Development of a Telemedical Platform

Challenges, Requirements, and Solutions

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Abstract—**Telehealth supported care coordination for patients with chronic diseases has been established for more than 10 years. New requirements and challenges for the development of a modern telemedical platform are emerging as organizations attempt large-scale implementations and the integration of telehealth in a variety of care settings. This paper describes a newly developed telehealth system that is already deployed commercially along with future challenges facing this system.**

Keywords – telehealth; remote patient monitoring; care coordination; multi-modal systems; chronic care

I. INTRODUCTION

As the burden of chronic disease conditions increases with the aging of the population in developed nations, healthcare systems across the world are stretched thin. In the case of the United States of America, this burden has serious consequences since healthcare costs are expected to claim 20 percent of the country's gross domestic product by 2019 [1]. As a direct consequence of legislative reform that occurred in 2010, an estimated 32 million currently uninsured U.S. citizens will enter health insurance plans over the next few years [2]. Additionally, according to the Association of American Medical Colleges, as a result of the current rates of graduating and retiring physicians there could be a gap of 150,000 physicians within 15 years [3]. Technologists, healthcare professional organizations, and policy-makers alike are, therefore, looking for ways to "bend the cost curve" while improving quality, access, and continuity of care beyond what is currently available. Telehealth that includes remote patient-monitoring is one way to achieve this goal.

Telehealth is a term that is still used loosely to describe both healthcare that is provided remotely and video-based remote consultation between patient and doctor or doctor-to-doctor. The latter definition, however, more correctly falls under telemedicine, in which medicine is practiced using a video network. Traditional telehealth, on the other hand, includes the remote monitoring of patients' vital signs and the management of their disease progression through continuous health-risk assessment via automated question and answer sessions. Data collected from both mechanisms are then used by an intelligent system to determine the risk level for each patient, thus enabling efficient, yet effective, patient population management by a health care professional. This intelligent system is based on the rules that the health care professional defines for each patient or population of patients with the same or similar medical conditions. Such a system can be extended to analyze past information for a patient, suggest possible future outcomes, and trigger timely intervention by the health care professional. It can also route the action plan necessary for a patient to the appropriate health care professional: a nurse, a primary care physician responsible for the patient, or even to a specialist if the medical system of the provider organization or the region allows for such automatic routing.

II. CHALLENGES AND REQUIREMENTS

The success of a large-scale telehealth deployment in a widespread geographic region by Veterans Health Administration (VHA) within the U.S. Department of Veterans Affairs has established the value of telehealth-based disease intervention programs [4]. Nevertheless, a few challenges to telehealth implementations remain, in addition to the requirement for the investment in an IT and network infrastructure to decentralize care. The first of these challenges is related to care coordinators, who are the pillars of success of telehealth programs. Care coordinators have a finite amount of time for patient care, which places constraints on the number of patients that they can manage (care-coordinator-to-patient ratio). The telehealth systems that are available today facilitate successful triage of patients based on the vital signs or health risk assessment data that is collected remotely. Unfortunately this still requires a significant amount of time and attention from the care coordinators in order to achieve the best health management outcomes for the patient population. Therefore, to bring in more chronically ill patients into the purview of telehealth regimens, it is important to recruit a large number of care coordinators or nursing staff. Unfortunately, the U.S. is currently experiencing a shortage of nurses, a situation that will be exacerbated by the aging baby boomers. In September 2010, the American Association of College of Nursing reported that nursing colleges and universities across the U.S. are struggling to expand enrollment levels to meet the new demand for nurses [5]. Under the current circumstances, technology can be a savior if organizations can significantly increase the number of patients managed by each care coordinator or health care professional by using **preventive** interventions that are driven by **predictive** analytics, that can be automatically **personalized** for patients, and which empower patients to **participate** as a

partner in the care delivery process. This is what Dr. Elias Zerhouni, 15th Director of the National Institute of Health (NIH), once described as his vision of the future healthcare [6].

Another challenge confronting health care providers who are willing to embrace telehealth as a care-delivery modality is the changes in patient demographics and their personal preferences in terms of the technology used [7]. The following are two phenomena which are occurring at the same time: 1) a significant number of younger patients have entered the chronically ill population with chronic disease conditions such as diabetes, obesity, and mental health disorders [8] and 2) a rapid proliferation of advanced consumer electronics and personal communication tools, even among elderly patients, has caused patients to ask for newer and more modern care delivery channels. Furthermore, younger patients are more mobile and they are more used to technology than their elderly counterparts. As baby boomers enter the chronically ill patient population, with their exposure to smart phones and the tablet PC and internet world, traditional hub-based devices are no longer the preferred choice for telehealth. As a result, a new "multi-modal" telehealth delivery is slowly but surely becoming a requirement for keeping patients emotionally engaged and compliant, two key critical success factors for a telehealth program. A "multi-modal" telehealth system can include various channels of patient-to-system communication: via a traditional telehealth hub device, web (PC or tablet), mobile phone, interactive TV, or interactive voice response system (IVR). Each "modality" has its own usability paradigm that needs to be understood and carefully modeled within the content of the communication in order to deliver the best value. At the same time, this "multi-modal" patient-system interaction needs to be transparent to a care coordinator; otherwise, a "multi-modal" telehealth system cannot be implemented at scale. In addition, despite the availability of multiple patient 'modalities', the care coordinator should have a single interface for managing data and assessments that flow from multiple channels of patient interaction.

III. INITIAL RESULTS AND ROLL-OUT

In the U.S., a successful large-scale telehealth program was pioneered by the Veterans Health Administration (VHA) utilizing primarily a novel system called the Health Buddy System, designed and developed by Health Hero Network, now Robert Bosch Healthcare. The Health Buddy System was one of the first telehealth platforms evaluated by the VHA in the initial trials of the Care Coordination and Home Telehealth (CCHT) program beginning in 2001. The CCHT program was based on the VHA's recognition that the high-risk, high-cost veterans, who represented 4 percent of the Veterans Integrated Service Network's (VISN) population, were driving 40 percent of its costs. Table I shows a comparison of the initial results of the year-long evaluation of telehealth-based care coordination for 791 Florida veterans with complex chronic diseases, including chronic obstructive pulmonary disease

(COPD), congestive heart failure (CHF), diabetes mellitus (DM) and hypertension, and the previous year's data [9].

TABLE I.

Measure	Results	
	Intervention Group	Control Group
Clinic Visits	14% increase	40% increase
ER visits	40% decrease	11% decrease
Hospitalizations	63% decrease	8% decrease
Hospital BDOC	60% decrease	8% decrease
Nursing Home Admissions	64% decrease	106% increase
Nursing Home BDOC	88% decrease	20% decrease

The program was designed to move the care setting for these patients from the acute and post-acute facilities to VHA clinics and ultimately to the veterans' homes. The intervention group received a dial-up-based Health Buddy device with health risk assessment surveys and measurement of blood sugar, weight, blood pressure, and chest pain. Additionally, diabetic patients received a camera for photographing their wounds. Along with the impressive results, as seen in Table 1, all Performance Improvement outcomes reached or exceeded the target goals set by the VHA. In 2003, based on these initial results, the VHA created a strategic plan for the national deployment of the CCHT program with an initial focus on 100,000 veterans with complex chronic conditions. This deployment began in earnest in 2005 and was expanded to include a variety of conditions. Approximately 47,000 veterans are currently enrolled in the CCHT program, of which approximately 24,000 of these veterans are using the Health Buddy System. In addition, a further 6,000 veterans are using the VitelCare System, which was also acquired by Bosch and will be incorporated into the newly developed Telehealth Plus system.

In 2008, VHA reported on the results of the CCHT program from 2005 to 2007 using a pre-post analysis. The paper concluded that a program of care coordination with telehealth:

- "reduces hospital bed days by 25 percent,
- reduces hospital admissions by 19 percent,
- leads to patient satisfaction scores on average of 86 percent,
- costs substantially less than other noninstituitional care (NIC) programs and nursing home care, and
- is cost-effective in both in urban and rural settings."

The per patient per annum cost in the telehealth program was $1,600 as compared to $13,121 per annum for home-based primary care services and $77,746 per annum for nursing home care [4].

IV. A NEW TELEMEDICAL PLATFORM (TMP)

A "multi-modal" system with a single clinician interface is only possible when a robust channel-agnostic platform is available. In a truly "multi-modal" system a patient will be able to use one or more interfaces, depending on his or her preferences or location. A patient can use a device dedicated for telehealth, such as the Health Buddy, at home while using an Interactive Voice Response (IVR) system via cell phone while at work or while traveling, without sacrificing the quality of care he receives. However, content delivered by those two interfaces will have to be modeled on two very different user interaction patterns. Such a "multi modal" system ensures that the patient remains compliant with the prescribed regimen regardless of where she is or which interface she has chosen to use. This is an extension of Dr. Adam Darkins' description of care coordination home telehealth (CCHT) as "the right care in the right place at the right time." [4] Bosch has developed a new Telemedical platform with such a future in mind.

The new platform is based on a services-oriented architecture that aims to modularize system components in a way that supports the alignment of the platform with key abstracted business processes of the care providers – just like organization services or its employees. Simply put, "subscribable" services can be orchestrated to facilitate complex business processes while re-using components and keeping the IT organization flexible. This software platform is part of the Bosch Telehealth Plus system that has been deployed commercially in England by NHS Barnsley (Fig 1). In the first phase of this project, 150 chronically ill patients living with congestive heart failure (CHF) will be enrolled in the telehealth program. In the second phase, a further few hundred patients with long term conditions, such as chronic obstructive pulmonary disease (COPD) and diabetes, will be chosen to take part in the program with the aim of enrolling thousands of patients in the third phase. More than 60,000 people, over 25 percent of the population in the Barnsley region, live with chronic illness. A key objective of NHS Barnsley is, therefore, to provide better care and quality of life for patients in their homes and thereby reduce unnecessary costs [10].

In the U.S., the Centers for Medicare and Medicare Services (CMS) is drafting requirements for the Accountable Care Organization (ACO) which are expected to decentralize healthcare and eventually share cost-saving rewards by delivering high-performance care delivery. When that happens on a large scale, healthcare IT requirements will become increasingly more complex to meet the demand of care coordination among multiple entities. A platform that can support multiple patient-to-system communication modalities (Figure 2, Figure 3) will have to successfully integrate into the complex IT organization of the care provider. The platform, therefore, needs to have a high degree of flexibility for integration. The Bosch-developed Telemedical platform recognizes this challenge and expects to deliver value to care provider organizations rapidly.
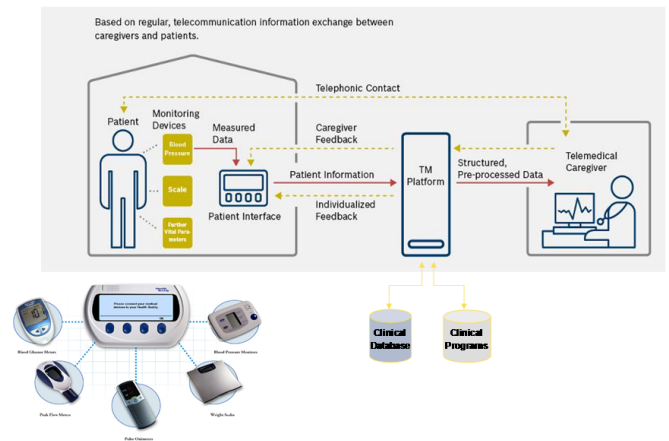

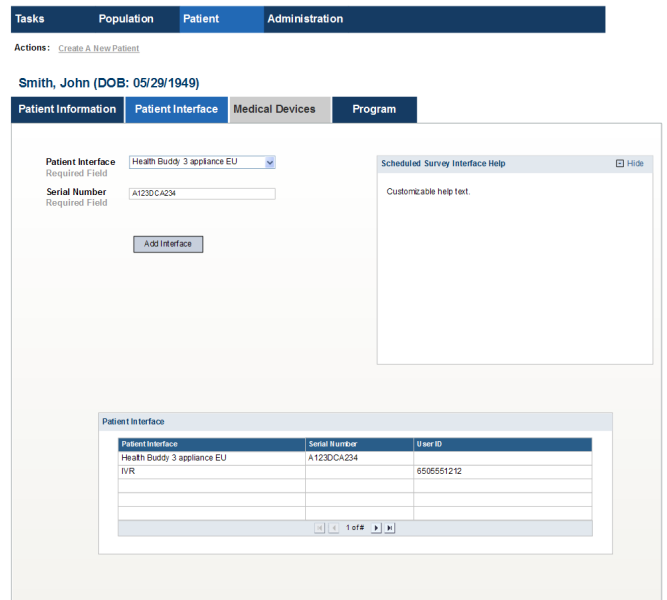**Figure 1**: A schematic view of the Telehealth Plus system

Figure 2: A sample user interface to assign a hardware telehealth hub device to a patient.

Figure 3: A sample user interface to assign multiple types of interfaces to a patient.

The future challenges of telehealth are not, however, limited to issues related to "multi-modality" or multiple kinds of IT system interfaces. As previously mentioned, future telehealth systems need to predict outcomes based on past data; recommend the appropriate interventions necessary based on the existing evidence base; route action items to appropriate entities without having to wait for human paper-pushers; and, last, but not least, dynamically tailor feedback and education to patients based on the patient's progress through the disease continuum.

Finally, in order for a telehealth program to be effective and successful it needs to be better targeted. As with any other drug or medical procedure, telehealth is also not for every patient. It is important to identify which patients will benefit most from such a care-delivery model based on a variety of information about the patients collected by care providers over time including, but not limited to, the insurance claims information, disease/condition, and patients' ability to use technology. Patient selection plays an important role in determining the success of a telehealth program. VHA used formal assessment of patients and upon enrollment they used a technology algorithm [11] to determine what kind of technology would be suitable for an enrolled patient. This, however, can be automated in a telehealth system which

would be able to digest these data and identify a certain population of patients within the large pool of patients for whom telehealth makes sense. Clearly for large scale deployment this needs to happen automatically utilizing built-in intelligence.

V. CONCLUSION

VHA's implementation of a large scale telehealth program demonstrated a practical and cost-effective way of providing care to chronically ill patients in rural and urban settings while promoting patient self-management. Telehealth is not, however, a panacea for addressing the chronic care burden of different countries, although it does provide a means of enhancing organizations' ability to provide quality care in patients' homes and delay the need for expensive hospital admissions or traditional nursing home care. Bosch Telehealth Plus system, which includes an intelligent and scalable Telemedical Platform, offers a solution to address the key challenges facing large-scale telehealth program deployments.

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