

## Literature Review

# Medical and Assistive Health Technology: Meeting the Needs of Aging Populations

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## Abstract

**Purpose of the Study:** To identify policy gaps in the delivery and availability of assistive health technology (AHT) and medical devices (MD) for aging populations, particularly in low- and middle-income countries (LMICs).

**Design and Methods:** The findings presented in this paper are the results of several narrative overviews. They provide a contextual analysis of the conclusions and evidence from WHO commissioned research and expert consultations in 2013 and 2014, as well as a synthesis of literature reviews conducted on AHT and MD.

**Results:** Practical, life-enhancing support for older people through AHT, MD, and related health and social services is a neglected issue. This is particularly so in LMICs where the biggest increases in aging populations are occurring, and yet where there is commonly little or no access to these vital components of healthy aging.

**Implications:** Health technologies, especially medical and assistive health technology, are essential to ensure older people's dignity and autonomy, but their current and potential benefits have received little recognition in LMICs. Viewing these technologies as relevant only to disabled people is an inadequate approach. They should be accessible to both older adults with disabilities and older adults with functional limitation. Many countries need much greater official awareness of older adults' needs and preferences. Such attitudinal changes should then be reflected in laws and regulations to address the specificities of care for older people.

**Key Words:** Technology, Disabilities, Function/mobility, Health policy

Using a conservative assumption of 20% of the population aged 60 and older being in need of two assistive devices (AD) items each leads to a global estimate of at least 800 million items being in use by older people in the year 2050. To ensure that this need is met, products and related services need to be available (they can be found on the market), accessible (they can be obtained and appropriately used when needed), affordable (intended users can pay for them), appropriate (they are acceptable to users and can be utilized and maintained with resources the community or

country can afford), and safe (they respond to quality and safety criteria). Resources to manufacture and handle them and adequate systems to provide them are also required.

Given that the proportion of current users of assistive technology (AT) and medical devices (MD) increases by age, for example, from 20% at age 70 up to 90% at age 90 for AD (Ivanoff & Sonn, 2005), the global growth of the aging population is leading to an unprecedented need for assistive health technology (AHT) and MD. Ensuring equitable access to AT and MD to support healthy aging constitutes a major challenge.

## Aim

The aim of this paper is to identify policy gaps in the delivery and availability of AHT and MD for aging populations, particularly in low- and middle-income countries (LMICs).

## Methodology

The findings presented in this paper are the results of several narrative overviews. They provide a contextual analysis of the conclusions and evidence from WHO commissioned research and expert consultations (WHO Centre for Health Development, 2013; WHO, 2014b), as well as a synthesis of literature reviews conducted on AHT and MD. As such, they are not comprehensive, and the quality of included studies was not systematically assessed.

Searches were performed at two different time points. In November 2014, to retrieve the main body of literature in English language from PUBMED and the WHO Library Database (WHOLIS), and in October 2015, to take into account information included in the newly published WHO World Report on Ageing and Health.

Two groups of keywords were combined: those relating to aging population (keywords: ageing, aging, elderly, older), those relating to AHT and/or MD (keywords: assistive device, assistive product, assistive technology, medical product, medical device, medical technology, technology for independent).

Gray literature was sourced through references presented at the WHO Global Forum on Innovation for Ageing Populations (Kobe, December 2013), the WHO Global Cooperation on Assistive Technology Meeting (Geneva, July 2014), and related citations from peer-reviewed work.

Material was included if it addressed or was focused on older people and AHT and/or MD and met at least one of the following criteria: a literature review, a report or proceedings of an international conference, a study or survey of older people AHT and/or MD use and/or requirement, a review of current emerging areas of technology, a review or report on AHT and/or MD systems and/or policy.

Included documents were retrieved and scanned for information of relevance to the objectives of this study. Data were analyzed thematically and a narrative summary of study findings within each theme is provided.

This approach was chosen because a systematic review encompassing the scope of the study would not have been feasible; however, the selection of the literature would provide sufficient scope to draw conclusions and provide guidance for future research and policy development, as well as provide a broad perspective on the issue of AHT and MD availability, accessibility, affordability, acceptability, and safety, in the context of LMICs.

The themes emerging from the review and contextual analysis are presented in five sections:

1. Aging and the need for health technologies in LMICs
2. Bridging gaps between policies and practices
3. Improving products and services
4. Barriers to innovation in health technologies
5. Conclusions and recommendations

## Aging and the Need for Health Technologies in LMICs

The global population aged 60 years and older is expected to reach more than 2 billion by 2050, which is 250% higher than in 2013. The greatest growth in older people by then will be in LMICs. This has major implications for health and social care systems because human function tends inevitably to deteriorate with age (Chatterji, Byles, Cutler, Seeman, & Verdes, 2015).

One of WHO's biggest priorities is to enable older people to remain healthy, active, and independent as long as possible (WHO, 2002). Achieving this requires early diagnosis, prevention, and treatment of prevalent diseases, such as noncommunicable diseases (NCDs), reduction of their risk factors, and prevention, delay, care, and management of functional and cognitive decline. A focus on NCDs is important because evidence shows that there is an increased prevalence of chronic conditions in older populations, and chronic conditions like these account for a large share of observed disabilities in older adults (Chatterji et al., 2015).

One of the well-documented challenges of old age is maintaining functional capacity. The 2002 WHO framework on Active Ageing, and the 2015 WHO framework on Ageing and Health, both point out to the range of functional decline experienced by people as they age (WHO, 2002, 2015b). Those declines are largely determined by behavioral and environmental factors, thus can be acted upon with appropriate interventions and policies.

One such policy is the use of AHT (see Box 1), as it has been found to contribute to improved functioning or slowed functional decline, improved well-being and quality of life, improved safety, reduced falls, reduced care and hospitalization, improved independence, and less worry among older people and their family members (Borg, Lindström, & Larsson, 2011; Bowes, Dawson, & Greasley-Adams, 2013; Lin & Wu, 2014). Moreover, evidence now shows that systematic approaches in AHT provision tend to enhance their key role in helping frail older adults—improving their condition, supporting their autonomy, delaying their institutionalization, and thus helping reduce health care costs (Anderson & Wiener, 2015).

Although paid care time at home may not always be significantly reduced by the use of AHT, the combination of informal and paid care time is typically reduced or more effectively utilized (Anderson & Wiener, 2015; Layton, Wilson, & Andrews, 2014).

Six core life domains are currently targeted by AHT: self-care and personal hygiene, physical and mental health, mobility, social connectedness/isolation (e.g., loneliness), safety, and daily activities and leisure (Löfqvist, Haak, & Slaug, 2013; Löfqvist, Nygren, Széman, & Iwarsson, 2005;

Schulz et al., 2015). Communication may be a part of several of these. The rise of “intelligent” technology and concepts like “Smart Homes” suggests other attributes that subdivide the AHT field: (a) monitoring/measuring the environment or the person; (b) diagnosis or screening for problems, needs, or desires; and (c) treatment/intervention as a result of (b) (Schulz et al., 2015).

The electronic connectedness of society and communities is a key feature of information and communication technologies for older people. Although many older persons have been both technologically averse and found such developments increased their isolation, many others are increasingly familiar with such connectivity and are expected to drive demand as they move into older age (Morris et al., 2014; Peetoom, Lexis, Joore, Dirksen, & De Witte, 2015; Reeder et al., 2013). This will be stoked by the expanding global use of the Internet, mobile phones and tablets, and health-related innovations such as eHealth and mHealth, which exploit and enhance information communication technologies and connect people more quickly with health and social services.

Surveys of AD actually used by older people suggest that only the basic items are widely used, including vision and hearing products, basic mobility devices (such as canes, walking frames), toileting equipment, and some cushions or adjustment to furniture or beds (Löfqvist et al., 2013; Löfqvist, Slaug, Ekström, Kylberg, & Haak, 2014; Mann, Llanes, Justiss, & Tomita, 2004; WHO, 2014b).

Similar issues apply to MD (see Box 1). A rapid systematic review of needs for MD of aging populations was conducted by WHO to identify MD required for five main cancers affecting the aged population in the Western Pacific Region (WPRO). This was part of the WHO objective to ensure improved access, quality, and use of medical products and technologies. Most of the devices identified were for diagnoses and therapies, such as CT scans, ultrasound and x-rays, radiotherapy, robotic surgical systems, and surgical lasers, and a few for prevention, such as lasers and endoscopes (Royal Australasian College of Surgeons, 2013).

WHO has also conducted several surveys of countries of various socioeconomic profiles and the medical service industry to better understand the key issues. Among those are concerns related to cost, regulation, and information for the selection and training of users. If the rising need by older people for MD is to be met, the lack of financial schemes for purchasing these devices must be addressed. These surveys show a strong reliance by families on out-of-pocket payment. The MD industry is becoming increasingly interested in developing adapted MD for older people. Although most of today’s technologies tend to focus on chronic disease, they fail to respond to a growing demand for innovative affordable devices for home-based care and for settings where no specialized human resources are available (WHO Centre for Health Development, 2013).

Research conducted in six Asian countries suggests four priority areas where public health efforts should be pursued to provide adequate MD: cardiovascular

diseases, malignant neoplasm, sense organ diseases, and respiratory diseases (Royal Australasian College of Surgeons, 2013).

#### Box 1: Terms and definitions

**Assistive health technology (AHT):** This is defined as a subset of health technology that encompasses *assistive devices (AD)* and services for their provision. AHT is thus the application of organized knowledge and skills, procedures and systems related to provision of AD and services, whose primary purpose is to maintain or improve an individual’s functioning and independence, to facilitate participation, and enhancement of overall well-being and quality of life. AHT is also known as *assistive technology (AT)* (International Organization for Standardization [ISO]).

Historically, AHT has been associated with disability and has often been shunned by the aging population. But the pervasiveness of technology in modern life suggests this may be changing both for older people and their caregivers (Aminzadeh & Edwards, 1998; Parette & Scherer, 2004). The range of AD stretches along a continuum from low to high technology (Bouck, Flanagan, Miller, & Bassette, 2012).

**Disability:** The International Classification of Functioning, Disability and Health (ICF) defines disability as an umbrella term for impairments, activity limitations, and participation restrictions. Disability can be understood in terms of loss of functional ability that encompasses the interaction between individuals with a health condition and personal and environmental factors. The most common causes of disability globally are adult-onset hearing loss and refractive errors. Mental disorders such as depression, alcohol use disorders, and psychoses (e.g., bipolar disorder and schizophrenia) are also among the 20 leading causes of disability. Moreover, disability prevalence rises strongly with age. The average global prevalence of moderate and severe disability ranges from 15% in those aged 15–59 years, to 46% in those aged 60 years and older (WHO, 2008b).

**Medical devices:** This term covers a broad range of medical equipment, from simple implements to highly sophisticated machines. The need for a particular medical device is highly context-specific. In this paper, medical devices are referred to mainly as those used in the prevention, diagnosis, and treatment of the main conditions—noncommunicable diseases (NCDs)—that affect aging populations. Medical devices are required in all aspects of clinical practice and are needed in the management of many chronic NCD conditions. They also are a source of cost for the health care system.

**Note:** This box provides definitions for key terms used in this article.

### Box 2: Policy priorities

Policies need to address four CRPD-based reasons for establishing and maintaining a service delivery system, namely: (a) the ethical issue: the principle of equal opportunities for all regardless of their capabilities; (b) the financial issue: the need to remove cost barriers to give equal opportunity of access to assistive health technology (AHT); (c) the expertise issue: the need for qualified support when selecting and implementing an AHT solution; and (d) the consistency issue: ensuring that AHT interventions fit an individual's life situation (WHO, 2008a).

These issues are also in line with the principles of Universal Health Coverage.

*Note:* This box highlights four areas of policy priority to ensure that service delivery address the recommendation of the Convention on the Rights of Persons with Disabilities.

Rapid technical advances are very likely to change technology design, development, and use. For AHT and MD to be truly beneficial to the health and well-being of a diverse range of people over their life course, a “one-size-fits-all” approach will be insufficient. Instead, AHT and MD will have to adapt to both declines in function and capacity and maximize and encourage positive goals and motivation. Integration of these new AD into the daily lives of older people and of those who provide them with family, community, or clinical care is a challenge almost as daunting as the development of the technologies themselves.

### Bridging Gaps Between Policies and Practices

National frameworks in LMICs are central to ensuring the inclusion of health technologies, such as medical and assistive devices, in health and aging policies, based on recognition of their effectiveness and usefulness. They need to address ethical, financial, expertise, and consistency issues (Andrich, Mathiassen, Hoogerwerf, & Gelderblom, 2013). Equity of access must be a core principle of such policies in order to reflect and support the current global agenda on Universal Health Coverage (UHC). Thus, for any government seeking to promote equitable, healthy aging cost-effectively, a first step is to ensure that appropriate policies that incorporate AHT and MD are adopted and implemented.

A global survey among 114 countries in 2005 found that 50% of them had passed relevant national legislation and 52% had AHT-related policies in place (Office of the United Nations Special Rapporteur on Disabilities, 2005). Governments will have to build agile policy and systems adaptable to the increasingly rapid changes underway, but they must also recognize that use and demand for certain technologies varies by generation (D'Ambrosio & Mehler, 2014).

The findings contained in a 2014 report by the WHO (WHO, 2014b) also expose the existing gap between

legislation and practice. Some examples of legislation and policies were found, but it remains unclear whether they have caused significant improvement in provision of AHT for older adults in practice. Furthermore, much of the legislation has focused only on individuals with disabilities, excluding nondisabled older adults.

Countries with no relevant legislation could begin by ratifying the *Convention on the Rights of Persons with Disabilities* (CRPD). Those that have ratified and have legislation in place could make amendments and adopt new legislation more focused on improving function and well-being of older adults. Providing AHT to older adults differs markedly from providing AHT to disabled children or middle-aged adults—so products and services need different approaches.

More often than not in government ministries, issues related to older people are discussed under umbrella terms such as “disabled care” or “family care” or “family medicine” (Marasinghe, Lapitan, & Ross, 2015). This partly explains the scarcity of existing legislation specially focusing on providing AT for older adults.

One good example is the Incheon Strategy in Asia and the Pacific, which underscores a policy direction where people with functional limitations have access to the physical environment, public transportation, knowledge, information, and communication through AHT and universal design (United Nations Economic and Social Commission for Asia and the Pacific, 2012). It recognizes the need to accommodate economic, geographic, linguistic, and cultural diversity and also encourages research, development, production, distribution, and maintenance to ensure AHT availability.

MD are critical to the delivery of health care, particularly for the prevention, diagnosis, and treatment of diseases. Making appropriate MD available and affordable in health care settings is linked to health equity and service delivery that is more responsive to the needs of patients.

A Baseline Country Survey on Medical Devices was launched in 2010 and updated in 2013 with responses from 177 countries (WHO, 2014, unpublished). The findings indicate an existence of national policies, national regulatory agencies for MD, and other relevant topics. Although 121 countries among 175 respondents have a national regulatory agency for MD, to date only 90 among 174 respondents still do not have a health technology policy. There is clearly a need both for further support in development of national policies and for development and enforcement of MD regulations.

This survey also revealed that too often in LMICs, the necessary apparatus to implement policies needs strengthening, and regulatory bodies are ill-equipped to address the challenges of prioritization and assessments of MD. Health Technology Assessments, when effectively staffed and operated, have proven themselves to be key instruments. They enable the cost-effective selection and identification of MD,

as well as recommendations on public policies regarding MD as they relate to the needs of the population and the national priorities.

### Improving Products and Services

Health technology products and services should be integral parts of all health and aging policies. As such these products and services must meet stringent criteria to respond to the needs and preferences of older populations. These criteria are availability, accessibility, adaptability, acceptability, affordability, safety, and quality of both products and related services.

This section deals with both products and services.

#### Products

Safety and quality depend largely on the existence of adequate regulations relating to all health technologies and on the need for registration and post-market surveillance.

Research suggests five major areas of functioning and the environment in which AD provide essential support for older adults (WHO, 2014b). Examples in each major area are provided in Table 1.

The need for and use of AT vary with individual and contextual factors, such as age, gender, living alone status, and infrastructural accessibility. Being able to successfully use some AT may necessitate adaptations of the home and other environments (Scherer, 2004).

Environments of importance for healthy aging include primary health care facilities, which need to be accessible to older people using AD (United Nations, 2007; WHO,

2008a). Older people make up society's largest group of AD users so it is important that AHT services are accessible to them, in terms of both geographical location and physical accessibility.

For example, applied to one area critical to sustaining autonomy of older adults, mobility, evidence from a systematic review shows that AHT mobility devices "improve users' activity and participation and increase mobility" (Salminen, Brandt, Samuelsson, Töytäri, & Malmivaara, 2009).

#### Services

Access to needed AHT and MD is a significant determinant of healthy aging and enabling older people to age in place (see Box 2). This means having access to a wide selection of devices that support and improve the basics of daily life, such as seeing, hearing, speaking, moving, remembering, eating and drinking, personal hygiene, and personal safety and protection. These are fundamental but essential devices such as spectacles, hearing aids, and walking sticks. Safe use of devices in homes or in circumstances where there are few or no health care workers must also be considered (WHO Centre for Health Development, 2013).

The 2014 WHO six-nation AHT survey found that although AT for vision, hearing, and mobility are reasonably available and utilized, many of the other product categories are limited in their availability, not available at all in certain countries/settings, and access to AHT advice is variable (WHO, 2014b). This was supported by participants at the WHO GATE Forum (July 2014) who attested that

**Table 1.** Examples of AD per Area of Functioning and Environment

| Area        | Examples of AD                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mobility    | <ul style="list-style-type: none"> <li>Walking stick, crutch, walking frame, manual and powered wheelchair, tricycle</li> <li>Artificial leg or hand, caliper, hand splint, drop foot brace</li> <li>Chair leg extenders, special seat, standing frame</li> <li>Adapted cutlery and cooking utensil, dressing stick, shower seat, toilet seat, toilet frame, feeding robot, pickup stick, book stand, grip tool, nonslip pad, trolley</li> </ul> |
| Vision      | <ul style="list-style-type: none"> <li>Eyeglasses, magnifier, magnifying software for computer</li> <li>White cane, GPS-based navigation device</li> <li>Braille system for reading and writing, screen reader for computer, talking book player, audio recorder and player</li> </ul>                                                                                                                                                           |
| Hearing     | <ul style="list-style-type: none"> <li>Headphone, hearing aid</li> <li>Amplified telephone</li> </ul>                                                                                                                                                                                                                                                                                                                                            |
| Speech      | <ul style="list-style-type: none"> <li>Communication cards with texts, communication board with letters</li> <li>Electronic communication device with recorded or synthetic speech</li> </ul>                                                                                                                                                                                                                                                    |
| Mental      | <ul style="list-style-type: none"> <li>Task list, picture schedule and calendar, picture-based instruction</li> <li>Timer, manual or automatic reminder, smartphone with adapted task list, schedule, calendar, and audio recorder</li> <li>Communication board with symbols or pictures, screen reader for computer</li> <li>Stove guard, automatic night light, smart home system</li> </ul>                                                   |
| Environment | <ul style="list-style-type: none"> <li>Ramp, wide door, handle, accessible toilet and bathroom</li> <li>Tactile map, braille buttons</li> <li>Hearing loop</li> <li>Simple signs</li> </ul>                                                                                                                                                                                                                                                      |

Note: The table lists examples of AD by functional and environment domain.

often vital AHT was beyond the financial capacity of many individuals and their families (WHO, 2014a).

Affordability has been identified as a major barrier to AHT for older people in most settings. Education and training of health personnel are critical to deliver the best outcomes from AHT for older people. Currently, educational programs operate almost in isolation with little understanding of the potential issues and requirements of older people. Technology (including AHT) for older people has often been simply “overlaid” on existing systems and care approaches (Schulz et al., 2015). Creative multidisciplinary teams and collaborations must look to redesign those systems and approaches to maximize the opportunities provided by AHT.

Older people may need more than one AD, for example, a hearing aid in addition to a pair of spectacles, or vice versa. But these ATs are seldom available in one place, thus creating avoidable difficulties in accessing them.

The provision of AHT is fragmented according to different impairments. WHO has recently called for integrated health and social care services to be built to prevent such fragmentation and to regard older people as whole individuals with interacting health needs and preferences rather than merely as a collation of diseases (WHO, 2015a).

Service providers are often specialists in a particular range of AHT, or AHT for a particular impairment group. There are few specialized professionals covering every group, especially in LMICs (Borg, Lindström, & Larsson, 2009). Action is required to ensure that the most essential AD covering common functional domains are available at the community level everywhere, for example, from a community clinic. This would improve access to AHT for older people closer to their own communities, especially in rural areas. To ensure equitable provision of AHT, service providers can learn from community-based rehabilitation strategies to raise awareness, to deliver services, to use local resources, and to collaborate, while at the same time considering cultural factors (Borg & Östergren, 2015).

The appropriateness of combinations of the following three different models may be evaluated. First, a medical model suggests that each AD should be prescribed by a qualified professional. Second, the social model suggests that the focus is on the solution rather than specific products, giving the user relative freedom to choose from a range of products. Third, the consumer model suggests that the user decides on the AD (Andrich et al., 2013).

Whichever model is favored when defining and implementing appropriate policies, it is important to continue to develop robust evidence of the most effective utilization of new assistive technologies for older people to provide balance to the aggressive marketing in some countries for this rapidly growing sector.

Access is also vital to those MD related to the major diseases that affect older people (such as cardiovascular and respiratory diseases, cancers, sense organ diseases, and neuropsychiatric conditions), without neglecting the needs

of persons with less common or rare diseases, conditions, or impairments.

Many of these health technologies are, however, neither available, durable, nor sufficiently acceptable to the user. In countries where various devices are financially supported by the health or social care system, access may well be inequitable, putting them financially beyond reach of many individuals.

Access to AHT and MD should be complemented with and supported by access to wider health and social services, qualified staff and caregivers, as well as information and advice.

Unfortunately, access, in all its senses, is virtually nonexistent for many millions of older people, especially in LMICs.

## Barriers to Innovation in Health Technologies

Existing and potential barriers to provisions of these technologies include the absence of legal frameworks and economic, social, cultural, educational, and psychological obstacles. Through surveys and consultations, WHO has identified some barriers to improving the delivery of AHT and MD in LMICs. Four of these barriers can be seen as key drivers for change and merit particular attention.

### Terminology

Care is required to ensure that both the terminology and scope of functional activity (and this associated AHT) are not limited by high-income country experiences. The 2014 survey on AHT in the Western Pacific Region (see Boxes 3 and 4) found that current classifications specify activities such as hunting/fishing and farming (“gardening”) as recreational, when for lower-income communities they may be essential socioeconomic activities. HelpAge International has cited an older person in an Asian low-income setting saying: “If I can’t plant, I don’t eat, and my family dies, I die. It’s very, very simple” (WHO, 2014c).

A reflection that certain activities may change domain, depending on context, may be necessary to recognize this important area for AHT.

### Stigma

The psychosocial issues of aging are now being confronted, somewhat belatedly. Older people often report loneliness and isolation, thus challenging technology and services to support their well-being through connectedness and self-efficacy. Initial “monitoring” solutions resisted by older people because of concerns about autonomy and privacy are now being integrated into collaborative health management with family and professionals (Kramer, 2014). The proliferation of personal smartphones and tablets with ready access to a vast array of applications has prompted efforts to provide assessment of their suitability both for

professionals (e.g., [telecare-epg.info](http://telecare-epg.info)) and consumers (e.g., [apps.nhs.uk](http://apps.nhs.uk)).

### Affordability

Affordability has been identified as a major barrier to AHT for older people in most settings and from other age groups in less resourced settings (Borg & Östergren, 2015).

#### Box 3: Rating of activity and functional areas for older people

In 2014, WHO conducted a survey on assistive and medical devices for older people (defined as older than 60 years) in six countries—China, Malaysia, Japan, the Philippines, the Republic of Korea, and Viet Nam (WHO, 2014b). The respondents to the assistive health technology (AHT) questions ( $n = 67$ ), primarily those involved in providing health or AHT services and not necessarily older people themselves, rated and ranked 12 activity and functional areas for older people. The areas, listed as they were ranked, were:

1. Eating and drinking as independently as possible
2. Transferring to or from bed or chair
3. Being able to be clean and hygienic
4. Being able to hear and communicate
5. Being able to dress
6. Being able to see and understand writing
7. Moving about and use transport
8. Gripping or pickup items and do housework
9. Managing health care and fatigue including following health advice
10. Participation in community activities (can include employment) & visiting others
11. Taking care of a family member
12. Experiencing intimate/sexual relations

After identifying the priority activities for older people, survey respondents were asked to select and rank their top priority AD under each activity and functional area. The top six device categories across *all* areas were:

1. AD for seeing
2. AD for transfer and turning
3. AD for cognitive assistance
4. (Non-AD) Personal assistance
5. AD for personal care
6. AD for environment

Technology for cognitive assistance was rated as a high priority but was rarely available in any setting. The use of personal support ranked at number 4, suggesting that for many people there are no suitable technological options to address particular functional needs, leaving human assistance as an important adjunct.

*Note:* The box provides a synthesis of priority areas to match current needs of older adults for technologies.

#### Box 4: Survey of needs for assistive and medical devices for older people in six countries of the WHO Western Pacific Region

This survey, conducted in the same six countries as described in Box 3, was conducted in 2014 as follow-on from a systematic review on medical devices (MD) and a study on assistive devices (AD) for older populations, in addition to a consultation on this theme and the first WHO Global Forum on Innovation for Ageing Populations.

The survey had three core objectives: to identify priority assistive and medical devices (AMD) that need to be available for people older than 60 years of age in the six focus countries of the survey; to understand the contributing factors for AMD availability or unavailability; and to identify possible approaches to improve access to high-quality AMD at an affordable cost, especially in middle-income countries.

The survey collected basic demographic information from survey participants ( $n = 100$ , 51% response rate) as well as detailed information on the priority needs for AMD, as well as their current availability.

MD were grouped by disease category (cardiovascular, sense organ, and respiratory disease, and malignant neoplasm) and also by other general categories (diagnostic, laboratory diagnostic, point-of-care in vitro, diagnostic imaging, and surgery and intensive care devices). According to respondents, cardiovascular disease devices (such as defibrillators, implantable pacemakers, and coronary artery stents) were available in more than 80% of private and public hospitals.

Devices for malignant neoplasms (such as colonoscopy, bronchoscopy, and mammography) were currently available in more private hospitals (80%) than public hospitals (71%).

Devices for sense organ diseases (such as ophthalmoscopes, hearing aids, and intraocular lenses) were available in 88% of private hospitals and 76% of public hospitals.

Respiratory disease devices (such as peak flow meters, spirometers, and ventilators) had similar current availability in public hospitals (87%) and private hospitals (89%).

Diagnostic were available in more than 86% of public hospitals, private hospitals, and community health centers.

Laboratory diagnostics and point-of-care in vitro diagnostics were available in more than 83% of cases. Diagnostic imaging devices (such as x-ray, ultrasound CT, and MRI systems) were available in 92% of private and public hospitals.

Devices for surgery and intensive care (such as anesthesia systems, resuscitators, and ventilators) were available in 94% of public hospitals (94%) and 93% of private hospitals and 75% in community health centers.

**Box 4: Continued**

There were some limitations to this survey, including its length and complexity, as well as the language, being only available in English. The ultimate aim is to ensure improved access, quality, and use of medical products and technologies.

*Note:* The box provides a brief overview of the findings of the survey.

Adequate funding by governments and other bodies is needed to resolve this barrier. In less resourced settings, this may include multiple contributors working collaboratively to deliver affordable AHT to older people. International collaboration in this regard is promoted by the CRPD.

Affordability is also a key issue for MD, where health care providers, both public and private, weight the cost-effectiveness of the technologies they purchase. Similar concerns will be faced by carers of older adults in need of MD at home. Frugal innovations in this domain may have a potentially tremendous impact on issues of equity and contribute to building UHC.

### Health Care Workforce Training

The lack of personnel who are appropriately trained to provide AD to older people requires urgent attention. The WHO, academic institutions, and other organizations have developed training resources and opportunities, which may contribute to competence development, although they are currently limited. Education and training are critical to deliver the best outcomes from AHT for older people. At present, educational programs operate almost in isolation with little understanding of the potential issues and requirements of older people (for technologists) and the scope, possibilities, and complexities of technology (for professionals in aged care). The incorporation of increasing levels of automation and decision support into mainstream and other products often reflects a desire to reduce operator burden but may be overlooking unintended issues of trust, confidence, and limitations associated with human-machine interaction (Reimer, 2014).

### Conclusions and Recommendations

This paper had two main aims. First, to draw international attention to the neglected agenda of AHT and MD and related health and social services for aging populations, particularly in LMICs.

Second, to identify as a solution to those policy gaps, the development by countries of lists of priority technologies and devices, equivalent in their ambition to the WHO List of Essential Medicines.

These two priorities are linked to the goal of UHC, which covers the whole human life span and therefore must take full account of the health needs and preferences of older people.

This paper demonstrates the rapidly increasing need for assistive devices and the services necessary for their provision (their combination is also referred to as AHT), as well as MD, as people continue to live longer irrespective of their health conditions and functional status. It provides evidence suggesting that appropriately provided AHT and MD are effective in addressing functional decline, concomitant health conditions of older adults, improve their well-being, and foster inclusiveness in our societies.

LMICs will soon have a much larger population of older adults. They will thus face a huge burden of NCDs, multiple morbidities, functional decline, and their consequences—in addition to infectious diseases—in old age.

Health technologies, especially medical and assistive health technologies, are essential to ensure older people's dignity and autonomy, but their current and potential benefits have received little recognition in LMICs. Viewing these technologies as relevant only to disabled people is an inadequate approach. They should be accessible to both older adults with disabilities and older adults with functional limitation. Many countries need much greater official awareness of older adults' needs and preferences. Such attitudinal changes should then be reflected in laws and regulations to address the specificities of care for older people.

With a high level commitment to AHT and MD, governments can invest in maintaining function and well-being of their aging populations. Further, in the current negotiations for a *Convention of the Rights of Older Persons*, the United Nations and governments should recognize the important role of both adequate and affordable access to suitable health technologies, and accessible environments in achieving healthy and functional aging. In addition, to comply with the CRPD, disabled older people must be consulted and actively involved in the development and implementation of legislation and other policies that affect them.

The analysis of review findings contained in this paper indicates that the gaps identified in the provision and delivery of AHT and MD may require a systemic approach to increase their current availability for aging populations in LMICs.

This approach would entail, yet not be limited to:

1. promoting initiatives for low-cost AHT and MD;
2. awareness-raising and capacity-building on AHT and MD;
3. bridging the gap between AHT and MD policy and practice; and
4. fostering targeted research on AHT and MD to ensure the availability, accessibility, affordability, and acceptability of safe and high-quality assistive and medical devices, as well as the services that allow their provision to older people and their carers.

Finally, we call for the development by countries of lists of priority technologies and devices, equivalent in their ambition to the WHO List of Essential Medicines.

This paper proposes an ambitious and innovative approach that it argues is urgently required, and which can be viewed as part of an essential response to one of the biggest health and social challenges of the 21st century.

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## Conflict of Interest

The authors declare no conflict of interest.

## References

- Aminzadeh, F., & Edwards, N. (1998). Exploring seniors' views on the use of assistive devices in fall prevention. *Public Health Nursing (Boston, Mass.)*, 15, 297–304. doi:10.1111/j.1525-1446.1998.tb00353.x
- Anderson, W. L., & Wiener, J. M. (2015). The impact of assistive technologies on formal and informal home care. *The Gerontologist*, 55, 422–433. doi:10.1093/geront/gnt165
- Andrich, R., Mathiassen, N. E., Hoogerwerf, E. J., & Gelderblom, G. J. (2013). Service delivery systems for assistive technology in Europe: An AAATE/EASTIN position paper. *Technology and Disability*, 25, 127–146. doi:10.3233/TAD-130381
- Borg, J., Lindström, A., & Larsson, S. (2009). Assistive technology in developing countries: National and international responsibilities to implement the Convention on the Rights of Persons with Disabilities. *Lancet*, 374, 1863–1865. doi:10.1016/s0140-6736(09)61872-9
- Borg, J., Lindström, A., & Larsson, S. (2011). Assistive technology in developing countries: A review from the perspective of the convention on the rights of persons with disabilities. *Prosthetics and Orthotics International*, 35, 20–29. doi:10.1177/0309364610389351
- Borg, J., & Östergren, P. O. (2015). Users' perspectives on the provision of assistive technologies in Bangladesh: Awareness, providers, costs and barriers. *Disability and Rehabilitation. Assistive Technology*, 10, 301–308. doi:10.3109/17483107.2014.974221
- Bouck, E. C., Flanagan, S., Miller, B., & Bassette, L. (2012). Rethinking everyday technology as assistive technology to meet students' IEP goals. *Journal of Special Education Technology*, 27, 47.
- Bowes, A., Dawson, A., & Greasley-Adams, C. (2013). *Literature review: The cost effectiveness of assistive technology in supporting people with dementia*. Report to the Dementia Services Development Trust. United Kingdom: The Atlantic Philanthropies, Dementia Services Development Centre, University of Stirling.
- Chatterji, S., Byles, J., Cutler, D., Seeman, T., & Verdes E. (2015). Health, functioning, and disability in older adults? Present status and future implications. *The Lancet*, 385, 563–575. doi:10.1016/S0140-6736(14)61462-8
- D'Ambrosio, L. A., & Mehler, A. C. (2014). Three things policy-makers should know about technology and older adults. *Public Policy & Aging Report*, 24, 10–13. doi:10.1093/ppar/prt007
- International Organization for Standardization. (2011). *ISO 9999:2011. Assistive products for persons with disability -- Classification and terminology*. Geneva, Switzerland.
- Ivanoff, S. D., & Sonn, U. (2005). Changes in the use of assistive devices among 90-year-old persons. *Aging Clinical and Experimental Research*, 17, 246–251. doi:10.1007/BF03324604
- Kramer, B. (2014). Dementia caregivers in Germany and their acceptance of new technologies for care: The information gap. *Public Policy & Aging Report*, 24, 32–34. doi:10.1093/ppar/prt002
- Layton, N., Wilson, E., & Andrews, A. (2014). Pathways to non-complex assistive technology for HACC clients in WA. Independent Living Center of WA Inc. Retrieved January 26, 2016, from <http://dro.deakin.edu.au/eserv/DU:30062929/layton-pathwaysto-2014.pdf>
- Lin, I. F., & Wu, H. S. (2014). Activity limitations, use of assistive devices or personal help, and well-being: Variation by education. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 69(Suppl. 1), S16–S25. doi:10.1093/geronb/gbu115
- Löfqvist, C., Haak, M., & Slaug, B. (2013). Assistive technology: From research to practice, assistive technology research series. In P. Encarnação, L. Azevedo, G. J. Gelderblom, A. Newell, N-E. Mathiassen (Eds.), *The use of assistive technology in different age-groups of old people* (Vol. 33, pp. 22–26). doi:10.3233/978-1-61499-304-9-22
- Löfqvist, C., Nygren, C., Széman, Z., & Iwarsson, S. (2005). Assistive devices among very old people in five European countries. *Scandinavian Journal of Occupational Therapy*, 12, 181–192. doi:10.1080/11038120500210652
- Löfqvist, C., Slaug, B., Ekström, H., Kylberg, M., & Haak M. (2014). Use, non-use and perceived unmet needs of assistive technology among Swedish people in the third age. *Disability and Rehabilitation Assistive Technology*, 19, 1–7. doi:10.3109/17483107.2014.961180
- Mann, W. C., Llanes, C., Justiss, M. D., & Tomita, M. (2004). Frail older adults' self-report of their most important assistive device. *OTJR: Occupation, Participation and Health*, 24, 4–12. doi:10.1177/153944920402400102
- Marasinghe, K. M., Lapitan, J. M., & Ross, A. (2015). Assistive technologies for ageing populations in six low-income and middle-income countries: A systematic review. *BMJ Innovations*, 1, 182–195. doi:10.1136/bmjinnov-2015-000065
- Morris, M. E., Adair, B., Ozanne, E., Kurowski, W., Miller, K. J., Pearce, A. J., ... Said, C. M. (2014). Smart technologies to enhance social connectedness in older people who live at home. *Australasian Journal on Ageing*, 33, 142–152. doi:10.1111/ajag.12154
- Office of the United Nations Special Rapporteur on Disabilities. (2005). Global survey on government action on the implementation of the standard rules on the equalization of opportunities for persons with disabilities. Amman, Jordan. Retrieved from <http://www.un.org/esa/socdev/enable/documents/GlobalSurvey07.doc> last accessed 26.01.2016
- Parette, P., & Scherer, M. (2004). Assistive technology use and stigma. *Education and Training in Developmental Disabilities*, 39, 217–226.
- Peetoom, K. K., Lexis, M. A., Joore, M., Dirksen, C. D., & De Witte, L. P. (2015). Literature review on monitoring technologies and their outcomes in independently living elderly people. *Disability and Rehabilitation. Assistive Technology*, 10, 271–294. doi:10.3109/17483107.2014.961179

- Reeder, B., Meyer, E., Lazar, A., Chaudhuri, S., Thompson, H. J., & Demiris, G. (2013). Framing the evidence for health smart homes and home-based consumer health technologies as a public health intervention for independent aging: A systematic review. *International Journal of Medical Informatics*, 82, 565–579. doi:10.1016/j.ijmedinf.2013.03.007
- Reimer, B. (2014). Driver assistance systems and the transition to automated vehicles: A path to increase older adult safety and mobility?. *Public Policy & Aging Report*, 24, 27–31. doi:10.1093/ppar/prt006
- Royal Australasian College of Surgeons. (2013). Systematic review on needs for medical devices for older people, ASERNIP-S, Report 81. Retrieved January 26, 2016, from [http://www.surgeons.org/media/20296551/2014-01-15\\_rpt\\_who\\_need\\_for\\_medical\\_device\\_for\\_older\\_people.pdf](http://www.surgeons.org/media/20296551/2014-01-15_rpt_who_need_for_medical_device_for_older_people.pdf)
- Salminen, A. L., Brandt, A., Samuelsson, K., Töytäri, O., & Malmivaara, A. (2009). Mobility devices to promote activity and participation: A systematic review. *Journal of Rehabilitation Medicine*, 41, 697–706. doi:10.2340/16501977-0427
- Scherer, M. J. (2004). Enhancing assistive technology selection and use: Connecting the ICF and ISO 9999. Newsletter on the WHO-FIC, 2, 10–11. Retrieved January 26, 2016, from <http://www.rivm.nl/who-fic/newsletter/newsletter2004-1.pdf>
- Schulz, R., Wahl, H. W., Matthews, J. T., De Vito Dabbs, A., Beach, S. R., & Czaja, S. J. (2015). Advancing the aging and technology agenda in gerontology. *The Gerontologist*, 55, 724–734. doi:10.1093/geront/gnu071
- United Nations. (2007). Convention on the rights of persons with disabilities. Retrieved January 26, 2016, from <http://www.un.org/disabilities/convention/conventionfull.shtml>
- United Nations Economic and Social Commission for Asia and the Pacific. (2012). Incheon strategy to “make the right real” for persons with disabilities in Asia and the Pacific. Retrieved January 26, 2016, from [http://www.unescapdd.org/files/documents/PUB\\_Incheon-Strategy-EN.pdf](http://www.unescapdd.org/files/documents/PUB_Incheon-Strategy-EN.pdf)
- World Health Organization. (2002). Active ageing: A policy framework. Retrieved January 26, 2016, from [http://apps.who.int/iris/bitstream/10665/67215/1/WHO\\_NMH\\_NPH\\_02.8.pdf](http://apps.who.int/iris/bitstream/10665/67215/1/WHO_NMH_NPH_02.8.pdf)
- World Health Organization. (2008a). Age-friendly primary health care centres toolkit. Retrieved January 26, 2016, from [http://apps.who.int/iris/bitstream/10665/43860/1/9789241596480\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/43860/1/9789241596480_eng.pdf?ua=1)
- World Health Organization. (2008b). The global burden of disease: 2004 update. Retrieved January 26, 2016, from [http://www.who.int/healthinfo/global\\_burden\\_disease/GBD\\_report\\_2004update\\_full.pdf](http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf)
- World Health Organization. (2014a). Concept note: Opening the GATE for assistive health technology: Shifting the paradigm. Retrieved January 26, 2016, from [http://www.who.int/phi/implementation/assistive\\_technology/concept\\_note.pdf](http://www.who.int/phi/implementation/assistive_technology/concept_note.pdf)
- World Health Organization. (2014b). Survey of needs for assistive and medical devices for older people in six countries of the WHO Western Pacific Region. Retrieved January 26, 2016, from [http://www.who.int/kobe\\_centre/ageing/ADMD\\_Survey\\_Report.pdf](http://www.who.int/kobe_centre/ageing/ADMD_Survey_Report.pdf)
- World Health Organization. (2014c). Global Cooperation on Assistive Health Technology. Meeting minutes. Retrieved January 26, 2016, from [http://www.who.int/phi/implementation/assistive\\_technology/gate\\_full\\_final\\_report\\_july\\_2014.pdf](http://www.who.int/phi/implementation/assistive_technology/gate_full_final_report_july_2014.pdf)
- World Health Organization. (2015a). WHO global strategy on people-centred and integrated health services. Retrieved January 26, 2016, from [http://apps.who.int/iris/bitstream/10665/155002/1/WHO\\_HIS\\_SDS\\_2015.6\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/155002/1/WHO_HIS_SDS_2015.6_eng.pdf?ua=1)
- World Health Organization. (2015b). WHO report on ageing and health. Retrieved January 26, 2016, from [http://apps.who.int/iris/bitstream/10665/186463/1/9789240694811\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/186463/1/9789240694811_eng.pdf?ua=1)
- World Health Organization Centre for Health Development. (2013). Summary report: Consultation on advancing technological innovation for older persons in Asia. Retrieved January 26, 2016, from [http://www.who.int/kobe\\_centre/mediacentre/summary\\_report\\_innovation\\_feb2013.pdf](http://www.who.int/kobe_centre/mediacentre/summary_report_innovation_feb2013.pdf)