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Anytime, anywhere access to secure, privacy-aware healthcare services: Issues, approaches and challenges



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Abstract

A new paradigm, which is at the early stage of inception, is reshaping global healthcare services with emphasis shifting from sporadic acute health care to continuous and integrated health care—an approach being further perfected as anywhere, anytime healthcare services. Recent advances in e-health informatics, digital transformation and remote data exchange, mobile communication, and medical technologies are the enablers of this new paradigm. Monitoring and on-time intervention, integrated care, self-care, and social support are four value-added features of anywhere, anytime health care. The already precarious security and privacy conditions of healthcare domain are expected to aggravate in this new paradigm due to lot more monitoring, collection, storage, sharing, and retrieval of patient information as well as collaboration among many different caregivers, institutions and systems. This paper aims to systematically rationalize and explore security-privacy related issues in providing anywhere, anytime healthcare services. We survey the existing approaches and discuss health IT infrastructural governance, institutional and cross-national policy challenges to address the relevant security and privacy issues. We categorize these issues in relation to the users, applications, communications, and devices. A consolidated effort from technological, human factor, and social research communities can lead to an adequate response to key privacy and security issues in this nascent anytime, anywhere healthcare paradigm.

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Introduction

In recent years, a new paradigm is sweeping across healthcare services at a global proportion with emphasis shifting from sporadic acute health care to continuous and more integrated health care. This shift in approach, characterizing

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today's healthcare services, may be effectively perfected through implementing and practicing anywhere, anytime healthcare services. The benefits of the integrated healthcare (IH) paradigm include more informed treatment, reduced healthcare cost and higher patient satisfaction.

The IH approach features four key value-added dimensions: *continuous monitoring and intervention*, *integrated care*, *self-care*, and *ongoing social and community support*. With e-health informatics advances and the miniaturization of mobile sensors and devices, rapid development and deployment of wireless communication, social computing, and smartphone technology, today's health care is equipped with technology to provide holistic health care.

A first step to preventing acute health condition and mortality is health status monitoring. In 2011, a UK Department of Health reports that remote monitoring cuts patient death by 45% [1]. Indeed, automated monitoring such as blood pressure or high blood sugar can assist patients in managing chronic disease or health conditions. Today, monitoring of basic activities of daily living (ADLs) such as bathing, dressing, toileting, and the like (commonly known as Katz ADL [2]) for the elderly patients has become an essential part of geriatric care, particularly for the aging baby-boomers. Apparently, such monitoring can provide good indicators of the patient cognitive and physical capabilities. Owing to the inability to independently seek health care and their proneness to emergency care, many elderly patients will benefit significantly from active health status monitoring. Oftentimes, when real-time intervention is necessary to maintain good health and wellbeing, lifestyle and activity monitoring can become part of the treatment for the patient.

From an integrated healthcare delivery perspective, the current health services system is largely fragmented. Fragmentation can adversely impact health services quality, cost, and outcomes [3]. Multiple providers are often engaged to offer different services through the different systems. Coordination among systems, services, and providers is therefore key to secured and high quality patient care. While receiving treatment, the movement of patients among multi-provider systems is characteristically not seamless as is desired in an integrated care model. Additionally, while traveling or temporarily residing abroad, a patient's frequent mobility, adds new challenges to well-coordinated patient care.

Self-awareness is precursor to self-management. Currently, the ability of the patients to self-manage their own health is the most desired route towards achieving better health and wellbeing. Living in a global village, we are so well connected with one another and frequently move (travel) from one location to another. As a result, we are exposed to different diseases and are likely to source a variety of services across a series of changing environmental and climatic conditions. In fact, the declining health and wellbeing among today's generation may be attributed broadly to our lifestyle changes with increased exposure to "arm-chair" technologies, for instance, the frequent use of, and engagement with, television programs and computer gaming resulting in a sedentary lifestyle for many people, leaving them little to no motivation for physical exercise or outdoor recreation activities, thereby leading to increased obesity.

As well, social and community support can impact one's health and wellbeing. A health-conscious friend, for example, can exert positive peer pressure on individuals towards

inculcating a healthy lifestyle (and habits). Friends, relatives, and social circles also play significant roles in the wellbeing of one's mental health. Indeed, the value-added emotional or informational support or companionship will often help reduce unnecessary psychological distress. Patients with chronic or terminal illness have found engaging with appropriate social media through the sharing of each other's experience to be beneficial [64].

While automated monitoring, integrated care, self-care, and social support can effectively support IH services, as epitomized by anywhere, anytime healthcare services, the main challenge for practicing this approach lies today in the security-privacy aspects of such services. Without ensuring the security and privacy of such services, they will fall apart eventually due to non-acceptance by end-users and/or failure to comply with security-privacy legislations. Moreover, abuses and misuses of such services can systematically cause harm of many forms, from minor inconvenience to financial loss to major injury, even towards death. Similarly, breaches of patient health information security and privacy in routine (and/or non-routine) data exchanges or transmission can dangerously victimize a patient (i.e., becoming a victim of embarrassment, prejudice, discrimination, and more).

Notably, IH services sustainability will depend chiefly on the assurance of service compliance with privacy and security mandates as legislated by the different countries where such practices are to be performed, as well as guiding such practices based on commonly established principles dictating the protection of personal data privacy and security, particular the cross-border flow of sensitive health data. Hence, our contribution here will be three-fold: First, we present a holistic approach to information and communication technology (ICT)-based anywhere, anytime healthcare paradigm; second, we explore security and privacy issues and review their considerations within the new IH paradigm; finally, we discuss existing approaches and report on health ICT infrastructural governance, institutional and cross-national policy challenges to address the key security-privacy issues.

The general layout of the paper is as follows. [Section 2](#) characterizes a scenario of anywhere, anytime healthcare services. [Section 3](#) presents security-privacy issues related to realizing IH paradigm. [Section 4](#) surveys potential approaches to address security-privacy related issues and inherent challenges faced by anywhere, anytime healthcare services to be practiced within and, when needed or where possible, across the boundaries of different countries. [Section 5](#) presents concluding remarks.

Anywhere, anytime healthcare services

More recently, the ease and convenience of receiving health care from anywhere and at anytime has become possible with advances in e-health informatics, sensor technology, and mobile devices (e.g., smartphones). Central to this approach is the consideration of health and wellbeing throughout a person's lifetime. As aforementioned, four added-value features of this approach include *monitoring and on-time intervention*, *integrated care*, *self-care*, and *social support*, each of which brings unique challenges and issues regarding the delivery of safe, secure, and privacy-aware healthcare services.

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