

Prioritized e–health data quality challenges: An application on the Tiered ART Monitoring Strategy

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Abstract

Data quality is regarded as one of the challenges experienced in electronic healthcare systems. Substandard data quality in electronic healthcare systems could have major effects on healthcare delivery as well as analysis and reporting of health data. A prioritized list of data quality challenges has been conducted with the purpose of guiding future health data quality interventions. The prioritized list of data quality challenges is practically applied in this paper.

The Department of Health South Africa recently introduced the Tiered ART (Anti-retroviral Therapy) Monitoring Strategy to support the monitoring and evaluation of antiretroviral therapy in high HIV burden settings. The tiered ART Monitoring Strategy consists of three tiers, namely: i) Paper registers; ii) Offline electronic registers and; iii) Networked electronic medical records.

The purpose of the paper is to describe prioritized data quality challenges and to apply it to the Tiered ART Monitoring Strategy, mitigating the risks with regard to the implementation of the strategy. The purpose of the paper was realised by providing a prioritized list of data quality challenges and applying these challenges to the three tiers of the Tiered ART Monitoring Strategy. The application of the data quality challenges on the strategy allows for possible mitigation of data related risks in the implementation of the strategy.

Keywords

E-health, data quality, data quality challenges, three-tier strategy

Introduction

The Department of Health South Africa introduced the *Tiered ART (Anti-retroviral Therapy) Monitoring Strategy* in December 2010 (Department of Health South Africa, 2012). The strategy is developed to support the monitoring and evaluation of antiretroviral therapy in high HIV burden settings (Osler et al., 2014). Unfortunately, the reliability of the data is a concern in the implementation of the strategy (Osler et al, 2014; Mate et al., 2009). Data quality is proven to be a significant challenge in the establishment of electronic healthcare systems (Lobach and Detmer, 2007; Minear, 2009, Accenture, 2010; Samyshkin and Timoshkin, 2004; Francis, 2013; Atreja et al., 2008). The purpose of the paper is to describe prioritized data quality challenges and to apply it to the Tiered ART Monitoring Strategy, mitigating the risks with regard to the implementation of the strategy.

The purpose of the paper is realised by providing a background to the current status of e-health in South Africa and expounding the importance of data quality in electronic healthcare systems. The paper is grounded on a prioritized list of data quality challenges as provided by Botha, Botha and Herselman (2015). A background to the prioritization is provided, supported with the research methodology followed in the study as well as the research results. A background and possible risks regarding the three-tier strategy is provided. Finally, the prioritized list of data quality challenges is applied to the three-tier strategy to mitigate the risks relevant to the strategy.

The current status of e-health in South Africa is explained in the following section.

Current status of e-health in South Africa

E-health is generally known to be the application of various technologies to improve the health status and quality of care for patients (Gerber, Olazabal, Brown and Pablos-Mendez, 2010). E-health has been implemented in cities and rural areas globally (Gerber *et al.*, 2010). This section describes the status of e-health in South Africa.

South Africa has made many improvements in the instituting and application of a health information system post 1994 (SAHR, 2011). Although many improvements have been made in this regard, the Department of Health South Africa is still facing many challenges (Department of Health South Africa, 2012). The e-health strategy of South Africa (2012) outlines ten strategic priorities for the successful application of e-health, which should be implemented by 2017. These strategic priorities should be addressed to support the healthcare transformation in South Africa:

- Strategy and leadership;
- Stakeholder engagement;
- Standards and interoperability;
- Governance and regulation;
- Investment, affordability and sustainability;
- Benefits realisation;
- Capacity and workforce;
- E-health foundations;
- Applications and tools to ensure healthcare delivery; and
- Monitoring and evaluation of the e-health strategy.

The Department of Health, South Africa aims to realise their mission by applying the strategies mentioned above (Department of Health South Africa, 2012). Their mission is *“To establish eHealth as an integral part of the transformation and improvement of healthcare services in South Africa, especially enabling delivery on the health sector’s Negotiated Service Delivery Agreement 2010-2014.”* (Department of Health, South Africa, 2012:8).

Information management staff and other health information resources such as hardware and software have improved in South Africa (SAHR, 2011). Although data quality has improved in the process, there are however many challenges still to be addressed (SAHR, 2011).

South Africa is still in the process of implementing a national health information system and still encounters numerous challenges, including data quality (Department of Health, South Africa, 2012). The importance of data quality in electronic healthcare systems is discussed in the following section.

Importance of data quality in e-health

Data quality is listed as a known e-health challenge (Botha, Botha & Herselman, 2014). As the purpose of the paper is to describe prioritized data quality challenges and to apply it to the Tiered ART Monitoring Strategy, mitigating the risks with regard to the implementation of the strategy, the importance of data quality in electronic healthcare systems should be explained.

Nix and Rosenau (2011) stated that data quality challenges in electronic health records are still in the process of being understood. They acknowledge that time and patience is required to assure that health information systems are functioning at full potential while meeting the needs of healthcare providers. They argue that accurate and complete data is compulsory when making use of electronic health records in healthcare systems. Conceding that the use of health information systems does not guarantee that data quality will improve, they acknowledge that quality of health records remains a significant challenge (Nix and Rosenau, 2011). The data collected and stored in health information systems is used for a variety of health related functions and the extent to which actions can be relied on is dependent on the quality of the data (Bowen, 2012).

Not only does data quality have an impact on effectiveness and advantage in the business sector (Redman, 1995), but data quality could also have significant effects in the health sector. The Connecting for Health Common Framework (2006) states that substandard data quality could:

- Impact quality of care in health facilities;
- Lead to privacy and security issues;
- Increase cost;
- Create risks; and
- Decrease the benefits from using health information systems.

The World Health Organisation (2003) states that health care data are sustained for the current and coming care of the patient, irrespective of the level of care at which the health service is provided. Data collected and presented must be accurate, complete, reliable, comprehensible and accessible to users if they are to meet the requirements of the patient, doctor and other health professionals, the health care facility, legal authorities, plus

state, province and national government health authorities (World Health Organisation 2003). Data quality is a significant factor in the usability as well as the sustainability when it comes to e-health (Ure et al., 2006).

The collection of data with substandard data quality leads to inappropriate information for health and management purposes (Samyshkin and Timoshkin, 2004); therefore the quality of that data is essential, not only for use in patient care, but also for monitoring the performance of the health service and employees (World Health Organisation, 2003).

A previous study, on the prioritization of e-health data quality challenges, conducted by Botha, Botha & Herselman (2015), is summarized and explained in the proceeding section.

Prioritized data quality challenges

This section describes the methodology and outcomes of the prioritization of e-health data quality challenges. The prioritized list of e-health data quality challenges could be applied to the three-tier strategy to possibly mitigate risks associated with the implementation thereof.

Background to the prioritization

Botha, Botha and Herselman (2015) conducted a study with the purpose of prioritizing data quality challenges as experienced by data users of electronic healthcare systems in South Africa. A total of 18 statistically significant data quality challenges were found after the final data analysis and were prioritized according to their significance. The research took place in four separate phases and is explained in more detail in the following section.

Research methodology

This study followed a sequential exploratory mixed method approach towards achieving the research purpose. This implies that a qualitative design was followed by a quantitative design and analysis. Oates (2006) mentions that it is not unusual to combine qualitative and quantitative research methods. The data collection methods for this study consisted of a literature review, which was used to set up a theoretical framework. The theoretical framework was used as the basis for qualitative data collection, by means of interviews. The purpose of the interviews was to verify and expand the data quality challenges identified through literature. A quantitative study followed the qualitative study, in order to prioritise the data quality challenges. The quantitative data was collected by means of questionnaires.

The research took place in four phases, as depicted in Table 1. Table 1 describes each of the research phases with the relevant outcomes:

Phase 1 Literature study	Phase 2 Qualitative research	Phase 3 Quantitative research	Phase 4 Recommendations
Phase 1 consisted of a literature review that included a	The objective of this phase was to verify and enhance the list	The objective of this phase was to prioritise the enhanced and	The objective of this research phase was to provide evidence

Phase 1 Literature study	Phase 2 Qualitative research	Phase 3 Quantitative research	Phase 4 Recommendations
<p>background to e-health in South Africa and the importance of data quality in health information systems and the current status of research on data quality challenges – both in general information systems and in health information systems.</p> <p>A theoretical framework followed, synthesising the results obtained in the two literature studies.</p>	<p>of data quality challenges that emerged from the literature studies.</p> <p>Interviews with four data quality experts were conducted to realise the purpose of this research phase.</p> <p>The questions asked in the open-ended interviews were derived from the exploration of literature in phase 1.</p>	<p>verified list of data quality challenges that resulted from the second phase of research.</p> <p>Questionnaires were gathered from 82 data users of electronic healthcare systems in South Africa to realise the purpose of this research phase.</p> <p>The participants were asked to rate the data quality challenges that emerged from phase 2 of the research.</p>	<p>based recommendations regarding data quality challenges in electronic healthcare systems in South Africa.</p>
Output	Output	Output	Output
<p>The exploration in Phase 1 provided insights which enabled the identification of existing data quality challenges. The identified data quality challenges served as a foundation for the qualitative research in phase 2.</p>	<p>The interviews resulted into an enhanced and practise specific list of data quality challenges.</p> <p>This enhanced list included verified data quality challenges from literature, excluded data quality challenges that could not be verified by the data quality experts, combined similar data quality challenges according to expert opinions and included additional e-health</p>	<p>The questionnaires resulted into a prioritised list of data quality challenges in electronic healthcare systems in South Africa.</p> <p>The prioritised list of data quality challenges excludes data quality challenges that were not statistically proven to be significant.</p> <p>The statistically significant data quality challenges were prioritised according to the weighted total score of the</p>	<p>Evidence based recommendations for data quality interventions were provided.</p> <p>The recommendations were developed according to the prioritised list of data quality challenges which emerged from phase 3 of the research.</p>

Phase 1 Literature study	Phase 2 Qualitative research	Phase 3 Quantitative research	Phase 4 Recommendations
	and other data quality challenges recommended by the data quality experts.	responses.	

Table 1: The phases and outcomes of the research (Botha, Botha & Herselman, 2015)

As depicted in Table 1, a prioritized list of data quality challenges, relevant to the South African Health System was produced in the final phase of the research. The research results are provided in the following section.

Research results

A total of 18 data quality challenges were found to be statistically significant (Botha, Botha & Herselman, 2015). The prioritized list of data quality challenges in electronic healthcare systems in South Africa is depicted in table 2:

DATA QUALITY CHALLENGE	PRIORITY	References
There is a need for more training for data users	1	Haug et al. (2013), Singh and Singh (2010), World Health Organisation (2003), Minear (2009)
<i>Data entry errors</i> (this includes errors such as: misspelled data; a certain data element is not captured; a certain data element is captured in the wrong format)	2	Singh and Singh (2010), Nix and Rosenau (2011), Ure et al. (2006), Horbatuk (2011)
Inaccurate data is collected from the patient	3	Samyshkin and Timoshkin (2004), Nix and Rosenau (2011), de Leeuw (2005), World Health Organisation (2003)
The shortage or absence of the necessary infrastructure, such as internet connections	4	Theobald (2014), Anderson (2007)
Inconsistent definitions and formats because of different systems used (standardisation)	5	Hayrinen et al. (2008), Atreja et al (2008), Jaroslowski and Saberwal (2014), Rodrigues (2008), Ammenwerth et al. (2003)
Physicians are hesitant to change existing processes	6	Jha et al. (2009), Jaroslowski and Saberwal (2014)
<i>Data governance</i> (this includes challenges such as: lack of assignment of responsibilities regarding data; in short of data administration; ambiguity of roles with regards to data tasks; a need for written data quality policies and procedures; the importance of data quality is not	7	Haug et al. (2013), Singh and Singh (2010), Samyshkin and Timoshkin (2004), Health information and quality authority (2011)

DATA QUALITY CHALLENGE	PRIORITY	References
emphasized enough by managers; ineffective organisational procedures; lack of data quality assessments)		
Information is produced by subjectivity of the data capturer	8	Strong et al. (1997), Nix and Rosenau (2011)
In short of appropriate software for data management	9	Haug et al. (2013), Singh and Singh (2010)
The length of the form is too long	10	Subar et al. (2001), Hess et al. (2001), Groves (1987)
Nurses' notes may go unread by physicians	11	Penoyer et al. (2014)
Transformation from paper records to electronic records	12	Braa et al. (2004), Waegemann (2002), Atreja et al. (2008)
Privacy, confidentiality and legal challenges	13	Wagemann (2002), Minear (2009), RTI International (2001), Accenture (2010), Samyshkin and Timoshkin (2004), Anderson (2007), Rodrigues (2008)
Omissions/errors of data	14	Nix an Rosenau (2011), Beacon Community Program (2013)
Data not meeting all relevant needs	15	Samyshkin and Timoshkin (2004), Vaziri and Mohsenzadeh (2012), Horbatuk (2011)
Information is not suitable for analysis purposes	16	Samyshkin and Timoshkin (2004)
Financial barrier to purchase necessary hardware and cost challenges in general	17	Theobald (2014), Iakovidis (1998), Jha et al. (2009), Atreja et al. (2008), Minear (2009), RTI International (2001), Jaroslowski and Saberwal (2014), Anderson (2007)
Data is out of date	18	Wentzel et al (2014), Singh and Singh (2010)

Table 2: Prioritized data quality challenges (Botha, Botha & Herselman, 2015)

The prioritized list of data quality challenges could be applied to mitigate the risk of the implementation of the three-tier strategy.

The three-tier strategy and possible risks with regard to the strategy is explained in the following section.

Tiered ART Monitoring Strategy

As stated in the Introduction, The Department of Health South Africa introduced the *Tiered ART Monitoring Strategy* to support the monitoring and evaluation of antiretroviral therapy

in high burden HIV settings, in December 2010 (Department of Health South Africa, 2012). This strategy consists of a paper-based (Tier 1), non-networked (Tier 2) and networked system (Tier 3) for patient monitoring. The three-tiered strategy is in line with the World Health Organisation's 3 Tiered Monitoring and Evaluation Strategy (Department of Health South Africa, 2011). The three tiers of the strategy are summarized in Table 3:

<p>Tier 1</p> 	<p>Paper registers</p> <ul style="list-style-type: none"> • Immediate solution while waiting for hardware to be produced; • Ideal for small facilities with low enrolment.
<p>Tier 2</p> 	<p>Offline electronic registers</p> <ul style="list-style-type: none"> • Quick back-capture directly from paper registers; • Offline, simple yet robust system; • Can scale up quickly and relatively inexpensively.
<p>Tier 3</p> 	<p>Networked electronic medical record</p> <ul style="list-style-type: none"> • Can collect a larger dataset and offers more management functions; • Can be used as a sentinel surveillance database for answering more complicated clinical questions and tracking patient movement; • Correctly utilising sentinel sites takes the burden off collecting large data sets away from the rest of the ART facilities.

Table 3: Three-Tiered ART Monitoring Strategy (Osler et al., 2014)

For the purpose of the *Tiered ART Monitoring Strategy*, the data quality produced at each of the three tiers should adhere to a certain data quality standard (Osler et al., 2014). According to Osler et al. (2014) the integrity of the three-tiered process in terms of record keeping, the completeness of folder processing and the accuracy of the data capturing is what ultimately determines the quality of the data. They argue that the use of electronic solutions eases the management of integrity reports (Osler et al., 2014). Furthermore, they state that the choice of tier does not have an impact on data quality (Osler et al., 2014). This implies that data quality challenges could occur at any of the three-tiers during the process of the strategy.

The following section applies Botha, Botha and Herselman's (2015) prioritized list of data quality challenges to the three tiers of the *Tiered ART Monitoring Strategy*.

Discussion

As stated in the first section of the paper, the purpose of the paper is to describe prioritized data quality challenges and to apply it to the Tiered ART Monitoring Strategy, mitigating the risks with regard to the implementation of the strategy.

As outlined by Mate et al. (2009) and Osler et al. (2014), data quality is a risk in the implementation of the three-tier strategy. Data accuracy, data completeness and data concordance between health registers have proven to be significant challenges in the *Tiered ART Monitoring Strategy* (Mate et al., 2009).

The prioritized data quality challenges are listed in Table 4. It is indicated in which of the tiers a certain data quality challenge could occur:

	 Tier 1	 Tier 2	 Tier 3
There is a need for more training for data users	✓	✓	✓
<i>Data entry errors</i> (this includes errors such as: misspelled data; a certain data element is not captured; a certain data element is captured in the wrong format)	✓	✓	
Inaccurate data is collected from the patient	✓		
The shortage or absence of the necessary infrastructure, such as internet connections		✓	✓
Inconsistent definitions and formats because of different systems used (standardisation)			✓
Physicians are hesitant to change existing processes	✓	✓	✓
<i>Data governance</i> (this includes challenges such as: lack of assignment of responsibilities regarding data; in short of data administration; ambiguity of roles with regards to data tasks; a need for written data quality policies and procedures; the importance of data quality is not emphasized enough by managers; ineffective organisational procedures; lack of data quality assessments)	✓	✓	✓
Information is produced by subjectivity of the data capturer	✓	✓	
In short of appropriate software for data management		✓	✓

	 Tier 1	 Tier 2	 Tier 3
The length of the form is too long	✓		
Nurses' notes may go unread by physicians	✓		
Transformation from paper records to electronic records	✓	✓	
Privacy, confidentiality and legal challenges			✓
Omissions/errors of data	✓	✓	✓
Data not meeting all relevant needs	✓	✓	✓
Information is not suitable for analysis purposes	✓	✓	✓
Financial barrier to purchase necessary hardware and cost challenges in general		✓	✓
Data is out of date	✓	✓	✓

Table 4: Data quality challenges applied to the three-tier strategy

The following describes how the data quality challenges apply to the three tiers of the strategy, as depicted in Table 4.

There is a need for more training for data users

A need for training for data users is a data quality challenge that occurs at all three tiers of the strategy. Since data quality is a risk at all three tiers, sufficient training for data users could lower the risk of substandard data quality along the three tiers of the strategy.

Data entry errors

A data entry error is a common data quality challenge. This data quality challenge could occur at the first two tiers of the strategy. Regardless of the data entry method (paper or electronic), data entry errors could occur. Data quality interventions should include methods to lower the risk of data entry errors occurring in the first two tiers of the strategy.

Inaccurate data is collected from the patient

When inaccurate data is collected from the patient, the first inaccuracy occurs at the first tier of the strategy. Unfortunately, the inaccurate data will be carried over to the second and third tier of the strategy. Data collected from the patient should be accurate to ensure a thread of accurate data through all three tiers of the strategy.

The shortage or absence of the necessary infrastructure, such as internet connections

Infrastructure is an important factor in the implementation of the three-tier strategy. Without the necessary infrastructure, especially internet connections, the relevant communication between the second and third tier cannot take place. To ensure the successful implementation of this strategy, the necessary infrastructure should be implemented.

Inconsistent definitions and formats because of different systems used (standardisation)

The communication between the networked systems should be accurate in order to ensure data of high quality. The strategy should adhere to certain technical standards to ensure successful communication and sharing of data.

Physicians are hesitant to change existing processes

The implementation of the three-tier strategy, entails altering of the existing processes followed in health facilities. It is of high value to include all staff members of health facilities in the new data capturing and sharing process, in order to ensure data of high quality throughout the strategy.

Data governance

Data governance is a factor that has an impact on all three tiers of the strategy. Proper management of data quality should be applied throughout the strategy to ensure data of high quality, which is usable and accessible.

Information is produced by subjectivity of the data capturer

Information should never be produced by subjectivity of the data capturer. This common error could occur in the first and second tier of the strategy. Data produced by subjectivity could lead to inaccurate data throughout the strategy.

In short of appropriate software for data management

Along with appropriate hardware and infrastructure, the appropriate software for data management should be installed. Without appropriate software for data management, the second as well as third tier of the strategy could produce data of poor quality.

The length of the form is too long

Research has shown that the length of the form could impact the quality of data. This data quality challenge should be dealt with in the first tier of the strategy. To ensure accurate and complete data, the paper form in the first tier should only request necessary information.

Nurses' notes may go unread by physicians

Although the implementation of the three-tier strategy should ease communication between healthcare workers, nurses and physicians should ensure that all paper records are distributed thoroughly amongst them to ensure sound healthcare for all patients.

Transformation from paper records to electronic records

The transformation from paper records to electronic records holds the risk of introducing inaccurate and incomplete data. This could occur between the first and second tier. Sound data management should be implemented to avoid this data quality challenge.

Privacy, confidentiality and legal challenges

Networked sharing of health data holds the risk of encountering privacy, confidentiality and legal challenges. The necessary access guidelines and regulations should be implemented in the third tier to avoid such challenges.

Omissions/errors of data

Data errors could occur in all three tiers of the strategy. Data quality interventions should be conducted regularly to ensure that the data remains clean between the tiers of the strategy.

Data not meeting all relevant needs

From the first tier, through to the final tier, the data should meet all relevant needs. The paper records in the first tier should be able to provide medical staff with the necessary information to perform healthcare tasks. The electronic and networked data should meet the needs of managers and for analysis purposes. To ensure that the data meet all relevant needs, relevant information should be requested from the first tier through to the third and final tier.

Information is not suitable for analysis purposes

Although data analysis only occurs after the final tier, the information should be suitable for analysis purposes. To ensure that data is suitable for analysis purposes, the relevant data should be collected in the correct format from the first tier. Analysis planning should be done to identify the analysis to be done and to design all three tiers to deliver data which is suitable for analysis purposes.

Financial barrier to purchase necessary hardware and cost challenges in general

The financial barrier purchase necessary hardware could cause challenges in the second and third tier of the strategy. To ensure successful implementation of the strategy, all cost factors should be adhered to before implementation.

Data is out of date

To ensure that data is up to date, the data should constantly be updated in all three tiers of the strategy. Data that is out of date could lead to inaccurate medical treatment and wrongful data analysis and results.

The concluding remarks of the paper are given in the following section.

Concluding remarks

The purpose of the paper was to describe prioritized data quality challenges and to apply it to the Tiered ART Monitoring Strategy, mitigating the risks with regard to the implementation of the strategy. The purpose of the paper was realised by providing a prioritized list of data quality challenges and applying these challenges to the three tiers of the Tiered ART Monitoring Strategy. The application of the data quality challenges on the strategy allows for possible mitigation of data related risks in the implementation of the strategy.

As explained in the Discussion, data quality challenges could occur in all three tiers of the strategy. The possible mitigation of risk provided in this study, could guide the Department of Health of South Africa in the implementation and monitoring of the Tiered ART Monitoring Strategy, to ensure data quality throughout the process of the strategy.

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