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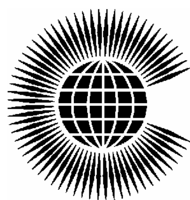

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Theme – 'E-Health: Challenges and Opportunities'

Agenda Item III **HMM(G)(08)3**

E-HEALTH FOR DEVELOPING COUNTRIES: AFFORDABLE STRATEGIES

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EXECUTIVE SUMMARY

Good, affordable e-health investment should help healthcare professionals to achieve continuous gains in health and healthcare quality and improve citizen's access to services. Healthcare professionals must be fully engaged in these e-health decisions. They will be the main users, and e-health must be easy for them to use to find the information and knowledge they need, when they need it.

2. Affordable e-health should be pursued alongside all other initiatives that are part of local, regional and national health and healthcare strategies. Then, e-health decisions can fit with other competing demands on scarce resources, especially for more doctors and other healthcare professionals, drugs, vaccines and preventative programmes, such as nutrition.

3. Sustainable e-health means relatively small and related e-health projects that fit into a longer-term strategic e-health picture. This jigsaw approach helps to manage e-health affordability. An indicative estimate for short-term affordable e-health investment may be between $1 and $7 per head of population each year. These modest levels will be demanding to secure and sustain for many developing countries.

4. The approach to e-health affordability outlined in this report should help developing countries to secure the support needed for integrated activities such as financing, affordability, procurement, price improvements, organisational change and sharing health informatics and ICT expertise needed for activities such as data definitions, standards, interoperability, architecture and the communication networks needed for long-term e-health investment.

5. E-Health strategies should seek to optimise relationships between costs, benefits, affordability, risks and time, and so realise affordable net benefits. This means investment in proven ICT applications and communication networks that can connect healthcare professionals in multi-disciplinary teams and support individuals in developing their clinical and working practises; telemedicine, telehealth and telecare; public health databases for prevalent diseases and local electronic patient records (EPR) that can be integrated gradually into wider, regional and national settings. Risks of these e-health investments are high and mitigation depends on compliance with recognised good practices and avoiding expensive, unproven, large-scale, big bang e-health projects.

6. Finally, developing countries are not e-health novices. They can learn from each other, not only from developed countries.

2 INTRODUCTION

7. Using e-health to support the daily work of healthcare professionals can improve healthcare provision and so improve citizens' health. However, investing in affordable e-health applications that can realise these benefits so they exceed the costs over time is not easy.

8. Identifying and justifying e-health for the Commonwealth's developing countries is more complex and demanding than in its developed countries. Extreme and massive health needs and stringent, very low healthcare resource levels of developing countries create a stubborn mismatch between healthcare supply and demand and high opportunity costs for e-health. Waste from high-cost e-health investment that delivers few benefits would be disastrous for developing countries. It must be avoided. It would deny resources and benefits to other under-resourced aid initiatives, such as nutrition, sanitation and water supply programmes, that can deliver immediate, significant net benefits for health.

9. Consequently, identifying and investing in affordable, proven e-health is critical to success. It can only be achieved by dealing with e-health strategies and investment as part of the whole health and healthcare strategy, and so enable decisions and choices from the whole range of potential initiatives, including more doctors and other healthcare professionals; more drugs and vaccines; more aid initiatives; more hospitals and clinics; and more e-health.

10. Successful e-health investment requires clarity on five questions:

- What are the health and healthcare challenges and priorities of developing countries?
- What net benefits are needed from e-health investment in response to these challenges and priorities?
- Which net benefits can be realised from e-health as part of an integrated strategy for health and healthcare?
- Will the net benefits from e-health exceed those from other health and healthcare initiatives?
- Which e-health investments are affordable?

3 WHAT IS E-HEALTH?

3.1 Two core components

11. E-Health has two components: one is information and communication technologies (ICT); the other is organisational change. ICT can provide more information and knowledge to healthcare professionals, enabling them to develop their clinical and working practices to expand the benefits to citizens. It includes hardware, middleware, software, licences, maintenance, data standards and definitions; telecommunications; access to information and knowledge and removing replaced ICT and related systems. Organisational change includes procurement, readiness, training, user support, project management, programme management, designing and introducing new clinical and working practices, systems implementation and operation, applying recognised good practices, risk management and benefits realisation. Substantial benefits from ICT in healthcare are usually impossible to realise without organisational changes.

12. The e-health Impact study[1] indicated that costs of organisational change over e-health investment life cycles could some 40 per cent of the ICT investment. So for every $1 spent on ICT, 66 cents may be needed for organisational change. Precise proportions depend on the type of e-health investment and the length of its life cycle. Both organisational change and ICT must be financed fully. If it is not, risk increases, and so does the probability of diminished benefits and in some cases, no net benefit, just additional net costs, sometimes from failure.

3.2 Four types of e-health

13. Four main types of e-health, which overlap, are clinical; telehealth; distributed; and compiled.

14. Clinical e-health provides specialised medical and related information and knowledge for healthcare professionals in hospitals and primary and community healthcare. Examples are picture archiving and communications systems (PACS) and nursing information systems across networks. Telehealth links patients remotely with healthcare providers, and includes telemedicine, telehealth, telecare and home monitoring across information networks. Distributed e-health enables access to information across networks that extend across regions, countries and between countries, including access to electronic health records (EHRs) and prescribing data. Compiled e-health includes medical and healthcare training, public health surveillance, research projects, supply chain management and administrative activities such as billing.

3.3 Two characteristics of e-health

15. These four types of e-health can have two other broad, but distinctly different, characteristics that are strategically important. One, such as telehealth and PACS, has a proven history of sustainability. Relatively little time is required from healthcare

[1] E-*Health if Worth it - the economic benefits of implemented e-health solutions at ten European sites* K A Stroetmann T W Jones A Dobrev, V N Stroetmann, "e-health is Worth ", Office for Official Publications of the European Communities, Luxembourg, 2006 (56 pp. - ISBN 92-79-02762-X) http://www.ehealth-impact.org

professionals and organisations for local adaptation and design work with suppliers. The impact is understood and the time, and way, to realise net benefits is known.

16. The second type includes national EHRs, and is complex, large scale and lacks evidence and operating experience. They may be commercially available only with a considerable investment in time and expertise of healthcare professionals and organisations working in partnership with suppliers. Costs are high and the impacts are not generally well understood due to their developmental nature. Large investments are needed, often over several years; and may have large cost humps in the early years that include long periods of design, development and organisational change, with even longer time scales to reach a net benefit, probably beyond six years. These e-health investments carry much higher costs and risks than the first type. Planning and securing their affordability are demanding and are not well developed as methodologies.

17. E-Health relies on electronic communication networks. Data captured at points of care where patients and healthcare professionals are together, are transferred to another point for additional action, review, summary or aggregation, and then made available for healthcare professionals to use for subsequent stages of patient care, public health activities, education, training or research. This communication infrastructure can be within healthcare and part of a secure communication infrastructure available to citizens, services, business, commerce and government. Developing this setting depends on the roles; resources; priorities; initiatives and performances of the ICT industry and government ministries, especially for technology.

Rajshahi City Corporation, Bangladesh, introduced a registry and tracking system for immunisation in 2001. An evaluation[2] in 2004 confirmed its success. No direct finance was available for the e-health investment of some $5,000. The evaluation proposes that e-health investment in developing countries should be targeted at healthcare professionals because they are critical in supporting the lives of the poor in communities by their high levels of contact. This support for e-health empowers healthcare professionals is seen as offering more benefits to the poor than numerous eGovernment portals.

4 FEATURES OF DEVELOPING COUNTRIES CRITICAL FOR E-HEALTH STRATEGIES

4.1 Some numbers

18. Developing countries have a high prevalence and incidence of several diseases and very low levels of healthcare resources. Health in Sub-Saharan Africa accounts for 11 per cent of the world's population; bears 24 per cent of the global disease burden; but spends less than 1 per cent of global healthcare expenditure. It also faces a severe shortage of trained medical personnel, with just 3 per cent of the world's health workers. Some 60 per cent of Africa's healthcare relies on private income and some 50 per cent of healthcare resources are deployed to private healthcare providers[3]. Sub-Saharan Africa's reliance on this mixed

[2] *Electronic immunisation registry and tracking system Bangladesh* M Ahmed Institute for Policy Development and Management University of Manchester http://www.egov4dev.org/banglaimmune.htm
[3] *The Business of Health in Africa* International Finance Corporation World Bank Group 2008

healthcare economy, and its equivalent in other developing countries, has to be acknowledged realistically in e-health strategies and investment.

19. Average healthcare spending in the Commonwealth's developing countries' is about 8 per cent of the Commonwealth's developed countries. But, the developing countries are not all the same. Averages conceal a wide range of about 1 per cent to 27 per cent of the healthcare resources of developed countries. Table 1 illustrates the position.

Table 1 – Indicative Comparison of Developing and Developed Commonwealth Countries 2004

	Developing	Developed
Healthcare Spending per head[4] - average	$214	$2,734
Healthcare Spending per head – lowest	$29	$2,081
Healthcare Spending per head – highest	$748	$3,173
Healthcare Spending as GDP % - average[5]	6%	9%
Healthcare Spending as GDP % – lowest	2%	8%
Healthcare Spending as GDP % – highest	14%	10%

20. These differences are reinforced by the World Health Organisation (WHO) findings[6] that several countries in Sub-Saharan Africa cannot afford to spend the $34 to $40 per person each year needed to provide basic healthcare. This poses a massive requirement on e-health investment. It must be low cost, add net benefits, avoid waste and rely on proven, available, successful, affordable e-health solutions, not expensive, experimental pilots and developments.

4.2 Some principles for e-health investment

21. E-Health that supports healthcare professionals who deal with highly prevalent diseases, such as HIV/AIDS, malaria, tuberculosis, polio and diabetes, should be significant priorities for investment. Others priorities are increasing levels of hypertension, cardiovascular disease and trauma[7], onchocerciasis, caused by parasitic worms and Severe Acute Respiratory Syndrome (SARS), an illness caused by a virus. Sudden outbreaks of diseases also occur, such as the Ebola hemorrhagic fever outbreak in 2007. All four main types of e-health can be part of relevant e-health investment in this setting.

22. Infant mortality is also a high e-health priority. In 2001, 56 million people died globally. Some 10.6 million, about 19 per cent, were children, and 99 per cent of these lived in low or middle-income countries. Over half the child deaths in 2001 were due to acute respiratory infections, measles, diarrhoea, malaria and HIV/AIDS. A comparison of the 2001 death rates is in table 2.

[4] Healthcare finance 2005 World Health Organisation (WHO)
[5] Healthcare finance 2005 WHO
[6] *Spending on health: a global overview* WHO factsheet
[7] *Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society 2005

Table 2 – Comparison between High-income Countries and Low and Middle-Income Countries of Death Rtes of Children Aged 0 to 4[8]

Region	Death rates per 1,000 Children Aged 0 to 4	
	1999	2001
Sub-Saharan Africa	48%	40%
South Asia	28%	21%
High-Income Countries	2%	1%

23. E-Health investment is also competing for resources with other health initiatives. Under-nutrition[9] is common in 50 per cent of child deaths. Over one-third of these are largely preventable, but only with more money, hard work, and avoiding reliance on non-existent magical technological bullets[10]. About 80 per cent of undernourished children live in 20 countries in four regions of the world; Africa, Asia, Western Pacific and the Middle East and aid for basic nutrition programmes in these countries is less than $2 for each child under two[11]. Interventions for children during pregnancy and up two are especially important to prevent irreversible damage to future health and development. A successful example is a programme in Malawi that has achieved over 90 per cent recovery rates, which has been scaled up into a national programme[12].

24. The fight against malaria also needs resources. WHO has recently evaluated the initiatives of the Global Fund to Fight AIDS, Malaria and Tuberculosis in Ethiopia, Ghana, Rwanda and Zambia[13]. Providing mosquito nets impregnated with insecticide and the drug artemisinin to communities, along with Dichloro-Diphenyl-Trichloroethane (DDT) spraying, has resulted in large improvements in mortality and health of children under five. In Rwanda, the reported malaria cases and the death rate both fell by about 66 per cent over two years. These improvements were about 60 per cent and 50 per cent respectively in Ethiopia and about 33 per cent for both in Zambia. Improvement is not clear in Ghana.

At Kijabe Hospital in Kenya, a project with Cisco[14], the NHS in England and Map of Medicine at the hospital and two of its seven collaborating health centres has been completed. Clinical staff now have online access to current best practice and medical information, which is important in developing countries due to their relatively slow rate of ICT diffusion compared to developed countries[15]. It also provides access for post-graduate education programmes. The result was improved diagnosis and treatment at the points of care. Wireless technology was part of the e-health solution. Before the project, the hospital already had 75 networked personal PCs, and some already had internet access.

[8] *Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data* A D Lopez C D Mathers M Ezzati D T Jamison C J L Murray *Lancet* 2006; 367: 1747-57
[9] *Nutrition interventions need improved operational capacity* J Sheeran *Lancet* 2008; 371: 180-181
[10] *Maternal and child undernutrition: an urgent opportunity* R Horton *Lancet* 2008; 371:179
[11] *The starvelings* The Economist 2008 Volume 386 Number 8564 Page 69 to 70
[12] *Nutrition interventions need improved operational capacity* J Sheeran *Lancet* 2008; 371: 180-181
[13] *Net benefits* The Economist 2008 Volume 386 Number 8565 Pages 66 and 67
[14] *Rural Kenya Adopts Wireless Technology and Unique Medical Map to Improve Patient Care and Student Education* Cisco Systems Inc 2005
[15] *Global Economic Prospects 2008* World Bank page 67

5 SOME EXPERIENCES FROM DEVELOPED COUNTRIES

5.1 The E-Health Impact Study

25. The European Commission's (EC) E-Health Impact (EHI) study evaluated the socio-economic impact of ten proven e-health investments in Europe. Time-scales needed to realise net benefits varied between two and eight years. Table 3 shows a comparison of the EHI results:

Table 3 – Summary of Socio-economic Findings from Ten e-health Sites in Europe[16]

	Average	Minimum	Maximum	Range
Benefits distribution				
Citizens	43%	1%	96%	95%
Healthcare providers	52%	4%	99%	95%
Third party payers	5%	0%	53%	53%
First year to annual benefit	4	2	7	5
First year to cumulative benefit	5	2	8	6

Healthcare providers gain most benefits, but within a wide range, depending on the type of e-health. Over 90 per cent of the benefits are classified as economic[17] [18], rather than financial, and seldom result in direct savings in cash outflows, which are often less than 5 per cent of all benefits, and insufficient to cover the full cost of e-health investment. Consequently, e-health needs cash investment, with the socio-economic benefits valued rigorously to justify the extra finance.

26. Organisations investing in e-health may not be the only beneficiaries. For example, a group of hospitals may invest in telemedicine, with citizens benefiting significantly, but not contributing directly to the cost. Some types of e-health enable some doctors to save some of their valuable time, but only when other doctors in other organisations take on more work. These features combine into two issues for e-health: who win and who pays? The resolution may require a direct role for ministries of health, technology and finance, and so governments. It can include providing a substantial share of e-health finance.

5.2 Benefits from e-health

27. Three main types of benefit are better quality, increased access and improved efficiency of healthcare.

28. Quality has five main components; better-informed citizens, patients, carers and families; healthcare provided more promptly; healthcare that is more effective; healthcare

[16] *eHealth if Worth it - the economic benefits of implemented eHealth solutions at ten European sites* K A Stroetmann T W Jones A Dobrev, V N Stroetmann, "eHealth is Worth ", Office for Official Publications of the European Communities, Luxembourg, 2006 (56 pp. - ISBN 92-79-02762-X) http://www.ehealth-impact.org

[17] *eHealth if Worth it - the economic benefits of implemented eHealth solutions at ten European sites* K A Stroetmann T W Jones A Dobrev, V N Stroetmann, "eHealth is Worth ", Office for Official Publications of the European Communities, Luxembourg, 2006 (56 pp. - ISBN 92-79-02762-X) http://www.ehealth-impact.org

[18] *Assessment of Financing Opportunities Available to Member States to Support and Boost Investment in eHealth* European Commission Information Society and Media Directorate General Brussels http://www.financing-ehealth.eu

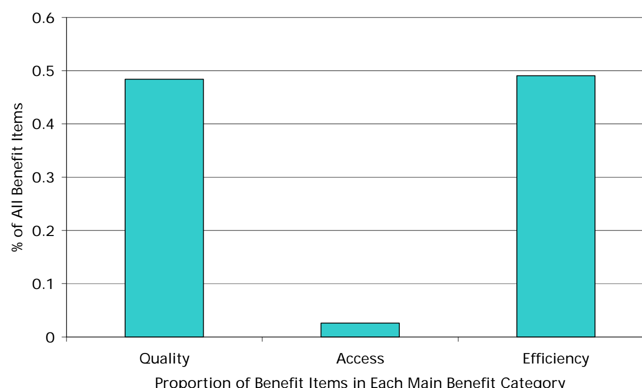
that is more streamlined and improved patient safety. They can all be demanding to realise consistently on a large scale.

29. Access has two core dimensions: geographic and social inclusion. Benefits include faster and comprehensive access for all citizens to health programmes, such as nutritional improvements. With such a large gap in supply and demand in developing countries, these benefits may be the highest priority, or have a similar priority to quality gains, especially for children.

An e-health Impact evaluation[19] of telecardiology services in Italy added to the findings shown in Table 3. Telecardiology services were developed from the Boario Home Care Project[20]. Initially, the service was modest, operated by cardiologists and subjected to rigorous clinical trials that produced valuable information about benefits. Benefits were realised from the first year in 1998, and continued to expand, even recovering from a major drop in utilisation in 2005.The distribution of benefits was estimated as about 70 per cent for healthcare providers and 30 per cent for citizens. As proportion of total Benefits, 47 per cent were from patients who avoided hospital admission or attendance, and 18 per cent from patients needing hospital admission or attendance, but were unable to access these services in the previous healthcare model.

30. Efficiency includes improvements in productivity, reducing waste and modest reductions in cash outlays. Improving productivity can enable resources to be redeployed[21] to support healthcare professionals and improve citizens' access to healthcare. Chart 1 shows an estimate of the balance between the three benefits categories in developed countries, derived from private analyses by *TanJent*.

Chart 1 – Illustrative Proportions of Individual Benefit Items in Each Main Benefit Category for Developed Countries



[19] *Telecardiology in Italy: benefits from a telemedicine network connecting chronic patients, general practitioners and healthcare provider organisations* Association of Chartered Certified Accountants London 2006

[20] *Boario Home Care Project: An Italian Telemedicine Experience* S Scalvini M Volterrani A Giordano F Glisenti Monaldi Archives for Chest Diseases Issue 60 Volume 3 pages 254 to 257

[21] *Assessment of Financing Opportunities Available to Member States to Support and Boost Investment in eHealth* European Commission Information Society and Media Directorate General Brussels http://www.financing-ehealth.eu

5.3 E-Health investment in developed countries

31. Developed countries are investing extensively in e-health. The review of France's Dossier Médical Personnel (DMP)[22] reported a range of costs per person for a range of national developments as shown in Table 4:

Table 4 – Indicative Investment per Person in National E-Health Investments

Country	e-health Investment	Indicative Investment € per Person
Denmark	MedCom	264
England	National Programme for IT (NPfIT)	233
Canada	Electronic Health Record	225
Australia	Health-Connect	60
Germany	E-Healthcard and SCIPHOX	50
France	DMP	18

These reported costs are often mainly ICT costs with long development periods. They often exclude much of the cost of organisational change, cost overruns and ICT obsolescence, so tend to be understated. Most of these projects are not yet complete and face cost rises above these estimates. The scale and complexity of these types of e-health should not be contemplated by developing countries where annual healthcare spending is $29 to $748 per head.

32. A valuable achievement of England's NPfIT has been to enhance the ICT purchasing power of NHS organisations[23]. By combining some e-health procurement plans of many NHS healthcare providers, the resulting lower price of proven, available ICT has reduced the total cost dramatically. This procurement model impacts directly on affordability and can be valuable for developing countries

33. The EC's EHI study[24] found several themes that could be relevant to developing countries. Kind en Gezin's Flemish Vaccination Database for Flanders in Belgium increased and sustained vaccination rates from about 77 per cent to 95 per cent within some four years; returned performance rapidly to the higher vaccination rates shortly after disrupted vaccine supplies; used re-orders to avoid waste and managed the supply chain to introduce new and replacement vaccines without reductions in vaccination rates. This last impact could be relevant where new vaccine, such as for avian influenza may to be added to programmes. The outcome was net benefits realised in seven years with a small increase in annual expenditure.

34. The e-health impact for vaccination programmes can be more valuable where they have attracted some resistance and hostility, such as in the UK, where some parents declined the measles-mumps-rubella (MMR) vaccination for their children following media reports

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[22] *Review of the DMP project* Ministry of Economics, Ministry of Finance, Ministry of Health Paris 2007

[23] *Assessment of Financing Opportunities Available to Member States to Support and Boost Investment in eHealth* European Commission Information Society and Media Directorate General Brussels http://www.financing-ehealth.eu

[24] *eHealth if Worth it - the economic benefits of implemented eHealth solutions at ten European sites* K A Stroetmann T W Jones A Dobrev, V N Stroetmann, "eHealth is Worth ", Office for Official Publications of the European Communities, Luxembourg, 2006 (56 pp. - ISBN 92-79-02762-X) http://www.ehealth-impact.org

on the increased chances of autism from MMR vaccinations[25]. Similarly, Global Polio Eradication's vaccination programme in Nigeria was disrupted by comments that the polio vaccines had been deliberately adulterated with anti-fertility drugs. The programme is back on track.

35. For longer-term success, e-health should be interoperable. The Institute of Electrical and Electronic Engineers (IEEE) defines interoperability as two or more parts of a system exchanging information, then using it[26]. Interoperability offers future benefits and incurs additional short-term costs. The EC has commissioned a study to use the eHI methodology to evaluate the economic impact of interoperable EHRs and ePrescribing[27]. As developing countries build up and extend their e-health coverage, interoperability will become more complex, and this study may provide appropriate insights.

5.4 Differences in general ICT contexts

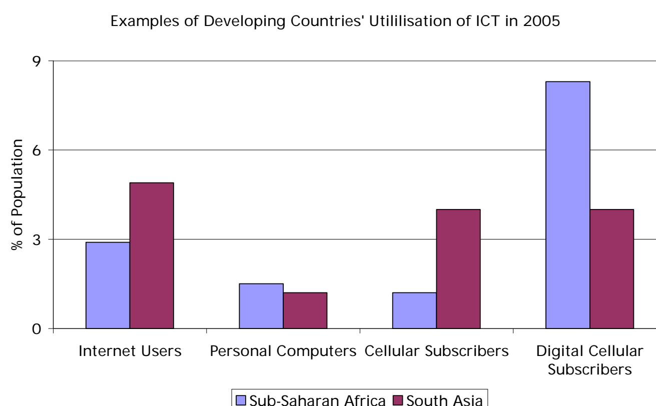
36. Globally, there are significant differences between regions[28]. Africa has about 3 per cent of the world's access to the internet, matched by a very low average penetration in African countries of about 5 per cent. The range is from the Seychelles at 35.4 per cent, to Sierra Leone at about 0.2 per cent. Penetration in Europe is reported as 49 per cent of the population, 57 per cent in Oceania and Australia and 71 per cent in North America. These differences may indicate the need for developing countries to encourage investment in public and commercial ICT networks alongside e-health.

37. The position of mobile phones differs too, but may be changing[29]. In 2001, less than 3 per cent of Africa's population had a mobile phone. In several developed countries, there were over 80 phones for every 100 people in 2002[30]. Forecast growth for Africa from 2004 to 2009 was some 230 per cent compared to a global forecast, including Africa, of about 80 per cent: almost three times the global average.

38. The World Bank reports the 2005 position as shown partly in charts 2 and 3.

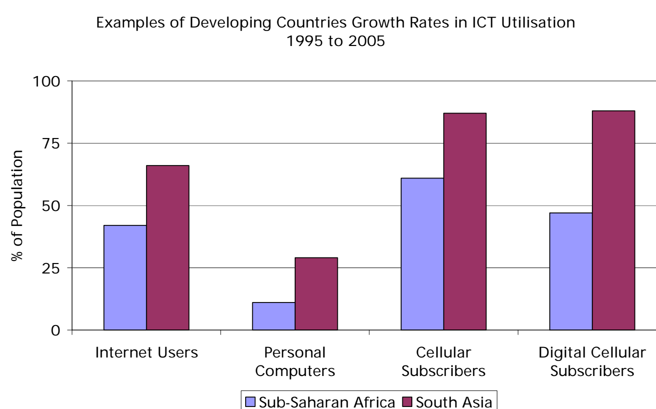
[25] *The Lancet* A Wakefield volume 351 page 637 1998
[26] *Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries* Institute of Electrical and Electronic Engineers New York USA 1990
[27] *Economic Impact of Electronic Health Records and ePrescription in Europe* European Commission Information Society and Media Directorate General Brussels 2008
[28] *Internet World Stats* www.internetworldstats.com
[29] *The Impact of Mobile Phones in Africa* N Scott S Batchelor J Ridley B Jorgensen Commission for Africa 19 November 2004
[30] *Mobile Phones by Country* http://www.nationmaster.com

Chart 2 – Examples of Developing Countries' Utilisation of Some ICT in 2005[31]



Equivalent rates for high-income countries are 53 per cent, 58 per cent, 77 per cent and 77 per cent respectively; roughly some ten times greater. However, chart 3 shows a changing position.

Chart 3 – Examples of Developing Countries' Growth Rates in ICT Utilisation 1995 to 2005[32]



39. Developed countries' ICT utilisation rates are 14 per cent, 12 per cent, 28 per cent and 19 per cent respectively, so the performance of the two developing regions has been mostly higher, albeit from a lower base. A possible blot is the growth in PCs Sub-Saharan Africa. At about 11 per cent, this is similar to developed countries. A consistent feature is that the performance of Sub-Saharan Africa is lower than South Asia's. These changes are seen as part of a trend that may mean a technological convergence of developing countries towards developed countries, but affordability is seen as the main constraint on technology diffusion.

40. When these findings are set alongside others that show low levels of internet penetration, a slower diffusion may reveal a limitation for developing countries in their readiness to adopt ICT. This may indicate a constraint on the readiness for e-health, which

[31] *Global Economic Prospects 2008* World Bank page 72
[32] *Global Economic Prospects 2008* World Bank page 72

may be exacerbated by low levels of ICT diffusion. Overcoming this will need strategies that expand the diffusion of general ICT, and increase the numbers of workers skilled in ICT.

At the Institut Curie, an internationally recognised centre of excellence for cancer treatment and research based in Paris, rapid access by doctors to comprehensive patient information using an EPR called Elios, and a meta-search engine called Prométhée, enables hospital doctors to work more effectively both directly with patients and as part of multi-disciplinary medical teams. Doctors can also complete clinical audit evaluations and achieve compliance to recognised standards much faster and cheaper than conventional methods.[33]

5.5 Financing e-health

41. The EC is looking to boost e-health investment in line with its e-health Action Plan[34] adopted in 2004. Despite some large e-health projects in several member states, annual spending on e-health in Europe seems to be stuck at about 2 per cent to 2.5 per cent of total annual healthcare spending. The EC has commissioned several studies, including the Financing e-health project[35], to find ways to improve e-health financing opportunities to increase e-health investment, and so try to match the performance of other sectors of the economy. The relatively slow rate of take up of e-health may indicate that strategies to increase e-health investment and secure additional benefits for stakeholders may have encountered several constraints. These include; resistance to change by healthcare professionals; low values assigned to e-health by policy makers and executives; affordability limits; and relatively low priority.

6 SOME EXPERIENCES FROM DEVELOPING COUNTRIES

6.1 Overview

42. Developing countries are not e-health novices. Several examples of a wide range of successful and less successful e-health investments can be found, and these offer valuable experience from which to build. Some already have direct experience of affordable and successful e-health investment in high priority health and healthcare activities. Their experience of partnerships and collaboration with agencies in other countries also offers excellent foundations for development.

43. Examples[36] of e-health impacts are improved dissemination of public health information; using telemedicine for remote consultation and advice; improved team working, collaboration and co-operation; improved research and dissemination; strengthened health monitoring and improved efficiency.

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[33] *eHealth if Worth it - the economic benefits of implemented eHealth solutions at ten European sites* K A Stroetmann T W Jones A Dobrev, V N Stroetmann, "eHealth is Worth ", Office for Official Publications of the European Communities, Luxembourg, 2006 (56 pp. - ISBN 92-79-02762-X) http://www.ehealth-impact.org

[34] *eHealth – making healthcare better for European Citizens: An action plan for a European eHealth Area* Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions Brussels 30 April 2004 adopted 3 May 2004

[35] *Assessment of Financing Opportunities Available to Member States to Support and Boost Investment in eHealth* European Commission Information Society and Media Directorate General Brussels http://www.financing-ehealth.eu

[36] *Improving health connecting people: the role of ICTs in the healthcare sector of developing countries A framework paper* World Bank 31 May 2006

6.2 Examples from developing countries

44. There are many large-scale public health priorities in developing countries. Two, the control of onchocerciasis in West Africa and the control of the SARS epidemic already benefit from e-health.[37] Reliance on current information and knowledge from public health databases enables the incidence and spread of diseases to be monitored, and responses to be implemented more rapidly.

45. Examples of successful e-health investment in developing countries are collected by the International Information Resource Centre[38]. It uses three classifications: disease control and prevention; diagnosis and treatment; and health management and information systems. Examples are from Bangladesh, South Africa, Mali and Uganda.

> The Tygerberg Children's Hospital and Rotary Telemedicine Project[39] in South Africa use telemedicine to link doctors at Tygerberg Hospital with doctors working in community and district hospitals. The project was developed locally using available hardware and software, which was more affordable than commercial telemedicine packages.

46. In 2007, telemedicine services in KwaZulu-Natal were evaluated[40]. Some 88 per cent of 10.3 million people rely on state hospitals. Over half, 54 per cent, live in rural areas. For each doctor, about 33,000 people have high prevalence of HIV, up to 77 per cent in women, and an increasing incidence of tuberculosis. After several attempts to develop a national telemedicine programme, videoconference facilities were used to develop a postgraduate tele-education service in KwaZulu-Natal. It started in 2001. By 2006, 17 academic disciplines, up from six in 2005, offered 765 hours of multi-point lecturing programming to 23,125 participants. The number of teaching sites also increased, up by five, from 16 to 21. There is now growing interest from other medical schools in South Africa and Sub-Saharan Africa to participate in shared postgraduate tele-education.

47. The experience at KwaZulu-Natal offers very valuable insights for e-health strategies, and identifies risks that have to be managed and mitigated. Slippage was a significant risk. A time scale of some six years had elapsed for benefits to emerge, much later that the net benefits from the telemedicine service in Lombardy, Italy, referred to earlier, where sustainable benefits emerged in the first year[41]. Using *TanJent's* e-health investment model to estimate the risk of the KwaZulu-Natal project, it shows that the risk exposure may have been about 75 per cent, compared to 55 per cent for an equivalent project in a developed country.

48. Implementation of a new health information system in Uganda was evaluated in 2003[42]. Technological issues, rather than wider organisational issues, dominated the

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[37] *Improving health in the Commonwealth: the role and importance of eHealth as an enabling environment* Prof S Yunkap Kwankam and Prof R J Richardson Commonwealth Health Ministers Reference Book 2007

[38] *Source* International Information Resource Centre London www.asksource.ids.ac.uk/

[39] *The Tygerberg Children's Hospital and Rotary Telemedicine Project* Cape Town 2003 http://www.bridges.org/case_studies/353

[40] *Telemedicine in Kwazulu-Natal: from failure to cautious optimism* M Mars Journal Telemedicine and Telecare Volume 13 Supplement 3 December 2007 pages 57 to 59

[41] *Telecardiology in Italy: benefits from a telemedicine network connecting chronic patients, general practitioners and healthcare provider organisations* Association of Chartered Certified Accountants London 2006

[42] *Implementing a new health management information system in Uganda* J Gladwin R A Dixon T Wilson Health Policy & Planning, volume 18 number 2 June 2003 214-24 p.

planning of the changes. The organisational context should have been included, because the process of changing information systems is more complex than some practitioners realise. It offers valuable learning about ICT implementation, confirming the need for a total e-health approach.

49. A commentary[43] on electronic medical records (EMR) in developing countries identified the need for excellent information management. Numerous potential benefits from EMRs included:

Clinical care

- Prompt and effective patient management by entering laboratory data from distant sites
- Warnings of abnormal laboratory results
- Seeking advice from remote physicians and specialists
- Prescribing support for allergy warnings and drug incompatibilities
- Managing chronic diseases.

Healthcare support

- Reminders for prescriptions and vaccinations
- Avoiding drug shortages
- Knowledge of drug stocks and supplies
- Assessing resource requirements
- Knowledge of patient numbers and types of diseases and treatments
- Track patient outcomes
- Legible clinical notes.
- Produce aggregated reports.

Education and research

- Improved medical education
- Support for clinical research.

50. Several EMRs and related e-health investments were reviewed in the study. They are summarised briefly in Appendix 1 *Examples of E-Health Investment in Developing Countries* alongside other e-health initiatives.

51. The review recognises that EMR development needs sensitive matching of local needs, available ICT and resources. Concerns and resistance often have to be addressed and the potential redeployment of resources to e-health from other healthcare activities has to be weighed against the potential to improve healthcare quality and efficiency by other types of investment. Making these judgements needs more than promising ideas: they need to be validated in the field, with potential improvements measured and evaluated against the actual performance when e-health is operational. Underpinning this is the critical

[43] *Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005

requirement to ensure that the core data model is designed against the long-term, concrete data requirements that need to be supported. A proposed approach is summarised as:

- Collaboration between projects using open models to help to improve software quality and reduce costs and avoid duplication; but not requiring open source operating system
- Create well-designed, effective low-cost systems
- Learn from each other
- Include the impact of risk exposure
- Evaluate projects and learn from them.

7 E-HEALTH STRATEGIES FOR DEVELOPING COUNTRIES

7.1 Integrated strategies

52. The Centre for Global Development in Washington, United States of America (USA) emphasises[44] that health issues should be dealt with in the context of the healthcare systems as a whole, not trying to beat individual diseases with separate initiatives. Strategically, this should lead to resource allocations that improve health, nutrition, sanitation, water supply, reduce mortality and so increase future demand for healthcare. In this scenario, it makes sense to try to invest simultaneously in improving the current health status of the population and their consequent increasing need to access to future healthcare, including e-health as part of the package.

53. Integrated strategies raise a core decision criterion: affordable e-health investment must add at least as much net benefit as competing healthcare investments, such as more doctors, more nurses, more drugs and expanded nutrition programmes. This opportunity cost comparison can be favourable for affordable e-health, but only if e-health helps people to respond to health and healthcare needs.

54. Healthcare financing that relies on a mix of private and public sources; needs a high proportion of direct payments by patients and their families; and depends on charities and the private sector to provide money, support and services, creates additional constraints for success. Several autonomous healthcare entities, each with their own priorities and approaches, can create difficult contexts for comprehensive e-health strategies and the required supporting financing arrangements. Disparate healthcare models and priorities of several types of providers can constrain efforts to provide the unified pools of finance needed to pursue integrated, affordable e-health investment across regions and countries. This can only succeed with effective partnerships and collaboration between healthcare providers, which can be challenging to create and sustain, and defines an e-health leadership role for health, technology and finance ministries.

7.2 Components of an affordable e-health strategy

55. At its 58th session in May 2005, the World Health Assembly called on all countries to develop long-term e-health strategies and policies to improve health worldwide. Generating and using information, intelligence and research about health and healthcare is

[44] *The starvelings* The Economist 2008 Volume 386 Number 8564 Page 69 to 70

seen as one of six building blocks[45]; service delivery; workforce; information; medical products, vaccines and technologies; financing; and leadership and governance. In this context, aims and attributes of effective health information systems are:

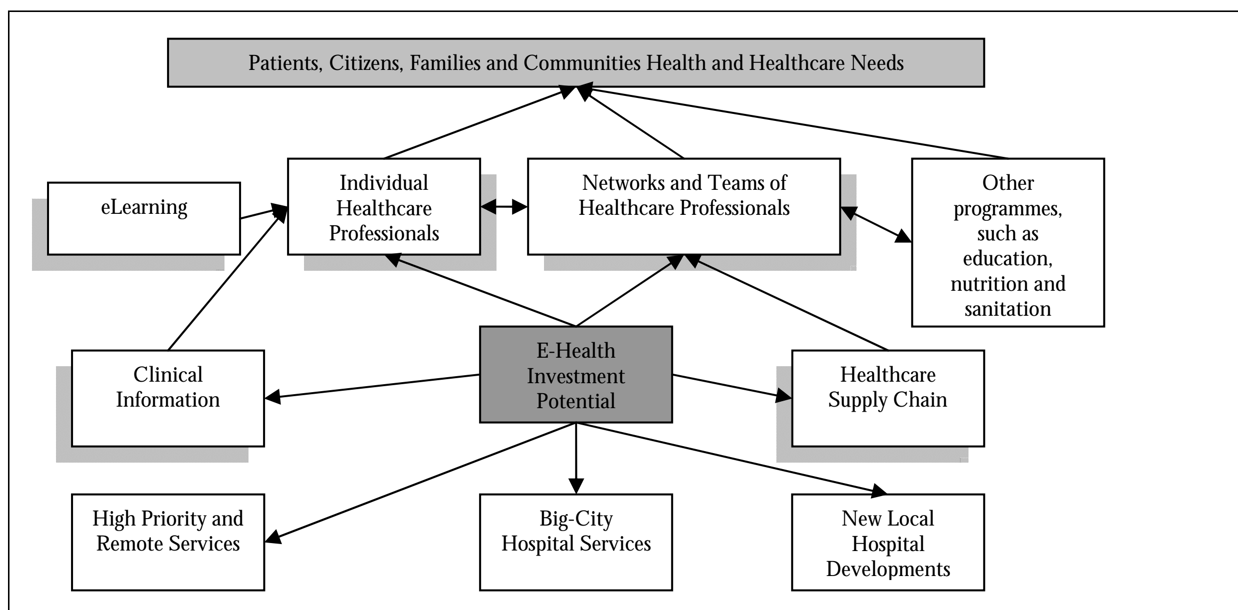
- Generating data about populations and facilities, such as registrations, public health surveillance, medical records and healthcare resources
- Detecting, investigating, and communicating to contain events promptly that threaten public health security
- Synthesising information and adding to and promoting the availability and use of new knowledge.

56. These lead to six priorities of information investment: national information systems support; avoiding parallel reporting; stronger capacity for national surveillance and response; core and additional health system metrics; standards, methods and tools; and synthesis and analysis of country, regional and global data. Affordability constraints have not been reflected in assigning relative value to these.

7.3 Assembling the opportunities

57. Diagram 1 shows a way to classify and integrate the e-health opportunities to benefit citizens and patients and healthcare professionals:

Diagram 1: Simplified View of the Potential Impact of E-Health Investment



With extremely scarce resources, it is important to develop a strategy that achieves a balance of e-health investment between diseases, healthcare activities, communities and locations. Directing e-health investment towards services for high priority diseases, such as HIV/AIDS will be an obvious choice, but it may also be valuable to ensure some e-health investments in

[45] *Everybody's Business Strengthening Health Systems to Improve Health Outcomes WHO's Framework for Action* World Health Organisation 2007 http://www.who.int/healthsystems/strategy/everybody's_business/.pdf

other services, such as hospitals in big cities. These could become leaders in affordable e-health for their country and regions, and provide e-health hubs from which to build networks and support pioneers for continuous e-health investment that can be extended and transferred to local settings. A similar opportunity may be to enhance new local hospital developments with new e-health capacity as they are being constructed. In addition to the new facilities and access for citizens, healthcare professionals will have more tools at their disposal.

7.4 Some ICT themes

58. ICT investment, especially communications infrastructures[46], such as wireless and satellites, will be needed to support several types of integrated small-scale e-health investments, using proven ICT, including:

- Clinical networks linking remote community services to community hospitals and teaching hospitals in large towns
- Databases for public health priorities, such as control of HIV/AIDS, onchocerciasis and the SARS epidemic[47]
- Telemedicine that enables patients to access services and healthcare professionals to access their specialist colleagues
- Vaccination and immunisation, including supply chain and stock management and introduction of new vaccines
- Prescribing, dispensing and pharmacy management to improve pharmaceutical supply chains and drug stock management
- Order entry and reporting for pathology and imaging services
- EMRs in hospitals and linked community and district hospitals and services
- eLearning.

59. Each country will have to take decisions about the types of architecture that will be needed and the mix of local and wide are networks. A mix of interfaces and access formats will also have to be set up, examples being PCs, laptops and intelligent phones with Linux and Microsoft Windows formats, PDAs, web sites and email. Decisions on the type and number of servers, PCs, laptops and PDAs will also be needed. Stable and sustainable expertise and resources, must be secured to support these activities and to express the human resource requirements in ICT plans that underpin e-health plans.

60. Health informatics is also a critical component of an affordable e-health strategy. Data definitions, standards, coding and interoperability are vital for developments in patient and clinical data, and have to be set for e-health to operate effectively over several different and related types of healthcare, especially where data is transferred electronically. This should be pursued in small, deliverable steps. Where countries plan to collaborate, they may benefit by dealing with these vital roles as a single, combined project. Again, a comprehensive range of expertise and resources will be needed for this role.

[46] *Rural Kenya Adopts Wireless Technology and Unique Medical Map to Improve Patient Care and Student Education* Customer Case Study, Cisco 2006
[47] *Improving health in the Commonwealth: the role and importance of eHealth as an enabling environment* Prof S Yunkap Kwankam and Prof R J Richardson Commonwealth Health Ministers Reference Book London 2007

61. Three themes should be addressed to progress these types of e-health strategies are:

- Ethical, legal and regulatory principle
- Risk management and mitigation
- Affordability strategies.

> In Cape Town and Durban, South Africa, the Cell-Life Project[48] backed by Vodacom, has developed software and data management systems so healthcare professionals can use their mobile phones to monitor HIV treatment and identify potential health problems before they become life threatening. Data includes symptoms, compliance with drug regimes, ability to pay for transport to clinics and nutrition. A central database stores the information, which can be accessed by healthcare professionals for their caseload of about 100 patients each.

8 ETHICAL, LEGAL AND REGULATORY PRINCIPLES

8.1 Some common principles

62. E-Health requires ICT and organisational change so that new forms of information and new clinical and working practices can benefit citizens by better access to better quality healthcare. Success also depends on changes to national and regional regulation and governance to reflect the ethical, legal and regulatory impact of e-health on healthcare.

63. Regulation can be through formal legislation, customary law or common practice and must ensure that using e-health in healthcare delivery respects commonly accepted legal and ethical standards. Consequently, e-health regulation in developing countries should be sensitive to local customs and practices, and so may not follow exactly the regulatory responses adopted in developed countries. However, it is still important to consider the commonly accepted tenets of the ethics of electronic information, often shortened to infoethics, and ensure that e-health in each jurisdiction complies with them where it is appropriate to the local culture.[49]

64. Approaches to medical law and ethics are numerous and span many hundreds, if not thousands, of years of scholarly thought. The Hippocratic Oath, named after the Greek physician Hippocrates, offers a longstanding guideline for medical ethics for doctors. Although the precise words have changed over time, the general philosophy has remained: an oath of respect to those who have developed the science of medicine; a pledge to respect patients; and a promise by doctors to use the best of their ability when treating them.

65. There are commonly agreed, fundamental themes of medical ethics and practice. A respect for patients' privacy; a duty to treat all patients equally; and a duty not to harm patients, either medically or through an abuse of power, are all widely accepted. More recently, interrelated principles of ethical behaviour in medicine and biomedical science

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[48] *Cell-Life Project* T Khan Science and Development Network South Africa 2004 http://www.scidev.net/News/index.cfm'fuseaction=readNews&itemid=1625&language=1

[49] *Ethical Implications of Emerging Technologies: A Survey edited by the Information Society Division, Communication and Information Sector UNESCO, Information for All Programme (IFAP)* B Radovkov (ed) UNESCO Paris 2007

have been classified as autonomy; beneficence and non-malfeasance and justice[50], and these apply to e-health too.

66. Autonomy is self-rule; the ability of individuals to make their own decisions based on conscious thought and consideration. In healthcare, patient confidentiality is a core aspect of the duty of respect for autonomy. It leads to a respect for citizens' rights to privacy. In this way, the ethical concept of autonomy becomes intimately linked with the legal duties of consent and confidentiality. e-health strategies must address the balance between maintaining privacy and simultaneously sharing citizens' medical and healthcare information so that their healthcare can be optimised.

67. The European Union's Data Protection Working Party has argued that consent has only a very limited place as a justification for sharing personal health data in the electronic age, and that seeking patients' consents to sharing information is not easily justified when it is tantamount to asking them to opt for lower quality healthcare[51]. Instead, a robust system of information security and ethical practice, which patients can trust, should be adopted. It would also maintain standards when patients' information is shared, and provide for patients' opt-outs when the information is especially sensitive.

68. This approach requires e-health strategies that develop and apply effective ethical guidelines for sharing information, including the use of anonymous data and pseudonyms. General information campaigns should also be used to that patients can be more aware of the circumstances and arrangements for sharing their information and, if they feel the need to, will know when and how to refuse sharing.

69. The second ethical principle for e-health is beneficence and non-malfeasance; benefiting, not harming. Its duality aims for a balance where, in seeking to help patients, doctors may inevitably risk harming them. It requires healthcare professionals to consider beneficence and non-malfeasance together, and aim to produce a net benefit. Problems arise when individual care is balanced against public good, when respect for one person's autonomy may lead to harm to another, to communities or the fabric of society. Balancing these competing ethical principles is often exercised through public health legislation requiring compulsory reporting and treatment of diseases, such as tuberculosis and cholera, when doing so breaches patients' rights to confidentiality and to refuse treatment. e-health strategies must comply with these requirements.

70. Balancing individual rights and benefits against the rights of others and the public good embraces the ethical principle of justice. Obligations to produce net benefits require definitions of whose benefits and whose harms are likely to result from proposed interventions. These are also consequences of seeking fair and just allocations of resources. These are problems of moral scope and particularly important in medical research and population medicine.

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[50] *Principles of Biomedical Ethics* T L Beauchamp J F Childress, Oxford University Press Oxford 1994

[51] *Article 29 Data Protection Working Party – Working Document on the processing of personal data relating to health in electronic health records (EHR). 00323/07/EN* WP 131, adopted on 15 February 2007 http://ec.europa.eu/justice_home/fsj/privacy/docs/wpdocs/2007/wp131_en.pdf

71. No ethical model alone will solve these problems. Its role is to clarify them and highlight the need to achieve a balance between competing needs.

8.2 A Way forward

72. E-Health enables new ways of delivering healthcare which differ from traditional models, especially in medicine. As e-health is increasingly adopted by developing countries, new ethical and legal demands will have to be addressed. A principle to adopt is to ensure an adequate balance between local custom, international law and international codes of medical ethics. So, when e-health, such as an EMR, is procured and needs some local adaptation, new insights about new clinical and working practices should be recorded and shared to help a co-ordinated response to ethical and legal changes.

73. In these settings, there may be issues around ownership of intellectual property and the subsequent issue of sharing the fruits of endeavour. It seems that these have an increasingly international theme, and healthcare providers in developing countries should be clear about their position as they enter into e-health investments and contracts. The position may be more complex where several healthcare providers, private, charitable and government, enter into collaborative e-health investments with a consortium of suppliers. Complexity increases further if this extends across country boundaries. Clarity on the legal position in this setting is essential in avoiding future uncertainty.

74. Where ICT suppliers hold healthcare data as part of the services they provide, contracts must be explicit about the ownership, location of storage devices and limitations on the use of the data. For example, confidential data about individual, identifiable patients is a normal part of healthcare records. Security and confidentiality protocols for data held on paper are well understood by healthcare professionals and other healthcare workers. These should not be changed just because an ICT supplier may become part of the resource chain. Information that ICT suppliers collect or receive must only be used for the purposes for which it has been collected, such as clinical, public health and administrative roles such as billing patients, so suppliers must comply explicitly. No other uses should be permitted.

75. Where services of international ICT suppliers are used, it may be appropriate to ensure that data storage is limited to devices located in the same country as the originating data. This avoids the risk of confusion and disputes arising from different data security laws being applied from other countries.

9 GOOD PRACTICE AND RISK MANAGEMENT FOR E-HEALTH INVESTMENT

9.1 Overview

77. Successful risk management requires recognised good practices to be applied. Three reasons to adopt good practices are to realise the maximum available benefits as rapidly as feasible; optimise the relationship between benefits and cost; and manage and mitigate risk effectively. Numerous good practices have been compiled from evaluations of e-health projects, some published, some private. It is not practical to have all good practices in place fully from the outset of an e-health investment, although they should be present to some

degree. The challenge is to achieve the right impact at the outset, and then enable good practices to develop at the right rate over the whole life cycle.

9.2 Core good practices

78. Many e-health investments do not apply all good practices. It often seems to be the case that the bigger and more complex the e-health investment, so the greater the need for good practices, but the weaker their prevalence. An example is where the delivery of the national care record in England as part of the NPfIT has been hampered by unclear communication[52]. It seems that e-health investment emphasises some good practices, and underplays others. This is not a good idea.

79. Experience and evidence from successful implementations shows that eight core good practices must be in place as foundations for all the others. They are:

- Effective executive and clinical leadership of ICT-enabled change
- Effective engagement with all healthcare professionals affected
- Meet concrete needs
- Pursue e-health strategies and investment in the context, and support, of all related health and healthcare strategies
- Manage e-health developments with other health and healthcare developments as a single programme of change
- Invest in ICT and organisational change as one integrated e-health project
- Develop e-health in small, manageable steps
- Manage and mitigate risks.

80. Of the eight, the first, effective leadership, is probably the most important. Five components of effective leadership of ICT-enabled change have been identified[53]:

- Create transformational value, rather than just implementing ICT projects
- Build capability for ongoing change
- Create a climate of open communication
- Manage confidence and risk
- Build personal capability and learning about ICT.

81. Twin traps to avoid were also identified as: extended implementation timeframes; and not fully exploiting business benefits. Additions to these two, identified by *TanJent,* are: failure to utilise all the functionality of the ICT that has been acquired and retaining the previous working arrangements and systems instead of removing them at the earliest opportunity.

82. Engaging effectively with doctors, nurses and other healthcare professionals is essential for success. It has been proposed[54] that ICT now constitutes the third pillar of the

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[52] *The Electronic Patient Record* Sixth Report of Session 2006-07 Volume 1 House of Commons Health HC 422-1 Committee House of Commons 13 September 2007

[53] *Business Leadership of Technological Change Five Key Challenges Facing CEOs* Chartered Management Institute, British Computer Society, The Change Leadership Network London March 2007

[54] *Improving health in the Commonwealth: the role and importance of eHealth as an enabling environment* Prof S Yunkap Kwankam and Prof Ricky J Richardson Commonwealth Health Ministers Reference Book 2007

healthcare sector. The first was chemistry in the 19th century, which led to the pharmaceuticals industry. The second was physics in the 20th century, which created imaging systems. The third pillar is consistent with the findings from EC's eHI study[55] that e-health is an investment in the information resources needed by healthcare professionals in their efforts to improve healthcare. This puts e-health alongside investments in more healthcare professionals, new drugs, new medical and scientific technologies and health initiatives such as nutrition programmes. From this perspective, the right types of e-health are essential tools that meet the concrete needs for clinical and operational information and knowledge for doctors and other healthcare professionals, and so benefit citizens.

83. The classic e-health risk is the magic bullet theory of ICT-enabled change[56]. It proposes that failure is seldom due to weak technical feasibility and reliability, but can often be attributed to:

- ICT specialists and managers adopting inappropriate roles
- People involved in e-health projects assuming a magic bullet theory where change occurs automatically, but mysteriously, with no help or effort
- Everyone neglecting change management best practices, so the project dies and blame is apportioned
- The magic bullet theory, which allows managers and ICT specialist to distance themselves from helping people, as users, to change
- Users using ICT as the scapegoat for their failure to realise benefits.

9.3 An e-health business case and the impact of risk

84. Initial e-health investment decisions and effective risk management relies on a sound business case as the start point. A proven methodology for an e-health business case is the UK's Treasury Green Book[57], often called the five cases model, comprising:

- Strategic case - strategic needs and goals
- Economic case – costs, benefits and risks based on ICT functionality, information needs, organisational change and timescales
- Financial case – affordability needs, envelopes and financing plans
- Management case – viable programme and project management
- Procurement case – options for supply and payment.

85. Options can be evaluated by four main summaries for the forecast economic case for each year of the e-health life cycle: annual costs and benefits; cumulative costs and benefits; net benefits, being the difference between costs and benefits, giving the economic return; and costs and benefits adjusted for risk.

86. An example of annual forecasts of costs and benefits of an e-health investment are shown in chart 4:

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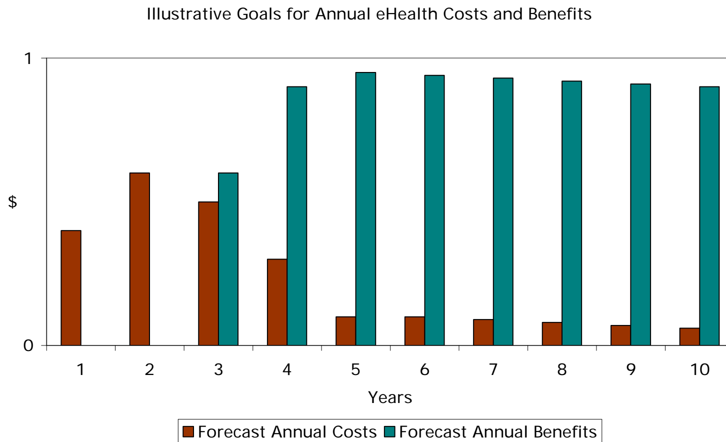
[55] *eHealth if Worth it - the economic benefits of implemented eHealth solutions at ten European sites* K A Stroetmann T W Jones A Dobrev, V N Stroetmann, "eHealth is Worth ", Office for Official Publications of the European Communities, Luxembourg, 2006 (56 pp. - ISBN 92-79-02762-X) http://www.ehealth-impact.org

[56] *The Magic Bullet Theory of IT-enabled Change* M L Markus R Benjamin Sloan Management Review v38n2 Winter 1997

[57] *Appraisal and Evaluation in Central Government* The Green Book HM Treasury London 2003 http://www.hmtreasury.gov.uk/medial/785/27/Green_Book_03.pdf

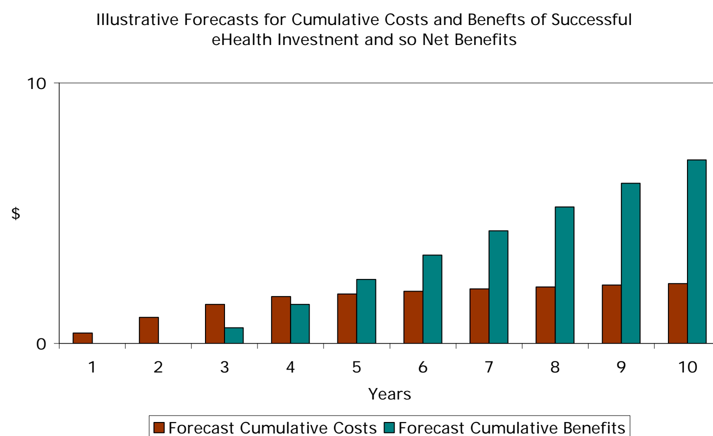
Chart 4 – Illustrative Economic Forecasts of Successful Annual E-Health Costs and Benefits



Two main features that make this a successful e-health investment are; the rapid rise in benefits from year three; and the reduced scale of the investment from year four sustained through to year ten. It shows the e-health investment hump in the earlier years and the rapid benefits slope shortly after implementation which can only be realised with the right investment in ICT and organisational change. This is consistent with a critical strategic e-health goal: maximum net benefits must be realised over the shortest feasible time scales. Shortest feasible is not always a short time scale.

87. When these are aggregated, the cumulative position for the e-health life cycle shows the forecast return as shown in chart 5.

Chart 5 – Illustrative Economic Forecasts of Cumulative Costs and Benefits of Successful E-Health Investment and so Net Benefits

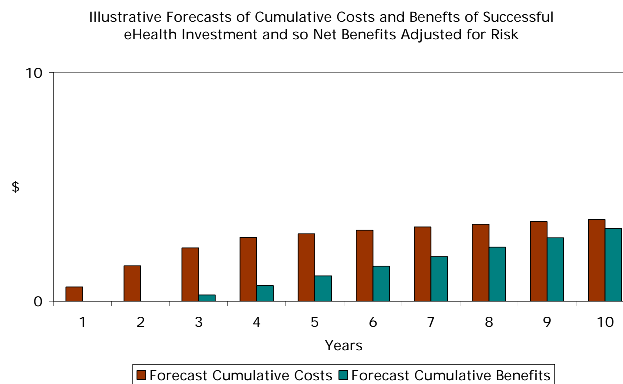


88. Important features are the steady build-up of cumulative benefits; the levelling of costs as the investment moves into its later life cycle stages; and the scale of the difference between cumulative costs and benefits at year ten to give a forecast sustainable economic return. For developing countries, the first year of a return is an important matter. Compared to competing investments in health programmes, where the return may be realised more immediately, e-health investment may take some four to five years to realise a net benefit. This difference should be evaluated in health care strategies so that the e-health opportunity

costs can be justified realistically and explicitly against other investment in health programmes.

89. For decisions and choices about e-health investment, cumulative forecasts need to be adjusted for risk. For e-health investments, these are usually substantial, and include potential cost increases, fewer benefits, delays and even failure. The forecasts in chart 6 show the forecasts in chart 5 above, adjusted for risk as a 55 per cent reduction in estimated benefits and a 55 per cent increase in estimated costs:

Chart 6 - Illustrative Economic Forecasts of Cumulative Costs and Benefits of Successful E-Health Investment and so Net Benefits Adjusted for Risk



90. In this example, the illustrative risk exposure shows that the e-health investment could result in a net cost, not a net benefit, and so is a bad e-health investment. Developing countries cannot afford this type of outcome. Two choices are available. One is not to proceed, because it is too risky. The other is to proceed, recognise the high risk, and ensure that effective risk management and mitigation can deliver a net benefit. It is unlikely that all risks can be mitigated, so the goals are to take the actions needed to lower the cost curve, and simultaneously raise the benefits curve, and enable an estimated net benefit.

91. A temptation is to make theoretical adjustments to the costs and benefits components in the belief that the net benefit curve can be brought forward from its natural position in the e-health life cycle by subsequent, undefined action. Unfortunately, this is extremely difficult to achieve in reality. The result is a fictional business case; never a good idea. The effort expended on fudging is always better deployed to dealing with reality.

92. Having identified the range of net benefits, forecast their net impact, then used ICT assessments and organisational change models to select the most appropriate e-health investments, the challenge is then to realise the net benefits. Without recognised good practices, increased risk and even failure is almost guaranteed. With them, the chances of success are increased, but still not assured: e-health is not a magic bullet.

10 AFFORDABLE E-HEALTH STRATEGIES

10.1 Overview

93. Resources allocated for e-health must be sustainable into the longer-term, which probably means modest amounts of additional money. Affordability of several e-health developments in local, regional, national and international settings is a demanding goal for developing countries. It should be pursued by integrating the affordability, financing and procurement activities. The resulting combination of e-health projects should have costs that can be managed and rescheduled to match the total affordability envelope. Whilst choices should emphasise the benefits that will be gained, the pace of investment should be driven by the availability of money and affordable ICT and organisational change.

94. The affordability of major e-health investment, such as complex, single, shared national EHRs, will be prohibitive. Costs are high; cannot be flexed easily; they overrun; they seem to defer modest, benefits; and there is no evidence of net benefits. These projects also carry high risks. The alternative is e-health investment in proven, commercially available solutions needing modest local development and implementation; a strategy of adopting and adapting.

10.2 Affordability envelopes

95. Affordability helps to explain the modest diffusion and penetration of many technologies[58]. Realistic affordability plans are an essential part of e-health investment. ICT spending each year, excluding the costs of organisational change, in a developed country can be about 2 per cent to 2.5 per cent of total healthcare spending[59]; about $55 per person. For some developing countries, this exceeds their total healthcare spending, so will be impossible to replicate. For better-off developing countries, it represents about 7 per cent of their annual healthcare spending, which is also not realistic. At the other end of the spectrum, a provision of 2 per cent of healthcare spending for e-health investment is between $1 and about $15 per person.

96. The lower end of the e-health investment range may not be sufficient to make much of a long-term impact across whole populations. However, it may be a realistic and foreseeable position from which to begin building longer-term e-health investment, probably adopting proven e-health with relatively narrow scopes that can integrate and aggregate into a longer-term, larger-scale e-health investment picture, like a jigsaw.

97. There are significant benefits from increased spending on nutrition above the current estimated aid of less than $2 for each child under two in the 20 worst affected countries[60]. This makes an e-health affordability envelope of $1 for each person extremely demanding to justify. However, a range of between $1 and $7 may be useful as an initial, indicative affordability envelope for e-health.

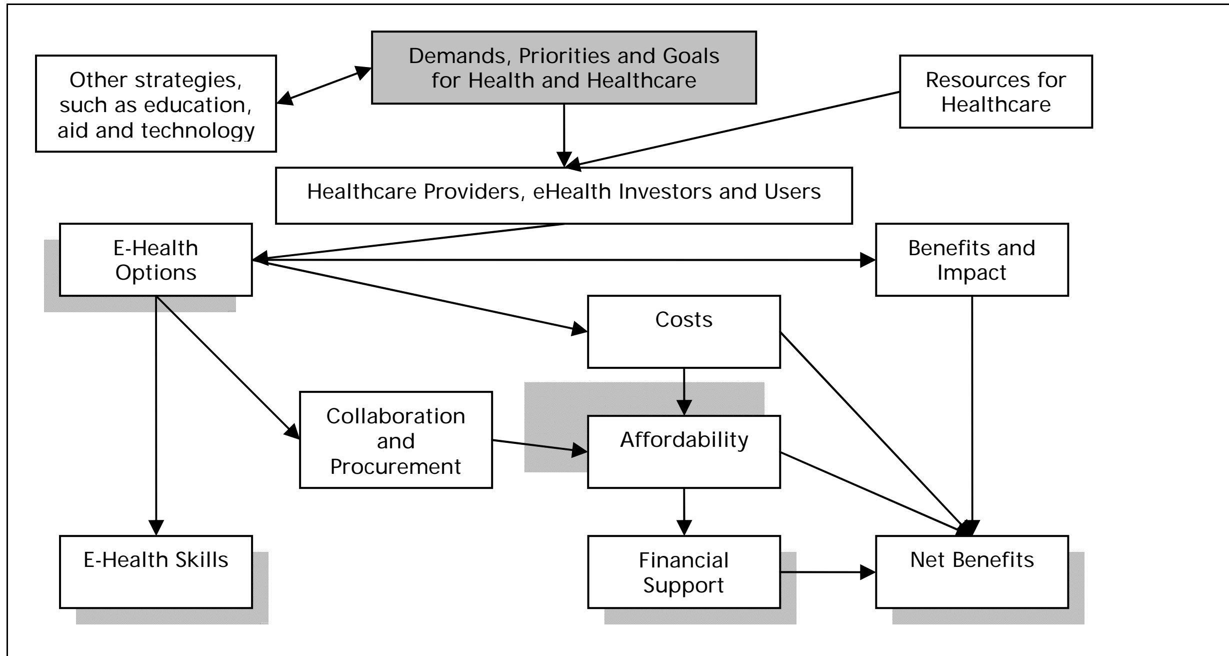
[58] *Global Economic Prospects 2008* World Bank page 62

[59] *Accelerating the Development of the eHealth Market in Europe* eHealth Task Force Report 2007 European Commission Information Society and Media Directorate General Brussels

[60] *The starvelings* The Economist 2008 Volume 386 Number 8564 Page 69 to 70

98. Affordability should be dealt with in the right e-health setting, and diagram 2 illustrates the links between some of the factors:

Diagram 2 – Illustration of Factors in E-Health Strategies

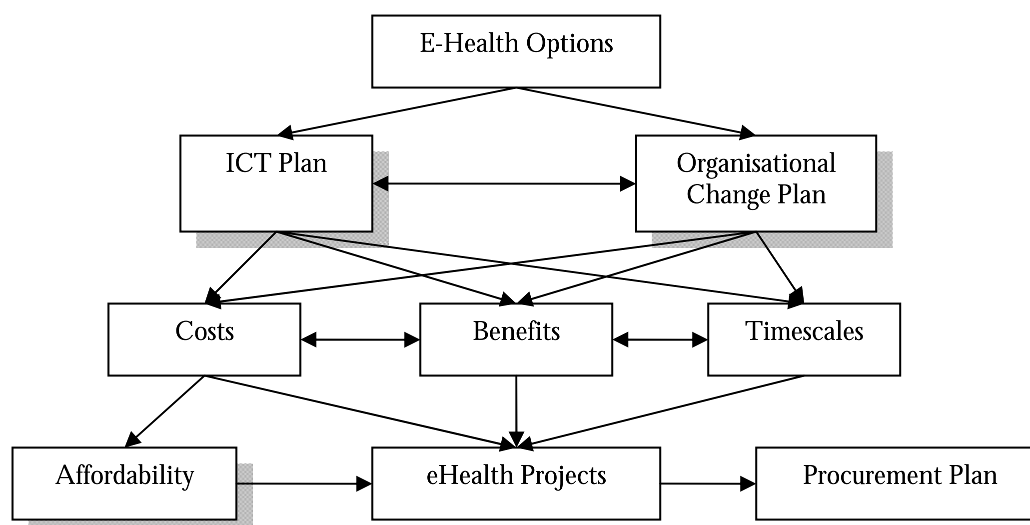


The shaded box referring to health and healthcare is the strategic context of e-health. It includes a wide range of health and healthcare activities, including aid projects such as more doctors, more nurses, more drugs, and better nutrition, sanitation and water supplies. These also have their own affordability envelopes that compete for resources with e-health investment.

99. Decisions on "e-health options" must be derived from an assessment of a range of strategic scenarios and then dealt with in a comprehensive health and healthcare setting. From this, affordability is driven mainly by e-health costs, collaboration and procurement and helps to drive the financial arrangements and support that is needed, ultimately supporting net benefits.

100. "E-Health Options" needs two plans with links to other parts of the e-health strategy. An approach is shown in diagram 3:

Diagram 3 – Illustrated Structure for an E-Health Strategy



The two e-health arms, ICT and organisational change, can be set out as integrated plans in a time frame of five to ten years. The ICT plan can include the national ICT infrastructure and capacity and the equivalent needed for the health sector. This should help to place e-health in the setting of the country's technological pathway. It still carries risks, but their scale and effect are manageable compared to big bang models. Routinely, after two years, the two plans should be reviewed thoroughly. Any changes needed, together with new opportunities and challenges can be introduced if they are affordable.

10.3 Big bang or jigsaw?

101. Two main investment concepts are available for "E-Health Options" in diagram 3: big bang and a jigsaw. Big bang e-health investments are large scale; large impact, including negative impacts; often developmental; high risk; and expensive. Jigsaw e-health investment begins with an agreed overall picture for e-health that is then constructed from its small, constituent parts. It can be a large picture, with many parts and take some time to complete. In practice, it is never complete, because new ICT opportunities change the picture.

102. The jigsaw approach is appropriate for developing countries. The big bang is not. However, a jigsaw model is not an easy option. An e-health investment jigsaw has four main foundations: health and healthcare goals; ICT settings; costs and affordability; and benefits. From these, the e-health jigsaw can move towards completion.

103. These e-health jigsaw strategies should be explicit about themes such as numbers and types of citizens who benefit; number of doctors and other healthcare professionals who can be trained, recruited and retained; the disease and healthcare areas that they work; in and the resources and facilities they will be able to use and develop with e-health. It must also identify the sources of the expertise needed for ICT and organisational change.

104. Developing countries may need to enhance some of the capabilities and capacity to evaluate e-health options systematically, comprehensively and rigorously. Two linked solutions may help to overcome this. For the longer-term, developing countries may need to

invest in graduate education related to e-health. For the immediate term, collaboration with other countries may help to share scarce e-health expertise and knowledge. This topic could be included in developing countries' education and technology strategies.

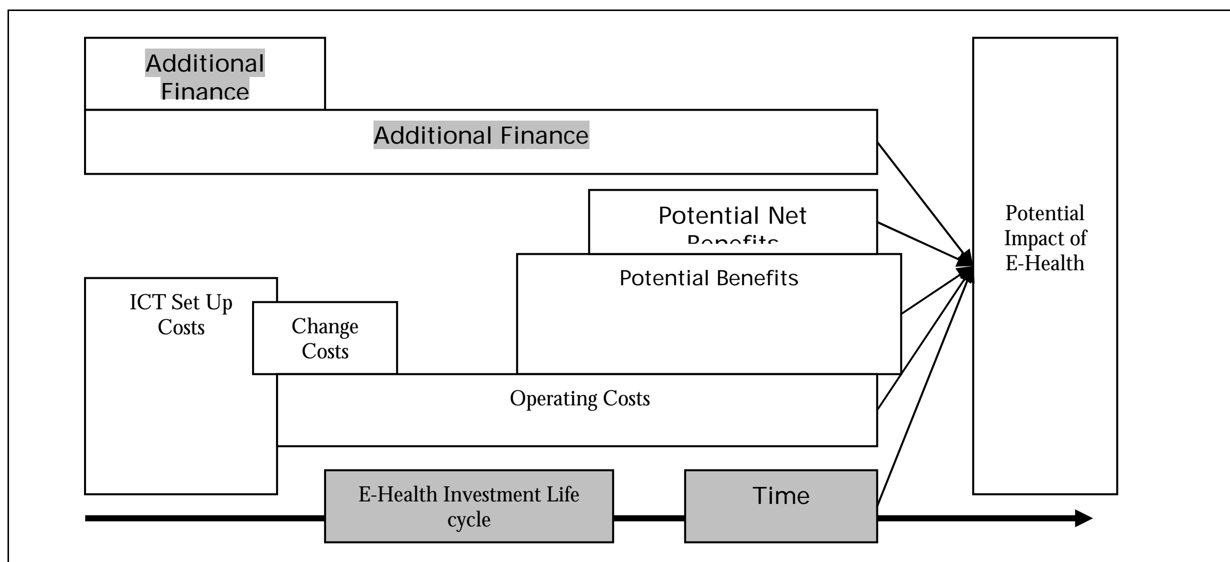
105. Collaboration is an essential part of affordable e-health. Valuable e-health expertise can be found in developed Commonwealth countries, such as Canada, the UK, and Australia, and collaboration has already proved valuable. An example is the collaboration between the NHS in England, Map of Medicine, Cisco and Kijabe Hospital Kenya[61]. Links outside the Commonwealth are also valuable, such as between Indiana University School of Medicine, USA and Moi University School of Medicine, Kenya[62] that developed into the OpenMRS.

106. Also important is the role of health ministries in each country in linking and leading healthcare providers, suppliers and other ministries, especially for technology and finance, in developing and sustaining the generic ICT infrastructures needed for e-health. Whilst e-health is a combination of ICT and organisational change, without an effective ICT infrastructure, the potential of e-health will be inhibited.

10.4 Affordability and finance

107. Affordability has to deal with a generic framework illustrated in diagram 4:

Diagram 4: Costs, Benefits, Finance and Time



108. Three important decisions for affordability are: How much finance will be needed? What are the cash flow needs? What will be the time scales for these? How much money is available over time? These are not fixed calculations, but depend on several other features of the e-health project, including: e-health investment humps; continuous investment; links to benefits; procurement model and time scales.

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[61] *Rural Kenya Adopts Wireless Technology and Unique Medical Map to Improve Patient Care and Student Education* Cisco Systems Inc 2005

[62] *Implementing Electronic Medical Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005

109. Investment humps are the most obvious affordability issues. They provide finance in the earlier years of an e-health investment for ICT development, implementation and organisational change. For most years of the e-health investment life cycle, additional finance will be needed to pay for maintenance, licences, continuous ICT support and obsolescence. These themes are being evaluated and developed as part of the EC's Financing e-health project[63] to provide experience and proposals that can be used to develop affordability arrangements.

110. One way to look at affordability is to set it in the context of healthcare spending for each person as in table 5:

Table 5 – Comparison between Developed and Developing Countries of Indicative Spending in $ on E-Health for Each Person

Estimated Spending	Developed Countries		Developing Countries			
			Poorer Countries		Less Poor Countries	
	$	%	$	%	$	%
ICT investment	55	2	> 1	2	15	2
E-Health investment	90	3	1	3	23	3
TanJent estimate			7	24	7	1
Nutrition programmes			2	6	2	< 1

In this indicative context, e-health investment in poorer developing countries of up to $1 per person, about 3 per cent of total healthcare spending, may be a reasonable, modest start and keep e-health in proportion with other demanding and beneficial health investment, such as nutrition programmes. It also offers another value in being insufficient to finance big bang e-health investment; a constructive constraint. For less poor countries, an affordability envelope of about 2 per cent, in line with ICT spending in developed countries, offers some $15 per person. However, this is a substantial change in resource allocation priorities and may not be sustainable or even feasible to turn on rapidly. A rate of about 1 per cent creates some $7 per person, which may be a more realistic start point. Taken together, an indicative affordability envelope may be to begin with about $1 per person as the potential for a steady expansion up to about $7 over some five to ten years as part of an e-health investment jigsaw.

111. Actual affordability envelopes should be constructed and agreed as part of each developing country's health and healthcare strategy and the subsequent business cases for e-health investment options. These can be used to set the relative scale of e-health investment and its place in the context of all healthcare resources.

112. Even with the economic growth forecast for Sub-Saharan Africa[64], it seems unlikely that most developing countries will be able to sustain and expand an e-health investment range of $1 to $7 per person without external help. Support and financial aid from international agencies, will be an essential component of affordable e-health investment in developing countries. It can be used to stimulate modest, viable e-health.

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[63] *Assessment of Financing Opportunities Available to Member States to Support and Boost Investment in eHealth* European Commission Information Society and Media Directorate General Brussels http://www.financing-ehealth.eu

[64] *The Business of Health in Africa* International Finance Corporation World Bank Group 2008

113. An option may be to seek loans, for example from the World Bank. These can help to flatten e-health investment humps in the earlier years across subsequent years. Two advantages of using finance from the World Bank are that it may also provide ICT and project management expertise. Additionally, the World Bank has seen several e-health projects run into delay[65], and its loans can be used flexibly in this type of situation. The annual cost of loans must be evaluated to ensure sustained affordability in subsequent years.

114. One feature of some types of e-health, such as telemedicine, is the creation of new healthcare models. These have to be priced and used in payments for services, possibly needing modifications to the flow of funds between healthcare providers. Decisions on these types of financial changes should be included in the initial e-health strategy and agreed at least in outline from the outset, then implemented as rapidly as possible to secure the financial platform of e-health services.

115. Financing arrangements must include estimates of the probability and cost of risk because it reflects the despondent Jeremiah lamentation, that if it can happen, it will happen. Seldom, if ever, does the impact of risk turn out to be zero. Adjusting e-health investment for risk can be tricky, because there is little available robust evidence about the probability and scale of the numerous e-health risks.

116. Affordability of e-health investment must be estimated and forecast rigorously and converted into annual budgets. The alternative often results in substantial, unplanned costs that have to be financed as an unforeseen commitment; always a bad idea.

10.5 Procurement

117. Affordability profiles over time depend on the procurement model. A Public-Private Partnership (PPP) model can transfer some of the finance from the initial investment hump into annual payments in later years, but at an additional cost, which may not always be advantageous. The options need to be assessed carefully to establish the best financing and contractual model for each type of e-health investment.

118. Procurement needs to be designed to fit the e-health investment. For commercially available e-health, procurement may acquire ICT products. In some cases, it may be feasible for healthcare providers to combine into consortia and exploit their purchasing power. Significant reductions in prices may be achieved which can help to improve affordability. However, collaborative procurement must not become so convoluted that it consumes the affordability and financial gains.

119. Procurement should also consider the option of securing expertise and services that can deal with complex ICT technicalities. These resources may not be readily available in sufficient numbers from current employees, so collaboration may offer a solution.

120. Where procurements rely on contracts with sub-contractors, it is essential that healthcare providers manage main contractors and sub-contractors simultaneously. The relationship required is a partnership between all the parties, not just between the healthcare

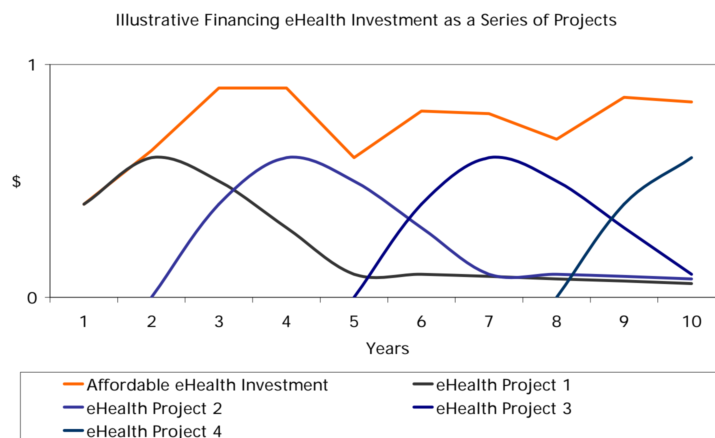
[65] *Assessment of Financing Opportunities Available to Member States to Support and Boost Investment in eHealth* European Commission Information Society and Media Directorate General Brussels http://www.financing-ehealth.eu

provider and the main contractor. This is also reflected in collaborations between healthcare providers. The main party to the contract must manage its healthcare partners effectively to ensure fulfilment of contractual obligations within the affordability plans.

10.6 Recycling e-health finance

121. Finance for e-health investment can include an element of recycling. Some of the money is needed to finance planning and implementation humps; some of it will be needed for continuing operation. Using an assumption that $1 for each person may be affordable chart 7 illustrates how four e-health projects could be financed within this affordability envelope over a ten-year period.

Chart 7 – Illustrative Financing of E-Health Investment as a Series of Projects Within a Single Affordability Envelope



122. Managing these phases and relationships as a single programme must be based on a longer-term financial plan that can be used to set each year's budget and build from the successes and challenges of each year. A minimum time scale of about five years is needed.

123. This type of financial management model should enable sponsoring entities, such as government ministries, to encourage good practices and performances in e-health investment, and to link these directly to implementing e-health strategies. It should also enable the main ministries to integrate their efforts so that technology development in the general economy and in healthcare can be integrated.

10.7 Optimism bias

124. Many e-health investment decisions are skewed by optimism bias; people and organisations tend to overstate benefits, and understate costs and timescales of projects. It is essential that this effect is identified and removed from e-health strategies and plans so that the challenges are properly stated and resources scheduled reliably. Optimism bias has serious consequences for affordability and economic performance, often obliterating forecast net benefits. Adopting good practices and testing e-health investment plans against them helps to identify and remove optimism bias.

125. For a developing country, affordable e-health investment has to be consistent with the need to improve the significant mismatch of supply of, and demand for healthcare resources and the large benefits that can be achieved from other health investments. In this context, net benefits must drive e-health affordability, and excessive optimism offers no solution.

11 NEXT STEPS

126. Affordable e-health strategies require developing countries to answer these questions:

- What are their health and healthcare challenges?
- Which net benefits do they need from e-health investment?
- Which benefits can be realised from e-health as part of an integrated strategy for health and healthcare?
- How can it be affordable?

127. Constructing an e-health cost, benefit and affordability model should help to find the answers. It will enable decision-takers to analyse, evaluate and test the strategic impact of a range of e-health options, the different risks and the affordability requirements for all stakeholders. Three main activities are needed to achieve this:

Priorities

- Identify the required high priority health and healthcare benefits
- Identify the e-health options that can support these
- Estimate the sustainable finance that can be allocated to e-health
- Evaluate and select affordable e-health investments for the next five to ten years
- Identify the barriers to success that need to be removed
- Deal with the ethical, legal and regulatory issues.

Leadership

- Engage with healthcare professionals and other stakeholders
- Set up the partnership and collaboration needed
- Acquire and retain the skills and expertise needed to succeed
- Set up the programme and project management arrangements

Management

- Prepare ICT and organisational change plans
- Adopt and use recognised good practices and mitigate risk
- Put in place and manage the affordability and financing plans
- Select, procure and implement the ICT needed from suppliers
- Realise the net benefits.

128. Health ministries in each country should take a lead role in brining together the main healthcare organisations to set the context; strategy; priorities; direction and plan for e-health investment. They need to work closely with ministries for technology and finance to integrate e-health into the wider ICT setting, including the diffusion and growth of ICT accessed by citizens and organisations.

129. E-Health strategies should be reviewed every two years and their affordability envelopes updated. From this, continuous, adaptable and affordable e-health strategies can be pursued to provide net benefits for citizens, communities, regions, healthcare professionals and healthcare providers and whole populations.

APPENDIX 1

EXAMPLES OF E-HEALTH INVESTMENT IN DEVELOPING COUNTRIES

E-Health Investment	Location	Collaborative Links	Data Sources
Best healthcare practice across communities	Kijabe Hospital, Kenya	Cisco, Map of Medicine	*Rural Kenya Adopts Wireless Technology and Unique Medical Map to Improve Patient Care and Student Education* Cisco Systems Inc 2005
Immunisation tracking	Rajshahi City Corporation, Bangladesh		*Electronic immunisation registry and tracking system Bangladesh* M Ahmed Institute for Policy Development and Management University of Manchester http://www.egov4dev.org/banglaimmune.htm *Source* International Information Resource Centre London www.asksource.ids.ac.uk/
Mobile phone tracking	Cape Town and Durban, South Africa	Cell Life Project Vodacom	*Cell-Life Project* T Khan Science and Development Network South Africa 2004 http://www.scidev.net/News/index.cfm'fuseaction=readNews&itemid=1625&language=1 *Source* International Information Resource Centre London www.asksource.ids.ac.uk/
Telemedicine	Tygerberg, South Africa	Tygerberg Children's Hospital and Rotary Telemedicine Project	*The Tygerberg Children's Hospital and Rotary Telemedicine Project* Cape Town 2003 http://www.bridges.org/case_studies/353 *Source* International Information Resource Centre London www.asksource.ids.ac.uk/
Telemedicine network	Mali	Geneva University Hospital,	*Telemedicine in Western Africa : lessons learned from a pilot project in Mali, perspectives and recommendations* A Geissbuhler O Ly C Lovis J F L'Haire American Medical Informatics Association Annual Symposium Proceedings 2003, pages 249 to 53. *Source* International Information Resource Centre London http://search.asksource.info/cf/search/search.cfm?db=biball&display=select

E-Health Investment	Location	Collaborative Links	Data Sources
Maternal Mortality	Uganda	The Rural Extended Services and Care for Ultimate Emergency Relief (RESCUER)	*Simple ICTs reduce maternal mortality in rural Uganda : a telemedicine case study* M Musoke Bulletin von Medicus Mundi Schweiz, Jul 2002 page 85 http://www.medicusmundi.ch/mms/services/bulletin/ bulletin200202/kap04/16musoke.html *Source* International Information Resource Centre London www.asksource.ids.ac.uk/
Réseau en Afrique Francophone pour la Télémédicine (RAFT) for education and consultation	Bamako, Mali	Geneva University Hospital	*Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005
Telemedicine	KwaZulu-Natal, South Africa		*Telemedicine in Kwazulu-Natal: from failure to cautious optimism* M Mars Journal Telemedicine and Telecare Volume 13 Supplement 3 December 2007 pages 57 to 59 *Source* International Information Resource Centre London www.asksource.ids.ac.uk/
Tele Doctor	India, Pakistan, Tanzania	Medisoft Telemedicine	www.medisofttelemedicine.com
Health Information System	Uganda		*Implementing a new health management information system in Uganda* J Gladwin R A Dixon T Wilson D Health Policy & Planning, volume 18 number 2 June 2003, pages 214 to 224 *Source* International Information Resource Centre London www.asksource.ids.ac.uk/
Academic Medical Records System (AMRS) Open Medical Records System (OpenMRS)	Eldoret, Kenya	Moi University School of Medicine, Kenya Indiana University School of Medicine, USA	http://www.amrs.iukenya.org http://openmrs.org *Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005

E-Health Investment	Location	Collaborative Links	Data Sources
EMR for HIV treatment	Uganda	Careware	*Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005
Touch screen access to patient management information	Kamuzu Central Hospital, Lilongwe, Malawi		*Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005
TB programme	Botswana	Epinfo	*Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005
Access to HIV results using Personal Digital Assistants (PDA):	KwaZulu-Land, South Africa		*Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005
Improving HIV/AIDS programmes	Lusaka, Zambia; Gabarone, Botswana; Maputo, Mozambique	Swedish Programme for ICT in Developing Regions (SPIDER); Southern Africa HIV and AIDS Information Dissemination Service (SAfAIDS); Delft University of Technology (TUDelft)	*ICT for mitigating HIV/AIDS in Southern Africa* Kista, Sweden: SPIDER, 2005, page 47 http://www.spidercenter.org/upl/filer/611.pdf http://www.spidercenter.org/upl/filer/588.pdf *Source* International Information Resource Centre London www.asksource.ids.ac.uk/

E-Health Investment	Location	Collaborative Links	Data Sources
Access to patients' community nursing records using pocket PCs	India		*Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005
Access to central medical records using PDAs	Uganda	Satellife	*Implementing Electronic Records Systems in Developing Countries* H S F Fraser P Biondich D Moodley S Choi B W Mamlin P Szolovits Informatics in Primary Care 2005 volume 13 pages 83 to 95 British Computer Society London 2005
District and provincial systems	Mozambique		*A study of the Actual and Potential Usage of Information and Communication Technology at District and Provincial Levels in Mozambique with a Focus on the Health Sector* J Braa E Macome J C Mavimbe J L Nhampossa J L da Costa B Jose A Manave A Sitoi http://www/ejisdc.org/ojs2/index.php/ejisdc/article/viewFile/27/27
Essential Health Interventions Project (TEHIP)	Tanzania	Government of Tanzania International Development Research Centre Others	*Integrated Health Information Systems in Tanzania: Experience and Challenges* M Smith S Madon A Anifalaje M Lazarro-Malecela E Michael http://www/ejisdc.org/ojs2/index.php/ejisdc/article/viewFile/395/227
Computer order entry and patient information management system	Lilongwe Hospital, Malawi		*The Lilongwe Central Hospital Patient Management Information System : a success in computer-based order entry where one might least expect it* G P Douglas R A Deula S E Connor AMIA Annual Symposium Proceedings 2003 page 833 *Source* International Information Resource Centre London www.asksource.ids.ac.uk/
eHealthopinion	India, Pakistan, Tanzania	Medisoft Telemedicine	www.medisofttelemedicine.com
Rainfall-monitoring for epidemic malaria early warning systems	Africa	Roll Back Malaria Technical Resource Network on	*An online operational rainfall-monitoring resource for epidemic malaria early warning systems in Africa* E Grover-Kopec et al Malarie Journal Volume 4 Number 1 2005 page 6

E-Health Investment	Location	Collaborative Links	Data Sources
		Prevention and Control of Epidemics International Research Institute for Climate Prediction (IRI)	http://www.malariajournal.com/content/4/1/6 *Source* International Information Resource Centre London www.asksource.ids.ac.uk/