

# ICT applications as e-health solutions in rural healthcare in the Eastern Cape Province of South Africa

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## Abstract

Information and Communication Technology (ICT) solutions (e.g. e-health, telemedicine, e-education) are often viewed as vehicles to bridge the digital divide between rural and urban healthcare centres and to resolve shortcomings in the rural health sector. This study focused on factors perceived to influence the uptake and use of ICTs as e-health solutions in selected rural Eastern Cape healthcare centres, and on structural variables relating to these facilities and processes. Attention was also given to two psychological variables that may underlie an individual's acceptance and use of ICTs: *usefulness* and *ease of use*. Recommendations are made with regard to how ICTs can be used more effectively to improve health systems at five rural healthcare centres where questionnaire and interview data were collected: St. Lucy's Hospital, Nessie Knight Hospital, the Tsilitwa Clinic, the Madzikane Ka-Zulu Memorial Hospital and the Nelson Mandela General Hospital.

## Key Words (MeSH):

*Computer Communication Networks; Communication; Telemedicine; Rural Health Services; Hospitals; Healthcare Facilities; Health Care Technology; Acceptance Processes; South Africa.*

## The potential of ICT for rural communities

Information and Communication Technologies (ICTs) have the potential to improve the lives of people in rural communities. According to the United Nations Development Program (United Nations Development Program 2006, cited in Ruxwana 2009), increased use of ICTs enhances service delivery by:

- delivering economies of scale to improve access to basic services
- optimising service delivery
- providing incentives for development and transfer of new technologies and products
- increasing efficiency through enhanced connectivity and exchange of knowledge
- enabling regions to focus on delivering services where they have a comparative advantage
- providing access to digital development for continuous improvement.

ICTs are changing rapidly, as are businesses surrounding their implementation (Louw & Hanmer 2002). The need to develop and organise new ways to provide efficient healthcare services has thus been accompanied by major technological advances, resulting in a dramatic increase in the use of ICT applications in healthcare and e-health.

## e-Health

Integration and assimilation of e-health into the everyday life of healthcare workers is becoming a reality in developing as well as developed countries (World Health Organisation 2004). ICTs enable online communication about medical issues and diagnosis of complicated diseases by linking medical practitioners who are separated geographically. They have the potential to change the delivery of healthcare services and patient care, as well as the management of healthcare systems. According to Eysenbach (2001), e-health is an emerging field in the intersection of medical informatics, public health and business, with referral and information delivery enhanced through the Internet and related technologies. In a broader sense, the term characterises not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking to improve healthcare locally, regionally and worldwide by using information and communication technologies. Thus, ICTs are widely perceived to have the capability, if used effectively, to bridge social and economic gaps that divide rural and urban communities (Gurstein 2000, 2005), improving access and providing a wider range of health services to enhance the wellbeing of underprivileged people, such as those in the Eastern Cape Province of South Africa.

## Implementation of ICTs in South Africa

The Presidential National Commission (PNC) on Information Society and Development (2006) states that ICT applications such as e-health are suitable for addressing the digital divide between rural and urban populations, including rich and poor, young and old, males and females, and unequal distribution of health professionals, particularly in specialist healthcare. Computerised health information systems can improve treatment of patients, management of health institutions, and provide up-to-date information for policy and decision making. The PNC defines e-health as the combined utilisation of electronic communication and information technology to generate, transmit, store and retrieve digital data for clinical, educational and administrative purposes (Presidential National Commission on Information Society and Development 2006).

According to the Municipal Demarcation Board (2007), the Eastern Cape Province is generally regarded as one of the poorer provinces in the country, even though it has played a significant historical role. It consists of six district municipalities and 38 local municipalities. The vision of the Department of Economic Development and Environmental Affairs in the Eastern Cape Province states that:

...the province strives to be devoid of the inequalities of the past, to be unified through an integrated and sustainable, economic, social and cultural development; and thus to provide an acceptable quality of life for its entire people in the context of a united, non-racial, non-sexist and democratic South Africa (Eastern Cape Province 2007:3).

In contrast, Thom (2007) states that this province is known as 'home to the poorest districts in the country'. Similarly, the Eastern Cape Department of Health (2006) is committed to attracting appropriately qualified employees to areas of service delivery with greatest need, to retaining good employees through a program of compensation and personal development in order to sustain quality healthcare, and to implementing e-health solutions through telemedicine programs that support education, training and academic services. In spite of these efforts, the Eastern Cape health system has continued to be plagued by challenges such as staff shortages, poor management and weak primary care, coupled with high levels of poverty and unsatisfactory access to basic services such as piped water (Thom 2007).

## The research problem

Although there are many ICT solutions available (e.g. electronic health records (EHR), hospital information systems, district health information systems, telemedicine, patient portals, OpenMRS [Hanseth & Aanestad 2003]), they are neither well-known nor much used in developing rural areas in South Africa. One possible explanation for this anomaly is the limited availability of suitable technologies. According to Herselman and Jacobs (2003), the development of the local economy in rural South Africa, and Africa in general, is severely compromised by lack of infrastructure, services and expertise. This is especially the case for enabling technologies in the information and communication technology arena.

Although it is generally accepted that ICTs have the potential to promote rural development in a number of ways, most scholars believe that the mere presence of ICTs, although vital, is not enough to realise development (Heeks 2002; Herselman & Jacobs 2003; Littlejohns, Wyatt & Garvican 2003; Olugbara et al 2006; Uys 2006). What is needed is the *effective use* of ICTs in rural developmental interventions (Gurstein 2005), and attention to prerequisite variables that facilitate this. Mansell and Wehn (1998) suggest prerequisites include access to ICTs, a variety of ICT-related skills (for producing and using ICTs and ICT services), and an appropriate policy framework. Conradie and Jacobs (2003) mention access to a supporting communication infrastructure that can serve as a link to relevant networks such as the Internet, while van Audenhove (2001) adds an appropriate 'infostructure' system that can provide suitable content and applications via the ICTs.

Another approach is to consider individual psychological variables that might underlie technology acceptance and use. According to the Technology Acceptance Model (TAM) (Davis 1989, 1993) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003), two variables impact on the decision to actually use available ICTs: the Perceived Usefulness (PU) of that technology and the Perceived Ease of Use (PEU). PU can be described as the extent to which a person believes that using a particular technology will meet that person's need(s) or enhance job performance. Thus, PU is largely to do with perceived benefits of using the technology and it is possible that some of the above-mentioned prerequisites for effective ICT use might also be perceived to be such benefits. Availability of useful information (the content of an ICT application) could heighten its perceived usefulness, as could a supportive policy framework. The PEU variable describes the extent to which a person believes that using a particular tech-

nology will be free of effort. Even a useful technology application may not be used if users perceive it too complicated to use or that performance benefits of usage are outweighed by the effort involved (Davis, Bagozzi & Warshaw 1989; Sandberg & Wahlberg 2006). PEU has to do with perceived barriers to using the technology; it is also affected by variables relating to levels of ICT access, access to supporting communication infrastructures and the Internet, and ICT-related skills.

There are many barriers to the implementation of e-health solutions that cause delays or hinder its use. The Commission of the European Communities (2004) stated that healthcare systems around the world are faced with major challenges, although their nature and scale differ between developed and developing countries. The challenges and setbacks facing implementation of e-health in rural areas of South Africa are the focus of the present study and warrant further detailing here.

### **Challenges facing adoption of e-health solutions in South Africa**

The South African health sector faces many challenges, such as epidemics, historical issues, and factors that impact directly on the digital divide between developed and developing countries. Rural communities in particular are compromised by lack of infrastructure, services and expertise, limited resources, low literacy levels and professional isolation (Herselman & Jacobs 2003; Littlejohns Wyatt & Garvican 2003; Olugbara et al. 2006; Uys 2006). Adoption and implementation of e-health solutions is often delayed when underlying problems are not resolved. For instance:

- According to IT-Online (2007), the four fundamentals of e-health solutions are improved access to healthcare, improved quality of care, illness prevention and health promotion, and better efficiency (i.e. better healthcare for the same or lower costs). However, the healthcare sector does not fully benefit from these fundamentals due to delays in reaching agreement on best practice and processes. In South Africa, there appears to be no uniform healthcare approach, let alone a system that can be truly proffered as a proven template for reform that enables by means of technology. Yet the recognised benefits of reform and automation go hand-in-hand.
- The lack of standardisation and integration between health information systems are major barriers to the full realisation of the benefits of e-health solutions. When systems are integrated and

there is a standard way of keeping and updating patient records, only one entry is necessary for each patient. Thus, duplication of diagnosis and patient history is avoided, medical errors reduced and costs saved.

- Further challenges in providing access to healthcare services are due to geographic distribution, as much of the population resides in rural areas. One way to keep information in one place is to implement a card system. A 'smartcard' can be read electronically when a patient goes to a hospital or clinic (IT-Online 2007).
- ICT infrastructure across the country needs to be improved in order to support not only transfer of information across the country, but also a successful e-health solution such as EHR. Some rural hospitals have little or no access to technological resources, a major barrier to implementing solutions (Jacobs 2003).
- Establishing a unique patient identifier is another challenge. In rural areas, some adults and children do not have ID documents, while those that do might not have ready access to their ID documents when hospitalised. Moreover, some people have the same names. Date of birth can also be problematic, as many of the rural aged population have no idea of their birth date, but know instead that they were born, for example, 'on the day of rain'. Identifying the right person quickly when searching for medical information is essential if the system is to be trusted by those who use it. IT-Online (2007) believes the right search mechanism, which is fast and accurate, should be built into the solutions.

In addition to these inherent problems, shortcomings in the knowledge and the skills of patients and health professionals to use ICT solutions represent other challenges. Even when implemented, the benefits of ICT cannot be realised if people are unable to use it. One challenge is to train people in the use of ICT solutions so they can improve their health or quality of service. However, there are other challenges that also need to be addressed before e-health solutions can be implemented in rural areas in South Africa.

### **The present study**

The present paper focuses on factors perceived to impinge on effective use of ICTs as e-health solutions in a Province of South Africa. The aim of the study was to better understand how ICTs can be used more effectively to improve the health system in a selected number of rural Eastern Cape healthcare centres and to make recommendations for their implementation.

The following general question and sub-questions were posed:

**What factors influence effective use of ICTs as e-health solutions in specified healthcare centres?**

- *Sub-question 1:* What technologies are currently in place that can support e-health solutions?
- *Sub-question 2:* What is the level of access to computer equipment at healthcare centres?
- *Sub-question 3:* What is the level of access to the Internet at healthcare centres?
- *Sub-question 4:* What are the perceived benefits of ICT applications in rural healthcare centres?
- *Sub-question 5:* What are the perceived barriers to ICT applications in rural healthcare centres?

**Methodology**

**Methodological approach and measures**

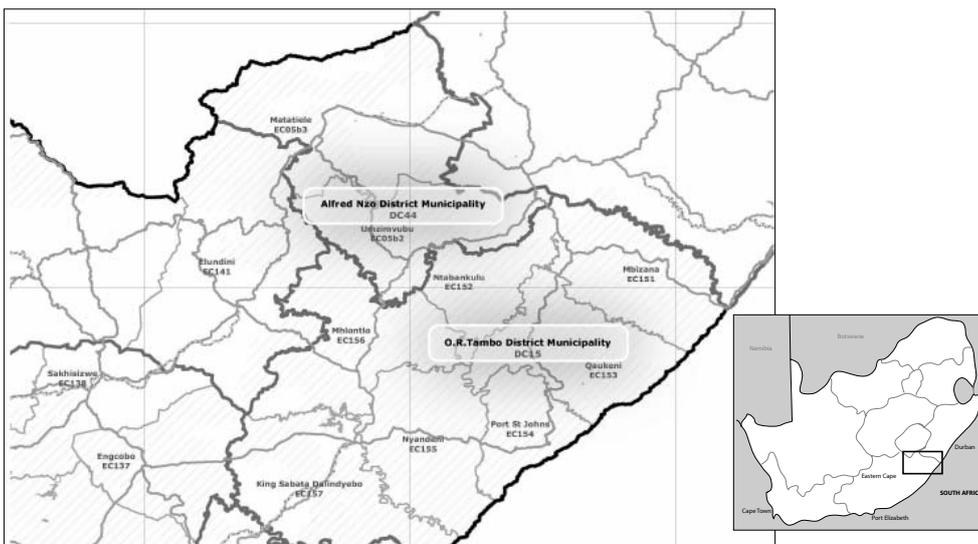
A multiple-case study methodology was applied. This is a type of qualitative research design whereby the researcher investigates a chain of single entities, phenomena or cases confined by time and activity and collects detailed information by using a variety of data collection procedures during a sustained period of time (Creswell 2003:12). According to Yin (2002), a case study of this nature is an empirical investigation of an existing event within its environment. It is mainly used when the boundaries between the event and its environment are not clearly evident. Several means can be applied to collect data using this approach (e.g. interviews, surveys, document analysis, observation, focus groups, questionnaires [Cooper & Schindler 2003]). It allows specific cases to be studied

in greater detail from the viewpoint of the participant by using multiple sources of data (Feagin, Orum & Sjoberg 1991). For the present purposes, questionnaire items and interviews were formulated in accordance with the sub-questions of this study to yield information about the perceptions of the participants on the following matters: .

- the different types of ICTs currently available at the healthcare centres
- the current access to computer equipment at the healthcare centres
- the current access to the Internet at the healthcare centres
- the benefits that ICT applications can bring to healthcare services and communities in the rural healthcare centres, and
- the perceived barriers for ICT applications in rural healthcare centres.

**Rural areas and healthcare centres**

Five healthcare centres in the Eastern Cape Province were selected from two of the most underprivileged districts, namely, OR Tambo and Alfred Nzo districts. The OR Tambo district, with a population of nearly two million people, is regarded as the poorest district in the country with virtually only a quarter of residents having access to piped water (Thom 2007). Similarly, only 40% of residents in Alfred Nzo district have access to piped water. Health indicators in this district are also poor, with the tuberculosis cure rate at 36% and the district having very high and increasing stillbirth and prenatal mortality rates (Thom 2007). Figure 1 contains a map of the Eastern Cape Province in which these two selected districts have been highlighted.



**Figure 1: The OR Tambo and Alfred Nzo district map (source: Municipal Demarcation Board [MDB], 2007. Reproduced here with permission of the MDB.)**

The five rural healthcare centres that participated in this research were the Nessie Knight Hospital, the St. Lucy’s Hospital, the Madzikane Ka-Zulu Memorial Hospital, the Nelson Mandela General Hospital and the Tsilitwa Clinic. Table 1 illustrates their locations. These centres are difficult to access due to road and transport issues. Each hospital is the only centre to render healthcare services in its specific village (except for a few clinics that focus on welfare of children). Communities have to travel for long distances to get to these healthcare centres. Issues such as the quality of service, efficiency and the standard of health care provided, as well as cost reduction in these healthcare centres, are of vital importance. Thus, these healthcare centres were selected due to their remoteness; the large community each has to serve, and the fact that some already have telemedicine solutions implemented (Eastern Cape Department of Health 2006).

**Table 1: Hospital locations**

DISTRICT	VILLAGE/TOWN	HOSPITAL
Alfred Nzo	Mount Frere	Madzikane Ka-Zulu Memorial Hospital
OR Tambo	Mthatha (former Umtata)	Nelson Mandela General Hospital
	Qumbu	Nessie Knight Hospital
	Tsolo	St. Lucy’s Hospital
	Qumbu	Tsilitwa Clinic

**Participants**

A total of 56 people were interviewed, 38 of whom had completed a questionnaire prior to interview. Participants were grouped into three categories: (a) hospital managers, (b) staff (doctors, nurses and

administration clerks/personnel), and (c) hospital inpatients at the time of data collection. (Tables 2 and 3 refer).

**Sample selection**

Care was taken to ensure that each of the three groups contained a range of people from different backgrounds for both the interview and the questionnaire. Participants consisted of a mix of youths or students, elderly people, professional nurses, assistant nurses, clerks, doctors, matrons and hospital managers. It was hoped that this broad range of respondents would contribute to the generalisability of the results.

**Survey instruments**

For each group, a detailed questionnaire and interview schedule was drafted. (Summary details of these survey instruments are included in Appendix A. For the purposes of this publication, only information relating to responses of direct relevance to the present research questions has been reported). Managers and staff provided information on all research questions, while patients’ responses generally yielded data on perceived benefits of and barriers to ICT applications in rural areas.

- *Questionnaires:* A total of 38 completed questionnaires were received: 9 from Madzikane Ka-Zulu Memorial Hospital; 12 from Nelson Mandela General Hospital; 8 from Nessie Knight Hospital; 7 from St. Lucy’s Hospital and the remaining 2 from the Tsilitwa Clinic. Table 2 indicates the distribution and response rate from each hospital.

**Table 2: Number and distribution of questionnaires completed**

CATEGORY	NUMBER OF QUESTIONNAIRES COMPLETED					TOTAL
	NESSIE KNIGHT HOSPITAL	ST. LUCY’S HOSPITAL	TSILITWA CLINIC	MADZIKANE KA-ZULU MEMORIAL HOSPITAL	NELSON MANDELA GENERAL HOSPITAL	
Manager	1	1	1	1	1	5
Staff	5	6	1	4	6	22
Patient	2	0	0	4	5	11
Total	8	7	2	9	12	38

**Table 3: Number and distribution of interviews conducted**

CATEGORY	NUMBER OF INTERVIEWS CONDUCTED					TOTAL
	NESSIE KNIGHT HOSPITAL	ST. LUCY’S HOSPITAL	TSILITWA CLINIC	MADZIKANE KA-ZULU MEMORIAL HOSPITAL	NELSON MANDELA GENERAL HOSPITAL	
Manager	1	1	2	1	1	6
Staff	5	6	2	6	6	25
Patient	5	5	5	5	5	25
Total	11	12	9	12	12	56

- *Face-to-face interviews:* Table 3 details the number and distribution of face-to-face interviews conducted by the researcher (NLR) between January and March, 2007. A total of 56 people were interviewed in five rural healthcare centres: 12 from Madzikane Ka-Zulu Memorial Hospital, 12 from Nelson Mandela General Hospital, 11 from Nessie Knight Hospital, 12 from St. Lucy’s Hospital, and 9 from the Tsilitwa Clinic. Interviews conducted among hospital staff and administrators were mostly a follow-up to previously administered questionnaires.

**Ethics approval**

Ethics approval from the Eastern Cape Department of Health was obtained before any information was gathered from any of the healthcare centres concerned.

**Results**

Responses obtained through questionnaires and interviews are combined and presented in terms of the light they shed on the five research sub-questions, the main goal being to identify factors perceived to influence the use of e-health solutions in specified rural areas of South Africa.

**Sub-question 1: ICTs currently available at the healthcare centres**

The purpose of the first sub-question was to investigate the number and type of ICTs that were available and could support e-health solutions in each of the healthcare centres. The main findings obtained by means of the questionnaires completed by the managers of the five healthcare centres studied are presented in Table 4 (due to security constraints the exact number could not be disclosed). When questionnaire data were interpreted in combination with subsequent interview data, the following details became evident with regard to each hospital:

- Nessie Knight Hospital had telemedicine equipment and Internet capabilities but there were few computers in the hospital, which would limit the realisation of any benefits ICTs might offer. This was illustrated by a respondent: ‘The hospital has a few computers that are only available for telemedicine services, which are out of order due to unreliable Internet service’.
- Technology levels in St. Lucy’s Hospital were slightly better, but still seen as limited (e.g. ‘The hospital has few computers and unreliable telephone’).
- Tsilitwa Clinic had a computer used mostly for telemedicine services (e.g. ‘The computer, digital camera, telephone and Internet...are only used for telemedicine services’). These services were also hampered by unreliable Internet service.
- Madzikane Ka-Zulu Hospital had a larger number of ICTs available (computers, printers, a Local Area Network (LAN), telemedicine equipment and a computerised radiology system). However, they were distributed in such a way that only certain departments could reap benefits (e.g. ‘Computers, telemedicine equipment and Internet services are there in selected departments’). Lack of maintenance and technical support was seen as a barrier to the effective use of these technologies.
- Nelson Mandela General Hospital had a relatively wide range of ICTs and telemedicine equipment (e.g. ‘computers and telephone services’), and had adopted and implemented some technology solutions, such as a computerised patient administration system. However, several departments did not have computerised facilities, which limits the realisation of benefits (e.g. ‘The hospital has limited and unreliable technologies; computers and Internet services are only available in selected departments’).

**Table 4: Number and types of ICTs available at the healthcare centres**

NESSIE KNIGHT HOSPITAL	ST LUCY’S HOSPITAL	TSILITWA CLINIC	MADZIKANE KA-ZULU HOSPITAL	NELSON MANDELA ACADEMIC HOSPITAL
Limited number of computers, telephone services, a photocopier, fax, printer and telemedicine equipment with Internet capabilities.	Computers, telephone service for a limited number of users. A fax, printer and photocopier.	A computer, a telephone, a digital camera and Internet services that are only used for telemedicine services.	Relatively large number of computers, printers, a Local Area Network (LAN), a fax, photocopier, a digital camera, and Internet services in the offices, plus telemedicine equipment and a computerized radiology system.	The hospital has a wide range of computers, a fax, printers, photocopier, telemedicine equipment and videoconferencing services.

### **Sub-question 2: Actual access to computers at the healthcare centres**

A total of 56 participants were interviewed to answer this question. Although almost all centres had some existing ICTs and telemedicine services, lack of access to computers by staff and management was seen as a common problem. For example, in only two of the five healthcare centres (Madzikane and Tsilitwa) did managers have any access to a computer, while access level of staff members to computers was zero at Nessie Knight and only 17% at both St. Lucy's and Madzikane healthcare centres. Even at Nelson Mandela General Hospital, staff's 33% access to computers was considerably lower than access levels of their patients to computers elsewhere. The seemingly high 50% level of access at Tsilitwa merely meant that one of the two participating staff members there could use the clinic's only computer.

### **Sub-question 3: Actual access to the Internet at the healthcare centres**

The purpose was to investigate how many participants at healthcare centres had access to the Internet. Again, 56 participants were interviewed and answered that there was limited access to Internet services in the healthcare centres. None of the participants from St. Lucy's and Nessie Knight Hospitals had Internet access. At hospital management level, only the manager of Madzikane Ka-Zulu Memorial Hospital had access. With regard to hospital staff, one person from Tsilitwa Clinic could access the Internet, and about a sixth of staff at Madzikane Ka-Zulu and Nelson Mandela healthcare centres. In only one hospital (Nelson Mandela) did patients have Internet access.

### **Sub-question 4: Perceived benefits of ICTs in rural healthcare centres**

A total of 25 participants (hospital staff) were asked by means of questionnaires and interviews to indicate what benefits applications of ICTs (computers, Internet, telephones) could have for improving healthcare in rural healthcare centres. Responses indicated that rural healthcare professionals believed in technology's capability to provide some resolution to many challenges facing rural healthcare services. More than 80% of questionnaire respondents (staff working in five selected rural healthcare centres) believed that ICTs could provide all six of the following benefits: enhancing quality of rural healthcare services, reducing costs, eliminating errors, providing a platform for personal development of hospital staff, speeding up health services, and making it easier to store and access health-related information.

Patients were also interviewed with regard to possible benefits of ICTs. Most believed ICTs to be a potentially critical factor for their wellness. From the patients' viewpoint, ICTs could save time and travelling costs, could provide timely access to emergency services and provide telemedicine services and other specialised services in hospital theatres. The following are some examples of their comments on how ICTs could help:

- Nelson Mandela General Hospital: 'Technology provides a safe environment to store information and easier access', and 'Computers save time: we wait in queues as they just check your name'.
- Madzikane ka-Zulu Memorial Hospital: 'Cellular phones help to call ambulance or a special car in cases of emergency;...(better) than sending someone to go to the hospital or (to) look for a car'.
- Nessie Knight Hospital: 'Technologies help doctors to diagnose the complex medical cases'.
- Tsilitwa Clinic: 'Telemedicine saves money and time spent on travelling long distances to doctors, here in Tsilitwa they use computer and camera to get help from a doctor in East London (a well-resourced city located about 400km away) about dermatological problems'.
- St Lucy's Hospital: 'Technology saves time, saves life and reduces the work load to the nurses...it helps them'.

### **Sub-question 5: Perceived barriers for using ICT applications**

The 25 participating hospital staff members were asked in questionnaires and during interviews to indicate, from a list of options, which barriers they felt were preventing them from using ICTs for e-health purposes. Table 5 shows that all staff members interviewed believed that a lack of information (i.e. a lack of relevant content for ICT applications) was a major barrier to using ICT applications as e-health solutions. ICT and telemedicine equipment was generally perceived to be old and unreliable. Almost all participants believed that a lack of computer equipment was still a major barrier to adoption of e-health solutions. Another perceived barrier was the lack of computer skills among the staff. Interestingly, nobody considered fear of computers, or the possibility that ICT applications might disagree with their working style, as being barriers. Similarly, the cost of ICT applications was not seen as a problem.

From responses of patients interviewed, it is evident they also believed the following to be barriers:

**Table 5: Perceived barriers for using ICT applications in rural healthcare centres**

BARRIERS	HOSPITAL				
	TSILITWA	NESSIE KNIGHT	ST. LUCY'S	MADZIKANE	NELSON MANDELA
Lack computer equipment	100%	100%	100%	100%	91%
Lack computer skills	0%	71%	67%	75%	82%
Lack Internet connection	100%	100%	83%	88%	73%
Old/unreliable equipment	100%	86%	100%	75%	64%
Lack broadband connection	0%	29%	17%	0%	9%
Unsuitable working style	0%	0%	0%	0%	0%
Cost	0%	0%	0%	25%	9%
Fear of computers	0%	0%	0%	0%	0%
Lack of information	100%	100%	100%	100%	100%

- A lack of sufficient ICT equipment, as illustrated by the following comments: ‘There is no technology in rural healthcare centres.’ ‘Rural hospitals have no computers used.’ ‘Technology needs resources such as power, phones and computers, and those resources are not there or are unreliable in rural healthcare centres; hence advanced technologies are only in the cities.’
- A lack of ICT-related skills and knowledge among staff (e.g. ‘They don’t have information about them, including the nurses, I’m sure there are some who don’t know how a computer looks like here.’ ‘The rural hospital staff have limited information about them (technologies) I guess.’).
- Unreliable equipment (e.g. ‘The unreliable telephone stopped the telemedicine use in this clinic and now we have to travel for help.’ ‘They bring unreliable technologies into rural healthcare centres.’).
- Inadequate maintenance of ICTs (‘They [technologies] stay out of order without support.’).

**Discussion**

The present study has attempted to better understand how ICTs can be used more effectively to improve the health system in a selected number of rural Eastern Cape healthcare centres. The main research question was to determine what factors were perceived to influence effective use of ICT applications as e-health solutions. Although all centres had some ICTs or telemedicine services, these were generally perceived (by hospital staff and patients) to be inadequate. Reasons for this view included that too few computers available and that ICTs were unreliable. A second factor investigated was access to computers by healthcare centre staff and management; a third factor was the access to Internet. Both of these factors appear to be relevant for adoption of e-health solutions. Only two of five healthcare managers had access to a computer, and at most centres remaining staff’s lack of access to

computers was seen by them as a problem. Internet access was limited in all centres studied; only one hospital manager and a small number of staff had Internet access.

Successful ICT applications in rural areas require investment in infrastructure on three levels: (a) access to ICTs (Mansell & When 1998); (b) access to supporting communication infrastructure and networks (Conradie & Jacobs 2003); and (c) a supportive policy framework. According to Gurstein (2005), the mere presence of and access to ICTs in rural areas is unlikely to be effective without relevant ICT-related skills, promotion of relevant content/information for ICT applications, and a policy framework in which interventions can function (Mansell & Wehn 1998; van Audenhove 2001).

Results of the present study indicate the following:

- A majority of participating staff perceived their level of ICT-related skills to be a problem that could hamper application of e-health solutions.
- All staff believed that lack of information (i.e. lack of relevant content for ICT applications) was a barrier to e-health solutions.
- In spite of some positive e-health policies that have resulted in ICT-related applications (e.g. computerised patient administration system) at some centres, there were also several indications of e-health policies perceived as inappropriate (e.g. policies that distributed ICTs to only certain selected departments and inadequate technical support and maintenance policies).

In summary, there were factors perceived to make ICTs less user-friendly, as shown by participants’ negative perceptions regarding certain structural variables (especially staff’s lack of ICT-related skills, lack of access to ICTs and the Internet at healthcare centres, and the old and unreliable state of computer equipment). On the positive side, none of the staff had a fear of computers, and nobody thought ICT applications might disagree with their working style.

Apart from structural variables shown to impact on e-health solutions, psychological variables that underlie individuals' technology acceptance and use appear to have a decided influence. Participating healthcare professionals (and most patients interviewed) strongly believed (a) in ICTs' potential to provide a variety of useful benefits in the healthcare centres, and (b) that ICTs could help resolve some of the challenges facing rural healthcare. These optimistic expectations were qualified by the respondents' more negative perceptions relating to certain structural requirements for effective ICT use, namely: perceived lack of a supportive policy framework governing the use of ICT applications, as well as perceived lack of useful information as basic to the content of these applications.

## Conclusion

It is evident that more effective use of ICTs as part of e-health initiatives at the rural healthcare centres was seen to be distinctly possible, but only if perceived shortcomings with regard to structural variables were addressed. Especially relevant was better access to more e-facilities, more health-related information made available via ICTs, ongoing ICT skills training programs and policies for improved technology maintenance and support.

In conclusion, all structural and psychological factors investigated were seen to impinge to some extent on effective use of ICT applications as e-health solutions in the rural healthcare centres involved in the study. Furthermore, there was a distinct interplay between the various variables, with perceived ICT-related shortcomings having a negative impact on perceived usefulness and ease-of-use variables and thus decreasing the likelihood of effective e-health solutions. This means that to increase effective use of ICTs that form part of e-health initiatives in the healthcare centres, a vital first step is to address reported perceived shortcomings. Broad-based recommendations covering shortcomings common across the various centres and are that:

- special attention be given to improving basic infrastructure: hardware, appropriate software and telecommunications
- skills and knowledge development, ICT skills training programs and policies for technology maintenance and support be introduced/upgraded.

Fully detailed recommendations specific to the unique situation of each centre belong in reports to the relevant authorities, rather than to the present forum. Briefly, these include type and amount of equipment needed, space and training requirements, water shortages and catering inadequacies. Having obtained a clear picture of how ICTs can be used more effec-

tively to improve the healthcare systems in selected rural Eastern Cape healthcare centres, it is hoped that the findings and recommendations will in some way contribute to better conditions. Closely related and equally pertinent issues are being addressed by research in progress. These issues have to do with quality assurance. Limited user participation and lack of information about initiatives appear to be major contributors to e-health project failure in rural South Africa. There is an urgent need for a quality assurance model that will aid successful acquisition of e-health solutions in developing countries.

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## Appendix A

Edited summary of selected questions/items from survey instruments  
(interview schedule, questionnaires) to provide an overview of data collected for this study<sup>1</sup>

### INTERVIEW SCHEDULE:

#### Summary of questions

- How can ICT be applied in rural hospitals to support E-Health solutions?
- What basic technologies are currently in place that can support E-Health solutions?
- Do you have access and use a computer?
- Do you have access to a computer with Internet connection?
- Do you have access and use a telephone?
- Where do you access the computer; home, work or community centre?
- How would you rate your knowledge of computers?
- What ICTs or e-health solutions does the community/hospital have?
- How can e-health solutions be applied to improve quality or service delivery, improve-decision making, and reduce costs of healthcare in the selected five rural communities?
- How can technology improve the quality of services in this hospital?
- How can technology reduce cost of services?
- What are the benefits that ICTs (computers, telephones, Internet) and e-health solutions bring to the rural community?
- What are the barriers for these benefits in your community or hospital?

### QUESTIONNAIRES

#### Questionnaire for CEO/Managers: summary of items

- 1 BACKGROUND AND HISTORY TO THE CLINIC/HOSPITAL:**
  - Ownership of clinic/hospital (private, provincial, other).
  - Type of geographical area (rural, township, informal settlement, town/city).
  - Clinic/hospital contact person(s) details.
  - Demographics for management staff, doctors, nurses, interns, clinic staff (gender, race), and quality of their scientific capacity (teamwork between groups).
  - How many people make use of the clinic/hospital services per day?
  - Demographics for clinic/hospital daily patients (age, gender and race of patient).
  - What are the major complaints/diseases of patients (injury/trauma; surgical; internal/organic; paediatrics; obstetrics/gynaecology)?
- 2 LANGUAGES USED IN THE CENTRE:**
  - Languages used by staff on a daily basis.
  - Languages used by patients on a daily basis.
- 3 SITUATION OF THE CLINIC/HOSPITAL:**
  - What kind of infrastructure is available to the hospital/clinic (transport, access to education, community centres, business/offices, industry/mining)?
- 4 HISTORY:**
  - When was the clinic/hospital established?
  - Who started the clinic/hospital?
  - Main projects so far (food gardens, aids campaign, inoculation, prevention).
  - Relationship between main projects and main achievements to date at the clinic/hospital.
- 5 FACILITIES AND EQUIPMENT:**
  - Do you have access to a telephone at the clinic/hospital?
  - If *no*, how close is the nearest phone you can use?
  - What equipment and facilities does the clinic/hospital have (desk, chairs; fax; photocopier; computers; printer; modem; computer network; digital camera; medical library; security; consultation rooms; beds in wards; beds in ICU; operating theatres/surgery; blood pressure equipment; ECG; lung

<sup>1</sup> The full survey instrument including interview schedule and three questionnaires is available from the author upon request.

function tests; ultrasound imaging; x-ray facilities; blood tests)?

- Specify equipment out of order and period out of order.
- Specify how regularly and which equipment is replaced or upgraded?
- What kind of equipment is needed?
- What treatment facilities (medicine, surgical facilities) do you have in your clinic/hospital?
- Which treatments do you normally provide to your patients?

**6 SERVICES PROVIDED BY THE CENTRE:**

- What are the main services that the clinic/hospital provides to the community?
- What percentage of your patients belong to a medical aid?
- How frequently do you see the patients after their first visit to the clinic/hospital?
- What are the typical complaints of patients? Specify the procedures you follow to address these typical complaints?
- If a doctor makes specific diagnoses, is the hospital able/equipped to realise the treatment or procedure? (Please specify cases where this is impossible).
- How is the compliance/obedience of patients addressed?
- What is the general expectancy of your patients in this hospital? Do some of your patients seek traditional medication? If yes, when, how often, before coming to you?
- Did the traditional medicine help/work? If yes, in which cases?
- What is your view regarding the combination of traditional and scientific medicine?
- How often have the following resources been used (phone calls to other experts; general information at the clinic/hospital; advice from other colleagues; referral to other clinics or hospitals)?

**7 LINKAGES TO OTHER CENTRES:**

- What is your relationship with other clinics or hospitals in the area? How often do you communicate with other clinics or hospitals (formal letters; informal meetings; phone; workshops)?
- What are the main topics communicated with other clinics or hospitals?

**8 PROBLEMS:**

- What are the main problems that your clinic/hospital has now, or has had in the past?

**9 NEEDS:**

- What are the needs of your clinic/hospital currently (training, advice, equipment, tools)?

**10 VISION AND PLANS:**

- Do you have any plans or vision for the future of the clinic/hospital?

**11 OTHER INFORMATION:**

- Is there anything else you would like to add?

**12 E-HEALTH SOLUTIONS:**

- How do you think your department could benefit from e-health?

- What do you think the barriers are to your department when making the most of e-health (.lack of computer equipment; lack of computer skills; lack of Internet access)?
- How many in your department use the e-health solutions?
- What benefits could e-health bring to the department?

**13 E-HEALTH FOR THE COMMUNITY:**

- In your own words, please define e-health.
- What is your current view of the reliability, quality, and validity of e-health technology for healthcare in a rural community?
- In general, do you believe e-health to be effective? Why or why not?
- How can e-health assist rural communities?
- What services does e-health provide for better health care?
- What benefit does e-health bring to the department and the community served?
- What solutions does e-health provide?
- When are e-health solutions used?
- Which of these solutions have you used?
- Why is it important to use e-health?
- How often do you use the e-health solutions (daily, weekly, monthly, seldom, never)?
- For what function do you normally use e-health solutions?
- Could you provide examples of current e-health solutions for healthcare that you believe to be effective? How do these work? How do you know they are effective? How are they evaluated?
- How would you go about evaluating the cost-effectiveness and quality of e-health solutions? Define what you mean by quality in this context.
- How can ICT be used to improve quality or reduce costs of services in rural healthcare centres?

**Questionnaire for Staff members:**

**Summary of items**

**1 PERSONAL DETAILS:**

- Description of your area (rural, township, informal settlement, town/city).
- Do you have access to telephone services?
- Do you have access to a computer?
- What connection does it have (broadband, dial-up, without Internet connection)?

**2 DEPARTMENT INFORMATION:**

**A About department:**

- In what field does your department specialise? Please specify.
- How many patients can your department accommodate at a time?
- What treatment facilities (medicine, surgical facilities) do you have in your department/ward?
- Which treatments do you normally provide to you patients?
- How often do you transfer your patients to other hospitals/clinics and common reasons
- What are the major complaints/diseases of your patients?

**B Facilities & Equipment:**

- Do you have access to a telephone at the department/ward? If *no*, how close is the nearest phone you can use?
- What equipment and facilities does the department/ward have?
- Specify equipment out of order and period out of order.
- Specify how regularly equipment (specify type) is replaced or upgraded?
- What kind of equipment is needed?

**C e-Health Solutions:**

- What basic technologies are currently in place that can support e-health solutions?
- How can ICT help improve quality or reduce costs of services in rural healthcare centres?
- How do you think your department could benefit from e-health? Please specify.
- What do you think can be the barriers to your department when making the most of e-health?
- How many people in your department use the e-health solutions?
- What benefits does e-health bring to the department?

**3 E-HEALTH FOR THE COMMUNITY:**

- In your own words, please define e-health.
- What is your current view of the reliability, quality, and validity of e-health technology (defined how) for healthcare in rural community?
- In general, do you believe e-health to be effective? Why or why not?
- How can e-health assist rural communities?
- What services does e-health provide for better health care?
- What are the benefits e-health brings to the department and the community served?
- What solutions does e-health provide?
- When are e-health solutions used?
- Which solutions have you used?
- Why is it important to use e-health?
- How often do you use e-health solutions?
- For what function do you normally use e-health solutions?
- Could you provide examples of current e-health solutions for healthcare that you believe to be effective? How do these work? How do you know they are effective? How are they evaluated?
- How would you go about evaluating the cost-effectiveness and quality (defined how) of e-health solutions?

**Questionnaire for Patients: Summary of items**

**1 PERSONAL DETAILS:**

- Description of your area (rural, township, informal settlement, town/city).
- Do you have access to telephone services (home, work, community centre)?
- Do you have access to a computer (home, work, community centre)?
- What connection does it have (broadband, dial-up, without Internet connection)?

**2 HEALTH INFORMATION:**

- How many times do you come to the hospital/clinic in a year?
- How do you usually get to the hospital/clinic (own car, hired car, public transport, other)?
- How much do you spend getting to the hospital/clinic?
- Is access to public transport to the healthcare centres: hard to find, average, always available?
- Have you ever been transferred to another hospital/healthcare institution for service? If yes, how many times?
- How did you get to there?
- How would you rate the cost involved?
- What was the reason for your transfer?
- Do you have any access to your medical record (limited, average, no access)?
- How do you gain access to your health information (lab results, disease information)?
- How do you rate the service provided by the hospital (excellent, good, average, poor, very bad)?
- Please supply any further comments you wish to make or name any other issues to do with the healthcare services provided by rural hospital that you think are important.

**3 TECHNOLOGY UNDERSTANDING:**

- What is your level of understanding of ICT technologies (very good, good, average, poor)?
- How do you rate your computer literacy (very good, good, average, poor)?
- What do you usually do with the computer?
- Is your computer, or the one you usually use, connected to Internet?
- How much does it cost for you to have an access to ICT technologies (very expensive, expensive, affordable, cheap)?
- Do you have any understanding of e-health and its solutions? If yes:
  - How do you define e-health?
  - What are the benefits it brings for rural communities?
  - Which solutions are you familiar with?
  - What impact do these solution have on rural communities?
  - What are the limitations to these solutions? ■