Developing Nations' eHealth and Telemedicine: Lessons Learned, Especially for Africa

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Abstract—**Telemedicine is being steadily introduced into African and other developing countries. The associated problems encountered often differ markedly from those in developed countries and merit study to facilitate application in all emerging nations. An overview and analysis of lessons learned from such pilot and other telemedicine projects is given in this communication and the consequent application to future programmes will be outlined. From this survey telemedicine and eHealth projects are deemed appropriate for developing nations, if allowance is made for their special conditions in the projects' strategic planning.**

Keywords-component; telemedicine; eHealth; developing country

I. INTRODUCTION

Developing nations are starting to apply increasing numbers of telemedicine (TM) and eHealth projects to provide partial solutions to their problems of providing appropriate public health service. This provision must serve many socio-economically deprived persons living in remote rural areas, with poor infrastructure, often far from doctors, hospitals and specialist medical services. Very frequently few funds are available for any health services and the health-care personnel often lack experience and knowledge of information and communication technology (ICT). This challenging base necessitates careful thought in initiating TM projects, normally inspired by, or in collaboration with, advanced nations' TM. eHealth is the use of ICT to convey medical information and permit certain medical services. Since it can involve many aspects of health services, such as health education, management, promotion, disease prevention, research and relevant population data collection, it is sometimes considered a broader activity than TM, which has a generally accepted definition as concerned with medical activity, or a function related to healthcare practice, where participants are not at the same physical location and they communicate using ICT.

The general ICT status of a developing nation is no guarantee that a country's eHealth will be adequate. A Thai comment on its eHealth foundations describes them as inadequate, even though ICT applications are in general of a high standard and widespread throughout Thailand [1]. But whatever the overall ICT situation, TM practitioners must have appropriate knowledge of ICT. This often lacks and in both Venezuela [2] and India [3] it has been noted that such basic knowledge frequently is deficient in primary health-care centres. There is a similar situation in South Africa where ICT expertise is overall of a standard comparable to most Western nations. However its distribution (as is true of the distribution of public health service facilities) is concentrated in urban regions. In rural areas primary health-care is usually supplied by clinics (over 4000 in all), directed by nursing sisters. Their ICT experience is often woefully inadequate for effective operation of a TM link, for there is currently insufficient material in the national nursing curriculum. This situation is reflected in most developing countries. When the eHealth of a region of emerging nations is studied, the lack of effective inter-nation TM links can be due to a deficiency in fruitful contacts between the relevant researchers, practitioners and policy makers. This was the conclusion of a Canadian study of the TM in 12 East Asian countries [4]. Although many TM projects have been reported in developing countries, most are not sustainable. For example the South African Minister of Health announced in 2010 that of 86 TM projects initiated, only 38 were functioning, because of inadequate connectivity and insufficient "coordination and management of the necessary work" [5]. In India there is a similar sentiment and in part this is because of inadequate evaluation and analysis of TM, for "no studies have been conducted to identify precise reasons why eHealth solutions have not been adopted in the Indian primary health centres" [3]. Evaluation of such projects is universally acknowledged as a very difficult undertaking, although a suggestion has been made that application of a suitable mathematical model may aid in providing useful information [3]. Another difficult, though necessary, consideration is the question of quantitative cost benefits and cost effectiveness. Although some economic advantages of TM are clear, such as reduced transport costs for patient referral and obtaining radiology and pathology opinions easily, in developing and other nations, elucidation of economic impacts is often not straightforward. Reasons for their complexity include the difficult estimation of cost advantages of TM, which provides services totally unavailable previously.

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This paper considers recent, selected, representative eHealth activities in developing countries, emphasising Africa, with a view to establishing principles for successful introduction of specific programmes. To do so there are considerations of collaborations with developed countries, how and why evaluations are essential, contributions of technology and distance education in medicine.

II. eHEALTH PLANNING FOR A DEVELOPING COUNTRY

A crucial attitude for the introduction of TM anywhere is to respond to "the pull of needs, not the push of supply" [6]. Regrettably in emerging countries some donor nations, which manufacture TM equipment or individual vendor companies, may encourage, or insist upon, purchases of unsuitable devices and render the TM projects unsustainable. So attention should be paid to "local experts, rather than external commentators" when disagreement occurs [6]. All potential stakeholders should be involved, for obstacles to successful eHealth can be "as simple as ignorance or as complex as political or national lack of vision and leadership" [7]. An example of extensive ignorance comes from a survey of Libyan physicians concerning TM. Those 'confused' or 'unaware' in 2008 were respectively 54% and 15% [8]. In such cases corrective action must be taken. A useful and most acceptable first application of TM is often the provision of a second opinion, as was found in the UAE in 2007 [9] When a developing country TM network is being planned, it is important to consider any existing regional networks of all forms of health-care and to coordinate them [10]. An example of where this was not done sufficiently well exists in South Africa (which has the world's highest number of HIV infected persons) where some of the 9 provincial databases for HIV patient information, etc., were found to be incompatible and unable to exchange data [11]. This clearly can be remedied, but only after considerable and unnecessary expense and effort.

An overall strategy to set up a TM project is first to identify the service or other activity required in terms of needs, then to commence properly controlled pilot studies to establish feasibility and to quantify health-care benefits, if practical, and with these data to estimate the consequences of large scale deployment, in terms of cost, benefits, etc [12]. Often, as found in Pakistan, there will be a need for eHealth readiness tools and an appropriate "process of change management" [13]. Another approach was used in the Balkans after 10 years' of war, which destroyed much of the existing medical system [14]. An initial healthcare assessment, an e-learning programme and 7 years' experience with a virtual hospital, together were confirmed as very successful [15]. Objectives of a TM project should be to delineate it in terms of small modules and "to keep the deliverables within sight" [16]. In all nations when there are eHealth programmes set up, licensure and practice regulations must be reviewed for all those health professions, which are involved [17]. However although in China there are now 3 large, wide-ranging TM networks functioning [18], there have not been any resultant changes in legislature [19], which could affect teleconsultations. These Chinese projects are associated with extensive medical distance learning programmes administered by 13 medical universities, in which 1.6 million persons had participated by 2010. In contrast to the teleconsultation situation, the distance learning is controlled by appropriate legislation and the necessary accreditation [19].

III. NORTH-SOUTH COLLABORATION

A frequent way for developing countries to enter the TM world is to collaborate with a nation that already has established TM. This contrasts with the way TM initially grew in developed nations, where there was no networking with foreign centres of excellence, as is indicated in a German-Estonian project [20]. The European Union has such an agreement with India and this emphasises distance medical education. However one difference between the two parties is that the participating European healthcare and TM are usually public while the Indian partners are mainly private and there are consequent European "sensitivities associated with commercialising healthcare". [21]. A wide range of disciplines has benefitted from such initial mentoring. These include surgical pathology, between Italy and Zambia [22], dermatology between USA and Egypt [23], paediatric neuro-oncology between Canada and Jordan [24], pathology between Germany and Iran [25] and retinopathy diagnosis and care between USA and Peru [26]. Important points are that for the Peruvian project non-ophthalmologists were trained to provide images, the Jordanians found "videoconferencing is a feasible and practical twinning tool in paediatric neuro-oncology with a potentially major impact on patient care" [24] and the Egyptian participants needed only a 5Mp mobile phone camera and access to Email. This gave about 75% agreement with face to face consultations and was the first report of m-teledermatology. All these projects were successful. An extensive Swiss TM partnership, the RAFT project, was initiated in 2000 by the University of Geneva, with collaboration from UNESCO and the WHO, as a French Language African Telemedicine Network in Mali. It was rapidly extended to 17 other Francophone African countries and then more slowly to 5 English speaking African nations. It links 45 healthcare institutions (mainly tertiary and district hospitals) allowing a wide range of tele-education interactive courses and teleconsultations and also supports medical laboratory quality control support, cooperative data bases, satellite enabled rural TM and tele-echography. It uses the iPath platform for pathology and other asynchronous consultations, mainly for difficult cases. The RAFT network has proved sustainable for individual healthcare districts, with 50 000 to 200 000 inhabitants [27].

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When any form of healthcare is transferred between different nations, cultural differences must be taken into \consideration. Even between two western nations this was demonstrated as essential after a phone based USA project for chronic care was made available in the UK and Italy. In both the USA and UK the use of phone and care managers proved successful, but in Italy additional face to face consultations proved essential for cultural reasons [28]. Chronic conditions account for about 60% of deaths worldwide and, according to the WHO, are largely preventable So since mobile phone usage in Africa and other developing areas is increasing very rapidly it is likely that such programmes, with appropriate cultural modifications, will be introduced there too, for they both significantly improved health and reduced need of other medical facilities.

IV. SOUTH-SOUTH COLLABORATIONS

The pan-African e-Network, an extensive TM network linking Indian and African medical institutions, mainly concerned with tele-education but also with teleconsultations, is described in the next section. There are also some Indian TM links, dealing with tele-education, to emerging countries in South Asia. A smaller Chinese eHealth programme is planned with Africa, but it has not been formalised yet. The Balkans eHealth network, mentioned above, is active in Kosova, Albania, Macedonia and Montenegro and includes healthcare assessment tele-education and establishing national TM networks. Extensions to other nearby nations are planned [14]. South Africa has a few individual links to nearby nations and more are planned. However there is also a regional network being established to make available surveillance for communicable diseases (HIV, TB, etc) and notification. This results from cooperation with the Southern African Development Community, the African Development Bank and WHO/AFRO. The power of such a surveillance network has been proven on a much smaller scale, with previous success of an Indian Ocean Island TM network, which provided early recognition of an outbreak of bubonic plague in Madagascar and so prevented an epidemic.

V. TECHNOLOGY

India, alone amongst emerging nations, has a satellite, "exclusively for purposes of healthcare" [29] and this is used in an ambitious south-south TM project, the pan-African e-Network, associating India with 47 of the 54 nations in the African Union. It involves 5 medical universities for tele-education and 15 super speciality hospitals in India. Participants in Africa are 4 medical universities for tele-education, 45 learning centres, 4 super speciality hospitals plus 40 other hospitals. Currently there is 1 hour per day for teleconsultations, which will be available for 5 years and so far $125 million have been spent on this project [30]. A lesser TM collaboration, which exists with emerging South Asian nations, is concentrating on distance learning and the provision of digital medical libraries [31]. TM equipment used in advanced countries is often insufficiently robust for use in remote regions of developing countries and this is an important consideration when setting up TM links.

Electronic medical records (EMRs) have greatly aided effective practice of medicine, especially when associated with TM. However it is not necessary to invest in elaborate and costly software to set up an EMR data base. A home-made, modular and effective system has been described in Serbia [32] and another for use in primary health-care facilities in Indonesia, that uses only open source software [33]. As everywhere in the developing world, the reliability of electrical power supplies is important, with ways of coping with power outages are often required, as has been reported from Haiti, for a HIV patient data base [34]

As mentioned, evaluation of any TM project is usually difficult to do and especially so in developing countries. But sometimes there are clear benefits indicated. One such is the reduction of the burden of eye disease in South Africa, as the result of a collaborative project with the UK [35]. More typically an extensive review of 43 projects involving 650 institutions, which have served over half a million patients in Colombia found that although "many projects seem to have had a positive effect, none of them had been rigorously evaluated" [3]. Even in the USA, whose eHealth activities are legion and have inspired and parented many projects in developing countries, when 250 eHealth programmes were examined it was concluded that they needed a detailed evaluation to determine their impact on quality, safety and efficiency and how to ensure such impact could be positive, in terms of value and sustainability [36].

VI. TELE-MEDICAL EDUCATION

Tele medical education can range widely from use of minimal web-based tools to virtual reality and a telepresence-based collaborative learning environment and even the simplest techniques have proven very useful indeed in developing nations. Indian policy in this respect is to ensure that use of the Indian satellite and free bandwidth supplied by the government, will significantly aid social development through eHealth [37]. In Australia there is much use of such training for all types of allied health professionals working in remote areas, who previously learned on-the-job. A videoconferencing programme, initially intended for therapy assistants and extended to others, has proved successful and it indicated that a standardised qualification is frequently not the best approach for therapy assistants [38]. Necessary flexibility in training can be built into distance learning programmes and this can be extended elsewhere. The RAFT tele-education service is now available for 16 hours monthly,

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with an average of 18 institutions participating per course. About 75% of the courses are now produced in Africa and there have been over 300 courses offered since 2003. Recent RAFT educational activities include the training of remotely located non-radiologist healthcare workers in use of ultrasound [39] and successful use of a computerised patient simulator in continuing medical education for health professionals as part of a pilot study [40]. The simulator has been appropriately adapted for African usage. Many other tele medical education programmes have been successfully completed throughout the world and some in developing countries have been reviewed elsewhere, together with an analysis of their benefits [41]. There is a general consensus that tele-education is a very valuable and practical application of eHealth techniques in developing countries.

VII. DISCUSSION

There are shortages of doctors, nurses and other allied healthcare professionals in developing countries, especially in Africa. This presents great difficulties in establishing and maintaining acceptable healthcare and is an important matter with serious consequences. Also available funds and health associated infrastructure are often lacking and serious diseases are prevalent there. eHealth is considered an important means of alleviating this dismal situation. But it is not usual for developing nations to have a general eHealth strategy, particularly in Africa, so experience from previous work can be beneficial. Since there are few local funds for capital costs to set up TM, the approximately 300 eHealth projects now underway in Africa usually receive external funds. So it is rare for them to have built-in sustainability or scalability. Many have started as research projects and so will probably last only as long as the donor funds remain available. Few African TM activities are funded by their governments. Hence it is clear that before an eHealth project is introduced, there must be careful planning to avoid unsustainability, with all potential participants to be consulted [42]. In developing countries appropriate legal and regulatory issues related to TM must be considered [43], but this has not always been done. In China, with major eHealth activity, there is virtually no specific legislation concerning TM, although in contrast for over a decade there has been strict control concerning tele-education and necessary accreditation [19]. However a detailed treatment of legislation, ethics, confidentiality, etc., will be given elsewhere.

The medical conditions managed by emerging nations' TM are varied and naturally they often tend to concentrate on those conditions most prevalent there (e.g., HIV, TB, malaria and other infectious conditions). These often differ from those of developed nations, but medical afflictions associated with modern western life are also steadily increasing throughout the world (e.g,. cardiovascular and neoplastic conditions, non-communicable illnesses reflecting life style, etc.). These, and many rarer medical problems, have benefitted from TM. A drawback in Indian oncology care is poor infrastructure and teaching. There is improvement for this in the Uttar Pradesh province of India (where over 100 000 new oncology patients present annually and about 70% of them need radiotherapy), according to the results of a recent 2 year audit of a videoconference based tele-education scheme for registrars [44]. TM can also be most effective in out-patient pulmonary medicine. A videoconferencing link with a telenurse resulted in satisfactory remote physical examination and management of 92% of patients who presented at the remote site [45]. There is recent interest in neuropsychiatric disorders, which account for over 20% of adult global disease. One form of coping with this is due to consultative-liaison psychiatry ("the psychiatric subspeciality devoted to practice of psychiatry in non-psychiatric settings".) After a pilot introduction using non-physician mental health-care providers in rural South Australia who liaise with psychiatrists using telepsychiatry, this was found to be a feasible form of care. Then it was successfully introduced into Ethiopia, to aid training of mental health-care providers and to offer a rudimentary psychiatric service [46]. A recent additional important finding, from rural California [47] is that a pilot asynchronous telepsychiatric service has been shown to be feasible, with clear relevance for developing countries [48].

The need for a specific eHealth project must be unambiguously identified and its aims scrupulously detailed. Equally essential are the practical matters of ensuring thorough preparation and training of all personnel involved and that technical and other backup are made available, while the project continues. A local champion is an ideal part of its management, as is prevention of the impression that the project will simply increase the workload, without additional remuneration. (The latter perception is a frequent consequence of inadequate preparation of those associated with the TM project.) An audit of the pre-TM situation is also necessary, if practical, in order to facilitate later appraisal. After the introduction it is necessary to monitor progress. These injunctions are related to lessons learned from projects mentioned and many others, which confirm this experience and have been described elsewhere [41].

Telemedical disciplines of a developing country eHealth project frequently differ from those of wealthier nations, which now usually have an emphasis on sophisticated radiology, access to patients' EMRs, home care and teleconsultations seeking specialist opinions for those in remote areas. All these have a place in poor countries, where there is usually more concern to support primary health-care, which, before the advent of a TM facility, was rudimentary or often absent. In South Africa, for example, most rural health-care is provided by simple clinics staffed by nurses, perhaps with an assistant. Such clinics are visited rarely or never by a doctor. Transport facilities for medical consultations are often poor and expensive with the

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destination distant, perhaps over a hundred km. So TM is seen by the government as an important aid to improve the situation. Tele-education is another valuable eHealth activity, which can be commenced soon after the establishment of TM links.

Benefits obtained from a developing country's TM project in its early stages can include the provision of second opinions [49]. But even when the project is running it often does not result in a general increase in referral rates and only about 1/100 of 1% of the potential demand for those in developing countries who could benefit from TM are believed to do so [49]. Various explanations for this have been given and include the professional participants being overworked and too busy to refer, or their fear of losing control of their patients' care. This can possibly be countered in developing countries by vigorous demonstration of the results of better training and having eHealth networks within the country, which indubitably improve health outcomes, are cost effective and sustainable [11]. Lessons learned for application to future programmes are many and, as sketched above, include thorough preparation, adaptation of equipment to local needs, appropriate choice of eHealth applications, inclusion of distance learning and provision for monitoring. eHealth has been shown to be a complex subject and to ensure its success the factors which must be considered in developing countries (and elsewhere) include primarily healthcare benefits, but also sustainability, scalability, costs, careful consideration of local needs and customs, safety and effectiveness. Considerations of all these factors must be part of the planning and execution of early stages of any eHealth project to determine that it will succeed. Taking note of all this can ensure that eHealth has a bright future in developing countries.

VIII. CONCLUSION

To avoid the failure of a developing country's eHealth project, very careful preparation must be made, to ensure it meets a valid need, is sustainable and appropriately monitored. Then it is clear that projects appropriate for emerging nations can be successful in their specific situations, which may differ from those of more wealthy and technically advanced countries.

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