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Assistive technologies in developing countries

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1 March 2018

Question

What is the existing literature on the availability of current and forthcoming assistive technologies, associated markets, business models, and innovative approaches that could help make these technologies more affordable and accessible in developing countries?

Contents

1. Overview

Assistive technologies enable people to live healthy, productive, independent and dignified lives, yet most people who need them are currently unable to access them. This rapid review looks at examples of existing literature on the availability of assistive technologies and efforts to make these technologies more affordable and accessible in developing countries.

A scoping review aimed at looking at the current evidence base on assistive technology in resource limited settings found that over 80% of the available papers focused on types of assistive technologies that address mobility (45.2%) and vision (35.5%) needs, with assistive technology types of spectacles and prosthetics comprising over 50% of all publications (Matter et al, 2016, p. 1). Evidence on assistive technologies that addresses hearing, communication, and cognition needs were the most underrepresented within the existing evidence base (Matter et al, 2016, p. 1). They concluded that evidence on assistive technologies in resource limited settings was limited in quantity and quality, as well as not being evenly distributed across all types of assistive technologies (Matter et al, 2016, p. 1). Visagie et al (2016, p. 1) also found that there is a paucity of evidence on assistive technology provision in low and middle income countries. Despite acknowledgement of the importance of assistive technologies that are affordable and accessible, within the existing literature there appears to be little focus on the specific ways in which this can be achieved, including in relation to market shaping. The available literature seemed to be largely gender blind, although some papers differentiated between the experiences of men and women in relation to assistive technologies.

Key findings include:

- **Access and needs:** Over one billion people need one or more assistive devices, with a projected two billion in need by 2050; yet only 5-15% of assistive technologies needs are currently met.
- People living in different countries or regions of a country, under different economic conditions, and people with different impairments, genders, ages, languages and cultures do not have equal access to assistive devices and services.
- Lack of access to assistive devices is due to high costs, limited availability, lack of awareness, lack of suitably trained personnel, lack of governance, and inadequate financing of assistive technologies.
- **Providers** of assistive technologies include government health services, international humanitarian aid, development, charity and religious organisations, and the private sector.
- **Availability:** The assistive technology industry is limited and mostly serves the requirements of high-income settings. The small scale local assistive technology producers and providers in low income countries cannot meet the needs of all those who need assistive devices. Assistive technology services are also often in short supply.
- Challenges in ensuring a reliable supply of assistive products and their replacement parts as a result of a lack of policies, funding, logistics, research, or high customs and excise charges, means there is only a limited range of assistive devices available to a small number of users.
- **Affordability:** The cost of assistive devices can be unaffordable in low income contexts. Indirect costs and the cost of maintenance can be additional challenges.
- **Quality:** Poor quality assistive devices can lead to secondary health complications and abandonment of the assistive device.

- Suitable assistive device service provision is essential to the success on any assistive device programme.
- **Design:** Assistive devices should be appropriate for the environment and individual characteristics of the user to ensure there is a demand for them, that they are used, and that they are safe.
- Design standards have been developed for a number of assistive devices.
- **Awareness:** Users and service providers are not aware of the range of available assistive devices and their benefits, which limits demand and incentives to supply.

Efforts to increase the affordability and accessibility of assistive technology

- The market potential is huge for developing and producing the right assistive devices at an affordable cost.
- At a global level efforts are being made to improve access to high-quality, affordable, assistive products through the Global Cooperation on Assistive Technology (GATE) and the WHO's Priority Assistive Products List.
- WHO is also supporting governments to develop national assistive technology programmes.
- Taking a systems approach could help improve access to affordable assistive technologies.
- Actors could engage in market shaping to help reduce transaction costs and balance supplier and buyer risks.
- The eye health sector has a number of initiatives to improve access to affordable eye glasses, including through school health programmes and optical shops, helped by the low cost and availability of glasses.
- Community based approaches may be a way to enable underserved groups to access assistive technologies.
- Non-profit and faith based organisations aim to increase the accessibility of assistive devices by distributing them to populations who could not afford them otherwise, although there are sustainability issues with this model which relies on donations.
- Partnerships of international governmental organisations, governments, NGOs, the private sector may be a promising way of distributing assistive devices.
- Actors such as China have been rapidly accelerating their activity in assistive technology.

2. Assistive technologies

Assistive technology 'enables people to live healthy, productive, independent and dignified lives, participating in education, the labour market and social life' (Director General WHO, 2017, p. 1, 3; Smith et al, 2016, p. 7; Visagie et al, 2016, p. 1; Borg et al, 2015, p. 14-16; Borg & Östergren, 2015, p. 301). Assistive technologies can also help to reduce the need for formal healthcare and support services (WHO, 2016, p. 1). Lack of assistive devices, on the other hand, can result in people experiencing exclusion, poverty, and increasing their support needs from their families and society (WHO, 2016, p. 1; Marino et al, 2015, p. 45).

People with disabilities have a right to affordable assistive technology. The UN Convention on the Rights of Persons with Disabilities, which has been ratified by 175 states, commits states to ensuring access to assistive technology at an affordable cost, and to foster international

cooperation in order to achieve this goal (Articles 4[1], 20[2], 26[3] and 32[4]) (WHO, 2016, p. 1; Visagie et al, 2016, p. 1; Borg et al, 2015, p. 17). As a gateway to inclusion, assistive technologies also enable people to realise their rights (Ali et al, 2014, p. 58). Tebbutt et al (2016) also warn that without promoting the availability of assistive products the Sustainable Development Goals cannot be achieved equitably.

Needs and access

The World Health Organisation (WHO) estimates that over one billion people, the majority of whom are people with disabilities and older people, need one or more assistive devices (WHO, 2016, p. 1). The number in need of assistive devices is projected to increase to beyond two billion by 2050 as a result of rises in non-communicable diseases and the aging global population (Director-General WHO, 2017, p. 1; WHO, 2016, p. 1). However, evidence indicates that an estimated 90% of people who would benefit from assistive technologies do not have access to them and there is a huge unmet need for such devices (WHO, 2016, p. 1; MacLachlan, 2018; Ali et al, 2014, p. 58). UNICEF carried out a global survey[5] which found that only 5-15% of assistive technology needs of children with disabilities are met (UNICEF, no date; Matter et al, 2016, p. 1; Borg et al, 2015, p. 7).

Looking at different types of assistive devices, estimates suggest that 70 million people need a wheelchair but only 5–15% have access to one, only 5% of the 40 million amputees have access to prosthetics, hearing aid production meets only 10% of global need and 3% of the need in low-income countries, and 200 million people with low vision do not have access to spectacles or other low-vision devices[6] (Director-General WHO, 2017, p. 2; McPherson & Clark, 2017, p. 1; Marino et al, 2015, p. 45). It is not known how many people with intellectual disabilities globally have access to appropriate assistive devices, as their use of assistive devices is a neglected

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[1] Article 4: General obligations - (g) To undertake or promote research and development of, and to promote the availability and use of new technologies, including information and communications technologies, mobility aids, devices and assistive technologies, suitable for persons with disabilities, giving priority to technologies at an affordable cost; (h) To provide accessible information to persons with disabilities about mobility aids, devices and assistive technologies, including new technologies, as well as other forms of assistance, support services and facilities.

[2] Article 20: Personal mobility - (b) Facilitating access by persons with disabilities to quality mobility aids, devices, assistive technologies and forms of live assistance and intermediaries, including by making them available at affordable cost; (d) Encouraging entities that produce mobility aids, devices and assistive technologies to take into account all aspects of mobility for persons with disabilities.

[3] Article 26: Habilitation and rehabilitation - 3. States Parties shall promote the availability, knowledge and use of assistive devices and technologies, designed for persons with disabilities, as they relate to habilitation and rehabilitation.

[4] Article 32: International cooperation - (d) Providing, as appropriate, technical and economic assistance, including by facilitating access to and sharing of accessible and assistive technologies, and through the transfer of technologies.

[5] 169 people from 54 countries

[6] Other estimates are as high as 2.5 billion people living with poor vision unnecessarily because they need yet do not have eyeglasses (Smith et al, 2016, p. 7). Smith et al (2016, p. 11) found that international NGOs and inclusive businesses were only able to address about 0.3% of global needs for glasses in developing countries, despite some new approaches and models.

area of research and practice, despite recognition that they have a disproportionately greater need for assistive devices due to higher levels of frailty and multimorbidity[7] (Boot et al, 2017. p. 1, 3; Borg & Östergren, 2015, p. 302).

Inequalities in access to assistive devices and services have been found between people living in different countries or regions of a country, under different economic conditions, among people with different impairments, genders, ages, languages and cultures (Borg et al, 2015, p. 19). Men are often more likely than women to have assistive technologies, adults are generally more likely to have them than children, and in some countries people with a specific type of impairment more frequently have assistive technologies than people with other impairments do (Borg & Östergren, 2015, p. 302).

Needs may vary depending on the situation. In humanitarian emergencies, for instance, there is often a surge in need for assistive devices as people with pre-existing conditions often lose their assistive devices, while people who were injured may need them for the first time (Director-General WHO, 2017, p. 5).

Lack of access to assistive devices is due to a number of factors including high costs, limited availability, and lack of governance and inadequate financing in many settings, as well as a widespread lack of awareness and suitably trained personnel (WHO, 2016, p. 1; Director General WHO, 2017, p. 2; Borg et al, 2017, p. 1; McPherson & Clark, 2017, p. xi, 1). Few countries have national assistive technology policies or programmes which means access to assistive devices is not universal (WHO, 2016, p. 3).

Products[8] and services

There is a vast range of assistive technology stretching along a continuum from low- to high-tech, and serving a variety of needs (Borg et al, 2015, p. 14). UNICEF (no date) found that low-technology assistive devices were more commonly used than high technology products in developing countries. Examples of assistive technology devices, include but are not limited to (UNICEF, no date[9]):

- **Mobility and dexterity**: orthotic and prosthetic devices, wheelchairs, walkers, crutches, adapted sitting chairs, adapted cutlery, adapted pencil grips, adapted mouse and keyboards
- **Vision**: eyeglasses, Braille systems, learning materials adapted with sound or textures, white canes, magnifiers
- **Hearing**: hearing aids, assistive listening systems and voice amplification, visual alerts
- **Communication**: computer software and hardware, devices with synthetic speech, pictures, photographs and objects, communication books

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[7] the presence of two or more chronic conditions

[8] See also Appendix 1 for the 50 priority assistive devices agree after global consultation. The WHO also produces a compendium of innovative health technologies for less resourced settings that incudes assistive devices. The 2015 edition can be found here: http://www.who.int/medical_devices/innovation/compendium/en/

[9] See also UNICEF: https://www.unicef.org/supply/index_82297.html

- **Cognition**: illustrated books, picture based instructions, adapted toys and games, automatic reminders.

Assistive devices need to be accompanied by the appropriate services, including referral, assessment, prescription, funding, ordering, product preparation, fitting/adjusting of the product to the user, training of the user or family members, follow-up, and maintenance and repairs (Borg et al, 2015, p. 14). Appropriate services can have a substantial impact on the outcomes of using assistive technology (Borg et al, 2015, p. 14).

Market actors

Providers

It is common that there is a combination of government, non-government, including faith based organisations, private sector and disabled people's organisations supplying assistive products in a country (Borg et al, 2015, p. 19; Marino et al, 2015, p. 45).

UNICEF's global survey looked at providers of assistive technologies for children which included governments, NGOs/DPOs, and families, although it is not clear how these providers have procured the assistive devices

Figure 1: Who is involved in providing Assistive Technologies (% of respondents)
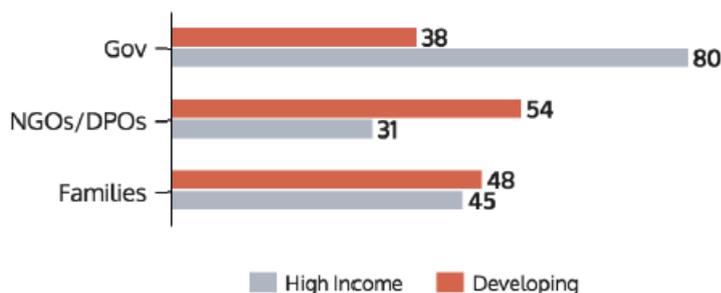
Source: UNICEF (no date)

Research[10] in South Africa, Namibia, Malawi, and Sudan found that the most common sources of assistive technology were government health services (37.8%), "other" (international humanitarian aid, development, charity and religious organisations) (29.8%), and private health services (22.9%) (Visagie et al, 2016, p. 1, 4-5). Private health services were more common as a source of assistive devices in urban areas and among females (Visagie et al, 2016, p. 5).

Research in Bangladesh[11] found that government facilities provided about 1% of the assistive technologies (Borg & Östergren, 2015, p. 303). About two-third of the users of hearing aids and three-quarter of the users of wheelchairs had their assistive technologies provided by NGO facilities. About one in five of the respondents using wheelchairs had received them from other

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[10] 400-500 households with members with disabilities were surveyed in each country.

[11] Cross-sectional data from a total sample of 581 hearing aid users, wheelchair users, individuals with hearing impairments not using hearing aids and individuals with ambulatory impairments not using wheelchairs living in eight districts of Bangladesh

sources, which included, community members, clubs and volunteer organisations (Borg & Östergren, 2015, p. 303). Most had received their assistive technologies free of charge (about half of the hearing aid users and three-quarters of the wheelchairs users) (Borg & Östergren, 2015, p. 303). Men, urban dwellers, older respondents and literate respondents were more likely to have paid the full cost for their hearing aids (Borg & Östergren, 2015, p. 303). The authors of the study noted that provision by NGOs in Bangladesh was much higher than a previous study in four African countries, where 2.3–9.3% of the assistive technologies were reportedly provided by NGOs (Borg & Östergren, 2015, p. 306).

Providers may shift as technologies and manufacturing develops. For instance, the dominant approach to providing glasses used to involve collecting used, donated glasses, for distribution through mission work in communities, however the significant decrease in the cost of glasses has allowed NGOs and inclusive businesses to pioneer models for selling and delivering low-cost, attractive new glasses through optical shops and vision centres, which is a more cost-effective model compared to distributing recycled glasses (Smith et al, 2016, p. 26).

Box 2: Sources of funding

Funding mechanisms for assistive devices include (Borg et al, 2015, p. 21):

• Government, insurance, donor or charity funding

• Assistive technology fund (which may channel above mentioned funds)

• Contributions from families

• Income generation by selling other products or services that subsidise the provision of assistive technology

• Voucher system to the value of assistive technology that meets minimum standards. If the user wants more expensive assistive technology they have to arrange to pay the additional funds themselves

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Manufacturers and producers

In many countries there is no, or only small scale, production of assistive devices (Borg et al, 2015, p. 19). The production that exists might be limited in terms of the ranges of types, models and sizes of products (Borg et al, 2015, p. 19). All major multinational hearing-aid manufacturers (making almost 90% global sales) for instance, are based in developed countries, although much of their manufacturing is done in the developing world, in countries such as China, Djibouti, Mexico, Thailand and Vietnam (McPherson & Clark, 2017, p. 1). They are primarily focused on products that can be marketed in high-income countries at a premium price (McPherson & Clark, 2017, p. 1).

3. Assistive technology: market characteristics

The mismatch in demand and supply of assistive technology products suggests that their associated markets are operating sub-optimally. This is also reinforced by the finding that as many as 75% of assistive devices are abandoned by users (Director-General WHO, 2017, p. 4).

USAID's *Healthy Markets for Global Health: A Market Shaping Primer* (2014: p.19) identifies five categories of market characteristics Affordability, Availability, Assured Quality, Appropriate Design, and Awareness. A discussion of these characteristics in the assistive technologies market is provided below.

Availability of assistive devices and services

The assistive technology industry is currently limited and extremely specialised, mostly serving the requirements of high-income settings (WHO, 2016, p. 3). There are 'often challenges in ensuring a reliable supply of assistive products and their replacement parts, including batteries, due to problems related to funding, logistics or customs and excise' which means there is only a limited range of assistive devices available to a small number of users (Director-General WHO, 2017, p. 4). While there is a 'small scale but highly resourceful and inventive industry of local assistive technology producers and providers' in many low income counties it is not enough to meet all the needs of all those who need assistive devices (MacLachlan, 2018). NGOs 'rarely have the financial means or capacity to develop country-wide sustainable service delivery systems' (Borg et al, 2015, p. 19).

Assistive technology services are also often in short supply and located far from the population in need (Borg et al, 2015, p. 19). There is a lack of available 'personnel properly trained in manufacturing or adapting products, or delivering services' (Borg et al, 2015, p. 20). Trained personnel are needed to ensure the proper prescription, fitting, user training, follow-up and maintenance of assistive devices (WHO, 2016, p. 3; Marino et al, 2015, p. 51; Chadha et al, 2014, p. 366). An additional challenge concerns the availability of repair services for assistive technologies. UNICEF (no date) found that in developing countries 28% of respondents reported that repair services were not available, 47% reported that only limited repair services were available, while only 25% reported that repair services were available, compared to the 62% in high income countries.

Challenges to the availability of assistive devices and services

WHO (2016, p. 3) found that 'there is a general lack of state funding, nationwide service delivery systems, user-centred research and development, procurement systems, quality and safety standards, and context-appropriate product design' which limits the availability of assistive devices.

Lack of governance including legislation, policies and national programmes is a key barrier to the availability of assistive technology (Borg et al, 2015, p. 18-19). Many states have not put in place the relevant legislation or policies relating to the provision of assistive technology (Borg et al, 2015, p. 18-19). This creates a bottleneck in the availability of services and products, alongside the lack of resourcing of assistive technology (Borg et al, 2015, p. 22).

WHO (2016, p. 3) emphasises that 'affordable and appropriate access requires government commitment to adequate and sustained financing, including efficient procurement of appropriate assistive products and delivery systems'. However, Visagie et al (2016, p. 2) found that 'African governments often struggle to fulfil their responsibilities to supply assistive technology and provide the necessary support services' as a result of 'individual and country level poverty, environmental barriers, poor procurement systems, a lack of support services as well as a shortage of service providers and inadequate training of the available service providers'.

An additional challenge is that, to date, most research and development has also focused on high income contexts, with a trend towards high-tech solutions with optimal functionality (Director-General WHO, 2017, p. 4; WHO, 2017, p. 11). Little research and innovation has been focused on 'developing robust, affordable but high-quality assistive products for which there is a much greater need' which has led to an increasing 'assistive technology divide' as the majority of the world is not benefiting from new technologies (WHO, 2017, p. 11).

Affordability of assistive devices

The cost of assistive devices can be prohibitive in low income contexts and 'lack of economic means has been identified as a primary barrier to access assistive technologies' (Borg & Östergren, 2015, p. 302). For example the least expensive hearing aid in northern Nigeria has cost almost a month's average salary (McPherson & Clark, 2017, p. 2). Market research[12] in Kenya also found that the main reason people with disabilities didn't use splints was the cost (Cassit Orthopedics Ltd., 2016, p. 1). Research in Bangladesh found that about two thirds of respondents who did not have a hearing aid or wheelchair reported that the reason for this was cost (Borg & Östergren, 2015, p. 304). Poor or non-existent access to assistive devices in the public sector has led to high out-of-pocket payments that are a burden for users and their families (WHO, 2016, p. 3).

Prohibitive costs also arise from the costs of maintaining and repairing assistive devices, and those involved in travelling and accessing associated services (Borg et al, 2015, p. 21; Marino et al, 2015, p. 46). Assistive devices can come with additional costs which also need to be factored into their affordability. For instance, the hearing aid itself is not the only expense and the additional costs of earmoulds, maintenance expenses and regular purchase of batteries can restrict access to hearing aids in low income contexts (McPherson & Clark, 2017, p. 2; Chadha et al, 2014, p. 366). Research has shown that in some cases the annual costs for batteries alone can exceed the total yearly income of an African subsistence farming family (McPherson & Clark, 2017, p. 2). One of the main reasons for prosthesis abandonment is the high cost of repairs and replacement (Marino et al, 2015, p. 46).

Indirect costs of assistive devices, such as the significant time people need to spend away from work or caregiving to travel to the nearest facility or affordable assistive device shop as they are mostly located in urban areas, can be problematic (Smith et al, 2016, p. 31). The indirect costs of obtaining a prescription for glasses are estimated to be $5-8, depending on geography, for example, although glasses themselves can cost less than this (Smith et al, 2016, p. 31).

These costs are aggravated by high import duties and informal charges levied on medical appliances such as hearing aids in some developing countries such as Ghana, where a 15% tax is imposed on imported hearing aids (McPherson & Clark, 2017, p. 2; Borg et al, 2015, p. 19-20). The rate of import duties levied on eyeglasses in Bangladesh is 93% (Smith et al, 2016, p. 31). On the other hand, 'local production may not be cost-effective where local markets are small' (Borg et al, 2015, p. 19).

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[12] 82 healthcare professionals

Quality of assistive devices and services

Poor quality assistive technologies are a problem. There is a lack of adequate regulation and oversight of assistive technologies, as well as a need for countries to adopt regulatory mechanisms to ensure that assistive products on the market meet the relevant standards and are safe, effective, and appropriate for that setting (Director-General WHO, 2017, p. 4). 'If national standards have not been adopted, products would preferably comply with relevant international standards of the International Organisation for Standardization (ISO)'[13] (Borg et al, 2015, p. 23).

Donations

People from poorer backgrounds or in humanitarian emergencies often rely on donations or charitable services (WHO, 2016, p. 3). However as these often focus on the provision of substandard or used products they are often not appropriate for the user or the context as they are not maintainable, repairable or replaceable locally, and can lead to secondary health complications (WHO, 2016, p. 3; Director General WHO, 2017, p. 4; McSweeney & Gowran, 2017, p. 4; Visagie et al, 2016, p. 2; Marino et al, 2015, p. 46, 49). Often donations are not followed by services due to 'either limited scope of the support and/or lack of integration in existing services at country level' (Visagie et al, 2016, p. 6). McSweeney & Gowran (2017, p. 4) found that inappropriate wheelchairs unsuitable for specific contexts were flooding the market, donated by well-meaning charities from industrialised nations without considering, for example, the geographical location and unruly terrain.

Visagie et al (2016, p. 6) also suggest that the providers of such donations 'might exclude the end user from market processes and may undermine the responsibility of the government'. Instead it is important that charitable organisations, the private sector, government, service providers and communities coordinate their efforts to ensure access to assistive devices and proper services (Visagie et al, 2016, p. 6).

Service delivery

Service provision of assistive technology is also in need of standards (Director-General WHO, 2017, p. 4). Assistive devices are often accessed without assessment and prescription, fitting, user training or mechanisms for follow-up, maintenance and repair, which means that they are often of no benefit, abandoned or even cause physical harm to the user, all of which result in extra health care costs (Director-General WHO, 2017, p. 5; Visagie et al, 2016, p. 2; WHO, 2016, p. 3). This is as a result of not enough personnel at all levels of the health system with the required knowledge and skills to provide assistive devices (Director-General WHO, 2017, p. 5).

Suitable assistive device service provision is essential to the success on any assistive device programme, irrespective to the technology identified (McPherson & Clark, 2017, p. 12). McSweeney & Gowran (2017, p. 3) for instance, find that research reiterates the importance of and need for, education and skills training for wheelchair provision personnel to ensure that wheelchairs meet their users' needs appropriately. The shortage of eye health workers and local laws that govern the level of certification required for a practitioner to prescribe and dispense glasses is a key barrier to adequately addressing the unmet need for glasses (Smith et al, 2016,

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[13] https://www.iso.org/standards.html

p. 31). As a result NGOs have been working to develop new training curricula that focus on providing the skills required to perform quality refraction and determine prescriptions, yet require significantly less time than obtaining a professional degree; although the sector would benefit from creating a set of minimum core competencies required to prescribe glasses (Smith et al, 2016, p. 31). The EYElliance warn that 'any approach that involves training eye health workers on a large scale requires collaboration with national governments to maximise cost effectiveness while ensuring compliance with the health ministry' (Smith et al, 2016, p. 20).

Available services are often stand alone or fragmentary and people are often forced to attend multiple appointments at different locations which is both costly and burdensome (Director-General WHO, 2017, p. 5; Visagie et al, 2016, p. 1). Visagie et al (2016, p. 1) found that a 'lack of government responsibility for assistive device services correlated with a lack of information and/or training of participants and maintenance of devices'.

The quality of services provided can differ. For instance, only 59.3% of participants in the research in South Africa, Namibia, Malawi, and Sudan received full information about how to use their device from their providers, with rural respondents receiving less information and having greater difficulties when using their devices (Visagie et al, 2016, p. 1, 5-6). Government and private health services were found to be much better at providing information than other sources of assistive devices (Visagie et al, 2016, p. 5).

Appropriate design of assistive devices

Not all designs of assistive devices are appropriate in all settings and unless the design meets the user's needs and is suitable in their physical, social and cultural environment, there will be a low demand for products (Borg et al, 2015, p. 20). Services and products need to 'accommodate differences in terms of individual factors (for example, health condition, body structure, body function, capacity, gender, age, ethnicity and preference) as well as environmental factors (for example, physical environment, psychosocial environment, climate and culture)' (Borg et al, 2015, p. 22-23). 'Factors such as efficiency, reliability, simplicity, safety, comfort and aesthetics should be taken into account to ensure that devices and related services are acceptable' to their users (Borg et al, 2015, p. 23).

Walking mobility aids (46.3%) and visual aids (42.6%) were the most commonly bought/provided assistive devices in the research in South Africa, Namibia, Malawi, and Sudan (Visagie et al, 2016, p. 1, 4). 'Visual aids [were] more common in urban areas and among females, and walking mobility aids more common in rural areas and among males' (Visagie et al, 2016, p. 4). This may be because basic walking and visual aids are relatively inexpensive and can be used effectively with little ongoing training and support, while having the potential to make a big functional difference (Visagie et al, 2016, p. 6).

Growing children and adolescents

As children and adolescents grow, their assistive devices need to be replaced or adjusted every year or two (Borg et al, 2015, p. 21). As a result, adolescents participating in the community based hearing aid provision in Bangladesh were not given custom-made earmoulds but used the soft earplugs that came with the hearing aid in varied sizes which reduced the need for costly earmoulds that had to be replaced as they grew, for instance (Borg et al, 2017, p. 4).

Manufacturing

Assistive devices are often manufactured using parts that cannot be replaced locally, examples including hearing aid batteries and wheelchair tyres, which contributes to high abandonment rates (Director-General WHO, 2017, p. 4). The Director-General of the WHO (2017, p. 4) states that 'assistive products need to be manufactured with parts that can be repaired, maintained and replaced locally' (see also McPherson & Clark, 2017, p. 12).

Wheelchairs[14]

McSweeney & Gowran (2017, p. 5) found that much of the literature suggests that wheelchair provision services in low and middle income countries remain largely substandard, with an overreliance on donated and western style wheelchairs that are negligently distributed without input from trained personnel. Their production takes place in other countries, which makes repair and maintenance challenging, and many of those available are of limited quality (McSweeney & Gowran, 2015, p. 5). They are often incompatible with the rural local environments and are often a one size fits all (McSweeney & Gowran, 2015, p. 5). Donated wheelchairs have led to severe pressure injuries causing death to a number of patients with spinal cord injury in countries like Nepal, especially when combined with a lack of education and training among service providers (McSweeney & Gowran, 2015, p. 5).

Prostheses[15]

Prostheses need to be robust and reliable enough to cope with rugged environments (Marino et al, 2015, p. 46). There is a need for 'easily customisable, durable, and affordable prosthetic devices that are designed for low resource settings' (Marino et al, 2015, p. 47).

Hearing aids

As well as being affordable and high quality, hearing aids in low and middle income countries need to be robust and low-maintenance, energy-efficient and able to cope with dust and humidity (McPherson & Clark, 2017, p. 2). Built-in noise reduction features and feedback suppression capabilities could also help counter the problems of noisy environments and poor quality ear moulds (McPherson & Clark, 2017, p. 2). As low and middle income countries often lack the capital required to carry a range of hearing aids, it would be beneficial to have devices which are adaptable to a wide range of hearing loss configurations[16] (McPherson & Clark, 2017, p. 2).

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[14] The WHO has established guidelines on the provision of manual wheelchairs in less resourced settings which present minimum standards and recommendations in all aspects of wheelchair provision. See: http://www.who.int/disabilities/publications/technology/English%20Wheelchair%20Guidelines%20(EN%20for%20the%20web).pdf

[15] The WHO has developed standards for prosthetics and orthotics. See: http://www.who.int/phi/implementation/assistive_technology/prosthetics_orthotics/en/

[16] Further information on the preferred profile for high-quality, affordable hearing aids intended for use in low and middle income countries can be found in McPherson & Clark (2017).

Awareness and demand

There is a lack of awareness among service providers and users about the range of available assistive devices and their benefits (Director-General WHO, 2017, p. 4). Limited awareness of assistive technology or purchasing capacity leads to a limited demand, which results in few incentives to engage in production (Borg et al, 2015, p. 19). As a result the Director-General of WHO (2017, p. 2) highlights that 'awareness needs to be raised and sustained about the existence of affordable assistive products', from district to national level.

Many people with disabilities and their families have limited awareness of assistive devices and services, which make it difficult for them to know what assistive technologies are available or suitable or how they could be beneficial (Borg et al, 2015, p. 18; Chadha et al, 2014, p. 366). For instance, the EYElliance finds that there is a lack of awareness about proper vision care in low income countries which prevents people proactively getting their or their children's eyes examined, while misperceptions about using glasses persist (Smith et al, 2016, p. 20, 31). Research in India and El Salvador found that most people had never bought glasses because they'd never had an eye exam or did not know their problem could be easily solved (Smith et al, 2016, p. 27, 31). Thus organisations offering subsidised glasses to a new consumer base create a market for themselves as people have been found to be highly likely to continue to purchase affordable glasses throughout their life once their vision problems have been corrected with properly prescribed glasses (Smith et al, 2016, p. 26-27).

Smith et al (2016, p. 10-11) also suggest that the unmet need for glasses in low income countries is less to do with cost (the cost of sourcing new frames and lenses for glasses is only $0.60-2.50 per pair) and more to do with a long history of neglect and lack of knowledge about the number of people in need of glasses. This led to governments not committing 'adequate resources to train eye health workers, or fully integrate the identification of poor vision and correction of vision with glasses into public health systems' (Smith et al, 2016, p. 10). Optical companies in these countries also tended to be concentrated in major cities and marketing primarily at high-income consumers, with little incentive to move into less mature markets (Smith et al, 2016, p. 11).

Stigma around disability can also reduce demand for assistive devices (Marino et al, 2015, p. 48; Chadha et al, 2014, p. 366). For example, research in Bangladesh found that nearly one in five of the literate respondents not possessing hearing aids, avoided them because they thought people would make fun of them (Borg & Östergren, 2015, p. 304). Borg & Östergren (2015, p. 307) suggest this can be overcome by raising awareness about disability rights and sharing the positive experiences of others.

4. Efforts to increase the affordability and accessibility of assistive technology

WHO (2017, p. 14) suggests that the market potential is huge for developing and producing the right assistive devices at an affordable cost. UNDP also recognises that an 'area of considerable

opportunity for private sector development is in producing and supplying assistive technologies', especially given the huge unmet need for them (Ali et al, 2014, p. 58).[17]

Global Cooperation on Assistive Technology (GATE)

The WHO is involved in a number of initiatives to improve access to high quality, affordable assistive devices, including introducing the Priority Assistive Products List (APL) (see appendix 1), which is the first stage of implementing a global commitment to improve access to assistive products – the Global Cooperation on Assistive Technology (GATE) (WHO, 2016, p. 1). GATE is an assistive technology stakeholder platform whose goal is to 'improve access to high-quality, affordable, assistive products globally' (WHO, 2017, p. 5; Director-General WHO, 2017, p. 2).

WHO: the Priority Assistive Products List

The Priority Assistive Products List contains 50 devices aimed at providing Member States with a model from which to develop a national priority assistive products list according to national need and available resources (WHO, 2016, p. 1). In addition, it can be used to 'guide product development, production, service delivery, market shaping, procurement, and reimbursement policies (including insurance coverage)' (WHO, 2016, p. 1).

To support the impact of the APL, WHO plans to help governments to initiate national policy dialogues to develop national assistive technology programmes, supported by the WHO Model assistive technology policy framework which includes financing mechanisms, such as health and welfare insurance programmes (WHO, 2016, p. 10). In addition they plan to support governments to develop the capacity of their health worker force through a training package on assistive products, including assessment, fitting, training, and follow-up and repair (WHO, 2016, p. 10). A further step includes supporting governments to develop a model service delivery system for assistive devices in their country (WHO, 2016, p. 11).

Systems thinking perspective

The Director-General of WHO (2017, p. 4) indicates that there is a need for long-term planning and sustainable systems in order to ensure a reliable supply of assistive devices and their replacement parts.

MacLachlan (in press) suggests that the lack of system-thinking approach in the assistive technology sector has been a major barrier to access. From a systems-thinking perspective it is important to promote access to assistive technologies by countering a funnel of inaccessibility (MacLachlan, in press). The adoption of such an approach requires a shift in mind-set regarding the effective interaction and interdependence relating to provision, people (users), policy, procurement, products, personnel (AT professions and those assisting AT use), place, pace and partnership (MacLachlan, in press). The 'development of national assistive technology systems, capable of providing end-to-end services, includes procuring reliable, quality, and affordable products to scale, and training and supporting a skilled and motivated workforce to assess, fit,

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[17] Transparency Market Research has conducted an analysis of the assistive technology devices market which can be purchased here: https://www.transparencymarketresearch.com/assistive-technology-devices-market.html

and maintain the products, with effective monitoring and assessment' – see Figure 2 (Khasnabis et al, 2015, p. 2).

Figure 2: Key questions for systems providing assistive devices
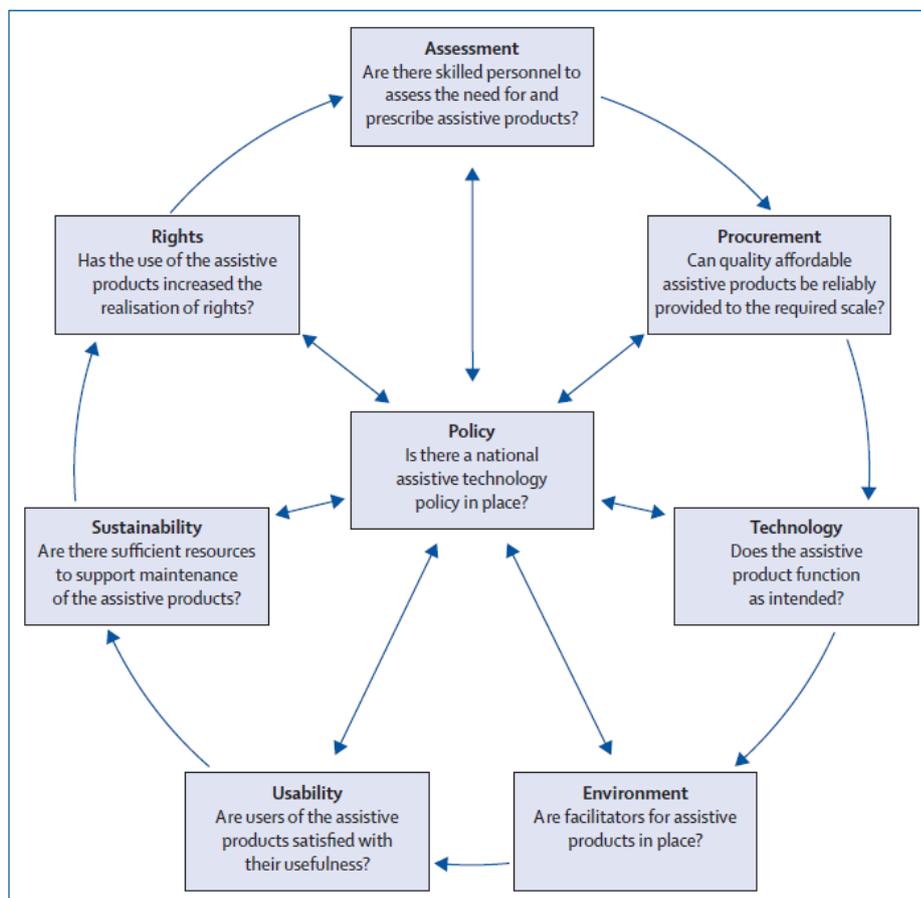
Source: Khasnabis et al (2015, p. 1)

Market shaping

Many low income countries lack the large-scale production and procurement that is required to meet the needs for assistive products (MacLachlan, in press). MacLachlan (in press) suggests that market shaping will be required to increase access to assistive technologies. This will often 'require working in some capacity with small community-level industries of assistive technology producers and providers' (MacLachlan, in press). The pooled purchasing-power of development and aid agencies could have a 'critical role to play in driving down prices; while ensuring producers have access to larger markets and greater economies of scale; and users have a means to influence supply and provision' (MacLachlan, in press).

Reduce transaction costs

The Director-General of the WHO (2017, p. 4) states that 'affordable access to assistive technology needs governmental commitment to adequate and sustained financing' as without it users and their families are left with burdensome high out-of-pocket payments. One suggestion for lowering costs is for coordinated and large volume procurement, as well as waivers on import

duties of assistive devices (Director-General WHO, 2017, p. 4). Efforts should be made to 'ensure that bulk purchases can be made at favourable prices from manufacturers and that government policy does not inflate consumer costs' (McPherson & Clark, 2017, p. 8). Raja (2016, p. 22), writing for the World Bank, suggest that 'governments can develop different types of financial assistance schemes to offset the cost of assistive technology such as loans and grants to support purchase of assistive and accessible technologies and reduce cost of imported assistive technologies by waiving customs duties and fees'.

A common way to reduce production costs while maintaining fit is to combine standard components with individually adapted components, such as an imported hearing aid manufactured elsewhere with locally made individual ear mould (Borg et al, 2015, p. 19). Whirlwind Franchise Network is an example of combining regional wheelchair manufacturing with provision and assembly centres around the world (Borg et al, 2015, p. 19).

Developments in digital technologies have helped reduce the cost and increase availability for some people with disabilities of some assistive technologies (Raja, 2016, p. 9). For example, the price of specialised augmentative and alternative communication (AAC) devices that aid persons who have difficulty with verbal communication such as those with intellectual or cognitive disabilities can come down by over USD 5,000 (Raja, 2016, p. 9-10).

The Brien Holden Vision Institute, an international eye care NGO, estimates that a one-time investment of $28 billion, including in training 47,000 new eye health workers, as well as 18,000 opticians to dispense glasses, would ensure that the 624 million individuals living with correctable vision impairment or blindness could receive appropriate care and glasses (Smith et al, 2016, p. 12). Smith et al (2016, p. 12) suggest that this 'estimated total figure could be reduced by integrating market-based solutions and strategies that deploy a lower-skilled workforce to identify vision problems'.

Balance supplier and buyer risks

The EYElliance suggests that to fully realise the potential for market-led development, governments need to eliminate barriers to market entry, such as high import duties on glasses (Smith et al, 2016, p. 24). 'The international financing community should offer impact investment and creative financing options to global, regional and local private-sector optical companies to de-risk their entry into less mature markets' (Smith et al, 2016, p. 24). Business that market their glasses to populations in low income contexts need to sell lower-priced glasses with a lower profit margin and, hence, must compensate for lost revenue by increasing sales volumes (Smith et al, 2016, p. 31). While the potential market is sizable, it is less mature, which means investing both time and resources to generate demand (Smith et al, 2016, p. 31). As a result private optical companies and NGOs pursuing market based solutions would benefit from access to impact investment and creative financing options to help offset the delayed return on initial investment (Smith et al, 2016, p. 31).

Public-private partnerships could promote greater local manufacturing of indigenous assistive technologies (Raja, 2016, p. 22).

Increase market information

Tools such as the APL aim to create awareness, mobilise resources and stimulate competition (WHO, 2016, p. 1).

EYElliance and eye health initiatives

A number of initiatives have been launched 'aimed at increasing coordination among NGOs, strengthening relationships with government ministries in support of school eye health initiatives, and funding the development of new business models (Smith et al, 2016, p. 15). The EYElliance is a multi-stakeholder initiative partnering with Vision For Life™[18] and Our Children's Vision[19] to encourage the international donor community, national governments and private sector prioritise access to glasses and to facilitate collaboration across sectors to accelerate market-led development, amongst other things (Smith et al, 2016, p. 15). The EYElliance suggest that as glasses are already a low cost, easily obtainable product, ensuring equitable access to eyeglasses is an opportunity for the global development community to gain a quick win (Smith et al, 2016, p. 14).

School Eye Health

A validated model for access to eyeglasses is School Eye Health which engages teachers to pre-screen and increase use of glasses; encourages close collaboration between ministries of health and education to enable teachers to prescribe and dispense glasses in schools; includes education and awareness raising to encourage behaviour change in relation to wearing glasses; and creates referral networks to treat children who are identified as having eye disorders (Smith et al, 2016, p. 19). This model can be made more cost-effective at scale by integrating cost recovery by offering a child's first pair of glasses for free as it does not affect the overall market for glasses; integrating eye health into overall school health programmes such as the School Health Integrated Programme (SHIP), supported by the Global Partnership for Education; and incorporating quality ready-made and ready-to-assemble glasses where appropriate (Smith et al, 2016, p. 19-20). Examples of programmes engaging in these approaches In China, Cambodia, and Mexico can be found in Smith et al, including examples for-profit ventures (2016, p. 21-23).

Optical shops, vision centres and training

The EYElliance highlight two eye care distribution strategies that demonstrate the viability of cost recovery and market-based solutions (Smith et al, 2016, p. 24). Free-standing optical shops and vision centres located in hospitals across low and middle income countries are selling low-cost glasses, with some cross-subsidising to reach the very poor with free eye care and glasses (Smith et al, 2016, p. 24). Examples can be found in Smith et al (2016, p. 27-28). Another model of cost recovery is expanding the eye health workforce through task shifting and training lower skilled workers, as these workers can conduct vision screenings and dispense reading glasses in remote communities with no access to healthcare (Smith et al, 2016, p. 24, 28-30).

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[18] 'In 2015, Essilor, the world's largest manufacturer of ophthalmic lenses, established Vision For Life™, a $33 million fund to accelerate initiatives that combat poor vision by improving access to vision screening, vision correction and protection' (Smith et al, 2016, p. 15).

[19] 'In April 2016, the Brien Holden Vision Institute and the Vision for Life™ fund launched Our Children's Vision, a coalition of 38 NGOs, professional organisations and businesses. The campaign seeks to ensure that effective, sustainable eye health initiatives for children and adolescents are included in appropriate health programmes and are integrated into regional, national and global education and health policy' (Smith et al, 2016, p. 15).

Community based approaches

One strategy to provide assistive technology in less resourced settings is Community Based Rehabilitation (CBR). CBR was developed as a vehicle to meet rehabilitation, including assistive technology needs among more vulnerable groups, including younger people (Borg & Östergren, 2015, p. 302). However very little has been published on the role CBR plays in the provision of assistive technologies (Borg & Östergren, 2015, p. 302). CBR has been successful in providing local rehabilitation services and assistive technology providers may learn from CBR strategies such as 'awareness raising and service delivery at community level, the use of local resources, collaboration and coordination, and the consideration of cultural factors' (Borg et al, 2015, p. 29; Borg & Östergren, 2015, p. 307).

A study[20] by Borg et al (2017, p. 1) in Bangladesh found that a community based approach to the provision of hearing aids (Simplified Hearing Aid Rehabilitation (SHARE)) that is adapted to the context is a viable and cost effective option for hearing aid delivery in low-resourced settings in comparison to the centre based approach.

Non-profit and faith based organisations

Non-profit organisations and faith based organisations[21] aim to increase the accessibility of assistive devices by distributing them to populations who could not afford them otherwise (Marino et al, 2015, p. 46). They both tend to rely on donations which can create long term funding challenges (Marino et al, 2015, p. 46). Non-profits often work with local partners, doctors, educators, and community leaders (Marino et al, 2015, p. 46). Faith based organisations are important healthcare providers in some African countries and have strong presences in rural areas which means they are able to distribute assistive devices such as prostheses to areas where they are least accessible (Marino et al, 2015, p. 46).

Chadha et al (2014, p. 366) argue that based on evidence from hearing aid provision, 'the distribution of ''free'' hearing aids has not always had a positive impact on availability affordability and service development' and they need to be linked with the local audiology infrastructure and takes into account the unique local cultural needs to be sustainable. In addition, evidence suggests that even a partial financial contribution towards the cost of the device or through purchase of ear mould or batteries, leads to a greater sense of responsibility towards the device and its maintenance (Chadha et al, 2014, p. 366).

Partnerships model

A study looking at hearing aids in low and middle income countries suggests that a partnership model promising for the distribution of hearing aids (Seelman & Werner, 2014, p. 399). Botswana's Solar Powered Hearing Aid project, for example, has benefited from its relationships with international government organisations (IGOs), the Botswana government, social

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[20] 140 12-18 year olds from eleven subdistricts participated in a cluster-randomised trial comparing a community-based service (n=75) with a centre-based service (n=65) provision of hearing aids.

[21] Marino et al (2015, p. 25) provide examples of non-profits providing prostheses in low-resource settings, which includes Jumping Kids, Prosthetic Suppliers, World Rehabilitation Fund, and the Polus Center. Faith based organisations working in this area include Standing With Hope and Christian Blind Mission.

entrepreneurs and NGOs (Seelman & Werner, 2014, p. 405). IGOs and NGO partners provide technical assistance, legal, policy and clinical expertise, while corporate and other donor partners may provide research and development, financial and market expertise (Seelman & Werner, 2014, p. 405). Governments are central actors that create health and legal infrastructure to establish private and public intellectual property, trade and competition rules (Seelman & Werner, 2014, p. 405). Seelman & Werner (2014, p. 405) warn that the partnership model may be bureaucratically complex.

China

China has been rapidly accelerating its activity in assistive technology (MacLachlan, 2018). MacLachlan (2018) identifies the challenge here 'is to systematically harness the ambitions of Chinese industry, the experience of longer established international producers and local entrepreneurs; with the potential collective purchasing power of the donor community and national governments'.

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Acknowledgements

Key websites

- Assistive Technology Info Map (Southern Africa): https://assistivetechmap.org/ - for more info see: https://hci4dacrossborders.files.wordpress.com/2015/09/p12-mark.pdf
- Mednet - Global Cooperation on Assistive Health Technology (GATE): https://mednet-communities.net/gate/
- Cassit Orthopedics website: www.Cassit-OT.com and Blog www.CassitBlog.com
- Assistive Products for Children with Disabilities (APCD) Forum: https://www.unicef.org/supply/index_82298.html
- MoveAbility: http://moveability.icrc.org

Suggested citation

Rohwerder, B. (2018). *Assistive technologies in developing countries.* K4D Helpdesk Report. Brighton, UK: Institute of Development Studies.

About this report

This report is based on six days of desk-based research. The K4D research helpdesk provides rapid syntheses of a selection of recent relevant literature and international expert thinking in response to specific questions relating to international development. For any enquiries, contact helpdesk@k4d.info.

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6. Appendix 1: Priority Assistive Products List (APL)

The APL was developed through an extensive global consultation with experts, including users and their caregivers, which involved first selecting key assistive devices and then prioritising them down to 50 (WHO, 2016, p. 9). An overwhelming consensus was reached on the following list – although it should not be considered to be restrictive:

1 Alarm signallers with light/sound/vibration

2 Audioplayers with DAISY capability

3 Braille displays (note takers)

4 Braille writing equipment/braillers

5 Canes/sticks

6 Chairs for shower/ bath/toilet

7 Closed captioning displays

8 Club foot braces

9 Communication boards/books/cards

10 Communication software

11 Crutches, axillary/ elbow

12 Deafblind communicators

13 Fall detectors

14 Gesture to voice technology

15 Global positioning system (GPS) locators

16 Hand rails/grab bars

17 Hearing aids (digital) and batteries

18 Hearing loops/FM systems

19 Incontinence products, absorbent

20 Keyboard and mouse emulation software

21 Magnifiers, digital hand-held

22 Magnifiers, optical

23 Orthoses, lower limb

24 Orthoses, spinal

25 Orthoses, upper limb

26 Personal digital assistant (PDA)

27 Personal emergency alarm systems

28 Pill organizers

29 Pressure relief cushions

30 Pressure relief mattresses

31 Prostheses, lower limb

32 Ramps, portable

33 Recorders

34 Rollators

35 Screen readers

36 Simplified mobile phones

37 Spectacles; low vision, short distance, long distance, filters and protection

38 Standing frames, adjustable

39 Therapeutic footwear; diabetic, neuropathic, orthopaedic

40 Time management products

41 Travel aids, portable

42 Tricycles

43 Video communication devices

44 Walking frames/ walkers

45 Watches, talking/ touching

46 Wheelchairs, manual for active use

47 Wheelchairs, manual assistant-controlled

48 Wheelchairs, manual with postural support

49 Wheelchairs, electrically powered

50 White canes