging certain medications or diagnoses that might prompt a review of the record for an indication of heart failure. Once identified, a transition nurse undertakes education of patients and their families while in the hospital about their disease and care in preparation for discharge to the home or other community setting.

Remote patient monitoring is an increasingly important component in the preparation of individualized care plans to support intensive follow up immediately after discharge and to coordinate post-acute follow-up care between inpatient and outpatient providers with the goal of reducing avoidable hospitalizations. In the Institute for Healthcare Improvement’s (IHI) survey of the published evidence, a large number of studies exist with regard to the effect of various remote monitoring strategies on patients with heart failure. However, because RPM interventions are often but one element of a comprehensive strategy, it is difficult to assess the isolated effect on reducing rehospitalization rates with IHI reporting the total effect ranging from a low of 14% to a high of 80% reduction.

In patients released from the hospital with heart failure, the Specialized Primary and Networked Care in Heart Failure disease management program (SPAN-CHF I) conducted a randomized control trial evaluating a nurse-run disease management program to prevent readmission of heart failure patients. A follow-up study, SPAN-CHF II, investigated the use of DM along with an automated home monitoring (AHM) system to further evaluate reduction in readmissions. The AHM utilized an interactive scale, blood pressure cuff, text messaging system, and the Bosch Health Buddy device. The study found that in-home monitoring (AHM) and coaching (DM) after hospitalization for CHF reduced rehospitalizations for heart failure by 72 percent, and all cardiac-related hospitalizations by 63 percent.38 (Figure 15)

**Figure 15: Preventing Readmissions: SPAN-CHF I and II Studies**

Overall, and particularly in CHF, remote monitoring interventions providing coordinated follow-up contact and patient education over time have been shown to be effective in reducing the frequency of hospitalizations. A systematic review of studies reported by IHI involving remote monitoring strategies, including telephone-based symptom monitoring, automated monitoring of signs and symptoms, and automated physiologic monitoring, found that six of nine studies experienced a reduction in all-cause hospitalizations (ranging from 14% to 55%) and heart failure hospitalizations (ranging from 29% to 43%). Other studies reported by IHI to demonstrate remote monitoring’s effectiveness include the following:

The use of multidisciplinary team management, inpatient education, as well as an outpatient telephonic program to reinforce education after discharge over three months reduced heart failure rehospitalizations from 854 to 200.

Nurse telemanagement as a remote monitoring alternative to weekly home nurse visits reported in patients using home monitoring devices to measure weight, blood pressure, heart rate, and oxygen saturation had 13 rehospitalizations due to heart failure compared to 24 rehospitalizations for the home nurse visit group after three months (p≤0.001).

A call center that provided 24/7 hotline support as well as a registered nurse who contacted patients on a regular basis was associated with an approximately 80% reduction in CHF readmissions. The 6-week long program reduced the CHF readmission rate from 12% to 2%.

At the Fuqua Heart Center of Atlanta at Piedmont Hospital, patients self-managed their condition and provided nursing staff with information using a user-friendly touch screen monitor. Nurses contacted patients that did not report for an extended period of time. Thirty-day readmission rates for heart failure patients were reduced from 5.85% to 1.45%, a 75% decrease.

NEHI reports the following CHF-associated cost savings from the use of RPM technologies:39

- Based on the potential of RPM to prevent between 460,000 and 627,000 heart failure-related hospital readmissions each year, NEHI estimates an annual national cost savings of up to $6.4 billion dollars.
- The annual cost of a heart-failure related hospitalization per patient ranged from $5,632 for RPM patients to $11,387 for disease management without RPM patients to $13,468 for standard care patients.

Over the long term, public policy adjustments that reduce barriers and promote accelerated adoption and use of remote monitoring tools, particularly around reimbursement and continued investment in broadband infrastructure, can lead to savings of $102.5 billion in CHF over the next 25 years for the U.S. health care system.40

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Examples of RPM for CVD Care Management

Standard remote patient monitoring systems consist of a hub device containing the communications and interactive/audio/video capabilities and the ability to connect wirelessly to peripheral devices to collect patient physiologic data. Such devices may include blood pressure cuffs, pulse oximeters, weight scales and possibly devices capable of more sophisticated heart rhythm and clotting factor measurements such as wearable electrocardiography devices. Systems may also contain multiple-choice questionnaires to collect additional patient health and behavioral information.

These data are then automatically transferred by both standard wired and wireless communications infrastructure (using both phone and computer) to a server associated with an attended remote monitoring service center that can review and provide clinicians with patient lists on a daily basis or report critical events related to specific patients in real time. Data are generally accessible to physicians at all times. Data mining algorithms can generate automated and customized educational content and coaching feedback to patients in response to the patient-reported data. See Figure 16 for a standard remote monitoring framework.

Figure 16: Standard Remote Monitoring Framework

Source: Philips Home Healthcare Solutions
A number of systems also provide interactive communication between providers and patients through audio and video conferencing capabilities that allow providers to interview, observe and educate patients as well as assist in the use of the peripherals or other medical devices. The increasing ubiquity and low cost of broadband access has been a critical enabling technology in advancing such functionality and is likely to continue to drive the development of remote monitoring devices (and related services with enhanced interactive functionality and continuous connectivity) for the foreseeable future. Further, the convergence of wireless technology, the Internet, mobile devices, and smart systems design are likely to continue to transform developments in remote monitoring capabilities related to patient education and self-management support and multidisciplinary team management.

Other RPM systems include sensors implanted within medical devices, such as pacemakers, implantable cardioverter defibrillators, and cardiac resynchronization therapy devices. These implantable devices can provide continuous, real-time tracking and analysis of patients’ heart rhythms as well as device components, like battery life and lead function. Such RPM devices involve the same data collection and transmission processes as outlined with the standard devices described above but without the sophisticated level of interactive communication and education functions associated with them. Reported benefits include reduced in-person clinic visits, early detection of health problems, increased patient satisfaction, and potential cost savings. Device companies, such as Medtronic and St. Jude Medical, have been making significant progress towards wireless-enabled capabilities that facilitate proactive management of CVD on a continuous basis through proprietary remote monitoring networks. As the number of older adults implanted with cardiac devices grows, device communications and network capabilities will continue to advance.

Most large cardiac physiological monitoring device manufacturers use RFID to wirelessly transmit data from the device to a base station, which can be stationary or mobile. Such transmissions are either manually requested by a patient using a wand tool, or automatically uploaded to the base station without patient involvement. Base stations then transmit data via an analog phone line (“landline”) or GSM network (cellular phone networks) to the clinician. Transmission to the clinician can occur daily or on a scheduled basis. Acute events, like shock administration by the device, trigger an alert to the clinician. Clinicians can receive alerts via SMS text messaging, e-mail, fax or phone. Clinicians can then investigate patient data to decide whether the patient should come into the hospital or stay at home. Some devices have the ability to create specific alerts for individuals, accessing and configuring alerts online, and stratifying risk. Other unique features include measuring lung fluid levels and generating alerts (Medtronic CareLink), using wireless peripheral devices like weight scales and blood pressure cuffs (Boston Scientific Latitude), and exporting the data directly into EHRs (Boston Scientific Latitude). In 2009, physicians became eligible under Medicare to receive reimbursement for the time spent interpreting and analyzing data generated by these devices.
Table 21: Comparison of Continuous Cardiac RPM Technologies

<table>
<thead>
<tr>
<th></th>
<th>Biotronik Home Monitoring</th>
<th>Medtronic CareLink</th>
<th>Boston Scientific Latitude</th>
<th>St Jude Merlin.net</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless communication with implanted device</td>
<td>Radiofrequency</td>
<td>Radiofrequency</td>
<td>Radiofrequency</td>
<td>Radiofrequency</td>
</tr>
<tr>
<td>Data Transmission</td>
<td>GSM network</td>
<td>Analog phone line</td>
<td>Analog phone line</td>
<td>Analog phone line</td>
</tr>
<tr>
<td>Transmitter</td>
<td>Mobile</td>
<td>Stationary</td>
<td>Stationary</td>
<td>Stationary</td>
</tr>
<tr>
<td>Frequency of transmissions</td>
<td>Daily FU; Alert events</td>
<td>Scheduled FU; Alert events</td>
<td>Scheduled FU; Alert events</td>
<td>Scheduled FU; Alert events</td>
</tr>
<tr>
<td>Physician Notification</td>
<td>SMS, e-mail, fax</td>
<td>SMS, e-mail</td>
<td>Fax, phone</td>
<td>Fax, e-mail, SMS</td>
</tr>
<tr>
<td>Special Features</td>
<td>Alerts fully configurable online Wireless PMs</td>
<td>Optivol lung fluid status alert Configurable red and yellow alerts</td>
<td>EHR data export capability Optional wireless weight scales and BP cuffs</td>
<td>Alerts fully configurable online Possibility of sending automated phone calls to patients</td>
</tr>
</tbody>
</table>

According to guidelines from the ACC/ American Heart Association (AHA)/Heart Rhythm Society (HRS), patients obtain many benefits from the use of standalone cardiac RPM devices. Preliminary results from the TRUST trial, which analyzed remote monitoring of patients using Biotronik ICDs, found that remote monitoring reduced the number of in-person clinic visits by 43%. The Biotronik device is the first to allow for automatic upload of patient data to the clinician. This automation will ensure transmission of data at appropriate intervals, and allow for increased frequency of transmission. The portable base station, which can be worn by patients, and the use of GSM networks to transmit data can improve the frequency of transmission as patients are not required to be in the same location as the stationary base station and/or landline ports. In the future, closed loop systems will permit devices to administer or adjust treatment based on sensor readings. Many continuous cardiac devices are capable of becoming closed loop systems. Such systems will emerge as algorithms and alert systems mature, error signals decrease, and remote overview by physicians becomes seamless.

Table 22 profiles selected home telehealth units with remote monitoring capabilities in use with CVD patients and with a summary overview of the key features offered:

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41 Burri and Senouf. Remote monitoring and follow-up of PMs and ICDs. Europace 2009.

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Table 22: Selected RPM Product Offerings

<table>
<thead>
<tr>
<th>Technology</th>
<th>Key Features</th>
<th>Other Comments</th>
</tr>
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<tbody>
<tr>
<td>Health Buddy (Bosch)</td>
<td>Simple four-button device with no audio or video</td>
<td>With more than 30 health management programs to choose from, the Health Buddy system can address a broad range of health applications that include chronic disease management, weight loss programs, diabetes management, cardiac monitoring, and clinical trials. An average of 27,000 patients connect daily to their care providers using the system. The VA deploys the technology nationwide. The technology is also being used in the Medicare High Risk Demonstration Project with approximately 1,000 patients in California. An ongoing study comparing Health Buddy system users to a control group saw an 85% daily utilization rate, resulting in a 40% drop in acute hospital days, 68% fewer nursing home days and a 3.75% overall net reduction in medical costs for the Health Buddy group.</td>
</tr>
<tr>
<td>Genesis DM (Honeywell HomMed)</td>
<td>User interface comprises voice and text prompts to guide patients through health assessments. On-demand patient management modules provide symptom-specific assessment and patient information by diagnosis or disease state. Peripherals include stethoscope, scale, blood pressure meter, glucose meter, pulse oximeter, thermometer, PT/INR meter, peak flow meter. Device forms part of Honeywell LifeStream Telehealth Ecosystem which provides a unified application platform for remote patient monitoring and disease-specific symptom management.</td>
<td>Over 40,000 Sentry Telehealth Monitors in use worldwide in the remote management of a variety of chronic conditions, such as CHF, chronic obstructive pulmonary disease, coronary artery disease, diabetes and hypertension. Allegan Homecare reduced home visits in CHF and COPD patients from an average of 22 nurse home visits per episode to 15 and, most recently, just 12 visits for CHF patients. The reduction in visits allowed nurses to increase the average patient case load at any given time from 15 to nearly 25. LifeStream Telehealth includes two new offerings: LifeStream Connect (a suite of interfaces that integrate electronic medical record and other point-of-care applications in a single platform) and LifeStream View (allows patient, caregiver, and family access to patient data using secure Internet access).</td>
</tr>
<tr>
<td>Health Guide PHS6000 (Intel)</td>
<td>Video-capable touch screen Two-way audio and video Peripherals include blood pressure, glucose meter, ECG, scale, peak flow meter</td>
<td>Received 510(k) market clearance from the U.S. FDA in July 2008 and has been available since the end of 2008. Among pilot partners and customers are insurance company Aetna, provider Providence Medical Group in Oregon, Erickson Retirement Communities, Medicare Advantage plan SCAN Health Plan, and the VA’s Rural Resource Center Western Region.</td>
</tr>
<tr>
<td>Technology</td>
<td>Key Features</td>
<td>Other Comments</td>
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<td>---------------------</td>
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<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<tr>
<td>TeleStation (Philips)</td>
<td>Two-way transmission of vital signs data and interactive communication</td>
<td>Philips provides remote cardiac monitoring services to more than 200,000 patients worldwide, including Event and Holter monitors, implantable device monitoring, and anti-coagulation surveillance. Philips home telehealth services target disease management firms, home care agencies and healthcare providers to provide remote monitoring of chronic diseases and send patients short health status surveys to make more timely care decisions and help prevent unnecessary hospitalizations. Banner Health reported telehealth services to more than 550 patients with heart failure and other chronic diseases in the past three years achieved a readmission rate of 3.8 percent for patients on telehealth versus a national readmission rate of 29 percent for Medicare-certified home health agencies. (Philips is also conducting pilot studies of the Motiva platform in Europe, which uses televisions as the platform for interactive patient monitoring and broadband, with 1,000 CHF patients in the U.K.‘s NHS)</td>
</tr>
<tr>
<td>LifeView (American Telecare)</td>
<td>Video-capable touch screen Two-way audio and video Peripherals: stethoscope, scale, blood pressure meter, glucose meter, pulse oximeter, thermometer, PT/INR meter</td>
<td>American TeleCare claims to have installed more than 95 percent of all video-based home telehealth programs nationwide. VA hospitals have been using its telehealth solution since 1999 and the company recently received new contracts to continue use through 2013. Centura Health at Home, Colorado’s largest health care system, is currently offering home telehealth services to 167 Medicare members with heart failure, COPD, and diabetes. Pilot study results found a 100 percent reduction in ED visits over a 6-month period. Atlantic Canada implemented a CHF outcomes study in 2008 to determine whether the model improves clinical care and outcomes. The primary outcome measured is a composite of total all-cause hospitalizations and total mortality at one year. A wide range of secondary measures includes heart failure morbidity and mortality, cardiovascular hospitalization, total inpatient and outpatient costs, patient-reported quality of life, and patient satisfaction. The study was scheduled to be completed by November 2009.</td>
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</table>

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<table>
<thead>
<tr>
<th>Technology</th>
<th>Key Features</th>
<th>Other Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal LIFE Pod</td>
<td>Inexpensive system of communications hub and peripherals</td>
<td>Applications targeting CHF, hypertension, asthma, and chronic obstructive pulmonary disease (COPD). Ideal LIFE products are currently available through select insurers, physician groups, and home care agencies. The company expects to have its products and services available in retail outlets by 2010.</td>
</tr>
<tr>
<td>(Ideal Life)</td>
<td>Open platform that allows devices to easily integrate with cell phones, telephone lines, and the Internet. No audio or video</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All interactive capability is contained in peripherals: blood pressure meter, glucose meter, scale pulse oximeter, peak flow meter, pedometer, chair scale</td>
<td></td>
</tr>
<tr>
<td>Viterion 200</td>
<td>“Text to speech” feature for the visually impaired</td>
<td>Applications for management of diabetes, CHF, and chronic obstructive pulmonary disease.</td>
</tr>
<tr>
<td>(Bayer HealthCare)</td>
<td>Creation of automated advise messages and questions in response to vital signs data to promote self-management</td>
<td>A recent study amongst CHF patients showed that the rate of rehospitalization was 45% in the “routine care” group, whereas it reduced sharply to 20% in the group monitored with Viterion telemonitors. 44</td>
</tr>
<tr>
<td></td>
<td>Peripherals include Blood Pressure and Pulse; Blood Oxygen level; Weight; Blood Glucose; Pain; PT/INR; Temperature; Asthma; Fluid Level and Peak Flow</td>
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</tr>
</tbody>
</table>

Source: New England Healthcare Institute; Company websites

As an example of emerging capabilities in automated, customized patient interactions in response to remote health monitoring capabilities for CVD, the Center for Connected Health and Partners Home Care developed Connected Cardiac Care, a self-management and preventive care program for CHF patients that combines telemonitoring capabilities with nurse intervention and care coordination, coaching and education to foster greater patient engagement, proactive interventions, and reduce hospital readmissions. The program has been launched throughout the Partners HealthCare network following a six-month pilot study that included 150 heart failure patients at Massachusetts General Hospital. Results indicate that individuals enrolled in the program had lower hospital readmission rates and fewer emergency room visits than those receiving usual care, and 95 percent of participants found the program improved their heart failure control, helped them manage their condition, and assisted them in staying out of the hospital.45

More recently, the Center for Connected Health has introduced SmartBeat, a hypertension self-management program, which uses a blood pressure cuff that stores and transmits data and an Internet-based system that combines personalized, data-driven feedback with educational content, after an employer sponsored pilot test with employees of EMC Corporation. Results from the six-month pilot study involving 400 people indicate that 90 percent stayed with the program for the study’s duration. Results of SmartBeat’s impact on healthcare costs and utilization were also studied and have yet to be publicly reported. These two initiatives are supported by a proprietary patient and practice management platform, Connected Health Care Suite, which includes a Remote Monitoring Data Repository to store patient data and create a single data integration capability with other enterprise health information systems that support automated, customized patient feedback capabilities.

Examples of other mobile and remote monitoring applications specific to CVD include the following:

**Mobile Cardiac Outpatient Telemetry System (from CardioNet)**
(http://www.cardionet.com)

CardioNet’s service line includes the Mobile Cardiac Outpatient Telemetry (MCOT) system, which uses a three-lead sensor connected to an electrocardiogram monitor worn externally by the patient. MCOT is indicated for use in primary diagnosis of cardiac rhythm-related problems, post-procedure monitoring, and titration of drugs for controlling heart rate. The system, which provides ECG monitoring, analysis and response, automatically transmits abnormal event data, such as arrhythmia, to a service center where the results are evaluated and then reported to the patient’s physician.

Since approved for use in the United States in 2002, the company reports that more than 80,000 patients have used MCOT. Patients, who typically use the system on average for two to four weeks, wear the device on a continuous basis over that period. Technical and professional components of CardioNet’s diagnostic services are reimbursed by Medicare and commercial insurers. In a 17-center, 300-patient randomized study comparing CardioNet MCOT with LOOP event monitors, CardioNet proved to be nearly 3-times superior to LOOP event monitors at detecting clinically significant arrhythmias.46

- CardioNet proven to be nearly 3x superior to LOOP event monitors at detecting clinically significant Atrial Fibrillation in all patients 23% vs. 8% (p<0.001); In the same group of patients, CardioNet detected asymptomatic Atrial Fibrillation 17% vs. 0% in LOOP event monitors (p<0.001)
- In patients with syncope or presyncope, CardioNet proven greater than 3x superior to LOOP event monitors for detecting clinically significant arrhythmias 52% vs. 16% (p<0.001)
- In patients with syncope or presyncope, CardioNet proven greater than 3x superior to LOOP event monitors for detecting Afib/Aflutter 24% vs. 2% (p<0.001); In the same group of patients, CardioNet detected asymptomatic Atrial Fibrillation 19% vs. 0% in LOOP event monitors
- In all patients, an arrhythmia was confirmed or excluded as the primary cause of the symptom in 88% of CardioNet patients vs. 75% LOOP patients (p=0.008).

**MedStar (from Cybernet Medical)**
(http://www.cybernetmedical.com/products/medstar.html)

MedStar is a web-based outpatient care solution that uses a small device to collect data from peripheral medical devices used at home, such as weight scales, pulse oximeters, and blood pressure cuffs, and sends data to a web-based patient and data management system. (See Figure 17) The product was launched in 2001 and has been available nationwide since 2006. For 53 CHF patients of a Midwest health system with affiliated home care, MedStar was used to monitor blood pressure and weight for 12 months. Results demonstrated savings of more than 80% of patient costs attributable to avoidable re-hospitalizations. Key outcomes measured included 86% reduction in CHF admissions and 89% compliance with the standard plan of care. Other results reported include 5% “Best Practice” benchmark achieved on 30-day CHF readmissions, 100% of users rated the “Quality of Service” & “Likelihood of Recommending” the service as “good” to “very good” with 73-77% ranking service as “very good”.47

Telescale (from Cardiocom)

http://www.cardiocom.com/telescale.html

Telescale is an interactive home CHF telemangement system with weight and symptom telemonitoring capabilities. Patients use Telescale to conduct a daily “Health Check” by answering a series of questions about current symptoms and measuring weight. Data are transmitted over a standard telephone line directly to the company’s server for review and assessment by nursing staff. Telescale forms part of the company’s Cardio-Plan disease management service for CHF. In a retrospective clinical review of over 1,000 NHYA Class III-IV patients using the Cardiocom Telescale over a 12-month period at nine different institutions, the heart failure admission rate was reduced to 0.234 per patient per month. Customers range from a multi-site hospital chain to smaller single site hospitals. The following are cost savings related to the care of CHF patients:

- At a small-sized hospital, 34 CHF patients incurred a total of $883,592 in medical bills in the year prior to use of the Cardiocom System. In the year since using the System, the patients’ medical bills dropped to $355,390, a decrease of more than 50%.
- In a larger hospital, data was analyzed from 71 patients in a 6-month pre- and post-Cardiocom period where each patient was used as their own control. In this study, inpatient admissions for CHF were reduced by 71% (admits 73 vs. 21) and inpatient costs for these CHF admissions were reduced by 73% ($315,351 vs. $83,999).  


AVIVO Mobile Patient Management System (from Corventis)
(http://www.corventis.com)

In an example of next-generation remote monitoring capabilities, Corventis is collaborating with the West Wireless Health Institute to conduct a trial designed to clinically validate remote wireless monitoring technology in proactively managing CHF patients and reducing hospital readmissions. Corventis develops wearable cardiovascular solutions that integrate sensors with advanced computational algorithms, wireless capabilities, and a web-based infrastructure to enable early detection, prevention and treatment of cardiovascular conditions. The device, which costs several hundred dollars, is a smart patch-like device that adheres to a patient’s chest. It is capable of monitoring heart and respiration rates, levels of patient activity using an accelerometer, and the accumulation of body fluid through an indirect electrical measurement using an impedance detector. Corventis’ first remote monitoring wireless system for cardiovascular applications, the AVIVO Mobile Patient Management System, was approved by the FDA in February 2009. (see Figure 18) AVIVO combines:

- The PiiX: An unobtrusive, water-resistant, patient-worn device that adheres to the skin and automatically collects and transmits physiological information
- zLink: A small portable device (similar to a cell phone) that wirelessly transmits information received from PiiX to Corventis
- Corventis Web Services: A hosted application for data analysis and storage, which enables secure access to physiological trends and clinical event information for interpretation and diagnosis

Figure 18: AVIVO Mobile Patient Management System
**Medtronic CareLink Network**
(http://www.medtronic.com/physician/carelink/)

Medtronic Carelink Network is an Internet-based remote monitoring service available for use with pacemakers to ensure timely identification of clinically important issues, such as asymptomatic atrial fibrillation or device integrity issues. *(Figure 19)* The system was evaluated by clinicians at 10 investigational sites in 9 states, with 62 Medtronic ICD patients enrolled, to assess ease of use and satisfaction as well as its clinical utility for Internet-based patient management, and to compare transmission data to in-office interrogations:

- Remote interrogation data transmitted from the Medtronic CareLink Monitor allows clinicians to provide patient care comparable to in-office, interrogation-only visits (96.5%).
- Cardiac device patients are able to use the Medtronic CareLink Monitor effectively to initiate interrogation and transmission (98.1%).
- Remote interrogation offers the potential for capturing previously undiagnosed arrhythmias and other device-related issues (captured one previously undiagnosed arrhythmia in one patient)

**Figure 19: Medtronic CareLink Network**

Next-generation remote monitoring with the Medtronic CareLink Network employs Conexus Wireless Telemetry for Medtronic’s newest devices. As a result, clinics:

- Are better able to accommodate the changing needs and schedules of both patients and of clinicians.
- Have access to CareAlerts, triggered by a device or physiologic events, which provide early event notification to help clinicians better manage patient outcomes. *(Figure 20)*

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Figure 20: Medtronic CareLink Network’s CareAlerts

CONTINUAL MONITORING FOR MEDTRONIC CAREALERT STATUS

• May set up a scheduling routine that fits into current practice methods. Scheduling becomes automated, saving time for the clinic.

• May use automatic prescheduled check to improve patient care and convenience while reducing compliance issues. (Figure 21)

Figure 21: Medtronic CareLink Network’s Automated Follow Up

AUTOMATIC FOLLOW-UP

Merlin.net Patient Care Network

Merlin.net Patient Care Network (PCN) is a secure, Internet-based remote care system for patients with implantable cardiac devices designed to capture and record information about device performance and a patient’s heart rhythms. Merlin.net PCN supports a range of St. Jude Medical’s family of implantable cardioverter defibrillators and cardiac resynchronization therapy defibrillator devices in the United States. Merlin.net PCN collects and stores data from the implant procedure, in clinic follow-up visits and from both patient-initiated and automatic remote follow-up and monitoring transmissions. Merlin.net PCN organizes data for clinician review to determine the appropriate level of care and transfers data directly to the provider’s electronic health records system. Physicians select the frequency and patient-specific criteria for critical device alerts. Merlin.net PCN offers features including:

• InvisiLink technology and RF devices – During implant, the combination allows device optimization to take place while the physician completes the implant procedure

• EHRDirect Export technology – In the clinic, this technology merges key device data with existing patient data in electronic health records, consolidating data in one place

• DirectCall Message – Delivers pre-recorded standard messages to patients – such as appointment transmission reminders – by phone or SMS text, reducing time spent making routine calls (Available in multiple languages)

• SmartSchedule Calendar – An online scheduler that lets a clinic choose the automated or manual scheduling, which allows follow-up scheduling to be customized to work with existing clinic processes
BIOTRONIK Home Monitoring
(http://www.biotronik.com/biohm/home)

BIOTRONIK Home Monitoring is an Internet-based, automated remote monitoring solution for patients with implantable cardiac devices to monitor patients’ clinical status and device status. Devices transmit diagnostic, therapeutic, and technical data to an external patient communicator, the CardioMessenger, which relays data automatically to the company’s service center via cellular networks. A patient status summary report uses a color-coded traffic light system (red/yellow/white) for clinicians to quickly identify patients with the most clinically relevant events (red-severe status change-high priority/yellow-important deviations-priority/white-absence of any significant change). (See Figure 22) Immediate event notifications for specific patients are provided in the event of a severe status change in a patient’s condition.

Figure 22: BIOTRONIK Health Monitoring Patient Dashboard

The FDA recently approved an expanded product labeling for BIOTRONIK Home Monitoring to provide early detection of symptomatic and asymptomatic cardiac arrhythmias, enabling earlier intervention than is possible with conventional in-office follow-ups. The FDA also expanded product labeling to include the use of device data to reduce the need for device interrogations during in-office device follow-ups. This latter decision was based on the findings from the TRUST clinical study to evaluate the safety and effectiveness of remote monitoring which found that BIOTRONIK Home Monitoring reduced 43% of in-office follow-ups without adversely impacting patients’ safety.42

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Mobile and Web Technologies for Cardiovascular Disease Care Management

The convergence of wireless technology, the Internet, mobile devices, and smart system design are emerging to transform developments in remote monitoring capabilities and applications related to patient education and self-management support and multidisciplinary team management. Examples include the use of portable devices that wirelessly collect data from peripheral devices and cell phones that provide access to patient data.

A number of specialized web-based applications that support patients in education and self-care management also interface with peripheral devices to automatically upload data for storage and use in helping patients monitor progress, stay on track with specific care management goals, share related information with care providers, and receive customized and timely communications on health-care related topics.

Personal health records are increasingly compatible with peripheral devices that connect to remote monitoring units to automatically upload data for storage and use by other web-based applications to help patients monitor progress, to stay on track with specific care management goals, to share related information with care providers, and to receive customized and timely communications on health-care related topics.

Examples of mobile and web technologies in CVD care management follow:

- **Heart 360** ([https://www.heart360.org/](https://www.heart360.org/)): Sponsored by the American Heart Association and American Stroke Association, Heart 360 is an online cardiovascular wellness center that allows users to manage blood pressure, blood glucose, cholesterol, weight, nutrition and physical activity, while receiving education and information specific to their condition to improve cardiovascular health. The data can also be transferred to the patient’s HealthVault personal health record for storage or use with other HealthVault-compatible applications.

- **CardioSmart Health Tracker** ([http://www.cardiosmart.org](http://www.cardiosmart.org)): CardioSmart Health Tracker, a collaboration between the ACC and Peoplechart, is an online hypertension management tool that tracks, organizes and presents blood pressure, medication and lifestyle data to support patient self-care in the context of lifestyle changes and to receive care recommendations that follow ACC guidelines. CardioSmart data are transferable to the HealthVault personal health record, and patients can use the tool to easily share information with providers to work collaboratively in tracking trended data and managing hypertension. HealthTracker is part of ACC’s CardioSmart patient-education program.
• **Heart Profilers** (https://www.heartprofiler.nexcura.com/Secure/InterfaceSecure.asp?DB=1): Heart Profilers offers online treatment decision support tools that help patients with heart disease to make informed treatment decisions through understanding treatment options and possible side effects. Users receive decision support specific to their clinical status as educational resources in the form of customized reports based on best practice and the latest clinical research, and assistance with provider communications in the form of questions to ask physicians about their condition status and care options.

• **HealthPAL** (http://public.medapps.net/Pages/Default.aspx): As part of the MedApps Mobile Health Monitoring System, HealthPAL is a portable device that integrates with various off-the-shelf medical monitors — including blood pressure monitors, weight scales and pulse oximeters — to automatically collect, transmit and store data in the user’s HealthVault account. As a result, users have the opportunity to be actively engaged in their own healthcare while remaining effectively connected to their clinicians by sharing information for monitoring and review. Clinicians can access data using a web-based patient management portal for care professionals.

**Figure 23: HealthPAL**
• **AllOne Mobile** ([http://www.allonehealth.com/personalhealth/mobile/Default.aspx](http://www.allonehealth.com/personalhealth/mobile/Default.aspx)): AllOne Mobile provides storage and centralized access through a cell phone to personal health information, provider and insurance information, information on allergies, immunizations and medications, and any other relevant personal health information stored online in a personal health record or in other health care information systems and applications. The application runs on all smart-phones and most consumer mobile devices, and allows users to synchronize data between different systems.

Cleveland Clinic is collaborating with HealthVault on patient-centric chronic care management in a pilot involving 400 patients with diabetes, CHF and hypertension to demonstrate that the program will enable patients and physicians to better communicate and manage chronic diseases remotely, improve efficiencies and lower costs. Eligible patients are provided with the appropriate monitoring devices for use at home, including glucometers, blood pressure sensors, peak-flow meters, pedometers, and weight scales. All devices are connected through the HealthVault platform, which automatically transfers data to the patient’s Cleveland Clinic MyChart account. The data will create an online log of the readings that will be available to the patient’s physician to enable them to adjust medications and therapeutic regimens on a continuous, customized basis. Although not explicitly stated in the Cleveland trial, the opportunity to use data transmitted to HealthVault with web-based applications to customize and support care interventions and self-care management exists.  

**IMPLICATIONS FOR ADOPTION AND IMPLEMENTATION**

Policy adjustments that reduce barriers and promote accelerated adoption and use of remote monitoring, particularly around reimbursement and investment in broadband infrastructure, will introduce significant cost savings for the U.S. health care system. Currently, adoption is largely driven by large private insurers or large employers that directly accrue benefits and justify the required investments in the technology infrastructure and services. Another barrier to broader adoption of remote telehealth systems is the lack of data on financial and clinical outcomes. Failure to address reimbursement and encourage widespread deployment of broadband will not encourage similar investment and broad adoption among health care providers, particularly fee-for-service plans. Furthermore, adoption of remote monitoring relies on the availability of enterprise clinical information systems, such as electronic medical records, to support the effective role for remote monitoring applications in the clinical care of patients. Smaller primary care practices are currently at a disadvantage with regard to the availability of such an enabling information technology infrastructure. And for those providers that do adopt such a technology platform, technical staff to maintain and operate services will be a critical need.

In addition to demonstrating improved outcomes and cost savings, provider and patient acceptance and satisfaction with such technologies is also critical in driving adoption. Although little physician resistance has been noted in the literature to date, the technology represents a shift in professional workflow practices and requires training to support physicians in incorporating HIT technology into their existing workflows and clinical activities. In pilot projects to date, patients have reported high levels of user satisfaction and comfort with systems, but larger sample sizes and studies will be required to validate that on a broader scale.

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Chronic Disease Profile: Asthma
SUMMARY
Asthma is the most prevalent chronic disease in children and also affects a significant number of adults. As the prevalence of asthma has risen dramatically in recent years, there has been a growing need for self-management tools to help patients manage their condition. This report discusses the many ways that ICT can play a role in improving asthma care self-management and outcomes, and gives an overview of some of applications currently available or under development to treat asthma.

Context
• Asthma is a disease that disproportionately affects children and those of lower socioeconomic status
• The origins of the disease are not well understood, making the management of its symptoms critical
• Asthma has seen a dramatic rise in prevalence over the last 20-30 years, and currently is responsible for billions of dollars in costs to the U.S. health system
• Asthma is also responsible for significant healthcare utilization in terms of inpatient hospitalizations, doctor’s visits, and emergency room visits
• An effective asthma chronic care management plan takes into account self management, clinical visits, and the management of environmental triggers.

ICT for Chronic Care Management
• Through mostly pilots and research studies, information and communications technologies have shown the potential to aid in the effective, cost-efficient treatment of asthma
• Such technologies are best able to aid in self-management applications (such as symptom control, medication adherence), and in some cases even alert notifications of environmental triggers, a critical piece of symptom control
• Early studies have found that technologies such as mobile-enabled remote patient monitoring, text-based messaging, telemedicine, and Web-based technologies have demonstrated promising results in asthma treatment including increased patient compliance, high levels of patient satisfaction, better control of symptoms, and decreased healthcare utilization
• Mobile/remote patient monitoring and web-based applications in asthma management are profiled in this report.
Implications

- Important factors for providers to consider in adoption include the availability of financial resources for patients and providers, providers’ gaps in their care process, patients’ needs and motivations, and patient demographics and technology literacy.
- The convergence of mobile and remote monitoring capabilities suggests that the interplay between these two technology areas will become increasingly important in the future.

CONTEXT

According to the U.S. Centers for Disease Control and Prevention (CDC), as of 2007, 16.2 million adults have asthma in the United States (7.3% of the population), while 6.7 million children have asthma (9.1% of the population). During the same time period, asthma resulted in 10.6 million visits to office-based physicians and over 400,000 hospital discharges, with an average length of stay of 3.2 days. In addition, over 3,600 people died from asthma in 2007 (approximately 1.2 per 100,000 population).

The costs associated with the management of asthma are also severe, in terms of both direct costs (such as treatment expenditures) and indirect costs (including lost workdays or productivity). Pulmonary disorders including asthma (as well as other chronic conditions such as chronic obstructive pulmonary disorder) resulted in $45 billion in total treatment expenditures and $94 billion of lost productivity in 2003, according to a 2003 study by the Milken Institute. In 1998, the estimated direct and indirect costs for asthma in the U.S. were $11.3 billion.

As the most prevalent chronic disease among children aged 0-17, improving care for asthma is of particular importance in children’s health. Asthma is a leading cause of childhood disability and has been shown to affect a child’s ability to play, learn, and sleep. The majority of children with asthma still suffer attacks, and the burden of avoidable ED visits and hospitalizations resulting from asthma is significant. Both the rate of attacks and burden of hospitalization have remained high despite efforts to better manage the disease.

Figure 24: Number of hospitalizations for asthma per 10,000 children 0-17 years of age, United States (1980-2004)
While these facts illustrate the widespread effect of asthma, perhaps of greatest concern is the trend behind asthma prevalence and resource utilization. From 1980-2004, asthma prevalence more than doubled\(^{52}\) (Figure 25), and the reasons behind this trend are not well understood. In addition, emergency room visits have also been trending up (Figure 26), and asthma has disproportionately affected minority children in terms of both symptoms and deaths. (Figure 27)

In addition to childhood asthma, adult pulmonary diseases such as chronic obstructive pulmonary disease (COPD) and emphysema also have a high prevalence and result in tremendous costs to the healthcare system. Though this report focuses on the disease and care process for childhood asthma, many of the approaches detailed can be potentially applied to adult pulmonary conditions as well.

Unfortunately, despite its broad impact, the causes of asthma and why certain people develop the disease are still not completely understood, though genetics and environmental factors are believed to both play a significant role. This lack of clarity on the causes of asthma further highlights the importance of developing and implementing technologies for the effective management of the disease.

ICT IN CHRONIC CARE MANAGEMENT FOR ASTHMA

As a chronic disease whose treatment contains a significant adherence component, and as one that has the greatest impact on children, asthma especially lends itself to the use of ICT as part of its core management strategy. Issues in the treatment and patient management of asthma often stem from not taking medicines according to schedule, which can end up aggravating a patient’s symptoms. In addition, asthma is a disease which correlates to ethnic and social disparities\(^53\), highlighting the importance of making information about asthma treatment and symptom management more easily accessible to all patients. ICT can help fill many of these gaps to make information about asthma treatment and symptom management more widely available, thereby reducing inequities. In particular, mobile and web platforms can play significant roles in delivering reminders to patients to improve adherence, which results in better outcomes and decreased emergency room utilization due to asthma. The care process for asthma spans multiple types of asthma, self-care mechanisms, and inpatient care settings. Certain technologies are applicable across all of these components, and each patient should choose the care process and technologies most appropriate to his or her needs.

We have tailored our chronic care management framework to focus on specific technology interventions for the care of asthma. Specifically for asthma care, it is important to approach the management of the disease from three perspectives – clinical management, self-management, and reduction of environmental triggers. In addition, the bifurcation between at-risk and minimal moderate disease is much clearer for asthma than for most other chronic diseases, such as congestive heart failure. Due to the fact that asthma does not follow a traditional chronic disease progression (as the disease often resolves itself when a child becomes older), the focus for those with minimal-moderate disease is to control symptoms and minimize unnecessary healthcare utilization, rather than to delay disease progression. (Figure 28)

### Figure 28: Asthma Care Management Framework

<table>
<thead>
<tr>
<th>Target Population</th>
<th>Healthy</th>
<th>At-Risk</th>
<th>Minimal-Moderate Disease</th>
<th>Significant Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention Goal</td>
<td>Keep population healthy</td>
<td>ID at-risk patient</td>
<td>Control symptoms &amp; minimize unnecces. healthcare utilization</td>
<td>Minimize complications &amp; costs</td>
</tr>
<tr>
<td>Intervention Approach</td>
<td>Population health management</td>
<td>Candidate selection and enrollment</td>
<td>Personal health management</td>
<td>Acute clinical care</td>
</tr>
</tbody>
</table>

#### Intervention Actions

<table>
<thead>
<tr>
<th>Health education</th>
<th>Medication adherence</th>
<th>Social networking</th>
<th>Health games</th>
<th>Regular clinician visits for intervention review &amp; adjustment</th>
<th>Patient/ symptom monitoring</th>
<th>Individualized care plan</th>
<th>Care team coordination</th>
</tr>
</thead>
</table>

#### Primary Settings of Care
- Home
- Community (including schools)
- Ambulatory
- Hospital

#### Expertise Level
- Self
- Paraprofessional
- Mid-Level professional
- High-level professional

Self-management mechanisms (which correlate to most of the intervention actions in the framework) can be highly effective across the spectrum of asthma types and care settings. For example, self-management mechanisms can be leveraged and applied to the most resource-intensive types of asthma to minimize care in inpatient settings, and at the same time optimize lower intensity care in outpatient settings. Self-care technologies for asthma, such as the mobile platform BeWell Mobile, have demonstrated decreased hospitalizations and ED visits, in addition to increased treatment adherence.

It is important to design any self-management program with consideration for the patient’s asthma type, technology familiarity and preferences, and current healthcare resource utilization. For example, a chronic asthmatic would require a treatment regimen that has a strong emphasis on medication adherence, monitoring and self-management, while a patient that prefers using mobile technologies should have their care focused around a mobile platform. The interplay of these three dimensions is critical to consider in optimizing a treatment’s effectiveness and minimizing unnecessary healthcare utilization. However, despite the development of many technologies for asthma and the promising
results that have been demonstrated for some, the adoption of these technologies has been rather slow for a variety of reasons. Chief among these is the lack of reimbursement available for such interventions, as well as the difficulty involved in integrating these technologies into a provider’s workflow. The lack of reimbursement is particularly important, considering that asthma disproportionately affects children and people with fewer economic resources, making their ability to pay for asthma management somewhat unlikely. In addition, a highly motivated and educated patient (the most likely segment to adopt such technologies) is somewhat rare, particularly given the relatively younger and less socioeconomically well-off population that asthma disproportionately affects.

Going forward, the increased awareness of technologies, establishment of an evidence base of cost savings and improved outcomes, and policy initiatives (such as outcome mandates or reimbursement changes) will be key to the adoption of these information and communications technologies in the management of asthma. However, given the limited success so far in terms of broad deployment of technologies, adoption will likely occur slowly.

The following section discusses specific ICT-enabled care interventions for asthma.

**ICT Applications in Asthma Care Management**

This report focuses on ICT applications available for treating asthma; however, it is important to note that given the challenges involved in technology adoption, many disease management programs exist that do not currently use technology (or incorporate a minimal technology component such as a telephone). Some examples of these programs include Kaiser Colorado’s Asthma Disease Management Program. In the 1990s, Kaiser employed case managers in an attempt to assist patients in learning self-management techniques and lifestyle changes to better control their asthma symptoms. More recently, researchers from the University of California San Francisco reported that asthma patients who spend 30 minutes with a healthcare professional to develop a personalized self-management plan show improved outcomes related to adherence and disease control. A 2009 study also found that asthma outcomes for minority children improved through the use of an informed mentor/ case manager approach. Such programs are not addressed in this report, but it is important to note that many of these programs do exist, and often have the potential to incorporate technology into their existing structure as a means to enhance current outcomes.

Mobile and Remote Monitoring Technologies for Asthma Care Management

Mobile technologies have demonstrated tremendous potential in improving the care of patients with asthma through adherence, reminder, education, and other mechanisms. A number of studies, performed both in the United States and internationally (particularly in the United Kingdom), have pointed to improved outcomes as a result of asthma patients using mobile applications. In particular, the use of short messaging services (SMS) and other applications have been shown to contribute to increased adherence, compliance, and patient satisfaction in asthmatic patients. With the rapid increase in the use of mobile phones (particularly among the young population that asthma strongly impacts), such applications can be expected to only increase in the future.

An early 2002 study conducted in the United Kingdom examined patients’ views on using mobile phones to manage asthma, via an SMS reminder system that simulated realistic and interactive text messages that were integrated into other lifestyle text messages and sent by a “virtual” friend. The effectiveness of this program was tested on a group of young people in Scotland; these subjects found the text messages credible and developed a rapport with their virtual friend, while showing some improvement in inhaler compliance. Other studies have also demonstrated the efficacy of mobile phones to manage asthma, such as a 2005 U.K. study that also found increased compliance, patient satisfaction, and outcomes as a result of using mobile phone technology and peak flow monitoring as part of a self-management plan. Currently more studies are being undertaken on mobile phone applications for asthma management.

Mobile phones can also be used for education or alert notification purposes. Text messages have been used to alert people in London about poor air quality that could trigger their asthma (in a project with the European Space Agency called airTEXT). This project draws upon data from regional air quality forecasts and information on local road traffic patterns. In addition, cell phones can also be used to send out self-management education support and tips to people with asthma. Patients can also use mobile phones to access their electronic medical records and other medical information, as well as send reports to their health providers on their conditions.

There is also a large degree of overlap between mobile and remote monitoring technologies for asthma, as mobile technologies are often used to facilitate patient monitoring. For example, some technologies capture information about a patient and then use a mobile platform to transmit this information or related reminders. The fact that mobile platforms lend themselves well to the transmission of information related to remote patient monitoring suggests that the interplay between these two technology areas will become increasingly important in chronic disease management in the future.

20 Ron Neville, Alexandra Greene, John McLeod, Andrew Tracy, and John Surie. Mobile phone text messaging can help young people manage asthma. BMJ. 2002 September 14; 325(7364): 600.
57 Ryan D; Cobern W; Wheeler J; Price D; Tarassenko L. Mobile phone technology in the management of asthma. Journal of telemedicine and telecare. 2005;11 Suppl 1():43-6.
Overall, these studies and currently available technology applications have demonstrated the power of mobile platforms to improve the health of people with asthma. Though mobile solutions for asthma are mostly in the early stages of development and are not yet widely used, the potential for such solutions is tremendous.

**Cell Phones**

Examples of mobile and remote monitoring applications specific for asthma follow.

**BeWell Mobile**

(http://www.bewellmobile.com/)

BeWell Mobile is a mobile platform technology that “leverages the ubiquity of cell phones, wireless data networks and the Internet to collect valid data and to help patients manage their health.” BeWell Mobile incorporates remote patient self-monitoring, the use of a mobile platform, and an approach that focuses on patient engagement and self-management. BeWell Mobile is based on a technology platform that combines flexibility, real-time availability and cost-effectiveness. The technology uses mobile phones to collect patient data so that healthcare providers can track a patient’s progress and determine if a personal intervention is required.

Currently, BeWell Mobile has shown strong outcomes through pilots in the chronic care management of both asthma and diabetes. The technology was involved in a 2-year study with San Mateo Medical Center to control severe asthma in urban youth. The study demonstrated promising results: 95% patient satisfaction and regimen adherence was reported, in addition to a loss of zero school days due to illness. (Figure 29)

---

**Figure 29: BeWell Patient Experience**
airTEXT
(http://www.airtext.info/)

airTEXT is an innovative UK-based program that is designed to provide alerts on poor air quality. As environmental triggers play a significant role in the development of asthma symptoms (even patients with strong clinical and self-management skills can experience significant exacerbations due to environmental conditions), airTEXT provides an important service in providing text-based alerts using forecasts of air pollution levels. (Figure 30)

The goals of airTEXT are as follows:

- Enable patients to self-manage symptoms and reduce exposure
- Reduce acute impacts of air pollution
- Improve patient quality of life and address inequalities
- Reduce resource implications for the U.K. National Health Service
- Evaluate health intervention

airTEXT is a relatively new program but has already demonstrated efficacy and high levels of patient satisfaction. Based on a 2006 pilot that was located in Croydon, 80% of users involved in the pilot reported that airTEXT has helped them manage symptoms better, 94% found it useful or very useful, 89% were more aware of pollution episodes, and 71% have changed their approach to the self-management of asthma.

Figure 30: How airTEXT Works
Think Positive Medical
(http://www.tplusmedical.co.uk/positive/)
Think Positive (t+) Medical is a company with operations both in the United Kingdom and United States, and produces disease management solutions that use existing mobile networks and infrastructure. This vendor focuses on remote patient monitoring through its mobile platform, and is the leading supplier of mobile phone disease management solutions for chronic diseases in the United Kingdom. t+ Medical offers mobile remote patient monitoring technologies for disease management that target both individual patients as well as healthcare professionals and other entities. In addition, the technology has demonstrated positive results in terms of better compliance and outcomes. (Figure 31)

Figure 31: t+ Medical
The platform can be accessed via mobile phone, Web (standalone or integrated portal), and data can be extracted for electronic consolidation and storage. Currently, applications are available or in development for the following four conditions: diabetes, blood pressure, COPD, and asthma. T+ medical offers a variety of solutions for individuals and families, health professionals, health organizations and plans, and employers.

Core components of the t+ Medical platform include (from the company’s website):

- **t+ mobile phone Assistant**: The patient supplies information and results, and receives feedback and personalized coaching through his/her mobile device.

- **t+ Clinical Management and Monitoring Center**: The Clinical Management and Monitoring Center provides on-demand web access to patients' current and historical data, demographic information, complete with reporting tools, interactive graphs and charts. A patient list automatically prioritizes patient review and follow-up based on clinical algorithms.

- **t+ Member Center**: The web-based t+ Member Center provides web access for the member, family and primary care physician to review current and historic member data collected from either the member’s mobile phone or directly entered by the member online. Users can access reporting tools, interactive graphs, and charts for quick review and printing. Family members can remotely monitor members, and alerting functions are also available.

The technology has also been the subject of several clinical studies. The company reports the following promising results in terms of asthma treatment (see Table 23):

### Table 23: t+ Medical Clinical Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcomes</th>
</tr>
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| Thames Valley Asthma Study                 | 91 patients (38 adolescents and 58 adults) recruited for 9-month study.  
65% of patients were highly compliant, providing at least one peak flow reading/day for 91% of the time over 9 months. Studies of a few weeks duration using paper-based diaries have compliance rates between 60 -65%.  
Reduced variability in Peak Expired Flow (PEF) was observed over the 9 months of the study, indicating improved control.  
Reduction in the use of reliever inhaler from, on average, 1.9 to 1.3 puffs during the previous 12 hours, indicating better control of asthma by the end of the study.  
78% of the patients reported the mobile phone solution helped them improve their ability to manage their asthma symptoms. |
| Isle of Man Asthma Study                   | 12 well-controlled patients, with high levels of compliance (1.5 readings/day, on average, throughout 9-month study).  
Reduction in use of reliever inhaler from, on average, 0.4 to 0.1 puffs during the previous 12 hours, indicating excellent control of asthma.  
Patients reported the study was successful and recommended extending it. |
| A Qualitative Study of the Use of Mobile Technology for Recording and Gathering Asthma Data | The data gathered on a daily basis were peak flow readings and asthma symptoms.  
An important finding in the study was that using the mobile phone technology led to subjects being more aware of their asthma symptoms.  
The main uses of the technology were seen as identifying poor control more quickly and facilitating communication with healthcare professionals without the need for face-to-face communication. |
**GoAsthma (from Avalis)**
(http://www.go-asthma.ch/GoAsthma/partners_00_e.html)

Avalis Telemedicine AG is a privately owned company located in Zurich, Switzerland. The drug company Avalis has developed a technology solution to manage asthma that combines telemedicine (by way of peak flow measurements) with the use of an Internet-enabled mobile platform. Different levels of the service (gold, silver, and bronze) are available depending on the severity of the asthma, degree of involvement of the clinician, and the degree of personalization required. An Internet-enabled mobile phone and peak flow meter are the only necessary requirements for using GoAsthma, and the device helps patients track their asthma symptoms and the status of their disease.

According to the technology’s website, only 2-3 minutes a day are needed to monitor asthma effectively through measurement of lung function. In addition, four key symptom questions are rated every week, which takes less than one minute. Patient information can be reviewed on a secure personal website. The program has so far been deployed in a German medical call center, with results pending.

**Figure 32: GoAsthma User Process**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Review</th>
<th>Manage</th>
</tr>
</thead>
</table>
| Patients measure peak flow and enter values as instructed by Go-Asthma on their handset or directly through a personal secure website. | Patients review peak flow and symptoms graphs on their handset or through a personal secure website. | Patients manage their treatment after consulting with their doctor. 

Following their doctor’s advice, patients can adjust their self management program on-line. This will automatically update Go-Asthma on their mobile phone. 
In addition patients can use their secure Website to enter medication use and personal notes, to keep track of all aspects of their personal care. |
School-based Telemedicine for Asthma

Telemedicine for asthma in schools has demonstrated promising results in several pilot projects around the country. While the spread of telemedicine in schools may be slow as a result of funding issues, resource constraints, and logistical difficulties associated with introducing healthcare delivery into schools, studies and pilots have shown that such programs have the potential to be very effective. Two examples are a school health clinic in Hart, Texas through Texas Tech University Health Sciences Center, and a telemedicine pilot in the San Francisco Bay Area conducted by academic researchers from Stanford University.

- **Texas Tech Telemedicine Health Sciences Center**: Through the F. Marie Hall Institute for Rural and Community Health, Texas Tech University operates a school health clinic in rural Hart, Texas. The school nurse is able to connect with specialists in a nearby town, who can then assist children with asthma care. As a result of this center, children have seen numerous benefits including much less travel time to see doctors, lower emergency room utilization, improved school attendance, and high levels of user satisfaction. The clinic also consults for other pediatric issues unrelated to asthma. The program has been very successful and has led to the consideration of other school-based telemedicine clinics in Texas.

- **The use of telemedicine access to schools to facilitate expert assessment of children with asthma**: Researchers hypothesized that they could improve access to asthma care by connecting a school and remote asthma specialist through telemedicine. Cohort studies were performed in three urban schools (located in the San Francisco Bay Area) to look at treatment outcomes and the feasibility of the solution, with a total of 83 subjects. The care process took place with each patient being seen by an asthma expert at certain times over a 32-week timeframe. The recommendations from the visit were sent to a primary care physician, and parents were instructed to follow-up with their physicians. As a result of this program, the patients experienced a significant improvement in family social activities and the frequency of asthma attacks. In addition, patient satisfaction was very high, with nearly 100% of the patients rating the program as good or excellent.

Despite the efficacy that these two programs have demonstrated, expert interviews have indicated that due to decreased funding and resource constraints for schools, asthma treatment will unfortunately trend away from disease management in schools. Schools have fewer resources to deal with children’s’ health, and the resources they do have will likely be focused on acute illnesses. The exception may be in well-funded school districts that have the luxury of being able to devote resources to the provision of health-care services in schools.

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Web-based Technologies for Asthma Care Management

Web technologies are also a powerful example of how technology is changing the care relationship and the management of chronic diseases. Web technologies serve to facilitate just about every component of the chronic care model, from providing educational resources regarding community programs, to allowing patients to access their medical information online and communicate with their doctors. Web tools include electronic medical records (EMRs), personal health records (PHRs) and other patient portals, websites containing medical or other health information, online self-management tools, and social networking applications that are part of online self-management programs. Given the high rate of Internet penetration among the general population, the application of web-based technologies for asthma management will continue to increase.

The patient benefits of EHRs and patient portals in improving asthma care are numerous: having access to personal medical information and prescriptions, communicating with physicians and other healthcare providers, and receiving guidelines and information online to treat symptoms. As the penetration of EHRs increases in the United States, it is expected that chronic disease management functions will be increasingly built into these technologies.

In addition, other studies have shown the interest of patients in communicating with their health care providers through online means such as e-mail, chat sessions, and Web portals. A 2009 survey by the Deloitte Center for Health Solutions found that 55% of patients would like to e-mail with their physicians and 68% are interested in remote monitoring devices. While there is some hesitancy on the provider side due to concerns stemming from misdiagnosis, privacy, and reimbursement, patients’ preferences for using such online tools is nonetheless expected to continue to drive their adoption.

Another usage of web tools to manage asthma is the use of informational websites to help guide patients in understanding the illness and treatment options. Many websites exist to provide self-help resources and education to an audience of patients. These websites can provide anything from general information about the disease and its symptoms to suggestions for treatment, as well as tools to help manage the disease.

An extension of these general information websites are more interactive online programs or social networking applications. A 2005 study by the University of Alberta in Edmonton, Canada, examined the use of a “virtual asthma clinic” to boost outcomes in patients with asthma. The study demonstrated that the online asthma management program can help patients get quality care while overcoming access barriers. The online management program in question was an interactive online program that allowed a Certified Asthma Educator to communicate daily with patients, and provide feedback and other care assistance. Patients were also encouraged to enter data on their lung function (peak flow rates) and other symptom-based measures as part of the program.

Informational Websites, Tools, and Resources

The following section details specific examples of web-based resources with applications in asthma care. Many of the more complex technologies in this area, beyond informational websites, are still in the early stages of development and not yet widely used, and currently there are few studies on the effectiveness and outcomes related to the use of Internet tools in asthma care management.

Numerous websites are available to provide care management, resources, and education to people with asthma. These websites provide resources ranging from general information on symptoms and treatments to tools that can be used to manage asthma. As Internet access (already at a high level of penetration) continues to expand, these websites will become increasingly accessible and widespread in terms of their impact on the patient care experience. Given the abundance of websites on health topics, it is important that patients choose websites from credible sources, such as government or professional organization-sponsored websites.

A sample of general informational websites on asthma treatment and care follow:

WebMD

(http://www.webmd.com/asthma/default.htm)

WebMD is a general health information website that provides information on a number of conditions, including chronic conditions such as diabetes, heart disease, and asthma. In particular, WebMD has an asthma-specific section that provides a variety of informational resources on asthma, including information on symptoms, asthma attacks, environmental triggers, and statistics on asthma. The information is well organized and is a good first stop for patients and family members looking for general information about asthma and up-to-date news articles and symptoms management options. In addition, WebMD offers links to other resources, as well as social networking opportunities for patients through discussion groups and message boards.

Figure 33: WebMD
My Asthma Central (from My Health Central)
(http://www.healthcentral.com/asthma/c/962/61352/web-asthma-management)

Similar to WebMD, My Health Central provides general health information on a variety of health conditions. My Health Central has an asthma-focused website, MyAsthmaCentral.com. In addition to providing basic disease information, MyHealthCentral is very community focused with social-networking capabilities, with updates on community members as well as an expert available to answer questions from the community featured prominently on its main page. Users can sign up for an account and personalize their website and information, and also access the web-based health tools available on the website (including a guide to asthma management plans, symptom checker, and videos on asthma).

Profiler Tools (from the American Lung Association)

The American Lung Association website provides general information for sufferers of many types of lung disease, including asthma. The website can be customized according to a particular patient’s health needs, and offers a wide variety of information including links to research, resources for professionals, and newsletters and information on treatment options. The website offers personalized interactive decision support tools for patients and providers to better understand treatment options, called Profiler Tools. These tools are designed to help patients make informed decisions on their treatment by providing full information on options, side effects, outcomes, and the pros and cons of various treatment choices. The tools also suggest questions that a patient can ask his/her physician regarding treatment, as well as provides links to applicable research. These tools are free for anyone to use and can be accessed through the ALA website.
Critical Tools (from Improving Chronic Illness Care) (www.improvingchroniccare.org)

Improving Chronic Illness Care (an initiative sponsored by the Robert Wood Johnson Foundation), an organization which prominently promotes Dr. Edward Wagner’s Chronic Care Model, provides tools on the Improving Chronic Illness Care website for managing chronic conditions, called Critical Tools. Using the analogy of a traffic stoplight, the website offers a Red-Yellow-Green asthma tool that provides patients information on how their symptoms (e.g., daily weight for chronic heart failure patients or blood glucose levels for diabetics) correlate to three different color-coded management zones (green indicates stability and good control over the condition, yellow indicates caution and suggests steps for regaining control, and red indicates a medical crisis that requires a provider’s attention. The analogy of a stoplight can be useful in teaching patients about monitoring and managing their chronic condition. The “Stoplight” charts can be adapted for standards of care in the provider setting. Variations of this tool are available for multiple chronic diseases, and patients can use them to monitor their symptoms and determine when additional clinical support is necessary. The Improving Chronic Illness Care website also provides information on quality improvement efforts across the country, research, and resources for practice change. (Figure 36)

Regional Asthma Management and Prevention (RAMP)

Regional Asthma Management and Prevention (RAMP) is an example of how a regional collaboration can use a website to disseminate information and resources to key stakeholders. RAMP (an organization based in and focused primarily on California) is working to expand knowledge about asthma and its triggers, and to increase access to resources, to build partnerships, to provide technical assistance, and to advocate for policy change at the state and local levels.

RAMP serves four key functions: to serve as a clearinghouse of asthma information through its website, e-newsletter, and other dissemination methods; to provide technical assistance to organizations working on asthma; to convene stakeholders in asthma treatment; and to advocate for policy change to improve the lives of asthmatics.

Though RAMP’s functions extend far beyond its website, the website is an important means of communication and dissemination of information on a regional level. The website has a number of available tools that may be helpful to a wide audience (including patients, providers, policy makers, community organizations, etc.), including asthma action plans, grant opportunities, and clinical practice guidelines.
Though RAMP’s functions extend far beyond its website, the website is an important means of communication and dissemination of information on a regional level. The website has a number of available tools that may be helpful to a wide audience (including patients, providers, policy makers, community organizations, etc.), including asthma action plans, grant opportunities, and clinical practice guidelines.

Taking on Asthma (from America’s Health Insurance Plans)
(http://www.takingonasthma.org/bestpractices.htm)

America’s Health Insurance Plans (AHIP) provides information on its website regarding best practices in addressing the care and management of asthma. AHIP is an organization that includes 1,300 member companies, which provide some type of health insurance coverage to over 200 million Americans. AHIP’s Taking on Asthma Initiative was formed in 2001 in collaboration with the American Academy of Allergy, Asthma, and Immunology.

Taking on Asthma provides information on its website regarding organizations who are pioneers in asthma management, asthma grants and awards, and links to other resource organizations. The organization has also put out a pamphlet titled Breathing Easier (May/June 2007), which profiles four health plans that have developed effective, multi-sector strategies for effective asthma care management, as well as AHIP’s 2006 assessment of the use of evidence-based interventions in asthma. Though many of the programs featured do not currently use technology, having such information on best practices available may be valuable to health plans and providers in assessing effective care management frameworks and considering potential applications for ICT.
The goals of the *Taking on Asthma* initiative are as follows:

- Promoting the proactive identification of patients with asthma through the use of nationally established guidelines (as set forth by the National Asthma Education and Prevention Program (NAEPP));
- Implementing evidence-based asthma self-management programs to increase control of asthma symptoms and reduce life-threatening acute episodes;
- Increasing the use of anti-inflammatory medicines and preventing the inappropriate overuse of bronchodilators;
- Increasing attention to comprehensive asthma care management that includes the management of indoor asthma triggers; and
- Demonstrating measurable improvement in the health status of patients with asthma across four measures: quality of care, health status, patient satisfaction, and cost.

**Quest for the Code (Online Health Game from Starlight Starbright)**
http://www.starlight.org/asthma/

The Quest for the Code is an online game that weaves education about asthma management into an engaging, story-based adventure. The game is geared toward children aged 7 to 15 and uses rich graphics and an interesting storyline to impart asthma education on its users. Many of the modules in the game feature celebrity voices in order to have added appeal to the game’s target audience.

Quest for the Code provides the following educational features:

- Lung Tour explaining how asthma works and what effect medicines have on asthma
- Early warning signs and symptoms
- Identifying and avoiding asthma triggers
- Myths about asthma
- How asthma affects the lungs
- Proper use of asthma medication devices
- Long-term control medicine and quick-relief medicine
- Measuring and monitoring peak flow
- How to answer questions from peers about asthma

![Figure 38: Quest for the Code](image_url)
Ringful (PHR application)  
(www.ringful.com)

Ringful has designed a number of PHR- and cell phone-related applications for asthma patients, including an Asthma Journal linked to a smart phone that provides access to PHR information (note: this technology could also be classified under mobile/RPM due to significant overlap between these areas). Ringful’s company mission is centered on the importance of preventive care, personal responsibility, and informed consumer choices guiding disease management.

The company currently has two asthma-related applications (the Asthma Journal and Pollen Journal) that are available on the iPhone platform. The asthma journal provides access to personal health information, allows the patient to track his/her symptoms, and also allows the sharing of information with others, including providers, through Google Health. General information on prevention and news is also provided, and the application can be linked to Facebook as well. The application also plans to integrate with Microsoft HealthVault, and possibly Dossia in the future.

From Ringful website:

The Asthma Journal application is a physician-designed asthma journal for cell phones. It provides a personal data dashboard for asthma symptom trends and triggers. Users can easily share the data with family, friends, and doctors via Google Health. The application also delivers daily news articles on asthma research and prevention, which users can then share with friends via Facebook Connect. (Figure 39)

The Pollen Journal app is available for both the iPhone and Android phones. It delivers the latest pollen forecast to users, and lets them keep a journal of allergy symptoms, which they can then correlate later with what’s in the air to determine which pollens they may be allergic to.

Figure 39: Ringful Asthma Journal
Internet-Based Communications (Research Study)

A July 2009 study published in the Annals of Internal Medicine\(^6\) demonstrated the potential of Internet-based care to improve the treatment of asthma patients. 200 patients were studied over the course of a year, with some patients receiving standard care and other patients randomly assigned to receive Internet-based consultations in addition. The Internet-based self-management program included weekly asthma control monitoring and treatment advice, online and group education, and remote Web communications. A nurse with expertise in asthma was in charge of helping patients use the Internet-based program in addressing medication, symptoms, and other concerns.

Researchers found that supplementing patients’ care with these Internet based consultations resulted in better control of symptoms, improved lung quality, and increased asthma-related quality of life. Though the study did not find a reduction in asthma attack frequency for patients receiving the Internet-based treatment, the study nonetheless suggests that Internet-based care can be used to improve asthma care in a cost-effective, convenient manner. Researchers on the study also commented on the potential of health systems to save costs and improve asthma care through using such programs, with a nurse specialist as supervisor.

While such programs are still in the early stages of development, as the Internet becomes more commonly used to enhance asthma treatment it is expected that such programs will continue to increase in number. Because using such Internet-based care is a relatively new type of technology-based approach for asthma, it is important to continuously assess and validate their ability to improve care.

IMPLICATIONS FOR ADOPTION AND IMPLEMENTATION

Despite the variety of ICT options available for asthma care management, the somewhat limited evidence base to date challenges their adoption. When considering how to best integrate such technologies into current workflow processes and ultimately make them effective in the care of patients, providers need to consider some important factors, including the following:

- **Financial resources of the provider and patient:** The first consideration in technology adoption will depend on the available financial resources available to providers and patients. As third-party reimbursement for the use of such technologies is currently nonexistent, the onus is placed on the provider and the patient to be able to independently fund these applications. Some technologies are more costly and disruptive to current workflow processes, such as a mobile management solution that requires clinician feedback. These technologies will likely be first adopted by organizations that have the upfront resources to fund and staff their operation, and also believe in their benefits. On the other end of the spectrum, for organizations and/or patients with extremely limited resources, some technologies (such as informational websites or many online games) are available free of charge, and providers only need to raise the awareness of their availability to patients and families.

• **Provider gaps in care process:** Providers should also examine their own care processes to see if there are any gaps that would benefit from being supplemented by technology. For example, a provider might find that emergency room utilization due to asthma is significantly higher than other hospitals, and in turn invest in a technology solution that has proven clinical outcomes of decreasing emergency room visits. Another provider might find that patients struggle with adherence to medication regimens, leading them to adopt an SMS program that improves medication adherence through reminders and other support services. The provider should look for solutions that have demonstrated evidence of proven outcomes through research studies.

• **Patient needs and motivations:** Depending on the severity of condition, patient requirements for technology-based programs as part of their treatment and care vary. For example, for those with sporadic asthma attacks, it may be sufficient to simply have access to information about the disease and management of their symptoms. However, those with severe asthma may be better served through the use of a daily medication reminder service. In addition, as certain technologies require more active roles and interaction than others, it is important to understand the patient’s level of motivation in managing his/her health when choosing an appropriate technology. Patients who are highly motivated are likely to make use of multiple technologies, including more passive choices such as general informational websites. Less motivated patients are likely to be better served by technology facilitating more regular clinician interaction rather than self-management.

• **Patient technology literacy:** The demographics and technology literacy of patients are also important factors to consider when implementing a new technology. A provider should be careful to choose a technology that the patient is familiar with and has access to in order to maximize its effectiveness. Technologies that are already integrated into their lifestyles, such as cell phones and the Internet, are likely to be more successful technology platforms on which to develop applications. For example, a patient who does not have access to the Internet at home would not be a good candidate for an online disease management program, whereas young patients’ familiarity with web or mobile solutions will likely see the benefits from their use to improve care outcomes.
## Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ACC</td>
<td>American College of Cardiology</td>
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<tr>
<td>AHM</td>
<td>Automated Home Monitoring</td>
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<tr>
<td>AHRQ</td>
<td>Agency for Healthcare Research and Quality</td>
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<tr>
<td>API</td>
<td>Application Programming Interface</td>
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<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<tr>
<td>CCR</td>
<td>Continuity of Care Record</td>
</tr>
<tr>
<td>CCHIT</td>
<td>Certification Commission for Health Information Technology</td>
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<tr>
<td>CCM</td>
<td>Chronic Care Model</td>
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<tr>
<td>CD</td>
<td>Chronic Disease</td>
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<tr>
<td>CDC</td>
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<tr>
<td>CDM</td>
<td>Chronic Disease Management</td>
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<tr>
<td>CHF</td>
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</tr>
<tr>
<td>CMS</td>
<td>Center for Medicaid and Medicare Services</td>
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<tr>
<td>COPD</td>
<td>Chronic Obstructive Pulmonary Disease</td>
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<td>CTIA</td>
<td>Cellular Telephone Industries Association</td>
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<td>CVD</td>
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<tr>
<td>ECG</td>
<td>Electrocardiogram</td>
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<tr>
<td>EMR</td>
<td>Electronic Medical Record</td>
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<tr>
<td>FDA</td>
<td>U.S. Food and Drug Administration</td>
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<tr>
<td>HIV/AIDS</td>
<td>Human immunodeficiency virus/ Acquired immunodeficiency syndrome</td>
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<tr>
<td>HIT</td>
<td>Health Information Technology</td>
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<tr>
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<td>Health Insurance Portability and Accountability Act</td>
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<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
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<tr>
<td>ICD</td>
<td>Implantable cardioverter-defibrillator</td>
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<td>IP</td>
<td>Internet Protocol</td>
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<td>Institutional Review Board</td>
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<td>LAN/ WAN</td>
<td>Local Area Network/ Wide Area Network</td>
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<tr>
<td>MCOT</td>
<td>Mobile Cardiac Outpatient Telemetry</td>
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<tr>
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<td>Plain Old Telephone System</td>
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<td>ROI</td>
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<td>United States of America</td>
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<td>Veterans Administration</td>
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<td>VHA</td>
<td>Veterans Health Administration</td>
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LIST OF INTERVIEWEES

(alphabetical by last name)

Peter Boland, Business Development Director, BeWell Mobile

Sophia Chang, Better Chronic Disease Care Program Director, California HealthCare Foundation

Adam Davis, Senior Director of Lung Disease, American Lung Association in California

Anne Lamb, Director, PHI RAMP (Public Health Institute Regional Asthma Management and Prevention)

Joe Kvedar, Founder and Director, Center for Connected Health

Mary McCain, LifeMasters

Ron Poropatich, Physician, United States Army

Suneel Ratan, VP of Business Development, HealthHero

Patricia Ryan, Veterans Health Administration

Randy Williams, CEO, Pharos Innovations

Ben Wilson, Director of Healthcare IT, Intel Digital Health