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**OFFICE OF BEHAVIORAL HEALTH,
DISABILITY, AND AGING POLICY**

Mitigating Direct Care Workforce Injuries in Homecare: A Summary of the Evidence

Prepared for
the Office of the Assistant Secretary for Planning and Evaluation (ASPE)
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by
Mathematica

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Office of the Assistant Secretary for Planning and Evaluation

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MITIGATING DIRECT CARE WORKFORCE INJURIES IN HOMECARE: A SUMMARY OF THE EVIDENCE

Authors

Sarah R. Brunskill
Andrea Wysocki
Mathematica

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Acronyms

ADL	Activity of Daily Living
AT	Assistive Technology
CMS	Centers for Medicare & Medicaid Services
COVID-19	Novel Coronavirus
DME	Durable Medical Equipment
DYNASIM	Dynamic Simulation of Income Model
HCBS	Home and Community-Based Services
HCW	Homecare Worker
HM	Home Modification
IADL	Instrumental Activity of Daily Living
LTSS	Long-Term Services and Supports
NHATS	National Health and Aging Trends Study
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
SPHM	Safe Patient Handling and Mobility
VHA	Veterans Health Administration

Glossary

Title or Term	Other Titles or Terms	Definition
Assignment		In the Original Medicare Plan, an agreement by your doctor, provider, or supplier to accept the Medicare-approved amount as full payment and not bill you for any more than the Medicare deductible and coinsurance (CMS 2019a).
Assistive technology	Assistive devices; assist transfer devices; special equipment; adaptive equipment; DME; technical patient handling aids	Any item, device, or piece of equipment used to maintain or improve the independence and function of people with disabilities and seniors in activities related to education, employment, recreation, and daily living. ¹ Assistive technology devices can range from the very basic (“low-tech”) to highly complex (“high-tech”). For the purpose of this report, we focus only on assistive technologies specific to lifting, transferring, and repositioning being used in homecare to improve worker safety.
Caregiver	Family caregiver; informal caregiver	Family members, friends, or neighbors who provide unpaid assistance to individuals with a chronic illness or disabling condition. ² Responsibilities may be similar to those outlined under personal care aide and home health aide job descriptions (PHI 2019).
Client	Patient; loved-one; beneficiary; consumer	The recipient of the care services.
Consumer-directed	Consumer-directed care; self-directed services	Medicaid beneficiaries have personal choice and control over certain services (for example, delivery of waiver and state plan services) and take direct responsibility for managing their services by determining by whom and how the services are provided. This model is an alternative to traditionally delivered and managed services (for example, agency delivery model). ³
Homecare workforce		Direct care workers who provide homecare services (for example, fellowship and protection, personal care, and/or health-related) within a private residence (U.S. Department of Labor 2016). This primarily comprises home health aides and personal care aides, and within some states, certified nursing assistants (PHI 2019).
Home health aide	Home health attendant; home hospice aide	Direct care workers who provide non-medical personal care and/or medical assistance to individuals and addresses their health-related needs (for example, changing bandages, dressing wounds, or administering medication). Work is performed under the direction of a licensed nurse or therapist. ⁴
Home modification	Environmental modifications; housing adaptation; environmental accessibility adaptations; home improvements	Home modifications are structural changes made to the homes of older people and people living with a disability (Carnemolla and Bridge 2020). They can range from the simple (for example, installing a grab bar) to more complex (for example, installing a stair lift or renovating a bathroom). For the purpose of this report, we focus only on assistive technologies specific to lifting, transferring, and repositioning being used in homecare to improve worker safety.
Lift		A procedure used to carry the entire weight of a client.
Musculoskeletal disorders		Musculoskeletal disorders can affect the muscles, nerves, blood vessels, ligaments, and tendons. Homecare workers are exposed to the following factors that increase their risk for injury: heavy lifting, bending, reaching overhead, pushing and pulling heavy loads, awkward body postures, and repetitive tasks. ⁵
Nursing assistant	Certified nurse aide; certified nursing assistant; nursing care attendant	In most states, these paid professionals are capable of working in both home or community settings. Within homecare, this job has the same responsibility as a home health aide. ⁶

Title or Term	Other Titles or Terms	Definition
Original Medicare		Original Medicare is a fee-for-service health plan that has two parts: Part A (hospital insurance) and Part B (medical insurance). After you pay a deductible, Medicare pays its share of the Medicare-approved amount, and you pay your share (coinsurance and deductibles; CMS 2019a).
Personal care aide	Personal attendant; health care assistant; direct support professional; independent provider; elderly companion; geriatric personal care aide; formal caregiver	Direct care workers who provide non-medical personalized assistance to individuals who require help with personal care and ADL support. This type of aide may also provide help with tasks such as preparing meals, housekeeping, laundry, and driving/arranging transportation to appointments or social or community outings. ⁷
Repositioning		A procedure in which a client is moved to a new position on the same surface (for example, repositioning in bed or while seated).
<p>Notes:</p> <ol style="list-style-type: none"> 1. See https://acl.gov/programs/assistive-technology/assistive-technology. 2. See https://www.cms.gov/Outreach-and-Education/Outreach/Partnerships/Caregiver. 3. See https://www.medicaid.gov/medicaid/long-term-services-supports/self-directed-services/index.html. 4. See https://www.bls.gov/ooh/healthcare/home-health-aides-and-personal-care-aides.htm#tab-2. 5. See https://www.osha.gov/SLTC/ergonomics. 6. See https://www.bls.gov/ooh/healthcare/nursing-assistants.htm#tab-2. 7. See https://www.bls.gov/ooh/healthcare/home-health-aides-and-personal-care-aides.htm#tab-2. 		

Executive Summary

Background. Many older adults and people with disabilities who require help with activities of daily living (ADLs) rely on paid homecare workers to assist them. The demand for homecare workers is growing, as an increasing number of people need help with ADLs and want to remain in their homes. The home is a unique workplace, in which homecare workers usually work alone and provide care that is physically demanding and can require strenuous handling tasks, such as transfers, lifts, bathing, and repositioning, all of which can lead to musculoskeletal disorders and other injuries. Due to the strenuous nature of the work, homecare workers have some of the highest occupational injury rates in the country (U.S. Bureau of Labor Statistics 2018). Given the high prevalence, workplace home safety for homecare workers and caregivers is a critical concern. The National Institute for Occupational Safety and Health (NIOSH) published guidelines defining safe lifting and transferring weight limits set at a maximum of 35 pounds per worker (Waters et al. 1994). Additionally, they are encouraged to take manual client-handling training and utilize ergonomic postural techniques to reduce strain on their body (interview). However, many homecare workers work alone, so adhering to the NIOSH guidelines can be difficult, and studies show that ergonomic postural techniques and manual client-handling training alone do not prevent musculoskeletal disorders; thus, assistive technology devices are highly recommended (Holtermann et al. 2015; OSHA 2014; Walters 2007). Assistive technologies and home modifications can be used to assist with lifting, transferring, and repositioning tasks to help reduce the load and strain from conducting manual client-handling (Sun et al. 2018). Despite the importance of homecare worker safety, little is known about the evidence for using assistive technologies and home modifications for lifting, transferring, and repositioning to reduce homecare worker injuries.

Research questions. The purposes of this report were to examine existing literature and interview key stakeholders within the industry to answer the following research questions:

1. What assistive technologies and home modifications (for lifting and transferring) do experts consider most useful to homecare workers for mitigating worker safety risks?
 - a. How prevalent is the use of these assistive technologies and home modifications?
 - b. How much do expert-recommended/evidence-based assistive technologies and home modifications cost?
 - c. What is known about assistive technology and home modification cost-effectiveness?
2. What are the barriers to wider adoption of assistive technologies and home modifications (for lifting and transferring), and how do beneficiaries obtain these devices?
 - a. How do beneficiaries find out about assistive technologies and home modifications that might benefit them, their homecare workers, and their family members by reducing risk for injury?
 - b. What are the sources of payment for assistive technologies and home modifications?
 - c. Do homecare agency providers routinely assess whether homecare workers should have access to assistive technologies and home modifications, and what role do homecare agencies play in helping beneficiaries obtain these devices?

Methods. We conducted a review of peer-reviewed and gray literature from 2015 to 2020 that addressed prevalence of use, costs, effectiveness, or barriers to adoption of assistive technologies or home modifications for lifting, transferring, or repositioning tasks in the home. We excluded studies focused on

institutional settings; assistive technologies or home modifications unrelated to lifting, repositioning, or transferring tasks; or themes unrelated to homecare worker or caregiver safety, injuries, cost, or barriers. We also conducted six stakeholder interviews with nine key industry representatives via telephone to supplement the literature review and used AbleData,¹ produced by the National Institute on Disability, Independent Living, and Rehabilitation Research, to supplement other information about the types and cost of relevant assistive technologies and home modifications for lifting, transferring, and repositioning.

Key findings. There was little literature or research on the prevalence of the use and effectiveness of assistive technologies and home modifications for lifting, transferring, and repositioning for reducing homecare worker injuries. The literature and stakeholders mentioned certain assistive technologies or home modifications more frequently, including gait belts, slide or transfer boards, toilet seats with supportive arms, shower chairs, handrails/grab bars, and Hoyer lifts, but did not recommend specific assistive technologies or home modifications to help reduce the likelihood of worker injuries. However, stakeholders had the following suggestions:

1. Use of assistive technologies or home modifications is preferred over manual handling.
2. Assistive technologies or home modifications should be selected based on both the client's and homecare worker's needs, specific tasks, and use environment.
3. Low-technology devices that are easy to use and assemble are preferred over complex high-technology devices.
4. Regardless of the type of assistive technology or home modification, both the client and homecare worker need to be trained on their proper use and techniques.

There are many barriers to obtaining and using assistive technologies and home modifications for lifting, transferring, and repositioning in the home. Such barriers include client resistance, difficulty identifying appropriate assistive technologies and home modifications, limited insurance coverage and difficulty covering out-of-pocket costs, environmental issues in the home, and limited training on appropriate use. Another important barrier is the lack of focus on assessing the need for or covering assistive technologies and home modifications for worker safety because assessment processes and coverage decisions are focused on client need. All of these barriers suggest that currently there is limited use of assistive technologies and home modifications to mitigate homecare worker injuries despite the growing importance of worker safety issues. In addition, if the client had assistive technologies or home modifications, they often were broken, installed incorrectly, not fitted properly to the client or use area. Thus, many barriers to ensuring that the equipment is able to assist the client, caregiver, or homecare worker in a safe manner also exist.

¹ See <https://abledata.acl.gov>.

Summary of Research Implications

- Expand and standardize data and measures in studies on homecare workers to better understand the prevalence of the use, effectiveness, and cost-effectiveness of assistive technologies and home modifications.
- Expand assistive technologies market research and development to focus on the home environment rather than limiting the research to inpatient or institutional settings.
- Adapt and disseminate successful injury prevention interventions from institutional settings to homecare.

Suggestions for Future Research

- Conduct further research to identify creative and innovative solutions to overcoming key barriers to wider adoption of assistive technology of assistive devices for lifting, transferring and repositioning clients for homecare workers.
- Explore whether current safe patient handling algorithms and apps developed by VHA be leveraged for wider use and application in the non-VHA homecare industry.

I. Background

A. Demographic trends

In 2018, nearly 8 million non-institutionalized United States residents reported having a self-care disability; that is, a need for assistance with one or more personal care tasks (U.S. Census Bureau 2018).¹ Such tasks, especially, bathing, toileting, and transferring into and out of bed and into and out of chairs often impose physical demands on caregivers with respect to lifting, steadying, and repositioning care recipients, which may subject caregivers to musculoskeletal injuries. About half of the non-institutionalized Americans who reported self-care disabilities are over the age of 65. Researchers estimate that more than half (59 percent) of Americans turning 65 today will experience a functional limitation or disability that will result in their requiring long-term services and supports (LTSS; Favreault and Dey 2020) as advanced age is correlated with both physical and medical challenges. Further compounding the issue, our population is also living longer, with those who reach the age of 65 living an average of 19.5 more years (20.6 years for females and 18.1 years for males; Administration for Community Living 2020). Thus, the number of people age 65 and older residing in the United States has increased steadily over the past century and is projected to nearly double (56.0 million to 94.7 million) between 2020 and 2060 (U.S. Census Bureau 2017). In addition to the increase in the aging population, the rise in numbers of people who are obese or have chronic health conditions is expected to lead to an overall greater number of people with disabilities (Thach and Wiener 2018). These dramatic demographic shifts will have a major impact on the homecare sector because an increasing number of people, especially older people, will need services and supports to remain at home. Projections based on the Urban Institute's Dynamic Simulation of Income Model (DYNASIM) indicate that the percentage of Americans aged 65 and older with severe disabilities (those whose level of disability would justify long-stay nursing home placement) will increase from 13 percent to 15 percent between now and 2065 (Favreault and Johnson 2020).

B. Demand for homecare workers

Many older adults and disabled persons rely on caregivers (either paid, unpaid, or some combination of the two) to stay within their homes (Joint Center for Housing Studies of Harvard University 2016; Hado and Komisar 2019). In 2018, an estimated 14 million adults in the United States needed LTSS with the majority of services (90 percent) provided within the community (Hado and Komisar 2019). While people of all ages may have LTSS needs, the likelihood of needing these services and supports increases with age (2 percent for 18-49 years, 5 percent for 50-64 years, 8 percent for 65-74, 17 percent for 75-84 years, and 42 percent for 85+).

According to DYNASIM, a microsimulation model developed by the Urban Institute, Americans turning 65 in 2020-2024 can expect to live another 20.5 years, during which over half (56 percent) will need some LTSS because of severe disability (two or more ADLs dependencies or need for supervision associated with serious cognitive impairment). About 10 percent will require LTSS for less than one year and 22 percent will require LTSS for more than five years. On average, the need for LTSS will last for 2.8 years, during which informal caregivers will supply all LTSS for 1.1 years. However, 53 percent of older

¹ The disability types include hearing difficulty, vision difficulty, cognitive difficulty, ambulatory difficulty, self-care difficulty, and independent living difficulty.

Americans with LTSS needs will receive no paid care; 20 percent will receive paid care for less than five years and 7 percent will receive paid care for more than five years (Favreault and Dey 2020).

Nursing home use has been declining among older Americans. For example, between 2004 and 2014, the percentage of older Americans living in nursing homes fell from 3.6 percent to 2.5 percent, a decrease of 24.5 percent. (Laes-Kushner 2018). Although some of this reduction was due to individuals choosing to live in more homelike assisted living facilities, much of it was associated with older Americans finding it more desirable and feasible to live “at home” in regular housing. The COVID-19 pandemic has resulted in fewer referrals to both short-term, post-hospital and long-stay nursing home care, threatening the financial survival of many nursing homes (Grabowski and Mor 2020). It remains to be seen whether the effects will be long-lasting and accelerate efforts by federal and state Medicaid policymakers to make remaining at home possible despite high levels of disability, further increasing the demand for homecare workers.

In response to this growing need, the homecare workforce has more than doubled in the last ten years (899,000 in 2008 to 2.3 million in 2018) and is currently projected to add more new jobs than any other single occupation in the United States by 2026 (PHI 2019). However, these numbers capture only a fraction of care providers and excludes individuals hired directly by consumers (PHI 2019). Some estimates suggest there are at least 1 million independent providers employed through Medicaid-funded “consumer-directed” programs (see the Glossary) not captured by the U.S. Bureau of Labor Statistics counts (PHI 2019). The homecare workforce primarily comprises home health aides and personal care aides, and in some states, nursing assistants (see the Glossary for a description of each position). For continuity within this paper, we refer to this workforce as “homecare workers” (see the Glossary). Although there are differences in job tasks among the various occupational titles, there is also considerable overlap. Typically, homecare workers provide in-home support for everyday tasks, also referred to as IADL (that is, instrumental activities of daily living that allow an individual to live independently in the community) and self-care assistance with ADL (that is, eating, bathing, getting dressed, toileting, transferring, and continence) that allow older adults and people with disabilities or illness to remain in their homes. Additionally, home health and nursing aides may also perform medical tasks (for example, catheter hygiene and administering medications), depending on their level of certification. According to our interviews and other research on homecare workers, they mainly are hired through two different methods (PHI 2019): (1) a homecare agency hires the homecare worker, assigns the worker to client(s), and supervises the work; or (2) “consumer-directed,” in which the client or client’s family hires, supervises, and can fire the homecare worker directly (see the Glossary). In addition, homecare may be financed through different public programs and/or private funds.

C. Musculoskeletal injuries and safety within the home

It has long been recognized that homecare workers are confronted with a myriad of potential health and safety hazards (Nakazato 2018; Polivka et al. 2015; Hittle et al. 2016; Campbell 2018) and ergonomic issues (Hamadi et al. 2018, 2019). The home is a unique workplace, where homecare workers usually work alone and provide care that is physically demanding and can require strenuous handling tasks, such as transfers, lifts, bathing, and repositioning (Mabry et al. 2018; Markkanen et al. 2017; Polivka et al. 2015), which in turn may lead to musculoskeletal disorders (Darragh et al. 2015; Campbell 2018; National Academies of Sciences, Engineering, and Medicine 2016; Butler 2018; Markkanen et al. 2017; Quinn et al. 2016; NIOSH 2012). These disorders include symptoms such as backaches, muscle strains, stiffness, swelling, numbness, or tingling (see the Glossary). The physical demands on homecare workers

are evident; they have some of the highest occupational injury rates in the country (U.S. Bureau of Labor Statistics 2018), with 100 events per 10,000 workers in 2016 and in most instances occurring when homecare workers overexert themselves through lifting or repositioning their clients (Campbell 2018). Data from workers' compensation claims also suggest there are high injury rates among homecare workers. An examination of 2012-2016 workers' compensation claims from Washington State found 368.9 claims per 10,000 full-time equivalents among homecare workers, and of these claims, work-related musculoskeletal disorders accounted for 34.3 percent of claims (versus 24.2 percent for all industries), with the back (23.0 percent) and neck (12.5 percent) as the most common injury locations (Howard and Adams 2019). Moreover, these rates may be severely underreported due to limited documentation and treatment of on-the-job injuries; also, as previously discussed, government surveillance mechanisms do not count the entirety of the workforce (Institute of Medicine 2008; PHI 2019), making tracking difficult. Because unpaid caregivers are not formally employed, there are limited reliable data on their injury rates. However, because of the similar if not even more demanding nature of unpaid caregivers' work, it is likely that musculoskeletal disorders are a problem and could be more prevalent among unpaid caregivers (National Academies of Sciences, Engineering, and Medicine 2016; Darragh et al. 2015).

Musculoskeletal disorders occur when tissues are exposed to excessive loads. They can be acute injuries attributed to a singular event (for example, trying to prevent a client from falling) or cumulative injuries resulting from the accumulation of damage over time due to chronic overworking and insufficient recovery time (OSHA 2014). Although more difficult to trace, cumulative damage is assumed to be the most common form of injuries among most direct care employees (for example, nurses, homecare workers) and caregivers (King et al. 2018). Traditionally, this was solved by training health care workers on proper ergonomics; however, studies show that ergonomic postural techniques and manual client-handling training alone have a negligible effect on preventing musculoskeletal disorders (Holtermann et al. 2015; OSHA 2014; interview).

For most patient-lifting tasks, the maximum recommended weight limit is 35 lbs.--but even less when the task is performed under less than ideal circumstances, such as lifting with extended arms, lifting when near the floor, lifting when sitting or kneeling, lifting with the trunk twisted or the load off to the side of the body, lifting with one hand or in a restricted space..."
— Walters 2007

To mitigate injuries, NIOSH has published guidelines for safe lifting and transferring weight limits at a maximum of 35 pounds per health care worker (Waters et al. 1994). However, this recommendation does not take common limitations (for example, unpredictable patient movements, heavy loads, slips, or falls) that ultimately affect the lift load into account (Walters 2007). Clients who are clinically obese can exceed these limits; a single limb of an obese client can weigh as much as 60-70 pounds (Zwerdling 2015)--almost double the weight of the NIOSH recommendation. In 1993, NIOSH later amended their guidance to clarify that the 35-pound limit should help identify tasks where assistive technology would be appropriate to assist the worker (Waters et al. 1994). Overall, research recommends using assistive technologies or home modifications over manual techniques in order to reduce injuries (Holtermann et al. 2015; OSHA 2014; Waters 2007; Sun et al. 2018).

Musculoskeletal disorders are likely to be exacerbated among older caregivers due to their own age-related limitations (Darragh et al. 2015). Within homecare, nearly nine in ten workers are women, with a median age of 46 years (PHI 2019). Person-level factors, such as body mass index and age, and lifestyle behaviors have been associated with daily musculoskeletal symptoms and could make homecare workers more susceptible to certain safety and health hazards (Olson et al. 2014). Given the high prevalence and

importance of this issue, workplace home safety for homecare workers and caregivers is a critical concern.

In response to this growing problem, some states have passed legislation requiring institutional providers to implement “no-lift policies” and provide health care workers with assistive technologies to assist with manual client-handling tasks. To date, no similar legislation exists to protect homecare workers.² However, similar policies could be difficult to enforce in the home setting, as many homecare workers and caregivers work alone and lack on-site backup or support, making it impossible to adhere to the current institutional standards, which often call for multiple workers to do a transfer. Thus, new approaches will need to be adopted to address occupational safety within the home.

D. Assistive technology

The ability to manage basic ADLs is a prerequisite to successfully remain at home (Favreault and Dey 2015; U.S. Bureau of Labor Statistics 2019; Administration for Community Living 2020; Joint Center for Housing Studies of Harvard University 2016). When assistance is required, it can come from assistive technologies or home modifications (see the Glossary), people, or both. However, as we discuss assistive technologies and home modifications throughout this report, it is important to understand what these labels encompass. Environmental adaptation is an important intervention that helps older adults and those with disabilities remain in their homes, in addition to easing the burden on paid and unpaid caregivers. For the purpose of this report, we focus on assistive technologies and home modifications used for lifting, transferring, or repositioning clients in a home environment.

Assistive technologies encompass a wide range of equipment and device choices that can be manipulated directly by a client (for example, an adjustable hospital bed or a rail) or operated by a caregiver (for example, a gait belt, slide, or lift). Home modifications are structural alterations made within the home, which can range from simple additions (for example, installing handrails/grab bars) to complete renovations (for example, updating a bathroom). Typically, items that fall under these categories can be classified as either low or high-technology (“low-tech” or “high-tech”; see the Glossary). Low-tech products are easy to manufacture or obtain (for example, slide or transfer boards, shower chairs, bath benches, gait belts, raised toilet seats, grab bars, rails), whereas high-tech products are more difficult to manufacture or obtain (for example, Hoyer or mechanical lifts, sit-to-stands, hospital beds, rolling shower chairs). Although the equipment under assistive technologies and home modifications varies widely in both complexity and cost, they have the same goal--to aid client and caregiver safety.

E. Purpose of this report

Homecare workers provide the majority of paid, hands-on care delivered to consumers receiving LTSS, yet the substantial mental and physical demands of their work are often invisible. Helping people transfer safely between locations, either manually or using assistive technologies, requires technical skill but also physical strength and stamina. Thus, homecare worker occupational safety is a prominent issue because it affects both client care and homecare workers’ health and well-being. Reducing homecare worker injuries by creating a safer client home may result in lower operating costs for employers, improved retention rates for workers, improved client health status, and decreased health care use. However, there is a notable gap between the recommendations (for example, the NIOSH 35-pound weight limit) and the availability of assistive technology and home modifications within the home, which motivated the study.

² See https://www.osha.gov/SLTC/healthcarefacilities/safepatienthandling.html#state_legislation.

The purpose of this report was to examine existing literature and interview key stakeholders within the industry to address the following policy questions:

1. What assistive technologies and home modifications (for lifting and transferring) do experts consider most useful to homecare workers to mitigate their safety risks?
 - a. How prevalent is the use of these assistive technologies and home modifications?
 - b. How much do expert-recommended/evidence-based assistive technologies and home modifications cost?
 - c. What is known about assistive technology and home modification cost-effectiveness?
2. What are the barriers to wider adoption of assistive technologies and home modifications for lifting and transferring, and how do beneficiaries obtain these devices?
 - a. How do beneficiaries find out about assistive technologies and home modifications that might benefit them, their homecare workers, and their family members by reducing risk for injury?
 - b. What are the sources of payment for assistive technologies and home modifications?
 - c. Do homecare agency providers routinely assess whether homecare workers should have access to assistive technologies and home modifications, and what is the role of homecare agencies in helping beneficiaries obtain these devices?

II. Methods

A. Literature review

We conducted a literature search with the help of a Mathematica librarian to ensure that relevant databases and search words were used to address the key policy questions. To identify relevant keywords, we conducted preliminary searches via subject-related wordlists and article keywords or abstracts to determine the final list of search terms (see Appendix A for specific keywords used for the search). We used SCOPUS and Google Scholar to implement the formal search. We compiled results from our formal search strategy with other references identified through supplemental searches and eliminated any duplicates. This approach yielded 433 articles, which we screened by title, abstract, and inclusion/exclusion criteria. The database parameters were limited to the following criteria:

Inclusion criteria:

1. Written and published in English.
2. Published between 2015 and 2020.
3. Either peer-reviewed or gray literature.
4. Qualitative, quantitative, or mixed-method studies.
5. Systematic reviews, meta-analyses, or government reports.
6. Addressed assistive technologies or home modifications in any way.
7. Included home settings in location of care.
8. Examined prevalence of use, costs, effectiveness, or barriers to adoption of assistive technologies or home modifications.

Exclusion criteria:

1. Location of care was exclusively hospital care, nursing homes, residential care homes, and ambulance or emergency care related to home worker safety or injuries.
2. Assistive technologies or home modifications did not address lifting, repositioning, or transferring tasks (for example, smart homes, remote monitoring, wandering monitors).
3. Discussion involved only client safety issues (for example, unwitnessed falls or development of pressure sore), with no physical interaction.
4. Text focused on discharge planning and transitions in care (for example, pre-discharge home visit).
5. Text did not address issues related to homecare worker or caregiver safety, injuries, cost, barriers, or similar themes.
6. Text focused exclusively on the client experience/safety/independence, with no mention of homecare workers or caregivers.
7. Text focused on assistive technologies that are hypothetical, in development, or not on the market.

After the title and abstract screening, we flagged 65 articles for full text review and ultimately excluded an additional 22 articles, for a total of 43 included in this report. Over the course of this report, we added

eight more articles. We extracted data from the studies using a standardized extraction form. We included other publications and content (for example, government websites and publications outside of our target date ranges) to supplement the report, but they are not included in the final counts.

B. Key informant interviews

We conducted six stakeholder interviews with nine key industry representatives via telephone to supplement the literature review. These interviews included the following: occupational health researchers (University of Massachusetts Lowell and University of Oregon); a homecare agency/trainer (Cooperative Home Care Associates); a homecare trade association and agency owner (Home Care Association of America); and experts in government organizations (Veterans Health Administration [VHA] and Center for Assistive Technology Act Data Assistance).

We developed separate protocols for the different stakeholder groups. In addition to general questions that applied across stakeholders, we developed targeted questions based on the stakeholder's expertise. We asked key informants about their organization and their role in it; their view of assistive technologies and home modifications, both overall and as specifically related to injury prevention within the homecare worker population; the effectiveness of assistive technologies and home modifications and their ability to prevent homecare worker injury; how homecare workers access assistive technologies or home modifications; barriers or concerns about using assistive technologies or home modifications in the home; gaps in the research about the effectiveness of assistive technologies and home modifications for mitigating homecare worker injury; and input on state and federal policies that help or hinder wider adoption of assistive technologies or home modifications in the community.

C. Product search

AbleData,³ produced by the National Institute on Disability, Independent Living, and Rehabilitation Research, provides information on a range of assistive technology products. We used this source to supplement other information about the types and cost of relevant assistive technologies and home modifications for lifting, transferring, and repositioning.

³ See <https://abledata.acl.gov>.

III. Results

PQ1: What assistive devices for lifting and transferring do experts consider most useful to homecare workers to mitigate worker safety risks?

As of the writing of this report, there are no standard expert recommendations for the types of assistive technologies or home modifications used for lifting, transferring, or repositioning considered most advantageous for reducing homecare worker injuries. Studies that examine assistive technologies or home

“Anything to make caregivers, clients, and homecare workers safer we absolutely endorse and recommend. But we don’t recommend any specific [assistive technology or home modification].”

–Homecare trade association

modifications for use in the home often focus on them generally while not identifying specific items. Thus, it is difficult to draw conclusions about which types of assistive technologies or home modifications are most effective for mitigating homecare worker injuries. Among studies or reports that discuss specific items, some of the more frequently mentioned ones include gait belts, slide or transfer boards, toilet seats with supportive arms, shower chairs, handrails/grab bars, or Hoyer lifts (NIOSH 2014); however, even

though these items are mentioned more often in the literature focusing on homecare than other devices or items, they are never recommended outright.

Experts with whom we spoke said that most types of assistive technologies or home modifications are generally effective, but what is effective for a particular client must be determined on a case-by-case basis as determined by the client’s condition and ability to weight bear and the homecare worker’s training (see Section PQ2 Other Issues), making standard recommendations difficult. Any type of assistive technologies or home modifications that can reduce manual lifting or transferring generally are considered useful for reducing injury risk (Sun et al. 2018). Although most assistive technologies or home modifications are considered effective in the right situation, some experts mentioned that gait belts can be dangerous for lifting or transferring because many clients will grab on to the homecare worker while being lifted, preventing proper ergonomics and creating a safety concern (Waters 2007; interview). Other experts mentioned that low-tech devices that are easy to assemble, use, and sanitize are preferred over complex high-tech devices that are more likely to break or be assembled incorrectly. Some high-tech assistive technologies, such as Hoyer lifts and slide boards, can be dangerous if homecare workers do not have the proper training for the specific type of item the client owns (interview; see Section PQ2 Other Issues). The specific home environment is also a factor for selecting the most appropriate equipment. For example, shower or bath seats are considered very useful low-tech assistive technologies, but if the seat does not fit properly, it can be a safety risk. Therefore, although most assistive technologies or home modifications can be beneficial, there are many factors to consider when selecting the most appropriate ones for a client that will also mitigate homecare worker injuries.

PQ1a. How prevalent is the use of these assistive devices?

Rates of use

A few recent nationally representative studies provide estimates of the prevalence of use of assistive technologies or home modifications related to lifting, transferring, or repositioning, suggesting that anywhere from under 10 percent to up to two-thirds of community-dwelling people have some type in their home (Table III.1). However, there is limited research describing and measuring specific assistive technologies because most national data focus on a limited set of home modifications. In addition, these studies are mostly based on self-reported ownership by the client but not directly connected to homecare worker use, and several studies focus on a subpopulation (for example, older adults), thus limiting the ability to make generalizations about the larger population. These studies highlight the difficulty in identifying reliable estimates of the full spectrum of devices used within the community, let alone by homecare workers. Experts with whom we spoke indicated that the presence of assistive technologies or home modifications in the home is generally limited, so most homecare workers do not have access to any equipment to help with lifting, transferring, or repositioning tasks in many situations when they need it.

“Assistive [technology] devices are almost non-existent within homecare. They are greatly lacking.”
 –Occupational research expert

TABLE III.1. Rates of Assistive Technologies (AT) or Home Modifications (HM) Use in the Home			
Study	Data Source	Sample	Estimate of AT or HM Presence or Use
Meucci et al. 2016	2011 NHATS	Medicare community beneficiaries 65 and older	Grab bars near toilet (12.8%), grab bars in shower (41.0%), raised toilet seat (24.4%), shower seat (35.5%); 60.8% reported at least 1 of these home modifications
Willink et al. 2019	2015 NHATS	Medicare community beneficiaries 65 and older	Help and/or assistive devices for at least 1 activity (60%)
Frochen and Mehdizideah 2018	2011 NHATS	Medicare community beneficiaries 65 and older	Assistive technologies for bathing (25.8%); assistive technologies for toileting (35.6%)
Anderson and Wiener 2015	2004 National Long-Term Care Survey	Community-dwelling respondents receiving assistance with ADLs	Assistive technologies for mobility-related needs (68.4%), bathing (61.2%), toileting (46.3%), getting in and out of bed (40.5%), telephone (9.3%)
Vespa et al. 2020	2011 American Housing Survey Household Accessibility Module	National panel sample of housing units	Built-in shower seats (8.3%), elevated toilets (6.7%), handrails or grab bars in bathroom (17.7%)
Hamadi et al. 2018	2007 National Home Health and Hospice Aide Survey	Nationally representative sample of home health aides	Use of lifting devices (71%); consistent presence of lifting devices (48%)

Specifically, several studies used early rounds of the National Health and Aging Trends Study (NHATS) data to examine the presence of home modifications among a nationally representative sample of Medicare beneficiaries age 65 and older (Frochen and Mehdizideah 2018; Willink et al. 2019; Meucci et al. 2016). These studies indicate that the presence of individual home modifications, including grab bars in the shower, shower seats, raised toilet seats, and grab bars near the toilet, ranges from 12.8 percent of beneficiaries reporting grab bars by the toilet to 41.0 percent reporting grab bars in the shower; almost two-thirds of community-based respondents reported at least one of these four types of home

modifications (Meucci et al. 2016) and six in ten use assistive technologies or have made modifications to their living space (Willink et al. 2019). Use of assistive technologies was most common for bathing and toileting (Frochen and Mehdizideah 2018; Willink et al. 2019).

Anderson and Wiener (2015) used the 2004 National Long-Term Care Survey to examine five variables representing use of various assistive technologies among community-dwelling respondents receiving assistance with ADLs. Each respondent was characterized as using or not using assistive technologies in each of the following domains: (1) indoor/outdoor mobility (for example, wheelchairs, walkers, canes, railings, crutches, elevators, ramps, orthopedic shoes, leg or back braces, chairlifts on stairs, and prostheses); (2) bed transfer (for example, bed lifts, wheelchairs, and walkers); (3) bathing (for example, shower seats, tub stools, handle bars, hand-held showers, and rubber mats); (4) toileting (for example, raised or portable toilets, grab bars, and special underwear); and (5) using the telephone (for example, amplifiers and enlarged dialers). The study found that assistive technologies use ranged from 68.4 percent of respondents receiving assistance with ADL tasks for mobility-related needs to 9.3 percent for the telephone, with about 61.2 percent for bathing, 46.3 percent for toileting, and 40.5 percent for getting in and out of bed.

A study using national data from the American Housing Survey explored the prevalence of housing units with aging-accessible features and found that 8.3 percent of respondents reported built-in shower seats, 6.7 percent elevated toilets, and 17.7 percent handrails or grab bars in the bathroom; the presence of these items varied by region (Vespa et al. 2020). However, this study focused on all housing and was not limited to housing for people who needed these items to perform ADL tasks.

An analysis by Hamadi et al. (2018) used the 2007 National Home Health and Hospice Aide Survey; they found that about 71 percent of home health aides reported the use of lifting devices and 48 percent reported the consistent presence of lifting devices, but the use or presence of the latter was not associated with injuries in their adjusted analyses.

NHATS analysis of rates of use

To further explore more recent estimates of the prevalence of use of different assistive technologies or home modifications related to lifting, transferring, or repositioning, we used NHATS Round 8 data to conduct descriptive analyses. These data reflect information from 2018 for a nationally representative survey of Medicare beneficiaries age 65 and older. Items in NHATS related to lifting, transferring, or repositioning included grab bars in the bathtub/shower, bath/shower seats, raised toilet/seats, grab bars around the toilet, and stair lift/glides. We limited the sample to people whose residential care status was in the community and had at least one limitation that could result in needing assistance with lifting, transferring, or repositioning (for example, bathing/showering, using the toilet, dressing, going outside, getting around in the home, or getting out of bed). Among this sample, we examined counts of assistive technologies or home modification use separately for those who reported receiving paid assistance versus those who did not (that is, none or unpaid assistance) and used sample weights to produce national estimates (Table III.2; see also Appendix B for more details).

There were 33,791,720 (weighted) Medicare beneficiaries age 65 or older in the community (Table III.2; see also Appendix B for more details). The majority of people in the community reported having one or more of the assistive technologies that we examined (any mobility device use or having any of the five assistive technologies related to lifting, transferring, or repositioning), ranging from 76.1 percent to 96.8 percent across the different samples we examined.

Of the total community respondents, 5,620,627 had an ADL limitation related to lifting, transferring, or repositioning, with 1,900,714 receiving paid help and 3,719,912 not receiving paid help.⁴ Use of any assistive technologies or having any of the individual assistive technologies items was higher among the sample receiving paid help compared with the sample not receiving paid help. More than 90 percent of both samples reported having at least one of the (broad) assistive technologies we examined. The most common individual types of assistive technologies were a grab bar in the bathtub/shower and bath/shower seat (ranging from 58.8 percent to 79.1 percent). Respondents with paid help more commonly had a bath/shower seat compared with people without paid help, who more commonly had a grab bar in the bathtub/shower. Although still relatively common, fewer respondents had a raised toilet/seat and grab bar around the toilet (ranging from 32.3 percent to 55.1 percent). The presence of stair lifts/glides was rare (3.5 percent to 5.0 percent of respondents).

Most NHATS community respondents who had a functional limitation reported using assistive technologies. The most common types related to lifting, transferring, or repositioning were for the bathtub or shower, including grab bars and seats in the bathtub/shower. They were followed by raised toilet/seats and grab bars around the toilet. Few respondents reported stair lifts/glides.

Aside from mobility devices, the home modifications (primarily for the bathroom) were the only assistive technologies related to lifting, transferring, or repositioning that have been collected in NHATS. There are no questions about other assistive technologies that help with lifting, transferring, or repositioning from beds or chairs, such as gait belts or transfer belts, slider boards (slides), mechanical lifts, medical trapezes, air transfer mattresses, sit-to-stand lifts, transfer boards, ceiling lifts, air-assisted lateral transfer devices, or lifting harnesses. In particular, there were no questions about items or devices that can be moved from room to room in the home, such as slides or lifts.

The NHATS analysis has several limitations. First, we did not have any detailed information about the home modifications that beneficiaries reported having. The presence of these items was high for all samples examined, but it is not clear whether they are always present to help with lifting, transferring, or repositioning tasks. It is possible that some respondents had these items within their homes for other reasons (for example, a shower design that has a seat or a bar not specifically meant to provide assistance for a limitation or disability); the numbers reflect these situations and cases where the person needed the item due to a limitation. Second, to identify people with limitations, we relied on items that assessed whether people had help with different activities. This approach may not fully capture the sample with limitations because beneficiaries may need but not receive help. Third, NHATS includes information about people receiving paid help from someone other than a spouse or partner, but it might exclude those people able to pay their spouse or partner through formal programs, such as Medicaid self-directed programs. Finally, NHATS does not capture information about homecare worker access and use of assistive technology devices.

⁴ Some weighted counts may not sum to 100 percent due to rounding.

TABLE III.2. Weighted Counts from NHATS Related to Asistive Technology

	Total number	Any AT (including mobility devices) ^d Count and % of total number in row	Has grab bar in bathtub/shower Count and % of total number in row	Has bath/shower seat Count and % of total number in row	Has raised toilet/seat Count and % of total number in row	Has grab bar around toilet Count and % of total number in row	Has stair lift/glide Count and % of total number in row
Total community respondents	33,791,720	25,708,851 (76.1%)	n.a.	n.a.	n.a.	n.a.	n.a.
Community respondents with any ADL or IADL limitation ^a	8,291,150	7,716,185 (93.1%)	n.a.	n.a.	n.a.	n.a.	n.a.
Community respondents with any ADL or IADL limitation ^a receiving paid help ^b	2,533,049	2,418,683 (95.5%)	n.a.	n.a.	n.a.	n.a.	n.a.
Community respondents with any ADL or IADL limitation ^a not receiving paid help ^b	5,758,101	5,297,502 (92.0%)	n.a.	n.a.	n.a.	n.a.	n.a.
Community respondents with ADL limitation related to lifting, transferring, or repositioning ^c	5,620,627	5,271,999 (93.8%)	3,770,913 (67.1%)	3,688,206 (65.6%)	2,844,126 (50.6%)	2,055,438 (36.6%)	225,586 (4.0%)
Community respondents with ADL limitation related to lifting, transferring, or repositioning ^c receiving paid help ^b	1,900,714 ^e	1,839,502 (96.8%)	1,426,873 (75.1%)	1,502,734 (79.1%)	1,046,853 (55.1%)	854,775 (45.0%)	95,397 (5.0%)
Community respondents with ADL limitation related to lifting, transferring, or repositioning ^c not receiving paid help ^b	3,719,912 ^f	3,432,497 (92.3%)	2,344,040 (63.0%)	2,185,473 (58.8%)	1,797,273 (48.3%)	1,200,664 (32.3%)	130,189 (3.5%)

Source: Round 8 NHATS data. Respondents for all counts were limited to people whose residential status was in the community, so no respondents in residential care or nursing facilities were included. Sample analytic weights were used to obtain weighted counts.

Notes: Some weighted counts may not sum to 100% due to rounding.

- a. Respondents with an ADL or IADL limitation include people who need help with at least 1 of the following: eating, bathing/showering, using toilet, dressing, going outside, getting around inside the home, getting out of bed, laundry, shopping, making hot meals, or handling bills/banking.
- b. Respondents receiving paid help include people reporting paid helpers.
- c. Respondents with an ADL limitation related to lifting, transferring, or repositioning include people who need help with at least 1 of the following: bathing/showering, using toilet, going outside, getting around in home, getting out of bed, or dressing.
- d. An AT is defined as any mobility device use (cane, walker, wheelchair, or scooter) OR having any of the 5 ATs related to lifting, transferring, or repositioning (grab bar in bath/shower, bath/shower seat, raised toilet, grab bar around toilet, stair lift/glide).
- e. The mean number of limitations for this sample was 3.1.
- f. The mean number of limitations for this sample was 2.0.

n.a. = not applicable

Characteristics of users

Some studies also examined user characteristics associated with assistive technologies or home modification use. A study of Medicare beneficiaries age 65 and older from NHATS found that minorities, individuals with less education, and those with less social support were less likely to have home modifications, whereas people who were older, female, and with a greater number of health conditions and disabilities were more likely to have home modifications (Meucci et al. 2016). Other NHATS studies showed similar findings, indicating that people who were older, Medicare beneficiaries, female, homeowners, and living alone were more likely to use devices (Frochen and Mehdizideah 2018; Willink

et al. 2019). Anderson and Wiener (2015) also found that the use of assistive technologies was higher among people using formal personal assistance services compared with those not using such services.

PQ1b. How much do expert-recommended/evidence-based assistive devices cost?

The cost to the client of assistive technologies and home modifications for lifting, transferring, and repositioning can range considerably, depending on the type of device (that is, low-tech to high-tech), insurance coverage (for example, coverage versus out-of-pocket), or access to other loan or grant programs (described further in Section PQ2b). The purchase cost can range from around \$10 for low-tech devices such as gait belts⁵ to thousands of dollars for high-tech devices such as patient lifts.⁶ However, there are other cost factors that must be considered. Many people fail to realize that costs for assistive technologies and home modification have three separate components related to: (1) purchase; (2) the labor for making necessary modifications or installations; and (3) additional materials. Additional costs can include training and device repairs (described further in Section PQ2a and PQ2 Other Issues). Each of these elements directly affects the overall price of the assistive technologies or home modifications.

Purchase cost

There are several factors that influence the client’s total purchase cost of assistive technologies or home modification equipment and are highly dependent on how the item is acquired. First, the amount is dependent on whether the individual has insurance coverage, is paying out-of-pocket, or is receiving the equipment as a donation through a community program. Insurance may cover certain assistive

“Physical DME stores or consistent DME providers come and go. This makes it hard for older adults to find reliable suppliers to purchase needed [assistive technology or home modification] equipment in the community.”
– *Homecare agency owner*

technologies or home modifications (for example, commode chairs, hospital beds, lifts, or hoist devices) but is often limited; however, this varies across insurance types (see Section PQ2b). Interviewees noted that some areas also have community loan programs established through local universities or non-profits, through which people can also obtain assistive technologies or home modifications if they qualify; however, clients more often pay out-of-pocket (see Section PQ2b). Also, the purchase cost depends on where they client is buying the assistive technologies

or home modifications, because prices differ between various retailers. Certain equipment can be bought from standard retailers (for example, Walmart, Home Depot) or online retailers (for example, Amazon), which is common for many types of home modifications (for example, grab bars and shower seats).

Assistive technologies or home modifications can also be purchased from specialized durable medical equipment (DME) suppliers; however, according to interviews, their presence varies depending on where clients live. Furthermore, purchase cost is dependent on the quality of the assistive technologies or home modification item as there can be a wide price range for a narrowly defined item like a grab bar. As with most commodities, there is a wide spectrum of quality that impacts the purchase price. For example, items can be custom made, high-end, or brand new, thus commanding a much higher price than other options. There are often options to buy refurbished equipment at a lower cost than new equipment, depending on the type of device. Interviewees pointed out that different state or national programs aid with assistive technologies and home modifications, and circulate refurbished items; however, they can differ across the nation. Last, the client’s geographic location (for example, urban versus rural, state), can directly affect

⁵ See <https://abledata.acl.gov/product/ableware-704022000-slip-gait-belt-handle-2-grips>.

⁶ See <https://abledata.acl.gov/product/elevator-700-patient-lift>.

price. Clients living in different parts of the country may have different access to retailers (that is, the ability to go to a physical store versus paying for shipping) or community programs (for example, refurbished options); other factors, such as taxes, can influence prices in different areas of the country, further complicating the ability to identify standard price ranges. Due to the wide variety of devices and items available in the market and the numerous ways a client can purchase them, it is understandably difficult to provide comprehensive or average purchase cost information on assistive technologies or home modifications.

The AbleData project, a website funded by the U.S. Department of Health and Human Services' National Institute on Disability, Independent Living, and Rehabilitation Research, was created to help older adults and people with disabilities find equipment that can assist them and improve their quality of life.⁷ AbleData has been the primary available source for impartial, comprehensive information on products and solutions for assistive technologies, including descriptions of functions and features, price information when available, and manufacturer and distributor contact information. Resources include a database of more than 50,000 products, in addition to citations of books, articles, fact sheets, brochures, and other resources related to assistive technologies. AbleData serves as a comprehensive impartial source for many types of assistive technologies but its information is not consistently up-to-date for all devices and specific products--particularly the purchase price--nor does it include all types or variations of assistive technologies or home modifications available in the current market. Also, due to a realignment of the National Institute on Disability, Independent Living, and Rehabilitation Research department priorities, AbleData will be discontinued as of September 27, 2020; thus, it will no longer serve as a resource for identifying different assistive technologies or home modifications. There is no other national, up-to-date source on assistive technologies or home modifications that provides comprehensive and accurate information on the representative average cost of different assistive technologies or home modifications.

Installation and materials cost

Once an item is received, there may be an added cost to install it within the home if the purchaser needs to buy additional materials and/or hire labor to complete the job. For example, when adding a stair lift or stair glide, the cost of the chair is separate from the cost of the sliding track needed to install the chair within a client's home. There may be an added cost to install the whole system if the client does not have a family or friend who can do so. For some clients, the stair lift and track may be covered as DME, but any labor costs to install it may not be. When older adults were asked what barriers they faced in installing equipment or implementing home modifications, after the cost, many cited not having anyone available to do these tasks for them or not knowing how to find a quality contractor they could trust (Meals on Wheels America 2017). Some non-profit organizations and charities offer home improvement assistance via free labor, but materials typically are not covered, and other programs help clients outsource adjustments or repairs to trusted contractors. However, many older adults are not aware of these programs, so they typically pay out-of-pocket for installation and materials (see Section PQ2b).

PQ1c. What is known about their cost-effectiveness?

Based on the literature review, we did not identify any research or gray literature that discussed or provided definitive conclusions regarding the cost-effectiveness of assistive technologies or home modifications, regardless of who was using the equipment. Expert interviews also confirmed the lack of

⁷ See <https://abledata.acl.gov>.

cost-effectiveness research on assistive technologies or home modifications for reducing homecare worker injury. Cost-effectiveness--defined here as the amount saved (that is, money, time) by the use of assistive technologies or home modifications--is usually a secondary analysis after effectiveness (that is, the ability to prevent or reduce musculoskeletal disorders of the user) has been conclusively established through rigorous research. According to our interviews, the effectiveness of different assistive technologies or home modifications is not straightforward. Instead, there are a wide variety of factors that inevitably determine their effectiveness in mitigating worker injuries, including those related to the client (for example, comfort level, weight, ability to help the homecare worker), home environment (for example, space, clutter; see Section PQ2), and homecare worker (for example, training, health, previous injuries; see Section PQ2 Other Issues). Due to the complexity of assessing assistive technology and home modification effectiveness, research is fragmented and limited. Additionally, earlier effectiveness research focused mostly on client safety issues, with little focus on injuries among homecare workers who need to perform lifting, transferring, and repositioning tasks. Thus, by extension, we cannot draw conclusions about the cost-effectiveness of assistive technologies or home modifications used in home settings to reduce homecare worker injuries. Because little is known about either effectiveness or cost-effectiveness, we include studies within this report that address correlations between assistive technology/home modification use and caregiver or homecare worker strain but do not directly address their effectiveness in reducing homecare worker injury.

Effectiveness of assistive technologies and home modifications for reducing homecare worker injuries

We identified only one study that directly measured homecare workers' use of assistive technologies and probable musculoskeletal disorders. Sun et al. (2018) measured homecare workers' hand-pulling forces during simulated laboratory transfers between a bed and wheelchair, and compared various combinations of slide board devices to a manual transfer. The results showed that transfers using a wood board with Tyvek™ or Beasy™ board required less hand force than a manual transfer and were the best options tested. One limitation for device generalization was noted: transfer boards were not good for unlevel transfers, particularly from a low surface (for example, a wheelchair) to a high one (for example, a bed). Researchers suggested using mechanical beds that can be adjusted to create a level transfer, or a transfer belt to enhance client maneuverability during a transfer, to improve homecare worker ergonomics and safety.

“Effectiveness depends. It depends on the client, their ability to help, what their needs are, and the homecare workers' training. There is no such thing as ‘one size fits all.’ So, it isn't really effective [assistive technologies] versus ineffective [assistive technologies], because in the right situation, all equipment is effective.”

–Occupational health & safety expert

Regardless, researchers noted that all transfers using assistive technologies, significant or not, had lower measured hand force than manual transfers, and suggested using them to assist client transfers and lifting when possible (Sun et al. 2018).

Issues impacting effectiveness

Other studies measured various specific assistive technologies and compared their biometric results to make recommendations about their ability to limit musculoskeletal disorders; however, they did not target home environments or the homecare worker population. In institutional settings, mechanical lifts are generally accepted as the safest way to reposition a client (American Nurses Association 2013); they can reduce the number of manual lifts required, leading to a decrease in the overall lifting forces experienced by health care workers during client-handling, which in turn can help reduce musculoskeletal disorders related to overloading. However, lifts are both large and costly, and so are less common within homes.

Unlike lifts, repositioning-type aids are more common because some of them are less expensive (Zhou and Wiggermann 2019). As opposed to mechanical lifts that fully support the weight of a client, these aids require caregivers to manually slide the client while the device reduces friction between the body and the bed. Zhou and Wiggermann (2019) found that most repositioning aids they tested (for example, friction-reducing sheets, turn-and-position systems, and a traditional cotton draw sheet) failed to diminish the risk of injury (measured by back spinal load) for all client weights. In their research, only air-assisted repositioning devices, typically more expensive and more common in hospitals, were found to significantly reduce musculoskeletal disorder risk among caregivers. Through a systematic literature search, Freiberg and colleagues (2016) found no convincing evidence that the use of small aids (for example, bed ladders, anti-slide mats, slide boards/transfer, boards, handling belts/gait, transfer mats, slide sheets, and slings), including less expensive repositioning aids, prevented musculoskeletal disorders among direct care workers, but mechanical lifts showed more promising results. Vinstrup (2019) found similar biometric laboratory results when comparing a variety of devices to manual handling. Technical measurement results indicated that the use of high-tech assistive technologies (that is, ceiling lifts, intelligent beds, standing aids, master turners, and regular hospital beds, in ascending order) leads to lower physical load for direct care workers in comparison to manual handling, whereas low-tech assistive technologies (that is, bedsheets, walking aids, sliding sheets, sliding boards) lead to higher physical load than manual handling.

Several studies and interviews identified the continued persistence of musculoskeletal disorders or pain despite the presence of assistive technologies or home modifications within the home (Darragh et al. 2015). Hamadi et al (2018) found evidence of increased risk of injury among home health aides who did not care for the same patients and decreased risk of injury among aides who indicated they had all

“...when assistive technologies worked as expected, there were significant benefits, such as increased use of assistive technologies and injury-reducing ergonomic postures.”

—Mabry et al. 2018

necessary devices to successfully lift a patient. Sun and colleagues (2018) noted that environment and conditions need to be considered to perform a safe client transfer. Thus, it is not surprising that several barriers of this nature were identified both within the literature and in interviews. Common issues were assistive technologies in the home that were broken, had missing parts, or were improperly installed (Darragh et al. 2015), or the client lacked additional assistive technologies that facilitated safer

transfers (Sun et al. 2018). Previous studies reported associations between infrequent use of assistive technologies and increased risk of musculoskeletal disorders (Holtermann et al. 2015), and also between frequent use and decreased risk (Boocock et al. 2019). However, when assistive technologies worked as expected, there were significant benefits, such as increased use of assistive technologies and injury-reducing ergonomic postures (Mabry et al. 2018).

Other issues were the result of working alone in a non-standardized setting (for example, cramped spaces), which complicate the proper use of equipment (Darragh et al. 2015; Hignett et al. 2016; Polivka et al. 2015; Karlsson et al. 2019). This issue is typically cited as one for most classically complex lifting devices that have a large footprint, but not as much for smaller low-tech transfer devices. Last, the clients themselves can also impact homecare worker injuries, as their weight (Zhou and Wiggermann 2019), severity of condition, or willingness to use the assistive technologies—in addition to inappropriate sizing of the available assistive technologies (Darragh et al. 2015), are all factors (Sivakanthan et al. 2019; King et al. 2018).

A number of studies use self-reported complaints (that is, pain) and injury claims data to define musculoskeletal disorders. As previously described, musculoskeletal disorders can result from a single traumatic incident, but it is more common in health care to see injuries developed from an accumulation of trauma over many years. These long-term injuries are harder to measure in worker compensation data because they typically require a specific date on which the injury occurred (King et al. 2018), which is not always possible to pinpoint for cumulative injuries. Additionally, it is harder to capture these injuries for research purposes because their severity may progress over time and, unless a longitudinal study is conducted, such musculoskeletal disorders might be overlooked or minimized. Within the homecare worker workforce, these claims can be problematic, as many workers may choose not to report their injuries. Hamadi and colleagues (2019) found that reporting an injury was associated with race, education, care delivery setting, agency ownership (that is, for-profit versus non-profit), the use of a lifting devices, and the need for other devices for job safety reasons. Additionally, homecare workers might not report injuries because they are unaware of the agency reporting protocols or employment benefits, or fear repercussions (Campbell 2018).

Research literature limitations

This literature identified serious flaws in the current effectiveness research--most notably, the lack of comprehensive research studying the efficacy of assistive technologies on injury prevention related to lifting, transferring, or repositioning in home settings (Tang et al. 2019). Interviewees noted that this limited research is due partially to the complexity of the subject and the number of barriers researchers face when implementing appropriate study designs to assess effectiveness, including institutional review board approval, client and worker consent, adequate sample sizes, ability to control for confounding variables, cost/funding, and lab space.

A number of studies have examined self-reported musculoskeletal disorder complaints of homecare workers and caregivers (Darragh et al. 2015; Love et al. 2017) that used validated and widely used instruments but did not use medical evaluations or physician-diagnosed disorders as outcomes. Because of the client-focused nature of assistive technologies and home modifications, many studies assessed their presence or use by the client or caregiver within the home, merely noting the presence of a homecare worker (Frochen and Mehdizadeh 2018; Anderson and Wiener 2015; Darragh et al. 2015; Willink et al. 2019). In these situations, homecare worker use of assistive technologies or home modifications can only be inferred. Some studies directly measured homecare workers' use of assistive technologies (Karlsson et al. 2019; Hamadi et al. 2018, 2019; Mabry et al. 2018; Olson et al. 2018); however, due to the broad nature of assistive technologies definitions, they rarely reported on frequency of use. Even though research on musculoskeletal disorders and use of assistive technologies or home modifications exists, we were unable to find any study that merged the two to specifically address the frequency of homecare workers' using them and the direct effect on work-related musculoskeletal disorders. Due to the low quality of existing evidence, such as small sample sizes, lack of a control, and multiple interventions included in single studies, little information exists about how often assistive technologies or home modifications were used, and for which purposes. Also, when addressing mixed populations and settings in single studies, assessments of the level of effectiveness of assistive technologies or home modifications for reducing homecare worker injury remain questionable (Freiberg et al. 2016; Hegewald et al. 2018; Tang et al. 2019). Freiberg et al. (2016) cited these issues in their systematic review when they found no conclusive evidence that interventions using low-tech assistive technologies prevented musculoskeletal disorders. Hegewald et al. (2018) noted that some intervention studies introduced both low and high-tech assistive technologies within the intervention, making it impossible to determine the specific effectiveness

attributed to either type. Similar limitations are found within the home modification literature. Although positive evidence exists indicating a correlation between home modifications and increase in function via ADLs (Carnemolla and Bridge 2020), there is a notable lack of evidence-based studies measuring home modifications, particularly as a single-factor intervention; thus, the true effects of home modifications cannot be determined.

Another limitation of existing research is the lack of standardized definitions for them. It is common for different researchers to adapt their own interpretations of these terms for their studies by using either an all-encompassing definition of assistive technologies that includes all forms (for example, low and high-tech), focusing on a general broad category (for example, lifting devices), or combining outcomes (for example, slip/lift/fall). Equally confounding is the blurred definition of what constitutes a home modification. It is common for research studies to include home modifications, particularly grab bars, within assistive technologies categories and define them as such. Thus, until single-factor interventions using a standardized definition of assistive technologies or home modifications are conducted on a wide scale, true effectiveness cannot be measured.

Effectiveness and cost-effectiveness conclusions

Despite the lack of solid evidence to definitively support the use of assistive technologies or home modifications to prevent musculoskeletal disorders among homecare workers, there is an overall trend within the literature that suggests they could be beneficial. Almost universally, research and interviewees recommended that manual lifting should be avoided whenever possible (Sun et al. 2018) because it puts caregivers and homecare workers at the most risk for musculoskeletal disorders (King et al. 2019; Hegewald et al. 2018). Tang and colleagues (2019) found that clients without equipment need to be able to support a minimum of 60 percent of their body weight to sit-to-stand successfully; if unable to do so, homecare workers must take on a more strenuous load to complete the task. A few laboratory investigations have assessed the use of different assistive technologies, demonstrating that using them during strenuous transferring or repositioning tasks can reduce physical load. However, due to the simulated setting, they did not examine injuries directly (Hwang et al. 2019; King et al. 2019; Sun et al. 2018; Zhou and Wiggermann 2019). Thus, it could be inferred that the presence of the right device, assistive technology, or home modification can either increase the client's ability to weight bear or assist the homecare worker in such a task, which would decrease the physical load the worker bears and could reduce the chance of an injury. Similar to institutionalized settings, bringing assistive technologies into the home and implementing home modifications is likely to result in cost savings benefits related to injury reduction (Tang et al. 2019; OSHA 2014), particularly when compared to manual techniques for completing lifting, transferring, or repositioning tasks. Nevertheless, standardization of terms and definitions is essential to answering these questions.

Last, there is a crucial need for the research community to continue investigating both assistive technologies and home modifications within controlled laboratory and uncontrolled home settings to directly compare a wide variety of devices on the market. Laboratory studies would allow researchers to build on earlier research and further device comparisons to understand which devices reduce physical load during client-handling activities. Other variables, such as client weight and homecare worker strength, could also be introduced in a safe manner. These results could mimic real-life scenarios that directly affect device selection and the likelihood of musculoskeletal disorders. Device comparison trials could be conducted in various home environments with client-homecare worker pairs, so researchers could understand which assistive technologies or home modifications are most promising for reducing musculoskeletal disorders under different conditions. Researchers could also explore having homecare

workers use wearable devices (for example, an exoskeleton) to allow them to measure body posture or strain as they perform their daily tasks in the home environment. Only when more research has been conducted in the home setting can we answer questions about the effectiveness and cost-effectiveness of assistive technologies or home modifications for reducing homecare worker injuries.

Key Barriers to Wider Adoption

- High cost.
- Fragmented financing.
- Lack of awareness of available AT options.
- Difficulty identifying AT needs and selecting AT.
- Client resistance.
- Need to customize AT to client and home environment.
- Maintenance challenges.
- Lack of training.

PQ2: What are the barriers to wider adoption of assistive devices for lifting and transferring, and how do beneficiaries obtain these devices?

Both the literature and interviews reported that it was common to find no assistive technologies or home modifications in the home, even when needed (Franzosa et al. 2018; Hamadi et al. 2018, 2019; Willink et al. 2019; Vespa et al. 2020; Hignett et al. 2016; Olson et al. 2015; Mabry et al. 2018; Quinn et al. 2016; Wills et al. 2016; Keglovits et al. 2015; King et al. 2018; Love et al. 2017). This is often due to the client's inability to afford them (see Section PQ1b), a general lack of awareness among physicians and clients (see Section PQ2a and PQ2b), or client resistance (see below). Alternatively, if the client had assistive technologies or home modifications, they often were broken, installed incorrectly, not fitted properly to the client or use area (see below), or the homecare worker is not properly trained to use them (see Section PQ2 Other Issues; Hignett et al. 2016; Wills et al. 2016; Keglovits et al. 2015; Love et al. 2017; interview). These findings suggest that, in addition to barriers to obtaining assistive technologies and home modifications, many barriers to ensuring that the equipment is able to assist the client, caregiver, or homecare worker in a safe manner also exist. Thus, to understand this complex process, it is worth exploring the different pathways in which a device can enter a client's home. The most common pathway is through the client, as most assistive technologies and home modifications are client centered (see Figure III.1). In this scenario, the client or family caregiver: (1) selects the assistive technology or home modification; (2) determines how to pay for the item, including whether insurance is an option; (3) purchases or rents the assistive technology or home modification; and (4) if needed, installs it. The second pathway involves homecare workers bringing the assistive technologies, typically a smaller more portable item (that is, a gait belt), with them into the client's home (see Figure III.2). This scenario is far less common than the first one. Both scenarios can encounter many barriers at each step of the process, possibly preventing the client or homecare worker from obtaining the assistive technologies and home modifications or from correctly using the device to prevent an injury; we discuss these barriers further below.

FIGURE III.1. Device is Owned/Rented by the Client and Stays Permanently within the Home

Client needs assistance lifting, transferring, or repositioning within the home.	
Identify the key tasks the client needs help with and where in the home.	<p>Issues</p> <ul style="list-style-type: none"> • The client accepts the individual needs help via a device and the client/family is open to installing or having AT/HM items within the home. • Current assessment tools do not capture needs in a standardized method. • Assessments focus on the client needs but HCW specific needs are typically not considered.
Identify which AT/HM would help for each task and space.	<p>Issues</p> <ul style="list-style-type: none"> • Typically, it is the client's responsibility to research AT/HM devices. • Not all AT/HM devices fit or are made for unique aspects within the home. Thus, the client needs to measure the intended space or know which size to order. This is often overlooked or incorrectly done. • The client's home needs to be taken into consideration (one vs two-story home, renting vs. owning) to select proper AT/HM.
Determine the purchase/rental cost of the AT/HM.	<p>Issues</p> <ul style="list-style-type: none"> • Process varies by insurance type (Medicare, Medicaid, supplemental, or private insurance). • If AT/HM is covered by the client's insurance, there may still be out-of-pocket costs. • Approval process may be lengthy due to processing, determination of need, and at times, denial and contesting processes. • If AT/HM is not covered by insurance, the client needs to find other methods of payment (loans, grants, personal funds, donations).
Determine where and how to purchase/order/rent the AT/HM.	<p>Issues</p> <ul style="list-style-type: none"> • Process varies by insurance type and/or payment method (out-of-pocket vs. rental). • Equipment can be available from standard or online retailers or DME stores, so client needs to identify where to purchase equipment. • For Medicare, the client needs to work with an approved retailer that accepts Medicare's rates.
Receive AT/HM.	<p>Issues</p> <ul style="list-style-type: none"> • Process for receiving AT/HM varies based on the type of device (low-tech vs high-tech). • If the item is special ordered, there could be a delay receiving it.vz1.
Install AT/HM.	<p>Issues</p> <ul style="list-style-type: none"> • Some AT/HM need to be installed by either the client/family or a professional. • If a professional is needed, the client/family needs to find and pay a professional or contractor who can install AT/HM device(s). Some devices can be cheap and easy to install by a standard contractor, while other devices are expensive and complex and will require a specific professional.
Receive training on how to use AT/HM properly and safely.	<p>Issues</p> <ul style="list-style-type: none"> • If applicable, the client, family, and HCW needs to be trained on how to properly use AT/HM device(s). • For the HCW, there may be issues to address such as who pays for the training, when it will occur, and whether the HCW charge hours for the training.
Maintain AT/HM.	<p>Issues</p> <ul style="list-style-type: none"> • The client and, if applicable, family, may need to be trained on how to properly use or assist the HCW when using the AT. • If the HCW feels comfortable, they may be able to do the training.



FIGURE III.2. Device Brought into Home by the Homecare Worker and does not Stay in the Home

Client needs assistance lifting, transferring, or repositioning within the home.	
Identify the key tasks the HCW needs help with and where in the home.	<p>Issues</p> <ul style="list-style-type: none"> • The HCW accepts and is open to using AT device(s). • The client accepts the individual needs help via a device and the client is open to the HCW bring a AT device into the home. • Current assessment tools do not capture needs in a standardized method. Assessments focus on the client needs but do not consider how the HCW performs tasks.
Identify which AT would help for each task and space.	<p>Issues</p> <ul style="list-style-type: none"> • The device typically needs to be small and portable so the HCW can transport it. This limits the scope of devices available and their ability to help on various tasks. • The HCW needs to measure or know which size to order to fit certain devices to themselves and the client. Different clients may require different sizes.
Determine the purchase cost of the AT.	<p>Issues</p> <ul style="list-style-type: none"> • Determine whether the client (see Figure III.1), the agency, or the HCW will pay for the AT.
Determine where and how to purchase/order the AT.	<p>Issues</p> <ul style="list-style-type: none"> • Equipment can be available from standard or online retailers or DME stores.
Receive AT.	<p>Issues</p> <ul style="list-style-type: none"> • Process for receiving AT varies based on the type of device (low-tech vs high-tech). • If the item is special ordered, there could be a delay receiving it.
HCW receives training on how to properly use AT.	<p>Issues</p> <ul style="list-style-type: none"> • Prior to using the AT, the HCW should be trained on how to use it safely, how to maintain the device, and any ergonomic techniques that need to accompany its use. • There may be issues to address such as who pays for the training, when it will occur, and whether the HCW can charge hours for the training.
Bring AT to client's home.	<p>Issues</p> <ul style="list-style-type: none"> • Client may not be willing to use the AT.
If applicable, the client and caregiver receive AT training.	<p>Issues</p> <ul style="list-style-type: none"> • The client and, if applicable, family, may need to be trained on how to properly use or assist the HCW when using the AT. • If the HCW feels comfortable, they may be able to do the training.
Maintain AT.	<p>Issues</p> <ul style="list-style-type: none"> • The HCW needs to ensure the AT is disinfected on a regular schedule, inspected for broken or missing pieces, and fixed or replaced when needed.



Client resistance

One of the primary barriers to bringing home modifications and assistive technologies into the home, as identified in both the literature and interviews, is client and/or family resistance. This resistance may be because of the client or family not wanting to change the home or feeling that such devices take away from the aesthetics or personal feel of their environment (Sivakanthan et al. 2019). Limited space or fear that home modifications may affect the resale value of the home might also be factors (King et al. 2018). Often the opposition is because of denial stemming from a psychological fear or stigma surrounding assistive technology or home modification use. Many adults struggle with accepting their own aging or that of a loved-one, and the consequent need for help with daily activities. The presence of home modifications and assistive technologies can constantly remind people of their increasing limitations and waning independence or similar limitations for family members, or serve as reminders for friends who

come into their home (Sivakanthan et al. 2019; King et al. 2018). Thus, many people have a strong desire to maintain a sense of normality within the home to avoid the image of disability. Unfortunately, this denial complicates care delivery and safety for the client, caregiver, and homecare workers, because care typically continues with or without the presence of assistive technologies or home modifications, even when they are necessary (King et al. 2018). Clients also frequently state a preference for the manual help of a homecare worker without the use of a device, so those workers continue to conduct manual lifts and transfers (Love et al. 2017) despite their better judgement. In focus groups, homecare workers described their struggles in empathizing with their client’s desires and finding it difficult to set boundaries and advocate for their own safety by insisting that equipment be provided and used (King et al. 2018).

Effects of the home environment on selecting or using equipment

Many older adults want to remain in their homes as long as possible, yet many homes in the United States are not built to accommodate this desire. Overwhelmingly, the traditional American home is not designed for health care delivery, nor is the environment easily adaptable to accommodate most assistive technologies or home modifications on the market (Meals on Wheels America 2017; Joint Center for Housing Studies of Harvard University 2016; Vespa et al. 2020). Most assistive technologies are designed for and commonly used within institutionalized care settings that are required to follow environmental and design standards for large equipment. It can be difficult to use the same assistive technologies in home settings due to the wide range of structural limitations, floor plans, and interior design. For example, grab bars and wall and ceiling lifts need to be installed permanently and might require additional structural changes or reinforcements. If clients are unable to install stationary grab bars (that is, into the wall), they are left with the subpar alternate of suction cup grab bars, which can be hazardous if not checked and regularly reattached (King et al. 2018; interview). The Joint Center for Housing Studies of Harvard University (2016) identified the three most critical accessibility features for successful aging in place; single-floor living, extra-wide hallways and doors, and zero-step entrances. It stated that less than 4 percent of single-family homes--the most common housing for older adults--and only 3.5 percent of housing units overall, offered all three. Although these home modifications are not directly related to lifting, transferring, or repositioning care tasks, such structural barriers can affect them. For example, if a wheelchair-bound client cannot fit through the bathroom door, the homecare worker might have to help manually transfer that person.

“Client’s often don’t have or want to spend the money on [assistive technologies or home modifications] or are often afraid the devices will hurt them. Family members are also barriers. They don’t want to admit their loved-one is disabled.”
–Occupational health & safety expert

“There is this assumption that you can just bring in [assistive technologies] and set it up within the home. But the home environment is just not workable for most devices. There is a broken link in the design of [assistive technology] equipment, even simple equipment, that limits or prevents [it] from being used in the home.”
–Occupational research expert

Research and interviewees alike highlighted small rooms, clutter (for example, pieces of furniture, medical equipment, clothing, magazines, paper on the floor), and obstacles (for example, pets; Love et al. 2017; Hignett et al. 2016; Karlsson et al. 2019; Polivka et al. 2015; Darragh et al. 2015; Wills et al. 2016) as common complications for both equipment and homecare workers. Researchers and experts most often cited the bathroom as the space that would benefit most from assistive technologies because of the number of lifting and transferring tasks that occur in this room. Nevertheless, bathrooms often have no safety equipment (for

example, grab bars, shower chairs) due to environmental barriers (Darragh et al. 2015; King et al. 2018, 2019; Kuboshima et al. 2018; Polivka et al. 2015). Home bathrooms typically are small and have tight

spaces around fixtures (for example, the toilet, bath, and vanity) that hinder movement and care activities. These tight spaces often prohibit the use of assistive technologies used in institutional settings (for example, sit-to-stand aids); even basic portable mobility devices that clients use throughout the rest of the home (for example, a walker) may be difficult to use in the bathroom. Several studies found that performing tasks like toileting, bathing, or helping the client out of bed in small spaces was a significant risk factor for injury because assistive technologies often cannot be brought into these spaces, and clients are more likely to need support from homecare workers or caregivers to transfer within them. Thus, homecare workers often encounter a significant risk of injury because they are simultaneously providing stability in addition to care activities (for example, lifting, bathing, transferring) via manual handling techniques (King 2018, 2019) while using unsafe, awkward, or stressful postures to complete these tasks (Polivka et al. 2015; King et al. 2018, 2019; Hignett et al. 2016; Darragh et al. 2015).

Even when clients have some equipment in the home to help the homecare worker or caregiver safely lift or transfer them, there may be cases in which they still use manual transfers. As mentioned previously, existing assistive technologies or home modifications often are sized inappropriately for the environment or client (for example, equipment and supplies that are designed for larger or obese patients), broken, or have missing parts (Hignett et al. 2016; Wills et al. 2016; Keglovits et al. 2015; Love et al. 2017), all of which add to physical risks for both clients and homecare workers. Sometimes the device is not used at all. For example, transfer benches often are recommended to assist clients during bath entry and exit, but they typically are large and do not fit standard bathtubs; if they do fit, they can splash water on the floor, creating additional hazards (King et al. 2018). Both interviewees and the literature also pointed out that a client may have devices present in the home that are not always available when needed (Darragh et al. 2015). For example, a client may have an elevated toilet seat in one bathroom but not another, which would require a manual task if the client uses that restroom. Additionally, the equipment may not be sufficient to replace all manual portions of a task (interview), such as if the client has a bath/shower chair to assist with bathing but the homecare worker still needs to manually help the client in and out of the bathtub or lift the client's legs over the bathtub wall (King 2018, 2019; Kuboshima et al. 2018).

Homecare workers' problems with assistive technologies and home modifications

Across the board, interviewees and published research frequently mentioned the lack of assistive technologies and home modifications as a barrier for homecare workers to conduct tasks safely.

Homecare workers frequently reported that clients' homes did not have the assistive technologies or home modifications they needed to perform their jobs in a safe manner (Franzosa et al. 2018; Hamadi et al. 2018, 2019; Willink et al. 2019; Vespa et al. 2020; Hignett et al. 2016; Olson et al. 2015; Mabry et al. 2018; Quinn et al. 2016; Wills et al. 2016; Keglovits et al. 2015; King et al. 2018; Love et al. 2017; Karlsson et al. 2019).

"Many homecare workers don't pursue [assistive technologies] covered by the client's insurance because it is a long, drawn out, and arduous process."

–Occupational health & safety expert

Homecare workers often did not know about procedures for acquiring safety equipment or reported those procedures as complicated, time-consuming, and rarely successful (Mabry et al. 2018; Love et al. 2017). Because acquisition of most assistive technologies or home modifications must be driven by the client, the homecare workers' only other option is to ask their agency to provide some small low-tech assistive technology, which is uncommon, or purchase it themselves. However, most homecare workers have limited resources, if any, for purchasing equipment (Sun et al. 2018); thus, many do without (Mabry et al. 2018). Even if the client is in the process of obtaining assistive technologies or home modifications to create a safer environment, care still needs to continue. For example, Wills and colleagues (2016) cite a

homecare worker who had to continue lifting and transferring an immobile client even though the client had requested lift equipment, pending receipt of the needed equipment/assistance. Both the literature and interviews highlighted that these barriers led some homecare workers to desperate measures. For example, some made their own Do-It-Yourself tools or modifications, such as using a kitchen chair in the tub or a towel rack as a grab bar (Polivka et al. 2015), a broomstick with a rubber stopper to mimic a rail (interview), or an office chair to transfer a client between locations in the home (Wills et al. 2016). These ad hoc tools can be inappropriate and create additional hazards for clients and homecare workers alike.

PQ2a. How do beneficiaries find out about assistive devices that might benefit them, their homecare workers, and their family members by reducing risk for injury?

Identifying needs and selecting equipment

When a client or family is open to the idea of assistive technologies and home modifications, adherence rates to recommendations tend to be high (Keglovits et al. 2015; Darragh et al. 2015), particularly with

“Most caregivers don’t even know this type of [assistive technology or home modification] equipment exists or are aware that this is possible. The expectation is that [homecare workers] are going to manually handle the patient like the caregivers. This is a horrific situation that needs to be corrected.”

–Safe patient handling & mobility expert

assistive technologies or home modifications that were more aesthetically pleasing within the client’s home environment (King et al. 2018). When a client receives home health care through Medicare, a standardized home assessment is conducted to identify the client’s needs and level of care required (Medicaid or private-pay home assessments may not be standardized). At that point, Medicare-approved DME (that is, hospital beds or lifts) may be recommended to the client to assist them with the identified needs. These

assessments and equipment recommendations are client focused; that is, caregiver and homecare worker needs or safety are not considered (see Section PQ2c, for more information about needs assessments). Even if the client’s provider or the homecare worker recommends assistive technologies or home modifications, it is typically left to the client or family to obtain the equipment. This is often limited due to client and their families general lack of awareness and challenges selecting assistive technology and home modifications due to the home environment (see Section PQ2), which creates further barriers to using equipment.

Although professionals are likely to be better suited than family caregivers to recognize the true extent of the client’s needs and recommend appropriate equipment, many clients and caregivers navigate home modification and assistive technology options on their own. There are numerous websites that offer information and support to caregivers (for example, the National Directory of Home Modification and Repair Resources,⁸ National Alliance for Caregiving,⁹ Family Caregiver Alliance,¹⁰ AARP,¹¹ and NIH¹²) to help them understand what equipment would fit their specific use cases. Additionally, clients and families might also seek guidance from their personal physician (National Academies of Sciences, Engineering, and Medicine 2016); however, the lack of physician awareness and sparse literature available to guide their recommendations are notable barriers (interview). This process can cause delays, as most clients, homecare workers, and families are not trained to understand the complexity of a client’s functional needs regarding their home environment, living arrangements, and the physical effects on their

⁸ See <https://homemods.org/national-directory>.

⁹ See <https://www.caregiving.org>.

¹⁰ See <https://www.caregiver.org/pilotIntegration/indexPersistent.html?uri=%2F>.

¹¹ See <https://www.aarp.org/caregiving>.

¹² See <https://www.nia.nih.gov/health>.

caregivers. It is also worth noting that sometimes older adults will attempt to hide the extent of their need from their caregivers. Although caregivers may know their clients' needs, they lack knowledge about the types of assistive technologies or home modifications that exist and differences between various devices and manufacturers. Many of them report difficulties in identifying needs and finding information (Meals on Wheels America 2017), further increasing caregiver burden (National Academies of Sciences, Engineering, and Medicine 2016). Research found that caregivers' feelings of isolation and lack of support when trying to obtain necessary equipment to provide care create cognitive risks relating to stress and decision making about medical device use (for example, selecting the wrong size slings for a lift; Hignett et al. 2016).

PQ2b. What are the sources of payment for these devices?

Key sources of payment for assistive technologies and home modifications include public and private insurance, government programs, foundations or non-profit programs, loans, grants, donations, and out-of-pocket. While there are many different payment sources or program options, cost is a major barrier to obtaining assistive technologies and home modifications.

Key Sources of Payment

- Public insurance.
- Private insurance.
- Government programs.
- Foundations or non-profits.
- Loans.
- Grants.
- Donation.
- Out-of-Pocket.

Payment using insurance

Government-funded insurance coverage for some assistive technologies or home modifications is available, but as with all insurance, there are requirements and limitations. Original Medicare Part B covers up to 80 percent of the approved DME cost for beneficiaries (CMS 2019a; see the Glossary). There are strict guidelines, however. A Medicare-enrolled doctor or health care provider (for example, nurse practitioner, physician assistant, or clinical nurse specialist) must prescribe the technology specifically for the home. Some devices require the physician to provide additional documentation regarding the client's specific medical needs for the equipment (CMS 2019a). If the client's needs change throughout the process, the prescribing physician must submit a new order, thus starting the process over. The prescribed assistive technologies must meet Medicare's definition of DME, which requires that devices must withstand repeated use over an expected lifetime of at least three years, be primarily used to serve a medical purpose, and generally not be useful to a person in the absence of illness or injury (CMS 2019a). To simplify this definition, DME is considered to be a subset of assistive technologies. Within the scope of assistive technologies used for lifting, transferring, or repositioning clients, Medicare usually covers only commode chairs, hospital beds, lifts, or hoist device rentals (CMS 2019a); the majority of assistive technologies and home modifications do not fall within this Medicare classification. Next, the client or caregiver must select a Medicare-approved and participating supplier (that is, enrolled in Medicare and having a current supplier number) and one who chooses to "accept assignment" (that is, accepts the Medicare-approved amount); otherwise, the equipment will not be approved or the client will

not be reimbursed for the claim. Depending on the type of equipment needed, Medicare might pay for a rental only, as it buys only inexpensive or routine items (for example, canes, walkers) and, in rare cases, custom-made devices (CMS 2019a). The supplier then works with the client’s doctor to submit all required information to Medicare. Typically, the client is responsible for 20 percent of the Medicare-approved amount, but this cost can be prohibitive for many people on Medicare with low, fixed incomes. In 2016, half of Medicare beneficiaries had incomes below \$26,200 per person and savings below \$74,450 (Kaiser Family Foundation 2019). Medicare’s coverage of DME repairs and maintenance depends on whether the client or the supplier owns the equipment. If the client is renting, the supplier must maintain and repair the equipment, without charge (CMS 2019a). If the client owns the equipment and the services are not covered by a warranty, Medicare covers 80 percent of the approved amount for equipment repairs and maintenance.

Medicare Advantage Part C Plans include Part A, Part B, and usually Part D coverage, and are an alternative to Original Medicare. These plans are offered by private insurance companies (for example, a health maintenance organization or preferred provider organization) approved by Medicare. Different plans have different out-of-pocket costs, and these costs may vary from location to location, even with the same provider; however, the out-of-pocket costs may be lower than Original Medicare (CMS 2019b). Medicare Advantage plans must cover, at a minimum, the same items and services as Original Medicare. Historically, Medicare Advantage plans have also provided supplemental benefits coverage for other kinds of health care services and supplements not included in Original Medicare. Thus, Medicare Advantage coverage of DME can be provided in one of two ways: (1) it can cover a larger portion of the cost of an item that Original Medicare covers; or (2) it can cover something that Original Medicare does not. However, DME coverage and repairs may differ between Medicare Advantage plans. All Medicare Advantage plans have a cost-sharing obligation for all Medicare-covered services; however, if the item is not covered by Medicare, it is up to the Medicare Advantage Plan to determine whether it falls under a supplemental benefit.

“[The client] may have the money to pay for the [assistive technology or home modification] equipment on their own; otherwise they have to deal with their insurance, which isn’t always successful. Many times, it is easier to get insurance to pay for cheaper [assistive technology] items; it’s the more expensive devices they tend to challenge more often.”
—Homecare agency

Medicaid is a joint federal and state program that provides health coverage for certain people with limited income and assets. Because states have considerable flexibility in the design of their Medicaid programs, there is varying coverage of assistive technologies and home modifications across and within states, depending on what program or services for which a person is eligible. Some Medicaid programs use a “consumer-directed” model, which may allow beneficiaries to purchase assistive technologies or home modifications within their allotted budget; however, they trade off purchasing services (for example, a lower number of personal care hours) if they choose to purchase equipment. For dually eligible beneficiaries covered by both Medicaid and Medicare, it is possible that Medicaid will cover services that Medicare does not, as well as pick up Medicare’s out-of-pocket costs (for example, deductibles, coinsurances, copayments) if the beneficiary meets the criteria and is enrolled in one of the programs that covers Medicare cost-sharing. Therefore, dually eligible beneficiaries may have access to assistive technologies or home modifications through Medicaid that they do not have through Medicare.

Until recently, Medicaid coverage for assistive technologies and home modifications was largely limited to home and community-based services (HCBS) waiver programs, although not all states chose to include such coverage in their HCBS waiver programs or did so only in some waivers but not others. However,

in May 2020, the Medicaid Home Health Services regulation (42 CFR 440.70(b) was amended to expand coverage of assistive devices, including devices and technologies well beyond the kinds of “durable medical equipment” covered under Medicare. The most relevant portion of the amended rule reads:

(3) Medical supplies, equipment, and appliances suitable for use in any setting in which normal life activities take place, as defined at § 440.70(c)(1).

(i) Supplies are health care related items that are consumable or disposable, or cannot withstand repeated use by more than one individual, that are required to address an individual medical disability, illness or injury.

(ii) Equipment and appliances are items that are primarily and customarily used to serve a medical purpose, generally are not useful to an individual in the absence of a disability, illness or injury, can withstand repeated use, and can be reusable or removable. State Medicaid coverage of equipment and appliances is not restricted to the items covered as durable medical equipment in the Medicare program.

(iii) A beneficiary's need for medical supplies, equipment, and appliances must be reviewed by a physician or, as defined in § 400.200 of this chapter, any other licensed practitioner of the healing arts acting within the scope of practice authorized under State law, annually.

(iv) Frequency of further physician or, as defined in § 400.200 of this chapter, any other licensed practitioner review of a beneficiary's continuing need for the items is determined on a case-by-case basis based on the nature of the item prescribed.

(v) States can have a list of preapproved medical equipment supplies and appliances for administrative ease but states are prohibited from having absolute exclusions of coverage on medical equipment, supplies, or appliances. States must have processes and criteria for requesting medical equipment that is made available to individuals to request items not on the state's list. The procedure must use reasonable and specific criteria to assess items for coverage. When denying a request, a state must inform the beneficiary of the right to a fair hearing.

Because home health services are a mandatory Medicaid benefit, this amendment has the potential to expand access, albeit only to individuals who are financially eligible for Medicaid.

Separate from their Medicaid programs, most states offer other programs to assist with acquiring or paying for assistive technologies or home modifications for those who prefer to age in place. Although some programs are more robust than others, all states offer Assistive Technology Projects¹³ (funded by the Administration for Community Living State Grant for Assistive Technology Program),¹⁴ which provide DME assistance via training, demonstrations, refurbished devices, and assistive technology loans to elderly and disabled persons. In addition, many states have various types of non-Medicaid¹⁵ programs-- for example, state-funded HCBS programs that provide financial assistance for home medical equipment or home modifications. These programs typically serve older adults (age 60+ years), younger adults (ages 19-59) with disabilities, and their family caregivers. They are part of a strategy to decrease reliance on expensive institutionalized care settings (for example, nursing homes) and increase community living through the cost-effective use of public and private resources (O'Brien et al. 2019). Unlike services

¹³ See <https://acl.gov/programs/assistive-technology/assistive-technology>.

¹⁴ See <https://acl.gov/grants>.

¹⁵ For program examples by state, see <https://www.aarp.org/content/dam/aarp/ppi/2019/02/home-and-community-based-services-beyond-medicare.pdf>.

supplied under other public funds, these services may be provided to both the care recipient and family caregivers. For example, the Pennsylvania Caregiver Support Program provides financial assistance to qualified caregivers who care for dependent, low-income older adult(s). Caregivers receive a one-time grant of up to \$2,000 to purchase assistive technologies and home modifications for the home.

The VHA also provides DME coverage to qualified veteran beneficiaries. Providers work together across care settings to obtain assistive technologies or home modifications for veterans in the home. The VHA has several options for assistive technologies and home modifications, such as covering an individual's Medicare copayments, providing money to purchase the equipment, purchasing or loaning equipment, obtaining grant funds, and a variety of support programs. For example, the Veterans-Directed Care¹⁶ program provides veterans with financial assistance by furnishing them with funds to purchase goods and services that best meet their needs, including modify their homes to age in place. Some veteran pensions (for example, VHA Aid) one-time bonuses to cover the cost of unreimbursed medical expenses, such as medically necessary home modifications.

The VHA is unique among payer sources in having explicitly addressed the problem of LTSS worker injuries and made recommendations for how to prevent or reduce them. The VHA has recently expanded its Safe Patient Handling and Mobility (SPHM) program to the home setting. The program was originally focused on the inpatient setting, but it is now paying more attention to safety in the home for veterans, caregivers, and homecare workers, including additional efforts to provide assistive technologies and home modifications. The VHA has developed and made available a Safe Patient Handling App for both VHA and non-VHA care teams, particularly direct care providers including nurses, physical medicine and rehabilitation specialists and imaging staff. The Safe Patient Handling App provides evidence-based SPHM techniques to help provide the safest care possible to patients. The app offers a blend of knowledge and tools to prevent injury of both health care professionals and the patients they care for by incorporating assessments, scoring tools, algorithms, equipment guides, videos for training and peer leader activity checklist. The information in this app offers the current best practices in SPHM at the point of care, preventing injury and improving interactions between patients and health care professionals.¹⁷

Although not as common, some clients can receive coverage for assistive technologies or home modifications through private insurance. Similar to the role that Medicaid can play in providing coverage for Medicare cost-sharing, having supplemental insurance can help cover Medicare's out-of-pocket costs. Private health plans may also cover assistive technologies deemed medically necessary. Like other public insurance, however, this distinction normally excludes assistive technologies that specifically benefit the safety of homecare workers because the focus for approving coverage is based on client need. When private insurance refuses to pay for equipment, clients can appeal the claim; sue their insurance company; seek aid through private, national or non-profit groups; or purchase the equipment out-of-pocket.

Other programs

There are a wide range of federal programs (U.S. Department of Housing and Urban Development,¹⁸ U.S. Department of Agriculture), foundations (for example, Rebuilding Together) and local non-profit programs (for example, Local Area Agencies on Aging and Independent Living Centers) that offer assistance for home modifications and obtaining assistive technologies. Some programs limit their aid to

¹⁶ See https://www.va.gov/GERIATRICAL/pages/Veteran-Directed_Care.asp.

¹⁷ See <https://mobile.va.gov/app/safe-patient-handling>.

¹⁸ See https://www.hud.gov/program_offices/housing/sfh/title/title-i.

populations with specific conditions or diseases (for example, Alzheimer's or multiple sclerosis), whereas others have financial requirements (for example, income or asset limits). Some organizations make free, long-term loans for devices--for example, a portable wheelchair ramp that can be returned when the borrower moves from the home or no longer needs it. There are some home improvement grants (for example, Single Family Housing Repair Loans and Grants)¹⁹ available for a specific home modification; they typically are one-time grants that do not need to be repaid. Last, some local organizations²⁰ or local chapters of national organizations (for example, Boy Scouts of America, Rotary, Lions, and 4H clubs) undertake home modification or improvement projects on a volunteer basis. In many cases, clients need to seek out these opportunities, assert themselves, and be prepared to wait a considerable length of time to have their needs addressed (interview). This effort is further complicated by noteworthy geographic variations in funding, types of services provided, and the nature of the organizations providing services, leaving some areas, often more rural, with a shortage of available assistance (Meucci et al. 2016). Typically, clients who face these barriers and have less caregiver support to help navigate and advocate for them are likely to be at a disadvantage.

Out-of-pocket

Although there is some coverage across different insurance types and various loan or grant programs, individuals or their families most commonly have to pay out-of-pocket for home modifications or assistive technologies, particularly when the equipment is primarily for a caregiver's or homecare worker's safety. Even when Medicare pays 80 percent of the purchase cost, 20 percent of the burden remains on the beneficiary. For smaller devices, this burden may be negligible, but items that can cost thousands of dollars may be difficult to cover. Medicare estimated private expenditure for both DME and other non-DME²¹ equipment in 2018 at approximately \$89.7 billion (\$25.5 billion for DME²² and \$64.2 billion for non-DME)²³ and predicted that this cost could more than double by 2028 (\$40.4 billion for DME²³ and \$101.8 billion for non-DME).²⁴ To save money, a client or family member can take different routes to obtain assistive technologies or home modifications. There are many online marketplaces for buying secondhand or refurbished equipment, but there are pros (that is, cost savings) to consider, as well as cons (for example, equipment may be broken or non-returnable). Some organizations, mostly governmental, offer low-interest or guaranteed loans that allow banks to have less restrictive lending requirements; however, these loans must be repaid. Clients can also use tax credits to reduce costs, but they typically have stringent qualifying criteria. For example, a caregiver can use the Child and Dependent Care Tax Credit and claim the purchased cost of the assistive technologies if: (1) the person needing the equipment is classified as the caregiver's dependent; and (2) the equipment increases the client's ability to function independently, thus allowing the caregiver to work outside of the home. Although some financial assistance options are available, on the whole they are both limited and complicated. Interviewees and previous research both noted that one of the main barriers preventing older

¹⁹ See <https://www.rd.usda.gov/programs-services/single-family-housing-repair-loans-grants>.

²⁰ See <https://www.medicaid.gov/federal-policy-guidance/downloads/cib081920.pdf>.

²¹ Because of Medicare's limited definition of DME, many types of assistive technologies used for lifting, transferring, or repositioning are not included; we also captured other non-DME. It should be noted that these numbers are not specific to equipment used only for lifting, transferring, or repositioning but also capture other forms of equipment, such as wheelchairs and oxygen systems. To our knowledge, there is no national data collection by assistive technology or home modification type, regardless of payer type.

²² CMS NHE Projections 2019-2028--Table 15: <https://www.cms.gov/files/zip/nhe-projections-2019-2028-tables.zip-0>.

²³ CMS NHE Projections 2019-2028--Table 12: <https://www.cms.gov/files/zip/nhe-projections-2019-2028-tables.zip-0>.

adults from implementing safety changes within their home is the inability to afford them (Meals on Wheels America 2017; Joint Center for Housing Studies of Harvard University 2016).

PQ2c. Do homecare agency providers routinely assess whether workers should have access to assistive devices, and what role do homecare agencies play in helping beneficiaries obtain these devices?

Agencies' assessment of needs

Based on the review of the literature and our interviews, it appears that agencies do not specifically assess whether a homecare worker should have access to assistive technologies; however, these needs can be identified during other assessment processes that can take place in the home. One opportunity to identify

“In-home needs assessments are considered a best practice within the [homecare] industry, but that doesn't mean that [all agencies] do them.”

–Homecare agency

such needs is during the agencies' in-home assessment. Whether these assessments occur and what type of assessment is done depends on state licensure requirements, individual agency preferences, and the payer (for example, private, Medicare, Medicaid); however, interviewees said that conducting an assessment is considered a best practice. In some states, the

licensure requirements mandate that assessments occur in the home before starting services. In states without licensure requirements, it is up to the individual agencies to determine whether or not to do an assessment if the payer does not require it. If a client is covered by a Medicaid managed long-term care plan, it may require the homecare agency to conduct an assessment. Some clients also receive Medicare skilled home health care in addition to homecare services, and Medicare requires an assessment to receive such services. Agencies that do assessments often use a trained social worker or a nurse (for example, one certified in nursing homecare) to do so. They assess for safety issues for both clients and homecare workers, and address what services will be provided to the client. As part of the process, the person doing the assessment may make recommendations to the family about assistive technologies, home modifications, or other safety issues (for example, moving carpets, cords, or personal items because they represent a fall risk), but ultimately it is up to the client or family to decide whether or not to accept the recommendations (see Section PQ2). To help caregivers and staff address this issue, the VHA has developed Safe Patient Handling algorithms²⁴ to identify strategies for different tasks and types of equipment that might fit the current need. Use of the VHA algorithms requires completion of a standardized assessment as they are based on patient characteristics and conditions identified in the individualized assessment. Algorithms have been developed to guide the choice equipment and number of staff required to assist with specific patient handling tasks. For example, the algorithms for transferring (from bed to chair, chair to chair, car to chair) provide a decision tree for making choices taking into account whether or not the patient can bear weight, is cooperative, and has any upper body strength. Nevertheless, developing such tools does not appear to be happening within the greater homecare industry, leaving homecare workers to advocate for themselves.

Even if an agency conducts a homecare worker needs assessment at the start of care, a single assessment will not capture changing needs. As discussed previously, most aging adults will need some form of LTSS during their lifetime, and the level of assistance increases with age (Johnson 2017; Administration for Community Living 2020). Therefore, an assessment conducted at the beginning of care may not reflect the current needs of a long-term client. To assess homecare workers' needs for assistive

²⁴ See <http://www.asphp.org/wp-content/uploads/2016/06/New-and-Improved-VA-Algorithms-and-New-SPHM-App-ASPHP-rev-MMM.pptx>.

technologies accurately, annual or ongoing assessments are needed, which some agencies have built into their process. Because most assistive technologies or home modifications must be acquired by the client (see PQ2a), it is usually up to the homecare worker to talk to clients about their perceived needs and encourage them to acquire the assistive technologies or home modifications (interview). However, both research and interviewees noted that the recommendation of assistive technologies or home modifications should not fall to the homecare worker, as this type of assessment exceeds their licensure. If a client declines a recommendation, the homecare worker's other option is to bring safety concerns to the agency. Some interviewees said that some agencies will provide low-tech (for example, a gait belt) or low-cost (for example, a folding chair) items to employees if there is a significant need, but this need is often evaluated on a case-by-case basis and is uncommon overall.

Another issue that affects homecare workers' assistive technologies needs and the ability to make an appropriate assessment is the client-worker pair itself. As described above (see Section PQ1c, pages 8 and 19), there are a wide variety of factors that determine the need for equipment, including the client (for example, comfort level, weight, ability to help the homecare worker) and the homecare worker (for example, training, health, previous injuries; see Section PQ2 Other Issues, page 33). Interviewees highlighted that homecare workers are sometimes assigned to clients who are difficult for them to assist, which can put them at higher risk for musculoskeletal disorders if the right equipment is not used. For example, a homecare worker who is 5'1" will most likely have a harder time transferring a 6'5" client than another employee who is 5'11"; therefore, their assistive technology needs are likely to be different. Agencies that create the client-homecare worker pairing should consider such issues when developing assignments and then evaluate the homecare workers' assistive technology needs on a case-by-case basis. Nevertheless, many agencies do not have the infrastructure to do such complicated scheduling. Some information (for example, height and weight of the client and homecare worker) often is not available to schedulers, and they typically focus on availability to ensure the client receives care as soon as possible. One interviewee said that they consider homecare worker training during the match process if an employee has been trained on a specific piece of equipment available in the home.

Assessment timing

The timing of these assessments can impede the agency's ability to identify safety concerns for their employees. Although Medicare assessments are made before starting services, for some new cases covered by other payers, the agency may send a homecare worker to a client's home to begin providing care before a home needs assessment (interview). These situations may be common; research indicates that homecare workers frequently receive little information about their clients' health or the home before their first visit (Franzosa et al. 2018; Love et al. 2017), giving them no ability to prepare and potentially exposing them to hazards. Some homecare workers felt that this information was deliberately withheld so they could not refuse a case (Franzosa et al. 2018).

Agency assistance in obtaining equipment

Depending on the payer and local resources (see Section PQ2b), the agency may provide some help to clients in procuring needed equipment. Some agencies provide information about local programs (for example, lending libraries, non-profits, grants) that can assist the client with finding the right assistive technologies or home modifications. Other agencies, such as Medicare-certified home health agencies, employ a dedicated nurse case manager who can follow up on client needs with other providers. For example, a nurse may report the in-home needs assessment findings to the client's primary care physician so the physician can prescribe DME (for example, a hospital bed; see Section PQ2b). One interviewee

said that this step alone can cause serious delays because it is common that the agency cannot reach the primary care physician or locate the physician at the clinic identified by the client. Thus, the agency cannot proceed with the prescription request until the client identifies a new primary care physician. Multiple interviewees said that the process of getting equipment into the home is lengthy and requires a great deal of follow-up and tracking (for example, following up with providers multiple times to get the prescription and receiving approval from the insurance utilization department and the company that delivers the equipment). Because the process is so time consuming, many agencies lack the ability to help clients because they do not have the appropriate number of qualified administrative staff available for the task.

Other issues

Homecare worker training

Training requirements, standards, and delivery methods vary across the homecare industry. For example, home health aides and nursing assistants must meet a 75-hour federal training requirement (42 CFR § 483.152; Institute of Medicine 2008), but other homecare workers who do not fall within these classifications have widely fluctuating requirements that vary not only by state but also across programs. Additionally, these training programs can be expensive and often the homecare worker needs to pay for them (interview). Both the literature and interviewees identified homecare worker training as a barrier to using assistive technologies because many of them either receive no or inadequate training before working with clients (Wills et al. 2016; Christman and Connolly 2017; Franzosa et al. 2018; Butler 2018; Campbell 2018). To date, seven states do not regulate training at all; 29 have varying requirements, depending on whether homecare workers work in specific Medicaid programs or for private-pay homecare agencies and are agency-employed; and 14 states have consistent training requirements for all agency-employed homecare workers.²⁵ The National Academy of Medicine has recommended that states standardize and establish minimum training requirements for all homecare workers (Institute of Medicine 2008) to close this gap. Nevertheless, as previously discussed, there are a wide variety of factors (for example, the client, the homecare worker, the home environment) that inevitably determine safety within the home (see Section PQ1). Thus, like home assessments (see Section PQ2c), customized training to address the unique client-homecare worker pair could also increase safety.

“Homecare workers themselves can be a barrier. Because many are not trained on [assistive technologies]; some think equipment takes more time than completing the task manually or they feel that the devices take away the human touch component of their job.”
–Occupational health & safety expert

The research and experts alike stressed the importance of proper training to help mitigate homecare worker injury (Wills et al. 2016; Campbell 2018). Research suggests that direct care workers with less training or who experience low quality training have a significantly higher likelihood of injury across settings (Walton et al. 2017). Stakeholders also said that even for workers who do have training, the specific topics addressed are not always relevant to the tasks performed on the job or, as described above, they may not be adequately trained to handle unique scenarios that arise with specific clients. For example, some homecare workers may never receive training on how to use or interact with common mobility-related assistive technologies (for example, wheelchairs and walkers), let alone more complex high-tech equipment. Some lifts (for example, mechanical, Hoyer) are difficult to operate alone, or the

²⁵ See <https://phinational.org/advocacy/personal-care-aide-training-requirements>.

homecare worker may lack the training to use the device safely (Hignett et al. 2016; Love et al. 2017; interview). Furthermore, if a client acts unpredictably or does not comply with the proper positioning for the assistive technologies, and the homecare worker has not received adequate hands-on training to mitigate the situation, it could put both the client and homecare worker at risk of injury (Love et al. 2017). For these reasons, some agencies have specific policies that limit or prohibit their homecare workers' use of particular types of assistive technologies that already exist in the client's home to avoid safety hazards, even when homecare workers may be placed in situations where its use is necessary and expected by the client (interview). High quality trainings have been shown to be effective in improving occupational safety across settings (Teeples et al. 2017; interview), and similar benefits are likely if trainings are standardized across the homecare industry as a whole. For example, in a multifactor intervention to improve safety designed for homecare workers, researchers measured self-reports of communicating with clients about unsafe conditions, correcting in-home hazards, using tools for lifting and transferring, physical health, diet, and emotional well-being both pre and post-intervention (that is, at six and 12 months; Olson et al. 2015). Homecare worker safety compliance increased post-intervention, with participants making safety changes to correct home hazards, talking with clients about home safety, and using new tools for lift and transfer tasks (Olson et al. 2016; Mabry et al. 2018). Although such studies have shown positive effects of training on improving homecare worker safety, extensive ongoing trainings along these lines are uncommon or too expensive for homecare workers to afford; also, they typically do not address unique scenarios, such as the range of assistive technologies the homecare worker may encounter. Without proper training, techniques, and access to assistive technologies, many homecare workers will continue to sustain workplace musculoskeletal disorders during their client lifting, transferring, or repositioning handling tasks.

IV. Conclusions and Discussion

A. Summary of findings

Homecare is one of the fastest growing employment sectors (PHI 2019). However, the home environment presents many challenges to providing care for direct care providers and caregivers. A unique aspect of homecare is that the client's autonomy and choice are inevitably at the forefront; thus, there are no national standards regarding the physical environment in which services are provided--a stark contrast to restrictive requirements within institutionalized settings. Thus, each situation (that is, for the client, homecare worker, and home environment) is unique, and selecting assistive technologies and home modifications must consider all of these factors for the equipment to work properly and mitigate injuries for the client and the homecare worker.

Although some assistive technologies or home modifications (for example, gait belts, slide or transfer boards, toilet seats with supportive arms, shower chairs, handrails/grab bars, or Hoyer lifts; NIOSH 2014) were mentioned frequently as being helpful in reducing worker injuries, no assistive technologies or home modifications were specifically recommended within the literature. Nonetheless, common suggestions emerged from stakeholders: (1) use of assistive technologies or home modifications is preferred over manual handling; (2) assistive technologies or home modifications should be selected based on both the client and homecare worker's needs, the specific task, and use environment; (3) low-tech devices that are easy to use and assemble are preferred over complex high-tech devices; and (4) regardless of assistive technologies or home modifications, both the client and homecare worker need to be trained on their proper use and techniques.

Our study findings indicate that there is limited quantitative evidence on the prevalence of assistive technologies or home modifications in the home related to lifting, transferring, or repositioning. It is widely understood that many homecare workers perform lifting, transferring, and repositioning tasks for their clients, but it is unclear whether and how often assistive technologies or home modifications are being used in the home setting to mitigate homecare worker injuries. Currently, their prevalence is measured by presence in the home or client use, but the studies that address prevalence are fragmented and limited because they tend to focus on limited types of assistive technologies or home modifications, or specific populations. In these studies, homecare worker use of assistive technologies or home modifications can only be inferred based on client reporting.

Cost for assistive technologies and home modifications for lifting, transferring, and repositioning varies widely and is dependent on many factors, making it difficult to provide national, up-to-date cost information. In addition, cost should be thought of as three separate components that may not always be captured in different resources related to cost: (1) the purchasing cost, which is highly dependent on how the item is acquired, the quality, and the client's geographical location; (2) the hired labor cost to make necessary modifications or installations; and (3) the additional materials cost for associated equipment replacement and/or repairs.

There is also limited evidence on the effectiveness of assistive technologies or home modifications for lifting, transferring, or repositioning in preventing homecare worker injury. Most research has focused on their use and effectiveness in institutionalized settings (for example, hospitals and nursing homes), but these settings are not comparable to the home. Research has also focused on safety issues in the home for clients, with limited focus on injuries among homecare workers who need to perform lifting, transferring, and repositioning tasks. Although some musculoskeletal disorders and assistive technology or home

modification utilization research exists, we were unable to find any study that directly measures their effectiveness in preventing homecare worker musculoskeletal disorders or injuries, making it impossible to draw conclusions about effectiveness. Last, the existing literature is of low quality and has significant limitations, including small sample sizes, lack of a control, multiple interventions included in single studies, little information about how often the assistive technologies or home modifications were used and for which purposes, and addressing mixed populations and settings in single studies. These limitations prevent clear conclusions regarding the effectiveness of assistive technologies and home modifications on reducing homecare worker injuries (Freiberg et al. 2016; Hegewald et al. 2018; Tang et al. 2019). Other reviews have also noted this limitation in the literature. For example, Carnemolla and Bridge (2020) found that no cost-utility or cost-effectiveness studies have been conducted on single-factor home modifications. Other limitations of the current research include limited outcomes and follow-up to determine long-term effects on injury rates among homecare workers. Due to these limitations, no studies address the cost-effectiveness of assistive technologies or home modifications for homecare workers, because cost-effectiveness analysis is usually secondary, conducted only after prevalence and effectiveness have been overwhelmingly established.

Both the literature and stakeholders highlighted that it was common to find no assistive technologies or home modifications in the home, even when they were needed (Franzosa et al. 2018; Hamadi et al. 2018, 2019; Willink et al. 2019; Vespa et al. 2020; Hignett et al. 2016; Olson et al. 2015; Mabry et al. 2018; Quinn et al. 2016; Wills et al. 2016; Keglovits et al. 2015; King et al. 2018; Love et al. 2017), suggesting that clients experience barriers to obtaining these items, which may directly affect homecare worker safety. We identified a number of barriers to obtaining assistive technologies or home modifications, particularly for addressing homecare worker safety. For example, both clients and their families can constitute a major barrier because they are frequently resistant to change, in denial about the extent of the client's disability, or concerned about the stigma surrounding assistive technologies or home modification use (King et al. 2018; Sivakanthan et al. 2019).

In-home assessments and insurance coverage (both private and public) are client focused, so they do not consider homecare workers' safety. Further, insurance plans typically have very specific requirements for the conditions needed to approve assistive technologies for a client, and most plans cover very limited types of equipment. Thus, caregivers are typically left on their own to identify and obtain assistive technologies and home modifications to address their needs, while lacking the essential knowledge about nuances. This situation often creates frustration, additional caregiver burden, and an inability to find the right information (Meals on Wheels America 2017; National Academies of Sciences, Engineering, and Medicine 2016), which can result in selecting inappropriate or ineffective equipment that may cause more harm than good (Hignett et al. 2016). Although there are some financial assistance options, they are often limited and complicated, which prevents many people from implementing safety changes within the home (Meals on Wheels America 2017; Joint Center for Housing Studies of Harvard University 2016).

Environmental barriers (for example, small rooms, clutter, tight spaces) often complicate the ability to incorporate assistive technologies or modifications within the home (Love et al. 2017; Hignett et al. 2016; Karlsson et al. 2019; Polivka et al. 2015; Darragh et al. 2015; Wills et al. 2016) or bring existing equipment into a space. These barriers were found to be a significant risk factor for injury because clients are more likely to need manual support to complete tasks; thus, the homecare worker simultaneously provides stability via manual handling techniques (King et al. 2018, 2019) in addition to care activities while using unsafe, awkward, or stressful postures (Polivka et al. 2015; King et al. 2018, 2019; Hignett et al. 2016; Darragh et al. 2015).

Although it is typically the client's responsibility to obtain assistive technologies or home modifications, homecare agencies can make recommendations. Evidence suggest that agencies do not specifically assess whether a homecare worker should have access to assistive technologies when matched with a client, but there are other opportunities to assess the need for equipment, such as through the agency's in-home assessment. Nevertheless, whether these assessments occur, and their level of detail greatly depends on state licensure requirements, individual agency preferences, and payer type (for example, private insurance, Medicare, Medicaid).

Last, both stakeholders and the research stressed the importance of proper training to ensure that assistive technologies and home modifications are used properly. Currently, training requirements, standards, and delivery methods fluctuate widely, not only by roles within the industry (for example, health aides and nursing assistants), but by state and across programs. The National Academy of Medicine recommended that states standardize and establish minimum training requirements for all homecare workers (Institute of Medicine 2008) to close this gap. Overall, training was identified as a barrier to reducing injuries because many homecare workers either received no or inadequate training before working with clients (Wills et al. 2016; Christman and Connolly 2017; Franzosa et al. 2018; Butler 2018; Campbell 2018; interview). High quality trainings have been shown to improve occupational safety in various settings (Teeple et al. 2017; interview); thus, similar benefits could be achieved by standardizing all homecare industry trainings. However, as we have seen throughout this report, standardized training is unlikely to resolve problems that arise in connection with the need to customize strategies for safe patient handling and use of assistive technologies according to differences in patient characteristics, the types of equipment available (including differences in similar equipment made by different manufacturers), and characteristics of the environment in which the equipment must be used.

B. Report limitations

There are several limitations to this report. In the literature review, we limited the time range to sources from 2015-2020 because of project resources, so we did not capture any findings on the prevalence or effectiveness of assistive technologies or home modifications for reducing homecare worker injuries published previously. As mentioned previously, there is little published evidence on this topic for the time period covered in our review. We also focused our review on homecare workers, who frequently perform lifting, transferring, or repositioning tasks, rather than more broadly including registered home nurses, who typically perform different tasks than homecare workers. Although we also touched on some related caregiver and client issues, we focused on the use of assistive technologies and home modifications for reducing homecare worker injuries as much as possible because of the time, budget, and scope of this project.

Our stakeholder interviews were also limited. We had planned to conduct a broader set of interviews that included perspectives from homecare unions and workers' compensation insurance providers, but because of project time constraints and difficulty in identifying people willing to participate for this topic, we were unable to include them. (Note that this study was conducted during the COVID-19 pandemic, which may have hampered availability.) We recommend that these perspectives be a priority in future research.

C. Suggestions for future research

To better understand worker safety and inform policy and coverage decisions, more research is needed in this area, from primary research on effectiveness to development research on the best designs for assistive technologies used in home settings.

Expand and standardize data and measures in studies on homecare workers. To better understand the prevalence of use and effectiveness/cost-effectiveness of assistive technologies and home modifications for reducing homecare worker injury, there are several considerations for improving national survey data and primary research.

National survey data developers could consider expanding existing surveys to collect information on more types of assistive technologies or home modifications, as well as their use by caregivers and homecare workers, not just the respondent. This approach could help inform national estimates of the prevalence of use of assistive technologies and home modifications by different people who could benefit from that use. In addition, it may help identify disparities or gaps in assistive technologies or home modification use that could be targeted through interventions or policies.

Primary researchers could focus on standardizing outcome measures related to homecare worker injuries and ensuring standard definitions of assistive technologies or home modifications that would allow for comparisons or meta-analyses across different studies and allow examination of their effectiveness in reducing homecare worker injuries. Studies in a laboratory setting could measure a single-factor intervention (by type of equipment), rather than those grouped (and hidden) in a suite of other interventions. By assessing a wide variety of assistive technologies in a controlled manner, comparisons could be made of how much each type of assistive technology reduces physical exposure during various tasks. Studies could also gather more detailed information about homecare workers, such as age, body mass index, and fitness level, so as to explore how different factors influence outcomes for different assistive technologies or home modifications.

Stakeholders said that there could be future opportunities to expand research on occupational safety in homecare beyond the laboratory setting by using new technology, such as wearable devices, to improve understanding of how performing different tasks impacts homecare worker injuries in real settings. Wearable devices (for example, an exoskeleton) could potentially be used to measure body posture or strain when homecare workers are performing tasks directly in clients' homes. Additionally, homecare workers could be monitored clinically over time to measure the presence and severity of musculoskeletal disorders, which could help inform whether safety is being improved through the use of different assistive technologies or home modifications.

Expand assistive technology market research and development to focus on home use. Most assistive technologies on the market have been designed with inpatient or institutional settings in mind; they have not been designed or adapted for home use. Many experts with whom we spoke said that using assistive technologies originally designed for other settings is not ideal because home environments are substantially different and present different challenges, such as cramped or limited spaces. These experts recommended that device manufacturers design new assistive technologies for home use to make them most effective in a home setting. Devices for the home need to be usable by a single caregiver or homecare worker, small enough to be used in confined spaces, portable, and easy to set up and clean, but aesthetically pleasing to address resistance from clients and family to obtaining them. Because of the specific risks of injury raised in the literature and by all of the experts we interviewed, focusing on new assistive technologies for home bathrooms is an important area for development.

Disseminate successful interventions to homecare. Effective interventions have been developed to prevent musculoskeletal disorders among workers in institutional settings, but there may be opportunities to disseminate these interventions and best practices into the home setting, with appropriate adaptations, and rigorously evaluate them for efficacy. For example, by exploring whether current safe patient

handling algorithms and apps developed by VHA can be leveraged for wider use and application in the non-VHA homecare industry.

Conduct further research to identify creative and innovative solutions to overcoming key barriers to wider adoption of assistive technology of assistive devices for lifting, transferring and repositioning clients for homecare workers is paramount. As is conducting further research to address the many barriers to ensuring that the equipment is able to adequately assist the client, caregiver, or homecare worker in a safe manner.

D. Conclusions

Due to the increasing demand for homecare workers and the high rate of occupational injuries among these workers, addressing homecare worker safety is critically important. The high injury rates among homecare workers contribute to turnover and absenteeism, and lead to high costs of workers' compensation insurance for employers. The COVID-19 pandemic has further underscored the essential role that homecare workers play in supporting clients at home, and the safety risks they encounter to perform their job.

Occupational safety is a complicated issue, and there are many barriers to obtaining and using assistive technologies or home modifications for lifting, transferring, and repositioning to help mitigate homecare worker injuries. In this study, we highlighted many programmatic and policy issues that hinder the use of assistive technologies and home modifications, including difficulty identifying what type of equipment is needed and a lack of awareness of what options are available, fragmented financing and high costs for clients and families to obtain equipment, and a lack of training among workers. Many of the barriers are further complicated by the fact that assistive technologies and home modifications need to be customized to the individual client and home environment. In addition, if the client had assistive technologies or home modifications, they often were broken, installed incorrectly, not fitted properly to the client or use area. Thus, many barriers to ensuring that the equipment is able to assist the client, caregiver, or homecare worker in a safe manner also exist.

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Appendix A. Keywords for Literature Search

After conducting preliminary searches to gather information, we used the following list of keywords and combinations for the literature review search:

Scopus: (Home*) AND (Assist* OR Lift* OR transfer* OR reposition* OR Slide OR “Standing aid” OR “Swing tray” OR “Belt”) AND (nurse* OR Aid* OR worker* OR caregiver*) AND (injur* OR safe* OR barrier* OR ergonomic* OR pain*)

Google Scholar: (+home) AND (assist OR assisting OR assistive) AND (Lift OR lifting OR lifter OR transfer OR transferring OR reposition OR repositioning OR Slide OR “Standing aid” OR “Swing tray” OR “Belt”) AND (injury OR injuries OR injured OR safety OR danger)

Additionally, we chose to exclude the following words and phrases: “nursing home*” “birth” “smart home*” “smartwatch*” “child welfare” “smartphone*” “pediatric*” “hemodialysis” “HIV” “Pharmacist*” “Pregnancy” “Dialysis”

Appendix B. Round 8 NHATS Analysis

A. Sample identification

We used the following criteria to define NHATS respondents of interest:

1. Limited the sample to respondents whose residential care status was in the community. This sample limitation excluded respondents in residential care and nursing homes.
2. Identified respondents with an ADL/IADL limitation. We defined an ADL/IADL limitation in two ways to explore counts for each group:
 - a. **Broad definition of ADL/IADL limitation.** Included respondents indicating they had help from another person for at least one of the following 11 activities: eating, bathing/showering, using toilet, dressing, going outside, getting around in home, getting out of bed, laundry, shopping, making hot meals, or handling bills/banking. For the items for laundry, shopping, making hot meals, and handling bills/banking, we identified respondents who reported help with these activities due to health or functioning or health or functioning and another reason.
 - b. **Narrow definition of ADL limitation related to lifting, transferring, or repositioning.** Included respondents indicating they had help from another person for at least one of the following six activities: bathing/showering, using toilet, dressing, going outside, getting around in home, or getting out of bed.
3. Identified respondents with and without paid help. We defined three variations of the sample to explore counts for each group:
 - a. All respondents in the community with a limitation. Included respondents with and without paid help.
 - b. Respondents in the community with a limitation receiving paid help. Included respondents who reported having a paid helper. NHATS identifies as “helpers” those people who in the last month have carried out a household activity or medical care-related activity with or for a sample person, given rides to the sample person, sat in on doctor visits, or helped with mobility or self-care activities; for helpers other than spouses/partners, NHATS ascertains whether the helper is paid. We identified respondents with at least one paid helper.
 - c. Respondents in the community with a limitation not receiving paid help. Included respondents who did not report having a paid helper.

Based on these sample criteria, we had seven variations of the sample for which we examined counts:

- Total community respondents.
- Community respondents with any ADL/IADL limitation.
- Community respondents with any ADL/IADL limitation receiving paid help.
- Community respondents with any ADL/IADL limitation not receiving paid help.
- Community respondents with an ADL limitation related to lifting, transferring, or repositioning.
- Community respondents with an ADL limitation related to lifting, transferring, or repositioning and receiving paid help.

- Community respondents with an ADL limitation related to lifting, transferring, or repositioning and not receiving paid help.

B. Definition of assistive technology use

We examined a broad indicator of assistive technology use as well as use of individual assistive technologies, including the following:

- **Any assistive technology.** Included respondents who reported any mobility device use in the last month (cane, walker, wheelchair, or scooter) OR presence of any of the assistive technologies related to lifting, transferring, or repositioning (grab bar in bath/shower, bath/shower seat, raised toilet, grab bar around toilet, stair lift/glide).
- **Grab bar in bathtub/shower.** Included respondents who reported having a grab bar in the bathtub/shower.
- **Bath/shower seat.** Included respondents who reported having a bath/shower seat.
- **Raised toilet/seat.** Included respondents who reported having a raised toilet/seat.
- **Grab bar around toilet.** Included respondents who reported having a grab bar around the toilet.
- **Stair lift/glide.** Included respondents who reported having a stair lift/glide.

C. Results

Results are presented in Table III.2.