Residential design for real life rehabilitation

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Abstract. This article provides readers with a review of the major considerations for designing living environments for persons with neurodisability due to acquired brain injury (ABI). Components that need to be considered in order to assure that the environment is designed with a functional perspective in mind are explored. The issues to be considered herein include the influences of cognition and visual and visuoperceptual, motor, behavioral, and sensory impairment on residential design considerations. Resources for individuals involved in residential design for this special population are also provided to facilitate design decisions and implementation.

1. Introduction

It is a common mistake to consider only one or two aspects of a person's disability when designing for accessible housing. One must keep in mind a variety of issues when designing for populations with special needs due to ABI related neurodisability. There are often many factors that can impair an individual's ability to effectively function in their living environment. Many of these factors are often overlooked relative to residential design accommodation and/or compensation. Design planning should reinforce the need to view individuals holistically, as well as functionally, and try as much as possible to individualize design modifications to optimize both home and community reentry. Collaboration with both the survivor of ABI as well as the survivor's family and/or payor in design decisions and choices facilitates optimizing the ultimate functional independence level for that individual in their living environment within the confines of what makes sense financially and otherwise for the family and/or payor.

Designing from a functional perspective It is important to consider each individual's specific needs in order to provide them adequate resources to participate in functional daily life tasks. One should take into account each element of a person's life when planning residential design. Persons with significant neurodisabilities often have a multitude of deficits that can compound their difficulties accessing their environments. Survivors of acquired brain injury, in particular, can have cognitive, visual, visuoperceptual, motor, psychoemotional and/or neurobehavioral, as well as sensory impairments that must be considered when designing residential environments.

Due to the unique areas of functional deficit seen in association with ABI, design modifications must be made to allow function to be optimized in the least restrictive living scenario. Design adaptations that promote independence and quality of life should be emphasized but often require not only a keen understanding of the functional challenges facing persons with ABI related neurodisabilty but also the ability to formulate creative architectural and adaptational solutions to such challenges. Functional activities that should be assessed relative to design considerations should include bathing, dressing, grooming, toileting, meal preparation, personal household management (i.e. money and medication management), laundry, home maintenance (i.e. cleaning), physical exercise and recreational activities (i.e. television/gaming, computer). If an individual's environment is not optimally accessible and/or does not facilitate functional independence with ADL and mobility needs, then one runs the risk of creating unnecessary emotional and physical obstacles which ultimately lead to increased needs for third par-

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ty assistance, increased frustration and decreased selfconfidence, as well as increasing societal costs due to lost opportunities for greater functional independence.

2. Cognitive considerations in design

Acquired brain injury may cause changes in cognition in multiple spheres of function including memory, attention, and executive skills such as organization, prioritization, judgment and planning [5]. Cognitive effects of ABI are one of the most functionally pervasive classes of impairments that negatively impact community and home reentry. One or more of these deficits can not only affect an individual's safety and independence in their environment, but also their quality of life. The unique subset of cognitive deficits observed in ABI often creates design challenges that would not necessarily be present in other patient populations. Therefore, it is essential that these areas also be considered when designing an accessible living environment.

The design of the living environment for such individuals needs to provide extra cognitive cues in order to decrease the individual's stress and effort levels, thereby increasing their independence. As persons with ABI often struggle with memory, signage needs to be utilized as much as possible to provide environmental cues so that proper identification of their environment is facilitated. More severely impaired individuals, especially those with deficits in topographical orientation, may require the use of maps of the house and/or special markers to ID rooms of interest (i.e. an object of significance they have chosen to decorate their bedroom doors). In residential facilities where there is more than one household on campus, it is recommended that the houses do not look exactly alike on the exterior (i.e. different color brick or siding) or interior (i.e. different color schemes in wall/furniture/carpet color), to trigger appropriate recognition. It is recommended that the building design provide for a visible area in a general location (such as entry or exit way) in order for placement of orientation boards so that individuals with memory loss can correctly orient themselves to the day and environment (such as day, date, time, weather, location, etc.). Due to cognitive and/or visual impairments, persons with ABI may have difficulty choosing clothing to wear each day. To compensate for this, shelving in closets can be designed to have 7 small individual cubbies for survivors to keep a separate outfit for each day of the week.

For individuals with cognitive dysfunction, another factor to be considered is use of kitchen and laundry appliances. It is suggested that these appliances have touch button controls with clear digital readouts to identify the settings being used. If knob controls are used, the settings must be clearly marked as to avoid confusion.

The design should also include appliances with safety measures to avoid fires and floods. Automatic safety turn-offs should be used when at all possible (i.e. with oven/stove, and small kitchen appliances), as well as, water leaking indicators (i.e. with washing machines). The automatic shut-off valve on most appliances prevents the main burner from coming on if the pilot is not lit. Most dryers have a 100 minute limit for on-time before shutting off. These automatic safety turn-offs are available at Home Depot such as the Zircon Leak Alert Electronic Water Detector as well as the Intermatic Electronic Auto-off Timer. Other appliance timers which can be set to go off after a specified amount of time, such as the stove can be programmed to completely power off after a certain time such as 10 PM or after a specified amount of time such as one hour, are available online such as at REWilliams Contractor Incorporated at www.rewci.com. In addition, higherfunctioning individuals living on a semi-independent basis need well-marked emergency shut-off levers in an easily accessible location.

As for additional safety concerns, any necessary emergency call bell systems and bed/chair alarms should be clearly marked and well within reach of an individual who may have fallen or may be in danger. Fire safety should also be taken into consideration, especially when designing a residential vs. commercial (i.e. medical facility) building. There should be clear fire evacuation policies with displays of evacuation maps in clear locations. The fire alarm system should take into account the various deficits individuals may have, providing both auditory and visual alarms.

3. Visual and visuoperceptual considerations in design

Visual and visuoperceptual impairments may lead to functional difficulties due to challenges in visual acuity, visual perception (such as depth perception, visual discrimination, visual closure, object constancy, visual matching), and balance [10]. For those with visual acuity and discrimination impairments, signs should be in large print and lettering should differ in color from the sign's background. Depth perception impairments may be compensated for in part by design that considers, grading of inclines and declines to assist in prevention of an overly rapid height change, which can cause loss of balance. It is recommended that building entrances and exits follow universal design concepts and not have stairs but rather gradual sloping entrance pathways, ideally with a textured surface to provide sensory feedback that the ground level is changing. It is recommended that thresholds be low enough to prevent tripping as well as be well marked via different coloring than the flooring. Color strips can be a quick fix to provide a visual cue in thresholds. Color variations can also be used for changes in surfaces. For example, one could utilize different colors when transitioning from hardwood floors to tile, linoleum or carpeting. Color changes can also be used for fall prevention on stairways (i.e. different colored wood inlays such as a dark step with a light colored central portion). If hand/chair rails are used, they should be a different color than the walls.

Individuals with neurodisability due to ABI may also suffer from photophobia [6]. They may be visual impairments that create problems with spatial and temporal decisions [6]. Therefore, lighting should be of the non-glare variety but allow for adequate illumination for both safety and function. The light should come from natural sources as much as possible, avoiding fluorescent lighting. Full spectrum light may have both improved visual appeal and positive psychoemotional effects on mood. Each individual's particular tolerance for light input should be taken into account and the choice in wattage for such light sources should be chosen according to their comfort level where possible. It is recommended that dining areas, food preparation and desk areas, hallways, entry and exit ways and bathroom areas have adequate lighting that will enhance not only an individual's ability to visually function in these environments but also maintain a level of alertness necessary for essential tasks in these environments. It is recommended that lighting should also be provided under cabinets and in shelving areas. As individuals often look for specific items in crowded cabinets and shelves, this extra lighting helps to more efficiently locate items. For security and safety reasons, doorways, as well as, parking and walkways should be well illuminated at nighttime.

Another challenging problem that can be associated with ABI is sensory neglect [11]. Persons with ABI may completely ignore or may simply have decreased attention to sensory stimuli in one or both hemifields. [11]. It has been found that unilateral neglect itself impairs activity of daily living (ADL) performance [17]. An individual with unilateral neglect or inattention is unable to participate in daily functional tasks because they cannot adequately attend to their environment. Therefore, environmental modifications are required to increase safety and function. These individuals often run into or forget objects on the neglected side. Doorways, light switches, door handles, grab bars, controls (sink, bath, kitchen) and toilet flushers should be clearly marked with brightly colored tape or paint on the individual's neglected side. There are two schools of thought, so to speak, when designing an environment for an individual who suffers from neglect. If working towards remediation with active rehabilitation therapy the environment should be designed to foster increasing attention to the neglected side via arranging furniture and needed ADL items to be on the neglected side. However, if working towards compensation to foster an individual's ease in active participation within their environment, that environment may be set up with furniture and needed ADL items to be on the side that is most attended to (the non-neglected side). For safety purposes, it is recommended that whether the goal is remediation or compensation, safety elements such as grab bars used for transfers should be placed on the attended-to side.

3.1. Physical considerations and design

Deficits in motor skills affecting extremity or trunk strength and/or movement abilities may significantly affect an individual's ability to access their environment. Use of mobility aides such as walkers, canes and wheelchairs must also be considered when designing environments for persons with neurodisability. Movement disorders may occur after ABI and can include: ataxia, tremors, dystonia, dyskinesia, ballismus, chorea and tics [9]. Motor disorders are also quite common after ABI and can include: abnormal muscle tone such as spasticity and rigidity, hypotonicity, and consequences thereof including contracture [2]. Problems with vertigo, lightheadedness and balance can also result from ABI [14], which can significantly impair one's mobility. Ideomotor apraxia, a disorder of skilled movement (or motor planning) [12] can interfere with an individual's ability to access objects in their environments. Deficits in dexterity coordination and praxis may affect an individual's ability to activate the appropriate muscles to complete purposeful movements effectively for functional tasks [16]. Each of the aforementioned deficits can significantly interfere with a person's ability to access their environments. There are a number of ways in which a home can be designed to accommodate the needs of an individual with the aforementioned impairments.

Adequate consideration must be given to designing hallways, rooms and thoroughfares to accommodate adaptive mobility device use such as wheelchairs (manual and power), power scooters, walkers, rollators or canes. The type of adaptive device used must also be taken into consideration as the sizes vary (i.e. power wheelchairs can be much larger than manual wheelchairs). Hallways, doorways and room spacing must be wide enough for an individual to not only pass through but also maneuver around. It is recommended that there not be sharp turns around doorways as this decreases maneuverability. It is recommended that hallways be at least 6 feet wide and that 90 degree angles be avoided unless one is prepared to place wall guards along major traffic areas and/or at wall angles. Ideally, doorways should be at least 36 inches in width to facilitate easy wheelchair clearance. If ramps are used for access or egress to the residence or within the residence they should ideally meet ADA code of 1 inch in height for every foot traversed. So if a ramp is supposed to traverse 10 feet, then the ramp should be 10 inches high off the ground at the higher end.

A hand or chair rail in hallways is recommended to assist the individual and optimize safety. Wall bumpers along the base of the wall and also on corners can be used to protect the integrity of the wall from damage by mobility devices. Thresholds should be low enough for devices to pass over with ease. All desks, dining tables, prep areas in the kitchen, vanities, bathroom and kitchen sinks and stovetops should have adequate spacing underneath for chairs to fit so that the individual can fully access their working space. However, the specific type of device being used also needs to be taken into consideration as many wheelchairs (especially power) are higher than standard wheelchairs. Angled mirrors are recommended over sinks (bathroom and bedroom) to allow chair users to either fully see their bodies in the mirror for self-care tasks (such as grooming) or to completely see into the pots and pans they are cooking with (i.e. if the water is boiling). Microwaves and ovens should be at chest level to decrease the need for reaching and bending to access these devices. Stovetops should have a visual display "map" of which controls operate which burner. All access should be on the front of appliances to facilitate use from a wheelchair level. Stove tops that allow a wheelchair to roll underneath should also be considered with a separate oven unit being mounted in a wheelchair accessible location elsewhere in the kitchen. There should be ample userfriendly timers in the kitchen to prevent burning foods during cooking and, preferably, all cooking appliances should have built in timers. Specialized pneumatic pulldown shelving can be utilized in overhead cabinets so that individuals can more easily access items stored on these higher shelves. The shelving should have a designated rail across the bottom of the shelf for easier grasp. In laundry rooms, it is recommended that there be a separate section provided for laundry sorting and folding with enough space for a chair to fit underneath. Closets should have shelving and railings that are low enough to be used by a person at wheelchair level. Access to television, phone and computers should also be considered. Roll under desks with adequate lighting should be provided with under desk-top keyboard trays and enough desktop spacing for the computer screen to be placed in the most optimal position depending on the individual's specific needs. Televisions should be positioned at the most optimal height for adequate viewing and remote controls should be as simplified as possible, such as universal remotes with large buttons and as few buttons as possible. Telephones should be located in easy-to-reach locations and should also have simplified and large buttons. Many standard sized home elevators are small in size and may not provide adequate space for large mobility devices. If there are caretakers also using the elevators with the patient, then elevator size would need to be larger to accommodate both individuals.

For individuals with upper extremity dysfunction affecting range of motion, reach, control, coordination, dexterity and/or strength, there are multiple design modifications that can be utilized. Front loading washers and dryers are recommended, as it is much easier to reach into the machines to retrieve the laundry with this design configuration. Lever handles for all doors and controls (i.e. faucet handles) require less physical effort to operate and are generally more manageable than other design options. Large-button automatic door openers should be used as gross motor as opposed to fine motor actions can be utilized to open doors with ease. Large-button switches should be used for all lights and garbage disposals versus standard, smaller switches. Some home elevators utilize a key system for operation, but it is recommended that button controls be utilized for increased ease of use and accessibility. In showers, on-the-wall soap/shampoo dispensers may be used that are either automatic or push-button to decrease the effort required to open individual soap, shampoo and conditioner bottles. Hand held shower nozzles that are height adjustable should be used in showers and baths so that the user can easily wash their entire bodies. Automated toilet flushers and paper towel dispensers should also be considered.

Trunk postural control and stability problems, along with balance problems, pose a fall risk concern. Therefore, in any location where transfers are performed (such as in bathrooms for toilet and shower/tub transfers), there should be multiple grab bars at various angles to provide safe transfer assistance. Grab bars are not to be confused with towel racks as these racks are not generally sturdy enough relative to the manner in which they are mounted to withstand the forces that are applied to appropriately mounted grab bars. Grab bars should be textured and not smooth to prevent slippage. Bathroom floor surfaces should also be textured to decrease fall risk, especially when wet. Anti-skid strips, shapes, and mats can be utilized as an extra safety precaution. It is not recommended that standard bath mats or throw rugs be used as these can easily be tripped over or cause slips and falls.

The aforementioned design considerations should also be considered in living room furniture. Furniture that is too low or too soft creates difficulties with sitting and rising from the furniture. As a general rule, if wheelchair users can transfer to/from this furniture relatively comfortably, they are at the desirable height. They should be comfortable, but firm enough so that the person with ABI does not "sink in" to the furniture, which would make sitting upright, as well as getting up, difficult.

The question of when to utilize roll-in showers vs. shower or tub seats or benches is frequently raised. Again, an individual's specific deficits should be taken into account. Generally, the more impaired an individual's mobility is the more easily accessible the bathing area should be. It is suggested that any individual with balance or vertigo problems, or issues with endurance or blood pressure, sit to bathe. Standard shower chairs can be used unless the individual has significant trunk control issues and/or is orthostatically hypotensive, in which case the shower chairs should have arms to provide better support or alternatively, the person should be laid down on a shower stretcher. For those with limited mobility, transfer benches should be used to allow for a lateral transfer as opposed to a stand pivot transfer. For those with severely impaired mobility or truncal postural control, a roll-in shower with a rolling shower chair should be used for increased safety. A

roll-in shower with a built-in shower bench can also be utilized for individuals with limited mobility. These roll-in showers should have low enough thresholds for chairs to pass over, yet be designed to prevent water leakage onto the outside floor. Bathroom floors with roll-in showers should also have adequate drainage systems in the floor to prevent pooling of water, which can create both a health (i.e. mold) and safety (i.e. fall) hazard. Adequate grab bars should be provided in the actual shower/tub area as well. The shower or tub seat should be within reach of the water controls and the hand held shower nozzles. Specialized tubs with waterproof door enclosures can also be used if desired.

Another important consideration that is often overlooked is the outside environment. Sidewalks and walkways must provide adequate width for clients with adaptive devices to be safe. They must have textured versus smooth surfaces to provide a texture for fall prevention. With any height change, sidewalks/walkways must have a gradual decline or incline. Also for safety, all walkways should be protected from any high drop offs. There should be curb cuts so that mobility devices can easily pass over sidewalks to enter/ exit buildings or transition to parking areas. Two-tone curb cuts should be used whenever possible, either via a bright color line (e.g. yellow) where there is a curb cut or the center of the curb cut should be a darker color of concrete than the sides. Adequate outdoor lighting must be provided during early morning, dusk and evening. To assist with visual differentiation, it is recommended that parking lots and driveways be of a different color than sidewalks and walkways. Parking lots spaces should provide enough width so that wheelchair accessible vans have enough room for the ramps. Standard vehicles should have enough spacing between parking spots for individuals to enter/exit vehicles safely. The distance between parking lots and the doors of the residence should be taken into consideration and accessible parking should be as close to residence entrances as possible.

4. Sensory considerations in design

A common problem in the brain injury population that is often overlooked is olfactory impairment (dysosmia or anosmia) [13]. This loss of sense of smell can significantly impair an individual's health and safety in their residential environment. These individuals must have adequate smoke and carbon monoxide detectors in their homes and gas detectors if gas stoves are used [13]. However, it is highly recommended that electric as opposed to gas stoves and fireplaces be used in homes for these individuals. Design decisions must also consider the storage of household cleaning supplies as these noxious substances can be toxic [13]. It is recommended that a specific area in the home be designated for storage of these substances in which no other substances are kept and that all containers are appropriately labeled for identification purposes. This area should be clearly identified with a sign. Food storage systems should be easily accessible for frequent checking of food items to assure they have not expired. The food storage areas (such as the refrigerator) should be structured so that perishables are kept together and clearly labeled (both by item and expiration date) so they can be frequently checked for freshness. Trash cans should be stored away from food items and should be clearly labeled or brightly colored in order to provide a cue to take the trash out regularly and avoid associated odors.

Survivors may also suffer from sensory processing disorders. The term "tactile defensiveness" was coined by Jean Ayres, and can be identified when an individual displays distress towards, and wishes to avoid, certain types of sensory stimuli when it is presented [1]. For these individuals it is important to consider fabric choices. Fabrics should be chosen that are comfortable and non-irritating to the skin and that are best tolerated by the person with the neurodisability. Some persons with ABI may suffer from diminished sense of touch or ability to detect temperature [8], and therefore require special considerations in residential design. Signs should be placed over stoves and other heating elements to serve as visual cues to prevent burns. Fabrics should be chosen that would not irritate the skin (i.e. smooth vs. rough fabrics). Ventilated fabrics should be chosen for furniture to protect skin integrity and prevent skin breakdown. Sinks and showers/baths must have temperature regulation controls or temperature limiters in order to prevent scalding. It is recommended that hot water heaters' temperatures be turned down so as to decrease the overall temperature of hot water and thus prevent scalding. Thermostat and humidistat controls should be used in the home and should have regular maintenance so that temperature and humidity are well controlled.

Hearing problems may also accompany brain injury [8], and individuals with such may be under or overly sensitive to sounds. Therefore, acoustics must be taken into consideration. Large, open spaces or homes with lofts can often cause sound to amplify and carry, creating an over-stimulating environment for noise sensitive individuals. For individuals with hearing loss, safety can be the biggest issue and therefore specialized alarm systems utilizing flashing, bright lights as well as sound should be used for emergency situations.

5. Behavioral considerations in design

Behavioral problems are frequent after brain injury, often displayed as amplified behaviors such as irritability, disinhibition or aggression or a reduction in normal behavior including abulia, increased social reclusiveness, among the most common [3]. To provide an environment in which such persons can actively and safely participate in their daily lives, as well as, to protect their caregivers, as applicable, design changes must be made. Therefore, care should be taken to avoid unsafe materials in the home. Breakable items should be out of reach of individuals with aggression and furniture should be heavy enough so that it cannot be picked up and thrown. Sharp tools or kitchen implements should be stored in a designated, locked cabinet. Glass tabletops and shelving should be avoided in areas where individuals with behavioral problems spend the majority of their time. Controlling the environment is one important step in modulating both aggression and agitation after ABI [7].

Often overlooked when considering design, mood affects one's ability to interact with their environment on multiple levels. Brain injury has also been associated with neuropsychiatric disorders, such as depression [15]. The incidence of depression is also high in this population and the risk for suicide is increased over the population at large. One way to improve an individual's mood is to maximize natural light in the living environment through large windows, skylights and/or tube lights or alternatively with full spectrum lighting. Placement should involve consideration of the residence's geographical positioning relative to the path of the sun and time of day when the most light would be available. Motion controlled lights should be used both indoors and outdoors, preferably on a timer system, in order to increase safety and resident independence in site navigation. These lights would provide the user with an automatically lit outdoor area in order to safely enter/exit the building. Additionally, such lighting improves indoor orientation. A timer system can be utilized to provide a safety backup to appliance and lighting use when persons may forget to turn off said appliances as well as ultimately improve energy efficiency. There should also be an abundance of brightly colored and pleasant art to promote a happy mood.

Given risks for self-harm due to the aforementioned behavioral issues, in particular depression with increased suicide risk, as well as, common impairments of disinhibition, impulsivity and poor judgment, residential design should also avoid providing opportunities, inherent in the building or resident design, for inviting self-harm and/or accidents such as unnecessary and excessive cords (due to risk of patient trying to hang themselves), balconies, large windows on second or higher floors that can be opened permitting patients to "escape", unsafe elevated surfaces where there is risk of falling off such as raised decks without adequate side railing, among other examples.

Anxiety disorders (including panic, PTSD, OCD and phobias) can also be common among the traumatic brain injury population [4]. These individuals need consistency in their environment to decrease their level of anxiety. Consistency can be provided via a structured set-up of furniture, which is rarely rearranged. The furniture should be arranged so that individuals can easily maneuver around their environment. The floor plan should be simple and easy to follow (i.e. kitchen and eating areas next to each other, bathrooms not far from bedrooms), without an abundance of unnecessary rooms, so that the individual can easily find their way around their homes without increased anxiety. Stimuli that may exacerbate anxiety disorders should be identified and attempts made to minimize and/or negate them from the residential environment.

Design should also consider the influence of color on behavior including mood. Specifically, there now exists evidence derived from industrial psychology and marketing to indicate that colors can have a positive influence on mood and cognition, as well as, have a "healing" effect. The use of color dates back to times past when Chinese, Native Americans and Egyptians used chromotherapy to "treat" those who were ill. Clearly there are cultural differences in how color is perceived that must also be considered in any discussion of the psychology of color, in design and elsewhere. In general, in Western cultures, the use of blue is associated with calmness; however, too dark a blue hue may have the result of conveying "coldness". Light green has also been shown to have a calmative effect. Pastel or light, golden yellow is associated with optimism and has even been shown to cause release of serotonin in the brain but must be used in moderation to avoid adverse behavioral consequences.

6. Resources available for accessible design

Readers should be familiar with some of the resources available dealing with designing for populations with special needs:

- 1. For current standards from the ADA on heights and widths when designing for users with disabilities: www.ada.gov.
- 2. For further more detailed information on residential design for persons with cognitive and physical challenges, the following resources are recommended:
 - * Barrier Free Environments, Inc. The Accessible Housing Design File. Indiana. Wiley & Sons. 1991.
 - * Centre for Accessible Environments. The Design of Residential Care and Nursing Homes for Older People HFN 19. London: The Centre. 1998
 - Cooper-Marcus, C. and M. Barnes. Healing Gardens: Therapeutic Benefits and Design Recommendations. New York: Wiley. 1999.
 - The Center for Universal Design. North Carolina State University College of Design. North Carolina: NCSU.
 - Peterson, M.J. Universal Bathroom Planning. Hackettstown, NJ: A Guide to Making the Most of Interior Design's Healing Potential. New York: Wiley. 1997.
 - Null, R.L. and Cherry, K.F. Universal Design: Creative Solutions for ADA Compliance. Amazon. 1996.
 - Peterson, M.J. Universal Kitchen Planning. Hackettstown, NJ: National Kitchen and National Kitchen and Bath Association. 1996.
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 - Regnier, V. Design for Assisted Living: Guidelines for Housing the Physically and Mentally Frail. Indiana: Wiley. 2002.
 - * Young, L.: Residential rehabilitation, remodeling and universal design. Center for Universal Design.NC State University. College of Design. 2006.
- 3. For information on accessibility products for the home, check out Accessibility Professionals: www.accessibilitypro.com.

- For information on home safety equipment (including grab bars, hand held showers, tub/shower/ toilet seats), consult www.lowes.com.
- 5. Your local Bed Bath and Beyond store has many adaptive equipment devices that can be used in accessible design (such as on-the-wall soap dispensers, non-skid mats, safety strips and shapes for baths and showers, automatic trash cans, hand held showers, shower/bath basket organizers, faucet and tap protectors, anti-scald shower systems, bath pillows, shower mirrors, long handled bath brushes, bath gloves)or go to www.bedbathandbeyond.com.
- 6. Easter Seals and Century 21 System's Easy Access Housing for Easier Living Program at www.easterseals.com.
- 7. The Right Space, a wheelchair accessibility guide for single family homes at www.trspace.com.
- 8. Accessible design/Universal Design Resources at www.makoa.org/accessable-design.htm.
- 9. Contact a local Occupational Therapist with experience in the area of accessible design.
- 10. Universal Design Programs North Carolina.

7. Formal assessment tools that can be utilized for home accessibility

- 1. Slips Assessment Tool at http://www.hsesat.info/.
- 2. Whole Building Design Guide at http://www. wbdg.org/resources/assesstools.php.
- 3. Home Accessibility Checklist at http://students. rockhurst.edu/OTUD/new_page_3.htm.
- 4. Housing Enabler at http://www.enabler.nu/.
- 5. Westmead Home Safety Assessment (WeHSA) at https://www.maa.nsw.gov.au/getfile.aspx? Type=document&ID=36610&ObjectType= 3&ObjectID=3322.
- SAFER Tool: Safety Assessment of Function and the Environment for Rehabilitation at http://www. highbeam.com/doc/1P3-269107611.html.

8. Conclusions

This article has provided suggestions for residential design for individuals with ABI. Certainly, many of these suggestions may also be applicable for individuals with other neurodisabilities. Ideally, people involved in design decisions for persons with neurodisability will work with a multidisciplinary team (not just architects) and consider each individual's specific design needs based on their ABI related challenges. It is much easier (and cheaper in the long run) to start with the most appropriate environmental set-up than to try and retrofit a home once it is determined that the current set-up does not work.

To summarize, multiple factors must be taken into consideration for individuals to access their environment and in particular, their residence (whether living alone or with others). Furthermore, those factors enable active participation in the essential, functional tasks of human life, thereby increasing independence and safety, as well as, enhancing quality of life.

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