

Connected Health Services

Internet, mobile and wireless technologies in healthcare

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Abstract— Connected health services have many meanings. This paper describes some new and emerging connected health service applications of internet, mobile and wireless technologies. The paper identifies three drivers that will change the health services landscape and the mindsets of patients, public and clinicians. Finally examples of connected health services are described.

Keywords— component; health services, health promotion, disease prevention, informed/expert patient, Internet, mobile phone technology, personal health systems, self-help, medical data on SIM card, rehabilitation, nutrition information, epilepsy alert

I. INTRODUCTION

Connected health services is a phrase that can, and does, have many meanings. Here I will use it to describe the new and emerging application of internet, mobile and wireless technologies to:

- i) 'connect' the patient to expert advice and information knowledge databases
- ii) 'connect' patients to each other in self-help groups
- iii) connect' the patient to monitoring devices for self-diagnosis
- iv) 'connect' the patient physiological measurement data to the clinician

In doing so, I will identify three powerful drivers that will change the healthcare landscape and the mindsets of patients, public and clinicians.

Firstly, there is a growing recognition in the western world that increasing affluence and improving medical technologies results in improved longevity, but at a price for the increased incidence of chronic conditions [1]. Societies face the challenge of delivering affordable high quality healthcare to all their citizens. Policy makers have realized that the most affordable way to deal with chronic disease is through delaying the onset, or preventing disease, through the use of education and increased awareness that lifestyle plays an important role in the etiology of chronic disease.

Secondly, there is an evolution that is attributed to the Internet that is moving today's patients from those that are

'informed' to one that is 'expert'. In the early days of the Internet a patient walking into a doctor's surgery or consultant's office with a print-out from a medical website was to some clinicians a source of amusement and to others it was an irritation. Nowadays the clinical practitioner will often refer the patient to websites for information. Anyone who is sufficiently interested can research the Internet to become knowledgeable about most subjects and patients are often very motivated to find out more about their particular condition. Self-help groups are also increasing using the Internet.

'...Patients no longer want information provided only by medical professionals; people find that exchange of experiences with other patients and ex-patients is the most reassuring and efficient way of getting support...' Source: Department of Health (UK) Self Care Support summary of work in progress (2005-07)

Thirdly, there is such a market penetration of mobile phone technology that it is unusual for those under 45 not to have a mobile phone in most developed countries [2]. The prevalence of mobile phone technology is such that it provides an infrastructure and momentum for new innovative medical applications. Similarly, other wireless technologies are also becoming widespread. Two common wireless technologies are WiFi and Bluetooth. WiFi is used for broad band connectivity typically at home, office or in a public building. E.g. the airport hot spots use WiFi technology, the range is tens of meters. Bluetooth is often used for connecting small devices like hand-free ear plug to a phone or a keyboard to a computer, the range is some meters.

These technologies are constantly improving their functionality and merging into devices such as the iPhone, other smart phones and potentially a dedicated Personal Health Assistant device (PHA). The advantages of using mobile phones are that they are familiar devices to most people. Mobile phone healthcare systems are easy and fast to install and systems can be updated without needing to return the device to a central location. Scientists predict that one day hand-held supercomputers will be available [3].

One of the observable issues currently taking place across Europe is the struggle to develop and implement national patient databases fed by primary, secondary and community care systems. These are ambitious and challenging

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programmes requiring an enormous investment of resources over many years. At the same time technology developments are being harnessed in small but innovative ways to bring quick beneficial results improving care processes and the lives of patients. These require relatively small amounts of resources and increasingly employ current consumer equipment and the existing skills and knowledge of the patient. These devices will help shift part of the diagnosis, responsibility and control from the clinical practitioner at the hospital to the patient at home.

Below I describe a few of these innovations some of which are already in place and in use while others are on the near horizon. It is likely that some will remain in niche markets but others will become absorbed into mainstream life.

II. APPLICATIONS

A. Expert knowledge - Websites

There are an enormous number of health related websites from trusted sources offering expert help and advice. In the U.K. NHS Choices [4] is a service that aims to put the individual at the centre of their healthcare. It has been designed to help visitors make choices about their health through to the practical aspects of finding and using different health related services, for example, assistance with smoking cessation, reduction in the consumption of alcohol, while increasing exercise,. The extract below shows the Body Map page through which you can select to view or hear expert medical advice for a particular disease.

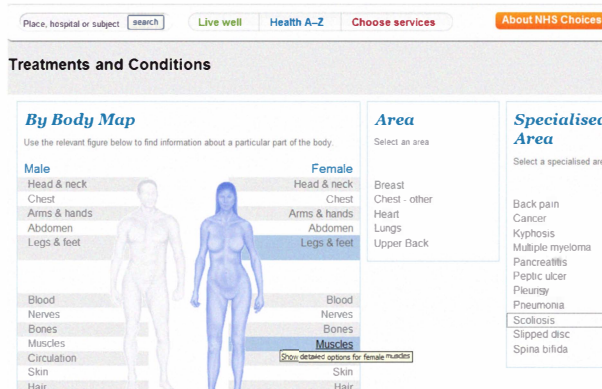


Figure 1 Starting page of the www.mapofmedicine.com [5]

Also from the U.K. is another site – Map of Medicine which produces health guides to help individuals prepare for discussions with clinical practitioners or for anyone who wishes to find out more information about a health issue.

B. Self-Help

In addition to the sites run by national health care organizations are those run by charities and others which provide advice and support and discussion forums. One of the recent internet phenomenons is the growth in social networking websites such as 'Facebook'. Since approximately 30% of people suffer from a long term medical condition, inevitably

social interaction on the internet will include sharing of health issues and experiences.

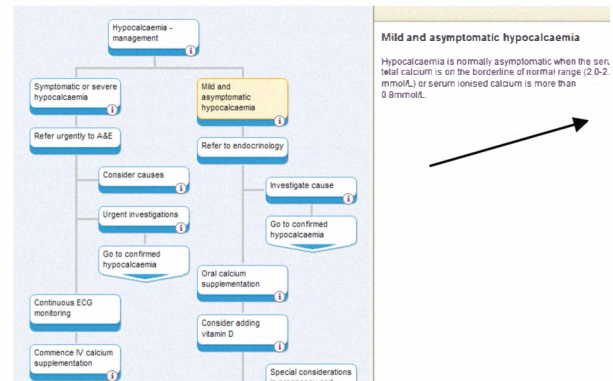


Figure 2 Healthguides has been developed by the Map of Medicine to give a clear understanding of the steps to better manage individual's health. It gives the same trusted information available to healthcare professionals [5]

Websites such as those of Diabetes UK report over 4,000 visitors a day. Increasingly new and updated information can be acquired by subscribing to a web feed such as RSS. In the typical scenario of using web feeds, a site providing information will publish a link to which the user can register within 'reader' software on their own device. RSS on health information sites will enable patients to keep informed of the latest information relevant to their condition in an automated manner that's easier than checking sites manually. Receiving information like this has advantages over emails which require rules to sort incoming data into separate folders and it is easy to remove the RSS link if the information is no longer wanted. St Johns Ambulance in the U.K. offers the facility to subscribe to medical advice feeds and download first-aid procedures to mobile devices.

Originally developed in America in the 1970s as a self-help programme to aid people with arthritis, the Expert Patient Programme has since been developed for a range of conditions across a number of countries to help patients with chronic problems to take more control over their health by understanding and managing their conditions. This has had great success in empowering people with chronic conditions giving them control, a greater sense of independence and leading to an improved quality of life. Expert patients are said to have more effective conversations with health professionals, visit the doctor less, have less time off work, and are less likely to suffer acute episodes resulting in admission to hospital [6]. Participants report life changing experiences acquiring the skills, knowledge and confidence to deal with the mental and emotional barriers to self-help.

It is easy to see how the patient can be connected with self-monitoring devices linked to trusted medical databases described in this article to help with initiatives such as the Expert Patient.

C. SMS

There are a growing number of applications utilising the fact that more and more people possess mobile phones. SMS

messaging is showing an expanded use in various health applications.

- Reminders for Appointments

Missed appointments are a significant waste of scarce resources. They are not only a waste of the clinician's time but also a waste of all the administrative processes that surround making and preparing for that appointment. Whilst this varies from specialty to specialty on average 10% of all patients in the United Kingdom miss their hospital outpatient appointment. The number of missed appointments in 2005-6 was calculated to be 6.8 million [7] and while the estimated costs vary from £300 million to over £600 million a year, any reduction in the percentage of failure to show up for an appointment would save significant resources.

The main reason that patients miss appointments is simply that they forget. Applications are now being used to send a timely reminder SMS message to the patient's mobile phone stating the time and date of their appointment. The advocates of these systems report great success in reducing the failure to attend rate and resulting efficiencies in throughput in busy clinics and surgeries.

Another reason for failure to attend is difficulty in cancelling or changing an appointment time. Again SMS can help here since it is technically possible to cancel or confirm an appointment using reply text.

- Sexual Health Service

One medical area where the characteristics of the mobile phone can be usefully exploited is in the treatment and prevention of sexual diseases since young people are an important risk group and they are most likely to have a mobile constantly available. Diseases such as Chlamydia are a high disease burden and the U.K. has initiated a National Chlamydia Screening Programme to control the disease by early detection and treatment. One of the challenges to overcome is the long waiting times in genitourinary medicine clinics.

Newham General Hospital in London has been using an SMS messaging service for patients waiting for sexual health test results to reduce unnecessary hospital visits and waits. Instead of returning for a second lengthy visit to the clinic, eligible patients are given a negotiated time and date for receiving their results by an SMS message on their mobile phone. By preventing delays and inconvenience for patients, it also frees up appointment time in the clinic, allowing services to be offered to more patients. The hospital reports that news of the user-friendly service has spread among the community and among young people and that as a result more people are coming forward for screening [8].

At the same hospital a text messaging service was piloted allowing patients to send blood sugar readings via SMS. These were read by a diabetes specialist nurse who texted or called to give appropriate advice. The project was aimed at improving care for women with antenatal diabetes by reducing the frequency of outpatient attendances and providing aggressive management of blood sugar levels by the diabetes nurse. The service was very popular with the patients.

D. Medication non-compliance

Failure by patients to take medication as prescribed by clinicians is a significant problem. Whilst there are many reasons for this, undoubtedly forgetfulness is one cause. The results of not taking the medication can be very serious for some patients. Companies offer to help patients and carers by sending SMS reminders direct to a mobile phone. Developments in this area can include the ability to for a message to be sent to a central system recording when a pill container was opened as the best indication that the patient has taken the medication. The central server could be programmed to send an alert to a carer or health worker if no compliance message was received.

E. Measuring device linked by PHA to expert systems

These applications can be used for a wide range of conditions. One important group are those patients suffering from long term chronic diseases such as diabetes, asthma and arthritis. To this list we need to add obesity which is increasingly recognised as a major health problem in developed countries.

People with long term conditions (LTC) are the most intensive users of health services. In England patients with an LTC account for 80 per cent of all GP consultations and they use approximately a third of all bed days whilst 78% of expenditure [9] in the U.S. is spent on patients with chronic diseases. Technology that automates chronic care processes can improve the life of the individual and release monies to be reallocated within health care.

An example of such automation is the use of measuring devices linked by a hand-held PHA to monitor chronically ill patients as they go about their normal daily routines. Daily monitoring can help patients with chronic diseases maintain appropriate drug, diet and exercise regimes.

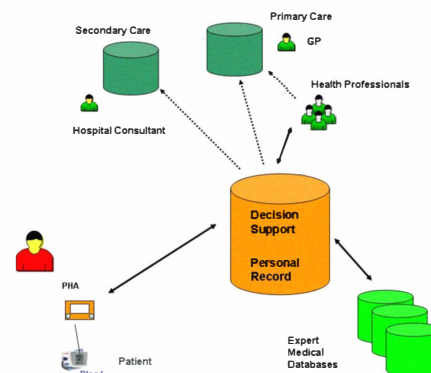


Figure 3 A Personal Health Assistant device is a stand-alone feedback system and an interface of an individual to the chronic disease management system.

The diagram above shows an application of PHA device which can give instant feedback to the patient or send the

recorded data to be stored, and analysed by either a software decision support system or by a clinician treating the patient. The software decision support could be useful for either a diagnosed patient actively managing their condition or for a non-diagnosed individual who wants to prevent illness occurring.

The diagram shows a blood pressure device but equally this could be a blood glucose monitor, bathroom scales fitted with a wireless module, a wireless ECG heart monitor, lung function Spirometer, Pulse Oximeter etc. All of these and more can be used in conjunction with a PHA operating as a mobile health monitor which transmits data to a central server where the results are analysed and the individual given expert advice from decision support software or from connected clinicians.

An increasing number of people are opting for self-diagnosis. In Germany, for example, 1.2 million self measurement devices are sold annually [10].

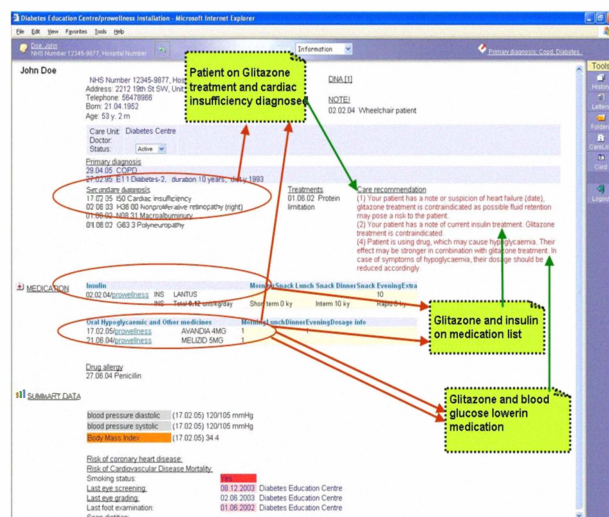


Figure 4 In the diagram below a scenario is depicted of the possible automated interaction between an electronic patient record and a decision support system accessing directly or indirectly trusted evidence based medical databases such as EBM Guidelines and The Cochrane Collaboration. The red arrows depict input to the decision support and the green arrow the output of recommendations. It is now possible to fit this decision support system onto hand-held devices like the PHA with the necessary security protection. [11]

F. Medical data on a SIM card

Issues such as privacy and cost are delaying the introduction of electronic ID cards. However mobile phone users already carry a form of ID card called a SIM (Subscriber Identification Module) that is embedded in their handset. Modern SIM cards have enough spare capacity to hold basic medical data applications including patient identification and the storage of basic medical data such as drug allergies and blood group. This would also provide an important step towards the patient taking ownership of their own electronic medical records.

Whilst governments are concentrating on building up national databases within the EU there is significant numbers of people travelling both for pleasure and for business. Especially amongst the retired there are large numbers of people in Europe who live in more than one country each year for extended periods of time. There is a need for cross-border health care for when someone falls sick in another country. A mobile phone with a SIM card containing basic medical data would certainly be a step forward although protocols for accessing that data in emergencies would obviously need to be worked through.

A scheme started in the U.K. following the London bombings in July 2005 to standardize on an emergency contact name in the mobile phone's address list continues to gain support. The entry ICE is stored and against it the number of the person you would want to be contacted "In Case of Emergency". In an emergency situation police and medical staff can then quickly find out who they need to phone.

G. Exercise and rehabilitation.

To manage a condition or to prevent illness individuals need to exercise. Resource levels mean that patients often have to make do with only an occasional visit to a physiotherapist. Wireless and mobile devices can be used to record, monitor and provide feedback to motivate an individual to keep to a planned exercise routine. Once again a care worker can be informed if the exercises are not being carried out so that the reason for non-compliance is explored and the plan adjusted or further advice given if required. The use of such devices to encourage exercise could alleviate depression and reduce lethargy.

H. Links to nutrition information expert knowledge systems

The importance of diet to health is well known but the information about eating in recent years has often left people confused. Some of the blame for this confusion lies in the hands of the media who will often pick up issues based partly on their entertainment value. Good expert advice is available but it needs to be packaged and delivered in a meaningful manner for the public.

Existing technologies can be applied in a number of ways. Smart phones could capture the bar code and be send it to a central database that could provide individual based advice for example if the person has an allergy that may be aggravated by the food product or requires a low salt diet.

The individual could subscribe to a service that allows them to record their food consumption and receive personalised coaching on whether it is matching a target plan.

Just as in Japan, where mobile phone companies provide immediate notification of earthquakes and other natural disasters to their customers, in cases when there has been a contamination of a food product, an alert message could be sent by a central service to mobile phones.

I. Epilepsy Alert

In the western world approximately five million individuals are affected by epilepsy and many of these are children. Of the

approximately 400,000 new cases diagnosed each year nearly one-third are children. Of great concern to parents is the thought that the child will have a seizure when they are on their own, for example outside the house or in bed asleep. A prolonged seizure can lead to brain damage and even result in death.

An Israeli company has developed a watch-like sensor unit worn by the patient on the hand or the foot which detects and processes the specific vibrations of epileptic seizures and transmits an alarm to carers.

J. Body-worn sensors

Wired sensor devices restrict the movement of the patient being monitored. As a result some suppliers have developed the ability to capture information wirelessly from sensors embedded in clothes or within a 'plaster'. This enables the patient to live a normal life moving about their home and work environment freely. These sensors are able to provide continuous monitoring and, for example, detect early life threatening signs of imminent cardiac problems. With appropriate software, data can be transmitted to a central remote server using GSM or GPRS and an alert sent to the patient and clinical support.

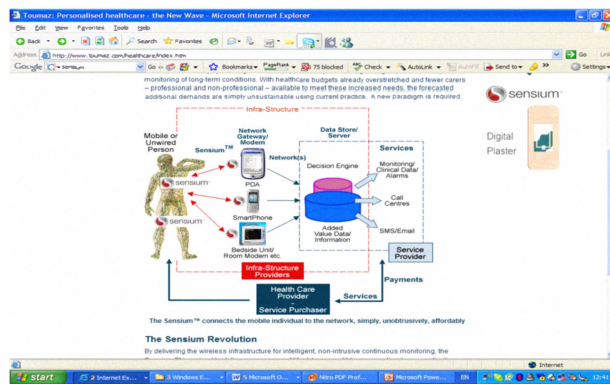


Figure 5 Body-worn sensors have been tested widely. [12]

III. CONCLUSION

David Colin-Thomé, National Director for Primary Care of NHS has written: 'When the NHS was conceived it was logical to bring the patient to the specialist; now, advances in technology and medicine present us with the opportunity to

bring the specialist to the patient. Bringing care closer to home. Making it personal rather than impersonal'

Over the last 50 years we in the west have concentrated on providing excellent services for the diagnosed patient. We have done this very well but the resulting increase in peoples' life-span now needs to trigger a new phase that will develop strategies to provide both the diagnosed patient and the healthy individual with the information and tools to self-monitor and manage their life-style to stay as well as possible.

These strategies can build on health innovations such as those described in this article. The traditional boundaries of health care will need to be expanded to take in the currently healthy individual and employ the internet and personal hand-held devices to provide information and feedback to enable people to make the right life-style choices to prevent or delay the onset of chronic diseases. By employing familiar consumer technologies and actively encouraging self-care the largest collaborative resource available, the public, can be motivated and mobilized to help meet the challenges we face and improve health outcomes and patient satisfaction within current funding levels.

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