ABSTRACT
Mobile phones are becoming increasingly important in everyday life and now in healthcare. There has been a steady growth of information and communication technologies in health communication and technology is used progressively in telemedicine, wireless monitoring of health outcomes in disease and in the delivery of health interventions. Mobile phones are becoming an important method of encouraging better nurse-patient communication and will undoubtedly increase in application over coming years. This article presents recent developments and applications of mobile technology for health promotion and patient-monitoring in chronic disease.

KEY WORDS
Technology • Mobile phone • Monitoring • Health communications

Whether aiming to improve health at the individual, community, regional or national level, increasing developments in the new millennium have seen a steady growth of information and communication technologies in virtually all areas of health communication. Technologies are used in research and education, knowledge transfer, social support, service delivery and health promotion. Mobile technology is increasingly used in telemedicine, wireless monitoring of health outcomes in disease management and delivery of health interventions. Mobile phones are emerging as an important method of encouraging better nurse-patient communication and are estimated to increase in use and application over coming years.

Health promotion
In recent years, there has been an increase in the development of health promotion programmes which use the text message or voice response function of the mobile phone, either as an intervention per se, or in combination with other technologies. These have been conducted mostly in Japan, the US, New Zealand and more recently, the UK, and have included interventions for diet or weight management, physical activity, alcohol and drug use and smoking cessation, many of which have shown positive outcomes.

While research on technologies at this stage has predominantly focused on younger age groups, the application of the technology is similar for use with an older population. This article provides a global view of the different areas of health promotion and health monitoring in which mobile phones have been applied. There are some studies emerging regarding the application of mobile phone technology with older people (e.g. monitoring wandering in dementia, monitoring blood glucose in diabetes, promoting health) and this is an exciting work in progress. This article therefore seeks to inform the district nurse of advances in health technology and of current health promotion activities which will inevitably be translated into their practice at a future date.

1. Dietary intervention
Several Japanese studies have reported the use of mobile phones for dietary programmes. In 2004, a health education programme named ‘i-exerM’ was developed in collaboration with commerce to deliver a 12-week body weight reduction programme to 136 adults (Kubota et al, 2004). Educational items about body weight reduction were sent by text message to participants on a daily basis and they were asked to record their body weight periodically on an internet website. There was a tendency for reduced body weight in those who participated and the programme was well-evaluated.

More recently, Wang et al (2006) evaluated a new dietary assessment method which consisted of a hand-held personal digital assistant with camera and mobile telephone card, called ‘Wellnavi’. Previous work by this team had suggested in a small sample that the Wellnavi could usefully measure individual dietary intakes for a variety of nutrients (Wang et al, 2002). In a cross-sectional study in 2006, participants were asked to keep 1-day weighed food records. Digital images of all recorded foods were obtained simultaneously and sent to registered dietitians by a mobile telephone card. Estimated median nutrient intake was compared across methods and the Wellnavi compared well with food records for most nutrients with some exceptions. Over half of the participants reported that the Wellnavi was the least burdensome method of assessment and the least time-consuming. Half the sample reported that they would be willing to record their diet in this way for a month. The authors concluded from this work that this system may be a valid and convenient method for recording diet. Later work highlighted
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Wellnavi method were lower than those estimated by the weighed diet record method and this seemed to be due to the low quality of the digital photo of the Wellnavi instrument. It may be that this type of instrument may have potential for gaining dietary information from a diverse population and thus be of interest to healthcare professionals, although further work needs to be done to improve the digital photo quality of the Wellnavi.

2. Smoking cessation intervention

Wireless text messages have shown promise for the delivery of smoking cessation interventions. Obermayer et al (2004) developed and evaluated a prototype program targeting US college students that integrated Web and cell phone technologies to deliver a smoking-cessation intervention (n=46 regular smokers). This individualized quitting program was delivered by means of cell phone text messaging with assessment tools delivered using the program Web site. At six-week follow-up, one fifth of the sample had quit smoking based on seven-day prevalence criteria and 43% had made at least one 24-hour attempt to quit.

Lazev et al (2004) looked at the feasibility of using mobile telephones to improve access to smoking cessation counseling in a low-income, HIV-positive population. The authors reported findings from two studies; the first assessed the interests and barriers towards such an intervention (n=49). The second evaluated the impact of an intervention in which a small sample of participants (n=20) were given free mobile telephones and received six telephone counselling sessions over a two-week period.

Participants in the first study expressed interest in mobile phone intervention although identified phone access as a barrier. In the second study, nineteen participants completed the intervention and all of these made a quit attempt, with 75% abstinence rate at the end of the two weeks. This work highlights the potential of mobile telephone smoking cessation interventions for providing under served populations with better access to care. Further work with this target group suggests that individuals living with HIV/AIDS are receptive to, and can be helped by, smoking cessation treatment (Vidrine et al, 2006a). In a randomized clinical trial (n=95), this mobile phone based smoking cessation intervention was compared with usual ‘smoking cessation’ care after the intervention and again at three month follow-up (n=77). The usual care group received brief physician advice to quit smoking, targeted self-help written materials and nicotine replacement therapy. The cellular telephone intervention received the eight counselling sessions delivered via mobile telephone in addition to the usual care components. Participants receiving the mobile phone intervention were 3.6 times more likely to quit smoking than those in receipt of usual care and these results were biochemically verified. In a second article, Vidrine et al (2006b) reported that the mobile phone intervention group experienced greater reductions in anxiety and depression, and increases in self-efficacy compared with the usual care group.

In New Zealand, a single-blind randomized controlled trial was conducted which targeted the recruitment of young Maori (Bramley et al, 2005). The research team recruited participants who were interested in giving up smoking within one month (aged over 16 years) and who had access to a mobile phone network. The intervention group received regular, personalized text messages providing smoking cessation advice, support, and distraction. Maori text messages related to Maori language, messages (in Maori and English) and information on Maori traditions. Text messaging was free for the intervention participants for one month. There were 1705 participants (355 Maori and 1350 non-Maori). At the six week follow-up, Maori receiving the intervention were more likely to have quit than Maori in the control group. The intervention was just as effective for Maori as for non-Maori and there were no significant differences between the two at any time point. This mobile phone smoking cessation programme demonstrated that a text messaging intervention can have a positive effect for short-term, self-reported quit rates. However, the findings are limited by an over-reporting of quit rates (possibly due to the timing of free text messaging incentives) and a differential loss to follow up, with increased attrition in the intervention group at 26 weeks.

A further New Zealand study examined the effectiveness of a mobile phone messaging service (Rodgers et al, 2005) in 1705 smokers who wanted to quit. The intervention group received regular, personalized text messages providing smoking cessation advice, support, and distraction. All participants received a free month of text messaging; starting for the intervention group on their quit day to assist with quitting, and starting for the control group at six months to encourage follow up. Follow up data were available for 1624 (95%) at six weeks and 1265 (74%) at six months. Smoking habits were assessed at six, 12 and 26 weeks. More participants had quit at six weeks in the intervention compared to the control group (28% versus 13%) and this treatment effect was consistent across subgroups defined by age, sex, income level, or geographic location. This difference was still evident at 12 weeks but not at 26 weeks. However, at 26 weeks, the smokers in the intervention group were more likely to smoke less cigarettes per day and be at a higher stage of preparedness to change than smokers in the control group. Of participants who reported quitting at 26 weeks, those in the intervention group were more confident about staying quit compared...
to those in the control group who reported quitting. This research showed that mobile phone intervention may be successful in smoking cessation although this needs to be tested further in different settings and with increased emphasis on achieving long-term quit rates.

3. Physical activity intervention
Several intervention programmes are currently being developed to increase physical activity in the general population. Consolvo et al (2006) report the development and testing of a mobile phone-based fitness journal, ‘Houston’, to track and share progress toward a daily step count goal within a small group of friends (n=13). This system is based on the concept that health benefits can occur simply from increasing daily steps and social support can be a motivating factor in increasing physical activity. Despite study limitations this work did suggest that such an intervention may be experienced positively by users provided that it gives users credit for their activities, provides personal awareness for activity levels, supports social influence and considers the practical constraints of users’ lifestyles.

A recent study evaluated the use of internet and mobile phone technology to deliver a physical activity programme with 77 adults (Hurling et al, 2007). This study was a randomized controlled trial which compared a fully automated, nine week intervention (n=47) with a no treatment control condition (n=30). Participants in the intervention group received tailored solutions for perceived barriers, a schedule to plan weekly exercise sessions with mobile phone and email reminders, a message board to share their experiences with others, and real-time feedback on their level of physical activity via the internet. Physical activity was measured in both groups using a wrist-worn accelerometer and self-report questionnaires. Self-reports and objective data showed that moderate level activity had increased in the intervention group. The intervention was successful and showed that a fully automated system incorporating mobile phones could both increase and maintain physical activity in adults.

Health monitoring
Patient symptoms, health status and quality of life are increasingly monitored using technology such as mobile phones. Research studies have been conducted that test the feasibility of these methods with patient groups. These have been predominantly conducted in Europe (Italy, Denmark, Norway, Spain, UK), Korea and the USA. Interventions have mainly focused on diabetes management, with some studies on cancer, asthma and healthcare of older people.

1. Cancer
Bielli et al (2004) developed a Wireless Health Outcomes Monitoring System (WHOMS). This system created a method whereby structured questionnaires could be sent directly to the patient’s mobile phone by their medical management team. Patient’s answers are automatically transferred to an authorized website which then displays the patient’s current state of health in graphical form, accessible by the medical team. The WHOMS was tested with 97 cancer inpatients and while more than half completed the questionnaire successfully, the non-responders were often older, had fewer years of education and were less familiar with new communications technology (mobile phone calls, mobile phone SMS, internet, email).

This evaluation work demonstrated that distance monitoring using mobile phones is plausible and health information can be collected from a large proportion of patients in this way. This proportion may increase in community settings if the family were involved to assist the patient with the technology. However, this type of technology may not be accessible to all patient groups.

2. Asthma
Such a system is likely to detect patient suffering earlier, and to activate a well-timed intervention. Internet technology is currently used for patient monitoring, however, web-based asthma diaries have been criticized for high rates of attrition. Mobile phones have been tested as an alternative to Web interface in the monitoring and self-management of asthma. Anhøj and Møldrup (2004) used the short message service (SMS) for asthma diary data collection in which patients (n=12) were sent four SMS messages per day and were encouraged to reply to at least three of them daily. Messages included a medication reminder, a request to enter peak flow, data on sleep loss and medication dosage. Responses were steady during the study period and did not decrease over time, with more than half of the participants reporting two-thirds of the requested data. This indicates that mobile phones may be a feasible method for self-monitoring, although focus groups suggest that daily messages requiring responses should reduce in number; and that graphical display of diary data would be preferred by patients. Mobile phones may therefore be a practical support for self-management of asthma although may be most effective in combination with web-based monitoring rather than as a replacement.

3. Diabetes
New communications systems have been used for the self-management of adult and child patients with diabetes who undergo rigorous procedures for blood glucose monitoring and regulation. In 2002, a Spanish study looked at internet and mobile phone use in adults with type 1 diabetes (Giménez-Pérez et al, 2002). The researchers interviewed 244 participants (115 men, 129 women) and found a low rate of access and use of the internet for health-related purposes with only a third of the sample reporting that they regularly used the internet for health-related purposes. However, of the 76.6% of the patients that owned a mobile phone, 96% used it more than once a week showing a high rate of ownership and use of mobile phones. Mobile phones therefore showed promise as tools in health communication and self-management of disease.

In the UK, Farmer et al (2005) describe the development and implementation of an innovative real-time telemedicine system based around transmission and feedback.
of data to and from a mobile phone. This intervention included the immediate transmission of blood glucose data from a blood glucose monitor and collection of information about physical activity, eating patterns and insulin dose. Participants received immediate feedback to their phone which included a colour histogram mapping levels of control over glycaemia over the previous two weeks.

Clinicians supporting patients had access to summary screens which allowed them to identify users who were not testing, and those with levels of blood glucose which were outside pre-defined limits. There were more detailed graphical displays of data and these were used to provide data about control of insulin dose and the degree to which it was modified in response to diet and exercise. This system has been used with success in both primary and secondary care environments.

Recent work by Kim and Jeong (2007) looked at the effectiveness of a nurse short message service (SMS) by cellular phone and wire internet on plasma glucose levels in people with type 2 diabetes for a period of six months. In this controlled study, participants were randomly allocated to either the intervention (n=25) or the control group (n=26). With the aim of keeping blood glucose concentrations to the normal range, participants in the intervention group were requested to input their blood glucose level, diet and exercise diary daily in the website by mobile phone or wire internet. The researcher sent optimal recommendations to each patient by mobile phone SMS text messaging, and wire internet on a weekly basis. In this study, glycosylated hemoglobin (HbA1c) decreased 1.15% points at three months and 1.05% points at six months compared with baseline in the intervention group. Patients in the intervention group had a decrease of two hours post meal glucose (2HPMG) of 85.1 mg/dl at three months and 63.1 mg/dl at six months compared with baseline. This study showed that a nurse-led mobile phone intervention can reduce HbA1c and 2HPMG for people with diabetes. This group also reported liking the integration of technologies for this purpose.

**Care of the older person**

Mobile technologies have also been applied in healthcare of older people. Miskelly (2005) reported the use of mobile phone alerts for the electronic tracking of patients with dementia and wandering and results were promising. However, there is currently little published research in this area and more evidence is needed for the application of mobile technology in this way. Mobile telemonitoring systems are becoming increasingly popular in the care of older people. Scanaill et al (2006) devised a telemonitoring system, based on mobile phone short message service (SMS) to remotely monitor the long-term mobility levels of older people in their natural environment. Each older person in the study wore an accelerometer-based portable unit to measure their mobility and summaries were transmitted hourly within an SMS message, directly from the portable unit to a remote server for long-term analysis. Using the text messaging function of a mobile phone it was possible to monitor mobility levels within an older population and alert appropriate medical personnel if mobility levels decreased.

More recently, Dalton et al (2007) conducted a small clinical trial with just six elderly people, and monitored their mobility over an eleven hour period. Again the SMS messaging service was used to alert health professionals to allow supervision of sitting, standing and walking time, although the study highlighted a need to assess practical issues regarding the size and weight of the equipment used. Although there is currently little published research in this area, evidence for the application of mobile technology in the care of older people is just emerging and will almost certainly develop in coming years.

**Conclusion**

A large proportion of the UK now owns or has access to...

PROFESSIONAL ISSUES

KEY POINTS

- Developments in information and communications technology have seen a rise in applications for mobile phones in healthcare.
- Mobile phone interventions have shown promising results for health promotion and chronic disease management.
- Rapid advances in technology mean that mobile phones will increasingly be used in patient care to improve nurse-patient communications.

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