Chapter 28
Cloud-Based Monitoring for Patients with Dementia

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ABSTRACT

Demographic changes are resulting in a rapidly growing elderly population with healthcare implications which importantly include dementia, which is a condition that requires long-term support and care to manage the negative behavioural symptoms. In order to optimise the management of healthcare professionals and provide an enhanced quality of life for patients and carers alike, Remote Electronic Health Monitoring forms a crucial role. This requires myriad functions and components to achieve patient monitoring while accommodating the technological, medical, legal, regulatory, ethical, and privacy considerations. The chapter considers the relevant components and functions of the current state-of-the-art to the provision of effective Remote Electronic Health Monitoring. The authors present the background and related research, and then they focus on the technological aspects of Remote Electronic Health Monitoring to which Cloud-Based Systems and the closely related Cloud Service Modules are central. A number of scenarios to illustrate the concepts are discussed in the chapter.

INTRODUCTION

There is a demographic challenge, which has potentially serious social geopolitical and financial consequences for individuals, families, and the wider society globally driven by the growing elderly population. A significant aspect of this issue is the prevalence of Alzheimer Type Disease (ATD) (a leading cause of dementia) (Rosenblatt, 2005). Effective management of dementia demands both medical treatment and patient management; both approaches include long term care to manage the negative behavioural symptoms which are primarily exhibited in terms of agitation and aggression.

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Caring for patients with Alzheimer's disease and related disorders (ADRD) is conservatively estimated to cost 80 to 100 billion dollars annually (Rosenblatt, 2005). The scale of the challenge for all stakeholders is clear.

In considering the prevalence of dementia, there is a direct correlation between the demographic changes alluded to and the incidence of dementia (Finkel *al.,* 1996). The results of the *Behavioral Symptoms of Dememtia* (BPSD) are manifested in suffering, premature institutionalisation, increased costs of care, and significant loss of quality-of-life for the patient and family and carers (Finkel *al.,* 1996). This chapter identifies the scale of the problem and the issues around *Alzheimer's Disease and Related Disorders* (ADRD) and dementia and demonstrates the correlation between an ageing population and dementia. To address the issues and challenges identified and provide for an increase in the Quality of Life (QoL) for patients and carers, while mitigating the burgeoning costs in managing patients with dementia and ADRD related conditions.

Dating from the early 1990's pervasive computing and its corollary, the use of context to enable Personalised Service Provision (PSP) (Moore *al.,* 2010) to individuals and entities (Dey & Abowd, 1999) has been the subject of a large body of research and application development. In recent years Cloud-Based Systems (CBS) (Moore & Sharma, 2013) have moved from the domain of computer research to the mainstream and have gained significant traction; the interest in and uptake of CBS applies to individuals, industry, commerce, academia, and importantly the healthcare sector to enable Electronic Patient Records (EPR) and Electronic Staff Records (ESR). In practice the use of EPR has been extensively discussed in the literature however ESR is a topic that received far less discussion and analysis.

The interest in CBS is motivated by many factors including the need to effectively utilise computing resources in an era when there is a general requirement to provide scalable data storage and processing to accommodate the exponential growth in the volume of data. Context and context-awareness have been the subject of much research in a computing laboratory environment however as with Translational Research (Ashford al., 2010) in the medical field there is a need to provide an effective approach to enable non-technical [from a computational perspective] users [who have domain knowledge and expertise] to build context-aware systems in a diverse range of domains and systems. To this end we propose a new CBS service model: Context-as-a-Service (CaaS) which is conceived as a framework designed to provide the components required to build context-aware systems (Moore *al.,* 2014).

This Chapter considers the issues and challenges with the technological developments, which may provide a solution to (or at least mitigate) the challenges faced in the healthcare sector. Patient monitoring with electronic health records is introduced and the relative merits and de-merits of patient monitoring for patients with dementia are discussed. As we have alluded to the use of Internet including the Internet-of-Things (IoT) in CBS. It is postulated that technology enhanced patient management based on situational awareness in intelligent context-aware systems has the capability to improve the patient experience and improve the QoL for both patients with dementia and carers along with improvements in resource utilization.

The chapter is structured as follows: dementia related research is discussed followed by consideration of Remote Electronic Health Monitoring (REHM). Data processing and temporal considerations are discussed with issues and challenges related to patient data monitoring. Internet technologies and health monitoring with the IoT and the Cloud-of-Things (CoT) are introduced along with consideration of CBS and the closely related Cloud Service Models (CSM) including the novel CaaS. Developments in sensor technologies are introduced with IoT based patient monitoring and patient monitoring using IoT and Cloud Based