

2007

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Attitudes and expectations of technologies to manage wandering behavior in persons with dementia

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W.D. Kearns, D. Rosenberg, L. West, S. Applegarth. Attitudes and expectations of technologies to manage wandering behavior in persons with dementia. Gerontechnology 2007; 6(2):89-101. **Purpose** Wandering is aimless or repetitive locomotion that may expose persons with dementia to falls, injuries, elopement, and untimely death. Using data from focus groups, this study obtained opinions on the potential effectiveness of existing technologies for managing wandering in persons with dementia living in the community, and on the elements that such technologies should possess from the user's perspective. **Design & Methods** Cross-disciplinary, consensus-based analysis was applied to data from 6 focus groups consisting of 7 elderly nursing home residents, 7 caregivers of persons with dementia, 9 home healthcare staff, 7 long term care staff, 7 medical surgical staff caring for dementia patients, and 6 engineers working in rehabilitation settings. Each group received a briefing on available technology for wanderer monitoring systems and elopement management systems. **Results** Participants in all groups wanted flexible systems that would allow for a normal daily life, accommodate to changes over time, and be inexpensive. Inside the home, motion detectors and weight-sensitive mats by doors were preferred over camouflage and other visual deterrents; outside, Global Positioning System based elopement management was preferred. For both technologies, ranges and sensitivities must be programmable and changeable as environmental and human conditions warrant. **Policy Implications** 60% or more of the 4.5 million Americans with Alzheimer's disease will wander and wandering predicts nursing home entry. The need for effective technologies to manage wandering in home and formal care settings is underscored by the high cost of nursing home care on the caregiver, his or her family, and government healthcare organizations. These technologies promise to delay nursing home entry and improve care but they must perform reliably, simply, effectively and inexpensively.

Keywords: wandering, cognition disorders, automation, data collection

Over four million Americans currently have Alzheimer's disease (AD) and this number is expected to swell to 10 million by 2020¹. An estimated 60% of dementia sufferers will wander², defined by Algate and Struble³ as meandering, aimless or repetitive locomotion potentially exposing the person with dementia to harm.

Unsafe wandering increases the risk for falling, injury, getting lost, and early nursing home placement and death³⁻⁹. When evaluated in formal care settings¹⁰, commercial wanderer management technologies have been shown to enable residents to access safe areas of their environment while preventing or discouraging them

from wandering into unsafe areas or leaving the facility¹¹. No published evaluations of the effectiveness of these technologies have been found for home use. Managing wandering at home becomes an increasingly salient problem for caregivers and policymakers as the maturing baby boom generation strains state and federal Medicaid nursing home budgets. Persons with dementia may suffer for many years^{12,13} and enter a nursing home (NH) early because they wander. Once transferred to formal care, the average annual NH cost exceeds \$49,000¹⁴.

Delaying NH entry may realize significant cost savings, and one strategy under evaluation is to provide home and community based services (HCBS) for persons with dementia at cost neutral reimbursement rates compared to NH care by using Title 1915c Medicaid waivers¹⁵. Successful HCBS may increase the time that the dementing disease's course occurs at home. Wanderer management technologies for the home will play an important role in HCBS management of dementia. In order to identify the optimal choices of existing technologies for wandering management in home settings, information is first required on user preferences and needs. Accordingly, this study convened several focus groups to gather opinions from persons that had experience with existing wandering technologies (non-demented patients or nursing staff in institutions caring for patients with dementia); experience with caregiving of persons with dementia at home; or experience with health care technology in home settings (rehabilitation engineers). In order that the various groups have similar information about wandering management technologies a briefing was prepared based on the material described below.

PRODUCT OFFERINGS

A survey of product offerings was conducted to discover the commercially available options available to caregivers.

Products from over 50 vendors of relevant technologies were surveyed using Internet sources, product brochures and the Thomas Register¹⁶, an Internet accessible product compendium. Over 97% were termed elopement management systems (EMS)^{17,18} that alert caregivers when wanderers leave monitored areas, may automatically lock doors, and/or incorporate radio frequency technologies to sound alarms. EMSs vary from stand-alone devices with local alarm coverage to sophisticated networked systems providing complete facility coverage.

Seven EMS subtypes were identified by Warner¹⁷:

- (i) Pressure activated systems respond to an external load applied to or removed from a pressure pad. These are usually floor mats laid next to the wanderer's bed, or before a doorway and stepping on the mat triggers an alarm. External pressure removed from a pillow, bed pad, or chair cushion may also trigger an alarm indicating the wanderer has moved. They operate at point of placement and may miss movement events if inadvertently relocated.
- (ii) Pull tab alarms connect a detachable tab to the wanderer's clothing and fix the monitor to a bed or chair. Movement pulls the tab from the monitor and sounds an alarm. Some play personally recorded messages instead of alarms to prompt the wanderer to sit down or return to bed. Their weakness is the connection to the person's clothing which may detach leading to missed detections.
- (iii) Audible Alarms. Door alarms sound when a door is opened or a wanderer traverses a doorway; some alert by triggering household lamps. Most cannot distinguish who passes through the doorway and give frequent false alarms. Advanced systems detect wristbands worn by the wanderer and alert caregivers only when the wanderer traverses the monitored doorway.
- (iv) Optically activated alarms alert when a wanderer approaches or traverses a monitored zone. Passive infrared technol-

ogy (PIR) motion detectors detect a wanderer up to 50 feet away and may trigger audible alarms or play pre-recorded messages. Others sound alerts if a wanderer interrupts a light beam when attempting to leave a bed. PIR is usually reliable but works by detecting body heat, and so may miss events in warmer rooms.

(v) Visual deterrents may be large bright warning signs (STOP or DANGER) stretched across a doorway to deter passage, and may sound an audible alarm if the barrier is crossed. They may also be camouflaged wallpaper depicting bookshelves or kitchen pantries that make the discovery of a doorway difficult for wanderers.

(vi) Tracking systems locate wanderers before or after elopement, and are either radio frequency (RF) range finding¹⁹ or global positioning systems (GPS). RF systems use transmitters worn by the wanderer and tracked by a hand-held device which triangulates location over a range of 1.6-64.4 km. GPS systems combine satellites, wireless networks, and the internet to precisely locate a wanderer and may have national coverage. The wanderer wears a transmitter shaped like a watch, pager, ankle bracelet or a box-like device in a fanny pack or rucksack and is located by computer, mobile phone, PDA, or central monitoring station. Tracking devices may provide the position of a wanderer at any moment, report if they have fallen or be an EMS if linked with alarm systems. Some GPS systems developed as house arrest solutions or locators for lost children have been adapted to senior populations.

(vii) Advanced systems incorporate many features into one multifunction device to monitor a predefined area and activate an audible or visual alarm or send the caregiver digital messages via e-mail or pager when a wanderer leaves. Some lock external doors and most require transmitters be worn to differentiate wanderers. They are sophisticated technologies requiring stable power sources and trained caregivers for successful operation.

METHODS

Research team and focus group protocol

Six focus groups sessions (described below) lasting approximately 90 minutes were conducted at the James A. Haley VA Hospital (JAHVAH) in Tampa, Florida. The group moderator was a PhD anthropologist with over 20 years of experience conducting qualitative research in healthcare settings; assistants had graduate Public Health coursework. Each session followed a sequence of introductory and closing statements, open-ended questions and instructions for a pen-and-paper exercise.

The convenience sample of participants was chosen from six target groups named below. The six to eight participants who attended each focus group received refreshments and a \$20 gift certificate. Caregivers (n=6) were spouses or adult children with at least three months experience caring for a person with dementia at home. Some caregivers were currently caring for a person with dementia while for others their care recipient had died previously.

Home healthcare staff (n=9), long term care staff (n=7) or medical surgical staff (n=7) from the JAHVAH were nurse practitioners, registered nurses, licensed practical nurses, certified nursing assistants, social workers, occupational or physical therapists, with a minimum of two years experience in geriatrics. They possessed direct experience working with persons with dementia, and some of them may have had some experience with wandering control technologies. NH residents (n=7) were over age 70 with no cognitive or physical impairment preventing their participation. Residents were not required to have experience caring for persons with dementia or have personal experience with wanderer control technologies; their opinions were sought because they resided in a nursing home where persons with dementia and wanderer management technologies were both present. Engineers (n=6) were recruited from the University of South Florida's College of Engineering

and Center for Microelectronics Research, and facility engineering technicians from the JAHVAH who had at least one year experience in their discipline, equipment design, maintenance or repair. Engineers were not required to have experience designing or installing technologies to control wandering but their opinions were sought on technical feasibility and limitations of wanderer management technologies. However, a few had opinions about wandering technologies based on personal experience with older relatives. The composition of the focus groups appears in Table 1.

Data collection protocol

The moderator and at least one assistant ran each session. Groups were audiotaped for later transcription; one assistant took notes on an easel facing the group allowing them to comment, add, or disagree with the contents, while another recorded group dynamics, quotes, and other observables. The moderator first obtained informed consent, explained the study's purpose including the role of technology to monitor or prevent wandering and asked participants whether they had any experience using wandering technologies. Next, an investigator with an engineering background gave a presentation on wandering technologies with animated examples derived from the product review, and answered technical questions. The moderator then began the discussion portion with a question, "What are your initial thoughts on wandering technologies?" followed by the questions from the focus group guide presented in Table 2.

The moderator used prompts as needed to generate group discussion, validate key points, and more specific questions to prompt discussion. At the close of each group the moderator summarized main points, asked if the summary was correct, and solicited additions or changes.

Analytic method

The analysis of qualitative data stresses a 'logic of discovery', to develop concepts, generalizations and theories²⁰. Notes and tapes from each session were transcribed into MS Word files, which were then re-organized so that the answers to the same question from all groups were combined and could be compared to each other to reveal patterns, similarities, and themes running through them. This process generated the level I or 'in vivo' codes describing the idealized characteristics the participants believed wandering technologies should possess. As level I codes were identified they were compared and combined to form higher level II codes describing the relationships between level I codes. As new data were collected, the researcher analyzed it with the previously collected data in mind²¹ and queried herself and the research team on commonalities and differences in participants' experiences, what was suspected and confirmed by the data about the types and necessary characteristics of wandering technologies and, more importantly, what were the unanticipated discoveries²².

Data quality

To ensure data quality the data were (i) analyzed after each group to develop subse-

Table 1. Focus group composition

Group membership	Males	Females	Mean age (SD)
NH residents	7	0	76.6 (6.21)
Family caregivers	0	7	71.9 (9.82)
Home healthcare staff	2	7	52.3 (7.91)
Long term care staff	1	6	44.0 (10.45)
Medical surgical staff	1	6	43.1 (6.82)
Engineers	6	0	42.2 (14.74)

quent questions to prompt discussion and modify existing ones as needed, although initial queries were unchanged, (ii) audio recordings of focus groups were transcribed; and (iii) analysis was conducted by two investigators and referred to the others for content validation. The team agreed how to code the data, their meaning, and the categories they represented, meeting the requirements for validity, reliability, and objectivity. A carefully managed data audit trail²³ allowing an independent auditor to evaluate the process and product of the research was created

consisting of: (i) organized files of audio-tapes, transcripts, field notes, and artifacts, (ii) electronically stored data including the analytic structure, (iii) organized files of analytic notes, concepts, and working hypotheses, (iv) methodological notes, and (v) organized personal notes and reflections about the progress of the study^{23,24}.

RESULTS

Only NH residents and long term care staff reported experience with wandering technologies and only in institutional settings, but there was surprising consensus

Table 2. Focus group content areas sampled in focus groups on wandering technologies

General questions

What are your initial thoughts on wandering technologies?
What functions should a wandering technology have?

Tracking systems

Definition: A tracking system electronically follows a person who wanders from home and helps them return safely. It may not register an alarm but provide purely informational data to the caregiver

- What are your initial thoughts on wandering tracking systems?
- What basic functions should a wanderer tracking system contain?
- How far should the wanderer tracking system range extend?
- How should the tracking device be attached to the wanderer?
- Who should be allowed to reprogram the tracking device?
- Who should be notified when the wandering tracking device detects wandering behavior?
- How should the person responsible be notified when wandering occurs?
- How sensitive should the tracking device be? Should it catch all wandering, or should it be allowed to miss some?
- What should the lifespan of the tracking device be?
- What services should be linked to the tracking device?

Elopement management systems

Definition: This system gently prevents a person from leaving home unsupervised but it may make use of tracking system capabilities to meet that goal

- What are your initial thoughts on elopement management systems?
- What basic functions should an elopement management system contain?
- How far should the elopement management system range extend?
- Should any portion of the elopement management system be attached to the wanderer? If so, how?
- How should the system be reprogrammed?
- Who should be notified when the elopement management system attempts to stop the wanderer from eloping?
- How should the person responsible be notified when an attempted elopement occurs?
- How sensitive should the elopement management device be? Should it catch every incident, or should it be allowed to miss some?
- What should the lifespan of the device be?
- What services should be linked to the elopement device?

among all groups on characteristics elopement management systems and tracking systems should have and their functions; but respondents did not differentiate the systems and spoke of each interchangeably. The results for each content area therefore present opinions covering both systems first and any opinions specific to elopement management or tracking systems second.

When asked their initial thoughts on wandering technologies group members agreed no approach in isolation would prevent wandering, but advocated overlapping elopement management and tracking systems in a strategy reminiscent of Reason's²⁵ 'Swiss-cheese' model for preventing errors in aviation; any 'hole' in one method is addressed by a different method's strength. Cost of the technology was a significant concern for all groups; they thought those most needing these systems lived on limited incomes, and Medicare and Medicaid did not cover the costs of wandering technologies. They also stressed that no technology could replace the caregiver but only support them.

For elopement management systems, nearly all thought the simplest techniques, such as camouflaging doors and warning signs, would quickly become ineffective once the wanderer discovered the deception or ignored them. Several mentioned that veterans with past training in specialized escape methods could pose significant problems, and cautioned that elopements will occur with the best systems if the wanderer is determined.

When queried on common design elements each system should possess, respondents agreed elopement management or tracking systems should be waterproof, portable, adaptable, flexible, and easy to use. Several mentioned elopement management systems should be easy to turn on and off, permitting easy entry of visitors and running errands. The caregiver and

engineering groups suggested alarms be distinctly different for inside and outside the house and should be carefully chosen to not annoy or agitate the wanderer. They suggested flashing lights, music, or recorded instructions in a familiar voice to the wanderer as substitutes: "...perhaps an audible sound that says 'you're leaving the living room, or you're entering the laundry room' so more than just the sound it's a instruction or a sequence of phrases that informs the person what's happened. ...if you see a child running you instead of telling them 'don't run', the opposite is to say 'walk' which is slightly different. You're telling them not to do something you're also informing them what they should be doing."

Respondents did differentiate elopement management systems and tracking systems regarding the range over which the systems should operate. The NH resident group suggested an elopement management system (perimeter alarm) should have a range from 45.7-68.6 m outside the home. The optimal range for GPS based tracking systems, which were the only type discussed in any depth or considered worthy of discussion, were much greater. Caregivers, NH residents, and healthcare staff had stories of wanderers traveling large distances far more rapidly than considered possible. When asked for an ideal range for a tracking system, some volunteered distances, but all seemed to wonder why their opinions about ranges were requested when they knew GPS coverage was worldwide. To the contrary discussants wanted to know a wanderer's location to within a few feet in an 'off-limits' section of the home, and how GPS technology would work in public places such as shopping malls.

Discussion of the problems encountered when attaching elopement management and tracking systems to a wanderer focused on common metallic spring clips that are too easily removed by wanderers

but required more dexterity than a caregiver had; it was suggested some consideration be given to redesigning the clips. All groups mentioned the desirability of having several means to 'attach' a device to a wanderer because none would be universally acceptable and over time a wanderer's deteriorating condition would require the characteristics of the device used for managing wandering to change. In early stage dementia, an inconspicuous device resembling a common necklace pendant (for females) or a watch (for males) was thought preferable; it would not 'mark' or stigmatize the person as having an illness, disability, appearing to be under house arrest, or otherwise exceptional. In moderate and late stage dementia keeping the device on the wanderer would be more important than inconspicuousness, however. An inconspicuous device should be attached to a part of the body not easily viewed or reached; the device should not be shiny or colorful, but blend with the wanderer's skin tone to attract minimal attention from the individual. Nearly every respondent requested that devices which look like watches also tell time, and one group suggested adding a 'walkie-talkie' feature to allow real-time communication between wanderer and a caregiver or a remote care-giving service such as Life Alert^{®26}. Home health care respondents suggested the watch device use pre-recorded caregiver audio prompts telling the wanderer to return home when they attempted to leave a safe area. Such a complex device would be appropriate for persons whose cognitive functions allowed independent living, and who were oriented to their surroundings, communicative, capable of understanding and responding to directions, and would not be disoriented by a voice emanating from their watch. Other suggestions were to miniaturize the device and sew it into the wanderer's clothing, place it in the heel of a shoe, or in the wanderer's eyeglasses. Every group mentioned implanting a "tracking chip" in the wanderer; but the engineering group

stated that power sources for "tracking chips" are currently problematic but noted their increasing role as identification devices for lost pets. It was evident "implantables" would be acceptable to many caregivers even if they functioned only as a method of identification. While a few NH residents did express privacy and autonomy concerns about implanted devices, most did not share those views. When the moderator asked, "That's an implantable device. Would you be willing to be implanted with something?" one NH resident replied "Why not? They want to put a defibrillator in me." When the moderator brought up the privacy issue in other groups, it was quickly dismissed as secondary. Implantable RFID microchip technology (VeriChip)²⁷ has received US Food and Drug Administration approval for human use and will soon be available for those who choose it. Welsh et al.²⁸ present an excellent summary of ethical issues associated with electronic monitoring of the elderly with dementia and caution against the role technology may play in dehumanizing persons with disabilities by enabling reductions in staffing essential for providing proper care. They contrast this negative view with the liberating role technology may also play in enabling persons with dementia to live more independent lives.

When attaching tracking systems to a wanderer, respondents felt a device should weigh no more than 113 g if attached to an arm or leg, but it could weigh 227 g if the device was worn on a belt.

The respondents agreed sensitivities and ranges of elopement management or tracking systems should be programmable by the caregiver to permit fine-tuning for changing circumstances, domicile, wanderer needs, and stage of dementia; a wanderer at a given dementia stage might be considered safe only in a specific part of the home, inside the entire house, or part of the property. When one participant in

a group mentioned it, the rest concurred: an elopement management or tracking system should be portable and programmable allowing wanderer and caregiver to visit friends and relatives even if they move between seasonal residences. All agreed caregivers who had anxiety or difficulty adjusting parameters should have technicians available for consultation.

There was consensus that caregivers should be the first notified when a wandering technology was triggered, followed by others as specified by the caregiver including family members, nearby neighbors, or emergency personnel: *"Like a cascade, no answer, go to the next, no answer go to the next, no answer go to a neighbor, no answer call 911"*.

Telephone calls were the favored method of notification by respondents, although some suggested pagers or email.

Respondents voiced no opinions about the sensitivity of tracking systems but agreed overly sensitive elopement management systems could be problematic. Doormats triggered by pets and small children, and pull tab systems whose short leads generate false alarms are examples. Nurse respondents indicated numerous and frequent alarms may go largely unnoticed in hospital settings: *"What I like about the Wander Guard, and I don't know if you could have it in a home situation, is that it locks our doors when they go by it, because what has happened is that we've become kind of 'la de da' about hearing the alarm go off and acting on it, but even though we don't act on it immediately, the doors are locked and they can't get out."*

The opinions about lifespan of the elopement management systems and tracking systems were uniform; respondents thought the battery life should be 1-3 years, but the technology "hardware" itself should last 5-10 years.

Finally, respondents opined on what services should be linked to the elopement management and tracking systems. The merits of different types of medical monitoring or alerting networks such as 'Safe Return'²⁹, which employ a centralized system notifying caregivers or others as necessary were discussed. One suggestion was a specialized 'Amber Alert'³⁰ type system using the Internet or local media to display photographs and descriptions of the wanderer so that citizens can assist in their recovery. Several groups discussed the merits of adding wandering behaviors to Life Alert^{®26} systems, including wandering among the medical conditions this organization monitors.

DISCUSSION

Despite their small sizes and varied perspectives the members of all groups agreed in large part on what a wandering technology should do, how it should do it, and on technical specifications. Within each group, participants identified a single continuum of care and recognized the need to prevent wandering and its dangerous sequelae, such as getting lost, and be ready for it when it inevitably happened. The respondents' idealized single system was an inconspicuous multifunction device that could be programmed by the caregiver for any given domicile and would verbally cue the wanderer to return when they attempted an elopement. Its range of operation would be national and it would notify caregivers, their surrogates, and selected service providers of elopements via telephone, email or pagers. Finally, it would weigh no more than 227 g, have a lifespan of 5-10 years, a battery life of 1-3 years, and be waterproof.

The preferred technologies whose functions might be incorporated in an idealized device were motion detectors and pressure-sensitive mats by doors to prevent elopements, and GPS functionality for locating wanderers once they had eloped. GPS technology was the only

tracking system considered acceptable and groups had widespread awareness of its integration into vehicles (OnStar), telephones (E-911 emergency locator services) and mobile wireless devices, doubtless enhancing its appeal. Mobile wireless devices' potential to aid rehabilitation and enable independent living for persons with disabilities is drawing increasing attention³¹. Patterson, Etzioni, Fox, and Kautz's³² GPS enabled "Activity Compass" has been demonstrated to provide location-aware assistance for persons with memory deficits by audibly prompting appropriate behaviors at defined areas; and our home-health care group suggested recorded prompts presented in familiar voices would have the best chance of influencing wandering behavior. Recorded voices used by Hart et al.³³ in portable electronic reminders for persons with moderate to severe traumatic brain injuries and memory deficiencies were found to be preferred by their subjects to other modalities. Use of voiced prompts cued to location is increasingly attractive since audio data storage in digital hand-held devices has recently increased dramatically.

Our respondents' apparent lack of concern about privacy issues and GPS tracking systems surprised us; the prospective value of GPS to recover an eloped wanderer far outweighed privacy concerns. Although none mentioned it, their acceptance might likely be traced to increased public awareness and acceptance of ubiquitous tracking systems present in today's telecommunications networks and transportation systems. For example, although not widely publicized, 'E-911' rules adopted by the Federal Communications Commission in 1996³⁴ require cellular telephones to automatically and surreptitiously reveal their location to an accuracy of 30.5 m when prompted by authorities. However, our engineer group cautioned against GPS use in large buildings like shopping malls where reflected GPS signals prevent accurate tracking.

A major concern was cost; all feared the most advanced technology would be cost prohibitive for the neediest. Insurance does not cover wandering technologies so those products under development must fit tight caregiver budgets. Given 'low tech' camouflage, diversion, and physical barriers were considered of limited value, access to more expensive technologies like GPS becomes a major hurdle. The research literature^{35,36} supports the effectiveness of inexpensive camouflage in managing wandering in nursing homes, so further study to determine if our groups' negative perceptions were due to differences in home vs. institutional populations or inadequate training in the use of these devices is warranted. Indeed, our groups' VA Hospital system affiliation may limit the generalizability of their opinions to the overall population. Broadening the composition of the focus groups to include police officers and rescue emergency service personnel would include the opinions of other professionals having considerable experience in retrieving persons with dementia who wander away from home or institutional settings and become lost. Also, a significant group of stakeholders whose opinions were not sampled in this study were persons with dementia themselves. Their attitudes towards these technologies, informed by a vested interest in the future use of the technology may have included attitudes differing considerably from our focus group of elderly veterans recorded at the nursing home setting. Indeed, the care setting may also impact the focus group results for those persons with dementia who opine on appropriate technologies. Persons receiving care in assisted living facilities may differ in opinions from those residing in nursing facilities on which technologies are most appropriate for managing wandering behavior. A further limitation of this study was that we did not address issues related to transportation such as becoming lost while motoring or those caretaker actions which may be taken to selectively disable a vehicle.

Technology costs may encourage vendors to offer mostly inexpensive alternatives to the public, forcing HCBS administrators of wanderer management services to use them or their expensive alternatives designed for use in nursing homes, with few options offered in-between. Yet as HCBS wanderer management services increase they may also spur vendors to offer a greater variety of technologies. Policy-makers assessing effectiveness and cost benefit ratios for these technologies must include costs borne by emergency rescue and law enforcement agencies that retrieve lost wanderers. These costs are substantial; Koester³⁷ cites 16% of all search and rescue calls in Virginia are initiated for the retrieval of missing elders. However, financial costs alone do not reflect suffering by caregivers and family members pondering their missing loved one's fate. Paradoxically, Silverstein, Flaherty and Salmons-Tobin³⁸ have observed that caregiver concerns and appreciation of the risk of elopement and becoming lost are unrelated to the enrollment of an at-risk elder in programs like "Safe Return" that employ a number of methods and technologies to identify, find and recover individuals who become lost. Some caregivers have been observed to come to rely upon the services of police officers as a first order anti-elopement strategy rather than taking more appropriate steps to protect the elder in their care.

A pervasive theme running throughout the study was technology could only support and never replace a caregiver. Discussions always reverted to how a device could assist a caregiver but never how it would allow a wanderer to regain independence, a viewpoint supported elsewhere³⁹. Technological assistance, while welcomed by our caregivers, would not replace needed human assistance and respite care, and when asked our caregivers indicated their sleep was always disrupted. All groups having direct contact with wanderers supported connecting tracking systems to a 'LifeLink'⁴⁰ type 24 hour monitor-

ing service with a knowledgeable human attendant available by telephone that would be notified when an elopement or emergency situation arose. Currently the Alzheimer's Association's Safe Return program maintains a 24-hour service uniquely tasked with finding and returning persons with dementia who become lost. Safe Return has returned over 11,000 individuals to their families and boasts a 99% success rate⁴¹. The Alzheimer's Association works closely with legislators to shape policy and provides training and support to law enforcement to assist in recovery efforts. Safe Return's 24-hour service could potentially integrate automated tracking system data with its recovery efforts so that an attendant with vital medical information about the lost wanderer could notify the relevant emergency and rescue services of the elder's location. However, there are no plans for integrating tracking systems with Safe Return at this time, partly because signal strength in current wireless tracking systems varies with the placement of the antenna on the body and other environmental factors that affect location accuracy⁴². A suggested extension by our focus groups was an 'Amber Alert'³⁰ for wanderers: local and/or regional media would distribute alerts, and an email 'tree' would be activated to assist in the wanderer's recovery. However, the Alzheimer's Association Safe Return program is considerably more tailored to the specific requirements for finding and returning a lost elder and these requirements differ considerably from those employed to retrieve missing children and may inadvertently result in added stigma.

The technologies described must have their in-home efficacy validated, and an essential first step is a common metric allowing comparisons of technologies whose heuristics may differ dramatically (i.e., pressure pads, camouflage and door alarms). Objective measures of the deterrent effect of some technologies might include the percent reduction in time wanderers

spend near exits, or declines in entries into areas protected by a technology.

FUTURE DIRECTIONS

Smart house technology that integrates data from its sensor networks can determine the services required by elderly residents at a given place and time (location based services). An example of a system under development is Honeywell, Inc.'s 'CareWatch', which uses a modified home security system to track persons with dementia in the home and alert caregivers to behaviors predicting impending elopement and becoming lost. Honeywell's approach uses conventional home security sensors (wired switches, passive infrared receivers, etc.) located in the rooms of interest, however, the system is incapable of differentiating individuals based on this information alone.

An alternative to Honeywell's approach is to use wearable powered ultra-wide-band radio frequency identification tags (UWRFID)⁴³ capable of broadcasting hundreds of meters, and having a form factor similar to a wristwatch. Three permanently mounted antennae on two walls in the home can determine the identity and vector of the wearer as often as twice per second for periods up to 1 year and give the wearer's location to within 15 cm in three axes. Because powered UWRFID

systems can be installed without major building renovation they will likely appeal to owners of older homes. The enhanced accuracy of position and identity inherent in this UWRFID approach will enable location based services to be more accurately delivered to frail elderly who are clearly identified by the technology. The miniature tags themselves are computers capable of gathering data (i.e., acceleration, temperature, pulse, etc.) and transmitting it to the receiving site for analysis or action contingent on specific readings. Their range may extend some distance beyond the home.

We conclude by requesting product designers be cognizant of human factors limitations when designing technologies for elders whose sensory, cognitive, and physical characteristics differ vastly from younger persons. It is seldom possible to take a technology created for one market (i.e., corrections or livestock management) and migrate it to another market (geriatrics) with equal impact, yet this approach is being attempted by some manufacturers of GPS based 'house arrest' or livestock tracking systems. All products must have their comparative effectiveness for managing wandering assessed in differing caregiving contexts in order for consumers and policymakers to make informed choices.

Acknowledgements

This research was supported by the University of South Florida Health Sciences Center Patient Safety Pilot Grant Research Award Program and conducted at the James A. Haley Veterans Administration Hospital in Tampa, Florida. The authors acknowledge the expertise and support of the International Research Consortium on Wandering in the development of this manuscript, and would like to thank the reviewers of this manuscript for their invaluable assistance.

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