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Satellite teleHealth: good for the cutting edge and in the bush?

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Satellites offer substantial promise in many areas of "electronic health" or *e*Health, defined as the use of information and communication technology in the health sector, including digital data transmission, storage and retrieval, for clinical, educational and administrative purposes (WHO, 2002; Dzenowagis, 2004). The discipline of *e*Health can be of use in the most precise area of medicine as well as help solve medical problems and boost training in remote areas of Africa. In the UK, for example, young surgeons simply don't have time to attend training courses or leave their hospitals to observe new surgical techniques or investigate new technologies. Within hospitals, shift rotas prevent most trainee surgeons from attending regularly-scheduled instruction sessions, making flexible training programmes absolutely essential. A pilot project called Telematic Training for Surgeons (TETRASUR), initially a collaboration between the University of Plymouth and the European Space Agency (ESA), funded by regional medical research grants and industry sponsorship, was established in 1997 to investigate telematics applications with respect to surgeon training, initially in local hospitals (Kingsnorth et al., 1999).

The TETRASUR project metamorphosed into the Satellite Network Telematics Training for Surgeons (SANTTSUR), following receipt of a £300,000 research grant from the ESA, as a distance learning package integrating live digital TV, video conferencing and the internet, with a service being provided to 26 nationwide locations. SANTTSUR delivered high-quality, live, interactive TV programmes to hospitals and medical centres broadcast from a studio in Plymouth via a TDS4b uplink provided by the ESA and received by sites throughout the UK and Ireland. The course material was modular, built on a syllabus devised by the Royal College of Surgeons (RCS). Telematic-based training enabled tutors and trainees to remain in their local hospitals and conduct training in close proximity to their patients. Trainees could interact with tutors, presenters and contributing experts via real-time phone, text-messaging, e-mail, fax and ISDN (Integrated Services Digital Network) video conferencing. Many hospitals, clinics and medical facilities already have considerable infrastructure in video conferencing and telecommunications, and reception merely required an additional small, cheap antenna, 1.2 m in diameter. Three sets of 10 lectures, were transmitted weekly via a single 90-minute lunchtime session. Each transmission comprised formal presentations, studio discussion, live ISDN6 video feeds from teaching hospitals and trainee question-and-answer sessions via ISDN2, telephone or on-line chat. A noteworthy "Case of the Week" was also included. Broadcasts could also be videotaped, and then made available at any time for the trainees. In several institutions, a consultant would assign a task based on the broadcast, with a written response required within a set time. A general review and open forum

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session could also be held at the end of each term (Vranch and Kingsnorth, 2001). Technically, ISDN6 proved good for dealing with visual content, although ISDN2 was not so good for handling real-time question and answer sessions. For interaction, text messaging emerged as the most popular medium.

SANTTSUR subsequently evolved into *mrcs*TV, once critical matters of administration, dissemination, expansion, accreditation and sponsorship were resolved. The new entity, operated by the University of Plymouth, ESA, RCS and Plymouth Enterprise Partnerships Ltd, became an education and training programme aimed at individuals studying for examinations of any of the four Royal College of Surgeons in the UK or Ireland, as well as being highly useful for those studying for similar qualifications abroad. Subscriptions were provided by registered centres and from individuals, with broadcast being supported by a dedicated website learning portal. Thus *mrcs*TV became a successful integration of satellite and telematics technology, video conferencing and rapidly-developing internet learning portals. Live broadcasts were reworked for dissemination via a dedicated multimedia website and supported by course information, downloadable materials and links to other relevant sites. Once operational, the entire system also became useful for other educational activities. The *mrcs*TV adequately met specific local needs by providing high-quality, structured, consistent learning and materials at the workplace. It saved time that would otherwise be lost through traveling to learning establishments. Synchronization of training at several locations also facilitated better sharing of expertise. The project demonstrated successful use of MPEG2 satellites as the ideal delivery platform (satellites can handle higher-definition images than the internet) and showed that the system was very viable.

The success of the *mrcs*TV model was mirrored in another ESA-supported project, called *Mayflower*, which used satellites to deliver university courses in medicine to students and nurses in Norway and Italy. Perhaps the most sophisticated of ESA projects was *Multimed*, in which satellites were used to allow trainees to not only watch live operations, but also to carry them out by remote control. A prone patient, nicknamed "Stan the Man", was the Guinea pig for all manner of medical procedures. His heartbeat pulse and breathing were normal, and when an incision was made, blood flowed. However, Stan was a high-tech robotic patient, his life-like characteristics controlled by a Human Patient Simulator computer, allowing students, physicians and medical support staff to familiarize themselves with real-life clinical scenarios without endangering life.

The main constraints in satellite-based operations such as *mrcs*TV are related to sources of funding (donations, subscription, sponsorship, course fees, registration fees, etc). In addition, the cost of TV studios and broadcast infrastructure can be problematic. The collaboration of experts, accreditation and licencing also pose significant challenges. However, the overwhelming threat proved to be the accelerated progress made in on-line systems and software programmes, especially with regard to streaming video, coupled with internet access (particularly the problem of firewalls), causing *mrcs*TV to cease broadcasting in 2005.

TETRASUR and the subsequent *mrcs*TV were successful initiatives that addressed an identified need with an innovative solution. Success was built on the provision of resources (from the ESA), the unbridled enthusiasm of a few key individuals, engagement of committed, already-overworked surgeons, and a regional focus to demonstrate a potential national-level scale-up. However, changes in key personnel proved devastating in a time-sensitive operation. Internet video streaming products coupled with mainstream, heavily-sponsored and government-led internet-based enterprises, such as HealthExecTV (http://www.healthexectv.tv), then basically excluded the use of satellites to provide this type of service, especially as all potential users have internet access (Vranch, 2005). Nevertheless, the success of *mrcs*TV, and the very factors that stimulated its demise, indicate that the well-proven

system could be a much-needed and viable "leapfrog" solution, especially for Africa.

The use of satellites in health commenced with the INTELSAT-sponsored Satellites for Health and Rural Education (SHARE) project during 1985-1987, when free satellite capacity was made available to test rural and remote educational and telehealth projects globally. Indeed, China began its educational TV activities, which now reach millions of viewers in remote areas, as part of SHARE. Today, with almost universal access to the internet in developed nations, the use of satellites is comparatively expensive and less integrated with other resources, the internet being much more user-friendly and accessible. However, satellite communication (Satcom) remains a technology with unique characteristics of reach, performance and flexibility. It can deliver bandwidth exactly where there is a need, completely independent of pre-existing terrestrial infrastructure or geography, creating broadband communication as a self-contained solution. Admittedly, Satcom-based access to the internet is expensive, around 5 times greater than normal terrestrial access via ADSL. But this is not the case in developing countries, where many parts - especially rural areas - remain 'unwired'. Moreover, such areas cannot be connected economically using other technologies. In these circumstances, Satcom offers the prospect of supplying audiences with the same quality of service that is provided in urban areas, in a cost-effective manner. Furthermore, the technology is available now and, increasingly, infrastructure is being provided free of charge through both the public and private sectors.

In Africa, 54 countries have access to the internet, but most use VSAT for internet access. As increasingly more fibre optical cables are laid (e.g. the $1.8 billion AfricaONE cable which will encircle the continent) commercial broadband access in capital cities and some coastal towns will increase - at a high cost to national governments and, subsequently, users. Yet much of the rest of the continent will continue to have inadequate communications infrastructure, meaning that satellites will remain the best means to broadcast radio, video and data files for many years to come.

In the public sector, the International Telecommunications Satellite Organization (ITSO) has launched the Global Broadband Satellite Infrastructure Initiative (GBSIi) as part of the WSIS Action Plan. The GBSIi will help overcome "digital divides" and redress the unequal distribution of connectivity between countries and regions, and between urban and rural areas. In Africa, the Regional African Satellite Communications Organisation (RASCOM), consisting of 44 country members, will belatedly launch its first dedicated satellite in mid-2006. Established in 1993, RASCOM aims to provide all Africa with efficient and inexpensive telecommunications facilities and meet all radio and television requirements, using all available technologies. The new satellite will cover the entire continent, providing overlapping beams in the Ku-band and a single C-band in a fully-integrated network. One of RASCOM's objectives is to ensure that satellite-based infrastructure serves all rural areas. The high-power Ku-band necessitates only small diameter, low-cost, easily-erected ground terminals, offering universal access to 700 million people, especially those in remote communities.

In the private sector, various organisations are providing 'satellite philanthropy' as exemplified by the WorldSpace Foundation, which donates 5% of space on the three WorldSpace Corporation satellites to non-commercial, social development ventures. In 2000, WorldSpace and Satellife (an international not-for-profit organization devoted to improving health using electronic communications) combined to launch the Public Health Channel for Africa. Initially, receivers will be located in health facilities, medical schools, ministries and research institutes in four countries (Ethiopia, Kenya, Uganda and Zimbabwe), the service later expanding to other countries as funds become available.

The only institution currently providing world-class multimedia products to the entire African continent is the World-Bank-sponsored African Virtual University (AVU). Similar to the *mrcs*TV model, the

AVU uses an interactive process that allows students – even those in remote and isolated areas – to engage in real-time discussions with experts in Africa and overseas in a manner that has proved sustainable, although the AVU signal is currently up-linked from Washington, DC. (Strehler, 2002).

As an indicator of the promise and potential that Satcom has in Africa, UNESCO has recently partnered with WorldSpace (operator of the AfriStar™ satellite) to demonstrate and test the potential of digital radio to deliver low-cost, effective multimedia-based and real-time distance education and information to rural areas, continent-wide. Three Community Multimedia Centres (CMC) in each of five countries (Ethiopia, Namibia, Tanzania, Uganda and Zambia) will be provided with digital radio receivers, data interfacing equipment and technical support. At least one of the CMCs will have internet connectivity, and one will be either a school, a training facility or a policy-formulation institution promoting Information, Communication and Training (ICT) for development. Up to 30 additional centres, NGOs or development agencies in Europe, those capable of receiving and decoding the Afristar signal, will also participate. Experts from Africa and from overseas will give live lectures with real-time interactive feedback.

On the ground, the African Medical and Research Foundation (AMREF) has already introduced a practical telemedicine project, providing long-distance medical advice via an audio-visual satellite link to doctors in remote desert towns in northern Kenya, and on the shores of Lake Victoria. Meanwhile, in the Schools-based Telecenter (SBT) project in Uganda, a national satellite network set up as part of the World Links initiative of the World Bank Institute and the World Links NGO (http://www.world-links.org), a much more basic problem is being addressed. The project, supported by the Bill and Melinda Gates Foundation, is investigating the use of solar energy to power the systems in rural areas where electricity supply is either unreliable or non-existent and generators are too expensive.

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