Phoning in sick—telehealth in the iPhone age

As mobile devices become ubiquitous, can health care finally be delivered effectively over the Internet?

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Telehealth—the remote delivery of health information and services—is a rather old idea that has worn many guises and has suffered many false dawns and pitfalls. Now, however, it seems that a combination of efficient communications, IT technology, better diagnostics and the driving force of spiralling healthcare costs for an ageing population is finally pushing telehealth into practical use. Moreover, growing interest among consumers in fitness, well-being and personal health monitoring is drawing in people who do not suffer from debilitating or chronic conditions, but simply want to monitor their bodies. The crucial catalyst is the abundance of smartphones and other mobile devices that can serve as hubs for collecting health-related data and facilitating communication with health experts.

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The potential use of remote communication tools in health care, including video, has been appreciated for at least 40 years. In 1975, a US study assessed the pros and cons of consultations between patients at home and their doctors over both closed circuit television (Fig 1) and telephone [1]. The authors found that remote consultation by television, in addition to the cost of deployment, actually increased the average length

of consultations by 25%, but significantly reduced the number of referrals to a hospital. The conclusion was that it was most valuable in remote areas where people feel more isolated and where the costs of long distance referrals might offset the costs of the system. Yet, closed circuit TV was never widely adopted because it was too expensive and logistically difficult to deploy on a wider scale.

Since that study, there has been a steady trickle of telehealth trials, but these have always been small and confined to local areas and specific sectors. More recently, though, broadband communication and mobile devices, along with advances in diagnostic equipment, have created the potential for more extensive trials. The desire to exploit this potential is driven by the growing numbers of infirm and chronically ill patients. The International Longevity Centre in the UK predicted in 2012 that spending on health care in the EU will rise from 7.1 to 8.3% of GDP by 2060 as a consequence of an ageing society (http://www.ilcuk.org.uk/index.php/publications/publication_details/the_cost_of_our_ageing_society1).

Though such predictions cannot accurately measure the potential impact of telehealth, they are certainly stoking growth in the field. According to a BCC Research report, *Global Markets for Telemedicine Technologies* (information obtained from the summary available at: <http://www.bccresearch.com/market-research/healthcare/telemedicine-technologies-report-hlc014g.html>), the global telehospital/clinic and telehome market could grow to US\$43.4 billion by 2019 at a compound annual growth rate (CAGR) of 17.7%. The telehome category—

remote patient monitoring—is currently surging ahead even faster at 24% CAGR. The report also highlights a direct link between rising healthcare costs and growth in the telehome sector in the USA, where more and more medical insurers are reimbursing the cost of telehealth sessions with doctors in the belief this will cut their costs.

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However, reliable data on the economics of telehealth remain elusive, partly because it involves a variety of components, and partly because it is difficult to separate out the contribution of each—remote monitoring, or video consultations with doctors, for example—from the overall healthcare service. Early studies were never able to recoup the cost of equipment and time, but there is now a nearly universal assumption that eventually telehealth approaches will save money, particularly for the management of chronically ill and elderly patients. The expectation is that savings from reduced hospital admissions will be reinforced by the benefits patients derive from not being subjected to the negative aspects of the hospital environment.

Figure 1. Reba Benschoter using a CCTV telehealth system in 1967.

The photograph was taken in the television studio of the Nebraska Psychiatric Institute (NPI) at the University of Nebraska College of Medicine campus in Omaha, Nebraska. This was one of the first telemedicine programmes in the United States, with a two-way closed circuit television link between the NPI and the Norfolk State Mental Hospital, located 112 miles away in Norfolk, Nebraska. More information about Reba Benschoter, who pioneered telemedicine, can be found on the University of Nebraska Medical Center's website: <http://www.unmc.edu/news.cfm?match=16468>. Photograph and caption courtesy of the UNMC Archives, Special Collections Department, McGoogan Library of Medicine, University of Nebraska Medical Center, Omaha, Nebraska.

There have already been some clear examples of both cost savings and demonstrable benefits in the USA. One example comes from the US Department of Veterans Affairs (VA), which helps ex-service personnel with a variety of physical and mental injuries and disabilities. About one-third of these patients reside in rural areas and rely heavily on telehealth for access to health care. The VA provided care to 485,163 patients in 2012 from 150 Medical Centres and 750 Community Based Outpatient Clinics via 1,380,431 telehealth consultations (<http://americas.nttdata.com/Industries/Industries/Healthcare/~ /media/Documents/White-Papers/Trends-in-Telehealth-White-Paper.pdf>). The department has budgeted US\$1.2 billion of its total requested budget of over US\$150 billion for telehealth in 2016 (<http://www.va.gov/budget/docs/summary/Fy2016-FastFactsVAsBudgetHighlights.pdf>). This may still be a fairly small percentage, but is huge compared with other health agencies. The cost of home telehealth—services and equipment—equates to around \$2,400 per patient annually and compares with \$22,000 a year for in-home nursing care and \$92,300 for placing a veteran in a nursing home facility (<http://www.va.gov/oig/pubs/VAOIG-13-00716-101.pdf>).

There is more evidence of both benefits and cost savings in the USA from various pilot programmes that cater for patients who suffer from chronic conditions. One example is the Intensive Ambulatory Care (IAC) pilot programme, part of the overall telehealth programme set up by the Banner Health Foundation in Arizona, for patients with multiple chronic conditions who account for 50% of overall healthcare costs. The IAC programme, first launched in 2013, reported in May 2015 that during patients' first 6 months, total care costs were reduced by 27%, hospitalizations by 45% and as a result of the latter, acute and long-term care costs came down by 32% (http://www.newscenter.philips.com/us_en/standard/news/press/2015/20150405_philips_telehealth.wpd#.VbVGX7NVhBc).

Europe lags well behind the United States in telehealth overall. Olaf Müller, CEO at Carus Consilium Sachsen, sponsor of Germany's biggest telehealth project in Dresden, points to the fact that funding in Europe is mainly allocated to projects on a one-off basis, rather than to encourage development of the underlying infrastructure. "The

problem with most EU funding on telehealth is that it encourages people to keep trying to come up with different ideas to get funding and then keep reinventing the infrastructure," he said. "This is a complete waste of time and is very inefficient." In a joint venture between the European Fund for Regional Development and the Free State of Saxony, Carus Consilium Sachsen is sponsoring a telehealth project called CCS Telehealth Ostsachsen, to put the field on a sounder footing by establishing the underlying infrastructure before conducting specific trials. "We have turned the whole process around and developed the basic components and services first," Müller explained. The first pilot applications started operation in July 2015. These include home care for patients who had suffered heart attacks and strokes, and a network for exchanging high-resolution images of tissue samples among consultants who can discuss cases by video conference. The initial aim is to improve the treatment of patients, each of whom has been issued with an Apple iPad configured specifically for their condition and requirements. These tablets submit data and have an emergency button for contacting doctors and setting up video calls if necessary.

The project will also assess which issues need to be resolved to make telehealth more effective and affordable. One such issue is the question of what devices people can or should use to interact with such services. Although patients have been given tablets for the CCS project, Müller indicated that this might not be sustainable on a larger scale. Instead, it would make more sense to use patients' own devices, given that many people already have a tablet or smartphone. "That will be the next step, to just provide an app for the patient's device and any hardware add-ons," Müller said. "Before we go to BYOD [Bring Your Own Device], first we need to solve the data protection problem." The concern here is that patient's devices could potentially inject malware into the healthcare infrastructure or otherwise be used to launch malicious attacks, so security mechanisms need to be in place before BYOD can be implemented. Müller also prefers tablets over smartphones because they are easier to use for elderly patients and have larger screens for video consultations.

However, as telehealth expands to reach a wider range of more mobile patients, Val

Jones from the University of Twente in the Netherlands, and coordinator for the Mobi-Guide telehealth project funded under the EU's Framework programme, believes there is a strong case for using the smartphone. The advantage of smartphones is that, unlike tablets, most people have them on or around them all the time. Jones also envisages smartphones communicating via Bluetooth with wearable or other sensing devices within a "personal area network."

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As many projects and deployments have found, the benefits of telehealth are greatest for patients in remote areas furthest away from hospitals and care centres. Yet, it is in precisely these locations where access to a high-speed Internet connection is not always available. "Transmitting data to and from remote areas is a problem, especially for video telephony," Müller said. "For example, we are thinking of supplying emergency doctors with equipment to operate at remote centres, but the issue is getting the right bandwidth to those emergency sites." To some extent, these communication problems are broader issues and not specific to telehealthcare. But it poses a problem for the CCS project's aim of developing a universal telehealth framework applicable across the whole healthcare sector for all patients. "We have built the system so that it is completely portable to other regions, as well as most other healthcare sectors or even different industries," Müller explained. "Indeed, we have already had several enquiries from vets looking at telehealth for their customers' pets."

Currently, telehealth is confined mostly to basic diagnostic measurements such as weight, body temperature, heart rate and blood sugar levels. One of the ambitions of some projects is to expand its diagnostic reach. Among the first targets are dermatology and the eye, as tests can be conducted at home without the need for a laboratory. The next step is to bring the

laboratory to the home using devices that can extract a small blood sample and then conduct tests automatically and send the resulting data to the telehealth centre for analysis. Müller mentioned the German company BiFlow Systems that has already developed a microfluidic chip that can potentially prepare and check blood samples at home (<http://www.biflow-systems.com/>). "The technology is ready, but needs to be linked into the telemedicine platform," Müller said.

Jones commented that benefits will come as much from advanced diagnostics as from data analysis. "The linking and analysis of data from multifarious sources will enable previously unheard of levels of monitoring and possibilities for inferencing based on the data. This obviously implies many dangers and challenges, as well as a vast potential for good," she said.

More advanced remote diagnostics and analysis capabilities will eventually converge with the already massive "wellness" and fitness monitoring business to expand telehealth to more patients. "The line between fitness, wellbeing apps and personal health monitoring is blurring. In affluent parts of the world we can already see what has been called 'the connected self' in action all around us," Jones said. "It will be interesting to see how far today's purchasers of fitness and wellbeing devices and apps continue self-monitoring as they age and in many cases acquire the chronic health conditions associated with aging."

Yet, diagnostic devices for health care have to be more accurate and therefore more expensive than those used for fitness monitoring. Heart rate monitors worn by cyclists or joggers, for example, are probably not accurate enough to rely on for matters of life and death in a telehealth setting. Nonetheless, economic and social trends are likely to further push the convergence between fitness monitoring and remote health care. "We have a society that has become more accustomed to using digital services and devices. The acceptance of a remote consultation is therefore greater as people have seen how services such as Skype can enhance their personal lives."

Another route to general telehealth could be healthcare kiosks in public places, as is already taking place in the USA (Fig 2). One of the leading providers of telehealth kiosks is HealthSpot, which has developed an

integrated unit that combines diagnostic capabilities with high-definition video conferencing and integration with patient health records. It is now deployed in a number of public places and has been accepted by medical insurance providers so that people with health policies can recoup the cost of consultations and tests conducted via the kiosk. "With an in-person station attendant always on hand to help as needed, the HealthSpot platform has been recognized by medical boards and health systems as being truly equivalent to an in-person visit for similar services," said Steve Cashman, CEO of HealthSpot.

The kiosks can take a range of measurements, including blood pressure, pulse rate, temperature, weight, and condition of the ear, nose or throat by an otoscope, while there is a magnascope for zooming in closely to look at the skin or into the mouth. There is also a pulse oximeter for measuring blood oxygen saturation level and a traditional stethoscope to record heart, lung and bowel sounds. People can also schedule direct face-to-face consultations over the video link, paying between US\$49 and US\$79 if they are not covered by medical insurance.

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Yet, deploying such kiosks is not just a matter of installing and connecting them. It also requires human resources and changes in working practices by doctors and others; otherwise, they would just be a cost burden without delivering any benefits. This is a major issue that has to be resolved for any successful telehealth deployment, according to Lucien Engelen, Director at the RShape Centre for Healthcare Innovation at Radboud University Medical Centre in the Netherlands. "The biggest challenge is the change of culture and attitude towards telehealth that must happen from inside the healthcare systems," Engelen said. "Big companies like Apple and Google are making their way into health, and next into healthcare, introducing consumerism in health care. So looking the other way doesn't help. We have to embrace new technology into our curriculum,

Figure 2. A healthcare kiosk produced by HealthSpot.

Such kiosks can be installed in public places to provide remote health care. Image obtained from: <https://www.healthspot.net/about/resource-center/>.

like we did at Radboud UMC starting this September.”

The need to train staff properly has also been identified in the UK as essential for making telehealth work, according to Claire Bentley, Research Associate for Telehealth & Care Technologies at the University of

Sheffield. “Technical issues can reduce clinicians’ confidence and willingness to use telehealth, and when getting used to a new way of working, workload may increase in the beginning until the intervention is more established,” she noted. “Whether or not telehealth is used as part of routine practice,

or as part of a trial, clinical staff need long-term training and support to do so. It does not matter if an intervention seems like ‘the best thing since sliced bread’, if clinicians do not like it then it will not be used, or will not be used effectively.”

Once telehealth has been accepted into clinical practice, it should improve working conditions, according to Ellis. “There are several stages of maturity in terms of digital technology usage. The first is when technology replaces paper or phone-based activity but does not fundamentally change the way work is done. The second stage is when the process is improved because the technology enables new ways of working. Then the third stage is when you realise you now have data that enables you to do things you hadn’t dreamed of originally.” The prospects of reaching that third stage in telehealth inspire much research and economic activity, but there is clearly some way to go even to reach the second stage, in particular outside the USA. But the pace of trials and evaluations elsewhere has picked up enormously just over the last year and this in turn helps to overcome resistance and bring down the cost of equipment.

Reference

1. Moore GT, Willemain TR, Bonanno R, Clark WD, Martin AR, Mogilnicki RP (1975) Comparison of television and telephone for remote medical consultation. *N Engl J Med* 292: 729–732