

# The Significance of Data Governance in Healthcare

## *A Case Study in a Tertiary Care Hospital*

Sarah Alofaysan, Bandar Alhaqbani, Rana Alseghayyir and Maryam Omar  
*College of Health Informatics, King Saud Bin AbdulAziz University for Health Sciences, Riyadh, Saudi Arabia*

**Keywords:** Data Governance, Data Warehouse, Healthcare Analytics, Corporate Data Quality, Data Accuracy and Completeness, Data Rules and Policies, Healthcare Data, Key Performance Indicators, Kpis.

**Abstract:** The paper investigates the importance of data governance to healthcare organizations. First, the paper introduces the main pillars of data governance namely, data quality, compliance, and business transformation. The paper then outlines the perceived challenges that may affect the adoption of data governance strategies. The paper then proposes a new framework for data governance within healthcare organizations. More importantly, the paper presents a case study on a leading tertiary care hospital in the Middle East in order to investigate the impact of absence of data governance. 179,450 patients' data records were analysed within three outpatient clinics. Discrepancies in the total numbers of seen patients were discovered between electronic data records and manually collected data. The main sources of the discrepancies were identified within each clinic and were rooted to the violation of hospital policies, the disregard to data related rules and policies and the lack of accountability on the data entered into the electronic systems. Finally, the paper concludes with identifying research directions that requires further investigation in this area.

## 1 INTRODUCTION

The sheer numbers of separated data sources in healthcare organizations are growing in volume each year, which makes the control of vital patients data an unattainable goal. Understanding that data can lead to better healthcare decisions, which ultimately lead to better business, shifts organizations to a new era of consuming patients' data rather than only producing it.

One of the mistakes in healthcare is approaching data as technology assets not as corporate assets, where in fact it must be treated as being as important as corporate financial assets (Fisher, 2009). This leads to many significant data problems such as losing accountability, poor quality, and noncompliance with external regulations. It is also noticeable that healthcare data have fragmented ownership with little authority and non-existent standards, policies, and procedures. Consequently, patients' data could be exposed to exploitation potentially resulting in bad decisions being made, money being wasted, and business opportunities being ignored (Sarsfield, 2009).

Data governance is the remedy for such data problems. Data governance in simple words is the process of controlling patients' data by identifying who is the data governor, what are the data rules, how to enforce these rules, and how to monitor compliance improvement. This control must maintain a balance between dual core objectives of data governance that are 1) limiting access to patients' data to ensure privacy and security, and 2) sharing patients' data between systems for integration and decision-making purposes.

Conceptually, data governance has three main interrelated modules which are administrative, technical, and business module (Orr, 2011). The administrative module represents the formal governors who are responsible for defining the governance scope and policies, resolving issues, and assigning stewardships roles and responsibilities. The business module represents stewardships that are responsible for data standardizations and definitions, and compliance with data policies, business rules and processes. Lastly, the technical module represents IT personnel who are responsible for technical aspects of data governance such as data integration rules and data modelling standards.

Proper collaboration between business and IT is the cornerstone for data governance initiatives in healthcare (Russom, 2008).

It is important to distinguish between data governance and data management. In general, data management is about making decisions and implementing them in the organization while data governance concerns who is authorized to make these decisions and based on which rules and policies. Data governance completes data management but never replace it (The Data Management Association, 2009). Well-established data governance programs can guarantee that other data-driven projects such as data warehousing and business intelligence will produce maximum value to the organization (Kooper et al., 2011).

## 2 DATA GOVERNANCE AND HEALTHCARE ORGANIZATIONS

In the following sections, we discuss the areas that yield massive benefits from data governance program in healthcare environments.

### 2.1 Focus Area 1: Data Quality

Many healthcare organizations are facing data quality challenges due to the complexity of the clinical-systems' data structure, massive growth in clinical data volume and the lack of standardization between the clinical systems in terms of naming and modelling. Undoubtedly, poor data quality has a tremendous impact on the efficiency and effectiveness of the healthcare organizations, at both operational and strategic levels (Brown and Khatri, 2010). As reported by The Data Warehousing Institute (TDWI), problems of data quality cost US businesses more than 600 billion dollars every year (Batini et al., 2010).

All data problems are attributed to the absence of effective governance. The data governance program helps healthcare organizations to pinpoint the root causes of data quality issues and identify the best remedy that tackle all the problem dimensions (Eppler, 2006). In the Electronic Medical Record system (EMR), for example, data could be entered through templates such as dropdown lists or checkboxes. Physicians point out that this method of data capturing does not allow them to describe patients' condition specifically. Rather, it has the potential to negatively impact the accuracy and

completeness of patients' documentation. It is extremely important to determine under which conditions structured data entry is appropriate (AHIMA, 2008).

Similarly, healthcare organizations wrestle with the inconsistency of naming and terms. For example, one department in a hospital refers to "inpatient" while another refers to "hospitalized" are both departments referring to the same activity! One system uses "pain killer" another uses "analgesic". The need for a unified data dictionary is critical for end users of information in order to assure them that the data they rely on for making-decisions is exactly what they expected (Soares, 2010). A study was conducted in a tertiary care hospital that experienced a failure implementation of an enterprise data warehouse showed that the absence of data dictionary compromised the data quality and reliability (Househ et al, 2011). Correspondingly, Fu et al. reviewed seven systems that are widely used in predictive toxicology, with a meticulous focus on their data governance aspect. They found that toxicology data were entered in different formats with no systematic and standard measures for checking data quality. Also, they reported that systems' metadata is crucial for toxicology prediction; however, it was totally absent (Fu et al., 2011). In response to predictive toxicology data quality problems, Palczewska et al. proposed a data governance model that address and mitigate the significant gaps in toxicology data (Palczewska et al., 2013).

### 2.2 Focus Area 2: Privacy, Security and Compliance

Many healthcare organizations establish data governance rules to ensure compliance with internal privacy and security policies, as well as complying with externally legislated regulations, such as Health Insurance Portability and Accountability Act (HIPAA) and the Privacy Act. However, while most healthcare organizations have formal policies that describe how and when privileged users may access healthcare systems, they do not have an effective mechanism to enforce, monitor, control, and audit the privileged users' actions (Wende, 2007). As a result, accountability becomes an impossible mission, especially with busy privileged clinicians who are sharing their system-access credentials with their workmates. Security and privacy compliance in fact is one of the top ten issues that might cause significant risks within the general field of healthcare (Rishel, 2001). Data governance role here

is to transform compliance with hospital internal policies and external regulations from manual audits to automated, real-time checks and change-driven business processes that instantly assess and manage risks.

### 2.3 Focus Area 3: Business Transformation

Business transformation is a change in the healthcare management strategy to align people, processes and technologies more closely with its business strategy. Business transformation is a facilitator to achieve compliance, quality improvement and business integration through managing changes in terms of data ownership and data usage (Lenzerini, 2002). Business transformation is a nightmare to any healthcare organization where a recent research shows that the failure rate of transformation program is considered high, up to 70-80% while the organizations that adopt effective data governance approach can obtain almost 80% success (RapidBI, 2007).

All healthcare organizations have to change the way of accessing patients' data and define who is allowed to access what type of data in order to comply with external regulations (HIPAA, for example). Also, healthcare organizations have to change the ownership of the data as it moves toward using data as an enterprise asset (Russom, 2008). In the beginning of establishing any data governance program, it is very crucial to locate one primary legal owner of the data. In reality, there is a great debate on who owns the data (Alkouri, 2012). Is it the data creator (physicians or other healthcare providers)? Is it the patient? Or is it the organization itself (where the data has been created)? According to HIPAA, the patient has a medical record, which is owned by his/her medical provider (Shay, 1999). But, if the medical provider died, fired or transferred to other healthcare organization we lost the real data owner. In fact, the ownership of healthcare data is still in a grey area.

As one of the big conceptual challenges that faced a tertiary care hospital while they were implementing data warehouse project is identifying the ownership of the systems, data, and Key Performance Indicators (KPIs) (Bergeron et al, 2007). Data warehousing is one of the data-intensive business initiatives that required well-structured data governance to enforce business transformation.

## 3 PERCEIVED CHALLENGES

The benefits of strong data governance initiative are many and diverse and so are the challenges. The core challenges in data governance are fundamentally not about technologies but about people and processes (Nigel, 2012). The first challenge is political leadership to establish governing council office. The lack of business involvement and executive level sponsorship is also one of the biggest challenges. In fact, the commitment of executives is difficult because the governance of data is often perceived as a mysterious issue, rather than as a program that delivers business measures (Hsu, 2009). As reported by The Data Warehousing Institute (TDWI) survey of data governance, the second leading barrier is the lack of people understanding of governance which includes non-sustainable executive sponsorship as well as lack of business justification (Russom, 2008). Lastly, the lack of data ownership, resistance to change, and resistance to accountability are focal barriers.

## 4 DATA GOVERNANCE FRAMEWORK FOR HEALTHCARE ORGANIZATIONS

There is a great need to compose a model that treats data as a strategic enterprise asset. There is also lack of data governance models in the market. The Data Governance Institute (DGI) framework and IBM framework are the only models currently available. However, both frameworks are very generic. They are not industrial oriented, which creates gaps when they are implemented in a specific industry. In addition, both frameworks fail to define a clear governance cycle that proactively puts into place data rules and policies, monitors and measures the on-going services, and reactively resolves issues. The business obstacles and needs in the healthcare industry are totally different from those of other industries. Physicians' and clinicians' resistance, for example, is significantly high. For this reason, change management becomes an important on-going process in the healthcare data governance framework. In addition, the compliance with the healthcare regulations and standards is crucial. The proposed framework in Figure 1 illustrates how the healthcare organization governs its data on the organizational and operational levels. This

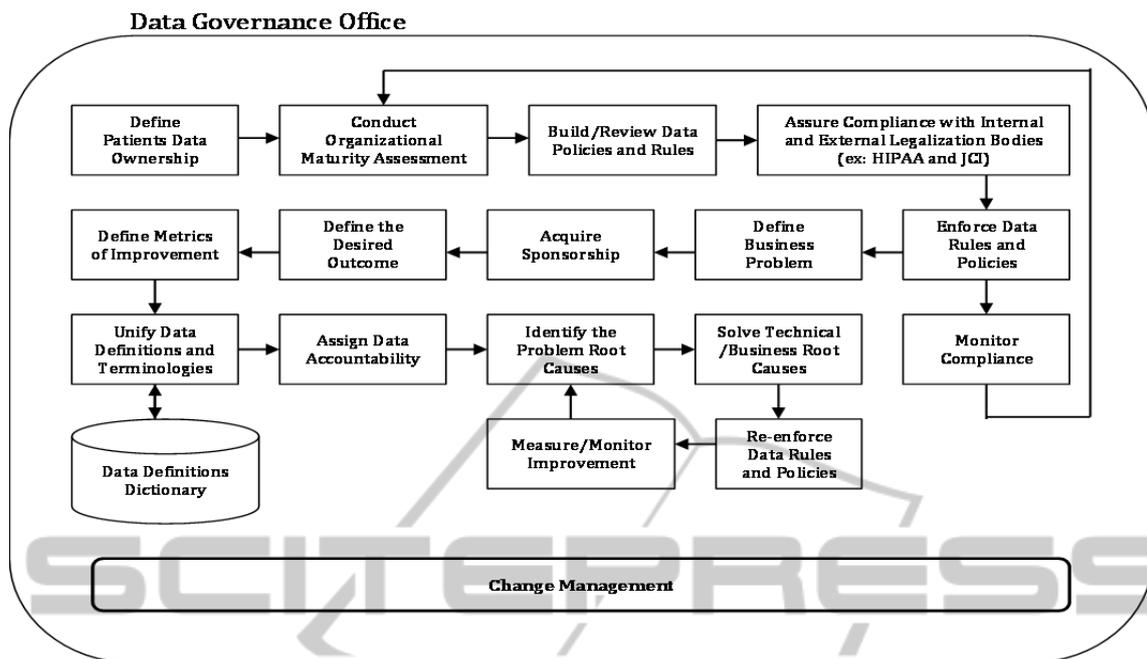


Figure 1: A New Data Governance Framework for Healthcare Organizations.

framework can be directly implemented after establishing the data governance office, appointing data governors, and defining their decision rights. The proposed model starts with the agreement on who owns the data, followed by an understanding of the maturity level of the organization, in terms of data governance. The goal is to build a clear understanding of the organization’s current state and define the gap between the current and the desired state. It is advised to conduct this assessment on a yearly basis in order to measure the progress of the governance initiative. On the operational level, data governors define business problems and assign a sponsor for each. Then, the governors and the sponsor define performance measurement metrics to assess the improvements over time. Then, they assign accountability for data that is related to this business problem in order to limit data problems in the future. After that, they work to identify and resolve the technical and business root causes of each problem. The defined metrics in each business area helps the accountable person to monitor improvements and breaches of data rules and policies. Any adjustment/addition or deletion of data rules or policies must be escalated to the board of data governors in the data governance office for reviewing and approval.

## 5 A CASE STUDY ON DATA GOVERNANCE IN A TERTIARY CARE HOSPITAL

In this section, we introduce a data governance exercise based on our proposed model. This exercise was conducted in a leading healthcare organization within the Middle East. In the study, we investigate the root causes of patients’ data quality problems and summarize the main findings.

### 5.1 General Background

This research was conducted in one of the leading tertiary healthcare organizations in the Middle East, with more than 2,200 beds and around 12,000 employees. This organization serves all eligible patients around the country through four main sites in different regions. In the capital city, the average yearly outpatients’ visits exceeded 485,000 visits, while the average yearly inpatients’ admissions and discharges is around 40,000 admissions/discharges. This organization has 15 core clinical and administrative systems that were running smoothly to serve all clinical and non-clinical needs. The core clinical system, which is the Electronic Medical Record system (EMR), is integrated between all the remote sites of the hospital. In 2007, the data

warehouse initiative began. A massive amount of data were captured, transferred, and loaded into the data warehouse. The average number of data records that are transferred daily to the data warehouse from the EMR system is about 5,832,000 records a day. Electronic data measures and dashboards showed significant discrepancies when compared with the organizational manually collected reports.

## 5.2 Research Aim

This research aims to identify the root causes of patients' data discrepancies in the chosen organization and investigates the effectiveness of the proposed data governance model.

## 5.3 Research Design

This research was conducted in the Ambulatory Care Services division (ACS). ACS has eighteen different outpatient clinics that run nine hours a day, five days a week. The high-volume of patients visiting the ambulatory care clinics in addition to the different processes implemented in each clinic contribute to the complexity of data discrepancies.

Three out of eighteen clinics were selected vigilantly based on their flexibility of accepting walk-in patients, their volume of booked and referred patients, the number of physician-clinics and nurse-clinics in a single specialty, and how strict they were in using the EMR system. The three chosen clinics were: the Employee Health Clinic, the Obstetric and Gynaecology Clinic, and Ophthalmology Clinic. We then formed a group of nurses, physicians, and clinical statisticians for each clinic and gave them the responsibility of producing their clinic's manual statistics. The role of these groups was to provide researchers with yearly manual statistics, as well as the manual log files for patients' visits in each clinic. Also, these groups were responsible for clarifying the KPIs definitions and formulas they used in producing their manual statistics. The list of KPIs, along with the definitions and formulas, were communicated to the data warehouse representative who was responsible of extracting each clinic's electronic data directly from the data warehouse. Table 1 illustrates a list of terminologies and definitions, as agreed upon by the formed groups.

We collected both manual and electronic data in the period between January 2011 and December 2012 for the three selected clinics. Both data sets were analysed in different timeframes in order to validate that the discrepancies in the clinical data was a phenomenon and not a coincidence.

Table 1: Unified List of Definitions.

Terms	Definitions
Manual Data	Data that is collected manually by nurses in a clinic using paper and pen
Electronic Data	Data that is captured from an electronic source of data such as Data Warehouse
Nurse-Clinic	Outpatients clinic that is run by a nurse
Physician-Clinic	Outpatients clinic that is run by a physician
Booked Appt.	Patients who did register an appointment for consultation
Kept Appt.	Patients who did attend their registered appointments and had their consultation
Walk-in Patients	Patients who attended a clinic without an appointment being made
No-Show Patients	Patients who did not attend their appointments
<i>Seen Patients</i>	Patients who visited the clinic as a walk-in or with an appointment. The total <i>seen</i> patients are equal to the total walk-in patients plus total kept appointments $Seen\ Patients = (Walk-in + Kept\ Appointments)$

## 5.4 Research Findings

In this section, we explore the data discrepancy's root causes in the three selected clinics.

### 5.4.1 Employee Health Clinic (EHC)

#### *Background*

The EHC is designated to provide primary healthcare services to the hospital employees and their dependents. This clinic is subdivided into two main categories: family physician-clinics and nurse-clinics. As a general practice, the EHC accepts patients as walk-in patients. Some patients are granted a booked appointment if their family physician asks for a follow-up on a specific date.

#### *Experimental Results*

We analysed the EHC manual collected data and electronic data from January 2011 to July 2011. The manuals reveal a higher number of *seen* patients than electronic data records, an up to 4.6% difference. Figure 2 below shows a bar chart of the total number of *seen* patients of both manually collected data and electronic data records, denoted by (M) and (E) respectively.

The total number of *seen* patients in EHC constitutes the sum of the numbers of all *seen* patients in both nurse and physician clinics. Thus, the discrepancy in the EHC data is a result of

discrepancy in either the nurse-clinics data or the physician-clinics data or in both. Starting with physician-clinics, we analysed the number of patients who visited these clinics as walk-ins or as booked appointments. The difference between both data sets is negligible as illustrated in Figure 3.

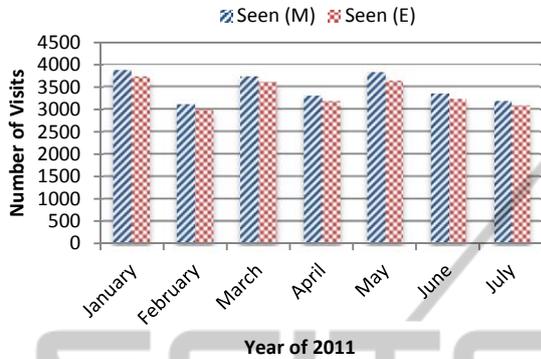


Figure 2: Total Seen Patients in EHC Clinics from January to July 2011.

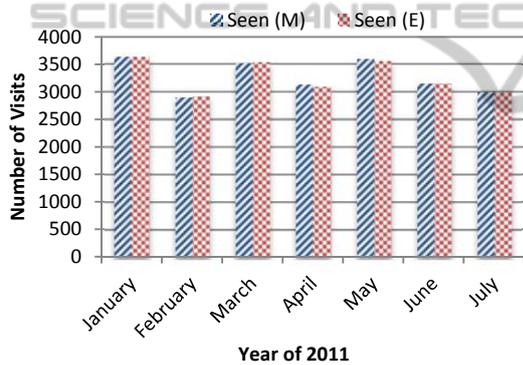


Figure 3: Total Seen Patients in EHC Physician-Clinics from January to July 2011.

Next, we examined the number of patients who visited the nurse-clinics as walk-ins or as booked appointments. The difference between both data sets

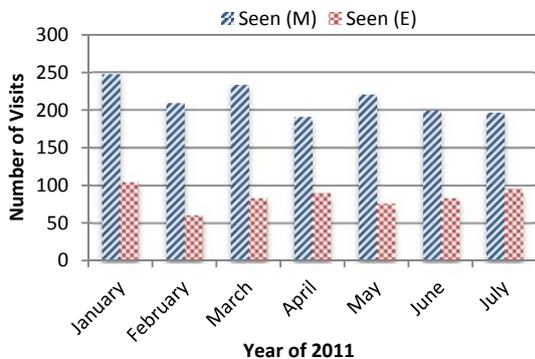


Figure 4: Total Seen Patients in EHC Nurse-Clinics from January to July 2011.

is very significant as illustrated in Figure 4. The data warehouse provided up to 70% fewer data in comparison with manually collected data for this case. Thus, clearly, the discrepancy observed in the EHC total *seen* patients (Figure 2) is a result of a discrepancy in the nurse-clinics data (Figure 4).

**Core Reasons for Discrepancies**

Nurses in the nurse-clinics are not using the EMR system to register all visits they encounter. The practice of using papers instead of using the EMR system is a large violation of the hospital’s policy.

**5.4.2 Ophthalmology Clinics**

**Background**

The Ophthalmology clinics provide patients with full range of eye care starting from routine eye check-up to complex surgical procedures. Unlike EHC, all Ophthalmology clinics are specialist physician-clinics. All patients should book their appointments prior to their actual visits. Walk-in patients, however, are accepted under certain conditions.

**Experimental Results**

The analysis of a random six-month timeframe data reveals discrepancies in the total number of *seen* patients. The electronic data provided up to 20% fewer records than the manually collected data. The total number of *seen* patients is the sum of both, walk-in patients and kept appointments. Thus, discrepancies were due to either errors in the number of walk-in patients or the in the number of patients that kept their booked appointments, or in both. The numbers of total kept appointments from both data sources were found to be almost matching as illustrated in Figure 5.

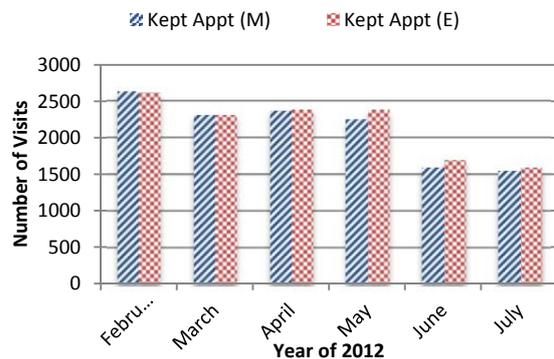


Figure 5: Total Kept Appointments in Ophthalmology Clinics.

On the other hand, the differences in the numbers of walk-in patients were significantly high. The electronic data showed up to 95% fewer records than manually collected data as shown in Figure 6. Clearly, the discrepancy observed in total number of *seen* patients is a result of not recording walk-in visits in the electronic data source.

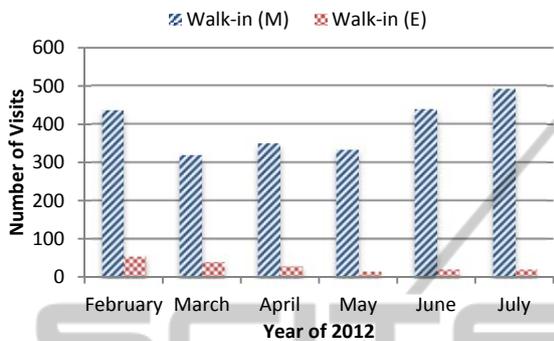


Figure 6: Total Walk-in Patients in Ophthalmology Clinics.

**Core Reasons for Discrepancies**

Nurses are not registering walk-in patients in the EMR system. Not using the electronic system for patients’ encounters is an unforgivable violation of the hospital’s policy.

**5.4.3 Obstetrics and Gynaecology Clinics (OB-GYN)**

**Background**

The OB-GYN department offers complete obstetrical and gynaecological services for female patients. It is the busiest department around the year. The OB-GYN clinics are divided into two groups, physician-clinics and nurse-clinics.

**Experimental Results**

We randomly selected a timeframe of seven months, from September 2011 to March 2012, to study the statistical inconsistencies. The analysis of both manual and electronic data sets shows similarities in the total number of seen patients as shown in Figure 7. An accurate measure on the clinical level does not necessarily mean that all sub-measures are accurate. Further analysis of both data sets is essential. In physician-clinics, the manual collected data provided up to 14% more records of seen patients as illustrated in Figure 8. On the other hand, the nurse-clinics indicate a significant difference between both data sets where the electronic data gave up to 45% more records of seen patients as shown in Figure 9. However, through analysing differences and

similarities in both nurse-clinics and physician-clinics, we noticed that the variances between the manually collected data and the data from the electronic source followed the same trend. The difference in the total number of seen patients in nurse-clinics was the same as the difference in the total number of seen patients in the physician-clinics as illustrated in Figure 10.

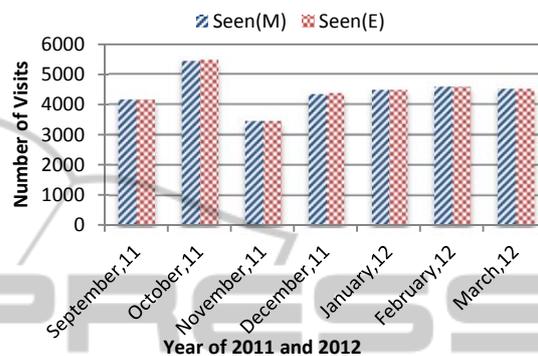


Figure 7: Total Seen Patients in OB-GYN Clinics from September 2011 to March 2012.

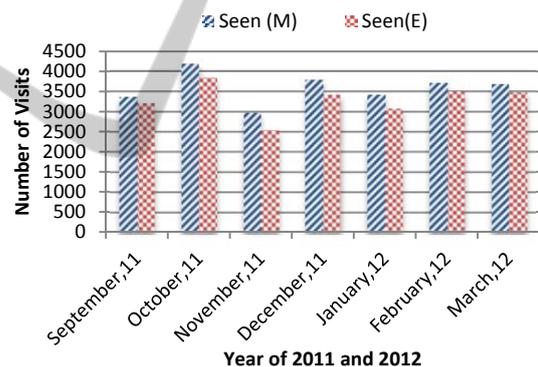


Figure 8: Total Seen Patients in OB-GYN Physician-Clinics from September 2011 to March 2012.

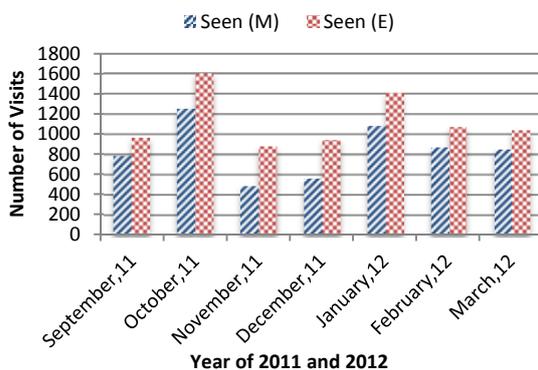


Figure 9: Total Seen Patients in OB-GYN Nurse-Clinics from September 2011 to March 2012.

**Core Reasons for Discrepancies**

The OB-GYN is the busiest department around the year. All physician-clinics' schedules are fully booked for six months in advance. Physicians in the OB-GYN department need to follow-up with patients who have critical cases on a regular base. To avoid moving these patients to the waiting list, physicians booked them follow-up appointments under the nurse-clinics. As a result, when measures were taken from the electronic data system, it revealed a higher number of *seen* patients in nurse-clinics and a fewer number of *seen* patients in physician-clinics.

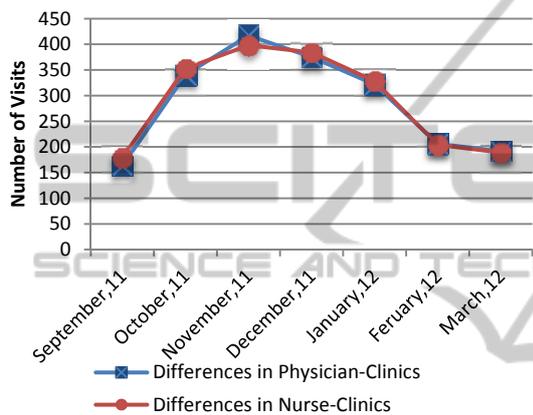


Figure 10: Differences in Numbers of Seen Patients in Physician-Clinics and Nurse-Clinics.

**5.5 Results after Implementing the New Data Governance Model**

We selected the Ophthalmology clinic to represent the implementation model of our new data governance framework (Figure 1). In June 2013, we started enforcing data policies and rules as well as monitoring compliance improvement. We also provided direct and indirect educational sessions to key clinicians in the Ophthalmology department, as small steps toward change management. By the end of November 2013, we investigated the changes that happened in patients' data during the four months of governance. The analysis of both data sets reveals improvement in total numbers of walk-in patients. The electronic data provided up to 21% fewer records than the manually collected data as shown in Figure 11. The electronic data was used to provide up to 95% fewer walk-in records as illustrated previously in Figure 6.

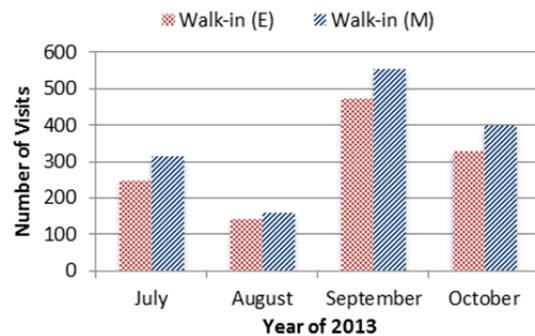


Figure 11: Total Walk-in Patients in Ophthalmology Clinics after Implementing our New Data Governance Framework.

**6 DISCUSSION**

This study helped the chosen healthcare organization to identify the root causes of their patients' data quality issues. The study reveals how the different business processes implemented in each clinic affect the data outcomes. The EHC physician-clinics, for example, had a robust walk-in business process in place. As a result, the measures of walk-in patients in this clinic were precise, even though the number of walk-in patients dropping by the clinic fluctuated over the year (due to seasonal changes). On the other hand, 95% of the Ophthalmology clinic's walk-in patients were omitted from the Electronic Medical Record system. This is due to the absence of a well-defined walk-in business process, and the weak enforcement of the hospital's policies, as well as the lack of education and training on the Electronic Medical Record system.

The study also provides evidence on how data outcomes were affected by nurses and physicians misconduct. 70% of patients *seen* by EHC nurse-clinics were not entered into the Electronic Medical Record system as a result of nurses' negligence. This misbehavior of not entering data into the electronic system is a breach of the hospital policy. Similarly, the malpractice of OB-GYN physicians in booking more appointments for their patients under the nurse-clinics resulted in discrepancies in the Electronic Medical Record system. This conduct, which was discovered through this data governance exercise, is a violation of the hospital's administrative policies and procedures. More importantly, the study provides evidence on the importance of adapting a robust data governance framework that designed primarily for healthcare needs. The proposed framework shows effectiveness on resolving patients' data issues

within a short period of time. This model helped to proactively control data, reactively resolve data issues, and monitor breaches of data rules and policies. However, it still needs more experimentation.

This research has clearly shown evidence of data errors that are related to the absence of data governance. Such data errors resulted from the lack of data privacy and security rules, the lack of data policies, and the absence of accountability on the data entered into the Electronic Medical Record system. The outcomes of this study were presented to the board of decision-makers in the chosen healthcare organization. The board decided to formally start two initiatives: Data Governance Project and Book of Measures Project, the latter of which aimed to build an enterprise dictionary of KPIs, terminologies, and definitions in order to unify the language used in the hospital.

## 7 CONCLUSIONS

We believe that applying data governance in healthcare will provide a solid start for data-driven projects such as data quality improvement, data warehousing, healthcare analytics, and business intelligence. The analytical measures of data alerts, data quality improvement, policy violation provenance, rules monitoring, and authority monitoring will increase the reliability and transparency of data governance for all users and regulatory bodies. Studying and comparing the outcomes of different data governance framework is an essential piece of future work. This research is a starting point that directly impacts many interesting research disciplines pertaining to healthcare data governance such as business governance, strategic decisions effectiveness, data error tracking and assessments of improvements to data quality.

## REFERENCES

- AHIMA. 2008. Quality Data and Documentation for EHRs in Physician Practice. *Journal of AHIMA*, 79(8), 43-48.
- Alkouri, A. 2012. DATA OWNERSHIP: WHO OWNS 'MY DATA'?. *International Journal of Management and Information Technology*, 2(1). Available from: <<http://www.slideshare.net/alkhouridata-ownership-who-owns-my-data>>. [10 August 2013].
- Batini, C., Mecella, M., & Viscusi, G. 2010. *Information Systems for EGovernment* (1st Edition ed.): Springer.
- Bergeron, B., AlDaig, H., Hoque, E., AlBawardi, F. S., & Alswailem, O. 2007. *Developing a Data Warehouse for the Healthcare Enterprise: Lessons from the Trenches*: HIMSS.
- Brown, C. V., & Khatri, V. 2010. Designing Data Governance. *Communications of the ACM*, 53(1), 148-152.
- Eppler, M. J. 2006. *Managing Information Quality*. Berlin, Heidelberg: Springer
- Fisher, T. 2009. *The Data Asset: How Smart Companies Govern Their Data for Business Success* (1 ed.): Wiley; 1 edition (June 22, 2009).
- Fu, X., Wojak, A., Neagu, D., Ridley, M., & Travis, K. 2011. Data governance in predictive toxicology: A review. *Journal of Cheminformatics*, 3(1). doi: 10.1186/1758-2946-3-24
- Househ, M. S., & AlTuwaijri, M. 2011. Early Development of an Enterprise Health Data Warehouse. In Borycki, E., M. et al. (Eds.), *International Perspective in Health Informatics* (Vol. 164, pp. 122-126). doi: 10.3233/978-1-60750-709-3-122
- Hsu, V. 2009. How Technology Enables Data Governance. Available from: <<http://www.oracle.com/us/products/applications/master-data-management/042941.pdf>>. [23 August 2013].
- Kooper, M. N., Maes, R., & Lindgreen, E. R. 2011. On the governance of the information: Introducing a new concept of governance to support the management of information. *International Journal of Information Management*, 31(3), 195-200. doi:10.1016/j.ijinfomgt.2010.05.009
- Lenzerini, M. 2002. Data integration: A theoretical perspective. *Proc. of the 21st ACM SIGMOD-SIGART Symposium on Principles of Database Systems (PODS)*.
- Nigel, C. 2012. Data governance. Health Informatics Society of Australia. 1. Available from: <[http://www.hisa.org.au/?page=thought\\_lship](http://www.hisa.org.au/?page=thought_lship)>. [13 July 2013].
- Orr, J. C. 2011. *Data Governance for the Executive*. Colorado Springs: Senna Publishing, L.L.C.
- Palczewska, A., Fu, X., Trundle, P., Yang, L., Neagu, D., Ridley, M., Travis, K. (2013). Towards model governance in predictive toxicology. *International Journal of Information Management*, 33(3), 567-582. Available from: <<http://www.inf.brad.ac.uk/~mick/papers/IJIM1227.pdf>>. [1 September 2013].
- RapidBI 2007. Business Transformation – a change strategy. Available from: <<http://rapidbi.com/created/businesstransformation/>>. [10 August 2013].
- Rishel, W. 2001. HIPAA: An Industry Progress Report. Available from: <<http://www.ehcca.com/presentations/HIPAA3/202.pdf>>. [27 July 2013].
- Russom, P. 2008. Data Governance strategies Helping your Organization Comply, Transform, and Integrate. TDWI Best Practices Report.
- Sarsfield, S. 2009. *Data Governance for Imperative*. Cambridge, UK: IT Governance Publishing.
- Shay, E. F. (1999). Legal implications of the informatics revolution. *Physician's News Digest*. Available from:

<<http://www.physiciansnews.com/computers/399shaydv.html>>. [27 July 2013].

Soares, S. 2010. The IBM Data Governance Unified Process. Ketchum: MC Press Online, LLC.

The Data Management Association. 2009. *The DAMA Guide to Data Management Body of Knowledge*. Bradley Beach, US :Technics Publications,LLC.

Wende, K., A. 2007. A Model for Data Governance – Organising Accountabilities for Data Quality Management. Paper presented at *18th Australasian Conference on Information Systems*, Australia, Toowoomba: ACIS 2007 Proceedings.

