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Evaluation of Patient to Provider Oriented Telemedicine in Hospitals and Physician Practices

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Telemedicine Background

The healthcare industry in the United States is evolving. Greater levels of technology are constantly being incorporated in care delivery models and virtually every layer of healthcare operations. Physicians are commonly managing their patient's records via robust electronic health records (EHRs) and most facilities have enabled patient portals that allow patients to communicate with their providers easily and from anywhere with Internet access. Web-based portals are a medium for patients to easily connect to their care team, and their personal health information (PHI). They can also be used to accomplish tasks such as scheduling, prescription refills, and referral requests. As the EHRs evolve, the process of healthcare delivery and health management are becoming increasingly efficient, allowing the delivery of care to become more patient centric. In many cases patients can remain at home, and focus on their personal recovery efforts while on site providers access the vital patient information via home-based device, ensuring proper care is being delivered.

EHRs are much more than a digital version of the traditional paper chart; these systems facilitate data collection with structured notes, reminders, and clinical decision making tools. These information systems provide clinical and administrative staff greater and more efficient access to those data needed for their work. The EHR is populated by data via entry from staff, connected diagnostic devices, and the patient portal. Other data interface from systems in remote locations. Data also originates from clinical devices stationed in patients' homes, or even on the person. These data inform providers, and allows them to monitor their patients' conditions from afar. New devices enabling high quality remote care are being developed and integrated into healthcare delivery models at a rapidly increasing rate.

Health information technology (HIT) is now integrated with our personal devices. The ubiquitous smartphone, now capable of remarkably high levels of functionality and connectivity, has recently gained the attention of the Food and Drug Administration (FDA) due to potential applications it has for the medical industry. Commensurate with the emphasis that smart technology developers have placed on health tracking, smartphone clinical applications are the subject of two recent FDA publications. Both are

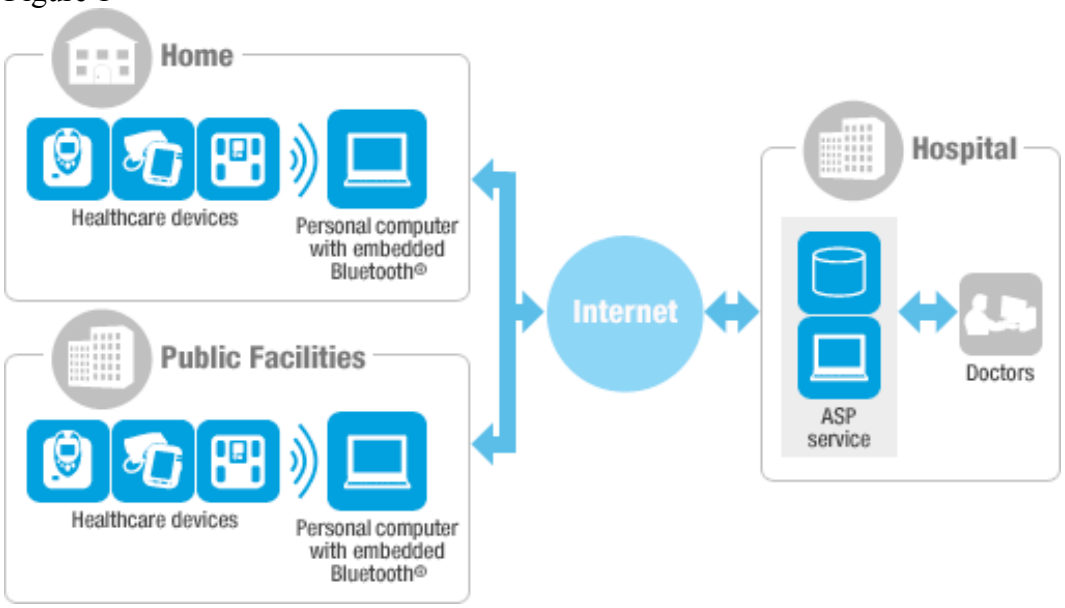
recommendations issued early in February of 2015 to HIT-related industries and related regulatory bodies, suggesting an official stance regarding usage of mobile medical applications and smart devices. The FDA maintains that with the specialized medical builds of smartphones and tablets, these devices, and the networks they operate over, should be considered "medical device data systems, medical image storage devices, and medical image communication devices." (U.S. Department of Health and Human Services Food and Drug Administration (FDA). 2015, p. 4). In essence, the FDA wants to reclassify smart devices used to facilitate medical care in any capacity, as clinical devices, so as to ensure proper regulation, and security measures that govern their use. The primary objective within the FDA (2015) publications is to highlight that,

> the progression to digital health offers the potential for better, more efficient care and improved health outcomes. To achieve this goal requires that many medical devices be interoperable with other types of medical devices and with various types of health information technology. The foundation for such intercommunication is hardware and software that transfer, store, convert formats, and display medical device data or medical image data. (p. 4)

Large amounts and various types of data can originate at the patient level and be used by medical providers. The FDA described this process as being of high value to the industry, and low risk to both the patients and providers. Provider EHRs are now able to capture, store, and utilize both audio and image data meaning that the use of these mobile medical devices has the potential to substantially broaden the range of healthcare delivery. The list of connected clinical devices grows longer by the day, and includes devices such as glucometers, biorhythm monitors, and vital monitors, all of which utilize cloud connectivity to transfer data. The reach of healthcare delivery now extends into the patients' homes, remote locations and facilities, and emergency medical transport vehicles. This is telemedicine, and it now has the potential to connect patients and providers across the globe (FDA, 2015). An overview of this infrastructure is provided in Figure 1.

Telemedicine Definition

Figure 1



("Compatible Healthcare Devices," 2015. Retrieved from: http://www.healthcare.omron).

Evolution of Telemedicine

The American Telemedicine Association (ATA) defines telemedicine as utilization of clinical data "exchanged from one site to another via electronic communications to improve a patient's clinical health status. Telemedicine includes a variety of applications and services using two-way video, smart phones, and wireless devices." (American Telemedicine Association (2010). ATA: Defining telemedicine).

Telemedicine has been an area of research for decades, beginning when the National Aeronautics and Space Administration (NASA) was preparing to send the first live crews to the moon in the 1960s, then enhanced when the NAVY adopted the technology for submarine deployments. The early era of civilian telemedicine delivery began in behavioral healthcare with clinicians conducting medication reviews with patients unable to maintain regular appointments. As a result, we have a large body of evidence demonstrating the efficiency and cost effectiveness of various telemedicine applications. As telecommunications and networking technology evolved, telemedicine technology followed in kind. Due to sluggish regulations and lack of supportive

reimbursement, however, clinical telemedicine research and practices are not keeping pace with the technology (Nicogossian, Pober, & Roy, 2001).

Over the years telemedicine practices were integrated into the operations of hospitals, specialty departments, home health agencies, and private physician offices. Technology and processes related to telemedicine are now an important consideration within larger investment decisions being made by healthcare institutions for both information technology and the delivery of clinical care. Currently, the most common, and the only federally recognized model of telemedicine in practice is physician-directed video consultation (American Hospital Association, 2011).

Telemedicine technology varies greatly. There is such an array of devices, different builds, and potential system models that could be incorporated into care delivery, value can only be determined by how well the technology serves the particular patients and providers. For example, cardiac patients can benefit from connected heart monitors that push vital data to the physician's EHR. Diabetic patients benefit from connected glucometers that push collected data when docked. Patients can be equipped with insulin pumps that stream real time data to both their Personal Health records (PHRs) and EHRs. Once data are captured by the EHR, built in clinical decision support greatly aids in managing risk, alerting clinicians when levels are out of range and intervention is needed. For example, one company that has focused on innovative telemedicine builds for the diabetic population is Tidepool. Their vision is to utilize smart phone technology to enhance the quality of care for diabetics ("Our Mission," 2015. Retrieved from http://tidepool.org).

Methods

A literature search through PubMed, a bibliographic database of medical research, includes over 12,000 citations of published works related to telemedicine. Much of the recent peer reviewed research focuses on the potential value of telemedicine technology; many studies report in terms of increasing the quality of care and others publish details on the potential cost effectiveness of incorporating this technology in care delivery models. The value of simultaneously increasing value while lowering cost became more prominent themes in the research released after 2012. This is when reports began

adopting the language of Patient Protection and Affordable Care Act (ACA) (American Telemedicine Association, 2015).

Other data sources for this report included marketing publications issued by the telemedicine developers. Many of the technologies reviewed are in their early release phase, which necessitated reliance on and review of publications and reports created by trade associations, e.g. recent American Telemedicine Association (ATA) releases highlighting the innovations to be showcased at their 2015 conference. These types of publications were reviewed to gain perspective on the various technologies currently available, as well as those on the development horizon.

To understand the perspective of HIT experts in Maine, semi-structured key informant interviews were conducted. Six total informant interviews were held amongst physicians, hospital and health network administrators, and HIT experts in Maine. The conflicting impressions and concerns offered by interviewees helped focus this work on several critical aspects of the work necessary to successfully navigate the integration of current telemedicine technology into the healthcare delivery infrastructure of Maine.

Scope of Project

Assessing the potential impact telemedicine may have on the future of healthcare delivery, next generation technologies, and emerging models in response to health care reform was the focus of this work. This included an array of connected clinical devices, innovative applications for smartphones and personal computers (PCs), wearable and implantable electronic medical devices, and cloud-based clinical software. The standouts came from companies such as Carena and Allscripts, which build software for clinical communication, consultation, prescribing, next step planning, and scheduling. These companies are clearly demonstrating that these functions can be safely and efficiently performed without patients setting foot in a provider's office. Telemedicine, however, does not need to be limited to communication or data transfer; current technology is capable of managing remote care delivery, and providing real time clinical decision support. Maine experts feel this technology possesses the potential to simultaneously raise the quality of care, while reducing the cost of delivery. What remains unclear is exactly how, when, and to what degree. With these questions in mind, this project

explores barriers to telemedicine adoption and meaningful integration with contemporary healthcare delivery systems.

Reviewed Telemedicine Technologies

An investigation of the next generation of telemedicine technologies revealed several companies developing applications for use on smart phones and PCs that allow patients to access providers via Wi-Fi connectivity. One example is Carena's Virtual Clinic, which provides access to an in-network specialist after a guided online registration. Another is DoctorOnDemand.com, which connects patients to medical doctors, psychologists, and various other clinical experts via smartphone, tablets, or PCs. This web-based software offers rapid access to care, which includes diagnosis, treatment plan, and if needed, electronic prescriptions sent to the patient's chosen pharmacy. All of this is done in minutes; no more need to take an entire sick day to be seen by a primary care provider (PCP) the day after contacting their office. If in-person direct care is needed, patients are linked to the closest available in-network provider.

Outside of the web-based services and clinical applications is a host of connected devices, sometimes referred to as the "Internet of Things," a term coined by technology pioneer, Kevin Ashton, of Cisco (Retrieved from http://www.cisco.com). The Internet of Things describes familiar devices, now equipped with the ability to connect and push data to the cloud, or Internet. The concept extends to the medical industry, as bathroom scales, glucometers, and blood pressure cuffs now make use of wireless technology and micro-electromechanical systems to automatically connect and push data to the providers' EHR. Intuitive decision support and emergency alert systems are being built into these devices, which can alert providers to the need for intervention if the device is not used as prescribed, or if patient data is outside set parameters. Telemedicine technology is being built into extremely practical, intuitive, and efficient designs for homes, as well as rural, emergency, and specialized care delivery settings. Of interest to this project is the patient to provider structured telemedicine builds. The aim is to investigate whether these devices and software are, or will soon be able to impact health care in Maine in a positive and meaningful way ("Internet of Things," 2015. Retrieved from http://www.cisco.com).

Despite the wide variety within this sector of technology, all facets of telemedicine hold one core principle in common. At it's most basic; each build has a two party design for the exchange of information, where data is either deliberately or automatically sent from a remotely located patient to the provider, or from the provider to the patient. This enables patients and providers to remain in their respective locations, while data is captured, reviewed and acted upon, thus increasing convenience and efficiency, and quite often reducing cost for all parties involved. For this system to work as intended, however, both parties must be able and willing to trust, and to navigate, the technology.

Industry Requirements

For telemedicine to run smoothly, and to be of value to patients and providers, many conditions must be met. If the cost is high, the requirements are many, and the interoperability, or data sharing, is problematic or costly, the technology is unlikely to be adopted. When these conditions have all been met, and the telemedicine technology can be well integrated into a system of care, it could be of great value to the provider, and could be life saving for patients. The aim of patient to provider-structured technology is efficient, patient-centered, and quality-based care delivery. The primary goal is to place the right data, in the right hands, at the right time so decisions can be made within the small window of time required for critical intervention.

Areas of concern cited in the literature and by key informants in Maine, which serve as themes interwoven throughout this report, include access, value, cost, reliability, and risk. With regards to access, questions raised ask what sort of patients will have ability to obtain and properly use these technologies? Relative to value and cost, key questions include how well will the technology interface or interoperate with the provider's EHR, and is there a budget to cover the cost of incorporation? In terms of reliability and risk, issues raised include concern for whether the resultant data can be trusted, and what is the extent of risk, and who bears that risk when systems go down or suffer from security breaches? The following sections consider federal and state telemedicine policies, provisions of meaningful use, telemedicine applications in emerging delivery models including patient-centered medical homes and accountable

care organizations, analytics and data and user interfaces, adoption barriers, concluding with a summary and discussion of findings.

Federal Policy

The healthcare has struggled with the lack of clearly defined state and federal regulations regarding use and reimbursement for telemedicine services. The Centers for Medicare and Medicaid Services (CMS) did not issue policy clearly approving reimbursement for telemedicine to Medicare patients until the inception of the Balanced Budget Act of 1997. The range of services, and those receiving them, was relatively constrained until 2001 when CMS broadened the range of services covered and established procedures. These changes increased types of treatment covered, eligible providers, and facilities, however, the allowable services were limited to audio and visual communication between a clinician stationed in a rural care facility also known as Health Professional Shortage Area (HPSA), and a patient at their home (Centers for Medicaid & Medicare services, 2015. Retrieved from http://www.cms.org).

The rules for Medicare reimbursement are becoming progressively more inclusive of telemedicine services each year; however, CMS continues to require that service include live interactive video sessions, and does not recognize uses where clinicians monitor and act on data transmitted from patient to provider, via connected device, telephone, software, or facsimile. Regulations also restrict access to approved patients and certified providers, and are reimbursable only when both are in pre-approved locations. Telemedicine services must be at specific health care facilities, deemed as a rural HPSA.

While the efforts to include provisions for telemedicine from federal and state sources are underway, public payment and policies lag behind the emerging potential for information technology. This is evidenced by the lack of inclusion of this technology within any of the three stages of Meaningful Use. Earlier this year the American Hospital Association (AHA) released an open letter to CMS with regard to “CMS-1461-P, Medicare Program; Medicare Shared Savings Program: Accountable Care.” That communication references several planned initiatives that could be advanced by the

integration of telemedicine technology. While this author was not able to locate a response from CMS, the sentiment expressed by the AHA suggests the growing awareness of the need for specific inclusion of telemedicine within future federal regulatory structures, which in turn suggests the importance of, and opportunities to employ this technology to advance the new and evolving goal sets of the ACA and healthcare structural reforms underway (Lustig, 2012).

Maine Policy and Regulatory Environment

Within Maine, telemedicine is governed the Maine Department of Health and Human Services, who have designated all sites in Maine's twelve rural counties as eligible providers. Currently MaineCare, Maine's Medicaid program, is significantly more flexible concerning telemedicine policy compared with other state/federal regulatory bodies. Home health, behavioral services, and medical providers within rural HPSAs, are all eligible to bill for provider initiated video conferenced consultation. Other Telemedicine applications within the state of Maine cannot be billed for, however, but they can be used to increase the efficiency of care.

Little information was located concerning the private insurance plan telemedicine benefits and coverage within the United States. Due to the vast number and varied nature of third-party payer plans, there is minimal standardization on this subject. Furthermore, because each state governs their own licensing and credential standards regarding telemedicine providers, as well as allowable services and reimbursable procedures, cataloging interstate telemedicine provisions is a massive undertaking beyond the scope of this project.

Under Maine's health insurance parity law, private insurers are required to provide coverage of telemedicine services subject to the same contract terms and conditions as any other healthcare service. For this reason all third party private payers allow reimbursement for telemedicine, though this is limited to the finite federal definition, e.g. audiovisual consult. Consult via telemedicine must be provided in a manner consistent with in-person coverage. A finer detail of note: neither federal programs nor private payers are required to reimburse for facility or transmission fees,

which complicates the reimbursement and makes providing telemedicine care less attractive financially (ME Revised Statutes Annotated. Title 24 Sec. 4316 (2012); retrieved from http://www.telemedicine policy.us & http://legislature.maine.gov).

HIT is being viewed as increasingly more valuable as quality based care delivery models emerge in response to ACA. Programs such as Meaningful Use, which was a product of the American Recovery and Reinvestment Act (ARRA), the National Committee for Quality Assurance's (NCQA) Patient-Centered Medical Home (PCMH), and Accountable Care Organizations (ACOs) all stand to benefit from HIT incorporation. At the core of these ACA respondent models is the Triple Aim, which is a contextual framework developed by the Institute for Healthcare Improvement (IHI) that describes an approach to optimizing health system performance. It is IHI's core tenant that new designs are needed to assure increases in quality, affordability, and patient experience of quality care (CMS, 2015. Retrieved from http://www.cms.org; & Institute for Health Technology Transformation, 2012).

The Affordable Care Act (ACA) provisions are designed to improve the quality and efficiency of the U.S. healthcare system as well as design strategies to test new reimbursement and care delivery systems. Integral to these strategies are new metrics to report and assess provider performance. Results from these assessments will serve to better inform public reporting programs, payment reform, value-based purchasing, and overall quality improvement efforts within the healthcare reform efforts. The ACA includes strategies for strengthening primary care, supporting clinical and patient decisions via evidence-based information, and enhancing HIT adoption rates. Telemedicine stands to positively impact each area of this plan, details of which will evolve within the context of the quality based care delivery programs.

These approaches to quality based care continue to gain traction in American healthcare delivery, and as a result, technology is becoming an increasingly important component of the medical industry. HIT includes varied systems and devices involving the design, development, creation, use and maintenance of information systems for the healthcare industry. Automated healthcare information systems stand to lower costs, improve efficiency, and reduce error, while increasing consumer access to care and improving service.

The federal bodies governing healthcare funding sources are demanding greater levels of quality and improved patient outcomes. To encourage this shift, reimbursement policies have been issuing financial rewards based on reports of quality outcomes rather than simply rewarding volume of procedures performed. In addition, the focus is on improving access to high quality of care. Many of the thought leaders within the industry are turning to technology as the means to meet these new goals.

Institute for Health Technology Transformation (2012), have this to say about healthcare reform, technology, and population health management:

> By applying technology to population health strategies to continually identify, assess, and stratify provider panels, physician groups can use technology and automation to augment the role of care teams, manage the patient population more effectively and efficiently, drive better outcomes, and decrease overall cost, as demanded by new payment incentives focused on value. (p. 19)

Regarding the quality of telemedicine applications, research has shown that there is no difference in the ability of the provider to obtain clinical information, issue accurate diagnosis, and produce effective treatment plans, which result in the same desired clinical outcomes, as compared to in person care. The ATA (2015) conducted a meta-analysis of the level of quality across telemedicine models in the U.S. The findings indicate utilization of this technology has resulted in significantly improved clinical outcomes in overall levels of care. If the regulatory and payment structures align to include the available technology, telemedicine stands to become a central component of quality based healthcare reform. As predicted, strategic adoption of telemedicine technology is becoming a game changer for quality based care models, most specifically for programs such as Affordable Care Organizations (ACOs), and Patient Centered Medical Homes (PCMHs) (American Telemedicine Association, 2015; Dellifraine & Dansky, 2008).

Meaningful Use

Within the ARRA, enacted in 2009, the purpose of the Meaningful Use program is to use health information technology, with specific attention on EHRs, to improve quality, safety, and efficiency of healthcare delivery. The technology will be used to reduce health disparities and engage patients, as well as improve care coordination and

clinical outcomes. The meaningful use program requires providers and facilities to report more robust data to CMS to feed the analytics intended to leverage federal quality improvement programs in an effort to elevate overall population health. An example of these reporting systems is the Physician Quality Reporting System (PQRS), which is a reporting program newly established and maintained by CMS that uses a combination of incentive payments and negative payment adjustments to increase electronic reporting of quality metrics by eligible professionals (CMS, 2015. Retrieved from http://www.cms.org).

As healthcare organizations navigate the stages of Meaningful Use, they will be required to integrate increasing levels of HIT into their care delivery models. Telemedicine technology stands to be an asset within information-driven systems by serving a larger patient base, more efficiently, while using fewer clinical resources. Data on these remote encounters can be easily captured, stored, and reported, thus enhancing Meaningful Use compliance, while simultaneously achieving the program's aims for access, quality and cost efficiencies.

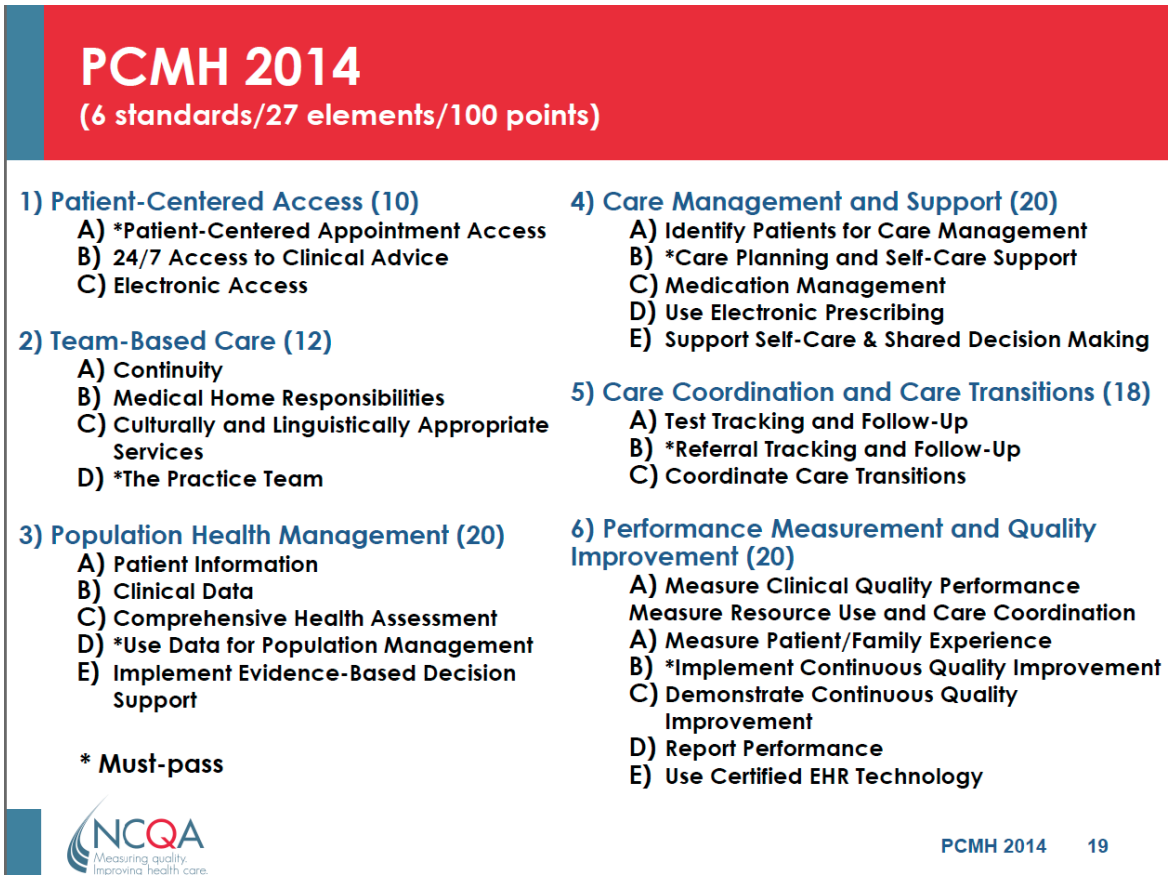
Patient Centered Medical Homes

Patient Centered Medical Homes (PCMH) are part of a national effort to reform primary care delivery. The model places the patient at the center, while coordinating care management with providers around the individuals' specific goals for care. Certified providers are required to meet six standards determined by the National Committee for Quality Assurance (NCQA) Telemedicine holds the potential to play a vital role in the support of most, if not all, of the six standards, which are detailed below in Figure 2.

The PCMH model is a promising structure for improving access to high-quality care for more Americans at lower cost. In 2010 the University of Pittsburg Medical Center (UPMC) released results on their integration of telemedicine within a PCMH based pilot program. The study reported significantly lower medical and pharmacy costs, more efficient service delivery, lower hospital admissions and readmissions, and fewer emergency department visits, compared with non-participating sites. The network also reported seeing a 160% return on the technology investment made to meet the

requirements of PCMH contracts. The study's authors observed the greatest function served by the telemedicine program was to close the gap between patients and providers by fortifying the ambulatory sector with clinical communication, monitoring, and remote intervention (Rosenberg, Peele, Keyser, McAnallen & Holder, 2012).

Figure 2



("PCMH standards," 2015. Retrieved from, http://www.NCQA.org.).

Accountable Care Organization

An Accountable Care Organization (ACO) is a quality oriented care model characterized by collaboration among providers who are collectively responsible for the care outcomes of a defined patient population. This payment and delivery model seeks to tie provider reimbursements to quality metrics while reducing the total cost of care for an assigned panel of patients. As the support for the ACO model grows, the hope is that pervasive payment structures for healthcare reimbursement will begin to move away

from fee for service and trend toward value based compensation. CMS sets the standards for specific quality metrics that ACOs must meet for their patient populations in order to qualify for CMS incentive payments. Payment to ACOs is a capitated, or finite sum, that is allotted to provide care for a specified population, for a prescribed length of time. The overarching context for this type of organization is a contracted care plan that rewards providers for improving the quality of care delivered, in the most efficient manner possible.

ACOs operate within the Medicare Shared Savings Program (MSSP), established by section 3022 of the Affordable Care Act. The Shared Savings Program is a key component of the quality reform initiatives within the ACA. Congress created the MSSP to facilitate coordination and cooperation among providers, and to improve the quality of care for Medicare patients while reducing costs. This system encourages partnerships among independent providers willing to accept risk and share savings based on a single capitated payment. This places emphasis on primary care, an appealing aspect for payers, who benefit from cost savings and reduction of global risk (CMS, 2015. Retrieved from http://www.cms.org).

In order to enjoy the shared savings of the MSSP, ACOs also have to meet 33 quality measures and as MSSP states, ACOs must

> define processes to promote evidence-based medicine and patient engagement, report on quality and cost measures, and coordinate care, such as through the use of telemedicine, remote patient monitoring, and other such enabling technologies." (CMS, 2015. Retrieved from http://www.cms.org).

One ACO of note is Eastern Maine Health System's Beacon Health, which is producing significantly positive results within Maine. Within the first two years of operation, Beacon demonstrated improved care coordination, efficiency, and quality; becoming the only clinically driven NCQA accredited program in the nation to report demonstration of cost savings. CMS "announced Beacon Health had a shared savings for performance year one of $2 million. These savings were reinvested in the ACO with 40 percent used to support care coordination functions and responsibilities, and 60 percent

invested in data analytics and infrastructure" (Building an Accountable System of Care, 2015. Retrieved from http://www.emhs.org).

Analytics

Data Interface: Healthcare analytics is an emerging science most commonly used by the larger facilities and networks to inform investments and strategies to maximize use of available resources. This science makes extensive use of data to fuel statistical and quantitative analyses, as well as for predictive modeling to target specific patient populations and to identify specific populations' needs. A typical model for information flow within patient to provider-structured telemedicine would be data from personal devices to provider portal cost savings that feed EHRs. All data from the EHR is then available to feed the analytics services.

Many EHRs and telemedicine systems may feed a single data warehouse, each with different data transmittal protocols. New technologies are also emerging to facilitate both the data interfacing and subsequent analytics. For example analytics platform, e.g. dbMotion, which will facilitates both the data interfacing and the analytics. Allscripts's dbMotion provides the foundation of communication in a disconnected industry, one that will allow for areas like telemedicine growing further. dbMotion connects otherwise disparate information silos, enabling healthcare organizations to communicate effectively, both in and outside of network, and to able to meaningfully leverage their captured data to benefit from better informed clinical process. Additional information regarding functionality of dbMotion can be seen in Figure 3 (dbMotion Overview, 2015. Retrieved from http://www.allscripts.com).

Figure 3.

(dbMotion Overview, 2015. Retrieved from http://www.allscripts.com).

PCMH and PQRS data analytics are used to provide a dashboard of physician quality performance, to track impact and outcomes, and to enable providers to identify high risk patients and drill down to learn more from available data. As EHRs are being integrated into health care throughout the U.S., the systems are generating massive amounts of data. In many cases, however, the quality of these data may be inferior, and may offer little value to the generating facilities. Analytics service providers clean the data, meaning they consolidate and reorganize the data into useable information for facilities, networks, and in a broader sense, the healthcare industry as a whole. These analyses provide facilities with a clear perspective on operations by tracking utilization rates and patient behavioral trends, which informs both healthcare provider strategy and health industry research. Analytics are central to achieving the systematic quality improvements and cost reductions that are the central goal of the ACA (Dellifraine & Dansky 2008).

The current limits to interoperability, inherent in disparate proprietary technology pose significant barriers for telemedicine as a contributor to healthcare analytics. Developers are actively working to navigate these constraints. Telemedicine builds are becoming increasingly able to populate providers' EHRs, though significant gaps remain. These and other barriers will be discussed in a subsequent section of this report.

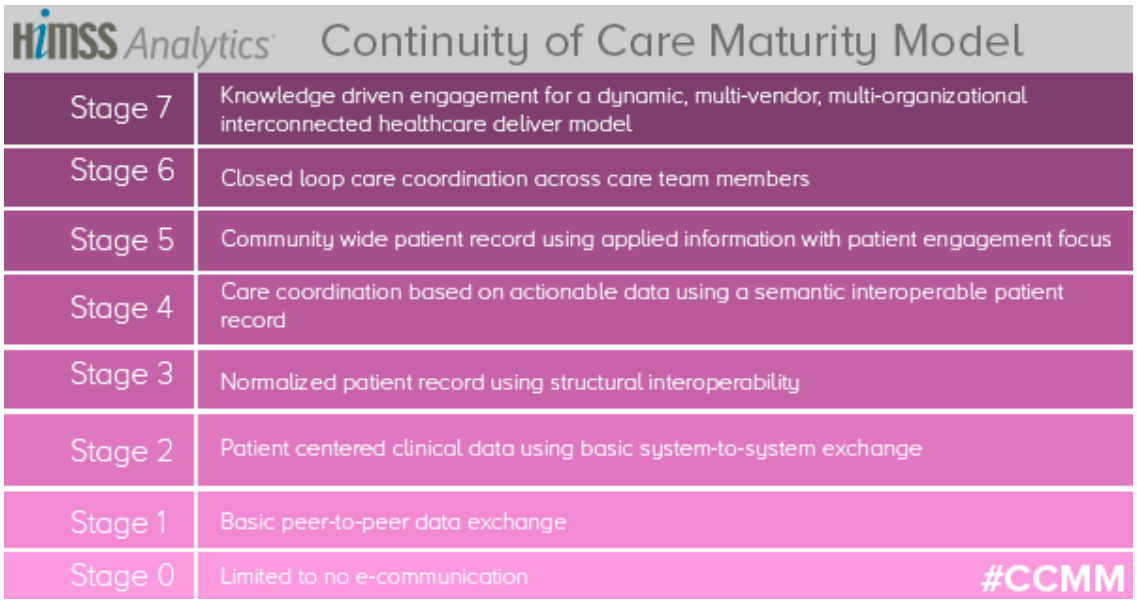
User Interface: As mentioned earlier, both the patient and the provider determine value for telemedicine technology. Using analytics to stratify and evaluate the needs of the patient populations will increase the potential of using the appropriate technology to make the providers better able to serve their patient's needs, thus increasing the overall value of the technology itself. To achieve this, it is essential that patients both can, and will, use their devices as intended. Using an analytics informed process to target users in the early stages of telemedicine diffusion could reduce the risk of ill-used technology. This ability to distinguish among patient populations by capacity and level of risk, will allow developers to design the technology to be of service to those who need it most, as well as to be of most use to those who will adopt it. For example, wearable devices and web-based urgent care applications are designed for the active and most fit populations who will access web-based portals and take action independently. In contrast, monitoring devices for at risk populations, like technologies designed for diabetic patients rely on data vital automatically being pushed simultaneously to patients and their providers (HIMSS Analytics, 2014).

Organizational Interface: The Healthcare Information and Management Systems Society (HIMSS), a non profit organization focused on better health through information technology, has developed a model to help optimize HIT outcomes. This design, known as the Continuity of Care Maturity Model (CCMM), serves as a healthcare network's guide for future HIT integration. This model is designed to facilitate greater levels of information exchange by establishing HIT interoperability, to foster care coordination, as well as patient engagement; all of which will ultimately raise providers' capacity to manage population health. The intent of CCMM is similar to the Meaningful Use program, with the most notable difference being CCMM's emphasis on a seamless HIT interface and EHR optimization informed by extensive analytics. Figure 4, describes the eight stages of the CCMM model (HIMSS Analytics Stage 7, 2015. Retrieved from http://himssanalytics.org).

As a direct result of the information made available via analytics, patients can now be efficiently categorized and evaluated, allowing delivery of care to be more precisely targeted, and impactful. Users can now know the level of monitoring required by each patient group, progress toward implementation of specific interventions and

evidence-based practices associated with various clinical scenarios. This use of information helps demonstrate why telemedicine technology is viewed as having such high potential value. Health systems are rapidly learning how, when, and where to employ the various technologies so they have the greatest positive impact on healthcare delivery. The process has yet to been perfected, however, it is informed, and higher adoption rates will provide the data needed to refine these processes.

Figure 4



(HIMSS Analytics Stage 7 Case Studies, 2015. Retrieved from http://himssanalytics.org).

Adoption Barriers

In their recent (2015) webinar International Data Corporation (IDC) focused on telemedicine adoption rates. Their forecast regarding patient to provider structures of telemedicine was eye opening, and emphasized the need to reduce adoption barriers. They predict that as healthcare costs rise, and focus shifts to quality, forward thinking healthcare operations will make the shift to "data-driven" hospital strategies. The prediction that stands out as most relevant to this project is their assertion that 65 percent of healthcare transactions will be conducted via mobile device by 2018, making web and

smart mobile device applications key components for future industry success ("IDC: Analyze The Future," 2015. Retrieved from http://www.idc.com).

The literature also paints a compelling picture of the important role available technology can play in improving the delivery of patient care more affordably. At the same time, next-generation telemedicine utilization rates are still quite low, and there are several reasons for this.

Cost: Nearly all research cites as the lack of reimbursement as the biggest challenge facing Telemedicine. A successful Telemedicine program requires considerable up-front investment and in many cases reorganization of the clinical workflow. There is an upfront cost of new technology, and the work to integrate the telemedicine build into existing EHRs and to establish interoperability, require significant investment of financial and human resources. Lack of a defined reimbursement model often makes the risk inherent in initial purchase easier to see than the potential return on investment.

Cost benefit: Both providers and payers need clear evidence that shows the economic and clinical benefits of telemedicine usage. While there are numerous documented successes employing this technology, the research literature tends to be limited to proving evidence based on very specific populations. Both private facilities, and CMS have released reports indicating substantial economic success, the difficulty remains in choosing from the best available technology in a particular geographic area and that will best serve targeted populations. With the limits of reimbursement keeping many players out of the game, it remains difficult to build a model for telemedicine integration that demonstrates value to a wide array of providers or networks (CMS, 2015. Retrieved from http://www.cms.org; Cryer, Shannon, Van Amsterdam, & Leff, 2012).

Volume of information: Telemedicine stands to produce large amounts of potentially valuable data, including patient vital signs and symptoms. Some physicians are worried that this critical information may get lost, misinterpreted by the software, or go unnoticed in amongst the large amount of streaming information. These sensitivities make data integration and user/provider interface concerns make the work of design teams more challenging. Another clinical concern is the complexity of algorithms and

review protocols for functions like reconciliation of a medication list across multiple systems. Too much unverified data can also serve to obfuscate, rather than inform the care delivery process. These concerns lead to a range of varied trust levels and impressions among the physicians. While many providers support the integration of technology, some fear overly intricate workflows, and others raise concern for increased potential of malpractice lawsuits.

Heterogeneous Users: Telemedicine programs can be successful if patients are engaged and compliant to the clinical process recommended by their healthcare provider. Research has shown many patients respond favorably to their experience with these technologies. Their ability to properly interface with, and to maintain their end of the technology, however, may present a limitation to the success of a telemedicine venture. Technology is varied, and often target populations are critically ill. In such instances the builds need incorporate passive design features that can be maintained either remotely, or by in-home aides. Other patient populations may be required to be highly motivated to maintain high levels of interaction with their technology. Again, each instance will be different, and each will have its own set of potential weaknesses. In any case, value is determined on both user ends of the technology, and each successful model will require both patients and providers to value, trust, and effectively navigate the technology. There are many elements required for a successful telemedicine program, and there is a lack of established process to be emulated.

Interoperability: Two levels of interoperability, or lack thereof, are often mentioned as barriers to adoption of telemedicine. The first is the wireless interoperability between the patient-level devices and data storage providers. The concern is for the ability of such devices to effectively capture the data produced at the patient level, and store it in the cloud. The company that hosts this data is responsible for the security as well as the accuracy of the data exchanged or transmitted. The second issue concerns the interoperability between the stored data and provider's EHR. The data captured by a patient's personal device is often incompatible with their provider's information system data protocols; translation is often required before the data can populate the patient's medical record. This extra step can be costly and is also another

potential source of risk. The more times data changes hands, the more costly, less secure, and less trusted the process and the data become. Telemedicine services requiring the least external support are more highly valued than those requiring contracted supports. For example, Continua Health Alliance is an industry consortium of 240 companies worldwide, with published standardized protocol specifications addressing data collection and storage. Despite their efforts, the number of devices compliant with their standards is far less than the number of devices currently available on the market.

Scope of Practice Regulations: Beyond the noted restrictions to qualified reimbursable telemedicine setups, some states require that physicians be licensed in the state where patients are treated. This significantly limits the reach of the technology and the array of available providers.

Critics of the federal regulations, several studies, and local key informants, describe the quality-based reformation efforts as paradoxical. Major frustrations include all the barriers noted above, as well as the volume of overlooked detail that has resulted in disjointed policies governing telemedicine. One example illustrating this paradox is Meaningful Use policies that require patient level scheduling ability to be written into any personal health record (PHR) service. The interoperability required for this function has effectively halted PHR development. Such seemingly minor misalignments of policy detail can create significant implementation barriers for the industry.

These gaps and uncertainty substantially increase cost, and lessen adoption rates for HIT. Absent a reimbursement structure akin to the MSSP system, smaller providers like PCMH are faced with the need to absorb the high up-front cost of the technology investment, with less potential for a positive return on their investment. These same smaller providers are also under increasing pressure for more and better information as insurance companies begin to rank providers and advertise their performance. These new incentive structures can have positive or negative impact on smaller providers position within the local market. As a result smaller facilities, and those providers less able to compete, have few choices other than to become subsidiaries of larger systems if they wish to be part of local PCMH networks.

Summary of Findings

The literature available regarding telemedicine is largely designed to demonstrate potential value through improving access, quality, and efficiency of care delivery. Telemedicine seems to be an excellent way to reduce cost while improving access to quality healthcare. It has the potential to have profound positive impact on many areas of the healthcare industry, by unburdening overloaded acute care systems, as well as improving primary care and remote, in-home, and emergency medical care. It also holds great value for the emerging quality-health care delivery models responding to current reform initiatives. This study revealed that the agencies and regulatory bodies driving healthcare reform are the very same that constrain the growth and integration of the technology poised to deliver these improvements. The value of bringing technology into healthcare is widely apparent. Digitizing data serves to better inform the patient as well as the provider, while data analytics hold the potential to improve the speed and quality of clinical decision-making. Without a means to cover the costs, however, telemedicine will remain simply a potential tool, rather than a valuable part of the process.

Learning With Live HIT Systems

Through researching telemedicine, it has become apparent that technology advances at a far more rapid pace than industry capacity. The scope of care delivery is vast, complex, and remains fragmented despite the best efforts of very innovative and passionate teams of creative minds. As new software and devices are created, so must new process be created to integrate the functions of that new technology. Weeding through the available software and hardware, and committing to the integration of new technology and process into a system that can never be suspended, is an expensive and daunting task. At the same time, healthcare delivery systems are expected to fund, build, redefine workflow, and simultaneously evaluate the performance for new HIT. It is unrealistic to expect these same systems to bear the burden and expense of independent research and evaluation of these new approaches. Unfortunately, these realities contribute to the shortage of evidence-based research within telemedicine literature.

The Challenge of Data Exchange Protocols

Despite the undeniable virtues of interoperable collaborative healthcare, many current HIT systems are not built to support complicated file transfer protocols and

needed interface security measures. As a result, complications frequently arise due to the firewalls and other private network features, which make it virtually impossible for many healthcare networks to transfer data out of network. This is especially true with regard to proprietary personal devices. As long as HIT systems remain fragmented, true integration of telemedicine technology will be an uphill battle.

Regulation and Payment Reform

For telemedicine to become a true part of U.S. healthcare delivery, state and federal regulatory bodies need to work with the HIT and analytics experts. This collaboration is vital to the success of healthcare reform. Regulations can be modernized to support the integration and utilization of telemedicine technologies, rather than limit, or prohibit it. In order for the innovative technologies, telemedicine devices, and software discussed in this work to be utilized at full potential, CMS must develop a payment structure that will support the various HIT models that can best serve quality based care delivery. Based on previous funding policy experience, private insurance providers can be expected follow suit with policies reflecting federal decisions on these matters.

Advances

Despite a long list of barriers, it is important to note several positive advances that offer a brighter light for the future of telemedicine. The Office of the National Coordinator for Health Information Technology (ONC) is now explicitly charged with promoting a national HIT infrastructure and overseeing its development. Private sector health service research entities like the RAND Corporation are working to increase the standards of interoperability by working with health information exchange programs on the state and federal levels. The efforts of these organizations, along with the FDA's championing mobile technology's reclassification as clinical devices, and the growing number of telemedicine models and devices being marketed, are all contributing to the growing momentum for HIT advances, despite the barriers identified here.

Conclusions

The potential for data driven, hi-tech healthcare delivery exists. With backing of federal policy, and a supportive reimbursement and payment structures, telemedicine technology will help the HIT industry move up to the next level of adoption and integration.

From discussions with thought leaders in Maine and review of the literature, three core elements emerge as necessary parameters required for advancing telemedicine as a meaningful component of healthcare delivery.

First: The value of the technology in health care delivery is dyadic and application specific. No one technology will serve the entire industry, or the general public. For telemedicine to significantly increase access to care, it must be designed to fluidly meet the specific needs of targeted populations, providers, and their EHRs. Once these prerequisites are addressed, this technology stands to dramatically increase patient access to clinical care. The win will be in the integration and sharing of data among these systems and standardization

Second: To fully trust the data, each new telemedicine build has a process validation period before produced data are trusted and clinically actionable. As the new telemedicine technologies and interfaces considered here generate data remotely and at the patient level, its validation period can be expected to take longer and be more involved than other earlier HIT applications. While the benefits are currently apparent to some, further documentation of the evidence of success will do much to more clearly demonstrate telemedicine's potential for enhancing quality care delivery.

Third: High initial costs, lack of reimbursement structures, and confounding regulations significantly limit telemedicine's perceived immediate value. The literature indicates that as development and integration gather momentum, telemedicine stands to free up valuable provider time and resources, while also reducing costly events such as hospital readmissions. When incorporated into such health care delivery models as Patient Centered Medical Home, and Accountable Care Organization structures, this technology can be expected to play a more central role and contribute to improved patient experience and care quality, while reducing the cost of care delivery.

The need for and potential impact of telemedicine in Maine places local providers at the forefront of change. According to federal classification schemes, used to determine eligibility for programs that assist with healthcare delivery, 11 of Maine's 16 counties are considered rural areas. In 2014, this represents 552,638 residents - or 42% of Maine's population. In addition, Maine is considered the oldest state in the nation, and the oldest residents are often living in our rural counties, counties that are known to have the lowest median income and the fewest number of healthcare providers. These demographic imperatives make development of HIT the infrastructure within the Maine healthcare system a vital process. Such infrastructure, incorporating strong, evidence based telemedicine models, with specific design features to serve the needs of rural Maine residents, can be expected to have a long run positive impact on overall access to care, elevating community health, while decreasing cost, for both the patient and their providers (Maine Rural Health, 2015. Retrieved on http://www.maine.gov).

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Appendix A: Additional Relevant Resources

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