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Environmental Interventions and the Design of Homes for Older Adults With Dementia: An Overview

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Abstract

In Western societies, the vast majority of people with dementia live at home and wish to remain doing so for as long as possible. Aging in place can be facilitated through a variety of environmental interventions, including home modifications. This article provides an overview of existing design principles and design goals, and environmental interventions implemented at home, based on literature study and additional focus group sessions. There is a multitude of design principles, design goals, and environmental interventions available to assist with activities of daily living and functions, although few systematic studies have been conducted on the efficacy of these goals and interventions. The own home seems to be a largely ignored territory in research and government policies, which implies that many problems concerning aging in place and environmental interventions for dementia are not adequately dealt with.

Keywords

dementia, Alzheimer's disease, environmental interventions, older adults, informal care, home modifications, architecture, interior design, assistive technology, aging in place

Introduction

In today's aging society, aging in place in combination with a sufficient amount of professional home care is commonly promoted as a strategy for maintaining autonomy, independence, sense of identity, as well as maximizing financial resources. The home and possessions represent what a person has accomplished throughout life and provide a quality of life that has no substitute in an institutional setting.[1] The wish to remain living independently, regardless of the condition of housing, neighborhood, and health, is often a personal choice[2] but is influenced by the personal disablement process or health status of a partner, and more specifically the objective and subjective burdens of care experienced by the partner.[3] Older adults with dementia, in particular, pose great challenges in terms of creating appropriate, healthy, and supportive living environments, in which they can perform optimally and are being compensated for a decreasing vitality and overall health status. According to international consensus, there are an estimated 24.3 million people with dementia worldwide.[4] For the European Union, estimates go as far as 8 million.[5] In contrast to popular belief, the vast majority of people with mainly early-to-moderate dementia live at home in industrialized countries (the Netherlands 65%; United States 70%, Italy 80%, Japan 85%, all industrialized countries 73%).[5-9] According to the Organization for Economic Co-operation and Development (OECD),[10] common policy principles in relation to dementia concern the support for older adults to remain at home as long as possible and the delay of institutionalization. Caregivers should be supported to achieve these goals, also because their availability in the longer term is under pressure. The policy shift to community-based care relies partly on the availability of informal caregivers as a substitute for formal care provided in institutions.[10] The importance of the own home environment as a setting for the provision of (dementia) care was already acknowledged at least 2 decades ago by Pynoos et al.[11] Good care is costly, and the financial and societal costs of care for people with dementia are rather significant.[5] The costs of informal care in 2005 were an estimated €26.8 billion for the European Union or about €4700 per person with dementia.[9] The direct costs of dementia care are an estimated €54.3 billion or €14 200 per person with dementia. Alzheimer Europe[12] explored the impact of dementia on

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informal caregivers and found that for the majority of caregivers, important care services were not available. Apart from the emotional burden caregiving poses on a relative, there are also negative financial consequences.[12] The large institutional long-term care sector in northwest Europe is under a multitude of pressures too, which have their origin in government spending and the availability of formal caregivers. There is a challenging shift toward substitution of institutional by noninstitutional living.[5]

Governments and community organizations try to solve the increasing demands of older adults in relation to the public housing task by constructing accessible dwellings in neighborhoods with a high density of services. Such housing concepts for older adults are, to a certain extent, not appropriate for people with dementia,[13] for instance, due to a decline in cognition, behavioral symptoms as wandering and an altered sensitivity to environmental conditions. People with dementia may benefit from a wide range of environmental interventions including home modifications (HMs), which can be seen as a nonpharmacologic intervention to assist both the individual with dementia and the informal caregivers with (instrumental) activities of daily living and caregiving.[13] The foundation of nonpharmacologic management is to recognize that for the individual with dementia, it is no longer possible to easily adapt to new conditions and that the environment must therefore be adapted to the individual's specific needs.[14] Adapting the private home to specific user needs, in a balanced combination with pharmacologic, behavioral, and occupational approaches, is likely to be the most effective intervention to improve the well-being of people with dementia and their caregivers. Environmental or behavioral techniques should be used as a first-line treatment rather than beginning with pharmacologic interventions.[15] Marshall[16] states that there is an increased awareness that the built environment has a fundamental effect on a person with dementia, which is probably much greater than for people without a cognitive impairment. This is also captured within the International Classification of Functioning, Disability and Health of the World Health (ICF) Organization. Within this classification, environmental factors may support or hinder the person with a (chronic) disease.[17] Schiff[18(p4)] mentions that the impact of the environment on the induction of problem behaviors is addressed in literature. At the time, there is a focus "on how 'bad' environments can hurt, but not on how 'good' environments can help." According to Lawton,[19] much of environmental psychology, especially gerontology, has the 1-sided view to cast a person as a reactor to environmental press. The environmental docility hypothesis suggests that "environmental press accounts for a greater proportion of behavioral outcomes as personal competence diminishes."[19(p506)] Lawton[19(p507)] has suggested the "environmental proactivity hypothesis," which states that "environmental resources are likely to be better used by people of higher competence." An individual with dementia may not be able to make sense of environmental cues and may ignore or misinterpret information that would otherwise support functional performance or adaptive behavior.[20] A poor fit between cognitive ability and environmental cues may negatively affect behavior and performance.[20]

Because an appropriate design of home environments and the implementation of environmental interventions have a great impact on the daily lives of people with dementia and their caregivers, and as the knowledge on these matters is scattered throughout literature and not described and discussed in their entirety, the goal of this article is to combine demand and supply in terms of design goals and environmental interventions. This means connecting the needs of people with dementia and their caregivers to specific design solutions. This is done in 2 ways. First, this article summarizes the various design goals and principles specified for dementia architecture. Second, this article provides an overview of environmental interventions available for people with dementia, which are used as a strategy by both informal and formal caregivers to support activities of daily living, to lessen or account for abnormal behavior, to compensate for loss of cognitive functions, and to alleviate the burden of care provided at home.

The results are discussed in relation to the implementation of environmental interventions, as well as in relation to the evidence supporting these interventions.

Methodology

This study makes use of the ICF of the World Health Organization[17] as a framework for analysis. Data were gathered through literature study and supplementary focus group sessions. For the presentation of data, a modified tabulation method first used by the Ministry of Community and Social Services of Ontario[21] has been used. These 3 aspects of the methodology are described in the following sections.

Framework

Within the ICF of the World Health Organization,[17] health problems are described as well as limitations and/or restrictions that result from diseases and disorders. In this classification, the built environment is an environmental (or external) factor that influences health, by focusing on facilitating or hindering impact of features of the physical, social, and attitudinal world.[17] In this case, the word environmental has a wider meaning than in the domain of building sciences, as it also includes the social environment and context. Within the ICF, supportive living environments with positive facilitators and negative barriers/hindrances (ICF domain e155 Design, construction and building products and technology of buildings for private use) may help maintain autonomy and self-direction or pose limitations. Therefore, such environments are believed to contribute to a delay in the demand of specialist care and facilities, whereas environments with barriers/hindrances have a negative impact. This article focuses on these facilitators and barriers/hindrances in relation to (instrumental) activities of daily living and needs of individuals with dementia and their informal caregivers, for instance, the need for safety and security. Other relevant domains within ICF that appear in this study are e115 Products and technology for personal use in daily living; e120 Products and technology for personal

indoor and outdoor mobility and transportation; e125 Products and technology for communication; and e150 Design, construction and building products, and technology of buildings for public use.

Data Collection

The gathering of data was made up of 2 parts: general design goals in relation to dementia and specific environmental modification practices at home. Many of the general design goals have been described for special care unit (SCU) design. As these goals address needs of persons with dementia irrespective of the stage of dementia and accompanying symptoms, they can also be considered for application to the home environment. The own home (the focus of this article) is where individuals with dementia dwell during the first stages of dementia. This is not the case if the person with dementia is first diagosed with dementia when already living in an institutional setting for somatic reasons.[5] In the own home, technological applications particularly serve as everyday items used by the residents and to a lesser degree for specific care purposes. The modifications identified and described in this study can also be used for assisted living facilities and to a lesser extent for institutional settings. An overview of design principles or design goals for living environments for persons with dementia is presented in the Dementia and Daily Living: Goals for Environmental Design section. The overview of architectural and indoor design modifications is given per activity/function and presented in the Environmental Interventions for Dementia section. To gather data, 2 methods were applied: literature study and focus group sessions. Discussion section provides a discussion of the findings in terms of evidence and implementation.

Literature study. Both books and peer-reviewed articles on architectural modifications and related technology for dementia are included in the search. This search included databases as PubMed and databases of technological papers, without a limitation to the age of papers, up to November 2009. All volumes of the journals "*Dementia*," "*American Journal of Alzheimer's Disease and Other Dementias*," and "*Alzheimer's Care Quarterly/Alzheimer's Care Today*," known for publishing on housing and technology in relation to dementia, were searched manually for relevant papers. Conference proceedings available in libraries in the Netherlands including papers on dementia and design were also consulted. In addition, the study included multiple sources from the Netherlands and mainland Europe, to provide a counterweight for the large amount of Anglo-Saxon literature, because housing and architecture differ greatly per country. Literature included in this study covers the whole housing continuum, which stretches from the own home to institutional types of housing such as nursing homes and SCUs. Literature available on the design of SCUs is elaborate, and the knowledge is often applicable to the private home and is thus included in this study. The search also included studies related to individuals with dementia who are younger than 65 years.

The literature search was complicated by the large differences in writing style or the use of professional terms between nursing and occupational therapy and technological sciences. These 2 domains give a different meaning to the term physical environment; the first meaning the indoor environment as a whole, the second as the whole of the thermal, visual, and acoustical environment as well as the indoor air quality.[22,23] An example from the domain of health care architecture is given by Diaz Moore and Verhoef,[24] who state that the physical environment consists of spatial attributes (volumetrics and degree of enclosure), sensory attributes (related to the indoor environment), fixed components, semi-fixed components (furniture), and nonfixed components (for instance, glasses and magazines).

Excluded from this study are technology requirements for appropriate use by people with dementia,[13,25] as well as ICT-based services for the support of people with dementia and their caregivers, which are reviewed by Lauriks et al.[26] This study does not include special clothing and certain assistive technologies as wheelchairs and walkers. The study does, however, include assistive device (AD) mounted to the home's physical structure as walls and ceilings and in cases that the modified technology specifically addresses dementia. The study included structural conditions needed for the proper use, or the installation, of assistive technologies. Products for leisure are also not within the scope of this article and are treated by van Rijn et al.[27] The indoor environment (ICF domains e225 [climate], e240 [light], e250 [sound], and e260 [air quality]) and building services are not included in this study. Their importance for dementia is described by van Hoof et al.[22,23] Outdoor spaces and gardens, which need to be safe and accessible, are reviewed by Mitchell et al[28] and are excluded from this study as well. This study only addresses indoor spaces in the own home. In case of assisted living facilities and block of apartments, public spaces and mutual corridors are excluded in this study as well.

Focus group sessions. A second method applied to gather data and to validate the findings from the literature study were 2 rounds of consulting by a focus group in 2006. The focus group consisted of representatives of various patient organizations and organizations for the aged, who have expertise in the field of care and environmental interventions including HMs. These focus group sessions were part of a second study by van Hoof and Kort.[13] The members of the focus groups have extensive knowledge of HMs and user needs and have long-standing experience with specific diseases and biological aging. The members were invited to provide feedback on a preliminary home design for people with dementia and its program (design features) and to bring various notions concerning the home environment and related design solutions together.[13] Apart from providing feedback on the design and the accompanying environmental interventions, the members came up with additional design principles and interventions they knew from daily practice. Problems pointed out by the focus group members were studied, and new design solutions were sought to address

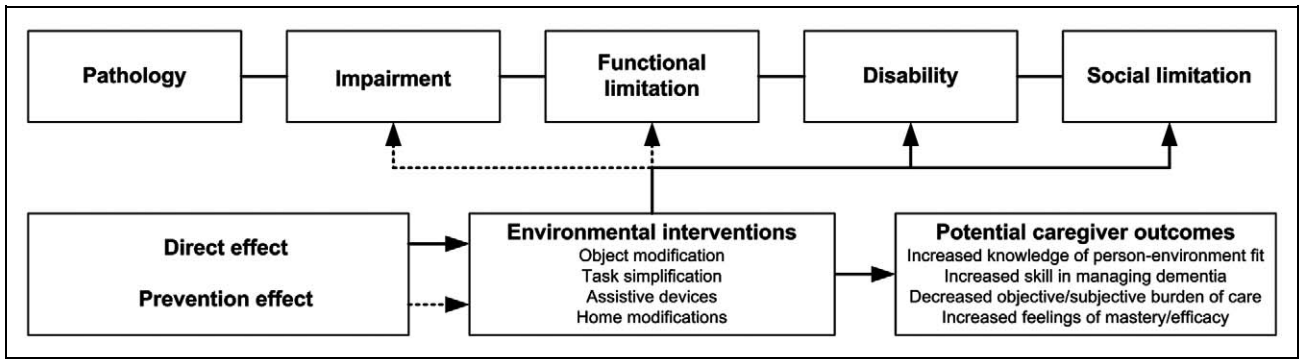

Figure 1. Disablement model, role of home environmental interventions, and affect on caregivers, taken and adapted from Gitlin and Corcoran.[20]

these problems. They present additional data applicable to countries in northwest Europe with similar the building traditions. Actual people with dementia or their relatives were consulted in an indirect manner via a representative of the Dutch Alzheimer Society (*Stichting Alzheimer Nederland*). This representative discussed the design during a number of "Alzheimer Café" sessions in the Netherlands, informal gatherings for people with dementia and their partners. The feedback from these persons was used as input for the design process. The results of the focus group sessions are only shown in this work if the results have not yet been reported in literature (Figure 1).

Presentation of Data

The overview of environmental interventions is based on specific activities the interventions relate to. In general, activities are carried out in a given space of the home, for instance, cooking is carried out in a kitchen space. Results are presented in tables per activity or function. The structure of the tables and the specific topics these tables deal with are taken and adapted from a report published by the Ministry of Community and Social Services of Ontario, Canada.[21] This report looks specifically at the ways in which technology and environmental design can be used to assist individuals with dementia with activities. It is the product of an extensive literature search as well as interviews with clinicians, technologists, and researchers.[21] The adapted tables include (1) criteria for use and associated deficits (the subheading "associated deficits" includes the idea of support of existing skills or those in danger in being lost), (2) specific environmental interventions, (3) description of the type of intervention, as well as (4) comments and additional information regarding the intervention. The environmental interventions in this study are labeled as object modification (OM), task simplification (TS), assistive device (AD), or home modification (HM), after Gitlin and Corcoran[20] (Figure 1). Some environmental interventions can have more than 1 label, depending on the type of problem that is addressed. In general, adaptations to the dwelling's structure are labeled "home modification." Modifications to furniture, utensils, equipment, and other items in the home are labeled "object modifications." Assistive device include assistive aids and technologies, which specifically address a given health problem. Task simplifications include remaining modifications that support independence at home. The tables include both low- and high-tech interventions, although most of the interventions can be classified as low-tech. There may be some overlap or duplication between the tables, because some environmental interventions address more than 1 activity or space in the home, or function. In the tables, there is no distinction between potential users of the environmental interventions; the person with dementia, the caregiver, or both. Caregivers, however, are most likely to implement the intervention in practice. In addition, some of the environmental interventions are—to a large extent—related to biological aging. These interventions may have benefits not only to individuals with dementia but also to the aging population in general. In practice, persons with dementia have different underlying causes of dementia, such as dementia of the Alzheimer type, vascular dementia, and Lewy body dementia. Individual variety in progress and manifestation of dementia is seen, and therefore, requirements may vary. This calls for a tailored approach when implementing environmental interventions, and this is the reason why type and stage of dementia are not explicitly included in the analysis.

Activities included in this study are toileting, bathing and personal care, dressing and doing laundry, sleeping, cooking, and dining. Functions that are supported through environmental interventions are (1) safety and security at home including wandering as well as (2) perception, orientation, and memory (Table 1).

Dementia and Daily Living: Goals for Environmental Design

Some of the performance deficits, particularly those seen in the first stages of dementia, can be countered or supported by design strategies.[36] The stage of dementia, of course, is not synonymous to the level of physical independence. The stage of dementia and personal abilities are more important in determining appropriate design than is the specific type of setting or housing.[21] Steeman et al[37] state that community-dwelling individuals with dementia emphasize their remaining competencies, instead of focusing on skills lost. As dementia

Table 1. Overview of Design Principles or Design Goals for Living Environments for Persons With Dementia

MCSS[21]/Zgola[29]	Environment should:	• Be structured • Be stable • Provide environmental routines (association of activities with certain locations) • Serve as a (memory) cue	• Facilitate orientation • Provide security • Promote recollection
Pynoos et al[11]	Environment should:	• Promote dignity and independent functioning • Provide appropriate sensory stimulation • Provide security and safety • Provide the appropriate level of activity/task • Provide a home-like and familiar atmosphere • Provide for individual control and privacy	• Create opportunity for socializing • Be flexible and adaptable in supporting the person's behavioral and physical needs • Emphasize wellness and maintain connection with the healthy and the familiar
Schiff[18]	Environment should:	• Be clear and well structured • Be stable and familiar • Serve as a cue to behavior	• Serve as a cue to memory • Support reality orientation
Cohen and Weisman[30]	Therapeutic goals for good design:	• Ensure safety and security • Support functional ability through meaningful activity to help maintain competence and enhance self-esteem • Maximize awareness and orientation • Provide (carefully regulated) opportunities for (sensory) stimulation and change, avoiding either deprivation or overload	• Maximize autonomy and control • Adapt to changing needs • Establish links to the healthy and familiar, for instance, maintain as many links as possible with past lives • Provide opportunities for socialization • Protect the need for privacy
Brawley[31]	A functional environment should:	• Enable communication and appropriate exercise • Minimize agitation • Minimize hazard and risks of falls and injury	• Provide nurturing, comfort, and security • Anticipate potential cognitive deficits • Provide cures and assistance for wayfinding
Marshall[16]	Design should:	• Compensate for disability • Maximize independence • Enhance self-esteem and confidence • Demonstrate care for staff	• Be orientating and understandable • Reinforce personal identity • Welcome relatives and the community • Allow control of stimuli
Fleming et al[32]	Special care units should provide or facilitate:	• Ensure safety and security • Reduce the size of the group and be small • Make the environment simple and provide good visual access • Reduce unwanted and unnecessary stimulation • Highlight helpful stimuli	• Provide for planned wandering • Make the environment as familiar as possible • Provide opportunities for both privacy and community • Provide for visitors, that is, links to the community • Make the environment as domestic as possible
Diaz Moore et al[33]	Day care settings should provide or facilitate:	• Safety and security • Functional independence • Orientation • Sensory stimulation • Meaningful activity • Social interaction	• Privacy • Personal control • Continuity of the self • Spirituality • Architectural delight
Burton and Torrington[34]	Dementia-friendly design should be:	• Familiar • Legible • Distinctive	• Accessible • Comfortable • Safe
Marquardt and Schmieg[35]	Criteria of a therapeutic environment:	• Legibility (logical room syntax, furnishing, fixtures, and fittings) • Familiarity (biographical reference, homogeneous and small groups, noninstitutional character) • Social interaction (privacy, belonging, communication)	• Autonomy (barrier-free, compensating environment; safety and security; orientational cues) • Sensory stimulation (encouragement, avoidance of overstimulation, access to the outdoors)

Abbreviation: MCSS, Ministry of Community and Social Services.

progresses, there comes a moment that persons can no longer acquire new knowledge or learn new skills, although the ability to perform previously learned skills that require repetitive motions appears to be retained.[32,38] This calls for a logical structure of the dwelling and the neighborhood, with a minimum of changes.[39] Living independently (alone or with a spouse) is predicted by the relationship with the caregiver and his or her perceptions of the functioning of the person with

dementia, more than by cognitive functioning.[40] In the end, modifying the home environment is a temporary solution to an ever-increasing problem.

Because older people with dementia often cope with the same ageing-related health problems as other older adults, the goals for planning and designing for dementia include those for the aging population in general,[21] for instance, designing for accessibility. In addition, numerous researchers and institutes have described design principles or goals for dementia,[11,16,21,29-35,41-43] in particular for the design of SCUs (Table 1). To achieve these goals, there is an extreme variation of modifications and environmental strategies among units ranging "from merely installing locks on the door, to elaborate and detailed environmental changes."[43] Apart from the goals stated by Brawley,[31] functional design for older adults may mean providing more traditional looking spaces, including the furnishings, finishes, fabrics, and patterns. Technological appliances should be incorporated into the design by disguising them in more conventional forms.[31] Marshall[16] summarizes an international consensus on design principles for institutional settings that can be embodied in design features. Although there is an overlap with the goals described by Cohen and Weisman,[30] the design principles by Marshall explicitly include the needs of caregivers. The features described by Fleming et al[32] show great similarities with those described by Cohen and Weisman[30] and Marshall.[16]

In summary, the goals presented in Table 1 prioritize the creation of safe and secure, simple, well-structured, and familiar environments that provide cues and privacy to residents. Such environments should allow residents to see everything in the dwelling, provide a décor that would have been familiar to the residents in their early adulthood, and offer quiet spaces for withdrawal for both the individual with dementia and the partner or formal caregiver. Fortunately, all goals described for SCUs can be applied without difficulty to the own home environment. The environmental modifications that pertain to the achievement of these goals have both direct and prevention effects[20] (Figure 1). Environmental interventions have a direct impact on the functioning and participation, which are affected by dementia.

Environmental Interventions for Dementia

There is a broad range of environmental interventions available to support individuals with dementia when doing a range of daily activities and functions. Activities included in this overview are toileting, bathing and personal care, dressing and doing laundry, sleeping, cooking, dining, as well as a section on general safety and security-related interventions at home, which includes wandering, and a section on assistance with perception, orientation, and memory.

Toileting

There are numerous environmental interventions available to support individuals with dementia and their caregivers during toileting (Table 2). These interventions can be applied to any type of space, whether it concerns a separate restroom or a larger bathroom. Environmental interventions identified in this study focus on an increased usability through an improved and faster localization of the restroom. Tilly and Reed[60] state that for people who need to use the toilet, providing cues to help find the restroom quickly may reduce the risk of wandering. The authors postulate that furniture should be sturdy and in good condition and, when possible, may be arranged in a manner that approximates the resident's previous bedroom-to-restroom path to enhance familiarity. However, it still remains necessary to create and maintain a clear path to the restroom. Other items identified are related to assistance during toileting as well as compensating for reduced judgment and awareness. There are also interventions that aim to increase safety during toileting and minimize or postpone incontinence by facilitating toileting. The interventions reflect a combination of solutions that address both the effects of biological aging and dementia.

Bathing and Personal Care

In most homes, bathrooms are the location for bathing and carrying out personal care activities (Table 3). To many, the bathroom is a place for relaxation.[45] The bathroom is often seen as the most dangerous room in the home. Risks include common home injuries, slips and falls, burns, poisoning, cuts, electrocution, as well as drowning.[48,55] Measures to increase general safety benefit both the caregiver and the individual with dementia. For instance, there should be enough space for a caregiver to assist during bathing.[48] Bathing also requires a good routine[49] privacy, and a relaxing, calming atmosphere. Often privacy is sacrificed for safety, yet certain compromises have to be made to preserve both.[48] By relocating the bathroom downstairs, the need for climbing stairs can be avoided.[48] Given the dangers present in the bathroom, and the restricted availability of domestic care, it is important to minimize the need for cleaning. This can be achieved by using certain coatings and maximizing tile size (smaller surface of mortar joints).

Dressing and Doing Laundry

Dressing and doing laundry are 2 activities that are connected to clothing. Dressing and undressing are activities that most often take place in the bedroom and the bathroom. Warner[48] advises to set up a special zone in the home for dressing or undressing. Apart from various modifications and simplifications that can be made to clothing, there are numerous environmental interventions and adaptations that can be applied for assistance (Table 4). People with dementia commonly have problems in choosing what to wear from the variety of clothes hanging in a wardrobe. The elimination of choices in the selection of clothing may help retain the functional ability to dress independently.[32,69] Namazi and DiNatale Johnson[69] mention that this is supported by clinical research that concludes that visual search and attention are hindered by additional visual information. Simplifications, however, do not address the complex components of the dressing task

Table 2. Environmental Interventions to Support Toileting

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Inability to locate the toilet				
Spatial disorientation and/or perceptual deficits	Visual cues: Red light at restroom door; colored line on floor leading to restroom	HM	Not suitable or useful for people with severe dementia	21
	Put (picture) sign on the door	HM		21,44-46
	Leave access door open to enhance visibility	HM/TS	Toilets are easily found. For localization and to prevent inappropriate sexual behavior	21,32,47,48
	Remove toilet lid	OM		29
	Colored toilet seat	OM	Adds contrast	50
Inability to reach the toilet fast enough				
Motor problems (tremor, psychomotor slowing)	Portable commode (chair), urinal, bedpan	AD		21,46,50-52
	Easy access to the toilet	HM/TS	Including open doors	21
Reduced mobility and balance	Raised toilet seat	OM	Raise by up to 8 cm	21,46,52-54
	Grab bars, guard rails, arms for the toilet	HM/OM	Person may continue to use the unsafe toilet paper holder/towel rack/soap dish to hold on to	21,29,48,55-58
Need assistance using the toilet				
Reduced mobility and coordination	Automated toilet with bidet function	HM/OM	Incorporates automatic flusher, warm water bidet, hot air drying (can be installed on a standard toilet bowl). May cause fear	21,48,59
	Nonslip floor covering near toilet and washbasin	HM		53
	Over the toilet chair, toilet raiser	OM		21,53
Reduced coordination, confusion	Pull cord	OM/TS	Often familiar way to flush. Can be supplemented with automatic flushing	Focus group
Weakness, reduced coordination	Rubber grips, doorknob adaptors, and covers for handles	OM		21
Reduced judgment or awareness				
Confusion; reduced coordination/tremor or spasticity of hands	Remove locks	OM		52
Confusion	Remove waste baskets, hampers and other items resembling toilet bowls	OM	Strategy if items are being used as such. In addition, toilets can be used for hiding or disposing of everyday items	20,48,58

Abbreviations: AD, assistive device; HM, home modification; OM, object modification; TS, task simplification.

from the perspective of individual autonomy and decision making in a supportive environment.[69]

There are also environmental interventions that can help in doing laundry, which range from small interventions such as placing washing machines and dryers near the bathroom,[48] and the transfer of dangerous laundry tasks to a new location such as the kitchen area,[48] to applying specific technologies and interventions presented in Table 5.

Sleeping

The bedroom should support optimum rest and sleep. Good sleep is important for restoration of body and mind. The bedroom is both a refuge and a personal space, and one should be careful when changing this.[48] Falls resulting from walking around, dressing, and transfers are considered a major problem in bedrooms.[48] When climbing stairs is difficult due to impaired mobility, bedrooms might be relocated to the ground level if the structure of the home allows for it.[55] Spouses, who used to sleep in the same bed, may find that this is no longer an option due to incontinence or nocturnal restlessness.[48] A second bedroom may then be advisable. In general, the bedroom should be a homelike and pleasant sleeping environment, for which a large number of environmental interventions exist (Table 6). Some persons will have their beds put in the living room by the care organization. In such a situation, results may be applied to the living room.

Table 3. Environmental Interventions to Support Bathing and Personal Care Activities in the Bathroom

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Difficulty in bathing independently				
Perceptual deficits and reduced mobility/ coordination	Visual cues: Reflective tape/strips	OM	It may not be safe to leave the person unattended	21,53
	Padded transfer seat/(fold-down) wall seat in shower. Bath seat/tub chair	AD	Ibidem. To be used in case of exhaustion or vertigo.	21,46,48-53, 55-57,61
	Grab bars on rim of tub, and shower wall, non slip material on floor such as tiles or stickers. Special non-slip coatings	HM/OM	It may not be safe to leave the person unattended, especially in areas with water spilled on floor	21,46,48-53,56,57,61-63
	Chair in bathroom	AD	To sit on while drying off	48
	Grab bar in front of sink	OM	To hold on to when standing	48
	Floor-to-ceiling safety pole	HM/OM	To hold on to when standing	61
	Replace towel racks with grab bars	HM/OM	People may hold on to any item	48
Reduced range of motion	Handheld showerhead (or hose) for bathing (with on-off pause button)	OM	Some have fear for shower water (when coming from above). To control spilling of water	46,48,50-53, 55-57,61
	Soap attached to a long handle/string or magnet, liquid soap dispensers, soap dish with raised edges	OM	To minimize the risk of falls or sliding after dropping soap	21,48,53
	Air dryer for body	AD	Should have enough air flow to dry entire body. In case of fragile skin. May also be misunderstood and therefore cause fear	21,64
	Provide a horizontal sloth near bottom of the bath tub (on external side)	HM	To create extra space for the feet of caregiver, to allow bending over/ reaching	Focus group
	Provide a one-handed faucet with a large handle	OM	Easy for caregiver to operate. According to Zgola,[29] such faucets should be replaced by traditional taps	Focus group
Reduced mobility	Hydraulic bath lift	AD	May be too complex for people with severe dementia	21
	Replacing the tub with a roll-in shower	HM	Access for wheelchairs. Also for disposal of cleaning water	20,48
	Washbasins which can be adjusted in height	HM	For persons in a wheelchair	Focus group
Inability to grasp/reach/hold objects				
Weakness, reduced coordination	Rubber grips and doorknob adaptors. Plastic foam covers	OM		21
	Faucet handles located on the side of the sink	OM	More accessible than rear faucets for people in wheelchairs	31
	Good quality shower curtain one can grasp or hold on to	OM	Calming color and pattern	48
	Remove glass (shelves) and fragile items	OM	Replace by plastics	48
	Soft floor covering	HM	Protection against breaking when items fall on hard floor	53
Need for protection				
Reduced judgment	Lower temperature of water heater	OM	To prevent burns. Not lower than 60°C to 65°C (growth of Legionella)	21,49,50,55-57
	Use hidden taps, knobs, control panels	OM	May contribute to feelings of suspicion	53
	Thermostatic tap	OM	Install a tap that cannot be broken by overturning. Thermostat taps, which often require a twisting hand movement, are difficult to operate and often unknown to people with dementia. A solution would be to install thermostat devices underneath the bathtub and washbasins	53,59,65
	Pressure-sensitive and/or temperature limiting (anti--scalding) balancing valve on taps	OM		48

(continued)

Table 3 (continued)

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Confusion/disorientation	Remove or lock plug sockets	HM/OM	Install childproof plug covers in outlets	48,49,53
	Outlets are ground fault interrupted (GFI)	HM	GFI outlets and circuit breakers help protect from shocks	48,53
	Remove/avoid (portable) electronics. Unplug small electric appliances	OM		48,49,53,59
	Hair dryer should be attached to the wall	OM	Similar to hair dryers found in hotels. GFI outlets do not protect against electrocution from most hair dryers	59
	Label taps hot and cold	OM/TS	Use colors	21,49,53
	Store away soap, cleaning fluids, shampoo, bath pearls, etc.	OM/TS	May be regarded as edible	50,53,55-58
	Medicine cabinet (childproof lock)	OM	For storage of dangerous items (that may be eaten). Or simply remove medication from bathroom	11,46,50,53, 55-58,63
	Remove sink stoppers from bathtub and washbasins	OM	To prevent flooding	54,57
	Remove lock on door	OM	Locks can be deactivated rather than removed	21,53,56,57,64
	Remove shower heads that spray over rim of bath tub/tighten hand showers	OM	To prevent flooding/sliding	53
	Remove sharp objects	OM/TS		11,57
	Install a grill type of door sill	HM	To prevent flooding/minimize risk of falling	Focus group
Perceptual deficits and reduced mobility/ coordination, disorientation	Cover, insulate, or block radiators/convectors/water pipes	OM	To prevent burns or injuries in fall incidents	48,50,53,55
	Install heat lamps and radiant floor heating systems	HM	Use timer switches for lamps	48,64
	Cover drains of washbasins	OM	When in wheelchair, protection of knees against burns	48
	Bathtub with cushioned walls	HM/OM		48
	Cushion or soften items that cannot be removed or relocated (taps, etc). Add cushioned edge protectors to washbasins	OM	To prevent falls when unattended	48,53
	Sheet rubber or a cushioned low glare vinyl on floor	HM	Warmer than tile floor and less slippery	31
	Remove auxiliary heat sources	OM	To protect against electric shocks	50
	Provide a window	HM	For additional (day)light and orientation	64
	Remove clutter and objects	OM/TS	In order to prevent falls	51,55,57
Need for assistance with perception				
Confusion due to reduced perceptual skills	Cover/remove mirrors	OM	In case mirrors are distracting or when people do not recognize their own reflections	48,49,53,558,63,66
	Remove or dismantle whirlpools	HM/OM	Whirlpools may cause fear and agitation by excessive noise	32,64
Confusion	Mark door to the bathroom	OM		58
Need for organization and privacy				
Need for privacy/confusion due to reduced perceptual skills	Towels should be kept ready	TS	Preferably a warm towel from a towel radiator	49,64
Impaired memory	Shower caddy	AD	Stores shampoo, soap, etc	21,52
	Remove excess materials	TS		53,57

Abbreviations: AD, assistive device; HM, home modification; OM, object modification; TS, task simplification.

Table 4. Environmental Interventions to Support Dressing

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Difficulty in dressing independently				
Reduced range of motion or coordination	Dressing aids: sticks, stocking devices, long-handed shoe horn	AD/TS		21
Confusion, impaired memory for dressing	Store away clothes out of reach from the person with dementia	TS	In case when the person with dementia puts on multiple layers	53
Perceptual deficits	Remove pictures of people	OM/TS	May be perceived as real people staring when (un)dressing	67
Confusion and impaired judgment	Place 2 wardrobes, 1 obvious and 1 hidden, with the obvious wardrobe containing only 1 or 2 sets of clothes	OM/TS	To limit problems in choosing	32
	Reduce choices in color and style	TS	Remove clothes from closet	20,21,32,49,50
	Arrange complete outfits	TS	On shelves or hanger	21,49
	Separate summer and winter clothing in 2 closets, as well as day and night outfits	TS		53
	Sliding closet doors	OM	Open, overlapping sliders reveal only half the closet and limit choice	48
	Open shelves instead of drawers for clothing	OM		68
	Put away used clothes in basket	TS	To prevent them from being put on again	53
	Organize clothing by color and outfit	TS		69
	Put pictures of complete outfits on closet door or near dressing location	TS		53
Sequencing difficulties	Lay out clothes to be put on	TS		21,32,49
Perceptual deficits and reduced mobility/ coordination	Provide physical support	OM	Grab bars, chair, or bed	53

Abbreviations: AD, assistive device; HM, home modification; OM, object modification; TS, task simplification.

Domestic and Homemaking Activities; Cooking, Cleaning, Doing Dishes

The kitchen is the space where domestic and homemaking activities as cooking, cleaning, and doing the dishes are carried out. It is a potentially dangerous room in the home. Apart from the use of gas and sharp objects, individuals with dementia may try to cook when being by themselves and then forget about it. Today's modern kitchens, which are often equipped with various kitchen appliances, often have a high-tech character and make no sense to someone with dementia.[45] One of the goals of a modified kitchen (Table 7) is to have people with dementia participate in various kitchen activities with a minimum of risks.

Eating and Drinking

Eating and drinking are important rituals that retain cultural, social, and psychological significance throughout life.[75] Dining is an activity that follows from the preparation of food and that is carried out in the kitchen, dining room, or living room. In the early and middle stages of dementia, the need for mealtime assistance may vary from complete independence to minimal support. The progression of dementia is often accompanied by a decreased ability to execute the sequential behaviors required to feed oneself.[75] Many environmental interventions are available to facilitate independent dining and to increase safety during mealtimes (Table 8). Mace and Rabins[55] state that some people with dementia do better in a dining room or kitchen, where there are many subtle cues such as food smells that remind them to eat. Moreover, the dining area should be well lit, so that people can see their food, but lighting should not be overpowering or glaring, and background noise should be limited to a nondistracting level.[23,49,55] Adequate exposure to light, for instance, near the dining table is important for the support of activities of daily living as eating,[23] whereas it also has benefits to behavior and circadian rhythmicity.[77,78] Some sources warn for poisonous plants that may be mistaken for edible vegetables. At the same time, Schiff[18] states that plastic plants and flowers, which could be used as a substitute, do not confirm the sense of what plants and flowers ought to feel and smell like.

Increasing Safety and Assistance With Perception, Orientation, and Memory

A wide range of environmental interventions can be introduced to maximize home safety. Safety and security constitutes a

Table 5. Environmental Interventions to Support Doing Laundry

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Difficulty in doing laundry				
Confusion, impaired memory and comprehension Reduced judgment or awareness	Use steam irons with automatic shutoffs	OM	Irons may be dangerous. Store away	29,48,53
Confusion	Provide a comfortable chair	OM	To allow one to assist and be with caregiver as he or she does the laundry	48
	Use silent machines		Washing machines, centrifuges, and so on, may cause fear	53
	Remove laundry baskets resembling toilets	OM	Strategy if baskets are being used as such	48
	Refrain from turning on washing machine, centrifuge during cooking	TS		53
Need for protection				
Reduced judgment	Prevent misuse of detergents and bleach	OM	Also store away cleaning chemicals	48
	Prevent portable electrical appliances near the laundry sink	OM		48
	Install flood detector/flood alarm	OM	Person with dementia may not understand the alarm	48
Perceptual deficits and reduced mobility/coordination	Refrain from hanging clothes line/rack indoors	OM	To prevent walking into them	53
	Use a toploader washing machine	OM	To prevent the need for bending over. Machine can also be raised	Focus group

Abbreviations: AD, assistive device; HM, home modification; OM, object modification; TS, task simplification.

large array of domains, including mobility and wandering, orientation and perception, and devices for communication, or in short, all items in the home, not per se in designated rooms, that contribute to safer living and a sense of security.

Carter et al[79] assessed 37 different environmental hazards in the homes of older adults in Australia in a cross-sectional survey, including interviews and inspections among 425 participants. About 80% of the homes inspected had at least 1 hazard and 39% had more than 5 hazards. Most hazards were found in bathrooms, kitchens, and stairways, of which poor flooring was the most potential hazard followed by poor lighting.

Much of what we know about safety and security is based on studies of what relatives and care professionals do themselves to manage dementia symptoms. The simplification of the home and the removal of clutter mean that the person with dementia does not need to think through more things, which may prevent the occurrence of accidents.[55] At the same time, tidy homes may even be understimulating, leading to sensory deprivation and disorientation, and a loss of familiarity. A home should encourage correct decisions and avoid wrong ones.[48] Another point often mentioned is lighting as a means to increase safety, in particular, in relation to mobility.[48,49,55]

Wandering behavior can pose safety hazards to the wanderer and is a cause of great concern among relatives. There are roughly 3 types of wandering: (1) as a consequence of disorientation, (2) habitual activity stemming from previous experience, and (3) restless activity seeking in case of understimulation. There are a number of environmental interventions available to limit the risks associated with wandering or to diminish the behavior.

People with dementia are known to have problems with perception, orientation, and memory. Many environmental interventions exist to support people in daily life, such as labeling things in the home, avoiding patterns that are distracting or confusing, and using see-through materials and items. Schiff[18] makes a good point about institutional settings, which may also apply to the own home. If a person with dementia looks out of a window and sees that it is snowing outside and then turns to see a large mural (or a picture or poster) of autumn trees, it is not surprising if disorientation arises. The home should be conductive to orientation in time (of year).

Tables 9 and 10 provide an overview of environmental interventions to improve general safety and security at home (including wandering), as well as an overview of interventions to assist with perception, orientation, and memory.

Discussion

The discussion section deals with a number of issues that are related to design goals and environmental interventions and their impact on daily practice. First, the design principles and goals are discussed in terms of how they came about and how they can be applied. Thereafter, the evidence and need for more research concerning environmental interventions, as well as the

Table 6. Environmental Interventions to Support Sleeping

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Need for protection				
Perceptual deficits and reduced mobility/ coordination, disorientation	Lower the bed, put mattress on the floor	OM	If one falls, the person is less likely to be injured. It is more difficult to get out	48,49,55
	Move bed against wall	TS	One-sided protection against falling. Bed approachable from 3 sides to help dress. Makes it easier to clean the floor or put a railing on the wall (for assistance)	48
	Place bed near a (secured) window	TS	Bed approachable from 3 sides to help dress	48
	Fall-prevention alarm	AD	Acoustical system or monitoring device. Person with dementia may not understand the alarm	48
	Illumination on the way to toilet/on corridor	HM/AD	To make trips to bathroom less dangerous. Automated systems available. Night lights	23,48,49,51,52,54
	Avoid electrical blankets	AD	No risk of electrocution in case of incontinence	53
Reduced range of motion	Extra outlets for bedside electrical appliances	HM	Table light, cordless phone, radio, clock	48
	Lighting operable from bed and near door	HM	Dimmers on light	23,48
Reduced mobility	Soft floor covering	HM	Protective measure against fall incidents. Add carpet for warm feet and acoustical value	31,53
	Account for rails in ceiling for bed lift	HM/AD	Preventive measure	
	Simplify and remove obstructions	OM	Furniture, and so on	48
Need for communication				
Reduced mobility	Install a wireless doorbell	AD	Allows for communication with partner in the house when bound to bed	70
Ability/inability to get out of bed				
Reduced mobility, coordination and strength	Trapeze device/grab bars, bed railings, and bed handles	OM	Requires arm strength beyond many individuals' capability	21,46,48,55
	Contoured bed/chair	OM		21
	Adjustable bed (upper part)	AD		21
Wandering	Put a musical welcome mat beside the bed	AD		58
Incontinence				
Reduced perception	Eneuritic alarm	AD	Preventive measure	21
	Protective bedding	OM		21,52
	Twin beds	OM	To protect partner from incontinence and nocturnal restlessness. A second bedroom may be used too	48
Perceptual deficits and disorientation	Make a "texture path" from carpet along the hall from the bedroom to the bathroom at hand level	HM	To improve wayfinding	58
Reduced judgment, awareness or perception				
Confusion and hoarding	Minimize places to hide items. Remove wastebaskets	OM	In case of hoarding. Also a strategy if wastebasket is used as a toilet. Camera surveillance optional	29,48
Confusion	Mark door to the bedroom	OM		58
Confusion due to reduced perceptual skills	Cover or remove mirrors	OM	When people become more bed-bound and do not recognize their own reflections	29,48,49,53,58,63,66
	Limit mirror size	OM	Real size reflections of a whole body may be frightening	48

Abbreviations: AD, assistive device; HM, home modification; OM, object modification; TS, task simplification.

Table 7. Environmental Interventions to Support Domestic and Homemaking Activities; Cooking, Cleaning, Doing Dishes

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Need for general assistance in cooking food				
Perception deficits, poor motor coordination, tremor	Install stove next to sink	HM	Meal preparation should not be attempted by persons with moderate-to-severe dementia. Minimize danger when draining boiled food	21,53
	Kitchen blade with variable height	HM	To provide access to wheel chair users	Focus group
	Cook top should be level with countertop	HM		21
	Fixed places for utensils and food stuffs	TS		53
	Store heavy and most often used items at convenient height	TS	The highest shelf at a maximum of 1.40 to 1.70 m. Refrigerator at a 40-cm platform	53
	Create sufficient work space	TS		53
	Minimize (counter) clutter	TS	Keep pans and pots accessible	48,53,55,57
	Grab bar in front of kitchen sink	OM		48
	Shelving units overwork and underwork surfaces should be minimized in favor of shallow shelving units at an accessible height	HM	To avoid accidents	30
Confusion, impaired memory	Place pictures, signs, and labels on doors, closets, cabinets, and drawers	OM/TS	Illustrating the contents. Of help to formal caregivers/ strangers. Use signs to identify objects safe to use	48,50,53,55,57
	Transparent (step) shelving and doors. Remove doors/panels. Clear, plastic storage containers	OM/TS	See-through. Also benefits formal caregivers	48
Poor motor coordination, impaired memory and attention	Provide place for person with dementia to sit (chair, table) and carry out activities or observe others	OM/TS	For helping to prepare food. Place could be the dining table. Place for the person to watch the caregiver (clinging behavior)	48,53,55,58
	A work island or table can serve as a center for unobtrusive observation of the household	OM/TS	Also for caregivers/partners	30
Need for protection from danger				
Impaired memory and attention	Safety switches on (gas) stove (hidden in back) to disconnect burners. Manually turn off gas. Automatic shut off of stove and other small appliances. Remove knobs. Install separate power switch on the stove	OM/AD	Turns stove off automatically or does not allow individual to turn on stove. Persons may forget altogether what they are cooking or timing. Zgola[29]: when gas is turned off, person with dementia may call a service worker	21,29,46,49,50,53, 56-59,61-68
	Install gas alarm	AD	Person with dementia may not understand the alarm. There are special alarms with a connection to a call center	Focus group
	Install remote switches or timers to kitchen equipment, unplug when not in use	OM/AD	Timers can be installed to control electrical outlets for stoves and other appliances. Also shut off after a certain time in the evening (curfew)	21,46,55,63,71,72
	Reminder-light on appliances	OM/AD	Persons may forget about the meaning	21
	Do not use (microwave) oven for storage	OM	Inappropriate items can be cooked and ruined	48,57
	Install induction cooker tops	HM	Leave no room for storage under a grill. Discussion on supposed dangers for people with pacemakers, see Frank et al[73] and Irnich and Bernstein[74]	48
	Cover stove top	OM	With aluminum cover or lid	56,57,63
	Decrease use of/store away dangerous items, spare items, and sharp objects	OM	Items as knives, scissors, letter/bottle/can openers, pincers, fireplace equipment, and cutlery, particularly in case of extreme agitation. Electrical equipment, mixers, kitchen machines. Dices, pet food, plastic fruits, fruit-shaped refrigerator magnets. Poisons	11,46,49,50,53,56-58,63

(continued)

Table 7 (continued)

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
	Cupboard/cabinet that can be locked. Safety locks	OM	One such cabinet is sufficient	30,57
	Put safety catches on cabinets and drawers	OM		58
	Store away appliances that can no longer be operated safely	OM	Including microwave, electric kettle	58
	Replace glass and earthenware by plastic or paper cups/plates	OM	Do not cause splinters when dropped and broken. Easier to clean up	48,53
	Food timers	AD	Persons may forget altogether what they are cooking or timing	21,63
	"Crash barrier" for pans on stove	OM/AD	Also available for boats and mobile homes	53
	Floor surfaces nonslippery, especially near sink	HM	To prevent falls when water is spilled	30,53
	Provide sufficient ventilation	HM	To allow fresh air to enter	22,23,53
	Install handheld fire extinguishers	AD		48-50,53,63
Confusion/disorientation	Outlets are ground fault interrupted (GFI)	HM	GFI outlets/circuit breakers help protect against shocks	48,53,63
Inability to handle complex tasks				
Inability to follow directions	Prepackaged, dried meals, and cold cuts. Improved packaging for opening/sealing	TS	Boil in bag food should be avoided. Too hot to be handled safely	21,53
	Hang a list of directions for preparing an easy meal	TS		49
Inability to clean independently				
Reduced motor coordination and mobility	Small light-weight vacuum cleaners	AD/TS		53
	Easily disassembled appliances	AD/TS	Minimizes bending and stooping	21
	Place tea towels in sight	TS	To promote their use	53
	Soil-resistant surfaces	TS	Reduces cleaning requirements	21
Inability to follow directions	Use a sink instead of a dishwasher	TS		29
Need to prevent losses				
Impaired memory and attention	Check your sink and drain. Make sure the trap underneath the sink/drain is accessible	HM	In case, something of value gets dropped down the drain	48
	Put a lock on the bin	OM	In case of hiding/storing/hoarding behavior to prevent throwing away valuables. Check before discarding	48,50
Inability to grasp and carry objects				
Weakness, reduced coordination	Rubber grips, doorknob adaptor, plastic foam cover for handles	OM/TS		21
	Nonslip coating or mats on work blade	OM/TS		53
	Single-control faucet	HM/OM		61
	Use solid, light-weight, plastic bowls, utensils, and tools	OM/TS	Possibly with a suction cup underneath. Unbreakable	21,53
	Jar openers, tube winders, built-up handles on utensils	OM/TS		21

Abbreviations: AD, assistive device; HM, home modification; OM, object modification; TS, task simplification.

Table 8. Environmental Interventions to Support Eating and Drinking

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Refusal or inability to eat independently				
Severe confusion; loss of appetite, or uninhibited appetite	Refrigerator door detector/monitor. Security alarm system	OM/AD	System to monitor how often door is opened	48,76
	Refrigerator and freezer with (childproof) locks	OM	To prevent excess eating	50,53
Impaired perception and/or judgment; poor coordination or tremor	Plate guards/spill proof cups/suction cups on plates/nonslip placemats/plates with rims	OM		21,53,68
Tremor or spasticity of hand, limited grasp range, weakness, reduced coordination	Book and loop strap to hold utensil. Rubber spoon, weighted spoon, or fork. Easily manipulated cutlery	OM		21,68
	Rubber grips, jar openers, tube winders, built-up handles on utensils	OM/TS		21
	Plastic bowls, plates, and cups	OM		21,50
Confusion, disorientation, impaired perception, and/or judgment	Remove unnecessary cutlery/items/condiments	TS	Papers, and so on, may cause the individual to focus on writing or reading rather than on eating	21,48,49,53,55-58,66
	Avoid placemats, tablecloths, dishes with confusing patterns and prints	TS	Prints of edibles, cutlery, and flowers	48,53,55
	Lay the table in contrasting colors	TS		21,31,49,53,53,55,68
	Store coffee and tea with the (electric) water kettle	TS	Behind a childproof lock	29,52,53
Reduced judgment	Control food temperature	TS	Before eating; burning mouth	21
	Put away inedibles and confusing items	TS	Also includes flower water, plant earth, and hydroculture clay. Due to dysphagia, eating inappropriate materials can lead to choking	21,48,53
	Remove small ingestible items	TS		56
Need for safety				
Confusion; impaired perception and/or judgment	Secure tablecloth	OM		53
	Avoid plastic cutlery	OM	Due to breaking and cracking	53
	Place hot items in the center of the table	OM		53
	Stable, heavy nontippable tables	OM	As people will use them to bear their weight when they get in and out of chairs	68
	Remove poisonous plants	OM	May be eaten or seen as salad. Also consider flower arrangements	31,53,56-58,63
	Refrigerator alarm for high temperatures inside or when temperature control knob has been handled	AD	To prevent eating spoiled food	48
	Store away alcohol	OM		53,56,57
Inability to clean independently				
Reduced motor coordination and mobility	Soil-resistant surfaces, plastic tablecloths, floor mats to protect carpets	HM/OM	Reduces cleaning requirements, when people spill food stuffs	21,48,55

Abbreviations: AD, assistive devices; HM, home modification; OM, object modification; TS, task simplification.

process of implementing environmental interventions are discussed.

Building Principles and Goals

In practice, there are many implicit and explicit principles and goals for the design of housing for people with dementia that do not provide actual instructions as how to create facilitators in the home environment. Cohen and Day[84(p8-9)] state that guidelines for the planning and design of environments for people with dementia "are best viewed not as inflexible directives, but as an attempt to expand and stimulate thinking on the relationships between dementia and design." Guidelines, in their view, "are hypotheses amenable to, and requiring, implementation and validation." Weisman[85(p168)] states that the guidelines by Cohen and Weisman[30] "might best be viewed as broad hypotheses or notions of best practice [. . .] regarding what ought to make a difference in environments for people with dementia, at the same time, these guidelines were never viewed as universally applicable, in the way that traditional models of positivist science were directed toward the formulation of ultimately generalizable principles. The guidelines were meant to be precisely that—broad principles the application of which must be tempered by circumstances specific to individual dementia-care settings."

Castell[86] expands the discussion on building guidelines toward the provision of equitable building access for the (intellectually) disabled, which concerns national legislation and building standards. Judd[87] discussed safety regulations for SCUs, for instance, fire safety, and labeling taps (yellow for warm water of thermostatic taps, instead of red). In his view, regulations should not naively assume full cognition, as they often do. More focus should be on the goals one wants to achieve, instead of just the enforcement of standards. Current building regulations for homes are also based on noncognitively impaired residents.

Zeisel[88] mentions that in the case of SCUs he visited, none exhibited a holistic understanding of how to integrate the separate elements of design guidelines to achieve an increased quality of life for the residents. Even willing designers did not seem to understand the full extent of the guidelines to design a setting that provides residents with cues to help understand where they live. Guidelines alone are thus not yet a guarantee that all goals are achieved. It is of utmost importance to form interdisciplinary design teams that focus on creating a holistic quality of life for all users of an SCU.[88]

In analogy to the conclusions by Zeisel,[88] the same seems to be true for the own home environment. Not all goals in designing and modifying dwellings seem to be achieved in practice, particularly because most modifications still target mobility problems. In addition, the roles and needs of informal caregivers deserve more attention. The Model of Integrated Building Design is suggested as a tool to gain more insight into the building-related needs of people with dementia and their caregivers, as well as the need on the organizational level.[22,23]

Warner[48] proposes identifying zones in the own home by nondemented spouses or caregivers, namely (1) danger zones, (2) respite zones, and (3) safe zones. Especially the respite zones or quiet rooms with comfortable furniture are important to caregivers, because these form sections off-limits to the person with dementia that is reserved for the caregiver, and where he or she can "relax" or get privacy for a while. This in turn should delay the demand for institutional care.[11,48,56,89] To protect the privacy of other family members living at home, locks may be placed on private doors.[29]

Olsen et al[89] interviewed 90 caregivers on HMs. The caregivers indicated that they felt assisted by 1-level living, generous space, simple layout, open floor plans, and safe bathrooms/kitchens, and outdoor access. In a compact home, everything one needs is nearby, and visibility is optimal to allow for monitoring in case of shadowing or clinging to a caregiver. This behavior may be an attempt to compensate for the fear of being powerless or even being left alone. In addition, one should think about creating an additional room for a care professional.[48,89] Similarly, a time-out room may be needed for the person with dementia in case of catastrophic reactions, in which the person can calm down.[21]

There are various scales that can be used to determine the quality of the living environment. These include the therapeutic environment screening scale (TESS) and the nursing unit rating scale (NURS) for institutional settings (Sloane and Mathew,[90] Grant,[91] Sloane et al[82]), as well as the Ambiance Scale (AS),[92] which can be used to assess the capacity of long-term care environments for generating affective and behavioral responses in people with dementia. Other scales include the Safety Assessment Scale (SAS) by de Courval et al[93] for use by community health care providers to evaluate and lower the risk of accidents at home, and the Environmental Cleanliness and Clutter Scale (ECCS) developed by Halliday and Snowdon[94] to rate the degree and various aspects of uncleanliness in rooms and areas with varying functions, for instance, toilet, kitchen, and bedroom, in cases of severe domestic squalor. The Sheffield Care Environment Assessment Matrix (SCEAM) is a tool, which is used to assess the physical environment and the architectural elements. It is composed of 11 user-related domains.[95] Apart from these scales, there are no widely available and all-embracing screening scales for the homes of community-dwelling people with dementia, which could be helpful to the further development of buildings codes.

Evidence-Based Practice in Implementing Environmental Interventions

As Mace and Rabins[55] mention correctly, it is important to remember that no single design suggestion will work in all situations. Different people need different approaches and solutions that work as facilitators, which in turn are influenced by the client system. One should look for solutions that make sense to the caregiver and are low in cost.[55] Personal abilities of the person with dementia play a role as well.[21] Solutions that are facilitators to 1 individual may turn out to be a barrier to

Table 9. Environmental Interventions to Improve Safety and Security at Home, Including Wandering

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Need for safety/security				
Perceptual deficits, disorientation	Sound monitoring, intercom, alarm system	AD		29,55,70
	Reduce size of operable windows	HM	Cannot be crawled through. Built into design of building	21
	Install security locks on windows and balcony doors in high-rise buildings. Keep windows on upper floor closed/locked	HM		52,53,55
	Install window guards	HM	To prevent opening more than 8 cm	63
	Home security systems	HM/AD	Alerts when doors or windows are opened	55
	Install alarms on danger doors and exits	AD	Intervention for caregiver	48,70
	Do not leave doors half-open	OM		53
	Put marks/stickers on glass sliding doors and exits with glass windows	HM/OM	To account for tunnel vision. Install safety glass or fences in front of glass	48,53,56-58
	Windows operable by large levers	HM		Focus group
	Provide clear and large door handles	HM	Lever-type handles for doors are easier to grip instead of round handles (arthritis). Also put the keyhole beneath the handle; not above	31,48,53,61,65
	Have spare items of things that repeatedly disappear	TS	Remote controls, keys, and so on. Extra keys in case the caregiver or person with dementia is locked outside. Provide the person with a substitute model	11,48-50,53,63
	Replace unstable or low furniture by strong, sturdy furniture	OM	Remove objects person can trip over. Remove chairs on wheels	11,21,29,48,50,53-57
	Remove furniture with sharp edges, corners, or protruding parts	OM	Also other sharp features in the dwelling	31,50,53,56,57
	Avoid breakable glass furniture and fragile items	OM	Glass tables, partitions of glass, fragile items, vases, statues, and glass doors. Cover glass showcases. Measure in case of agitation	53,56,57
	Avoid excessive numbers of objects in rooms and on countertops	OM		56,66
	Put lamps/luminaires high on ceiling	OM		53
	Avoid furniture with moving parts	OM	To avoid fingers getting stuck	53
	Fixed shelves	OM	Do not put heavy items on top shelf	53
	Place items of interest in areas without trouble reaching	OM/TS	Avoid damage by knocking over other items. Not above eye height or lower than 0.7 m	48,53,54
	Store away unused items	OM	Creates extra space at home. A tidy home facilitates the localization of possible dangers	53
	Store hazardous substances out of reach or remove them	OM	Including medications, kitchen tools, matches, power tools, electric gadgets, insecticides, gasoline, paint, solvents, and cleaning supplies	21,29,48,50,55-58
	Maximize storage for safekeeping of valuable items	OM	May cause angry behavior	29,48,50

(continued)

Table 9 (continued)

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
	Place mailbox outside	HM/OM	For valuable mail not to get lost. Put lock on mailbox	48
	Refrain from moving furniture and items. Keep in fixed place. Keep consistent	OM	To avoid disorientation that may lead to falls. Also important in low vision	49,50,53
	Simplify and accentuate pathways	HM/OM	Make them as straight and direct as possible	48,53
	Put away extension cords, wires, and electrical cables in pathways	OM	Store beneath furniture or fix them to walls or in cable plinths. Do not put cables below carpets to avoid damage	11,46,49,50,53-57,63
	Add sockets for excess plugs	HM		53
	Avoid electrical cords too close to heat, water, or oven	OM		56,57
	Remove cords in disrepair	OM		56,57
	Install appliances/devices that turn off automatically after use	AD		48
	Remove clutter, obstacles, equipment, and furniture from corridors and stairs	OM	Also remove excess items in other spaces. Remaining equipment should be maintained on one side of the hallway only to avoid the sense of a "maze." Store objects along baseboards or pathway	31,46,48-50,53-58,63
	Add storage space near front door for walkers, wheelchairs	HM		Focus group
	Corridors should be wide enough for 2 people to stand side by side	HM	When assisting the other	48
	Consider length of corridors	HM	The longer the corridors become, the more cavernous and confusing these corridors are	31
	Remove loose and worn carpets. Remove carpets with holes. Replace broken tiles or stairs. Remove area rugs	HM/OM	Carpeting is hard to clean in case of incontinence/ leakage. Thick carpet is uneasy for wheelchairs and walkers. Select low, uniform nap (height and thickness), tight weave, shag, and carpeting	11,29,48,49,53,54,56,57
	Indoor partitions at least 1.2-m high and 0.3-m wide	HM	May interfere with open character	54
	Room dividers: not full height	HM/OM	Open plan basis. Possible to see everything	45
	Use removable room dividers	OM	May increase attention/prevent distractions	80
	Remove furniture that blocks or restricts view from favorite chairs	OM	May increase attention/prevent distractions. Fear of abandonment	48
	Avoid shiny (or waxed) floors	HM/OM	May look like waxed and can cause glare	48,53
	Apply light colors on ceilings, walls, and floors	HM	Colors with considerable are easier to see than pastel or colors of similar intensity	53,55,81
	Strong contrast between walls and floor	HM	Distinction between wall and floor	31
	Install light switches at an appropriate height	HM		54
	Install dimmers on lighting	HM		53
	Provide sufficient support; grab bars, railings	HM	Apply in contrasting colors at an appropriate height	11,50,53,53,56,58
	Install secure handrails or grab bars in stairway	HM	Stair elevators may be a more technological solution. Handrails made of a warm material are preferred. On both sides	31,48,49,56,57,61,62,82

(continued)

Table 9 (continued)

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
	Put gates/fences downstairs and upstairs	HM	Person can climb over. Some studies recommend the removal as persons can climb over them and fall	11,21,29,46,48,50,56-58,63
	Refrain from putting pictures and memorabilia in stairway	OM	Danger of stopping (distraction) and falling	48
	Install colored, reflective, slip-resistant strips on stairs or work with contrasts	HM		48,50,53,56,57,61
	Illuminate stairways at all times	HM		56
	Put rounded corners to handrails that go into the wall	OM	Make sure people do not get stuck behind a railing with a sleeve when going down	21,48
	Install smoke and fire detectors in the home	AD	Also carbon monoxide detectors available. Important when cooking independently or smoking. Check batteries regularly. Alarms may not be understood	29,49,50,53,55-57,63
	Install handheld fire extinguishers	AD		48,50,53,63
	First aid kit	AD		49,63
	Pillboxes with day indication	AD	In case of emergency, have telephone number of GP ready	49,52,63
	Telemedicine to control medicine intake	AD	Camera, digital pillbox	Focus group
Confusion/disorientation	Remove or lock plug sockets	HM	Install childproof plug covers in outlets	48,49,53
	Outlets are ground fault interrupted (GFI)	HM	GFI outlets and circuit breakers help protect from shocks. Have spare fuses at home as well as a torch light	48,53,63
	Illuminate stairway at all times and eliminate shadows	HM		57
	Remove plugs from sockets	OM	Optional	29,53
Reduced mobility, coordination, and strength	Widen doorways to make rooms easier to enter	HM		57,59
	Permanent or portable ramps	HM		61
	Use stable chairs that are easy to get out of. Cushion-lifting chair	OM/AD	Put the chair near where the caregiver often is, so the person can watch you (clinging behavior). Put up a chair by the window. Mechanical or hydraulic	21,55
Wandering and pacing				
Disorientation, confusion	Camouflaging/hiding exits: adding mirrors, pictures, curtains, cloth panels, or painting doors same color as wall	OM	For doors that should remain closed	21,29,46,47,53,56,58,63
	Secure doors. Complex unlocking mechanisms on doors. Install additional locks	OM	Preventive measure. Placed in strategic places. Place locks low or high on door. Bowlby Sifton[58]: extra locks should be used with caution; be sure that the person and others in the house can get out in the event of an emergency	20,21,46,50,55,57,58,63,70
	Put piece of furniture in front of the door	OM		46
	Remove doors or keep them open	HM/OM	Allows persons to walk freely	48
	Do not leave keys on doors. Store keys out of sight	OM		53,57
	Place stop sign or "Authorized Personnel Only" on door leading to outside	OM		57

(continued)

Table 9 (continued)

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
	Accentuate doors of bedroom, bathroom, and kitchen	OM/TS		53
	Refrain from hanging/placing coats, boots, and walking stick in sight	OM	May invite people to wander	53,56,57
	Stationary bicycle, treadmill, and rocking chair	AD	May give the same sensations as pacing/wandering: sensory feedback from joint and muscle movements. Provide exercise and stimulation during day	11,29,56,57
	Dutch/half bedroom doors	HM	May reduce person's dignity. Gives people private space at the same time and allow for visual access	21,48,68,83
	Bells, bead/fly curtains, or alarm systems connected to doors	OM	May scare person, resulting in greater confusion. Placed on all exit doors	21,53,56,57
	Put a musical welcome mat near the front door	AD		58
	Video camera surveillance	AD	Surveillance camera can also be used to monitor when hiding and hoarding become a serious problem	21,48
	(Infrared) movement monitoring, fall detection, and GPS tagging	AD	Electronic devices available to alarm in cases of wandering, falls, and periods of no movement	50
	Tag detection devices	AD		21
	Provide safe space indoors or in the garden for pacing	HM	Created so that there are no dead ends	11,21,53,57

Abbreviations: AD, assistive device; HM, home modification; OM, object modification; TS, task simplification.

Table 10. Environmental Interventions to Assist With Perception, Orientation, and Memory

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
Difficulty with orientation				
Confusion, disorientation	Colored stripes on floors and walls	OM	To mark paths to important rooms/spaces. Person may also follow these patterns when applied on carpets	21,53
	Avoid 2-dimensional patterns on the floor. Avoid large, bold geometric patterns in carpet. Avoid designs that may appear as bars. Avoid intertwining patterns. Avoid combinations of geometric patterns that may seem to move	OM	May be interpreted as 3-dimensional barriers due to problems with depth perception. Vertical stripes: jail bars. May reinforce delusions of being incarcerated or held against the will. Minimizing feelings of unsteadiness and instability	47,48,64
	Avoid patterns on the wall, wallpapers, carpets, and upholstery that may cause hallucinations or disorientation	OM	Choose solid colors	48,55,58,66
	Avoid doorsteps/door sills, and color accents resembling (door) steps, holes, or pits	HM	Visual cliffing is the misinterpretation of changes in colors as differences in depth, elevation, or planes	31,48,53,56,68
	Avoid use of border trim for carpet or multiple borders as a decorative trim	OM		31
	Avoid use of arrows on the floor	OM		31
	Avoid dark mats	OM	Can be perceived as a hole	53
	Label doors, drawers, cabinets, with pictures, and/or signs illustrating their contents	OM/TS	Words may not be recognized (aphasia). Use picture labels	20,48
	Install pictograms on light switches	OM	For instance, of a light bulb	Focus group
	Label doors with extra large letters or pictures	OM		21,45
	Name and photo of person on room/front door	OM		21,45
	Show case or photo corner	OM	For reminiscing or comfort	31,45
	Reality orientation board	OM	Records date, weather, and time. Signs and decorations related to season	21
	Large print calendar	OM	To help orient and record appointments	11,21,50,52
	Large analogue clock	AD	To help orient. Instead of digital version, even though reading hands may be difficult. Time may no longer be clearly understood	11,21,29,48,52
Memory impairment, disorientation				
	Simplify the environment	TS		21,29
	Keep familiar objects in the same place	TS		21
Need for assistance with perception				
Confusion due to reduced perceptual skills	Use contrast: separate foreground from background/walls from floors. Dark door knobs on light doors. Distinguish steps from floors or furniture	HM		21
	Carpet floors to reduce glare	HM		21
	Remove or cover mirrors, shiny surfaces, and traditional art	OM	Fear may go away after a while. Perceptual deficits contribute to confusion. Reflections can be seen in windows (pull curtains), tables (use a scarf) and highly polished furniture	21,48,49,52,63,66
	Childproof lock on television. Adult lock	OM/AD	Television is a common source of misinterpretations. Violent or sexually oriented programs may cause fear or arousal. Reflections from screen may cause fear	48,53
Need for assistance with memory				
Impaired recent memory	Make lists of daily activities/notes	TS	Not effective for moderate or severe dementia	21

(continued)

Table 10 (continued)

Criteria for Use and Associated Deficits	Environmental Intervention	Type of Intervention	Comments	References
	Punching bags and pounding dough	OM	To vent emotions	29
	Headsets allow listening to music, while the other person listens to television	OM	Cordless headphones help people who otherwise cannot hear the television	55
	Avoid headsets with cables	OM	When person stands up, the headset is connected and may cause damage. Panic from sounds	53
	Have pictures of visitor ready for recognition	OM		53
	Display family pictures and mementos. Provide a handheld photo album with labels	OM	To be used for reminiscence	11,58
	Answering machines and number identification	AD	To check who made calls when absent	55
	Automatic dial phone	AD	Use telephone with preprogrammed rapid dial numbers and train person to use	50,57
	Dial phone instead of touch-tone model	AD		29
	Telephone as means for contact	AD	Put numbers, pen, and paper ready. Volume control. Express dials with pictures. Account for poor sight, apraxia, tremors, and muscle weakness	53

Abbreviations: AD, assistive device; HM, home modification; OM, object modification; TS, task simplification.

another. Results show that there is a variety between design goals and that even a number of discrepancies exist between these goals. In practice, these differences may cause confusion or hinder the proper implementation of goals into the actual design. In addition, Day and Cohen[96] stress the importance of culture in good design, for instance, to accommodate for culturally based activities. According to Olsen et al,[97] a successful modification strategy follows a 3-stage movement-access continuum. Approaching HMs along this continuum encourages independence and movement when appropriate, and at the same time provides safety and control. Olsen et al[97] state that "[w]ith a sensitive and ongoing modification strategy, the home environment can become an asset rather than a liability for caregiving."

Architects often think that, apart from being responsible for the esthetics in the environment, they can influence human behavior through their designs, despite findings that design features do not prescribe patterns of social interaction or social binding.[97] Architectural designs are complementary to human activities and not the cause of them. The most important social function of a design is to enable people to do whatever they need or want to do.[98] It is questionable whether proper architectural design and additional indoor design can help people with dementia, even though these people rely very much on their senses. Or as Warner[48(p2-3)] states it: "We must be realistic. Alzheimer's is a disease of the mind, not of the home. The environment is not a treatment, and it offers no cure. But many problems related to the disease can be lessened for the person with [Alzheimer's disease] and especially for the caregiver by making changes in the home environment." There is increasing evidence that environmental interventions are not just desired by people with dementia and their partners but also these interventions can sort some effect. The effects of such interventions are greatly disputed, however, and still subject of numerous studies. According to Weisman,[85(p169)] the review by Day et al[47] "provides substantial support for many of the broad recommendations presented in the various design-for-dementia guidebooks." Weisman[85(p171)] also states that there is "a growing number of model facilities, with care providers increasingly willing to develop environments which purposefully implement and evaluate innovative approaches to dementia care." Previous work by van Hoof and Kort[13] on the design of a dementia dwelling can also be seen in that light. Weisman[85(p171-172)] continues by stating "[t]he findings and lessons to be derived from the body of work on dementia care environments seem to be substantial. They should not, however, be limited to those derived solely from the empirical research on environments for people with cognitive impairments. It's equally important that we keep in mind the innovative ways in which these model facilities were planned, programmed, and designed; the systemic way in which they were conceptualized; and the innovative ways in which they have been publicized."

Gitlin et al[99] have systematically evaluated a range of environmental strategies. About 90% of the 63 studies reviewed reported positive outcomes, although most studies were methodologically flawed, involved small samples, and were conducted in nursing home settings. Tilly and Reed[100] reviewed 28 articles (1994-August 2006 time span) and came to the conclusion that there are successful interventions for assisted living facilities and nursing homes to reduce falls and related injuries, including carpeted floors, and home-like environments. Most of the environmental interventions described in this article have not been systematically studied. Nevertheless, there are a number of studies that are relevant and discussed in the following paragraphs. These studies deal with falls in relation to carpet design, signage, and open architecture in relation to wayfinding and distractibility, the modification of doors to manage behavior including wandering, and closet modifications to support dressing.

Falls and carpet design. The need for fall prevention measures in older people with dementia is paramount. Carpets are among the materials used in environmental interventions to counter the consequences of falls. Perritt et al[101] investigated the impact of carpet design and pattern on walking time and stability of 107 persons with Alzheimer's disease selected from day care and retirement facilities. Significant differences were found for walk time due to texture and pattern and in number of incidents due to the carpet's pattern. Slower walk times were associated with the pile texture. Patterns having the smallest motifs and lowest contrast were walked best. In short, flooring decisions may play an influential role in user safety, the use of large, bold patterns may be not appropriate for application in homes, and may even reinforce dependency and immobilize. More evidence, however, is needed on shades and contrasts on floors in relation to walking.

Signage, wayfinding, and distraction. When considering wayfinding, signage is a logical starting point. Signs, however, play a minor role in orientation within a space. The overall layout of the plan should be the first element to consider.[102] Open plan layouts are advised for numerous reasons, including clinging behavior. Marquardt and Schmieg[35] studied the wayfinding abilities of nursing home residents in relation to the physical environment. In total, 5 wayfinding tasks were tested (going to the live-in kitchen, the private bedroom, the restroom, garden or balcony, and the common room). Results confirmed that people with advancing dementia were increasingly dependent on a compensating environment. The significant factors include a small number of residents per living area, the straight layout of the circulation system without any changes in direction, and the provision of only 1 living/dining room.

Related to open plan architecture is how dementia and sensory sensitivity to environmental stimuli influence distractibility. For the least impaired barriers such as room, dividers appear to decrease distractibility and may support attention span and increase concentration.[80] Portable screens may help support both the person with dementia and the caregiver wherever there is a high level of activity by allowing people to carry out activities. The barrier shields them from intrusive stimuli. Once a task is completed, the screen could once again be a part of the larger family setting.[80] Gross et al[103] studied the effects

of environmental signage in dementia care facilities on facilitating adaptive behavior of 10 females with moderate-to-severe dementia, including room finding, in 3 experiments. Many of the participants were able to identify written names and photographs of themselves, and names and photographic labels helped identify belongings.

Much attention is given to labeling restrooms/toilets. Wilkinson et al[44] studied toilet signs among 28 persons with dementia. Symbols representing men and women were most suitable for persons with normal cognition and mild dementia. Pictures of a toilet bowl worked best for persons with moderate dementia.

Modifying doors to manage behavior. In a review (n = 39) on the effects of subjective exit modifications to prevent wandering, Price et al[104] concluded that studies on this matter were unsatisfactory and vulnerable to bias. There was not sufficient evidence that patterns on floors or doors, mirrors, camouflaging doors, and so on, were effective in reducing wandering behavior. The study also states that subjective barriers may cause fear and anxiety in some individuals with dementia. Unfortunately, no studies were based in the own home of participants. When locking people at home, one can state that people are bereaved from their freedom, which goes together with ethical dilemmas. However, the risks of accidents happening out on the street are surely taken away.

In many psychogeriatric nursing homes and SCUs, the exit doors are secured and locked to ''insure'' residents' safety.[105] Many residents feel a sense of confinement, which is carried over into other observable behaviors, including wandering or pacing from one exit door to another. Namazi and DiNatale Johnson[105] studied behavior when doors of an institutional setting were left open (n = 22). The nonverbal behaviors displayed by residents after they found that the exit doors were open are particularly worth mentioning. For the ones most eager to leave the unit, the experience usually ended when the resident was assured that the door was open and it was possible to depart. ''Several residents held the door ajar with one hand, stepped outside, looked around, and then came back inside.'' The element of choice appeared to decrease negative exit door behaviors.[105] It is important to realize that a similar conflict can take place when people are locking the door of the own home to cope with wandering behavior and that attention should be paid to a sense of autonomy at all times.

Closet modifications to support dressing. Namazi and DiNatale Johnson[69] performed a study on closet simplification modification (n = 8) by putting a sequential arrangement of clothing in the modified side of a closet. The study sample was too small to be conclusive, although results showed that a modified closet may be helpful for some who are in the middle stages of dementia and are still able to make some decisions. The simplification separated the selection and sequencing of appropriate clothing (at night) from the decision making required with the physical act of dressing.

The need for more research on evidence. There are many environmental interventions to facilitate aging in place for people with dementia. Such interventions provide a solution to (perceived) barriers and alleviate care given by relatives. The private home, where most spend their lives in the early and moderate stages of dementia, is a largely ignored territory (ICF domain e155) in both research and policies. If we look at the aforementioned studies, it is clear that most studies have been carried out in institutional settings (ICF domain e150). It is unsure how many of the design guidelines are applicable to the home environment, and to what extent, given differences in cognitive status of the residents and in the architecture of the homes as a whole. More research is needed on the effects of modifications within the own home environment. In addition, the small number of participants in most of the studies should be larger when repeating these experiments. One should test the most promising interventions, known from institutional settings, among community-dwelling older adults with dementia, although research in this field is difficult. Calkins[106] is somewhat cautious about the potential successfulness of the environmentally deterministic approach, in either research or design. She states that the approach basically assumes that a finite, relatively small number of variables can account for a significant proportion of the variance. Yet, the number of variables and the relationship between them are very complicated. Calkins is supported by Lawton,[107] who concluded that there are far too many possible design variations to hope that any great proportion of them might ever be tested experimentally. In addition, Lawton states that the interface of person and environment in real situations may be too complex to capture in a linear experimentally controlled test.[107]

Preconditions for the Implementation of Environmental Interventions

The actual implementation of the environmental interventions in practice is a complex matter involving numerous stakeholders and their needs. There seem to be differences in the ease at which strategies for supporting activities and functions are implemented. Within the Model of Integrated Building Design,[22,23] the integrated design process, that is, the implementation of environmental interventions, should fulfill the building-related needs of all relevant stakeholders on the individual and organizational levels. Following the model, the preconditions for the implementation of environmental interventions are influenced by the dwelling people live in, the urgency to have interventions carried out, the role people with dementia and the stage of their dementia, the needs of informal caregivers, the capabilities of formal caregivers and occupational therapists in particular, as well as financial aspects.

Challenges concerning the existing housing stock. Charness and Holley[108] already made notice of challenges that lie in updating existing housing, because retrofitting is more expensive than designing properly in the first place. Readily adapted dwellings

are scarce and often designed to support persons with impaired mobility. Environmental interventions are can be considered more easily during the design phase of a building than during retrofitting. About two thirds of buildings have architectural constraints, and not all of them can be compensated by modifications or environmental interventions. Going through numerous official procedures related to retrofitting can be a stressful event for both the person with dementia and the informal caregiver. Fortunately, most environmental interventions are simple when known to the person carrying out the intervention, such as the majority of OMs, and do not require getting permits.

Individual level: the need for environmental interventions. Some researchers studied the implementation of modifications and pointed out to the need for such environmental interventions. Silverstein et al[50] studied the implementation of recommended adaptations (n = 501) in practice. Target problems addressed by adaptations were cognitive and behavioral impairments (45.3%; falling, wandering), safety (30.9%; prevention of poisonous ingestion or chocking/fire prevention), caregiver ease (19.8%; minimization of rummaging, increasing coping strategies of caregivers), and impairments in activities of daily living (3.4%; decreasing incontinence, support for decreased fine motor coordination). On average, 25 recommendations were made per household, with a range from 1 to 53. Lach et al[63] conducted a telephone study among 35 caregivers. About 71% of these caregivers indicated that people with dementia engaged in unsafe behavior. Wandering was reported by 37%. About 68% of the caregivers took precautions to help avoid accidents, including modifications. A history of unsafe behavior or accidents was significantly associated with the use of precautions. Calkins and Namazi[46] carried out a field study of interventions (n = 59) at managing wandering and incontinence, at increasing safety and independence, and aimed at the reduction of disorder and confusion at home. In 69% of cases, there were modifications for wandering behavior, of which 73% worked well. There were fewer modifications for incontinence, although in 68% of cases, incontinence was indicated to be a problem. About 63% of cases had modifications to the bathroom, of which 91% were reported to work well. A somewhat lower 56% of cases made modifications to the kitchen for reasons of safety and independence. About 76% of these interventions worked well. Messecar et al[109] interviewed 24 caregivers of community-dwelling older adults. Of these older adults, 67% dealt with cognitive impairments. Forty-four modification strategies were identified and categorized into 1 of 7 home environmental modification purposes: organizing the home, supplementing the older person's function, structuring the older person's day, protecting the older person, working around limitations or deficits in the home environment, enriching the home environment, and transitioning to a new home setting. The majority of identified strategies are environmental interventions described in this study, which indicates that caregivers already implement a multitude of interventions in practice despite the limited amounts of information and guidance.

Individual level: the role of people with dementia. The role of individuals with dementia in the implementation of environmental interventions is multifaceted and depends largely on his or her abilities to make decisions relating to choice of interventions and the implementation thereof, as well as the acceptance of the environmental interventions. It is of the utmost importance that the actual people with dementia are involved, as environmental interventions take place in his or her dwelling and he or she needs to live with them. Particularly, in the early stages of dementia, when environmental interventions may have a maximum effect, the same measures may be confronting and perceived to be stigmatizing. Modifications carried out in the early stages of dementia may support performance, whereas in moderate dementia, the disablement process continues and more assistance is required from caregivers.[20] Additional modifications may be needed with progressive memory loss and require a periodic reevaluation.[56] A person with dementia can decline without caregivers realizing the increased risks.[55] It is important that people with dementia are encouraged to participate in familiar tasks to make them feel useful and purposeful. Abstract or unrelated tasks that require a series of sequential decisions can be too challenging, which stresses the need for simplification of activities and items.[38]

Moreover, the implementation of modifications is influenced by their costs and allowances people can receive and appearance of the home. People with dementia often receive assistance from spouses and other relatives, although a large portion of these people live alone in the community. Some of these independently living persons are managing well because of their independent spirit, coping skills, and acceptance of assistance from social support networks. It is this group that may know their way toward obtaining the environmental interventions needed for daily support. Others face the difficulties of remaining their independence and risk imminent institutionalization.[110] In practice, both care recipients and caregivers may have difficulties in getting the right interventions implemented in their homes. In addition, some of the work that needs to be carried out may require workers to be in the home for some time. Getting work done as early as possible allows for better management of less stress.[48] When big modifications are being made, one can later modify gradually.[48]

Individual level: the role of informal caregivers. Informal caregivers play a crucial role in providing care to people with dementia, also because of the general shift to community-based care. If individuals with dementia can no longer make decisions regarding environmental interventions independently (even though some form of consultation is likely when a partner is present), informal caregivers are the ones who make the decisions and take action. At the same time, caregivers have specific needs of their own.[10] Informal caregivers emphasize that their greatest needs were the needs for more trained helpers, more education, support programs, and in particular more respite care.[29] Environmental interventions constitute only a fraction of what is needed for people with dementia to remain independent.[29] Spouses should receive support from the full array of options including domestic care and counseling. According to Silverstein

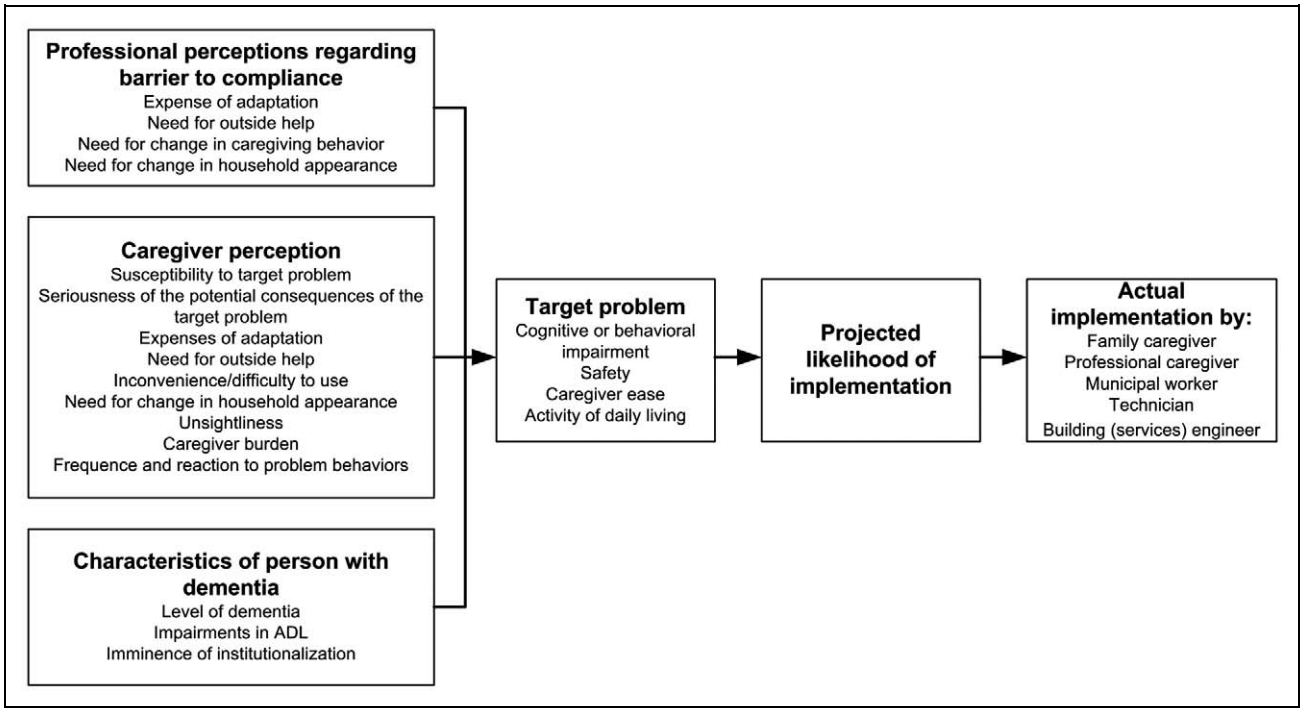

Figure 2. A schematic representation of the road toward implementing environmental interventions. The actual implementation of an intervention can be the responsibility of many and may vary per country. Adapted from Silverstein et al.[50]

et al,[50] the role of caregivers should not be underestimated in the process of implementing HMs (Figure 2). Many people with dementia are living in the community and do not get the appropriate environmental interventions needed to age in place, as knowledge is practically not available to informal caregivers.[5] Too often, informal caregivers are unfamiliar with specific modifications that can be made, and how these modifications are paid for and by whom they are installed at home. There are still many efforts needed to fully emancipate and empower families that deal with dementia. Fortunately, many caregivers do implement a range of environmental interventions, although such interventions seem to be underused by informal caregivers.[20]

Organizational level: the role of formal caregivers and occupational therapists. Particularly care professionals will witness a change in professional tasks: home care workers will increasingly help people with environmental interventions and show people the way to other professionals to have the more severe modifications carried out. Caregivers increasingly find themselves in the role of consultant, in which they should be able to advise on environmental interventions and get to informed about the domains of (assistive) technology, construction, and interior design.

Gitlin et al[111] determined the short-term effects of an environmental intervention on self-efficacy and upset in caregivers and daily function of people with dementia in a randomized control study involving 171 families. The intervention involved a series of sessions from an occupational therapist. Caregivers of the intervention group reported significantly fewer declines in instrumental activities of daily living of the individuals with dementia and fewer declines in self-care and fewer behavioral problems 3 months after the intervention. Moreover, spouses of the intervention group reported reduced upset. A single-blind, randomized, controlled trial by Graff et al[112] shows that occupational therapy for community-dwelling older adults with dementia can improve the quality of life for both the person with dementia as their informal caregivers. In addition, there is a decreased demand for formal care and a delay of the moment of institutionalization. The methods used by occupational therapists are directly supplementary to building-related environmental interventions and were found to be very cost-effective (€1183-€1239; £848-£888; $1738-$1820 per 3 months[111]). Galasko et al[113] and Galasko[114] have come up with an overview of loss of optimal (independent) performance of various (instrumental) activities of daily living in relation to a person's MMSE score (Table 11). The loss of function is slow, but at the same time predictable. This allows occupational therapists and professionals responsible for modifying the home to cautiously plan ahead.

Organizational level: costs and allowances. The implementation of modifications is influenced by their costs and allowances people can receive, appearance of the home, and of course characteristics of the person with dementia. Throughout the European Union, there are large differences between the how environmental interventions are financed, which depends on the country's care regime and care and housing policies.[5] The OECD report on dementia[10] states that "[d]ementia is a relatively new area of policy focus compared to many other of the diseases and conditions which impose a large burden on society. Few OECD countries have specific policies for the condition, [which] is frequently encompassed in wider policies and

Table 11. Cognitive, Functional, and Behavioral Change as Associated With the Progression of Alzheimer's Disease[114]

Stage (MMSE)	Impairment Cognition	Function	Behavior
Early (21-30)	Recall/learning Word finding Problem solving Judgment Calculation	Forgets details of conversation, reading, complex hobbies, work, driving, handling money/shopping, taking medication Needs reminders, notes	Apathy Withdrawal Anxiety Irritability Depression
Mid (10-20)	Recent memory (remote memory unaffected) Language (names, paraphasias) Comprehension Construction Insight Orientation Visuospatial ability	Needs reminders for basic activities of daily living Complete loss of instrumental activities of daily living Gets lost Misplaces things Cannot be left alone Social graces retained	Delusions Hallucinations Agitation Wandering Insomnia Loss of insight (social skills unaffected)
Late (<10)	Very limited language skills Attention Apraxia	Loss of basic activities of daily living: dressing, grooming, bathing, eating with utensils, walking, continence	Agitation (verbal or physical) Outbursts Insomnia
Terminal	Mute of incomprehensible	Bedridden Total loss of ambulation	May scream or make noise

Abbreviation: MMSE, Mini-Mental State Examination.

statements. In addition, discussions of policy issues are relatively rare in the research literature.'' The omission of dementia from policies may have serious consequences to the provision of adequate support and environmental interventions in practice. The adage for modifications within the current system of funding, considering the steady decline in functioning, would be considering the person's present level of impairment when doing the first round of adaptations, while at the same time one should plan ahead for the gradually increasing impairment. The dwelling should be adapted to the fullest extent to keep people at home for as long as possible and/or as long as desired. In addition, there are differences throughout the European Union in the percentages of houses, which are privately owned or rented from a social housing cooperation. A home's ownership influences how larger HMs are carried out and paid for.

Conclusive Remarks

There are numerous environmental interventions such as HMs, ADs, OMs, and TSs that serve as facilitators for people with dementia in their desire to remain living in the community and help support both informal and formal caregivers. Many of these interventions find their origin in design goals and guidelines for dementia and conventional HM practice. Despite the limited scientific evidence of the efficacy of many of these facilitators, many hold a promise for the people with dementia and their caregivers that cannot be dismissed, as environmental interventions are much needed in the years to come. Many of these measures are already implemented in practice to solve perceived barriers identified within the home environment by caregivers. Governments and patient/health care organizations have the important task to supply information regarding environmental interventions to individuals with dementia and their informal caregivers. This information should make the target groups aware of the existence of such interventions and how to implement and benefit from these interventions in the own home environment. Future research, which should be carried out with larger numbers of participants, should particularly focus on evidence-based solutions for memory support, orientation, and personal care and dressing. Developments in the field of safety and security and outdoor orientation currently receive most attention from the industry.

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