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Electronic health information systems for public health care in South Africa: a review of current operational systems

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Background and Purpose: The South African eHealth Strategy was published in 2012 and acknowledges that health information systems should be used to strengthen the public health care system in the country. While the benefit of electronic health information systems has been documented in the literature, the implementation of these systems in public health care in South Africa remains limited. Currently, patient data is still manually recorded in the patient's file, while data required for monitoring and evaluation purposes is hand written by the nurses in registers, aggregated and only the results entered into electronic health information systems for analysis.
Methods: The objective of the paper is to review existing electronic health information systems in public health care in South Africa in terms of their role and focus on health care. A qualitative approach was undertaken to identify the role of health information systems that are most prevalent in public health care in South Africa.
Results: The results indicate that the most common role of health information systems include support for clinical care, e.g. radiology and pathology, as well as monitoring, evaluation and administration purposes. While some systems do capture limited clinical information, there seems to be few systems that support patient centred clinical care.
Conclusions: The recommendation of the paper is that the role of health information systems should be expanded to support direct patient care and improve health outcomes for individuals.

Keywords: Health Information Systems, Primary Care, district health care, electronic patient record, South Africa

1 Introduction

In South Africa, the eHealth Strategy states that it needs to "implement patient-based information systems at all facilities where healthcare is delivered", and that all indicator data should be derived from data captured electronically at the point of care [1]. There is evidence that health information systems (HIS) can improve the quality of healthcare by increasing adherence to guidelines, enhancing disease surveillance, and decreasing medication errors [2]. Furthermore, electronic patient record systems (EPRs) can reduce the time spent by nurses on documentation in hospitals [3]. The evidence of improved quality and safety of patient care due to EPRs is limited to a few successful sites worldwide, while there is still a lack of evidence of their cost-effectiveness [4].

Literature suggests that HIS and EPRs may in fact cause primary clinical work to be conducted less efficiently if the health care worker is not computer literate or the system was not designed to fit with the task flow. In contrast, secondary work (audit, research and billing) may become more efficient as administrators have access to all the patient's information in one repository [5]. Despite these

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reservations, there is widespread support for HIS both in the developed and developing world, [6] including South Africa [1]. The district health system (DHS) is the institutional vehicle to deliver primary care services. While HIS for primary care comprises those at clinics and community health centres, it is also necessary to consider those at district hospitals. District hospitals form part of the DHS and the services they provide should be integrated with those in primary care [7]. The objective of the paper is to review existing electronic health information systems in the public health care sector in South Africa in terms of their role and focus in health care.

2 Materials and methods

The authors made use of a qualitative, inductive approach in the study. Firstly, a literature search for HIS in South Africa using the search engines PubMed and Google Scholar was conducted. A secondary search was conducted on Google, and the first hundred hits were reviewed. Keywords used included 'electronic health records', 'health information systems', 'eHealth strategy', 'primary care', 'district health care' and 'South Africa', which was used alone and in combination with the others. The references of articles retrieved were also examined. Secondly, where information on HIS was not found in the literature, experts in both the private and public health industry were requested to provide information as personal communications.

The rest of the paper is presented as follows: the next section will discuss the HIS that are currently found in South Africa after which the common challenges of HIS in the primary care sector are discussed. Critical success factors are provided as a possible solution to improve the uptake of HIS in the public health care sector of South Africa.

3 Results

3.1 Existing Public Sector Health Information Systems in South Africa

HIS can be divided into two categories depending on whether the user is focused on the 'subject' or 'task' that the system must perform. A subject based system relates to a particular subject, such as a doctor or nurse, in the health care system and will be used by the individual to perform their duties. In contrast, a task based system supports a particular task, regardless of who enters the data e.g. prescription system or a billing system [8]. In this paper, HIS will be categorised according to the tasks they perform.

Furthermore, Beaumont [8] provides an overview of the information systems pyramid and how it fits with HIS in the primary health care system (figure 1). The pyramid classification provides a tool for the Department of Health to determine how mature HIS implementation is. Operational HIS are normally the first to be developed and implemented, and the pyramid then highlights an uneven or inappropriate HIS development.

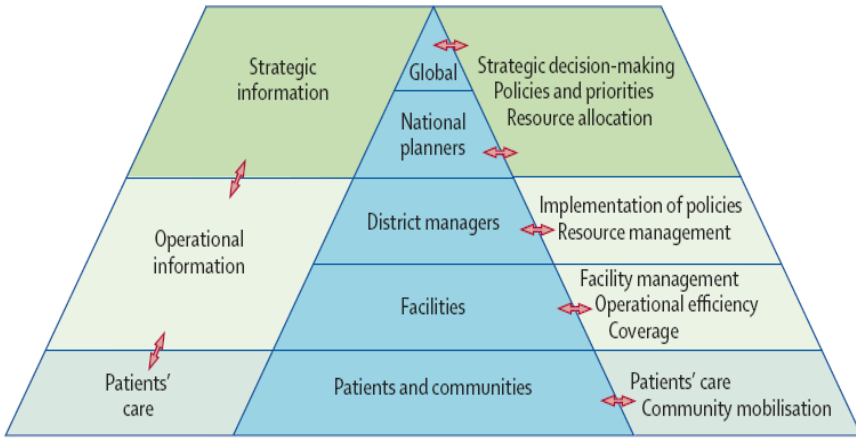

Figure 1: Health information System pyramid

 J Health Inform Afr. 2017;4(1):51-57. DOI: 10.12856/JHIA-2017-v4-i1-164

The next section will discuss the current HIS that were found during the literature review and personal correspondence with experts in the field.

3.2 Health information systems

The CSIR and Department of Health [9] reported at least 42 different HIS, i.e. systems that recorded transactions specifically in support of patient administration and care, in operation in the public sector in 2013. Only seven (7) of these HIS were operational in five or more of the nine provinces; and of these, five were for surveillance and monitoring and only two concerned patient care.

The major systems that were identified during the current literature review have been divided into patient level systems e.g. clinical care and supporting services; operational level HIS e.g. monitoring and evaluation (M+E) and administration systems; and strategic level HIS. These are discussed below:

Patient Level HIS: Clinical care and supporting services systems.

eHealth@Joburg: A primary care EPR is being implemented by Med-e-Mass, a private vendor in 83 facilities in the City of Johannesburg, Clinical notes are entered into the system with templates for mother and child health and non- communicable diseases. There is as yet no pharmacy module [10].

Additional EPR Systems: In line with the National Health Insurance strategy, South Africa has started to implement EHR systems in the public health care sector. Currently, five out of the nine provinces in South Africa have some form of EPR system implemented in public hospitals. In KwaZulu-Natal province, some hospitals use the Medicom or Meditech EPR system, while a few hospitals in the Western Cape use the Unicare EHR systems. Hospitals in the Limpopo province also use the Unicare or Medicom EPR systems [11]. An EHR can be described as a comprehensive electronic collection of a patient's health history that is maintained and controlled by healthcare personnel [1]. The implementation of different EHR systems from various vendors presents a challenge as these systems are built with different underlying database architectures and therefore often fail to communicate and share information amongst each other. However, while these systems have been implemented in a few areas, the majority of the public health centres in South Africa still make use of a paper-based record system [12].

TrakCare Lab: From 2008, this proprietary laboratory management information system (InterSystems Corporation®) has been used by most laboratories in the National Health Laboratory Service that is responsible for all diagnostic pathology in the public sector [13]. Patient details are entered into the system either manually or scanned from barcodes, and results are printed or available electronically via the Internet on computers and smartphones.

Picture archiving and communication systems (PACS): Many South African public sector hospitals have implemented PACS systems but none seem to be operating optimally [14]. While current digital radiology imaging machines use the Digital Communications in Medicine Standard (DICOM) to communicate standard information on images [15], PACS vendors use different formats for non-image data (patient identifiers and clinical details), file registry and repository [14]. Thus, vendors' systems are not interoperable, and significant costs are involved in changing files if migrating to another vendor's system. Other problems identified included disruption to workflow, a lack of integration with existing patient information systems, an absence of government standards for PACS integration, and a lack of expertise in project management [16].

JAC Pharmacy System: This proprietary pharmacy dispensing and stock control system was launched in 1999 and is now installed in most hospitals in the Western Cape, [17] and in an increasing number of CHCs, totalling 70 facilities in 2015.

Patient and Operational level HIS: Administration systems.

CLINICOM Hospital Information System: This is used by nearly all hospitals in the Western Cape, providing patient demographic and hospital administration data. It supplies a unique patient identification number that is shared across other HIS for public-sector users throughout the Western Cape [18].

Delta 9™ Hospital Information System: Little detail is provided on the company website about the functionalities of its product Unicare™ that are used in 108 institutions (hospitals and clinics) in both the

 J Health Inform Afr. 2017;4(1):51-57. DOI: 10.12856/JHIA-2017-v4-i1-164

public and private sector [19]. It contains a master patient index that can provide demographic and administrative data about patient visits based on input from paper records. It does not provide a unique patient identification number and is not HL 7 compatible [19].

Patient Administration and Billing System (PAAB)*:* A private company runs PAAB, which is owned by the Department of Health. While mainly used for administration, a clinical data-recording module has been added but lacks the functionality to enable the data to be used in an integrated manner. However, the system does not currently support electronic linkage to a pharmacy system, direct importing of laboratory or radiology results, and decision support [20].

RxSolution: This stock control programme was funded by the US Centres for Disease Control and Prevention (CDC), and implemented in clinics and hospitals in five provinces [18].

Primary Health Care Information System (PHCIS)*:* PCHIS Basic was developed for public-sector community health sectors and clinics in the Western Cape. It provides demographic data and ICD 10 codes for patient visits. It uses a unique patient identification number (administered by CLINICOM) that is attached to a patient's paper record as a bar code. Data capturers enter data into the system [19]. A second system, EKAPA, was built on the same platform as PHCIS but was for HIV case management and cohort monitoring, and is now being merged with PHCIS (Boulle, A. Personal communication, 26 June 2015).

Patient Record and Health Management Information System (PREHMIS): This is a Linux-based system operated by the City of Cape Town (capital of the Western Cape) in primary care clinics. Data capturers read patient records, select an indicator from a printed menu, and then scan the barcode into a computer [18].

Operational and Strategic Level HIS: Monitoring and Evaluation systems.

Primary health care (PHC) in South Africa is provided mainly by nurses at community health centres (CHCs) and clinics in the public health sector [21, 22]. Data that is required for monitoring and evaluation (M & E) purposes by the Department of Health is hand written by nurses in multiple registers (mainly for vertical programmes) within each clinic and then aggregated for data capturers to enter in electronic HIS [9]. This process is associated with poor data quality, and the nurses perceive a high work burden [23-25]. In 2010, Odama et al. [14] found no evidence "that data analysis informs any policy or programme management in individual clinics" in the Eastern Cape Province.

National Health Patient Registration System: This system allows identity verification and records the reason for a visit and is installed in 650 public PHC facilities countrywide. The system is considered the most reliable source of national patient demographic data [26].

DHIS: South Africa has a District Health Management Information System (DHMIS) that is responsible for the collection and analysis of routine healthcare data from all primary care facilities and district hospitals in the public sector [27]. This function is achieved by use of the open source District Health Information System Software (DHIS). A National Indicator Data Set has been developed, consisting of about 200 indicators, of which 140 are relevant for PHC [28]. Data for calculation of these indicators is sent monthly from health facilities to the Department of Health (DoH). Provinces are asked to report 27 indicators quarterly to the National DOH [29]. Surveys, census data and registration of deaths and births supplement the routine monthly data.

Weaknesses identified in the DHMIS include limited alignment of the goals of the health sector and the present indicators; too many indicators, especially with requirements for donor-driven programmes; lack of Information and Communication Technology (ICT) infrastructure, and a lack of experienced health information personnel [27, 28]. Challenges with DHIS software include that it stores aggregated data which means patient-level data cannot be analysed, and there are no cut-off dates for data input resulting in inconsistent outputs [28]. Other HIS challenges include legislative, leadership, software and hardware resources, and data management. Data for vertical programmes are collected separately and later incorporated into the DHIS.

 J Health Inform Afr. 2017;4(1):51-57. DOI: 10.12856/JHIA-2017-v4-i1-164

3.3 Challenges with current HIS

The eHealth strategy of South Africa states that "data quality will remain inferior where there are mainly paper-based systems or a mix of paper and computerised systems" [2, p21]. Challenges have been identified with the data quality of the health care system in South Africa. It is useful to classify these challenges according to the socio-technical theory as a starting point to understand and address the challenges. The socio-technical theory, first developed by Trist and Bramforth in the 1950s, describes the social and technical dimensions that affect the data quality in the PHC sector in South Africa [20]. The technical subsystem comprises the devices, tools and techniques needed to transform inputs into outputs in a way which enhances the economic performance of the organisation. The social system comprises the employees and the knowledge, skills, attitudes, values and needs they bring to the work environment as well as the reward system and authority structures that exist in the organisation.

Technical subsystem.
While there is an eHealth strategy in South Africa, there is no national master patient index and enterprise architecture that support the national public health system. The development of HIS is flawed as too many health indicators are included for reporting purposes with no clear delineation to the health outcomes that they support [30]. Other technology barriers that contribute to the failure to implement HIS systems include the high costs associated with these systems. The lack of ICT infrastructure needed to support these systems was also highlighted as a further challenge and includes the lack of computer equipment as well as reliable Internet connectivity. Additionally, there is insufficient capacity for data analysis in the health care department [30]. This has resulted in differing levels of eHealth maturity across and within provinces with a large number of different HIS from which little or no interoperability and communication is possible. As a result, information silos have developed which contribute to the duplication of effort and discrepancies in reporting [31].

The social subsystem.
The prevalent paradigm in South Africa is that data capturers undertake data entry from clinician paper records. Problems identified with the manual system include lack of continuity of care due to missing or duplicated files, time wastage as data have to be duplicated in multiple registers, and data entry errors. This statement is supported by the National Health Research Summit which identified poor information systems at facility level to provide information on the implementation of health interventions [4]. Venter [32] concurs that there is inaccurate reporting on the numbers and treatment and outcomes. Accurate M & E statistics are often only available at research sites. Therefore, this also means that clinicians are not engaged in information management and its use other than as the collector of the data [16].

There is an increased recognition that the failure to implement effective HIS cannot be attributed only to technology factors. The role that managerial, cultural and financial issues play in the success of information technology projects must be considered. There is thus an increased awareness of the interrelation between technology and the social environment in which it exists. This has necessitated a new research focus area with particular emphasis on the human and organisational factors involved [16, 33]. Factors that will contribute to the acceptance of HIS by health care workers include the attitude of the health care worker towards the HIS, the leadership style, the organisational structure, and change management when planning and implementing the technology. Individual barriers reported include the computer literacy skills of the healthcare workers and their awareness about the purpose and benefit of the system [25, 33]. Often healthcare workers are not consulted when new systems are designed, which could mean that the workload of the healthcare worker is increased as the technology does not fit into daily workflow processes [33]. While some EPR systems do capture limited clinical information, there seems to be no EPR that supports patient-centred clinical care in South Africa [34]. There is also limited evidence of the effectiveness of EPR systems in the PHC system at present, which has resulted in pilot projects not being sustainable [30].

4 Discussion

From the literature it is clear that the National Department of Health has prioritized HIS to improve the health care quality especially in the public health care sector, however there is no implementation plan as

 J Health Inform Afr. 2017;4(1):51-57. DOI: 10.12856/JHIA-2017-v4-i1-164

of yet. The development of HIS, despite the eHealth strategy, has been done in silos and on an ad hoc basis as the need arose for different task-based services to be completed. These legacy systems make it difficult to implement an overall HIS that will be able to serve the needs of the patient, health care worker, hospital manager and National Department of Health.

While there are clinical systems to record patient data, these are mostly support services e.g. radiology and pathology without EHRs that are able to integrate all the services. Patient-centered care is defined as "care that is respectful of and responsive to individual patient preferences, needs, and values" [35]. However, the most advanced HIS seem to support the upper level activities of the HIS pyramid such as monitoring and evaluation or administration needs of the Department of Health. The lack of patient-centered care could be one of the reasons health care workers are resisting the use of HIS as they perceive the systems as non-beneficial to their patients

In summary, existing HISs in South Africa are predominantly paper-based and geared toward M & E and administrative purposes of public health programmes. The lack of integration between the various systems that was identified makes it difficult to use the systems for patient-centric care. However, there is the beginning of integration of systems in the Western Cape which links a unique patient identifier module to a master patient index that can then be interfaced.

While some systems do capture limited clinical information, there seems to be no public sector EPR that supports patient-centred clinical care. A paradigm shift is needed in South Africa towards designing an EPR for patient care rather than for collecting epidemiological or management data. Information should support clinicians' decisions and actions; 'if it fails to do this, it is irrelevant noise'.

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Statement on conflicts of interest

There is no conflict of interest that the authors need to declare.

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