

Safety first *continued from cover*

inability to quickly lift their legs to clear obstacles in their way increases the chance of falling. Sensorimotor changes such as a loss of vision, balance, hearing, motor planning difficulties, or overall muscle weakness can also prevent seniors from perceiving or clearing obstacles during movement.

Psychologically, seniors may be at risk of falling if they experience depression, the loss of a spouse, mild memory loss, difficulty learning new tasks, or decreased thought-processing speed. Each of these events may alter seniors' ability to perceive changes in their environment and to react quickly to these changes, thus increasing the chance of falling.

Socially, new living arrangements, including a recent move to a long-term care facility, may create confusion, especially in the middle of the night. Excess alcohol consumption or large quantities of medication use can alter brain functioning and result in poor perception. A senior can hire home care help or ask family and friends to assist with daily functions; doing so will help the senior attempt tasks that may be beyond his or her level of functioning.

Environmentally, potential hazards include entrances, doorways, stair railings, stairs, lighting, flooring, bathroom space and heights, and slippery surfaces. Each of these must be addressed based on the senior's functional level.

Preventing falls

If a client has fallen, the following clinical protocol may help prevent further falls. First, health care professionals must identify any mobility issues or circumstances surrounding the fall. What was the client doing? Was there a loss of consciousness and any injury? Has there been a pattern of falls prior to this? What were the circumstances surrounding the other falls?

Next, the client should visit a family doctor to determine any mental status change or occurrence of a headache 24 hours post-fall. As well, all medications, including non-prescription drugs, should be reviewed. The doctor will also

determine any changes in the client's underlying medical status. The client should also be seen by a physiotherapist for an evaluation of gait, balance, and extremity strength.

Finally, an OT assessment will be valuable if the client fell during a transfer, as transfers can be evaluated and transfer training or assistive devices can be recommended. A look at housing adaptations or assistive devices to reduce bending, reaching, squatting and kneeling may be necessary. An alert system may also be required if a fear of further falls is limiting functional activity. If the client is in a wheelchair, a seating assessment may be required if he or she fell by sliding out of the chair.

The following areas are important in preventing falls:

1. Home safety recommendations/checklists.

These checklists identify environmental barriers in the home. Issues of access and safety need to be reviewed in all areas, including the basement, kitchen, bathrooms, entrance areas, bedroom and all main living areas.

2. Assistive devices recommendations.

Examples include larger hand grips to prevent slippage of items during carrying activities, non-slip matting, automatic light timers, pill dispensers to prevent medication overdose, fluorescent tape to identify surface level changes, bathing equipment to assist with transfers, and long-handled items to prevent bending and reaching. Consider devices that will prevent a senior from rushing while transferring, walking or climbing stairs. For example, portable phones or cell phones, front door openers or buzzers can prevent someone from rushing to get to the phone or door, and treating incontinence will prevent a person from racing to the bathroom.

3. Physical activity/exercise program.

The more flexible and active a senior is, the more quickly he or she will respond to a change in the environment, thus preventing a fall. Exercise helps strengthen muscle, maintain bone density and

build a healthy cardiovascular system.

4. Mobility equipment review. Seating systems, restraint-free positioning, and transfer techniques used within the home or long-term-care facility must be reviewed frequently. Changes in the client's physical functional level must also be addressed. With respect to the institutional setting, the focus needs to be on transfers in and out of wheelchairs and beds. A review of appropriate seating systems is also needed. Most clients in institutions fall when attempting to find positions of comfort; therefore, seating programs to increase client comfort and reduce restraint use need to be developed.

5. Community resources. Fall clinics, home maintenance services, home safety videos, home safety checklists, and training courses run by seniors should be made available to the client and his or her family once the senior has been identified as being at risk for falling.

Determining needs

Health care professionals need to determine the needs of clients as well as how much pain or the fear of falling influences a client's activity level. As the focus with the elderly moves from optimum mobility to comfort, functional mobility, and the minimization of pain and fatigue, a therapist's technology recommendations must adjust to meet any new needs. Recommendations must also provide a sense of well-being and self-esteem for the client.

By predicting and minimizing the risk of falling and by providing appropriate intervention and treatment, health care professionals can help reduce the enormous medical and emotional costs of falls in the elderly. The elderly client may then remain autonomous, with a decreased fear of falling, increased self-esteem, and a general feeling of comfort within their environment.

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CLINICAL NOTES

I N N O V A T I V E H E A L T H C A R E S O L U T I O N S

Safety first: Developing fall prevention programs

By Sheila Buck, BSc (OT), Reg (Ont), ATP.

Falls are common among the elderly and can pose a serious threat to their mental and physical health. Every year, a third of all persons 65 years and older who reside in the community report one or more falls. Those adults who survive falls often develop fears of instability and of future incidents. As a result, falls can lead to decreased mobility, individual and family distress, nursing home placement, and, while in a nursing home, chemical and physical restraint use. In institutionalized clients, falls can account for up to 90 per cent of all reported incidents.

Understanding falls

Research shows that falls and resulting injuries are not random, unpredictable events but are understandable and preventable. Falls are the result of physiological, social and environmental factors. A challenge for occupational therapists

(OTs) and other community health professionals is to develop community and institutional awareness programs and checklists that help identify the predictable factors for fall prevention. In doing so, health care professionals can take a leading role in falls prevention education.

Identifying seniors at risk

First, it is important to identify who is at risk for falling. Some of the warning signs for seniors who are at risk for a fall may include one or more of the following:

- two or more visits to a family physician within the last year for other than routine visits or checkups
- two or more general health problems
- lack of physical activity
- use of blood pressure medication
- more than two prescription drugs

taken regularly

- more than two limitations in daily activity

Examining risk factors

These risk factors can then be examined in the context of their physiological, psychological, social and environmental make up. Physiologically, we need to consider if the client has had any ongoing cardiovascular difficulties such as a previous infarct or high or low blood pressure. Changes in blood flow to the brain can cause the client to experience a brief loss of consciousness, which can result in a fall if the person is standing or walking during the occurrence. As well, clients with neurological deficits such as Parkinson's disease or a cerebrovascular accident with hemiparesis have limited reactions; their

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Aging and disability supports: A profile of Canadian seniors

By Social Development Canada.

As people age, the chance of having a disability increases. After age 65, about one in three people will have developed a disability, and that likelihood continues to increase with advancing age. So what disability supports will Canadian seniors need as they grow older?

Defining disability supports

Disability supports are the goods and services that people with disabilities need to fully partic-

ipate in daily life. They are important to help individuals develop personal independence, but significant numbers of people are not able to access all the supports they need.

Obstacles to getting needed supports go beyond availability and affordability. Some seniors, experiencing disability as a result of aging, may not seek the "disability supports" they need, due to the stigma they associate with

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Practical pressure ulcer care: Approaches for the care provider

By Patricia Coutts, RN, and Linda Norton, OT Reg (ONT).

Intact skin, our largest organ, protects the body. A break in the skin tissue can result from a number of causes. “Textbook solutions” aimed at preventing and managing pressure ulcers do not always meet the client’s need. For the care provider, one of the challenges for care becomes taking “textbook answers” and applying them in a practical way.

Recently, clients with a history of pressure ulcers were asked by one of the authors for their perspectives on the prevention and treatment of pressure ulcers. Their answers have been used to form the practical strategies in this article. One of the overwhelming themes was that clients want health care providers to be up to date on best practices and current resources.

What are you treating?

“I choose to live in the country, even though I know that in town I would have easier access to transit ... and even though it means I may be up in my chair longer than optimal.” (Person with a pressure ulcer)

The health care provider needs to be ever mindful that this is a person that happens to have an open wound caused by pressure rather than just a wound that needs treatment. While local wound care is important, to optimize the wound healing environment three areas—treating the cause, local wound care, and patient-centered concerns—need to be addressed as recommended by Sibbald et al. (2000).

Understanding the patient’s perspective regarding the cause of the wound, factors that influence healing, and the impact of the ulcer and treatment on the patient’s lifestyle form the basis for assessment and treatment.

To foster treatment adherence, clients need to be engaged in the treatment planning process. The client’s goal of treatment should drive the plan. For example, the client’s priority may be to control odour, control pain, or minimize the impact of the wound on their lifestyle. The plan of care needs to be consistent with this goal.

When clients choose a course of action, they need to understand that they are also

choosing the outcome of that choice. For example, if the client chooses to sit in a wheelchair with a cushion that does not manage pressure, he is also choosing not to optimize the healing environment and can not expect optimal healing.

Practical approaches to prevention

“Pressure ulcers are preventable, but each individual needs to figure out their own personal prevention program.” (Person with a pressure ulcer)

With their “Best Practices for the Prevention and Treatment of Pressure Ulcers: Update 2006,” the Canadian Association of Wound Care has published recommendations on the education of the patient, caregivers and health care providers regarding the prevention and treatment of pressure ulcers. When developing best practice guidelines for diabetic foot ulcers, the Registered Nurses Association of Ontario asked clients about the education they had received. Although these patients had received education upon diagnosis of their diabetes, patients reported that they had not received education regarding ulcer prevention. To be effective, client education must be targeted, individualized, and incorporate clear, simple prevention messages.

Treat the cause

“The biggest frustrations are never knowing when the nurse is coming and always having to be available.” (Person with a pressure ulcer)

Best Practices Guidelines (BPG) recognize that nutrition is an important component of wound healing and recommends that a client’s nutritional status is optimized. The reality in the community may be that the client lives alone and may not be able to eat a balanced diet. These clients need support and a realistic plan to move toward a more nutritious diet. Any recommendations need to be practical for the client.

Macerated skin is more susceptible to further breakdown, so keeping skin clean and dry is recommended. The challenge comes when there are limited staff resources or supplies. Education and advocacy are powerful tools in this situation. Keeping the skin clean and dry will prevent further skin breakdown, reducing the future costs and time required to care for that resident.

BPG recommend reducing friction and shear by keeping the head of the bed elevation to less than 30 degrees, using heel protectors and lifting not sliding the client. It also recommends reducing interface pressure and limiting seating. Bed rest, and limiting the head elevation to less than 30 degrees, is difficult for clients, and they may not adhere

to this plan.

Additionally, evidence suggests that bed rest is not an effective treatment for pressure ulcers. Incorporating the client’s mobility and functional goals into a treatment plan while managing interface pressure, friction and shear on every surface in which the

client comes in contact is a more realistic approach.

Sensation and cognition also impact pressure ulcers. Often, clients do not identify skin health as an issue, as they lack sensation or are unable to express their concerns. BPG recommend detecting and optimizing co-morbidities, yet the view may be “if it doesn’t hurt, nothing needs to be fixed.” Again, caregiver education is the best approach. Understanding the potential co-morbidities and their potential to reduce the risk of further ulcers will help caregivers address these issues.

With the seemingly decreasing resources and the push to see more clients, some health care providers may feel that they don’t have time to talk to the client. In a preparing the wound bed paradigm proposed by Sibbald et al., patient-centred concerns have equal importance with treating the cause and local wound care. The client’s primary goal may

As clients have been actively involved in the treatment planning process, they are more likely to adhere to this plan.

not be to heal the ulcer. Their goal may be to control odour, prevent leakage or engage in life. Addressing the client's individual concerns and involving them in the treatment plan will ensure that the plan meets the client's individual goals.

Typical patient concerns include the following:

- Is there a smell?
- Will it hurt?
- Will the dressing leak?
- When will the nurse come?
- When will it heal?
- How will it affect my self-image?

Compliance and adherence

"Care of the wound done on a regular basis, day after day, month after month, becomes almost a robotic way of life." (Person with a pressure ulcer)

Clients who don't follow the recommended treatment plans may be labeled as "non-compliant." Compliance is the act of conforming or acquiescing. This perspective implies that the health care provider is "right" and any deviation is "wrong," and that the client needs to shape their life and goals to meet the treatment plan. As this plan may not be in line with the client's goals, clients may choose to be "non-compliant."

Adherence is being attached to a cause or set of opinions. In this framework, health care providers and clients discuss the goals and the options for treatment. The client chooses the option or approach that they want to pursue. As clients have been actively involved in the treatment planning process and have chosen a plan that fits with their goals and lifestyle, they are more likely to adhere to this plan.

The final word

"Everything is not medicinal or mechanical . . . The person has a life that needs to be accommodated." (Person with a pressure ulcer)

Best practices are the foundation of pressure ulcer assessment and treatment. However, sometimes you need to extend the best practice principles. In the real world, some best practices may not be practical or possible. In these situations, moving the client towards best practices may be the best approach to take.

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Linda's corner

Linda Norton, Rehabilitation Education Co-ordinator at Shoppers Home Health Care, answers your seating and mobility-related questions.

Q I have a client with multiple sclerosis (MS) who is currently driving a power wheelchair and is gradually losing his hand function. If he can't continue to use his current joystick, how do I decide what specialty control he should use?

A Several steps should be taken when selecting a specialty control. The first step is to ensure that the client is positioned well in the chair and has adequate support. Sometimes a client's functional movement improves with a better posture and/or more support.

Once the client is appropriately positioned, the next step is to determine what movement the client can reliably control throughout the day. This is particularly important for clients, such as those with MS, who tend to fatigue during the day and, as a result, notice a decrease in functional movement. For example, a client may have the sufficient strength and active range of motion to drive the chair with a joystick in the morning but not have the strength to move the joystick in the afternoon.

Once you find a reliable movement, it can be harnessed to control the chair. In my experience, almost any reliable movement can be used to drive the chair. Some of your options for controls include the following

Specialty joysticks

- **Mini joystick:** This small joystick requires very little strength or range of motion to control. A client could

control this joystick with just one finger.

- **Goal post, mushroom, joystick extension:** A variety of styles of joysticks and extensions are available which may make controlling the direction easier.

- **Switch arrays:** Single switches or a switch array can be mounted where it will be easily accessed by the client. Each switch may perform a different function or set of functions. For example, if a client wants to drive forward, they press the button labelled forward. Switches can often be selected and mounted creatively to harness almost any movement.

- **Sip and puff:** Clients who can drink from a straw usually have the physical capacity to operate this type of system. The client controls the wheelchair through four commands: hard puff, soft puff, hard sip and soft sip. While learning to drive this type of system can be challenging, clients who master this system can become excellent power wheelchair drivers.

- **Head array:** With this type of system, the client's head essentially becomes the joystick.

- **Single switch scanning:** A light on a display scans through the directions the chair can go (e.g., left, forward, etc). When the direction the client wants to go is indicated, they activate the switch. The chair will then go in the selected direction until the client releases the switch.

Along with the specialty controls, the drive parameters of many wheelchairs can be adjusted to improve the client's driving ability. The final step is to work with your sales representative/technician to ensure that the chair is set up to optimize your client's driving abilities.



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Building partnerships: The nurse's role as a health care leader

By Carol Boswell, EdD, RN, and Sharon Cannon, EdD, RN.

The need for partnerships between health care professionals within geographical communities is increasing as new health care needs, trends, and issues arise. Nurses are vital contributors to these alliances and partnerships. According to Daiski (2004), nurses are recognizing the value of collaboration both within the nursing profession and with other health care professionals and community leaders. Successful collaborative efforts include networking, leadership, and vision. These behaviours enable providers to address a greater number of ideas and issues with fewer resources.

This article presents three elements, specifically networking, leadership, and vision, which are identified in the literature as necessary for the development of successful collaborative efforts. Examples of collaborative efforts encountered by two nursing leaders, the authors of this article, are used to show how networking, leadership, and visioning increase the effectiveness of community partnerships.

Understanding collaboration

In 1992, Grohar-Murray and DiCroce described collaboration as “a current buzzword and one that can be applied to relationships between practicing nurses and several other groups.” This description holds true today. More recently, Chitty (2001) has defined collaboration as the process of toiling directly with other individuals in an attitude of teamwork that benefits the organization, individuals, and health care consumers. In other words, collaboration is the integral working of like-minded people toward a common goal. The *Merriam-Webster Online Dictionary* describes collaboration and its related terms as follows:

- *Collaboration* is perceived as working together toward a common goal.
- *Partnerships* are seen as a state or condition of associating or participating with others regularly regarding a joint interest.
- *Teamwork* is the process of co-ordination of efforts to use the collective efficiency of a group of individuals to be successful at a task or focus of attention.

Overall, these terms reflect the idea of indi-

viduals coming together for a mutually accepted goal or mission.

Successful collaboration

Based on the collaboration and partnership literature, we have identified three key behaviours that enhance the work of collaborative partnerships. Our experiences, too, have shown that these behaviours facilitate collaboration. These behaviours include networking, leadership, and visioning.

As we examined our experiences, we noted that networking was the most crucial element in each of these partnerships. Although the other two behaviours, leadership and visioning, were very important, networking consistently stood out as the most significant contributor to our success.

Networking: Collaborative efforts are strengthened by networking, which enables one to draw upon multiple resources and build a team to accomplish the desired objectives. An important networking skill is the ability to identify resources available within the community. These resources include both financial and human resources. Lavoie-Tremblay (2004) noted that successful projects involve financial, cognitive, and human support and commitment from a variety of colleagues and superiors.

Putting multiple resources together requires networking skills. Kerfoot (2002) has observed that the development of a complementary and synergistic group of individuals is imperative to the success of collaborative efforts. It is often necessary to look outside of one's normal networks to find the right individual(s) for a given partnership. When an idea is developed appropriately, multiple individuals are frequently eager to become involved with the venture. It takes a community of individuals all working together to be successful. The development and maintenance of effective working teams is fundamental to advancing the success of community endeavours (Institute of Medicine 2001).

Leadership: Another necessary element of col-

laborative partnerships is that of good leadership. The credibility of the leader is paramount to the success of the venture; leadership entails inspiring stakeholders to devote energy, time, and resources toward a positive endeavour (Buonocore 2004). Leaders need to be able to transform practice cultures to achieve the desired outcomes (Wesorick 2002). Kerfoot (2001) has

gone so far as to suggest that successful leaders will motivate the group to achieve outcomes that exceed the prospects of the endeavour.

Leaders must take the time to investigate the issues and become knowledgeable about the possible opportunities for success to occur.

They need to remain visible, enthusiastic, and actively involved with the goals of the organization for the outcomes to be successful (Wagner 2004). Outhwaite (2003) noted that leaders need to be willing to persevere and take risks as they develop new opportunities for addressing the challenges identified by key stakeholders.

However, leaders also need to be able to trust the group members. Scahaefer (2004) wrote that a leader identifies the responsibilities for the different individuals involved in the program but then needs to get out of the way and let them do the jobs assigned. The reputations of the group's members also play an enormous part in the success of the project. Laying of a sound foundation of leadership and membership for the collaborative efforts can be time-consuming, but in the long run is invaluable to the venture's success.

Vision: The success of a collaborative project requires that everyone on the team be actively captivated by the mission and/or goals of the group. The Institute of Medicine noted the importance of a system's identifying its shared purpose; this allows for a core set of principles to be developed to guide the innovation or partnership. Cooper (2003) concluded, “. . . leadership is therefore about influence, but it is also about inspiration—those with the inspiration to inspire belief in ourselves.” Kerfoot has stated “inspirational leaders instill an intrinsic drive that is fueled by a higher purpose, a sense of mission,

Collaboration is the integral working of like-minded people toward a common goal.

and a commitment to a vast array of possibilities," and added that inspired individuals engage a "fire of passion" for the vision of the project that results in an inherently and independently driven success for the endeavor.

Vision comes from the leader. Without the leader taking the initiative to excite the committee, the efforts of the group frequently become fragmented and ineffective. A shared vision held by all partners is an essential early step in the partnering process. Once steadfastness to the goal is developed, the enthusiasm for the consortium seems to fall into place.

Collaborative efforts

The following are examples of partnerships and collaborative efforts in which the authors have participated during the past six years. These examples will illustrate the ways in which networking, leadership, and vision have worked to enhance the success of the initiative.

Getting started with a collaborative project can be as simple as two interested parties discussing mutual research interests. Such was the case when two regional deans (medicine and nursing) met to explore a potential interdisciplinary research project examining health care literacy which would include colleagues from other local higher education institutions. The pilot project received internal funding. After implementation, it was presented at a national and an international venue, and reported in two peer-reviewed journals. The original researchers are now exploring national grant funding opportunities. Networking and visioning contributed to the success of this partnership.

Another example, which demonstrates networking, leadership, and vision, involved the establishment of a Health Careers Consortium to address the shortage of health care providers in a local community. Three nursing leaders met for dinner and discussed ways to address the nursing shortage. Each went back to his or her organization to obtain support. Other community leaders were identified and invited to participate. As a result, the Health Careers Consortium is currently composed of 17 organizations and continues to receive multiple requests for membership from other interested parties. The consortium has developed a recruitment video tape; provided information about scholarships; participated in multiple health/career/business fairs; been recognized in newspapers, journals, and television; collaborated with a Workforce Board to obtain \$380,000 in funding for skill development and incumbent

worker programs; and aided in the establishment of an Area Health Education Center.

As these two previous examples were occurring, the local Chamber of Commerce was examining the impact of health care on the local economy through a medical expansion committee. The regional deans were invited to participate on the committee and to present issues related to their profession at the annual Chamber Board Retreat. This resulted in the Chamber sponsoring a project in which the nursing shortage was addressed, an endowed scholarship fund of over \$50,000 for local nursing students was established by a local bank, and funding to support faculty salaries at a community college was obtained.

A further example shows how bringing the right people together at the right time through networking helped to confront an identified challenge and improve community health care. The challenge was the lack of professional registered nurse (RN) circulator nurses available for the acute care facilities in the region. A group of individuals involved in other projects met to discuss this concern. From these sessions, a course was developed to increase the number of RN circulator nurses. The course utilized multiple experts in the region to provide instruction while three different acute care facilities in the area provided a comprehensive look at the requirements of the role of the RN circulator nurse.

Our last example illustrates the important roles of networking and vision as multiple institutions of higher education and state agencies partnered to confront the growing challenge of the nursing shortage. Within the state of Texas alone, over 4,700 nursing student applicants for the 2003–2004 academic school year were denied admission into any nursing program. This number does not include duplication of applications across the state. As a result, innovative strategies for opening additional educational opportunities were greatly needed. To address this shortage of nursing educational opportunities, a group of nursing programs have organized to seek a multi-

million dollar grant to investigate innovative strategies for educating individuals to be RNs.

One project leads to another

Overall, the experience of the authors is that one project leads to another. Neither of us set out with a strategic plan for collaborative projects. However, we found that as nurses we were already skilled as networkers, leaders, and visionaries. As the stakeholders realized the quality of the group's work, they were willing to engage in further projects. We found that developing the appropriate foundation for a project's initiation was important. Also important was an emphasis on the quality of the work and effective implementation of the plans. Timely evaluation and reporting were keys to our success.

Time must be taken for sharing the results of the endeavor with the stakeholders. Without this closure, the stakeholders can become wary about engaging in future endeavors.

In summary, partnership opportunities are there for the taking when one remains cognizant of trends and issues within communities, organizations, and the profession. Being prepared to take the initiative is also very important

as one project may mesh or overlap into another. An understanding of the process of collaboration enables leaders to develop and manage the environment to meet the needs identified within the community (Outhwaite 2003). The elements of networking, leadership, and vision are all important as relationships between stakeholders are developed. By carefully addressing each of these areas, partnerships become strong and beneficial outcomes follow.

Adapted with permission from "New Horizons for Collaborative Partnerships" by Sharon Cannon and Carol Boswell. Online Journal of Issues in Nursing. Vol. #10, No. 1. The full article is available at www.nursingworld.org/ojin/topic26/tpc26_2.htm.

References are available in the on-line source document.

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Smart wheelchairs: The future of rehab

By Richard C. Simpson, PhD, ATP

Several studies have shown that both children and adults benefit substantially from access to a means of independent mobility, including power wheelchairs, manual wheelchairs, scooters, and walkers. Independent mobility increases vocational and educational opportunities, reduces dependence on caregivers, and promotes feelings of self-reliance.

However, while the needs of many individuals with disabilities can be satisfied with traditional manual or powered wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently. This population includes individuals with low vision, spasticity, or cognitive deficits. These individuals often lack independent mobility and rely on a caregiver to push them in a manual wheelchair.

To accommodate this population, several researchers have used technologies originally developed for mobile robots to create “smart

wheelchairs.” A smart wheelchair typically consists of either a standard power wheelchair to which a computer and a collection of sensors have been added or a mobile robot base to which a seat has been attached. Smart wheelchairs have been designed that provide navigation assistance to the user in a number of different ways, such as assuring collision-free travel and autonomously transporting the user between locations.

Smart wheelchairs have been the subject of research since the early 1980s and have been developed on four continents (Table 1). This article presents a summary of smart wheelchairs and their features, which are outlined below.

Form factor

One way to classify smart wheelchairs is form factor. Early smart wheelchairs (e.g., Mister Ed) were actually mobile robots to which seats were added. The majority of smart wheelchairs that

have been developed to date have been based on heavily modified, commercially available power wheelchairs (e.g., NavChair, OMNI); a smaller number of smart wheelchairs (e.g., SWCS, SPAM) have been designed as add-on units that can be attached to and removed from the underlying power wheelchair.

Integrating the smart wheelchair technology into the underlying power wheelchair offers several advantages. Perhaps most important, the user’s input can be fed directly into the processor to the wheelchair’s motors, bypassing the manufacturer’s proprietary control electronics. This eliminates the need to “reverse engineer” the protocol that the wheelchair manufacturer uses to communicate between the joystick and the motor controller. An additional benefit of tight integration is the ability to add optical encoders to the wheels, which allows the wheelchair to track its velocity.

On the other hand, systems designed as add-on units must connect to the underlying wheelchair through the interface options provided by the wheelchair manufacturer. Early add-on units (e.g., Hephaestus) were able to take advantage of analog connections between the joystick and the motor controller. It was relatively simple to intercept the continuous stream of voltages generated by the joystick, modify that stream, and pass it on to the wheelchair’s motor controller. More recent add-on units have to contend with proprietary digital control buses, which greatly complicate the task of interfacing with the wheelchair.

The promised advantage of the add-on unit approach is that a consumer will be able to buy the system once and transfer it to multiple chairs over their lifetime. This is particularly important for children, who may go through several wheelchairs in a short period of time as their bodies grow.

Input methods

Smart wheelchairs have been used to explore a variety of alternatives to the more traditional input methods associated with power wheelchairs (e.g., joysticks, pneumatic switches). Voice recognition has often been used for smart wheelchairs because of the low cost and widespread availability of commercial voice recognition hardware and software. More

Table 1

Smart wheelchairs

Some of the more recently developed smart wheelchairs reported in the literature include the following:

Smart chair	Significant feature
CWA (Power) National University of Singapore, Singapore	Uses dead reckoning to keep wheelchair on prescribed path.
Hephaestus TRAC Labs, U.S.	Provides obstacle avoidance. Compatible with multiple brands of wheelchairs.
Intelligent Wheelchair System Osaka University, Japan	User provides input to system with head gestures. Response to user input (facial gestures) adapts based on wheelchair’s surroundings.
MAid RIAKP, Germany	Able to follow moving objects.
Orpheus National Technical University of Athens, Greece	Either navigates autonomously to position or provides obstacle avoidance while user navigates.
Siamo University of Alcalá, Spain	Used as a test bed for various input methods (voice, face/head gestures, EOG). Provides obstacle avoidance.
SmartChair University of Pennsylvania, U.S.	Provides several modes of operation, including “travel to target” mode.

exotic input methods include detection of the wheelchair user's sight path (i.e., where the user is looking) through electro-oculographic (EOG) activity or the use of machine vision to calculate the position and orientation of the wheelchair user's head.

Smart wheelchairs are excellent test beds for novel input methods because, unlike standard wheelchairs, smart wheelchairs have an onboard computer with which input sensors can interface. More importantly, the obstacle avoidance provided by smart wheelchairs provides a safety net for input methods that are inaccurate or have limited bandwidth. Voice control, for example, has proven very difficult to implement successfully on standard wheelchairs; however, on the NavChair, the obstacle avoidance capabilities built into the control software protect the user from the consequences of unrecognized (or misrecognized) voice commands. The software also "fills in" small, rapid navigation commands that are much easier with a high-bandwidth input device like a joystick.

Sensors

To avoid obstacles, smart wheelchairs need sensors to perceive their surroundings. By far, the sensor most frequently used by smart wheelchairs is the ultrasonic acoustic range finder (i.e., sonar). Sonar sensors are very accurate when the sound wave emitted by the sensor strikes an object at a right angle or head on. As the angle of incidence increases, however, the likelihood that the sound wave will not reflect back toward the sensor increases. Sonar sensors are also susceptible to "cross talk," which happens when the signal generated by one sensor produces an echo that is received by a different sensor.

Another frequently used sensor is the infrared (IR) range finder. IR sensors emit light rather than sound, and can be fooled by dark or light absorbent material rather than sound absorbent material. IR sensors also have difficulty with transparent or refractive surfaces. Despite their limitations, however, sonar and IR sensors are often used because they are small, inexpensive, and well understood.

Neither sonar nor IR sensors are particularly well suited to identifying drop-offs such as stairs, curbs, or potholes. It is not uncommon for floors to be dark and smooth, which means that both sonar and IR sensors would need to be facing almost straight down toward the ground to receive an echo. In this case, the smart wheelchair would not have warning in enough time to stop.

More accurate obstacle and drop-off detec-

tion is possible with laser range finders (LRFs), which provide a 180°, two-dimensional scan within the plane of the obstacles in the environment. Unfortunately, LRFs are expensive, large, and consume lots of power.

A significant obstacle to bringing intelligent mobility aids to market is the need for sensors that are accurate, inexpensive, small, lightweight, and impervious to environmental conditions (e.g., lighting, precipitation, temperature): they also have to have low power requirements. Because no single sensor exists that meets these needs, many smart wheelchairs fuse information from multiple sensors to locate obstacles. In this way, the limitations of one sensor can be compensated for by other sensors. For this reason, sonar and IR sensors are frequently used in combination. When other sensors fail, the last line of defense is often the bump sensor that is triggered when a smart wheelchair comes in contact with an obstacle.

Operating modes

Some smart wheelchairs operate in a manner very similar to autonomous robots: the user gives the system a final destination and supervises as the smart wheelchair plans and executes a path to the target location. To reach their destination, these systems typically require either a complete map of the area through which they must navigate or some sort of modification to their environment (e.g., tape tracks placed on the floor); they are usually unable to compensate for unplanned obstacles or travel in unknown areas. Smart wheelchairs in this category are most appropriate for users who (1) lack the ability to plan or execute a path to a destination and (2) spend the majority of their time within the same controlled environment.

Other smart wheelchairs confine their assistance to collision avoidance and leave the majority of planning and navigation duties to the user. These systems do not normally require prior knowledge of an area or any specific alterations to the environment. They do, however, require more planning and continuous effort on the part of the user and are only appropriate for users who can effectively plan and execute a path to a destination. A final group of smart wheelchairs offers both autonomous and semi-autonomous navigation.

Internal mapping and landmarks

Smart wheelchairs that navigate autonomously to a destination often do so with an internal

map. The map can encode distance (in which case it is referred to as a metric map) or can be limited to specifying the connections between locations without any distance information (i.e., a topological map). There are, of course, other approaches to autonomous navigation that do not require an internal map, such as following tracks laid on the floor.

A significant problem with the use of an internal map is unambiguously determining where the wheelchair is located on the map. A small number of smart wheelchairs (e.g., TAO, NLP Robotized Wheelchair) use machine vision to identify naturally occurring landmarks in the environment, but the majority of smart wheelchairs create "artificial" landmarks that can be easily identified and linked with a unique location. Most smart wheelchairs use machine vision to locate artificial landmarks, but other smart wheelchairs have used radio beacons (e.g., MAid, TetraNauta).

Several smart wheelchairs also use a "local" map that moves with the wheelchair. This map is often referred to as an "occupancy or certainty grid" and stores the location of obstacles in the wheelchair's immediate vicinity. Occupancy grids are used as the basis for many obstacle avoidance methods.

Enormous potential

Several barriers must be overcome before smart wheelchairs can become widely used. Despite a long history of research in smart wheelchairs, very few are currently on the market. Two North American companies, Applied AI Systems Inc. (Ontario) and ActivMedia (Amherst, New Hampshire) sell prototypes for use by researchers, but neither system is intended for use outside of a research lab.

A significant technical issue is the cost versus accuracy trade-off that must be made with existing sensors. Until an inexpensive sensor is developed that can detect obstacles and drop-offs over a wide range of operating conditions and surface materials, liability concerns will limit smart wheelchairs to indoor environments.

Another technical issue is the lack of a standard communication protocol for wheelchair input devices and wheelchair motor controllers. There have been several efforts to develop a standard protocol (e.g., Multiple Master Multiple Slave), but none has been adopted by industry. A standard protocol would greatly simplify the task of interfacing smart wheelchair technology with the underlying wheelchair.

continued on page 9

Driving safe: The role of executive functioning

By Shirley Rolin, BSc (OT), Reg OT (Ont), CDRS.

Herman, a senior citizen, is out for a Sunday morning drive on the highway when his cell phone rings. Answering on his hands-free cell phone, he hears his wife's anxious voice, "Herman, I just heard on the news that a car is driving the wrong way down the highway. Be careful!"

Herman replies, "It's not just one car. It's hundreds of them!"

A myriad of skills

While we can chuckle at the fictional story above, the fact is driving requires performing a myriad of skills and integrating complex information very rapidly. Regardless of age, a driver's information processing skills, or executive functioning, can be impaired, putting the driver and community at risk of a serious accident.

The term "executive functions" is often used to explain behaviour and refers to higher-level cognitive abilities that enable someone to successfully engage in independent goal-directed behaviour. Executive functioning skills are critical to the safe operation of a motor vehicle in a complex traffic environment.

Three areas of behaviour

Executive functions oversee three areas of behaviour:

1. Organization, which involves maintaining attention to a task and shifting between tasks smoothly. Such transitions are difficult for people with executive dysfunction, as are tolerating changes in the environment and thinking flexibly in solving problems.

Driving is a multi-levelled task. You must be able to focus attention on important stimuli (i.e., road signs, other traffic) and not on unimportant stimuli (i.e., a pretty girl walking by, parked red Ferrari).

Although driving might seem natural, it's actually a complex, fast-paced activity. It involves sensing information about traffic, road conditions, signals and markings. Then, it involves deciding what to do based on this information and then acting within a split second. A typical driver makes 20 decisions per kilometre and has less than half a second to act to avoid a collision.

2. Inhibition, a basic and vital function that enables someone to delay automatic responses to stimuli, thoughts, and changes in an environment.

Consider another driver cutting in, turning without signalling in front of you, honking, or just being rude. Inhibition allows a driver an instant to consider consequences before acting, avoiding mistakes, or making bad decisions. A person who has difficulty with temper or self control is putting his or her safety on the road at risk.

"Executive functions" ... refers to higher-level cognitive abilities that enable someone to successfully engage in independent goal-directed behaviour.

3. Unawareness, which includes a denial of deficits. As a result, the driver does not understand why he or she has to participate in treatment and may present as non-compliant.

General behaviours associated with impaired executive functions include the following:

- socially inappropriate behaviour
- inability to apply consequences from past actions
- difficulty with abstract concept formations (the inability to make the leap from the symbolic to the real world)
- difficulty in planning and initiation (getting started)
- inability to shift mental sets
- difficulty processing, storing, or retrieving information
- needs frequent "policing" by others to monitor the appropriateness of their actions.
- fine motor skills are more affected than gross motor skills
- moody "roller coaster" emotions
- may demonstrate lack of remorse toward people and animals and show apathy toward activities

• unawareness or denial that their behaviour is a problem

As mentioned, driving is a complex task. In addition to the visual acuity needed, an individual must have intact perceptual skills (e.g., the ability to judge distances between cars or space in parking lots) and interpret very complicated visual information, all while operating a rapidly moving vehicle.

To better understand driving, we can look at Michon's (1979) model, which involves a three-level hierarchy of task performance in car driving. The highest level of Michon's model involves strategical decisions such as what time of day to drive, what route to take, and whether to drive or use alternative transportation. Decisions at this level affect all other driving-related behaviors. The second level is tactical, which involves decisions made while operating the vehicle (e.g., adapting speed to road and traffic conditions, deciding to pass or not). The third level is operational and includes the physical manipulation of the controls, use of visual-motor skills, and overall co-ordination.

The role of the frontal lobe

Executive functioning appears to be governed in the frontal lobes of the brain. When damage occurs in the frontal lobes, residual deficits can impair judgement, reasoning, reaction time, planning and organization skills, impulse control and decision-making skills—all of which are essential to safely operate a moving vehicle.

Unfortunately, the frontal lobe is extremely vulnerable to injury or disease. Head injuries are a major cause of executive loss in younger people, and executive functions are among the first to be eroded by Alzheimer disease and dementia.

Executive function has nothing to do with intelligence or memory. A person can be intelligent and still struggle in life if he or she lacks the ability to plan, organize time and space, initiate and complete projects, and resist immediate temptation in favour of later reward.

When the frontal lobe is damaged, even

intelligent and talented people may flounder. These people are often misunderstood by others as being wilfully disorganized or lazy, having a bad attitude and even, from a family/therapist's viewpoint, "doing this on purpose to drive me crazy."

A sound driving assessment

So what can be done for a driver who has executive functioning damage? First, a thorough examination must be completed. However, driver assessment is a complicated issue. In order to do a scientifically sound driver assessment, a health care professional must understand what driving really is. Driver performance relates to the driver's perceptual and motor skills (what the driver can do) as opposed to driver behaviour (what the driver in fact does). Driving performance, road knowledge and behaviour—all very different things—uses every limb, sense, and cognitive process. If any one or combination is potentially faulty, which one would you test for?

As occupational therapists (OTs) have a thorough understanding of the inter-relationship between the person, occupation, and the environment, they are the best professionals to provide client-centred driver rehabilitation intervention. All registered OTs in Canada should have the knowledge and skills to deliver some driver evaluation and rehabilitation services. OTs have a skill set that enables addressing the subskills of driving such as range of motion, gross motor function and

perceptual abilities.

An OT with advanced training in driver rehabilitation may assess more detailed aspects of driving, such as visual scanning and the use of adaptive equipment. An OT with additional specialized training may deliver in-depth driving assessments and on-road evaluations with a registered driving instructor and may be certified as a recognized Driver Rehabilitation Specialist through the Association for Driver Rehabilitation Specialists.

Most importantly, each driver must be evaluated as an individual. No single test will provide data with predictive value equal to a battery of tests and screenings. A combination of objective testing tools are better predictors of on-road performance than diagnosis or subjective impressions.

More people are surviving brain injury than in the past, and a percentage of these people are driving. Also, older people, who do not have disabilities, continue to drive, yet we know that certain cognitive capacities diminish with age. So how can we determine if a driver is safe? How can we determine if a person's executive functioning is sufficient to safely operate a motor vehicle? Research suggests that a combination of cognitive testing, visual screening, physical functioning, and actual driving (on-the-road evaluations) is necessary to predict safe driving performance.

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Head injuries are a major cause of executive loss in younger people....

Smart wheelchairs *continued from page 7*

Even if these technical barriers are overcome, issues of clinical acceptance and reimbursement still remain. Third-party payers are unlikely to reimburse clients for the expense of smart wheelchairs until they have been proven to be efficacious, if not cost-effective. Unfortunately, the evidence needed to prove efficacy will not exist until sufficient numbers of smart wheelchairs have been prescribed.

This is not to imply that smart wheelchair technology cannot be commercialized. Smart wheelchair technology is ready, today, for use in indoor environments that have been modified to prevent access to drop-offs. These modifications can take the form of baby gates, doors in front of stairwells, and ramps placed over single steps. The first smart wheelchair that is commercially successful in North America is likely to be marketed as a device that can be operated independently indoors, but must be controlled by an attendant outdoors or in unmodified indoor environments. However, as sensor technology improves, the environments in which smart wheelchairs can safely operate will continue to expand.

Adapted with the author's permission from "Smart wheelchairs: A literature review" by Richard S. Simpson. Journal of Rehabilitation Research and Development, July/August 2005. The full article is available at www.vard.org/jour/05/42/4/simpson.html.

References are available in the original source document.

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Aging and disability ... continued from cover
 disability. For example, some people believe using a wheelchair is a sign of frailty, but more seniors are using scooters to move around in public spaces. It seems that having a scooter is not associated with disability but rather with aging, making it more socially acceptable—although both devices achieve the same purpose of increasing mobility.

Aids and devices needed

Seven in 10 seniors with disabilities have all the assistive aids and devices they need.

Assistive aids and devices include any type of equipment or aids that help people with disabilities with everyday tasks and activities. Examples include motorized scooters, hearing aids and service animals. In Canada, the most commonly needed technical equipment or assistive aids are those designed to assist with disabilities usually associated with aging, such as mobility and hearing disabilities.

In 2001, an estimated 2,008,000 adults with disabilities required some type of assistive aid or device. Of those, 657,000 or 33 per cent did not have their needs fully met. Seniors—particularly those over 75 years of age—are more likely to need assistive aids and devices than younger people—representing almost half (48 per cent) of overall requirements. At the same time, seniors, compared to others, are more likely to have these needs fully met. Within the seniors’ population, women are more likely to require supportive aids and devices, but they also have fewer unmet needs. Figure 1 indicates that younger seniors (those 65–74 years of age) are less likely to have their requirements fully met.

In particular, about 10 per cent had none of their needs for aids or devices met in contrast to five per cent of older seniors.

The reasons why seniors with disabilities do not have all their needs met are complex. The most common barriers cited are cost and lack of insurance; other reasons include lack of information about where to find them and some reluctance of seniors aging into disability to obtain the aids. For many seniors, there is a strong stigma associated with the use of such aids, as it is seen as a symbol of diminished capacity.

Medication support

Medication support is of particular importance for this age group, because both senior men and women with disabilities are more likely than other adults with disabilities to report using medication regularly. Almost 85 per cent of senior men with mild disabilities reported using medication at least once a week, compared with 90 per cent of senior women with mild disabilities. These figures increase to 94 per cent for men and 95 per cent for women with severe to very severe disabilities. Some 95 per cent of seniors with disabilities are able to get the medication or drugs they are supposed to use. However, the remaining five per cent cannot get them due to cost, with women representing almost 70 per cent of these seniors.

Most Canadians have coverage for prescription drugs from one source or another. They receive drug coverage from government programs, private individual plans or via their employers. However, there are wide variations in plan design, eligibility criteria and out-of-pocket costs. For people covered by government plans,

the responsibility is largely that of provincial and territorial governments, with substantial regional differences in drug coverage, especially for coverage against catastrophic drug expenses.

Help needed for everyday activities

Like younger people with disabilities, seniors with disabilities may also need some assistance with activities of everyday life. Most of this assistance takes the form of meal preparation, errands and transportation to appointments, housework, specialized nursing or medical treatments, personal care and help getting around the home.

About 69 per cent of Canadian seniors with disabilities receive all the help they need while approximately 24 per cent receive a portion of needed assistance. Similar to the situation for aids and devices, younger seniors are less likely to have their needs for assistance with activities of daily living fully met. Working age adults with disabilities are even more likely to have none of their needs met—7.5 per cent do not have any of the assistance with daily activities that they need.

Data show that men and women have very similar patterns of need for help with everyday activities. However, senior men with disabilities are more likely to be receiving help from their wives than the other way around.

The majority of seniors with disabilities receive help for everyday activities from family members.

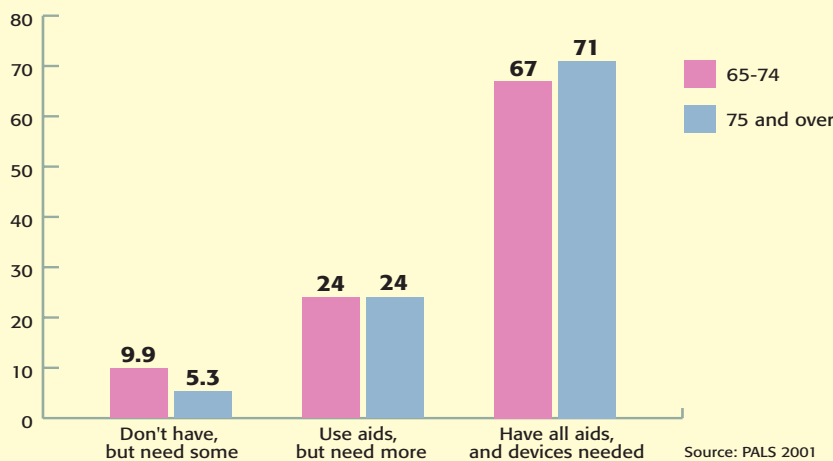
As shown in Figure 2, help needed for everyday activities for seniors with disabilities is generally provided by family members, either living with the person (58 per cent for men and 49 per cent for women) or living elsewhere (46 per cent for men and 49 per cent for women).

Approximately 21 per cent of seniors with disabilities 65 to 74 years of age and 38 per cent of seniors with disabilities 75 years of age and over receive help from formal service providers such as organizations and agencies. Most of this help comes in the form of specialized nursing and medical treatment.

Of those who do not have the help they need, cost and lack of insurance coverage are the most significant barriers. Among those who do find the supports they need, a significant number indicate problems with delays, costs and finding qualified help (45 per cent, 43 per cent and 42 per cent respectively).

Five in 10 women with or without disabilities

Figure 1
Use and need for aids and devices for seniors with disabilities



aged 75 years and over live alone.

Seniors may depend on relatives living elsewhere or formal services for assistance because they frequently live alone. Senior women, both those with and without disabilities, are more likely to live alone than are senior men. Most of these women live as widows, reflecting longer life expectancy and a tendency to enter married life at a younger age than their husbands. As a result, five in 10 (49 per cent) women with or without disabilities aged 75 years and over live alone.

Information in multiple formats

A number of different types of disabilities and health conditions make conventional print information difficult or impossible to access. Fully inclusive environments require easy and universal access to information in multiple formats. Technology developments in recent years have provided people with disabilities with a growing variety of means to create and share information. Specialized computer software, screen magnification, voice recognition systems and other electronic devices are now part of the lives of many people with disabilities. However, information transmission in electronic formats and on computerized-equipment may not be appropriate in the case of seniors with disabilities. Among seniors with disabilities, only 11 per cent use a computer and 6.6 per cent use the Internet at least once during a year.

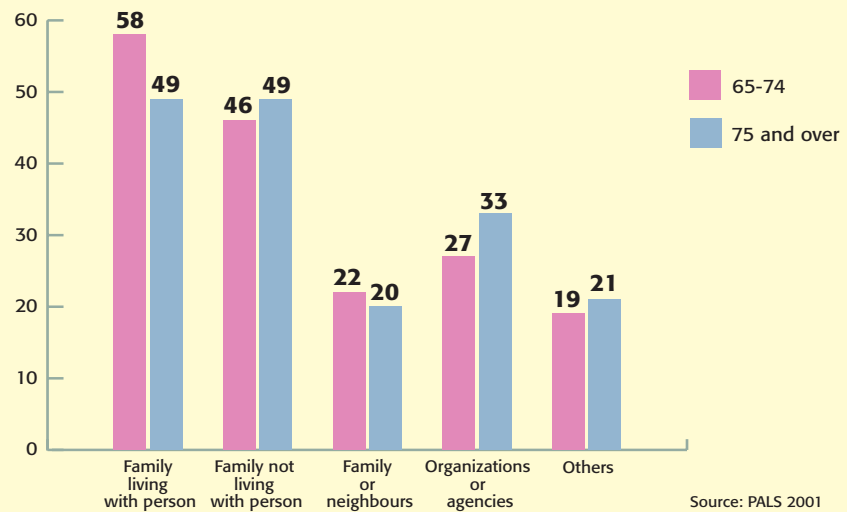
Supports for family caregivers

Family and other unpaid caregivers provide services critical to maintaining independence at home for seniors with disabilities, as well as those with chronic and acute care needs or who require support because of physical, cognitive or mental health conditions. More and more Canadian seniors are receiving care in their own home, often from a family member but also from friends and neighbours. The General Social Survey (2002) indicates that almost 20 per cent of Canadians over 45 years of age were providing informal care to one or more family members or friends over 65 years of age.

Caregiving tasks include activities of daily living, personal care, monitoring and emotional support. Time spent in caregiving can be substantial depending on the type of care provided. For instance, caregivers 45–64 years

Figure 2

Source of help with everyday activities for seniors with disabilities receiving help



of age who are caring for seniors spent on average 23 hours per month providing care. It has been estimated that informal caregivers provide more than 80 per cent of all home care needed by people with long-term health problems. While caregiving is often a rewarding experience, more and more evidence exists of significant and often hidden costs associated with providing care. Some of these costs are economic, but many are not. For example, a considerable number of caregivers face a constant challenge trying to balance work, their own health needs and caregiving responsibilities. A large proportion of caregivers, especially women, subsequently reduce work hours or leave employment altogether for caregiving reasons. This has both immediate and long-term economic repercussions.

Some caregivers of seniors with disabilities may need support due to their own aging.

People who have been providing care to a partner or parent with disabilities can face difficulties in providing the appropriate quantity and quality of care, due to their own declining energy or increased frailty. According to the General Social Survey 2002, some 185,000 or 9 per cent of women and 131,000 or 8.1 per cent of men 65 years of age and over were providing care to another senior due to a health condition. Of these, some 11 per cent said that caregiving had affected their own health.

Full participation for seniors

Disability supports provided directly to indi-

viduals and in the form of accessible environments are the foundation for full participation by seniors with disabilities. This review has shown that the majority of seniors have the supports they require; however, there are some significant gaps and specific issues.

Research suggests that younger seniors may be less likely to have the support they require than older seniors. Both younger and older seniors, even though they are more likely to need supports, are more likely to have their needs met than are working-age people with disabilities. Financial barriers are most often cited as the reason for not having what is needed, but reluctance to acknowledge the presence of a disability may also be a factor.

There is not a significant difference in access to supports for men and women; however, when it comes to personal assistance, men are more likely to rely on family members such as wives and children to help them than are women. The primary reason for this is the longer life expectancy of women and the gradual loss of informal sources of support as they grow older.

Looking to the future, a source of concern is a potential shortage of informal caregivers as the number of seniors with disabilities will increase at a greater rate than the numbers of younger family members.

Adapted from "Chapter 4: Disability Supports" from Advancing the Inclusion of People with Disabilities 2005. © Social Development Canada. For the full report, visit www.sdc.gc.ca.