

I've got 99 problems but a phone ain't one: e/m-Health in LMICs

Author: Pratap Kumar^{1,2}, Chris Paton³, Doris Kirigia⁴

Affiliations:

1. Institute of Healthcare Management, Strathmore Business School, Nairobi, Kenya
2. Health-E-Net Limited, Nairobi, Kenya
3. KEMRI-Wellcome Trust Research Programme, Nairobi, Kenya
4. Centre for Tropical Medicine and Global Health, Nuffield Department of Medicine, University of Oxford, UK

Correspondence to:

Dr. Pratap Kumar

P.O. Box 357-00606, Nairobi, KENYA

pratap@health-e-net.org

+254 731848163

Keywords:

e-Health, m-Health, telemedicine, healthcare quality, access to healthcare

Word count: 2404

Figure count: 3

Table count: 0

ABSTRACT

Mobile technology is very prevalent in Kenya – mobile phone penetration is at 88% and mobile data subscriptions form 99% of all Internet subscriptions. While there is great potential for such ubiquitous technology to revolutionize access and quality of healthcare in low-resource settings, there have been few successes at scale. Implementations of electronic medical record systems in countries like Kenya are yet to tackle human resource constraints or the political, ethical, and financial considerations of such technologies. This paper outlines recent approaches that could improve access and quality while considering the costs of healthcare. One is an attempt to create a scalable clinical decision support system by engaging a global network of specialist doctors and reversing some of the damaging effects of medical brain drain affecting countries like Kenya. The other is an innovation on paper-based record keeping using low-cost and locally produced tools such as rubber stamps to improve adherence to clinical practice guidelines. By bringing down the costs of remote consultations and clinical audit respectively, these projects offer the potential for clinics in resource-limited settings to deliver high-quality care. This paper makes a case for continued and increased investment in social enterprises that bridge academia, public and private sectors to deliver sustainable and scalable electronic and mobile health solutions.

INTRODUCTION

The mobile technology revolution is very real in Kenya. In a country of 44 million people there are almost 38 million mobile phone subscriptions (penetration of over 88%), about 29 million mobile money transfer subscriptions, and an estimated 32 million Internet users; mobile data subscriptions form 99% of all Internet subscriptions.¹ The rest of the continent is not far behind, but this advance in connectivity, trumpeted across sectors as the revolution in access that we've been waiting for, has yet to reach its potential in healthcare.²

E-Health, a broad term inclusive of mobile health (m-Health) that encompasses electronic-supported processes and communication in healthcare, is making forays in areas as diverse as medical recordkeeping, clinical decision support and coordination of care in almost every country and setting. It is broadly expected that such technology will positively impact access and quality of healthcare services in low- and middle-income countries (LMICs). Indeed, technology initiatives are making significant differences to both healthcare delivery and management in Kenya and other countries.² These advances are however primarily at limited scale, and mostly focused on well-funded infectious disease programs like HIV/AIDS.^{2,3,4}

Why has e-Health not yet engendered the 'revolution' in access to and quality of medical care in LMICs that was expected? Some reasons include traditional

challenges such as the severe shortfall of human resources that limit any initiative to increase access to care.² Others include 'human' issues that limit the buy-in and use of new technologies by their stakeholders.⁵ Various referred to as 'human centred design' or 'process innovation',⁶ attention to existing workflows, incentive structures, participation of users at multiple levels of implementation, and broader links into the health system are all important issues that can determine the success of e-Health interventions. Even if many pilots are considered 'successful', small-scale implementations often lack programmatic evidence to inform the scale-up of e-Health interventions.⁷ In this article, we detail some of the broader problems facing technology adoption in LMIC healthcare systems and possible ways to addressing them.

ADOPTION OF E-HEALTH SYSTEMS IN HIGH VERSUS LOW-INCOME COUNTRIES

Over the last two decades e-Health systems such as Electronic Medical Records (EMR), Picture Archiving and Communication Systems (PACS) and Patient Administration Systems (PAS) have been widely adopted in high-income countries. This adoption has been achieved at a high cost, and different drivers of adoption, from medical coding and billing to participating in government programs, have resulted in systems that are often difficult to use at the point of care and limited in their ability to share clinical information across facilities.^{8,9} Increasing emphasis is therefore being placed on issues of interoperability and clinical usability.¹⁰

To address the problems with sharing data and allowing e-Health systems to communicate with each other, a process of international standardisation has emerged. Led by institutions such as Health Level 7 (HL7), Integrating the Healthcare Enterprise (IHE), Digital Imaging and Communications in Medicine (DICOM) and the International Health Terminology and Standards Development Organisation (IHTSDO), these standards have achieved reasonably high levels of adoption. However, much work is still needed to ensure seamless integration of systems and secure sharing of health data. By using internationally agreed standards the global marketplace for e-Health systems can grow with less friction and benefit from pooling expertise from different countries.

In LMICs such as Kenya hospital-level systems are now beginning to be implemented following several years of successful implantation of clinic-level EMR systems. One of these systems, OpenMRS, has been installed in multiple East African countries and in over 300 clinics in Kenya.¹¹ However the majority of the documentation of the implementation of such systems has focussed on functionality, and organisational and technical infrastructure. As highlighted in a recent review of EMR system implementations in low-resource settings, sufficient training and skilled personnel were mentioned in about 10% of 47 articles, with few political, ethical, or financial considerations.¹² While it is likely that low-income countries will take a different approach to the large-scale adoption of e-

Health systems that has been seen in high-income countries, there are similar concerns around issues such as interoperability, privacy and sustainability that must be addressed while generating an evidence base for scale-up.

TELEMEDICINE AND TABLETS – CHALLENGES & SOLUTIONS TO GAPS IN HRH

There are large shortfalls of human resources for health (HRH) in LMICs. The WHO recommends a minimum health worker to population ratio of 23 per 10,000.¹³ This ratio in the 47 counties of Kenya varies from a high of 15.6 to as low as 1.2 (Figure 1).¹⁴ Similar shortfalls and disparities in HRH exist for secondary care services, as measured by proxy through the number of hospital beds and cots available to the population. The number of hospital beds (across public and private sectors) ranges from approximately 34.8 per 10,000 people to as few as 3.9 – an almost ten-fold difference across Kenya's counties.¹⁵

LMICs also face a large and growing burden of non-communicable diseases (NCDs) alongside a continued presence of infectious diseases. With the latter still taking the majority investment into healthcare, the ability to manage illnesses like hypertension, diabetes, heart disease and cancer is a looming challenge for LMIC health systems.¹⁶ For example, Kenya has just 12 oncologists and 64 orthopaedic surgeons for a population of almost 45 million (author's compilation). Most of the few specialists (83% of the oncologists and 73% of the orthopaedic surgeons) practice in Nairobi, which is home to just 8% of the Kenyan population.

Exacerbating this disparity, secondary care services are mainly delivered via the private sector, and most of their costs borne out-of-pocket.¹⁷ When combined with large geographic scales, poor rural roads, and high costs of transport, access to anything beyond primary care services is mostly restricted to urban and/or affluent populations.

Telemedicine has been viewed as a potential means of overcoming geographic disparities in access to care. The ‘promise’ has been that telemedicine could be more practical, affordable, and sustainable than traditional programs, and attract physicians, nurses, and other HRH to work in remote areas on a short- or long-term basis.¹⁸ This is yet to be demonstrated at scale, especially in LMICs due to some significant limitations.

The first is the traditional ‘hub-and-spoke’ design of telemedicine services where a tertiary hospital or ‘hub’ provides the technology and clinical expertise to support rural or ‘outreach’ sites. The scalability of this design is limited by the number of doctors in any given hub and the amount of time they can spend offering remote consultations. This is an absolute limitation beyond challenges such as legal and billing hurdles that restrict the use of remote consultations in Western countries.¹⁹

One solution currently being tested in Kenya is a distributed network of individual doctors and institutions to provide remote consultations.²⁰ This mix of local and global skills includes retired and diaspora doctors, medical missionaries, and medical schools with global health track residency programs, each with different, but powerful incentives to support healthcare in LMICs (Figure 2). Consultations are requested through and mediated by locally-registered medical professionals, typically nurses and clinical officers. Such mediated, ‘provider-provider’ remote consultations have the potential to be less complex than direct ‘patient-provider’ remote consultations and could also expose healthcare professionals in LMICs to global knowledge and practices. The distributed network limits the time required of any one provider, but one disadvantage is limited control over turn-around times, making such ‘network’ telemedicine less suitable to emergency situations.

Other limitations include a reliance on ‘real-time’ video-based telemedicine, and the limited ability to digitise, store and share medical data as part of the consultation. The use of interactive video can be traced to the origins of telemedicine,^{18,21} and most instances of telemedicine expect multiple care providers and patient to engage simultaneously. This however is in contrast to much of consultative medicine, which is practiced asynchronously, with clinicians leaving messages for each other, requesting tests and referrals.¹⁸ Real-time telemedicine implementations (‘call-a-doctor’ services or videoconferencing) often ignore the need for sharing medical records, limiting the meaningfulness of

such consultations, or are paired with traditional EMRs – complex software that typically require extensive training to use. With very limited use of EMRs in LMICs, the pairing of telemedicine with traditional EMRs is likely to limit its ability to scale in low-resource settings.

Possible solutions include the asynchronous or ‘store-and-forward’ telemedicine model (rarely used beyond teleradiology or telepathology),^{22,23} and EMRs based on the concept of a structured narrative,²⁴ with tools to easily digitise and link medical data, where available, to the narrative. A narrative history is not only intuitive for healthcare workers to enter electronically with minimal training, but also provides important context and placeholders for digitised data. A current implementation being tested by one of the authors is a tablet-based application combining efficient, offline entry of narrative information, the creation of digital medical data from paper-based records, and a communications platform to interact with a distributed network of remote physicians.

RUBBER STAMPS AND MOBILE PHONES - CHALLENGES & SOLUTIONS TO

ADHERENCE TO CLINICAL PRACTICE GUIDELINES

Beside shortages in HRH, there are other challenges to delivering high-quality clinical care in LMICs, and particularly in rapidly growing urban slums. Improving adherence to clinical practice guidelines (CPGs) is one means of improving quality of care. However, there are challenges to developing guidelines relevant

for use in low-resource settings and even greater ones to implementing and monitoring their use.^{25,26}

To be effective CPGs need to be: a) developed or adapted in an inclusive manner with direct input from the medical staff who will be implementing them,²⁷ b) included into existing workflows without requiring significant additional effort or cost,²⁸ and c) paired with systems to measure, evaluate, feedback and reward evidence-based practice, thus motivating providers to deliver high-quality clinical care.²⁹ While the impact of audits and feedback in LMIC healthcare systems can be high,³⁰ one factor limiting the use of such methods is the cost of performing audits,³¹ particularly in the absence of EMRs. The alternatives to clinical audits for collecting data on quality of clinical care in LMICs are also expensive, involving detailed interviews and observations.³²

A solution to some of these challenges is the use of checklists, as widely demonstrated in surgical settings.³³ An extension of this concept being tested in Nairobi involves the use of rubber stamps to place checklists for various clinical conditions into the paper case sheets for use during patient encounters.³⁴ The Guideline Adherence in Slums Project (GASP) has prototyped rubber stamp CPG templates (RST) that are condition-specific (e.g. urinary tract infection, malaria, etc.), incorporating important elements of relevant CPGs, diagnostic differentials and treatment options while accounting for the limitations of a particular clinic or

clinical setting. The RSTs (Figure 3) function both as a ‘checklist’, reminding providers of often-missed care (e.g. screening for sexually transmitted infections in cases presenting as urinary tract infections), and a means to record important clinical information (e.g. antibiotic used and justification for use). While RSTs are not intended to replace traditional paper-based case documentation, they are designed for easy digitisation using a mobile phone camera, rapidly capturing key clinical data in settings with limited resources. Early results from RST use show promising reductions in antibiotic prescription rates for common infections and other metrics of quality of clinical care, as well as enthusiastic support from providers using the tools.³⁴

CONCLUSION

Almost every patient and provider owns a mobile phone, so it is vital that mobile technologies play a part in improving healthcare in LMICs. With ever-greater processing power in mobile devices and growing telephone and Internet connectivity, the capacity for these devices to deliver change is unprecedented. However many social challenges remain. In Kenya for example, mobile phone ownership and usage is associated with gender, level of education, literacy, urbanization and the socio-economic status of the individuals.^{35,36}

There are also likely to be differences in the ways e-Health interventions will be used in LMICs when compared to high-income countries. While the focus of e-

Health technologies in high-income countries is on healthcare consumers, the shortage of skilled human resources for health in LMICs highlights the need for such tools to empower healthcare providers.^{37,38} With greater efforts being made in the standardisation of such technologies it is also likely that Open Source software will garner a larger proportion of the e-Health market. Hospital systems in LMICs are also likely to adopt 'mobile first' and patient-centred approaches to their technologies. As high-income countries adapt their existing PC-based systems to support mobile technology, it is possible that innovation in low-income settings could 'leap-frog' usability, connectivity and privacy issues that are causing serious problems in the high-income world due to legacy systems still in use. To succeed, however, e-Health solutions in LMICs also need to innovate on additional fronts to overcome the HRH and other challenges mentioned earlier.

The rapid advancement of ICT sector in Kenya coupled with presence of a sizable ICT human resource base has contributed to increased implementation of e-Health projects in the country and as a result, the Ministry of Health in 2011 launched a National e-Health Strategy 2011-2017.³⁹ The strategy describes how the Kenyan health system is faced with the challenge of rising cost and demand for quality health care services against a backdrop of skilled health care personnel shortage. The e-Health strategy therefore clearly highlights the gaps in healthcare services and aims to address these challenges by harnessing ICT. Five strategic areas have been identified: telemedicine, health information

systems, m-Health, e-Learning, and information for citizens. The strategy anticipates that ICT would promote and deliver efficient healthcare services to Kenyans and consumers beyond Kenya's borders. The launch of the national e-Health strategy in Kenya has seen numerous public and private sector initiatives across the strategic areas.^{4,40,41}

As in any sector, innovation in healthcare addresses the unmet needs of consumers. For-profit enterprise and related investment vehicles have traditionally been the agents that design and deliver sustainable, demand-driven solutions. Improving healthcare for underserved populations in LMICs may not generate large profits, yet the inherent value in private sector enterprise methods have resulted in a proliferation of 'social enterprises' – businesses with social objectives.⁴² Social enterprises could prove to be the agents for the innovation needed in e-Health, merging entrepreneurship with efficient financing and operations needed for delivering impact that is both sustainable and scalable.

E-Health solutions in healthcare, especially in LMICs, are still in their infancy. It is a time for policymakers, funders and regulators in LMICs to actively encourage innovation and entrepreneurship, the main vehicles driving change. Regulation will naturally follow in the wake of innovations, encouraging changes that benefit society while protecting its citizens.⁴³

ACKNOWLEDGEMENTS:

PK is funded by a Stars in Global Health award (S5 0420-01) from Grand Challenges Canada. PK and CP are funded by Health Systems Research Initiative grants (MR/N005015/1; MR/N005600/1) jointly supported by the Department for International Development (DFID), the Economic and Social Research Council (ESRC), the Medical Research Council (MRC) and the Wellcome Trust (WT). DK is funded by a grant from the Canadian International Development Research Centre (IDR-AHI01). The authors are grateful to Meghan Bruce Kumar for comments on the manuscript, Dr. Bernadette Kleczka for work on template development, to Emily Bowler for research assistance, and to colleagues at Health-E-Net Ltd., Strathmore Business School and the KEMRI-Wellcome Trust Research Programme for their support.

CONFLICT OF INTEREST:

Dr. Pratap Kumar is the CEO of Health-E-Net Ltd., a healthcare social enterprise in Kenya.

References

1. Communications Authority of Kenya. First quarter sector statistics report for the financial year 2015/2016 (July-September 2015). <http://www.ca.go.ke/images/downloads/STATISTICS/Sector%20%20Statistics%20Report%20Q1%202015-16.pdf> (accessed 03 Apr 2016).
2. Lewis T, Synowiec C, Lagomarsino G, et al. E-health in low- and middle-income countries: findings from the Center for Health Market Innovations. *Bull World Health Organ* 2012;90(5):332-40.
3. Obasola IO, Mabawonku I, Lagunju I. A Review of e-Health Interventions for Maternal and Child Health in Sub-Sahara Africa. *Matern Child Health J* 2015;19(8):1813-24.
4. Déglise C, Suggs LS, Odermatt P. SMS for disease control in developing countries: a systematic review of mobile health applications. *J Telemed Telecare* 2012;18(5):273-81
5. van Gemert-Pijnen JE, Nijland N, van Limburg M, et al. A Holistic Framework to Improve the Uptake and Impact of eHealth Technologies. *J Med Internet Res* 2011;13(4):e111
6. Alpay LL, Henkemans OB, Otten W, et al. E-health applications and services for patient empowerment: directions for best practices in The Netherlands. *Telemed J E Health* 2010;16(7):787-91.
7. Tomlinson M, Rotheram-Borus MJ, Swartz L, et al. Scaling up mHealth: where is the evidence?. *PLoS Med* 2013;10(2):e1001382
8. Blumenthal D and Tavenner M. The "meaningful use" regulation for electronic health records. *N Engl J Med* 2010;363(6):501-4
9. Greenhalgh T and Keen J. England's national programme for IT. *British Medical Journal* 2013;346:f4130
10. Kuperman GJ. Health-information exchange: why are we doing it, and what are we doing? *J Am Med Inform Assoc* 2011;18(5):678-82
11. Tierney WM, Achieng M, Baker E, et al. Experience implementing electronic health records in three East African countries. *Stud Health Technol Inform* 2010;160(1):371-5

12. Fritz F, Tilahun B, Dugas M. Success criteria for electronic medical record implementations in low-resource settings: a systematic review. *J Am Med Inform Assoc* 2015;22(2):479-88
13. Campbell J, Dussault G, Buchan J, et al. A universal truth: no health without a workforce. Forum Report, Third Global Forum on Human Resources for Health, Recife, Brazil. Geneva, Global Health Workforce Alliance and World Health Organization, 2013.
14. Ministry of Health, Government of Kenya. Integrated Payroll and Personnel Database. 2012.
15. Ministry of Health, Government of Kenya. Master Facility List. <http://ehealth.or.ke/facilities/download-latest.aspx> (accessed 28 Jul 2015).
16. Temu F, Leonhardt M, Carter J, et al. Integration of non-communicable diseases in health care: tackling the double burden of disease in African settings. *Pan Afr Med J* 2014;18:202.
17. Ministry of Health, Government of Kenya. 2014. 2013 Kenya Household Health Expenditure and Utilisation Survey. Nairobi: Government of Kenya.
18. Field MJ (Ed.). Telemedicine: a guide to assessing telecommunications in health care. Washington DC: National Academy Press, 1996.
19. American Telemedicine Association. State Telemedicine Gaps Analysis. <http://www.americantelemed.org/policy/state-policy-resource-center#.VewSsZ2qqko> (accessed 31 August 2015).
20. <http://www.grandchallenges.ca/grantee-stars/0420-01/>
21. Freiburger G, Holcomb M, Piper D. The STARPAHC collection: part of an archive of the history of telemedicine. *J Telemed Telecare* 2007;13(5):221-3.
22. Allely EB. Synchronous and asynchronous telemedicine. *J Med Syst* 1995;19(3):207-12
23. von Wangenheim A, Nobre LFD, Tognoli H, et al. User satisfaction with asynchronous telemedicine: a study of users of Santa Catarina's system of telemedicine and telehealth. *Telemed J E Health* 2012;18(5):339-46
24. Johnson SB, Bakken S, Dine D, et al. An electronic health record based on structured narrative. *J Am Med Inform Assoc* 2008;15(1):54-64.

25. Rowe SY, Kelly JM, Olewe MA, et al. Effect of multiple interventions on community health workers' adherence to clinical guidelines in Siaya district, Kenya. *Trans R Soc Trop Med Hyg* 2007;101(2):188-202.
26. Agweyu A, Opiyo N, English M. Experience developing national evidence-based clinical guidelines for childhood pneumonia in a low-income setting--making the GRADE?. *BMC Pediatr* 2012;12:1.
27. Higuchi M, Okumura J, Aoyama A, et al. Application of standard treatment guidelines in rural community health centres, Timor-Leste. *Health Policy Plan* 2012;27(5):396-404.
28. Kawamoto K, Houlihan CA, Balas EA, et al. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. *BMJ* 2005;330(7494):765.
29. English M, Nzinga J, Mbindyo P, et al. Explaining the effects of a multifaceted intervention to improve inpatient care in rural Kenyan hospitals--interpretation based on retrospective examination of data from participant observation, quantitative and qualitative studies. *Implement Sci* 2011;6:124.
30. Jamtvedt G, Young JM, Kristoffersen DT, et al. Audit and feedback: effects on professional practice and health care outcomes. *Cochrane database of systematic reviews (Online)* 2006;2:CD000259.
31. Lock P, McElroy B, Mackenzie M. The hidden cost of clinical audit: a questionnaire study of NHS staff. *Health Policy* 2000;51(3):181-90.
32. Rannan-Eliya RP, Wijemanne N, Liyanage IK, et al. The quality of outpatient primary care in public and private sectors in Sri Lanka-how well do patient perceptions match reality and what are the implications? *Health Policy Plan* 2014:1-16.
33. Haynes AB, Weiser TG, Berry WR, et al. A surgical safety checklist to reduce morbidity and mortality in a global population. *N Engl J Med* 2009;360(5):491-9
34. Kumar P, Kleczka B, Ngunjiri D, et al. The Guidelines Adherence in Slums Project (GASP). 1st Annual Regional eHealth Conference, Ministry of Health, Kenya 2015.

35. Wesolowski A, Eagle N, Noor AM, et al. Heterogeneous mobile phone ownership and usage patterns in Kenya. *PLoS ONE* 2012;7(4):e35319
36. Zurovac D, Otieno G, Kigen S, et al. Ownership and use of mobile phones among health workers, caregivers of sick children and adult patients in Kenya: cross-sectional national survey. *Global Health* 2013;9:20
37. Free C, Phillips G, Galli L, et al. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. *PLoS Med* 2013;10(1):e1001362
38. Free C, Phillips G, Watson L, et al. The effectiveness of mobile-health technologies to improve health care service delivery processes: a systematic review and meta-analysis. *PLoS Med* 2013;10(1):e1001363
39. Republic of Kenya, *Kenya National e-Health Strategy 2011-2017*, Ministry of Medical Services and Ministry of Public Health and Sanitation, Editors. 2011: Nairobi.
40. Talbot D. Kenya's mobile prescription: local programmers and homegrown business models are helping to realize the vast promise of using phones to improve health care and save lives. *Technology Review (Cambridge, Mass.)* 2012;115(2):52
41. Juma K, Nahason M, Apollo W, et al. Current Status of E-Health in Kenya and Emerging Global Research Trends. *International Journal of Information and Communication Technology Research* 2012;2(1):50
42. Roy MJ, Donaldson C, Baker R, Kerr S. The potential of social enterprise to enhance health and well-being: a model and systematic review. *Social science & medicine* 2014: 123,182-193.
43. Jamard A. Innovation in regulation turmoil. *Wired* 2014: <http://www.wired.com/insights/2014/06/innovation-regulation-turmoil/> (accessed 31 Aug 2015)
44. Naicker S, Plange-Rhule J, Tutt RC, et al. Shortage of healthcare workers in developing countries--Africa. *Ethn Dis* 2009;19(Suppl 1):S1 60-64.

45. Clemens MA and Pettersson G. New data on African health professionals abroad. *Hum Resour Health* 2008;6:1.
46. Young A, Chaudhry HJ, Pei X, et al. A census of actively licensed physicians in the United States, 2010. *Journal of Medical Regulation* 2011;101(2):8-23.
47. Maki J, Qualls M, White B, et al. Health impact assessment and short-term medical missions: a methods study to evaluate quality of care. *BMC Health Serv Res* 2008;8:121.

Figure 1: Within-country disparities in human and hospital resources for health in Kenya

The line represents the population of the 47 counties of Kenya (millions). Red bars represent the number of healthcare workers (nurses, clinical officers, doctors) per 1,000 people in the public sector, which ranges from 1.56 in Isiolo to 0.12 in Mandera.¹⁴ Blue and green bars represent beds and cots (both public and private sector) per 1000 people respectively. Counties are arranged in descending order of beds to population ratio, from 3.48 in Isiolo to 0.39 in Mandera. Cots available ranges from 0.93 per 1,000 population in Isiolo to 0.03 in Bungoma.¹⁵

Figure 2: Illustration of the shortfall of doctors in LMICs and global skills available to provide remote medical consultations

There are two or fewer doctors per 10,000 people in 37 countries in Africa (including South Sudan).⁴⁴ However there are both local and global resources that can be used to temporarily address this shortfall using telemedicine. These include diaspora doctors,⁴⁵ retired doctors,⁴⁶ those taking part in medical missions,⁴⁷ and residents enrolled in global health track programs.

Figure 3: A to-scale illustration of a template for managing UTIs

The template is placed in the case sheet using a rubber stamp. Fiducial markings in the corners help accurate digitisation and image analysis using mobile phone cameras. The optical 'bubble' sheet format allows for rapid and efficient automated analysis of paper-based medical records.