

Walking Aids for Older Adults: Review of End-User Needs

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Abstract

Aged population of senior citizens is growing noticeably at different regions in the world. Consequently, there are great numbers of demands for healthcare services. One of the services is assistive walking devices which have important role in mobility, stability, walking, and independency of older adults. Although various type of walking devices are available for older adults, yet fall incidents with severe injuries take place. Therefore, it is critical to analyze fall incidents, find out fall factors, and assess walking devices to minimize fall. This paper mainly focuses on risk factors of fall, considerable role of Information and Communication Technology (ICT) in walking devices, and also analyzes fall incidents with the purpose of understanding how fall incidents take place. This paper assists to have a clear understanding about fall incidents and its associated injuries.

Keywords: assistive walking device, elderly needs assessment, information and communication technology, fall incident, falling factors, analysis of fall incident, assessment of assistive walking device

1. Introduction

Today's world has undergone dramatic changes by advent of ICT. In the recent decades, there have been noticeable developments in technology. The development in technology has paved the ground for scientists and scholars to conduct further research studies with the purpose of ameliorating services in different industries. Medical industry having witnessed substantial improvements in service sectors such as assistive medical robots and assistive services specifically for older adults and disabled. In many regions in the world, population of senior citizen aged sixty years old and above is growing rapidly (Parker & Thorslund, 2007; Pignini et al., 2012); therefore, demand for high-end healthcare centers and medical services such as home-care and nursing service raises noticeably (Alaiad & Zhou, 2014). The increasing demand for healthcare services and centres requires remarkable amount of costs (Alaiad & Zhou, 2014). However, the development in medical sector shifted healthcare from hospitals to elderly's homes. This created a great number of advantages such as a reduction in transportation and admission costs, amelioration in patient autonomy, and a boost in healthcare quality (Bayer, 2010). Over years, healthcare robots have strengthen their positions in human lives especially older adults to fulfill their needs and expectation, ameliorate their life quality, and improve their health condition. Currently, there is great number of assistive medical robots such as remote presence robot, paro-robot, telerobot, skillegent robot, and RIBA utilized widely by elderly and disabled to fulfill specific needs of them (Alaiad & Zhou, 2014).

1.1 Overview and Contribution

Assistive walking devices noticeably ameliorate elderly's autonomy and also they have pivotal role in elderly's daily routine tasks including walking support, stairs climbing, propelling, mobility, and maneuvering. Therefore, it is significant to identify falling reasons and assess senior citizen's needs and expectations from walking devices with the purpose of fulfilling their needs and expectations. The authors of this paper present a review of fall incidents, fall factors, and the important role of ICT in walking devices. They reflect on fall factors and incidents for fall preventions.

1.2 Paper Organization

This paper is organized as follows: Section 2 reviews the remarkable role of assistive services in elderly life and also a series of walking devices. Section 3 primarily focuses on analysis of fall incidents and fall factors. Assessment of assistive walking devices and role of ICT in walking devices are discussed in Section 4. Section 5

concludes the paper and highlighting the importance of the role of consistent exercising programs and development of ICT walking devices for fall prevention purposes.

2. Walking Aids

Amongst assistive services to the elderly and disabled, assistive walking devices providing walking aid have an imperative role in elderly’s life. Falling risk factors, functions of walking aid, falling reasons, and elderly’s needs assessment are of significant concern to researchers and also designers of walking device According to a focus group study by Aminzadeh, and Edwards (1998), the vast majority of older adults’ participants (aged 65-86) were strongly concerned about falling and its associated consequences such as psychological shock, physical injuries, loss of independency, and death. Summary of walking support aids and the associated features are introduced in Table 1.

Table 1. Summary of walking aids

Category	Features	Supportive Needs
Cane	<ul style="list-style-type: none"> ▪ Alleviate balance issues and weak legs ▪ Resurrect safety and security feelings to the users ▪ Comprises various designs in accordance with user’s needs such as foldable, standard, and quad canes 	<ul style="list-style-type: none"> ▪ Compensate disability ▪ Assist mobility, standing, and sitting ▪ Improve independency ▪ Ameliorate stability and confidence in walking
Crutch	<ul style="list-style-type: none"> ▪ Ameliorate transferring weight from legs to the body ▪ Includes different designs such as forearm, ergonomic, bariatric, lightweight, specialty, and standard crutch 	<ul style="list-style-type: none"> ▪ Enhance supporting weight with legs ▪ Increase independency ▪ Enrich mobility, walking, stability, standing, and sitting
Knee Walker	<ul style="list-style-type: none"> ▪ Assists elderly and disabled to endure weight on disabled or injured leg whilst propelling ▪ Maintain different features such as adjustable seat and brake to facilitate propelling 	<ul style="list-style-type: none"> ▪ Improve enduring weight on injured or disabled leg ▪ Enhance autonomy ▪ Ameliorate mobility, walking, stability, standing, and sitting
Rolling Walker	<ul style="list-style-type: none"> ▪ Provides free movement of user’s legs and feet ▪ Includes numerous designs such as standard and foldable rolling walker with useful specifications such as crossbar, adjustable height, reversible brakes, and detachable seat 	<ul style="list-style-type: none"> ▪ Maintain greater balance, stability and walking support ▪ Facilitate mobility, maneuvering, walking, standing, sitting, and independency ▪ Fall protection

2.1 Canes

Canes are produced in various designs to assist not only elderly but also individuals suffering from injuries affecting lower leg namely broken foot or leg, surgeries such as hip or knee joint replacement, and obesity and weight issues. Different designs of cane are created primarily to fulfill and ameliorate certain needs of individuals such as independency, mobility, walking, standing, and sitting (Wilkinson, 1990).

2.2 Crutches

Crutches are created to target not only elderly but also individuals facing short time injuries or suffering from lifetime disabilities. Crutches are made in pairs with the purpose of supporting individuals facing difficulties to transfer their weight from legs to upper part of body. This kind of assistive walking device assists users to ameliorate stability, mobility, walking, sitting, standing, and autonomy (Joyce & Kirby, 1991).

2.3 Knee Walkers

Knee walker is also referred as platform walker or knee scooter providing walking aid to older adults and

disabled to propel themselves by one leg, whilst the other leg rests on provided platform. Knee assistive walkers are created with the purpose of assisting individuals facing difficulties to tolerate weight on an eternally disabled leg or a short-time hurt leg. Wheeled walking device is a substitute to crutches, canes, and standard walker. This type of walking aid is empowered with noticeable number of features such as adjustable seat and brake (Anderson, 2011). The following table represents a series of walking aids for disabled and older adults.

2.4 Rolling Walkers

Rolling walker is a common type of walking aid and also called wheeled walker, walkers with wheel, or rollator. This compact walking aid is empowered with useful specifications namely three (3) or four (4) large wheels for decreasing friction, high crossbar for easier walking comfort, reversible brakes, handle, attachable bag, and modifiable height for better stability to assists elderly and handicap to move conveniently (Van't Schip, 2004).

3. Fall in Older Adults

Fall refers to an event which an individual or a patient is observed or not observed on the floor or an inadvertently lowering of an individual or a patient on the floor by a third party (Kalisch et al., 2012; Johnson et al., 2011). Over the last twenty years, falls and its related injuries amongst senior citizens are identified as a significant and costly public health issue (Hill & Wee, 2012; Kalisch et al., 2012; Al-Aama, 2011). It is stated that one elderly amongst three of them with the age of sixty-five years old and above falls annually which results in severe injuries requiring treatment in hospitals (Ambrose et al., 2013; Callisaya et al., 2011; Hill & Wee, 2012; Coussement et al., 2008). Albeit there have been noticeable improvements in fall prevention, yet fall incidents causing mortality and morbidity consequences have not diminished. Escalation in number of falling cases not only results in injuries but also raises costs related to hospitalization (Cameron et al., 2010; Gillespie et al., 2010; Ambrose et al., 2013; Hill & Wee, 2012). Falling injury was ranked number fifth as a factor causing mortality especially in group range sixty-five (65) and above (Ambrose et al., 2013); therefore, numerous research studies are conducted by scholars to analyze fall incidents.

3.1 Analysis of Fall Incidents

Johnson et al. (2010) analyzed fall incidents in hospitals. They indicated that a vast majority of fall incidents (77%) were not observed and caused minor injuries namely soft tissue injuries, lacerations, and bruises. The result of their research work reveals that falling cases took place mostly during two periods 9am - 12am and 1pm - 5pm. Moreover, it was discovered that elderly underwent falling cases happened surrounding their bed areas especially when they are transferred to and from beds and also inside washrooms during standing up. In addition, it was learned from this study that although elderly are novice in use of assistive walking devices yet they refuse to seek help from care givers or nurses. The recommended solutions for fall prevention during use of walking devices are educating older adults and use of an early alerting system. Table 2 presents a summary of this conducted research.

Table 2. Summary of Johnson et al. (2010) research work

Fall Incidents	
Fall common periods	9 a.m. – 12a.m. and 1 p.m. – 5 p.m.
Fall common location	<ul style="list-style-type: none"> ▪ Beds surrounding area ▪ Inside bathrooms and toilets
Reasons	<ul style="list-style-type: none"> ▪ Dearth of knowledge in terms of use of walking devices ▪ Refusing to ask help from nurses and care givers
Recommendations	<ul style="list-style-type: none"> ▪ Provision of adequate education for use of walking device ▪ Utilization of alerting system

3.2 Falling Risk Factors

There are critical consequences of fall incidents including: fatal and nonfatal injuries, growth in use of healthcare, functional disabilities, untimely institutionalization, loss of confidence, social withdrawal, rise in dependency, and self-imposed limitations (Centers for Disease Control and Prevention, 2016; Tinetti & Powell, 1993). Various studies have been conducted to identify falling risk factors with the purpose of diminishing fall incidents and severe injuries. Fall risk factors can be categorized mainly into five categories: demographic, illness,

physical impairment, living environment, and medication (Drootin et al., 2011; Sartini et al., 2010; Axer et al., 2010; Inattiniemi et al., 2009).

3.2.1 Demographic

This category consists of gender, age, and race of older adults. Increase in age results in changes in both pathologic and physiologic paving the ground for falling and injuries (Ambrose et al., 2013). It is stated that women suffer 58% more from falling nonfatal injuries as compared to men (Dunlop et al., 2002). In contrast, it is reported that death rate as a consequence of falling in men is 46% more than women. In terms of race, number of white elderly women passing away by virtue of falling is 2.5 times more than black women (Ambrose et al., 2013). Those studies support that demographic factors have significant role in falling and fatal and nonfatal varies in accordance with gender, age, and race.

3.2.2 Illness

In accordance with conducted previous studies elderly suffering from disease such as cardiovascular, hypertension, atrial fibrillation, and orthostatic are more in risk of falling and its injuries. These illnesses have noticeable effect on elderly balance; therefore, growing fall incidents (Hausdorff et al., 2003; Sanders et al., 2012; Gangavati et al., 2011; Freeman et al., 2011).

3.2.3 Physical Impairment

Visual and balance impairments are identified as one the effective factors in fall incidents. It is reported that poor balance management, impoverished eyesight, and obstacle prevention ability give way to misestimating of distance and misapprehension of spatial information resulting in misjudgment of depth (Klein et al., 2003). It is substantial to estimate spatial distances accurately in order to walk safely. In addition to depth misestimating, impoverished contrast sensitivity is another significant factor in fall incidents (Patino et al., 2010; Salonen & Kivelä, 2012). It is stated that actions such as bifocal and multi-focal spectacles replacement (Johnson et al., 2007; Lord et al., 2002) as well as cataract operation diminish fall incidents (Harwood et al., 2005; Hodge et al., 2007). Increase in senior citizens age weakens muscle strength and body flexibility as well as reduces height and step lengths which lead to difficulty in balance control (Deandrea et al., 2010; Jensen et al., 2001).

3.2.4 Living Environment

Living environment is known as one of the factor contributing in fall incidents. Take this as a prime example, environment with poor lighting and unnecessary items such as loos rug lead fall incidents for elderly with visual impairment (Menz et al., 2006). For this reason, it is substantial to assess home hazard with the purpose of reducing fall incidents (Gillespie et al., 2003). Moreover, another risky falling factor is walking footwear namely socks, slippers, and shoes with heels. It is found that footwear affects postural stability. In accordance with previous studies, walking with slippers, socks, or shoes with heels grows number of fall incidents (Menz et al., 2006; Koepsell et al., 2004; Menant et al., 2008).

3.2.5 Medication

It is found in a great number of conducted research studies that elderly who are under medication of specific illness such as diabetes, psychotropic, ant-epileptics, and cardiovascular are far more in danger of fall incidents in virtue of medicine effects (Woolcott et al., 2009; Hartikainen et al., 2007; Berlie & Garwood, 2010; Hegeman et al., 2009; Kelly et al., 2003; Ensrud et al., 2002).

3.3 Recommendations

It is obvious that there are a great number of risk factors associated to fall incidents. Albeit a noticeable number of assistive walking devices are designed for older adults to diminish falling and related injuries yet elderly witness fall incidents. For this reasons, in accordance with previous studies, it is recommended to embed frequent activities in elderly's routine life. For instance, hundred-fifty (150) minutes aerobic physical exercise weekly, twice a week muscle strengthening exercise, and balance training minimum three (3) day a week (Moyer, 2012). Moreover, it is reported that frequent physical therapy and supplementary medicine such as vitamin D and calcium alleviate fall incidents (Dite & Temple, 2002). In addition, there are effective intervention actions which can be taken to ameliorate older adults' situations. These actions are: considering footwear and foot issues, modification in home environment, reduction in psychoactive medication, management of postural hypotension, and surgeries such as cataract to ameliorate eyesight (Ambrose et al., 2013). It is learned from the other studies that falling awareness, precaution approaches, self-management approach consisting empowering elderly, improvement of problem solving skills, and action planning have pivotal role in fall prevention (Pohl, 2015). Besides, educating senior citizens in both fields of fall prevention and how to use assistive walking devices is

considerably effective in fall prevention (Drootin, 2011). We summarized the falling factors and recommended solutions in Table 3.

Table 3. Summary of falling factors and recommended solutions

Falling Factors	Proposed solutions
<ul style="list-style-type: none"> ▪ Demographic ▪ Illness ▪ Physical impairment ▪ Living environment ▪ Medication 	<ul style="list-style-type: none"> ▪ Weekly muscle strengthening and aerobic physical exercise ▪ Balance training ▪ Physical therapy ▪ Supplementary medicine; Vitamin D and Calcium ▪ Taking effective interventions such as considering footwear and foot issues, modification in home environment, reduction in psychoactive medication, management of postural hypotension, and cataract surgeries ▪ Increasing awareness of fall prevention factors <p>Educating older adults</p>

4. Assessment of Assistive Walking Device

Wheeled walkers (WW) have appealed a noticeable number of senior citizens; therefore, they are utilized widely by them. Albeit wheeled walker have compensated older adults’ difficulties in moving yet in accordance with conducted research work, wheeled walkers can be ameliorated to facilitate moving and fulfill elderly’s needs (Lindemann et al., 2016). Wheeled walkers are utilized primarily to fulfill elderly’s needs of balance control and mobility (Bateni & Bateni, 2005; Salminen et al., 2009) and also decreasing fall incidents (Graafmans et al., 2003). It is stated that fall incidents whilst using wheeled walker lead acute injuries (Van Riel et al., 2014). Based on the previous studies, it is found that elderly suffering from disease namely Parkinson refuse to utilize wheeled walkers (Bryant et al., 2012).

According to a conduct research study by Lindemann and his team members (2016), there are a noticeable number of problems during use of wheeled walkers triggering fall incidents. These problems are walking on uneven surface, walking backward, uphill, and downhill, facing obstacle during walking namely stairs in public transportation, carrying an object when facing an obstacle. Based on their findings, vast majority of older adults responded that it is challenging to maintain balance and open a door which is in opposite direction of their wheeled walker. This situation impoverished when an elderly carries an object whilst walking through a door. Therefore, older adults found it easier to walk without a wheeled walker when passing or opening a door. In order to solve this problem, it is recommended to take steps backward with walking device whilst opening the door. On the other hand, this recommendation is rejected because solely the front wheels of wheeled walker are powered with 360 degree navigation, whilst the navigation of back wheels is limited. The other recommended solution is intelligent considering obstacle preventing, navigation equipment, and powered impulsion (Rentschler, 2013). Using intelligent walkers is recommended to overcome the limitation of wheeled-walking devices (see Table 4).

Table 4. Summary of falling factors and recommended solutions

Problems associated with wheeled walking devices	<ul style="list-style-type: none"> ▪ Walking on uneven surface ▪ Walking backward, uphill, and downhill ▪ Facing obstacle during moving ▪ Carrying an object when facing an obstacle
Solution	<ul style="list-style-type: none"> ▪ Intelligent walkers

4.1 Role of Information and Communication Technology in Walking Devices

Over the recent decades, Information and Communication Technology (ICT) has been embedded into assistive

walking devices with the purpose of fall detection and prevention as well as alarm system in case of fall incident (Hawley-Hague et al., 2014). Advent of ICT in the field of walking devices leads to greater fall monitoring and also alerting system for informing caretakers or medical professionals (Brownsell & Hawley, 2004). ICT plays imperative and effective role in diminishing waiting time for both lying down on the surface and receiving assistance when a fall incident takes place (Hawley-Hague et al., 2014). It is learned from a noticeable number of research studies that activity programs play substantial role in fall prevention ((Sherrington et al., 2011; Gillespie et al., 2012). Consequently, ICT is utilized widely in balance control and muscle strengthening training programs for senior citizens with aim of fall prevention. The prime examples of the mentioned training programs are kinect and wii-fit (Miller et al., 2012; Williams et al., 2010). The noticeable advantage of ICT utilization in training programs is cost and time saving since the training service can be expanded to older adults' homes. Despite of great advantages, the main problem of ICT is adoption and utilization of ICT walking devices by senior citizen (Demiris & Hensel, 2008). A noticeable number of research studies were conducted to assess older adults' needs and preferences from ICT walking devices for fall prevention purposes at home. In the following, two main types of ICT devices for fall prevention purposes are assessed based on older adults' perspectives.

4.2 Home Automation System

This wearable device is attached to the body through neoprene belt and transparent film. The device is featured with video monitoring function to detect fall incidents (Mihailidis et al., 2008; Mathie et al., 2004). It is learned that vast majority of older adults are concern about their privacy; therefore, they prefer to have blurred images when they at private places of the house namely bedroom. On the other hand, it is acceptable to have clear images when they are at places namely living room (Londei et al., 2009; Mihailidis et al., 2008). It is found that senior citizens decline to fancy visual surveillance or cameras (Steele et al., 2009). The older adults prefer to have full control over functions of the device (Londei et al., 2009; Heinbüchner et al., 2010; Blythe, 2005). For instance, elderly prefer to cancel false alarm by themselves. Surprisingly, it is obtained that one the primary reasons that elderly decline to use ICT device is disability to switch off the device alarm (Van Hoof et al., 2011; Londei et al., 2009; Chou et al., 2012; Horton, 2008). It is learned also that a great number of elderly are concern about the cost and maintenance fees of the device; therefore, this is one of the factors that they decline to utilize ICT devices (Mihailidis et al., 2008; Steele et al., 2009; Demiris et al., 2004; Dorsten et al., 2009). In accordance with Heinbüchner et al. (2010) research work, it is found that older adults faced difficulties to wear the device. In addition, it is discovered that elderly prefer small assistance button, better set of transmitter, considerable comfort, greater long-lasting, ease of technology utilization, and greater adaption (Heinbüchner et al., 2010). In another needs assessment study by Holzinger et al. (2010), it is discovered that senior citizens fancy unobtrusive and light devices designed in various colors. Moreover, findings of this study indicate that older adults faced difficulties to use the device button and to read the grey color text with same color background. In addition, wrist devices are more favorable as compared to the other devices in virtue of facing difficulties in wearing (Holzinger et al., 2010). Apart from older adults' needs and preferences from home automation system, research work of Brownsell et al., 2004 shows that older adults feel more secure and autonomy to take risk whilst using ICT devices.

4.3 Portable Computers and Communication System

As opposed to home automation system, both portable computers and communication devices are not wearable and can be easily move in the environment (Silveira et al., 2013; Wu & Hensel, 2008). Research work of both Silveira et al. (2013) and Wu & Hensel (2008) represent that older adults found portable devices such as ipad and teleconferencing greatly convenient for carrying out activities. Moreover, in virtue of high level of satisfaction, elderly noticeably recommended portable devices specifically iPad to their members of family and friends. The iPad application namely Active Lifestyle successfully appealed a great number of older adults to carry out exercise. Besides, older adults responded that it is easy to utilize the technology. It is reported that social motivation has a dramatic role in appealing elderly to carry out activities especially by comparing progress with each other. Social motivation paved the ground for older adults to feel supported, whilst sharing opinion, experience, and concern.

5. Conclusion

All in all, in accordance with various conducted research studies, it is obvious that fall incidents are of a substantial concern to older adults, caregivers, members of family, medical professionals, and even designers of assistive walking devices. It can be learned from the past studies that some of fall factors are inevitable. One of the inevitable factors is age resulting in reduction in mobility, stability, and muscle strengths. Therefore, it is pivotal for senior citizens to carry out consistent weekly exercise to compensate small portion of their weakness.

Moreover, although assistive walking device facilitate movement and diminish risk of fall, yet there is gap for improvement to fulfill elderly needs and preferences. In conclusion, it is evident that both development of walking devices and elderly's weekly base exercise are in line with each other. Therefore, both of them have imperative role in reducing fall incidents and associated injuries as well as improving life quality of older adults.

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