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A qualitative study of in-home robotic telepresence for home care of community-living elderly subjects

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Summary
We examined the requirements for robots in home telecare using two focus groups. The first comprised six healthcare professionals involved in geriatric care and the second comprised six elderly people with disabilities living in the community. The concept of an in-home telepresence robot was illustrated using a photograph of a mobile robot, and participants were then asked to suggest potential health care applications. Interview data derived from the transcript of each group discussion were analyzed using qualitative induction based on content analysis. The analyses yielded statements that were categorized under three themes: potential applications, usability issues and user requirements. Teleoperated mobile robotic systems in the home were thought to be useful in assisting multidisciplinary patient care through improved communication between patients and healthcare professionals, and offering respite and support to caregivers under certain conditions. The shift from a traditional hospital-centred model of care in geriatrics to a home-based model creates opportunities for using telepresence with mobile robotic systems in home telecare.

Introduction

Robotics in health care are generally viewed as a way of helping people who have lost some of their physical or mental abilities to maintain a degree of autonomy.[1,2] There are three main applications of robotics in healthcare: assistive rehabilitative devices based on mechatronic technology that can be used for robot-assisted movement training in rehabilitation therapy;[3-6] assistive manipulator robots based on robotic arms on a mobile base that can be used to control equipment or grasp objects;[1,7] and autonomous mobile robots that can run errands to and from pre-designated rooms, patrol, verbally remind people about events and collect data.[8,9]

We have examined the needs for robots in home telecare.

Methods

A user-centered design strategy was chosen.[10] A trained moderator conducted focus group interviews with two groups: the first were six healthcare professionals (HP) and the second were six community-living older adults with disabilities (CLOA). The study was approved by the appropriate ethics committee and participants gave their written informed consent prior to the focus group interviews. The discussions lasted for 75-120 min.

Composition of the focus groups

Participants in the HP group were selected from healthcare professionals working in the Sherbrooke Geriatric University Institute network using a purposive sampling strategy to bring together a diverse group of participants. Participants in the CLOA group were selected from a database of older adults with disabilities living in the community who had previously participated in research projects at the Research Centre on Aging in Sherbrooke. Participants were selected according to their living situation (e.g. living in a house, apartment, assisted living), functional status and age in order to ensure a representative group of users.

The participants in the HP group were various professionals with an average of 18.5 years of experience (Table 1). The participants in the CLOA group were aged 68-92 years and most lived with a spouse or family members in rented or owned housing. Disability scores on the SMAF scale (Functional Autonomy Measurement System)[11] for CLOA participants varied from -4 to -18 out of a total disability score of -87 and were linked to physical impairments secondary to musculoskeletal (arthritis, hip fracture) neurological (stroke and postural imbalance) and vascular conditions (diabetes). The SMAF is designed for clinical use in connection with a home support programme or for admission and monitoring of clients in geriatric services and residential facilities. The median total SMAF score varies according to living environment (-13.5 own home, -29.0 intermediate resources and -55.0 long-term care institutions) and nursing care time. A disability score of -20 corresponds to 43.4 min per day of nursing care time.

Data collection

Interview guides for each focus group were written beforehand and followed by the moderator. The interview questions progressed from general topics to specific topics related to the concept of an in-home robotic telepresence. First, pre-selected and open-ended questions were used to generate discussion amongst participants about contextual topics such as: (1) factors that can contribute to the loss of autonomy of elderly people living at home; (2) strategies used to maintain autonomy and prevent disability; and (3) the use and impact of technology in maintaining autonomy and preventing disability for elderly people living at home. Second, after establishing a discussion on the use of technology to help maintain autonomy and prevent disability, the moderator introduced the concept of an in-home telepresence (i.e. technology that enables users to hear, see and interact with each other and their environments at a distance) and asked participants what uses they envisaged for this type of technology in the home. Third, the concept of an in-home robotic telepresence was illustrated using a photograph of a mobile robot, and participants were then asked to suggest potential applications. Finally, the discussion was oriented toward the identification of potential issues in the use of an in-home mobile robotic telepresence and positive outcomes related to its use. Questions were elucidated for the two target groups by trying to formulate similar questions from slightly different perspectives. The discussions at each focus group interview were video recorded. The audio recordings were transcribed verbatim and checked for accuracy prior to data analysis.

Data analysis

Interview data derived from the transcript of each group discussion were analyzed using qualitative induction based on content analysis. The categories, dimensions and sample units of information for the content analysis of the transcripts were established by emergent coding.[12] Prior to coding, the categories and dimensions were formally defined after independently reviewing the transcripts. The interpretation of the data (unit of information) with respect to the defined categories was tested with two coders on a sample of transcripts for each target group. The categories were revised and coders were trained until there was 80% agreement between coders in independent coding tests on 10% of the text units for samples from each focus group. Text units with common nodal headings within a transcript were analyzed with qualitative

induction. Concepts and broad ideas from each text unit within a common nodal heading were formulated and summarized as statements.

Results

The results from the content analysis of the focus group interviews were summarized under three headings:

Potential applications

The use of robotic telepresence for telehealth interventions in a home environment was perceived by healthcare providers and community-living older adults with disabilities as a means of accomplishing specific tasks such as: (1) facilitating the provision of care for older adults living at home; (2) enhancing their safety; and (3) giving caregivers some respite and support. A robotic telepresence service would not replace healthcare professionals or family members, but could supplement them in providing care. The potential applications for robotic telepresence are summarized in Table 2. Robotic telepresence was also seen as a way of reducing the travel time of healthcare professionals, especially for interventions that are of short duration (e.g. monitoring of injuries, verification and follow-up with the family).

Usability issues

Usability issues for robotic telepresence are summarized in Table 3. The principal concern of both groups of participants was the use of cameras on the robot and the potential effect on their privacy. The size of the unit was also an issue as there were doubts about the operability of the mobile robot in small cluttered spaces. Community-living older adults with disabilities questioned the cost and financing of the service and were doubtful about its usefulness in the context of institutionalized care. Health professionals voiced ethical concerns related to the eventual need to obtain clear consent from third parties interacting with the patient when the robotic telepresence solution was employed. They were also concerned that telepresence could replace human resources for senior citizens, limit social contacts and create dependency on it.

User requirements checklist

User requirements were easier to elicit from the healthcare professionals than the community-living older adults with disabilities. They are summarized in Table 4. Most of the user requirements mentioned were related to the operation and control of the mobile robot in the home. Specifically, the need to create a security perimeter around the robot to avoid increasing the risk of the patient falling and an efficient kill override of the unit for patients and/or third parties were identified. The quality of the audio/video communications, the physical appearance (size) of the system, its user-friendliness and its reliability were listed as key factors in the development of a prototype. Concerns were also raised about the noise generated by the unit when in operation.

Discussion

Participants in the two groups were unfamiliar with the following concepts: home telecare, telerobotics and teleoperation. They had great difficulty imagining how an in-home robotic telepresence could be used in home care. As a result, responses on this subject were more difficult to obtain than answers to questions on contextual topics related to the loss of autonomy. This was more acute in the CLOA group as the study participants' understanding of the concepts of an in-home robotic telepresence in relation to their current needs was incomplete, even after numerous attempts by the moderator to guide the discussions. This problem has been noted before.[13]

From statements about potential applications, the concept of using an in-home robotic telepresence to support virtual home visits by health professionals and offer respite services emerged. Preventive home visit programmes are based on the concept that a decline in functional status can be delayed or prevented by periodic multidimensional geriatric evaluation to detect modifiable risk factors.[14] Respite service are aimed at decreasing caregiver burden, providing caregiver education and training, avoiding or delaying institutional placement, linking caregivers and care recipients to other community services, and preventing unnecessary hospital admissions.[15] Respite service is also seen as a way of providing periods of relief for caregivers. It seems plausible that teleoperated mobile robots could facilitate these two applications and fill a complementary position between hospital and home-based evaluations.

Concerns were expressed about the privacy of people (e.g. can a user control the system and turn it off and on?) and the privacy of information. These were also reported by Blanchard[16] as potential ethical issues raised by home monitoring in an aging population. Similar findings resulted from focus groups reported by Demiris *et al*.[17] The appearance (size) and operation noise of the components of the in-home robotic telepresence system were identified as key factors to be considered in the development of future prototypes. These observations are in line with studies that have reported that equipment characteristics are one of the determining factors for the perceived intrusiveness of home monitoring devices.[13,18] We have taken this into account in planning our own prototype (Figure 1).

Conclusion

The shift from a traditional hospital-centred model of care in geriatrics to a home-based model creates opportunities for using telepresence with mobile robotic systems in the context of telehome care. Results from focus group interviews with healthcare professionals and community-living older adults with disabilities suggest that the perceived capabilities offered by teleoperated mobile robotic systems in the home could be used to assist multidisciplinary comprehensive patient care through improved communication between patients and healthcare professionals and offer respite to caregivers.

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References

1 Forlizzi J, DiSalvo C, Gemperle F. Assistive robotics and an ecology of elders living independently in their homes. *Int J Hum Comput Interact* 2004; **19**: 25-59

2 Heck H, Prentza A, Peruchon E, *et al*. User requirements for robotics in health care and rehabiliation. In: Katevas N, ed. Mobile robotics in healthcare. Amsterdam: IOS Press, 2001: 17-44

3 Burgar C, Lum P, Shor P, Machiel Van der Loos HF. Development of robots for rehabilitation therapy: the Palo Alto VA/Stanford experience. *J Rehabil Res Dev* 2000; **37**: 663-73

4 Fasoli SE, Krebs HI, Stein J, Frontera WR, Hogan N. Effects of robotic therapy on motor impairment and recovery in chronic stroke. *Arch Phys Med Rehabil* 2003; **84**: 477-82

5 Hesse S, Schulte-Tigges G, Konrad M, Bardeleben A, Werner C. Robot-assisted arm trainer for the passive and active practice of bilateral forearm and wrist movements in hemiparetic subjects. *Arch Phys Med Rehabil* 2003; **84**: 915-20

6 Stein J, Krebs H, Frontera W, Fasoli SE, Hughes R, Hogan N. Comparison of two techniques of robot-aided upper limb exercise training after stroke. *Am J Phys Med Rehabil* 2004; **83**: 720-8

7 Driessen B, Bolmsjo G, Dario P. Case studies on mobile manipulators. In: Katevas N, ed. *Mobile Robotics in Healthcare*. Amsterdam: IOS press, 2001: 271-93

8 Graf B, Hans M, Schraft RD. Care-O-bot II - Development of a next generation robotic home assistant. *Auton Robots* 2004; **16**: 193-205

9 Pollack M, Brown D, Colbry C, *et al*. Pearl: a mobile robotic assistant for the elderly. In: *Workshop on Automation as Caregiver: the Role of Intelligent Technology in Elder Care (AAAI)*. Edmonton, Alberta: AAAI Press, 2002: 85-91

10 Bray I. *An Introduction to Requirements Engineering*. Harlow: Addison-Wesley, 2002

11 Hebert R, Guilbault J, Desrosiers J, Dubuc N. The functional autonomy measurement system (SMAF) : a clinical-based instrument for measuring disabilities and handicaps in older people. *Geriatrics Today* 2001; **4**: 141-58

12 Krippendorff K. *Content Analysis : An Introduction to its Methodology*. 2nd edn. Thousand Oaks: Sage, 2004

13 Mann W, Marchant T, Tomita M, Fraas L, Stanton K. Elder acceptance of health monitoring devices in the home. *Care Manag J* 2001; **3**: 91-8

14 Stuck A, Egger M, Hammer A, Minder CE, Beck JC. Home visits to prevent nursing home admission and functional decline in elderly people: systematic review and meta-regression analysis. *JAMA* 2002; **287**: 1022-8

15 MontgomeryRJV. Examining respite care: Promises and limitations. In:
Kane RA, Penrod JD, eds. *Family Caregiving in an Aging Society: Policy Perspectives*. Thousand Oaks: Sage Publications, 1995: 22-45

16 Blanchard J. Ethical considerations of home monitoring technology. In: Mann WC, Helal A, eds. *Promoting Independence for Older Persons with Disabilities (Assistive Technology Research Series, Volume 18)*. Amsterdam: IOS Press, 2006: 121-6

17 Demiris G, Oliver D, Fleming D, et al. Hospice staff attitudes towards telehospice. *Am J Hosp Palliat Care* 2004; **21**: 343-7

18 Fisk M. Telecare at home: factors influencing technology choices and user acceptance. *J Telemed Telecare* 1998; **4**: 80-3

Table 1. Sociodemographic characteristics of participants in the focus group interviews for the two target groups.

(a) Health professionals

	Job	**Function**	**Experience (years)**	**Sex**
1	Social worker	Geriatric home care for regional agency	7	F
2	Physical Therapist	Geriatric home care for regional agency	30	F
3	Physician	Geriatric home care for regional agency	22	F
4	Occupational Therapist	Department head of occupational therapy for geriatric acute and long-term care hospital	26	F
5	Physician	Department head of rehabilitation programme for geriatric acute and long-term care hospital	27	F
6	Physical Therapist	Department head of professional services for geriatric acute and long-term care hospital	20	F

(b) elderly people

	SMAF*	**type of residence**	**living situation**	**disability**	**Age (years)**	**Sex**
1	-9.5	apartment	assisted living	lives alone	68	F
2	-7.5	private residence	apartment	lives with someone	72	F
3	-4.5	private residence	apartment	lives alone	92	F
4	-5	private residence	house	lives with someone	79	F
5	-18	private residence	house	lives with someone	81	M
6	N/a	private residence	apartment	lives alone	80	F

*Score for Functional Autonomy Measurement System

Table 2. Summary of potential applications identified from the content analyses of the focus group interviews

	Potential applications	**Examples**
1.	Mechanism to remotely monitor loss of autonomy and the patient's abilities in everyday life.	Evaluate the senior's autonomy by means of a task analysis in the actual situation and in the natural environment (e.g. do you cook?); regularly verify patients' ability to carry out specific tasks in their environment (e.g. making dinner).
2.	Mechanism to help ensure safety when patients leave hospital (i.e. offer supervision or rapid access to a professional when they return home) and reduce travel for healthcare professionals related to specific interventions that are of short duration but necessary (monitoring of injuries, verification and follow-up with the family, instructions to verify something).	Verify the understanding and execution of prescribed exercises with the patient; retroactively (playback) review the accomplished tasks with the patient for educational purposes; visual verification of the taking of medication; taking vital signs remotely (blood pressure, sugar level).
3.	Mechanism that can be used to facilitate the supervision and quality control of services.	Carry out a follow-up (virtual visit) to verify if advice and recommendations have been followed through; the system can be used to support training programmes.
4.	Mechanism to help family caregivers, through training (e-learning) in the provision of medical care and the operation of specialized equipment.	Training to carry out the necessary medical care (e.g. change bandages of a bedridden patient); training in using specialized equipment (e.g. adjust intravenous antibiotic pumps?, oxygen, etc.).
5.	Mechanisms to give respite to family caregivers.	Regular short-term (4 hours) remote telesurveillance of the older person so the family caregiver can leave the house.
6.	Mechanism to enhance the feeling of safety for individuals living at home.	Telepresence as a guardian angel who can intervene in case of emergency (increased feeling of security); telepresence as a way to overcome social isolation by facilitating communication.
7.	Mechanism to facilitate communication with others.	Telepresence as a means of overcoming social isolation by facilitating communication.

Table 3. Summary of usability issues identified from the content analyses of the focus group interviews

Usability issues – Healthcare professionals	
1.	Fears and resistance that the telepresence system could replace human resources for seniors and/or create a dependency on this system.
2.	Fears and resistance that the telepresence system would further isolate seniors by favoring the loss of autonomy, and of relational or social autonomy (efforts to maintain social or family relationships in person).
3.	Recourse to and implementation of a telepresence system requires sound judgement.
4.	Concerns expressed regarding the space necessary in the patient's home to assure utilization and storage of the mobile telepresence system (small house with small corners and small rooms).
5.	Concerns expressed regarding the usability of the mobile telepresence solution in a hostile environment (small corners and small rooms + slanted floors and doorways).
6.	Concerns expressed regarding acceptance of the mobile telepresence system by patients and the protection of their private life (i.e. presence of a camera).
7.	Questions concerning the future need to obtain clear consent from third parties interacting with the patient where the mobile telepresence system is employed.
8.	The telepresence systemn could be intimidating for the current generation of seniors (not in their culture) but would be better received in the following generations of seniors (more comfortable with technology).
9.	Potentially destabilizing results with utilization by patients suffering from cognitive problems.
Usability issues – Community-living older adults with disabilities	
1.	Discomfort associated with the preservation of privacy (an eye that watches us).
2.	Doubt concerning the possibility of intervention in small spaces (i.e. the bathroom).
3.	Usefulness of the telepresence system in the organized environment in question (residence).
4.	Potentialities of telepresence system limited because if telepresence system becomes necessary, the solution of a nursing home would seem more pertinent.
5.	Concerns regarding the financing of the telepresence system (who will pay for the service?).

Table 4. Summary of user requirements identified from the content analyses of the focus group interviews

User requirements – Healthcare professionals	
1.	Importance of structuring the communication exchanges for the patient to ensure the image and sound do not confuse the patient (e.g. "hallucinogenic effects").
2.	Ensure that the technological means utilized allow for effective visual surveillance of quality for the patient.
3.	Efficient and easy control of the settings in operation and at rest (on/off) that takes into account the limitations of seniors with cognitive deficits.
4.	Telepresence system and components must not be too loud to avoid frightening the patient when in operation.
5.	When the system is moving in the patient's environment, it must not significantly increase the risk of falling for the patient (security parameter to respect).
6.	System must be as small as possible and a neutral colour (discreet).
7.	System must be easy for the patient or third party in the home to control ("kill override").
8.	System must be able to overcome getting stuck (i.e. being trapped in a corner).
9.	System must be reliable and require minimal technical support during effective use in the home.
10.	Audiovisual communication between the patient and clinicians must be able to support a multipoint connection (allowing more than one clinician's viewing at a given time).
11.	In a multi-clinician context, teleoperation functions must be transferable from one clinician to another.
12.	System implementation and use must not require many professional resources in terms of time (i.e. user-friendly).
User requirements – Community-living older adults with disabilities	
1.	The telepresence system must be discreet and the least invasive possible (i.e. I want my peace and quiet).
2.	Minimum height.

Figure legend

1 Design for a prototype robot