Chapter 53
NoSQL Technologies for Real Time (Patient) Monitoring

Ciprian Dobre
University Politehnica of Bucharest, Romania

Fatos Xhafa
Universitat Politécnica de Catalunya, Spain

ABSTRACT

Today we witness a growing change in how public health administration thinks about medical data. We have slowly moved from paper-based patient records to digitally storing medical data, in support for advanced evidence-based mining and decision support processes. With this change comes great responsibility, among which efficient storing and accessing the health status of the patient is particularly important. In this chapter, the authors analyze current storage technologies for storing medical data. We are witnessing a shift from traditional relational database support to NoSQL technologies capable of offering great availability and scalability options, and back to the mixture between the SQL and NoSQL worlds, and scalable SQL databases. All these alternatives come with their own pros and cons, which the authors carefully analyze. They believe that their survey will help medical practitioners and developers of health applications make a more informed decision when designing medical data storage support.

INTRODUCTION

The healthcare industry is generating large amounts of data, because of record keeping, compliance and regulatory requirements, and patient care (Aleksovska-Stojkovska & Loskovska, 2013). In the past, much of this data was stored on hard copy form, but today we witness a trend towards medical-related data digitalization. In 2005, only about 30 percent of office-based physicians and hospitals used even basic electronic medical records (EMRs). By 2012, the figures increased to more than 50 percent for physicians and nearly 75 percent for hospitals (Aleksovska-Stojkovska & Loskovska, 2013). More than 45 percent of US hospitals today either participate in local/regional health-information exchanges (HIEs), or are

planning to do so in the near future. In US, medical data records that include information for millions of patients are today already being transferred between 80 hospitals, such that over 18,000 physicians take advantage of it (McKinsey, 2013).

Slowly, the huge pile of patient folders in the physician's cabinet is being replaced by the bits and digits stored on hard drives. Behind this move are several advantages: the potential to improve the quality of healthcare by mining records and deriving timely medical conditions, and the need to reduce costs associated with medical practice and care-giving services are among them. The digital form of medical data longly hold the promise of supporting a wide range of medical and healthcare functions, including clinical decision support, disease surveillance and population health management (Dembosky, 2012; Feldman et al, 2012). There is no surprise that, driven by the industry and health practitioners alike, a big-data revolution in health care is well underway, partly because of vastly increased supply of health information available. Over the last decade, pharmaceutical companies alone have been aggregating years of research and development data into medical databases, while payers and providers have digitalized their patient records. The US federal and EU governments, and various other stakeholders, have been opening their vast stores of health-care knowledge, including data from clinical trials and information on patients covered under public insurance programs. In parallel, recent technological advances have made it easier to collect and analyze information from multiple sources—a major benefit in health care, since data for a single patient may come from various payers, hospitals, laboratories, and physician offices.

The increase in medical data rates being produced led, as expected, to new requirements for the solutions to efficiently and securely store them. The medical data has to be available to stakeholders being potentially in different locations (e.g., the physician might need to access the medical record of the patient, and simultaneous the record could be used in some statistical analysis, run by the hospital administration, regarding the health in a given population; when the patient goes on holiday the physicians there might also need access to his medical records). When availability and scaling are two main requirement pillars for patient data beyond traditional patient EMR records, NoSQL becomes an appealing alternative to storing medical data. For over four decades, data management typically meant relational data processing, and relational database management systems (RDBMSs) became commonplace in all medical data processing environments. But today NoSQL data management systems unleash the full power of cluster environments, and offer simpler key-value data models.

But with all the excitement around the NoSQL hype, today examples of data management implementations based on pure NoSQL databases in healthcare are still missing on large extents. Most NoSQL products analyzed in this chapter are still in beta or research pilots' stages, and largely open source, lacking in support. There are claims that medical apps are inevitably going to be extremely conservative, because people could die if the IT system fouls up (see the famous CAP theorem below). But, still, NoSQL can offer many advantages to the future, which is why we already see today more and more NoSQL Electronic Health Record systems appearing: VistA, CHCS, AHLTA, Epic, Cerner… And, on the horizon, new hybrid mechanisms designed to combine the best of both these two worlds, relational and non-relational, start appearing.

The chapter presents an analysis of current NoSQL (and scalable SQL) technologies, and their applicability to support efficient storing of medical data and patient tracking. We analyze current trends, give insights into the pros and cons of different technological choices, and present the future challenges in need to be addressed. The rest of the chapter is structured as follows. We first present an analysis of the different choices in storage technologies, for both medical data and the particular case of dementia

Related Content

No Entry: Prohibitions and Violations in Organizational Spaces Across the Patient-Staff Interface in Hospital
Livia Bruscaglioni (2017). *Healthcare Ethics and Training: Concepts, Methodologies, Tools, and Applications (pp. 695-715).*
www.irma-international.org/chapter/no-entry/180610

Strategies for Expanding Access and Improving the Quality of Pharmaceutical Services
Marcus Vinícius Dias-Souza (2017). *Healthcare Ethics and Training: Concepts, Methodologies, Tools, and Applications (pp. 35-60).*
www.irma-international.org/chapter/strategies-for-expanding-access-and-improving-the-quality-of-pharmaceutical-services/180578

A Smart Card Based Software System for Surgery Specialties
Nektarios Konstantopoulos, Vasileios Syrimpeis, Vassilis Moulianitis, Ioannis Panaretou, Nikolaos Aspragathosand Elias Panagiotopoulos (2017). *Healthcare Ethics and Training: Concepts, Methodologies, Tools, and Applications (pp. 394-409).*
www.irma-international.org/chapter/a-smart-card-based-software-system-for-surgery-specialties/180593

Transforming Education in Health Care Administration and Opticianry
Warren G. McDonald (2015). *Transformative Curriculum Design in Health Sciences Education (pp. 312-325).*
www.irma-international.org/chapter/transforming-education-in-health-care-administration-and-opticianry/129439

The Patient-Centered Medicine as the Theoretical Framework for Patient Engagement
Borghi Lidia, Galli Federicaand Vegni Elena Anna Maria (2017). *Health Literacy: Breakthroughs in Research and Practice (pp. 415-429).*
www.irma-international.org/chapter/the-patient-centered-medicine-as-the-theoretical-framework-for-patient-engagement/181205