eHealth-as-a-Service (eHaaS): A data-driven decision making approach in Australian context

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Abstract. A commitment in 2010 by the Australian Federal Government to spend $466.7 million dollars on the implementation of personally controlled electronic health records (PCEHR) heralded a shift to a more effective and safer patient centric eHealth system. However, deployment of the PCEHR has met with much criticism, emphasised by poor adoption rates over the first 12 months of operation. An indifferent response by the public and healthcare providers largely sceptical of its utility and safety speaks to the complex sociotechnical drivers and obstacles inherent in the embedding of large (national) scale eHealth projects. With government efforts to inflate consumer and practitioner engagement numbers giving rise to further consumer disillusionment, broader utilitarian opportunities available with the PCEHR are at risk. This paper discusses the implications of establishing the PCEHR as the cornerstone of a holistic eHealth strategy for the aggregation of longitudinal patient information. A viewpoint is offered that the real value in patient data lies not just in the collection of data but in the integration of this information into clinical processes within the framework of a commoditised data-driven approach. Consideration is given to the eHealth-as-a-Service (eHaaS) construct as a disruptive next step for co-ordinated individualised healthcare in the Australian context.

Keywords. PCEHR, eHealth, data-driven, cloud computing, SOA, eHaaS

Introduction

The Australian national e-health strategy paints the Australian healthcare landscape as a complex network of public and private sector healthcare providers with multi-government funding and oversight [12]. Thus it is perceived by policy makers that the introduction of a national eHealth infrastructure and the personally controlled electronic health record (PCEHR) will deliver a nationally consistent approach for the implementation of interoperable information systems. However, the PCEHR has received criticism from consumers and practitioners regarding the lack of inclusive stakeholder governance and useful health information content. Moreover, resistance by practitioners and unrealised consumer expectations bring into question the functionality of the current model.

The roadmap presented by the National E-Health Transition Authority (NEHTA) clearly articulates project milestones and objectives successfully achieved over the life of the project nevertheless, sociotechnical factors inherent in projects of this scale appear to have been underestimated. As a catalyst for healthcare reform, it is suggested

that the PCEHR program be expanded as part of a larger data-driven framework. Individualised patient care is achievable with the PCEHR by facilitating large scale data scalability, analytics and visualization to augment clinical decision making. Technology trends point to emerging data capture, management and dissemination technologies driving the democratisation of data resulting in an increasingly sophisticated digital healthcare consumer. The expectation of a new generation will be to access records containing longitudinal health information online aggregating information from all data sources [5].

Establishing the PCEHR as the keystone of a holistic eHealth 'as a service' strategy unifying longitudinal patient information must take priority on the healthcare reform agenda. Moreover, the real value in patient data lies not just in the collection of data but in the integration of human-centred information into clinical processes within the framework of a commoditised data-driven approach to the delivery of care. As a preliminary work, this paper explores the proposition of developing eHealth-as-a-Service (eHaaS) as a data-driven extension to an integrated health record bank construct. The aim is to establish contextually relevant decision support modalities that will encourage universal stakeholder engagement. This will be achievable through the delivery of actionable insight extracted from vast data clouds defining the quantified digital consumer of the 21st century. Thus, the focus of this paper is an examination of where research may contribute to the development of a data-driven approach for clinical decision support and co-ordinated care management.

1. Method

The proposition encourages a top-down approach for the synthesis of current theory to establish an understanding of a multi-disciplinary coherence between technology, environment and healthcare stakeholders. As a means to develop and contextualise a theoretical framework underpinning the adoption of the eHaaS construct it is useful to conduct a preliminary literature review. The intent is to distil key concepts and identify common themes in order to consolidate an understanding of the socio-technical aspects of knowledge sharing, data unification and value creation in a complex ecosystem. Developing an informed perspective of how the eHaaS construct might be established as an appropriate data-driven platform was underpinned by searches of Web of Science, PubMed, SpringerLink, ProQuest, JAMA, IEEE Xplore, Google Scholar. Search terms relating to 'health record', 'health record bank', 'personal health record', 'PHR', 'EHR', 'PCEHR', 'health information bank', 'health information exchange', 'HIE', 'ehealth', 'health IT', 'health information technology', 'HIT', data-driven', 'decision support', 'DSS', 'CDS' 'cloud', 'big data', 'SOA' were used. This review draws on the literature published in the period between 1995 and 2013.

2. Results and Discussion

With over 150 articles accessed the review does not offer an exhaustive overview of all references due to limited time and limited space to detail. However, it does provide conceptual perspectives on future directions for sharing and adding value to health information and establishes potential research streams within the complex technology and social frameworks inherent in healthcare. Moreover, it highlights that a new

generation of consumer increasingly immersed in a personalised online ecosystem is disseminating vast amounts of data both human and machine generated. With the emergence of Big Data technologies these disparate data sets are being mined to build detailed profiles of the quantified digital consumer for actionable insights by business, government and increasingly by the life sciences. In all areas, the life sciences have evolved in the digital age into a data-enabled science [8]. Using terms like big data, data-intensive or data-driven, this type of approach to healthcare is characterised by those technologies located in the domain of data analytics, data mining, business intelligence and decision support [9].

The challenge faced by practitioners using contemporary care models is the reliance on population based statistical averages, fragmented health records, selective laboratory testing and diagnosis based on the skill and tacit knowledge of individual practitioners [3]. A data-driven approach will facilitate the analysis of large volumes of time-series data useful for pattern discovery and predictive modelling [2]. However, emphasis must be placed on reliable data and the aggregation of data from large and diverse populations to produce reliable and replicable findings [1]. The Institute of Medicine (IOM) envision future clinical decision making that leverage "personal health knowledge bases" to support practitioners in the aggregation, integration and transformation of information into actionable decisions [14]. Therefore it is suggested that the new wave in clinical decision support systems adopt a data-driven approach drawing on a multitude of relevant data repositories and sources to create "personal health knowledge bases". In conjunction with the PCEHR these systems will intelligently integrate personal information with an individualised form of evidence for collaborative decision making by the practitioner and patient [14]. To achieve this potential however requires a platform that will facilitate efficient and trusted unification of all health information available in real-time across the continuum of care. As the building blocks of an eHealth system, personal health records (PHR), electronic medical records (EMR) and Electronic Health Records (EHR) are encapsulated in the eHaaS framework with the interconnections comprising human behaviour and information flow a key design consideration [16].

2.1. Value of healthcare information

An effective interoperable health information community must establish strong partnerships between all stakeholders in a complex interdisciplinary ecosystem. Providing the "glue" for this partnership is the patient controlled integrated personal health record containing complete longitudinal patient information. While the theoretical benefits of patient controlled health records point to a reduction in costs and medical errors, improved coordination, quality of care and better stakeholder communications, the practical benefits have not yet emerged [17]. The PHR model like many emerging Internet-based health-related services, tend to exhibit limited functionality, and lack permanence [6]. Intrinsically, a unified functioning system for the exchange of comprehensive health information does not exist [5] and this can also be said for the Australian context.

While a connection to national and international health policy is drawn through the recognition that consumer engagement is critical to quality improvement and cost containment, a study based on interviews with healthcare professionals in the U.S. provide valuable insight into the importance of practitioner engagement and endorsement for successful stakeholder adoption of PHR systems [13]. When coupled

with privacy and security concerns, patient confidence and trust, practitioner liability and risk concerns, the digital divide, information ownership, transparency and policy implications, financial sustainability and information quality [18] it becomes clear that the development of an appropriate data-driven model meeting the expectations of all stakeholders is a complex undertaking.

2.2. Defining eHealth-as-a-Service

The rise of the internet as an enabling technology has resulted in the emergence of cloud computing. Best characterised by its just in time, scalable and elastic nature utilising internet technologies for the provision of IT capabilities 'as a service' [4] cloud technologies are maturing. The traditional economic drivers for its adoption is giving way to a more user and solution driven focus on innovation. According to IDC, the growing interdependence on 3rd Platform technologies - mobile, social and Big Data, signals a new phase of growth for cloud computing [7]. With forecast growth of 25.3% between 2013 and 2017, cloud services are a key enabler for organisations in the way they consume information technology [7].

Drawing a connection to the varied definitions of eHealth that encompass a broad range of medical informatics applications there is a common theme that emphasize the communicative functions of eHealth utilising the internet [15]. When surveying the literature there is an abundance of novel enabling technologies and research studies delivering improvements in the quality, safety and efficiency of healthcare. However, there remains a significant disconnect between the promise and reality in the delivery of eHealth [11]. As the architectural core for eHaaS cloud computing, application programming interfaces (API) and a service oriented architecture (SOA) based platform will deliver the rich functionality required to support complex multidisciplinary workflows. Similarly, the growing commoditisation of data requires a consolidation of cloud services that provide seamless and efficient access to health information from multiple platforms at any time from any location. However, services must be aligned to operational requirements in order to create value specific to the individual needs of the stakeholders. Thus, at the operational level, eHaaS offers a framework for identifying service models that will facilitate value creation, collaboration and knowledge sharing across the continuum of care. In this context the opportunity to address diverse perspectives inherent in eHealth programs illustrate the potential for collaboration and co-creation leveraging eHaaS (Refer Figure 1).
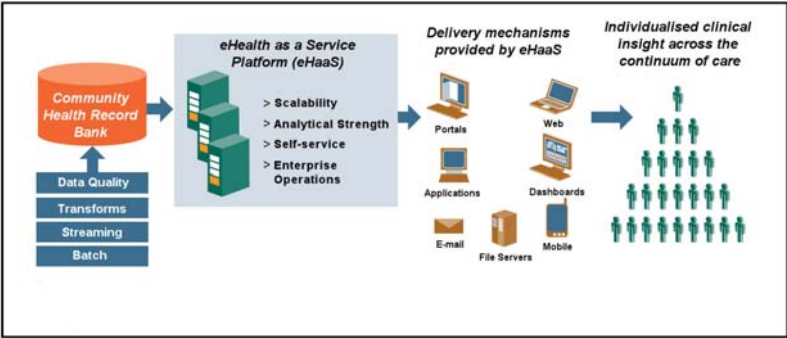

Figure 1. eHaaS conceptual model, adapted from [10]

3. Conclusion

The PCEHR represents a nascent step towards a broader more individualized approach to the delivery of care and as such requires continued support from policy makers, healthcare leaders and providers in its adoption. At the heart of a larger eHaaS initiative, an integrated PCEHR and the national eHealth infrastructure present a unique opportunity for Australian healthcare practitioners to leverage eHealth in innovative ways to improve healthcare. What is more, an eHaaS construct advances the future state perspective that truly open global healthcare systems will address the inequities in health care access and thus improve patient safety through universal stakeholder engagement.

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