Electronic tracking of patients with dementia and wandering using mobile phone technology

SIR—Wandering is a common problem in people with dementia. Current methods of physical or chemical restraint are unpalatable and can have serious adverse effects. Locating missing persons has hitherto been difficult although electronic tagging can locate people within a closed environment, e.g. a residential home.

This report describes the use of global positioning system (GPS) technology to locate missing persons anywhere in the country, except inside buildings and on public transport, and to an accuracy of approximately 5 metres. Using a GPS-enabled mobile telephone we were able to locate clients with accuracy and reliability. The only technical problem encountered was user compliance, although significant ethical issues remain.

Technical information

Using GPS technology, the geographical position of a tracking device can be determined with considerable accuracy. The tracking device system used for this project was a Garmin Navtalk GPS integrated mobile phone [1]. All GPS phones were linked to a mobile phone service via GSM network and were registered to a central computer based at the London Borough of Ealing Control Centre. The computer was connected to the internet and the GSM network. It was used to obtain the geographical information of any registered handsets on demand (these features are known as location requests and continuous tracking) and to handle any incoming emergency voice calls (EMB). Continuous tracking produces a breadcrumb trail on the screen while location requests provide an individual’s location at that moment.

The tracking system

The validation work was conducted in three phases.

Phase 1: preliminary tests of the GPS tracking system

During the first phase, various experiments were conducted to investigate some of the fundamental problems underlying the practicality and effectiveness of the tracking system and to gain a firm understanding of the equipment. These showed that the optimal carrying position was a shoulder holster.

Phase 2: simulation

The overall performance of the tracking system was studied in simulated random walks by staff volunteers.

Phase 3: clinical trials

Ethical approval for the study was obtained from Riverside Research Ethical Committee. Each participant gave written informed consent. GPS handsets were released to 11 participants for a total of 84 patient-weeks. Each participant had a relative or carer who was taught how to use the phone and given a manual. The relative or carer was responsible for ensuring that the phone was set up correctly and that the participant wore it correctly every day. Each relative/carer was interviewed and daily/weekly activities of the patients were recorded, so that the tracking could be tested when the participant was active. The level of successful tracking was examined and the relative/carers were interviewed to determine feedback about the general usability of the phones.

Random walk simulation

To study the overall performance of the GPS integrated phone as a tracking device, participants were sent out to walk randomly with GPS phones in a shoulder bag or waist bag in an attempt to simulate the walk of a lost elderly person. Five random walks were performed and location requests were made at 5-minute intervals. If a request failed, continuous requests were made until successful. The five sets of data are listed in Table 1.

Three definitions for success were examined. The first definition (instantaneous) was the ratio of positive location requests to total location requests. For the second definition (5-minute intervals), the number of times that a positive location could be acquired within 5 minutes was divided by the total number of 5-minute intervals within the walk. The success rate within 10 minutes is defined the same way, only over 10-minute intervals instead of 5-minute intervals.

Random trials consisted of random combinations of built-up, open field, indoor and confined transportation environments. The average for all five successful trials was 87% over 40 m of walk in a time span of 565 minutes (9.4 hours). Therefore, we expect a location request to return a positive result 87% of the time as long as the person is not in a building or using public transportation.

Tracking the participants

Continuous tracking was used to locate the patients when they were most likely to be outdoors. To confirm the tracking was accurate, the participant’s location on the central computer was compared with either the information given by the relative/carer during the preliminary interview or with a description of where the participant was given by the relative/carer over the phone. The participants were seven males and four females, of whom three were <70 years, two were 71–80 years and six were >80 years.

A total of 430 location requests on participants were made using the continuous tracking function within known routine activities windows over a total time span of approximately 75 hours. It is difficult to draw an explicit conclusion from the large amount of data generated from the location requests.
made; however, the data are in good agreement with the pre-recorded profiles of their routine activities. Therefore, it is a reasonable assumption to say that the system, in a technical sense, can operate with good efficiency and reliability.

Tracking was accurate when there were no compliance issues. More than 90% of the location requests matched the description given by the relative/carer of where the participant was. More than 95% of location request failures were due to the user not wearing the phone, as opposed to a technical error. This shows that compliance is the main issue relating to system failure.

Out of 11 patients, five patients stopped participating due to usability or comfort issues: phone too heavy and bulky to carry (3/5); deterioration of dementia illness—change of care method, i.e. no freedom at all (1/5); privacy reason—participant felt being monitored (1/5); self-care dementia suffer—too many worries (1/5); family felt the use of tracking was unnecessary, i.e. not practical enough (2/5); problems with private carers—extra work for the paid workers (1/5); participant registered blind during the course of the trial and dropped out (1/5); carers/relatives could not be asked! (1/5); too traditional, i.e. culture shock (1/5); participant found it repulsive to wear (1/5).

Participant compliance was determined by two factors: usability of the phone and participant comfort level. The majority of the participants (9/11) mentioned the large size and weight of the handset while 27% of the participants found the handset physically too demanding to carry. There was, however, a comment from a carer that the large size of the handset enhanced the wearability and made it easier to locate. Some carers found that the set-up procedures for the handsets were too much of an effort (4/11) while others found it easy (4/11) and three were undecided. For many it quickly became a routine (5/6). All relatives found the charging procedure easy although one complained about the short battery life (~16 hours). General comments were: too many buttons and functions (2/11); hassle for the carers (2/11); culture shock (2/11).

Discussion

Tagging gives an alarm when a person leaves a predefined area, e.g. their house. However, it does not tell you where they are. Tracking locates the person precisely. No previous studies have looked at electronic tracking using mobile phone technology and previous attempts using other technologies have been unsuccessful [2]. Electronic tagging has already been applied successfully [3]. The area is very controversial [4], mostly because human tracking technology has been widely adapted by authorities to monitor persistent offenders.

The ethical issues relating to tracking people with dementia were discussed extensively at the local research ethics committee before the trial began. It was felt that this technology, if successful, would be the least restrictive method of helping the problem of wandering in dementia and would be preferable to chemical alternatives. The Alzheimers Society has produced a policy document on electronic tagging and tracking which encourages this avenue of research [5].

The tracking system is theoretically limited by two factors: user compliance and technical constraints. User comfort level and the ability to operate the phone contribute to the amount of compliance. The ability of the phone to receive GPS signals as well as mobile service and the stability of the central computer software are factors that determine the effectiveness of the system from a technical perspective. Our investigations did not detect any technical problems with the system but user compliance was an issue.

Although small scale, the participant trials showed that when compliance is high, the tracking system was highly reliable and accurate. Most participants were located within 10 minutes of searching, although public transport and buildings did sometimes block the signal. If a person with dementia or wandering issues is wearing a phone with GPS capabilities, they can be located with confidence in a high proportion of cases. User compliance failed when the relative/carer did not have a grasp of how to set up the phone correctly. Participants and their relatives/carers who had trouble using the phone became frustrated easily, and this led to neglect and rejection of the system.

The GPS tracking system may need to be modified to accommodate a larger group of people. A simpler phone that is easier to use and more comfortable to wear may be necessary. When compliance is high, however, the system works well enough to be used as a reliable tracking device for dementia patients.

Key points

• Wandering is a common problem in people with dementia.
• We provided patients with a GPS-enabled mobile telephone.

Table 1. This table presents data collected from the six random walks performed by two participants in shoulder bag and waist carrying positions

<table>
<thead>
<tr>
<th>Trial ID</th>
<th>Carrying position</th>
<th>Distance walked (km)</th>
<th>Time taken (min)</th>
<th>Success rate—instantaneous (%)</th>
<th>Success rate—5 min intervals (%)</th>
<th>Success rate—10 min intervals (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SB*</td>
<td>N/A</td>
<td>N/A</td>
<td>80</td>
<td>96</td>
<td>100</td>
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<tr>
<td>2</td>
<td>SB*</td>
<td>9.4</td>
<td>155</td>
<td>92</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>SB*</td>
<td>10.2</td>
<td>135</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>WB*</td>
<td>11.5</td>
<td>165</td>
<td>73</td>
<td>91</td>
<td>94</td>
</tr>
<tr>
<td>5</td>
<td>WB*</td>
<td>10.0</td>
<td>110</td>
<td>96</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>40.1</td>
<td>565</td>
<td>88</td>
<td>97</td>
<td>99</td>
</tr>
</tbody>
</table>

SB: shoulder bag; WB: waist bag.
We can locate the phone to within 5 metres anywhere in the country.

This technology is the first to successfully locate people who are lost.

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**NHS Direct and older people**

SIR—The recent Joseph Rowntree Foundation publication, ‘Are you listening?’ [1], considers the provision of good services for older people to be dependent upon effective communication. This traditionally has meant face-to-face discussion with a health professional. However, the nationwide telephone medical consultation service, NHS Direct, is increasingly being recognised. For the cost of a local call, it has grown to become the world’s largest telephone helpline and is soon to play a pivotal role in out-of-hours health care (OOC) [2]. How NHS Direct engages older people remains uncertain. This study explores this new and developing relationship.

**Methods**

A 10% sample of patients aged 70 years and older was randomly selected for a postal questionnaire study (see Appendix 1 available as supplementary data on the journal website www.ageing.oupjournals.org) from a single general practice in the West Midlands. Those considered by the practice elderly care nurse as being acutely ill (hospitalised or terminally ill), from a nursing or residential home, or incapable of a meaningful response (even with help) were excluded from the postal list. Non-responders were not followed up.

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**Results**

A response rate of 60% was obtained when 312 questionnaires were returned from the 518 posted. Ages range from the starting criteria of 70 years, up to 100 years, with a median age of 78 years. Thirty-six per cent (112/311) were male and the majority, 98% (305/312), considered their ethnicity to be ‘white’. Almost all respondents had a telephone (306/307), although five did not provide a response.

When asked if they had heard of NHS Direct, over half the subjects (53%, 166/312) said they had, while 36% (113/312) said they had not. A further 10% (33/312) gave no response. Awareness of NHS Direct declines with advanced age: 26% in the 80 and over age group report awareness, compared with 53% in the 70–79 age group (P<0.001) (see Table 1). Subjects who had heard of NHS Direct were more likely to have driven a car in the preceding month and twice as likely to have access to a home computer. Those aware of NHS Direct were twice as likely to have a mobile phone, but no more likely to make more than an average number of calls a week. Conversely, they were less likely to have a care line or pendant alarm.

Of the 166 subjects aware of NHS Direct, 32% (53/166) knew the telephone number. When asked to write down this number, the majority (50/53) did so correctly. When asked where they had last heard of NHS Direct, most cited the television (33%, 55/160), followed by newspapers (22%, 35/160) and the radio (14%, 22/160). Friends acted as a source of information in 8% (13/160), family in 4% (7/160) and the television (33%, 55/160), followed by newspapers (14%, 22/160). Those reporting to know the number were more likely to cite a leaflet or newspaper as the information source: 24% (35/160) and health care workers in 2% (3/160) of cases. Those reporting to know the number were more likely to make more than an average number of calls a week. Conversely, they were less likely to have a care line or pendant alarm.

When subjects were asked who they think answers the calls at NHS Direct, 85% (129/151) of those aware of NHS Direct had a different opinion. A further 15% (22/151) thought others answered the call. Of those who thought someone else answered the call, the majority (126/146) thought a professional was involved.

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**Table 1. Comparing the characteristics of those who have, and have not, heard of NHS Direct**

<table>
<thead>
<tr>
<th></th>
<th>Not heard of NHS Direct</th>
<th>Heard of NHS Direct</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex</td>
<td>44/112 (39%)</td>
<td>61/166 (37%)</td>
<td>0.6</td>
</tr>
<tr>
<td>Age 80 or over (versus 70–79)</td>
<td>60/113 (53%)</td>
<td>42/164 (26%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Living alone</td>
<td>34/112 (30%)</td>
<td>43/161 (27%)</td>
<td>0.5</td>
</tr>
<tr>
<td>Driven a car in last month</td>
<td>43/113 (38%)</td>
<td>95/166 (57%)</td>
<td>0.002</td>
</tr>
<tr>
<td>Have access to PC</td>
<td>11/112 (10%)</td>
<td>42/161 (26%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Have access to internet</td>
<td>8/111 (7%)</td>
<td>31/162 (19%)</td>
<td>0.006</td>
</tr>
<tr>
<td>Have mobile phone</td>
<td>28/110 (26%)</td>
<td>75/163 (46%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Phone calls: 8 or more/week</td>
<td>55/107 (51%)</td>
<td>83/163 (51%)</td>
<td>0.9</td>
</tr>
<tr>
<td>Health considered poor</td>
<td>7/111 (6%)</td>
<td>18/166 (11%)</td>
<td>0.1</td>
</tr>
<tr>
<td>Have pendant, care-line alarm</td>
<td>22/109 (20%)</td>
<td>18/165 (11%)</td>
<td>0.03</td>
</tr>
<tr>
<td>Lonely often or very often (last month)</td>
<td>8/109 (7%)</td>
<td>9/164 (6%)</td>
<td>0.5</td>
</tr>
<tr>
<td>Questionnaire completed by another</td>
<td>29/113 (26%)</td>
<td>12/165 (7%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Carer for other (s)</td>
<td>6/112 (5%)</td>
<td>8/165 (5%)</td>
<td>0.8</td>
</tr>
</tbody>
</table>