

eHealth: A Model for Developing Countries*

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ABSTRACT. This paper proposes a model, or framework for analysis, to inform the development of e-Health in developing countries. The framework has five components – the 5Cs. Firstly there is the *Context* of poverty, meeting the Millennium Development Goals and the role ICT can play to support health workers. Then, there is the *Content* of health information provided to health workers and how it can be migrated from being paper-based to a digital format. Providing wireless *Connectivity* within and between health facilities that supports the transmission of health knowledge and management information provides an entry-level health information infrastructure. Over such a health facility-based wireless infrastructure it then becomes possible to build workforce *Capacity* as well as support *Community* development, via the delivery of information to enable better individual and community decision-making in health and other development issues.

KEYWORDS: *Community decision-making, Community development, Developing countries, e-Health, Wireless connectivity*

Introduction

Advances in information and communication technologies (ICT) have raised expectations for health, and the WHO, World Health Organization, is now facilitating “the development of model e-Health solutions which, with appropriate modification, could be established in national centres and networks of excellence for e-Health” (WHA, 2005).

The models for e-Health that have been developed, e.g. in the UK (NHS, 2005a), Canada and the EU (eEurope, 2005), have emerged in a context of wealth where there are well developed national and local ICT infrastructures already in place over which health and other public and private services to support all aspects of national and local economies are delivered. In these countries, as in some low-middle income countries, such as South Africa and Turkey, an e-Health infrastructure is being constructed which can support Electronic Health Records.

In low-income developing countries where, for example (GHC, 2005):

- one out of every seven children born will not survive to age five
- there are 12 million AIDS orphans in Africa alone
- in sub-Saharan Africa, life expectancies have been dropping during the last decade, and the average life expectancy is now 48 years.

The context is not wealth but poverty. In this context, the appropriate models for e-Health may look very different at this stage from those seen in developed economies. That is not to say that they should be developed without attention to, and contributing to, the development of a global health and health information agenda. The impact of AIDS, SARS, antimicrobial resistance, avian flu and the threats of bioterrorism have heightened public awareness of the borderless nature of global health issues, and the importance of strategic information management. The WHO's e-Health and Health Metrics Network initiatives are examples of its concern with the development of global ICT and information standards (WHO, 2005). The key issue is how to develop e-Health for developing countries in a way that is contextually appropriate whilst supporting national and international health information management.

It is suggested that the following "5 Cs" model may serve as a useful framework of analysis. The central proposition is that it is only when there is synergy between the e-Health aspects of these components that the full benefits of investing in e-Health can be realized. The "5Cs" are:

- Context
- Content
- Connectivity
- Capacity
- Community

Context

The policy context for this analysis begins with the facility-based health worker and with what it is that such health workers need to do their job on a day to day basis to provide good quality care to the patients they see. Health workers need to be able to apply their training to deliver care for their patients (making assessments, diagnoses, treating and/or referring).

They need current and good quality knowledge that is easy to use, and also to be able to take and review a patient's history and use or make a record of this information. The analysis is patient-centered, similar to the path taken by the National Health Service in the UK. The current £6 billion Connecting for Health programme is focused on delivering integrated patient care records at, or near to, the point of care. On the back of the costly infrastructure needed to deliver electronic care records, some significant clinical knowledge support is now available and management information can flow swiftly up and down the organisational structures. But it took a long time to get to this level of investment. The foundations for the programme began to be laid in 1992 (NHS, 1992) with

a focus on person-rather than organization-based information systems, and were added to in 1997 (NHS, 1997) and 2002 (Wanless, 2002), and completion is not scheduled until 2010 (NHS, 2005b).

But, in countries where there is extreme poverty (with incomes below \$1 per capita per day, and that is the case for 1.1 billion people (Chen, Ravallion, 2004) the issues are different. Can e-Health be developed where there is no electricity? Can e-Health be developed where there are no roads of telephone lines? Can e-Health be developed when there is no IT available? Can e-Health be developed when staff have little opportunity for receiving management support and continuing professional development, let alone training in e-Health? Can health services be improved when the quality of the management information is poor?

In this context, the most pressing issue is how to escape the “poverty trap”. As Sachs and McArthur put it, this is where “poor people are simply too poor to carry out the investment needed to overcome hunger, disease and inadequate infrastructure, and as a result are also unable to achieve sustained economic growth. The key to ending the poverty trap is for high-income countries to help developing countries make the necessary investments in health, education and basic infrastructure” (Sachs, McArthur, 2005).

There is debate over the most effective way for high-income countries, and Non Governmental Organizations, to make these investments (Lockwood, 2005). But perhaps the most important framework currently guiding decision-making is that for meeting the Millennium Development Goals (MDGs). The current UN Millennium Project is addressing extreme poverty in its many dimensions – income poverty, hunger, disease, lack of adequate shelter, and exclusion – while promoting education, gender equality, and environmental sustainability, with quantitative targets set for 2015. Complementing the 7 MDGs is an eighth goal which is to establish a global partnership for development. It also has targets associated with it, one of which is “in cooperation with the private sector, make available the benefits of new technologies, especially information and communications” (MDGs). In low income countries where resources for ICT are scarce, investment in ICT should not be focused on one sector alone. Indeed Gilhooly argues that ICT will most profoundly impact the MDGs as a generic platform technology and enabler for the achievement of the other developmental goals (Gilhooly, 2005), within a broad and integrated development approach, rather than simply as a standalone production sector. Goal 8, for example, is to develop a global partnership for development, within which target 18 is “in cooperation with the private sector, make available the benefits of new technologies, especially information and communications”.

In the context facing developing countries, the delivery of health (and its ICT) needs to be understood as part of the national approach to reduce

poverty and meet the MDGs. And, a corollary of this is that attention needs to be focused on pro-poor health issues rather than on refining the health ICT solutions of high income countries that may deliver high quality care but are not the most cost-effective way to use national, or donor-generated, funds in low-income countries.

The nature of the existing ICT infrastructures in developing countries will of course vary, but it forms an important part of the context for developing an e-Health infrastructure.

To what extent, for example, should e-Government strategies focus on delivering content to rural communities rather than on making back-end applications more efficient for those who already have Internet access?

Content

A major effect of poverty is limited access to health care. Patients sometimes delay getting the care they need until they are severely ill, and often come with more than one complaint.

Whilst many cases are straightforward presentations of, e.g. malaria, there are many that reflect complex interactions, e.g. of tuberculosis and HIV/AIDS. When the cost of travel, or treatment, for the patient may amount to several days' income, the decision to refer is not taken lightly. The first issue, therefore, is how to get current knowledge to the health worker in the field in an appropriate format to support them when necessary. Pakenham-Walsh et al. argue that "providing access to reliable health information for health workers in developing countries is potentially the single most cost-effective and achievable strategy for sustainable improvement in health care" (Pakenham-Walsh et al., 1997). There have been many excellent books published, as well as posters etc for use by health workers in developing countries. Some have been produced by the WHO (WHO-MLP), others by Ministries of Health (MoH/WHO, 2002), and Non Governmental Organizations (see AMREF for an example of material produced for use in Africa). But, the reality is that in many small health facilities, the knowledge available is often limited and dated. It is not easily accessed at the point of care, and is usually condition-specific rather than in a symptom-based format which helps to make a differential diagnosis. By contrast, in a well funded health service, such as the NHS, where there are 22.5 kg of guidelines produced and distributed each year, the issue is one of knowledge management and synthesis. Nevertheless, improving the quality of paper-based knowledge is an important first step. The e-Health perspective suggests that the first step is likely to be more cost-effective if it is on a pathway to accessing knowledge in a digital format later on when it can be more easily kept up to date and be searched in user-specific ways.

One useful tool to support health workers in the NHS is the symptom-based

care pathways that are held online in “The Map of Medicine”. Initial testing of selected care pathways in Kenya indicates that the paperbased version of this tool is of great utility it needs some adaptations before it can be made available nationally. As the “tropical diseases” section in the Map are refined, they will add to the knowledge base available for use in the NHS. The potential is there for this approach to be replicated elsewhere thereby improving the global knowledge base, whilst at the same time allowing for “localisations” of content and also of training to ensure it’s appropriateness in other contexts.

Other knowledge-support systems are also available electronically. For example, the use of CD-ROMS as a low cost means of access, that can be updated by regular reissues, has been promoted for use in developing countries (see e-TALC).

Others have shown that in developing countries, Hand Held Computers (HHCs) such as Personal Digital Assistants (PDAs) may be the most affordable entry-level device for widespread access to knowledge (IICD, 2003). Health knowledge applications written for PDAs and available on PDA cards, or online, can provide health workers with access to knowledge content at the point of care, but the current examples (see Epocrates, PEPID, InfoPoems), are written for use in developed countries which raise issues of contextual appropriateness. When HHCs become moreaffordable, and practitioners have enough resources to afford them for their own use, other issues of compatibility of interoperability within the health facility can arise (McAlearney, 2005).

To minimize costs, many developing countries are pursuing Free Open Source Software (Kagai, 2004). Such applications have been promoted for records and hospital management systems. The requirement of the developing world for low cost software that can be localised is a powerful driver for the development of FOSS. Total costs of ownership may well prove to be higher than anticipated, but FOSS is now a global option, albeit one that may be best seen as a powerful lever to secure fair deals for developing countries from the purveyors of proprietary software (Heeks, 2005).

There are already powerful pressures building to invest in patient record systems, albeit for specific diseases – in particular HIV/AIDS. The benefits to patient care (and monitoring compliance with ART regimes) from patient record-systems are considerable.

However, there is the risk that vertical condition-specific systems will not be cost-effective. Incompatible record structures, coding systems, approaches to confidentiality and security, etc., may well be developed. At this stage, it is premature to focus informatics efforts on resolving these difficult technical issues for developing countries, even though such efforts would contribute to the development of international standards (e.g. for clinical terms). Much simpler infrastructure would

bring more immediate benefits by supporting knowledge management and management information, where the costly issues of confidentiality, security, identity management, bandwidth etc. do not need to be comprehensively addressed.

Connectivity

If the entry-level device is a stand alone HHC, the potential cost-effectiveness may be significantly increased if it is WiFi enabled.

Most hospitals in developing countries do not have computers or networks. Narok District Hospital, for example, is typical of many in Kenya. It has three standalone computers, all of which are used for administrative purposes. They may be well positioned for beginning the process of ICT development by introducing WiFi-based HHCs, such as PDAs, tablets and portable PCs.

With these networks in place, there is little additional cost for realtime access to knowledge that may be stored on local servers, or via those servers to the Internet and the provision of e-mail and web browsing (albeit within formatting and security restrictions). The development of forms for requesting tests, supporting the collation of management information can be done once, and subsequently replicated.

This would support the development of management information systems based on (the same sorts of) HHCs needed for knowledge support.

But what about connecting health facilities and providing the ICT infrastructure for a health system (that may well consist of a rich mix of public, private and faith-based provision)?

Again, in most developing countries, there are virtually no wired networks, though mobile phone growth has been accelerating. There were 51.8 million mobile subscribers in Africa at the end of 2003, reflecting an increase of more than 1000 per cent in five year (Waverman et al., 2005). "WiFi and WiMax technologies are increasingly seen as the most appropriate solution for rural connectivity due to their maturity, affordability and pervasiveness and the potential to leapfrog" (Gilhooly, 2005). One approach that will be tested in Kenya is to locate WiMax communication services inside health facilities (as they are staffed 24/7), and thereby provide wireless data access not only between health facilities but also to all communities within a 10 (and potentially up to 30) kilometer radius. Using such an infrastructure, knowledge updates, including management information, can be pushed to devices, e.g. new/ revised care pathways or public health and performance statistics. It is important to note, however, that ICT to support health and the MDGs can utilize other technologies as well. For example, VSAT, World Radio, call centres, community radio, TV, video, CD, DVD are all media that can be blended to provide cost-effective solutions.

The NHS has shown that use of call centres (NHS Direct), and TV (NHS Digital) can provide useful knowledge for patients, care givers and the general public. Again, there may be opportunities to tailor this information and know how for developing countries.

Given that a health-facility based wireless infrastructure can cover up to perhaps 95% of a population with both voice and data services, the business case for government-private sector partnership would prove strong. In short, it may be that it is in developing countries that the business case for mobile health ICT to support and nurture health workers is strongest.

Capacity

Many developing countries suffer from health worker migration as doctors and nurses head to richer countries such as the UK, US and Canada (Lucas, 2005). Hence, there is an urgent need to improve the skills of existing staff on a fast pace, at low cost and as close to their place of work as possible. This policy is being pursued in Kenya. A recent press release states “the Kenyan Ministry of Health asked AMREF to work in conjunction with the Nursing Council of Kenya to upgrade 26,000 nurses from certificate to diploma level, allowing them to deliver basic health services, as well as manage and treat new and re-emerging diseases such as HIV/AIDS, malaria and tuberculosis. With the current shortage of nursing instructors, training 26,000 nurses would take 100 years; by leveraging Accenture’s innovative electronic learning solutions, we are targeting to train the same number in just five years” (Ngatia, 2005). Whilst there is great potential for this mix of Government, Non Governmental Organization (AMREF), Professional Body and private sector ICT expertise (Accenture) to progress the e-Learning agenda, the technology proposed is to use CD ROMs at Training and Development Centers. This is a low risk high impact solution, but it will still incur significant costs for nurses to travel away from their place of work.

The introduction of a health-facility based wireless infrastructure would enable the training closer to the workplace (and indeed the home). It would also support training and Continuous Professional Development (CPD) at the point of care. Already, the AMREF Telemedicine Outreach Programme is aiming to improve the quality of and access to specialist surgery as well as the improvement of care through training using teleconsultation and Continuous Medical Education (CME) courses. Other software, such as “Second Opinion” which is designed to support simple “store and forward” clinical communications with images etc. as attachments, can of course be used to seek opinions and training support from experts both locally and in the developed world too. With the development of groupware, it has also become possible to support small

group learning. These capacity-building applications for health workers will provide much added value to the investment in a wireless infrastructure.

Community

Building capacity has to extend outside health facilities. Community-based workers address the issues of both poverty and health, but they do not have ready access to the information tools to perform their work in an optimal fashion. As mobile WiMax standards emerge (during 2006-7) the potential to support mobile health workers with online access to health knowledge, management information and communications services will become increasingly cost-effective.

Disseminating knowledge from the many projects that have been run by Government, NGOs etc. so that the lessons learnt are widely available to all communities is hampered by poor communications. In Kenya some projects of the Kenya Medical Research Institute and AfriAfya address the issue of indexing and updating such health-related knowledge.

Knowledge that will be generated from the Millennium Village Projects (such as in Sauri, Western Kenya) being run (by the Earth Institute, Columbia University) to address all the MDG issues will need to be synthesized and made available to communities throughout the country. If the health sector's ICT infrastructure can extend to the communities within a 10-30 km radius of all facilities then a significant contribution will have been made to improving health, education and the basic infrastructure, and thereby to meeting the MDGs.

Public health information about communities must be collated. Community-based health workers must be able to alert District Medical Officers of notifiable diseases, or births and deaths, and a number of other returns (including some which are donor-specific).

At present, it takes time to send and collate paper-based reports. Hence, public health surveillance at local (let alone national and international levels) is poor; but a health facility based wireless infrastructure to HHCs could significantly improve that situation.

The analysis can now conclude where it could have begun – with the individual, and the health-related decisions they make when they are sick. For many, Traditional Medicine (TM) is the only affordable source of health care. The WHO is facilitating the integration of TM into national health care systems. Herbal medicines for treating malaria are considerably cheaper, and may sometimes even be paid for in kind and/or according to the “wealth” of the client. Many TM practitioners work in rural areas (and need no electrical power supply to do so). In Kenya, the Government is looking at ways to bring some practices used in TM into mainstream health care (Nunan, 2004). Instead of competing, the two treatment methods complement each other, especially in the context of

psychiatric health care (*Kenya's mix*, 2003).

Changing the culture of decision-making for individuals and families is easier if there are readily demonstrable benefits from doing so. Community-based health workers must be empowered within every community to deliver good quality advice about health care. This empowerment may come from their use of a (community-supported) HHC with wireless connectivity and access thereby to national and international sources on good practice. This includes public health advice (water, sanitation, vaccinations, use of mosquito nets etc.).

When individuals are sick, the advice needed may be costly e.g. travel to the nearest Health Center. It is often cheaper if given early rather than taken late, when the condition(s) may have progressed so far that a referral on to a hospital becomes necessary. The safekeeping of personal health records may need encouragement too. In developing countries, the patient-held record is not a new concept. Often focused on a particular condition, e.g. HIV/AIDS and the ART (WHO, 2005) status, they are paper-based (often a school exercise book) and, whilst this is likely to be the appropriate technology to be used in the near future, the widespread use of mobile phones (or perhaps PDA/phone hybrids), or even the sub\$100 dollar laptop computer (MIT, 2005), may change this assessment.

Conclusions

For developing countries model e-Health solutions that replicate the current ICT agenda of the developed world (with its focus on electronic patient records and reimbursement) may be inappropriate and unaffordable. Instead, the 5Cs model outlined here suggests that developing countries should see e-Health in the context of the existing national ICT infrastructure.

Given that external support for improvements in health and infrastructure is available as part of meeting the MDGs, the model suggests that attention is focused first on improving the paper-based support that is available to health workers where there is no ICT solution available, particularly if it can lead to a later introduction of contextually appropriate content on affordable HHCs. Connecting up HHCs within health facilities to knowledge servers using a WiFi infrastructure, and then connecting health facilities using a WiMax infrastructure, should provide the basis for improvements in management information as well as better coordination of care. Applications that can address the major capacity building requirements, both in terms of individual and group e-Learning that is closer to the place of work, add value to such an infrastructure. Extending the infrastructure to support health workers in communities, delivering health knowledge and collating public health information will

play a direct role in improving health. But the infrastructure can also help communities make better informed developmental decisions and, in reducing poverty, thereby improving health.

How long will all this take? If the MDG targets are funded and projects are well managed, it should be possible by 2015 for any health worker (in a facility or the community) to retrieve and send contextually appropriate health knowledge and information from or to anywhere. By then, perhaps, the developed world will have resolved the technical, standards and acceptability issues, driven down costs and have proof that investment in electronic patient and personal health records is worthwhile.

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Sintesi

Il modello proposto come schema di analisi riguarda la crescita delle attività di e-Health nei Paesi in Via di Sviluppo e si articola al suo interno in cinque componenti: le 5C. In primo luogo, il Contesto della povertà (Context of poverty) che si inserisce negli obiettivi del Millennium Development Goals relativamente al ruolo che le Tecnologie Informatiche e di Comunicazione (TIC) possono giocare in sostegno degli operatori della salute. Il secondo fattore è quello del Contenuto (Content) e riguarda le informazioni sanitarie fornite agli operatori e il modo per gestire il passaggio di tali informazioni dal formato analogico-cartaceo al formato digitale. Lo sviluppo di Connessioni (Connectivity) wireless all'interno e tra le strutture sanitarie per la trasmissione di conoscenze medico-sanitarie e di informazioni gestionali costituisce un primo livello di infrastruttura informazionale per la sanità. Disponendo di una tale infrastruttura wireless diventa possibile creare Capacità (Capacity) professionali e lavorative e supportare lo sviluppo della Comunità (Community), attraverso la distribuzione di informazione che faciliti i processi decisionali individuali e comuni e lo sviluppo generale delle strutture.

