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Leveraging Cloud Computing for Systematic Performance Management of Quality of Care

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Abstract

Governments and healthcare providers are under increasing pressure to streamline their processes for efficiency, to reduce operational costs while improving service delivery and quality of care. Systematic performance management of healthcare processes is important in determining if quality of care goals are being met at all levels of the healthcare ecosystem. The challenge is that reaching these goals requires the aggregation and analysis of large amounts of data from various stakeholders in the healthcare industry. With the lack of interoperability between stakeholders in current healthcare compute and storage infrastructure as well as the volume of data involved, our ability to measure quality of care across the healthcare system is either limited or non-existent. Cloud computing is an emerging technology that can provide the needed interoperability and management of large volumes of data across the entire healthcare system. In this paper, we review various cloud computing applications for surveillance and performance management of quality of care in healthcare. We also introduce a framework for achieving systematic surveillance and performance management across the entire healthcare system.

1. Introduction

Quality healthcare delivery requires coordination of numerous entities within and outside the circle of care. In the inner circle of care are hospitals, physicians, diagnostic imaging centers, laboratories and pharmacies. In addition,

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there are specialist clinics, public health clinics, ambulatory centers, long-term care homes, insurance companies, technology vendors, employers, and medical device manufacturers. Outside the circle of care are national and regional governments that devise and enforce regulations to ensure quality of care the promotion of public health. The overall goal of the healthcare system is to provide a cost-effective and high-quality integrated environment for efficient healthcare service delivery[1]. Other important objectives are to enable safe care delivery, streamline clinical and administrative tasks, and to safeguard patient data.

Continuous, aggregation and analysis of healthcare data is needed for performance management across the healthcare system to ensure quality of care. Most surveillance processes today are either manual or semi-automated and take excessive time for decision makers to receive the necessary data for critical decision-making across the various levels of care delivery. According to Sun and Reddy[2], worldwide digital healthcare data is expected to reach 25,000 petabytes in 2020 while an average hospital would be required to manage up to 665 terabytes of patient data, 80% of which would be unstructured medical imaging data.

Internal infrastructure within most healthcare organizations cannot sustain this massive, and exponential growth of health data. Moreover, a complete analysis of quality of care requires integration of data across many different organizations (family doctors, specialists, hospitals, clinics, etc.). Timely analysis of this health data is impossible using traditional data analytics methods. Cloud computing could provide the infrastructure for big data analytics, helping reduce the cost of care delivery, streamline health care processes, and analyze health data to detect disease outbreaks. It would also pave the way for incorporating the growing number of Internet Connected Devices (ICD) and Internet of Things (IoT) in healthcare[3,4].

In this paper, we survey applications of cloud computing and describe why it is an effective tool for surveillance and performance management of quality of care. We also introduce an architectural framework for applying this technology in a systematic manner across the healthcare system.

2. Cloud Computing and Healthcare Data

Systematic performance management of quality of care requires a scalable, highly available data aggregation infrastructure. With the rapid explosion of healthcare data[2], many organizations are slowly hitting various thresholds in the amount of data they can handle using their internal IT infrastructure. The need for the right infrastructure with the capacity to aggregate and analyze such large volumes of data in real-time is essential to providing needed operational and governance related statistics as well as key performance indicators for healthcare performance management.

Cloud computing fills this need since it offers unlimited scalability of computing resources and capacity. Ochian et al.[5] describe cloud computing as a mechanism for generating ubiquitous access to a pool of convenient, on-demand computing resources (compute, storage, platform, application and services) through a web interface with low administration overhead and the least intervention from a cloud service provider. Cloud-based infrastructure and applications offer a consolidated view of patient-relevant data to healthcare providers[6] while providing better and more effective quality of care and facilitating their ability to share information, improve collaboration and reduce expenditure on infrastructure[3].

Popular cloud providers like Amazon, Google, and Microsoft offer Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) cloud packages to end users[7,8]. Some of the significant benefits[9] of cloud computing include device and location independence, 24x7 support, lower total cost of ownership (TCO), reliability, scalability, sustainability, agile deployment, lower capital expenditure and a single infrastructure to fulfill all computing, networking and storage needs for various applications.

Cloud computing is a potential platform for national and regional healthcare systems interoperability. Torre-Diez et al.[9] explored interoperability options for the Spanish Public Health National System and came to the conclusion that cloud infrastructure should be used for data sharing and service orchestration. Similarly, Biswas et al.[10] propose an "eHealth Cloud" platform for the government of Bangladesh. The eHealth platform would connect physicians, patients, hospitals, government departments, insurance companies, and pharmaceutical companies to the same