3 eHealth Programme reference implementation in primary health care facilities

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The South African eHealth Strategy (2012) provided the framework to govern and co-ordinate initiatives supporting digital health in South Africa. This strategy formed the basis for a roadmap towards the development of a standards-based eHealth enterprise architecture. The Health Normative Standards Framework was published in order to support interoperability and convergence of data sources. The process of defining the integrated eHealth architecture building blocks did, however, highlight a lack of national co-ordination resulting in data repositories maturing in isolation without contributing to the broader eHealth ecosystem.

Health Information and associated technologies have a high degree of complexity and in order to navigate the policy, legislative and regulatory terrain efficiently, the National Department of Health implemented an integrated programme in the 10 National Health Insurance (NHI) pilot districts. The programme was used to develop and refine the eHealth architecture building blocks and assess the challenges in implementation of the interoperability norms and standards. This is being achieved through a reference implementation methodology, as described in this chapter.

Preliminary results indicate the need for in-depth engagement with the health system at the primary health care facility level. Local ownership is essential for the sustainability and success of the programme.

The eHealth Strategy forms the basis for a roadmap towards the development of a standards-based eHealth architecture.

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Introduction

The Negotiated Service Delivery Agreement (NSDA) 2010–2014 of the health sector, produced in 2010, observed that:

> Although large sums of money have been used to procure health ICT and HIS in South Africa in the past, the ICT and HIS within the Health System are not meeting the requirements to support the business processes of the health system thus rendering the healthcare system incapable of adequately producing data and information for management and for monitoring and evaluating the performance of the national health system. This results from the lack of technology regulations and a lack of policy frameworks for all aspects of infrastructure delivery.[1]

This chapter describes the major developments in preparing the South African National Health Information System for the institution of a shared electronic health record through the Primary Health Care (PHC) eHealth Programme. The foundational steps consist of the key components – or building blocks – of an integrated health information system. This encompasses the policy framework, the technical information architecture design, and the reference implementation methodology used to test and contextualise the methodologies going forward.

The eHealth Strategy for South Africa[2] is a roadmap for achieving a well-functioning, patient-centred electronic national health information system. The strategy ensures that the integrated national patient-based information system will be based on agreed scientific standards for interoperability, improving the efficiency of clinical care, producing the indicators required by management, and facilitating patient mobility.

The realisation of the national health information architecture, or eHealth enterprise architecture, proposed in the eHealth Strategy is an iterative process nested within the establishment of key building blocks or technical components. This is to facilitate integration with other information systems in the health sector as a critical enabling factor for the implementation of National Health Insurance (NHI).

The PHC eHealth Programme addresses the principles required for South Africa to move to the next eHealth maturity level, such as establishing a unique identifier for each patient, and patient-based information systems being installed at all facilities where health care is delivered. All patient-based systems will be linked to a national electronic health record repository, thereby supporting access by all facilities to all records at all other facilities. All routine public health data will then derive from patient data captured electronically at the point of care.

Several of the foundational eHealth components required by the eHealth Strategy have been implemented. These include:

- The National Health Normative Standards Framework for interoperability in eHealth (HNSF).[3] This framework was developed and gazetted in the public domain by the Minister of Health on 1 April 2014, and commissioned by the National Department of Health (NDoH) from the Council for Scientific and Industrial Research (CSIR). The primary objective of the first version of the HNSF was to set the foundational basis for interoperability in national healthcare information systems.
- The National Data Dictionary.[2] This provides an up-to-date version of dataset specifications including data elements, indicators and data validation rules, and currently serves as a public healthcare facility registry. It therefore offers a reference point to facilitate data exchange between electronic systems as required by the eHealth Strategy and District Health Management Information System (DHMIS) policy.[4]
- The Health Patient Registration System (HPRS). The Green Paper for National Health Insurance in South Africa[5] identified the need for a patient registration system, so as to plan the provision of healthcare facilities and services as well as support tracking the usage of health services. This requires the provision of patient indexing capabilities for electronic health records. The HPRS has been developed and set up to provide a Patient Registry and Master Patient Index (MPI) service using the South African Identification Number and all other legal personal identification numbers (e.g. the passport number) as the primary patient identifier, making it possible to track patients at all levels of care for improving quality and continuity of care.

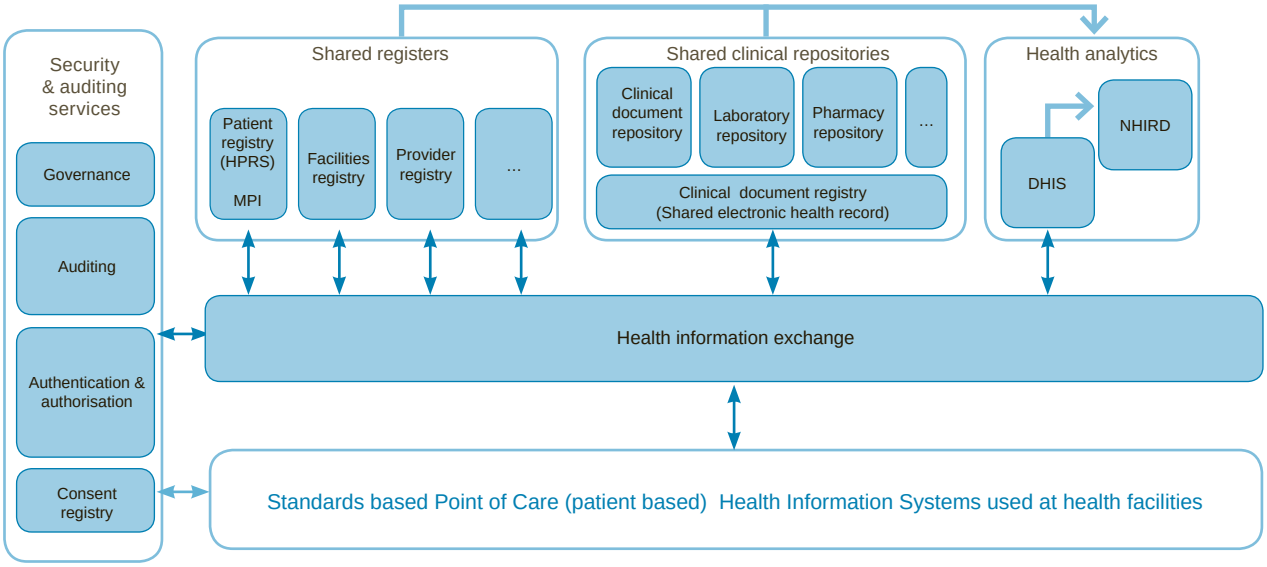
Description of the enterprise architecture

Health Information is captured and required for different purposes at different levels of the health system. In order to co-ordinate the exchange of health information data, it was imperative to design a framework within which the different information systems and data repositories interact in a standardised manner. The HNSF proposes the architecture of a fully integrated national shared electronic health record. This is illustrated in Figure 1 and is termed the National Enterprise Architecture.

A number of technical components are required to enable interoperability between eHealth systems that comply with the stated standards. The HNSF establishes, among others, the following:

- Facilitation of interoperability between different eHealth systems on the basis of participating systems complying with the HNSF standards
- Maintenance of electronic shared registers and repositories required to support eHealth interoperability
- Provision of appropriate security and auditing services to ensure data integrity, preventing unauthorised access and complying with privacy legislation
- Provision of health analysis support for purposes such as analysing the health of the population and planning.

Figure 1: The National Enterprise Architecture described in the HNSF



Source: Adapted from the eHealth Interoperability Health Normative Standards Framework, 2014.[3]

The Health Information Exchange (HIE) described within the broader shared eHealth enterprise architecture approach as recommended by the HNSF is an interoperable layer that enables sharing of electronic health-related information among compliant health information systems used in health facilities. The HIE implements the norms and standards defined by the HNSF by controlling and mediating standard-based messages between compliant consumer applications and shared registers and repositories.

Shared electronic registries are used to store, manage and provide access to master demographic and other information stored by entities, as required for interoperability. The patient register (provided by the HPRS) will be the authoritative source of patient demographic information. It will allow authorised applications and systems to feed into the HPRS, effectively allowing them to create patient files and update patient demographic data. It will also allow authorised implementations to search for patient information and retrieve their demographic and identifier data.

The shared electronic facility and provider registries will contain information on all health providers and facilities in the country. Facility information will include attributes such as 'facility name', 'physical location', 'offered services' and 'contact information', while the provider information will contain demographic information of health service providers including doctors, nurses and community health workers. The National Data Dictionary provides the capability to establish an electronic facility registry.

Shared clinical repositories will be used to store and provide controlled access to clinical information of patients related to healthcare encounters. Shared clinical repositories will facilitate the construction of a longitudinal health record or medical history over different encounters at different facilities using various eHealth applications that are standards-compliant. The shared clinical repository will, in essence, provide a subset of the clinical information at point-of-care health information systems utilised by different health facilities, and therefore does not replace the need to maintain accurate patient records for local use.

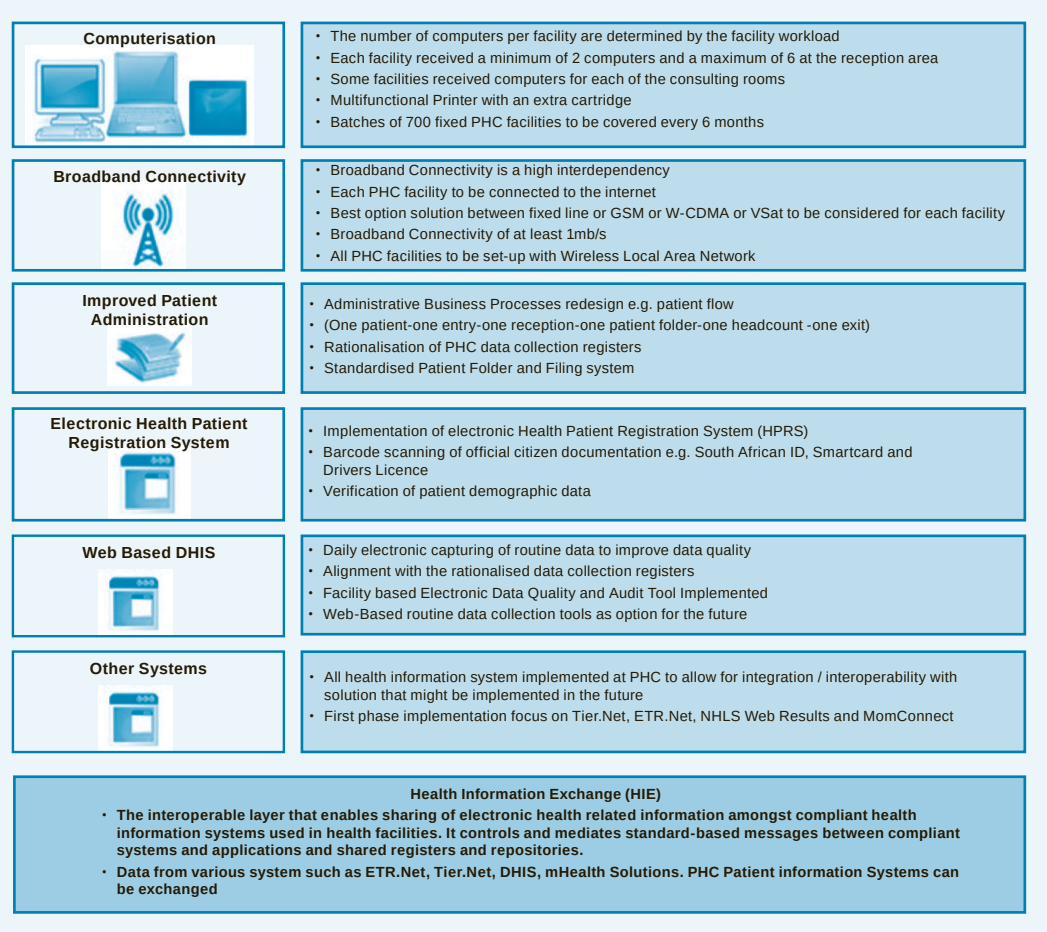
Health analytics make it possible to derive surveillance data from shared clinical repositories. These capabilities are progressively built into and provided by the District Health Information System (DHIS) and the National Health Information Repository and Data warehouse (NHIRD).

The security and auditing services component will provide audit services to ensure that the privacy, security and integrity of information exchanged and stored within the eHealth enterprise architecture ensures compliance with legislation, which includes the National Health Act (61 of 2003)[6] and the Protection of Personal Information Act (4 of 2013).[7]

Reference implementation of the eHealth enterprise architecture

The PHC eHealth Programme focused on the 700 primary health care facilities in the NHI pilot districts as a unique opportunity to implement and refine this strategy, with the vision of its expansion and upscaling for the improvement of the health system. In the context of the eHealth enterprise architecture, several modules were identified for roll-out in the 700 NHI pilot district PHC facilities as part of an integrated health information package that supports implementation of NHI (Figure 2). Pilots of other public healthcare electronic services – such as TIER.Net and ETR.Net – are also ongoing. The first five modules are described in this paper along with the implementation strategy and findings to date.

Figure 2: 700 PHC facility intervention modules



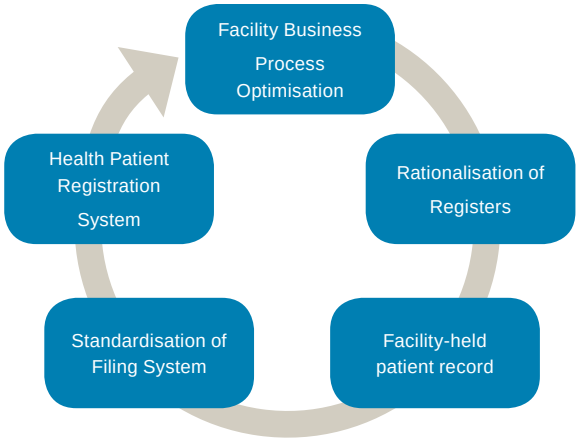
Computerisation and broadband connectivity

A critical dependency for introducing any electronic-based data management components is the provision of foundational information and communications technology (ICT) hardware. A package of ICT hardware and utility software was selected to ensure compatibility with current and future needs and cost-effectiveness, and provided to PHC facilities. Equipment is fully compliant with State Information Technology Agency (SITA) standards, and procured with three-year on-site next-business-day support. The utility software package was pre-installed on all computers to support the reference implementation of the PHC eHealth Programme. This standardisation makes it possible to provide cost-effective support for both hardware and software, with continuity of access to software applications deployed by the Department. This initiative ensures that the minimum required hardware is available at PHC facilities and that this is dedicated for the implementation of health information systems. Ensuring adequate data connectivity is a consultative process between the NDoH, provinces and districts, with access control to limit data abuse being a central feature.

Improved patient administration

A cohesive patient administration system is the first step in ensuring a rationalised process of patient access to healthcare facilities that in turn supports quality health information services and effective facility management while improving patient experience. Five elements were identified as key to its iterative development: the optimisation of facility business processes; the rationalisation of registers; the development of a standardised facility-held patient record and accompanying filing system, and the development of the HPRS.

Figure 3: Patient Administration System



Facility business process optimisation

The introduction of electronic registration tools at a PHC facility will contribute to efficiency gains, but is not a panacea for existing problems. Prolonged waiting times at facilities contribute negatively to the patient experience of care. Prior to the introduction of electronic registration tools, it is important that the facility flow is functioning optimally and that its business processes are refined.

To address this, facility patient and data flows were redesigned through business process mapping to support health facility administration as a means of optimising patient and facility management. These restructured business processes enabled the assignment of designated areas for specific activities within each facility, thereby streamlining key functions. Activities such as patient registration, patient record retrieval, patient appointment and visit recording (PHC headcount) are now contained as one business process within designated reception areas. This process is further guided by the Integrated Care Service Model (ICSM) to restructure clinical care functions in a manner that obviates patients having to visit many consulting rooms spread across the facility to receive care. Patients will now receive one-stop service in one consulting room or designated service area.

Rationalisation of routine data collection tools

A pilot study was commissioned by the NDoH for Health Systems Trust (HST) to test the acceptability, feasibility and effectiveness of rationalising the average of 54 routine data collection tools used in PHC facilities. The study paved the way for the implementation of a rationalised set of six registers for collection of routine health programme data as of the 2015/16 financial year. Based on these results, programmatic data were delineated from clinical, management and administrative data. Other systems and tools were then designated to collect management and administrative data, such as the HPRS and patient records.

Moreover, the rationalisation process led to the standardisation of data collection and collation tools in order to improve timeliness and data quality. Other benefits include a reduction in the administrative burden placed on facility staff, and more time to be spent rendering clinical services.

Development and implementation of a standardised filing system

A uniform system was designed that ensures (a) integrity and continuity of records, such that records remain complete and accessible with minimal misplacement, loss and duplication; (b) efficiency in minimising time wasted in searching for records; and (c) communication using a common filing language that fosters co-operation in the retrieval and exchange of records within the facility in general. The resultant design was an Alpha Numeric Filing System (ANFS) to enable identification of the facility, identification of the patient, and locating the physical position of the patient record within the filing system. The ANFS thus required a record identification system, with the HPRS providing the perfect technology and in turn facilitating integration of the ANFS into the HPRS.

The Alpha-Numeric Filing System:

- uses the technology provided by the HPRS to automatically generate the patient record number, thereby linking the unique patient identifier to each patient's record in each facility;
- reduces the risk of human error as the patient record number and allocation are automatically produced and controlled by the HPRS;
- automatically incorporates the position of the patient record on the filing cabinet into the record number generated by the HPRS;
- allows for rapid retrieval of patient files, consequently reducing waiting time and optimising the functionality of the facility;
- provides a common filing language that ensures continuity despite changes in personnel; and
- is adaptable for different sizes of filing cabinets across the facilities by taking into account varying infrastructural realities.

Electronic Health Patient Registration System

The National Department of Health contracted the CSIR to develop a Health Patient Registration System. The HPRS will maintain an index of patients using healthcare services, and is designed to maintain and cross-reference a set of identifiers including the South African Identification Document, passport numbers, the driver's licence, asylum permits and refugee permits. It therefore offers Master Patient Index capabilities and will serve as a patient registry to standardise compliance with eHealth applications. This capability is essential for a shared electronic health record, and is therefore critical for improving the quality and continuity of care in the public health system.

The HPRS is also linked to the standardised filing system, thus assisting with faster file retrieval and storage. Currently there are over 500 000 patients registered on the system.

Web-based District Health Information System

In the South African context, the District Health Information System (DHIS) plays a pivotal role in the capturing, reporting and analysis of routine data. The existing manual data capture and verification processes require a 45-day period between when source data is collected and aggregate information is made available at national level. Improving timely access to data is central to the PHC eHealth Programme: the move to a Web-based DHIS (WebDHIS) is structured around making facility-level aggregate data available for health analytics as soon as possible after it is generated.

Implementation strategy

The successful implementation of this system hinges on a tight sequence of events, namely hardware deployment and establishment of connectivity, training in the use of the software, and careful

implementation of a change management process to ensure that nurses and clinicians are supported in the move from paper-based systems to electronic systems. Optimal usage of all resources for development, training and roll-out is in line with the ethos of an integrated approach.

The approach to implementation was centred on establishing sentinel sites to attain a national footprint and contextualise the intervention in the NHI pilot districts.

Phase 1: Beta or sentinel sites to prove concept and refine strategy, implemented in a staggered approach. Lessons learnt included the importance of stakeholder engagement and ownership, and sensitivities to maturity model and context.

Phase 2: Full district deployment to demonstrate district-level health system strengthening. The implementation team followed an action-learning approach and responded to problems as they arose rather than adhering to a rigid framework for implementation. The implementation guide used the terminology 'maturity level' to depict the different stepping stones, with zero being ground level, and Level four being the peak.

The maturity model would comprise different levels that a province, district or facility may achieve over time as more prerequisites for the level become established. Some levels may be implemented concurrently, provided that the prerequisites for the level are in place.

Box 1: Different levels of maturity

Maturity Level Zero: Stakeholder engagement national, provincial, district and facility level Buy-in for an integrated approach; facility-level support is critical for success
Maturity Level One: Deployment of IT hardware support Co-ordinated with the provincial and district IT departments
Maturity Level Two: Site preparation, hardware integration and phased connectivity Facility flow and patient administration optimised; networked computing
Maturity Level Three: Implementation of Health Patient Registration System and Web-based District Health Information System solution Improves patient file retrieval and waiting time; efficient reporting because staff have more time for clinical services
Maturity Level Four: Web-based reporting and online capture Centralised routine data and therefore real-time data

The first level of implementation engagement is termed Maturity Level Zero. This entails the vision of the programme being communicated at all levels of the health system, starting with the provincial stakeholders, in order to establish the necessary legitimacy for implementation. The next step is to engage the districts that will be ultimately responsible for technical and information support to the facilities. This process brings about changes in the health system and it is thus imperative that the immediate reporting hierarchy be both responsive and supportive of these changes.

The engagement model continues with the orientation of the facility staff, in particular the operational managers. It is at this point that the most significant functional changes occur, and the lessons learnt from the Beta Testing in the 50 sentinel sites indicated that the highest levels of anxiety and inertia were experienced in this area. In order for Maturity Level Zero to be reached, full understanding of and support for the local facility and district staff must be in place. The level of effort required to reach maturation of this level varies and is context-specific. In regions where structured systems are in place or a legacy of operating in a particular environment exists, more investment in achieving Maturity Level Zero is required.

Only once sufficient support is attained can activities relating to Maturity Level One commence. This level focuses on preparatory activities to ensure that the health facilities have adequate infrastructure to implement new systems.

Maturity Level Two focuses on the streamlining of business processes, such as the allocation of a single area for patient registration and patient flow optimisation. Technology supports processes and improves efficiencies; it can only augment service delivery when these have been addressed. In addition to identifying ways to improve administrative and clinical service structures, the facility data quality was assessed as a baseline indicator. This contact with the facility was an opportunity for implementers to engage directly with the facility staff and act as change management agents. Level Two also establishes the first level of connectivity: a local network that links the hardware and computers in a facility to improve services and assist in the aggregation of information at the facility.

Maturity Level Three is based on using information systems to adapt the way in which processes operate in the health facility. The targeted area of intervention is the standardised patient registration system. This complies with the building blocks for National Health Insurance and assists with workflow management at the reception desk area of a health facility. The full value of this system is evident when synchronised with a central server (where Internet connectivity is available). However, as there is a prevailing risk of Internet downtime in the South African context, this system has both online and offline capacity with the ability to synchronise when connectivity is available. Improving data quality is driven by the practice of daily data capturing. This reduces error as smaller amounts of data are collated daily, and only these daily totals are added to compile a monthly report, which lowers the chance of errors. The District Health Information System has been configured to accept daily totals and automatically generate a monthly report.

Maturity Level Four involves facilities being linked to the Internet. This level is of particular interest to district and provincial management as it allows for real-time monitoring of facility utilisation and performance. Connectivity streamlines the information data flow with efficiency gains due to reduced administrative burden, as well as the improved link between measurement and accountability of data quality.

Vhembe case study

Vhembe is a rural district located in Limpopo Province with 123 PHC facilities, of which eight are community health centres (CHCs). There is a shortage of clinical and administration staff, as well as of landlines or stable mobile phone network coverage.

The PHC 700 Project, as part of the Beta Implementation phase, was responsible for providing six PHC facilities with Internet connectivity in 2014. Subsequently, in early 2015, the Limpopo Provincial Department of Health decided to leverage the province's ongoing Telkom telephonic infrastructure project to provide Internet connectivity in Vhembe which included 1 gigabyte of data. The Vhembe Health District Task Team was set up to drive implementation of connectivity and its utilisation in the district, and by July 2015, 90 PHC facilities were connected.

The NDoH used this opportunity to identify requirements for implementing a Maturity Level Four model throughout a district. Support teams provided comprehensive on-site technical and service training assistance over four weeks in July and August 2015.

Installation and use of the standardised patient registration system were supported, along with three other real-time facility monitoring services: daily data capturing for WebDHIS to ensure daily access to facility indicators; Stock Visibility Solution for facility pharmaceutical stock visibility; and NHLS TrackerCare for timeous access of laboratory results online. Fifty-two facilities were visited over the course of the four-week period.

The connectivity project was judged successful in terms of outputs and increased capacity, based on the commitment from both the NDoH and the province to ensure that connectivity infrastructure was available, as well as to provide structured data access at the non-Telkom supported facilities. Telkom had connected 84 of the 90 PHC facilities through VSAT (Very Small Aperture Terminal) satellite infrastructure, with six as NDoH installations. Fifteen of the 46 Telkom-implemented sites that were visited required assistance with establishing data connections. The Telkom installations did not allow the provincial authorities the same level of control as was experienced at the NDoH installations in limiting online access to sites: facilities that reached the data cap were then unable to submit or access data for the remainder of the month.

In general, facilities without administrative staff had limited or no use of online services. The reasons consistently given for this ranged from administrative staff being the first to notice and address connectivity issues, to low levels of digital literacy (most nurses of an older generation were less willing to engage with new technologies; also, nurses tended to regard their primary focus as being clinical care with data management as an additional workload). District staff did not feel capable of training others on the connectivity-enabled services, in part because of insufficient training but also due to a lack of teaching tools on basic computer skills. The District Task Team was committed to the implementation, with a strong sense of teamwork, although its ability to provide on-site support to facilities was reliant on additional support from the NDoH and provincial Department of Health.

Recommendations included ensuring that each PHC facility has at least two administrative staff. A phased capacity-building plan based on up-skilling local resources, with additional resources made available where necessary, is key to sustainability. Above all, the concept of data as critical to quality health care must be promoted among healthcare workers.

Lessons learnt

Additional human resources often support the implementation of new systems and processes in the context of the public health system. This allows for the rapid deployment of solutions but raises difficulties around ensuring sustainability.

Processes should be owned and implementation should be driven by provincial, district and facility staff members so as to facilitate institutional change and thus support sustainability.

An engagement model was developed to establish adequate ongoing support from within the health system so that an enabling environment could be created.

The Beta Implementation

The Beta Implementation phase (which consists of sentinel sites and is intended to prove the concept and refine the strategy), tested an implementation approach, tools and strategy at the 50 Beta Implementation sites across eight participating provinces. Such an undertaking was made possible through sufficient capacity-building at provincial level in order to promote local ownership and accountability. The initiative provided for benchmark implementation which will be used for the development of a rapid scale-up programme. Success drivers were revealed to be provincial ownership, co-ordinated and integrated implementation, and local capacity-building. The experiences gained from the implementation phase identified that allowance should be made for province-specific scenarios to ensure rapid scale-up and sustainability.

Conclusion

The PHC eHealth Programme's reference implementation of the eHealth interoperability norms and standards entailed massive systemic overhaul. It was therefore essential that buy-in from the grassroots officials be secured for its success. Every programme implementation commenced with a provincial-level meeting, and tools and knowledge were handed over to ensure sustainability.

Several key factors were identified for implementation. In order to implement the Programme, the technical requirements at each facility will have to be met. These are: adequate IT infrastructure (hardware and software), data connectivity via a stable connection to the Internet, and provision for electrical spikes and other contingencies.

Ensuring capacity at the health facilities is critical. This requires not only sufficient staff who are adequately trained on the software packages, but also sensitisation to the change management process. As each health facility is a unique context, the assessment and streamlining of the current facility filing systems (record management) will assist with the implementation of the patient-based systems. All stakeholders should be engaged in the visibility activities to ensure buy-in.

The introduction of computers and conversion of paper-based information systems to electronic systems is no small task, and the change management process that is required to make a successful transition should not be underestimated. Implementation of this programme offers manifold potential benefits to the health system, including more accurate data and shorter timeframes between end-of-reporting periods and availability of data for programme management.

The integrated implementation of the eHealth strategy undertaken by the National Department of Health in the NHI pilot districts has the potential to revolutionise how information is collected and patients are managed.

References

1 National Department of Health. Negotiated Service Delivery Agreement. A long and healthy life for all South Africans. Pretoria: National Department of Health; 2010.

2 National Department of Health, South Africa (2012): eHealth Strategy South Africa, 2012-2016. URL: http://www.doh.gov.za/docs/stratdocs/2012/eHealth_Strategy_South_Africa_2012-2016.pdf (Accessed 19 September 2013).

3 Minister of Health. Notice in terms of the National Health Act No 61 of 2003: National Health Normative Standards Framework for Interoperability in eHealth. Government Notice No. 353, Government Gazette No. 37624, 9 May 2014. URL: http://www.gov.za/sites/www.gov.za/files/37624_gon353.pdf

4 National Department of Health (2011): District Health Management Information System (DHMIS) Policy, Pretoria.

5 Minister of Health. National Health Insurance in South Africa Policy Paper. Government Notice 657. Government Gazette No. 34523, 12 August 2011.

6 Republic of South Africa. National Health Act (Act 61 of 2003).

7 Republic of South Africa. Protection of Personal Information Act (Act 4 of 2013). Government Notice No. 912, Government Gazette No. 37067, 26 November 2013. URL: http://www.gov.za/documents/download.php?f=204368