Impact of Aging: The New Frontier of Healthcare at Home

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Abstract. With the ageing of the population, more services will be required for the treatment and management of chronic and acute health conditions at home, especially those most prevalent with ageing. Several research experiences show that Healthcare at Home offers potential advantages over traditional healthcare options for both healthcare organizations and patients, however, there also are many challenges. The paper identifies criteria for the design of the physical environment (including the home, equipment, furniture, etc.) that support and facilitate safety, comfort, and healing, in relation: to the various patient populations (older adults with acute and chronic conditions, patients in rehabilitation, and patients of all ages with chronic illness) and their own physical and psychosocial needs; to the range of equipment/technology (for low- to high-acuity levels and chronic to acute care); to the caregiving and daily living activities (protocol, processes, and human behavior). Design criteria that support physical and psychosocial needs include the following: physical/technological bedroom layout; items of furniture and technological equipment.

Keywords: Patient-centered design · Aging in place · Universal design · Healthcare at home · Psycho-physical needs

1 Introduction

Advancements in medical care and quality of life, in the last few decades alone, have helped vast numbers of people live longer and healthier lives. WHO' statistics show the growth in the size of the elderly population, stating that the number of people aged 85 years and older is projected to rise from 14 million to 19 million by 2020 and to 40 million by 2050 [1]. These population trends are driving the shape and scope of home health care services.

The desires and complex care needs of an ageing population, the advances in medical technology and care delivery models have initiated a shift from providing care in hospitals to outpatient settings. Recently, these factors – and their the acceleration/amplification – are pushing healthcare options, even further from the traditional inpatient and outpatient settings towards acute and subacute care in the home. The 2011 report by the National Research Council (NRC) declared, "Health care is coming home" [2]. However, the literature is confusing because there are different terms of healthcare at home (Hospital in

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the home, HITH; Home Healthcare; Home Hospitalization; Early Supported Discharge) [3] and different types of services, some of which focus on specialities (surgical and medical specialities, rehabilitation medicine, geriatrics, psychiatry, infectious diseases, respiratory diseases), others on diagnostic groups (e.g. hip fracture or stroke), or a mixture of them [4, 5].

Both the complexity and the intensity of the health care services provided in home settings are increasing and making changes to home care. In fact, it is changing from a service to help people or older adults – with disabilities, chronic illness, or cognitive impairment by assisting in their daily living activities – to a service that provides acute or subacute treatment in a patient's residence for a condition that would normally require admission to hospital. The key is substituting for in-hospital care. Home-Based Care includes admission avoidance (i.e. full substitution for hospitalisation) and early discharge followed by care at home (i.e. shortened hospitalisation). It can be cost-effective and convenient, reducing unnecessary hospital admissions and allowing patients to receive the care they need where they are most comfortable [6].

The advantages of Home-Based Care can be summarized in the following ways:

- greater safety for frail elders because they will have fewer of the common complications of hospitalization (such as delirium, stress etc.). The NRC [2] report noted that acutely ill older persons often experience adverse events when cared in the acute care hospital, while they value the delivery of health care at home, as it promotes healthy living and well-being when it is managed well. Living independently at home is a priority for many, especially individuals who are ageing with disability;
- greater patient-centred care [7], that leads to a better understanding of important issues, such as how medications and nutrition are handled, a more intimate clinician-patient relationship;
- greater patient autonomy [8], especially patients with lower levels of mobility and elders can benefit from the opportunity to receive the care they need where they are most comfortable. Ageing in place in the home includes efforts to help beneficiaries remain comfortable at home in the last 6 to 12 months of life;
- lower costs [3, 7];
- lower strain on saturated healthcare facilities (including emergency departments and hospitals with limited bed capacity) [9]. Besides, Home Healthcare can reduce unnecessary hospitalization and connected risk of healthcare-associated infections [8, 10].

While there are numerous advantages to Healthcare at Home, there also are many challenges. There are still only a few healthcare organizations that offer formal home-care models for primary and hospital-level care (e.g. Johns Hopkins Hospital at Home, Ohio Veterans Administration Hospital in Home) and there are limited researches available on the role of the built environment in safe and effective delivery of healthcare at home, for both patients and providers (Universal Design, Aging in Place, Healthcare at Home approaches). However, as Healthcare at Home is becoming more commonplace as a practice, there is an opportunity to shift thinking from the typical residential design to a more sustainable home concept, 'how the home can support health and healing'.

This has led the medical community to seek to provide more tools and methods of care that patients can safely access right from home, and the designers to think as the homes of the future will need to be laid out strategically to address both an array of ageing needs and support this form of healthcare delivery.

2 The Challenge: Interaction Between Persons, Tasks, Equipment/Technology and Environments

The research on design for Healthcare at Home considers the design of every single architectural component as a matter of adaptation between the organism and its environment. This user-centred approach involves a broad vision of the human-designed system-environmental relationship, in which the quality of the designed systems is conveyed through the correct correspondence among the users, the tasks, the physical environment and the range of equipment/technology. Some considerations can be made about the type of users and tasks, the physical environment and the range of equipment/technology.

Users and Tasks (The Caregiving and Daily Living Activities). The primary persons involved in home health care are: the health care provider; the health care recipient; family and friends, who are not primary caregivers, but are included within the social environment of the patient. The physical environment (e.g. including home, equipment, furniture) can support and facilitate – in carrying out the tasks – safety, comfort, accessibility and healing, but the people and their tasks must be considered simultaneously with the abilities/disability that evolve and shift throughout the life course (both on a temporary and permanent basis). With the ageing of the population, more services will be required for the treatment and management of chronic and acute health conditions at home, especially those most prevalent with ageing (e.g. hypertension, arthritis, heart disease, cancer, diabetes, and stroke) [11].

The well-being of the users – who receive care at home – depends on the capacity of space/equipment to maintain/facilitate their level of independence; minimize patient stress anxiety and risk of fall; guarantee accessibility, safety of use, patient satisfaction and comfort. The well-being of care-providers depends on safety against the risk of injury, such as musculoskeletal injuries from patient handling; slips/trips/lift injuries from dangerous flooring/rugs/stairs [12]; control of the infections [12, 13]; mental health stressors [13].

Physical Environment and Range of Equipment/Technologies. Many home health care tasks require the use of technologies and equipment (medication administration equipment, durable medical devices, dialysis machines, feeding tubes, catheters, defibrillators, ambulation aids and oxygen tanks) by the health care providers as well as the care recipients. However, these technologies and equipment were designed by manufacturers to be used only in clinical settings by trained professionals. This most complex medical equipment leads to the highest risk of injury, as shown by an analysis of adverse events at home. Moreover, The home environment differs in many ways from the controlled environment of a hospital or clinic. This imposes unique challenges because each home a health care worker visits is different and their ability to provide adequate

care may be hindered by environmental (i.e., crowded or dimly lit surroundings) and socio-environmental factors (such as family over or under-involvement) [14].

The design process aims are thus focused on designing physical and cognitive interfaces. They are intended as places where a continuous process of functional interaction occurs among the users, the systems (space and range of equipment/technology/furniture), and the environment. In this broader view of the human-interface-environment paradigm, the configuration of the interface as a prosthetic system intent on satisfying the individual's well-being can be identified on two levels characterizing the design process: Physical/technological layout level and the level of furniture/technological equipment.

3 Physical/Technological Layout and Furniture/Technological Equipment Criteria

The layout of a home environment can have important implications for delivering care safely, supporting activities of daily living, and minimizing the risk of injury, especially for impaired, elderly or otherwise physically compromised individuals. The human and private-space relationship involves considerations of spatial organization and on the technological apparatus that impacts the usability of that apparatus, regardless of the body's shape, posture or capacity to move. This level concerns the choice of spatial and technological solutions able to facilitate care tasks and ensure conditions of psycho-physical well-being, accessibility and safety for patients and operators.

Likewise, the user-object system (furniture/technological equipment) relationship involves considerations of the quality of objects constructed in relation to human needs. In order for this system to assume an interface role and become prosthetic, it must be capable of enabling/disabling the functional capacities of a person in relation to his/her remaining abilities [15]. This is done through observation of gestures and is not leveraged on a single standard of performance but rather on the capacity to guarantee performances that are helpful and useful toward the user's remaining functionalities.

Considering that the location of care delivery in the home depends on the level of care needed and that the planning for a renovation or remodel to support home healthcare needs can be challenging when future needs are unknown, designers should consider how the home might accommodate some of the more challenging healthcare needs that may arise, and prioritize from there, to determine what is most critical and feasible. Focusing on the bedroom that may be more appropriate for acute care, some researches show the following needs and consequent design criteria.

Accessibility, Ease of Use, Safety and Physical Well-Being of the Patient. In this framework of needs, design criteria of the layout of bedroom concern: 1) maximize open areas around the bed and primary path of circulation (i.e. from the bedroom to the bathroom); 2) place the bedroom adjacent to the bathroom and on the main level (street level) of the home (or accessible by ramp, stairlift, or elevator) [16]; 3) use of smooth, level floor surfaces with minimal variations (minimize thresholds) that allow freedom of movement [17]; 4) avoid sources of falling using soft interior flooring materials (e.g., cork, rubber, or linoleum) that are gentler underfoot than harder materials and can lessen

the impact of falls, also avoid deep pile carpet or loose/worn carpet and flooring materials with intricate high-contrast patterns [18]; 5) provide wainscot trim that protrudes from the wall (i.e. handrails, grab bars with wood pleasant finishes) to offer support and a reference for orientation of the patient [19].

In this framework of needs, design criteria of the furniture/technological equipment that may help to support increased independence for patients receiving care at home concern: 1) integrate technological device in the furniture system, such as an intercom system or voice-activated smartphone technology, easy-to-reach operational (remote) controls that allow natural light to be blocked/reduced during the day if needed, electrical system with sufficient output to support all medical equipment without overloading outlets, Aging Service Technologies (ASTs) including sensors and actuators that monitor and evaluate health conditions and monitor daily activities (fall- and wandering-detection technologies) [20]; 2) easy-to-open doors/furniture (consider handling grip, mechanics, and weight of the door); 3) bed and lounge chairs adjustable for safe entry and exit [16].

Psycho-Emotional Well-Being and Psychosocial Support of the Patient. While home care can offer many benefits to one's mental state, the same care may also present emotional challenges. Social, cognitive, personal, and behavioural factors are key when designing to support better outcomes for patients receiving healthcare in the home and for staff providing healthcare [21].

In this framework of needs, design criteria of the layout of bedroom concern: 1) Access to positive distractions (e.g., nature-themed artwork, music, TV, Internet, reading materials); 2) movable screens/curtains for visual and auditory separation minimizing stimulation and optimizing privacy; 3) allow reorganization of space (e.g., easily movable furniture, modular elements) to accommodate changing needs; 4) ample windows that open on the outside with scenes of good quality that can be seen from any seat, integrating to them easy-to-reach operational (remote) controls that allow natural light to be blocked/reduced during the day if needed [16]; 5) Space for people to sit with the individual receiving care without obstructing the provision of care; 6) Space for second bed/sleeping arrangements to facilitate the proximity of a family member [22].

In this framework of needs, design criteria of the furniture/technological equipment concern: 1) integrate (into equipped walls and furnishings) medical equipment (e.g., oxygen tanks, home-dialysis units, infusion pumps, blood glucose meters, feeding tubes, catheters, commodes, ambulation aids, patient lifts/hoists and specialist equipment) near the bed/chair care areas to support changing levels of care [14]; 2) movable screens/curtains to cover medical equipment whether fixed or mobile, from the patient's view during exams and/or the administration of treatments; 3) integrate medical devices (medical gases electrical devices, oxygen and) in a compact package within technical interstitial spaces such as ceiling or equipped floors or technical cores that can be expanded and integrated over time as the conditions of use change concerning the patient subjective conditions (intensity of care); 4) wireless or wired internet connection to facilitate telehealth/telemedicine [2]; 5) monitoring devices (sensors or wearables) to record daily living activities and transmit data to caregivers (where data is measured against present targets); 6) furniture that is easy to move and adjust (e.g. furniture with modular elements) can accommodate changing needs for the variety of the patient types receiving a variety of care in their home.

Efficient Delivery of Care and Work-Related Safety of the Caregivers. In this framework of needs, design criteria of the layout of bedroom concern: 1) design spaces for care that are quiet or can be closed off (at least temporarily) from distractions from pets and children to support safe care procedures (medication preparation, use of sharps, exams and treatment) [14, 22, 13] and that facilitate better communication between patients and care providers through telesupport systems [14]; 2) easy access to sink or alcohol gel dispenser in care areas, in a location where caregivers can wash their hands and still keep direct visual contact with their patients; 3) guarantee adequate space for two people to provide caregiving assistance using patient-handling equipment (e.g. to move the patient to toilet, bed, car).

In this framework of needs, design criteria of the furniture/technological equipment concern: 1) easy-to-clean materials to reduce surface contamination; 2) provide computer devices for digital processing, and archiving for paper documents, and devices for viewing diagnostic images by multiple users contemporaneously; 3) integrate the furniture with telemedicine exam equipment such as a laptop with integrated medical devices (e.g., horoscopes, stethoscopes and vital signs monitors, spirometers); 4) provide a designated location for medical device and patient handling equipment manuals for caregiver access; 5) prepare the ceiling or wall for ~~a~~ future integration of repositioning devices that support ergonomic conditions for patient handling and movement, if needed (e.g. ceiling-mounted trapeze hooks); 6) arrange multiple storage locations for personal protective equipment to facilitate proper safety protocols; 7) provide easily accessible and adequately sized storage for sharps disposal, it may help to reduce exposure to punctures or cuts [13].

Psycho-Emotional Well-Being of the Caregiver. This need can be satisfied by design criteria concern: 1) Operable windows that can be opened for cross-ventilation and fresh air inlet; 2) lighting systems with scattered light that is uniform, indirect, and not blinding, dedicated to the various work areas, with characteristics and arrangements that do not cause disturbance, and with an adequate light quality; 3) furniture and equipment organization to allow communicative exchange between health personnel; 4) efficient ventilation to minimize unpleasant smells and control system of air temperature, relative humidity and flow speed maintained at comfort level without dramatic difference between spaces; 5) use of Telehealth that may also be able to help support the psychosocial needs of care providers who in a particular context (eg. rural zone) can feel quite isolated by lack of a collegial support (burnout, stress from mentally and emotionally taxing profession).

4 Conclusions

Healthcare at Home offers potential advantages over traditional healthcare options for both healthcare organizations and patients, which suggests in the future, there will be the potential for more wide-reaching extensions of the hospital into the home environment. However, if the home is not properly equipped, or if a formal home-care model for hospital-level care is not available, hospitalization or a move into a rehabilitation or long-term care setting may be the only viable option for people with increasing healthcare needs [23].

The majority of the literature refers to individuals receiving care at home as "patients". However, the individuals receiving care may or may not see themselves as patients in their own home. This is an important distinction in the way care is provided and design conducted. Multidisciplinary equips (formed by owners, architects, designers in the healthcare, long-term care, and residential sectors) may be the best qualified to undertake the challenge of design for Healthcare at Home. It aims to balance the provisions for safety with preservation of the personal effects and person-centred experience that make healthcare at home such an attractive option for healing in the first place. Therefore, the validity of a project is appreciated by the multifactorial quality of the space. It can be connected with physical, environmental, management, perceptual, psychological, relational elements, in a perspective that is no longer "patient-centric" but considering the totality of users [24].

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References

1. WHO: Demographic trends, statistics and data on ageing. https://www.euro.who.int/en/health-topics/Life-stages/healthy-ageing
2. National Research Council: Health care comes home: the human factors. Technical report, p. 9. The National Academies Press, Washington, DC (2011)
3. Caplan, G.A., Sulaiman, N.S., Mangin, D.A., Ricauda, N.A., Wilson, A.D., Barclay, L.: A meta-analysis of hospital at home. Med. J. Aust. **197**(9), 512–519 (2012)
4. Shepperd, S., Harwood, D., Jenkinson, C., Gray, A., Vessey, M., Morgan, P.: Randomised controlled trial comparing hospital at home care with inpatient hospital care. I: three month follow up of health outcomes. Br. Med. J. **316**, 1786–1791 (1998)
5. Caplan, G.A., Ward, J.A., Brennan, N.J., Coconis, J., Board, N., Brown, A.: Hospital in the home: a randomised controlled trial. Med. J. Aust. **170**, 156–160 (1999)
6. Levine, D.M., et al.: Hospital-level care at home for acutely Ill adults: a pilot randomized controlled trial. J. Gen. Intern. Med. **33**(5), 729–736 (2018). https://doi.org/10.1007/s11606-018-4307-z
7. Cryer, L., Shannon, S.B., Van Amsterdam, M., Leff, B.: Costs for 'hospital at home' patients were 19 percent lower, with equal or better outcomes compared to similar inpatients. J. Health Affairs **31**(6), 1237–1243 (2012)
8. Covinsky, K.E., et al.: Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. J. Am. Geriatr. Soc. **51**(4), 451–458 (2003)
9. Cohn, D., Taylor, P.: Baby Boomers Approach 65, Glumly. Pew Research Center's Social & Demographic Trends Project, December 2010. http://www.pewsocialtrends.org/2010/12/20/baby-boomers-approach-65-glumly/
10. Leff, B., Burton, L., Mader, S., Naughton, B., Burl, J., Inouye, S.K., Burton, J.R.: Hospital at home: feasibility and outcomes of a program to provide hospital-level care at home for acutely III older patients. Ann. Intern. Med. **143**(11), 798 (2005)
11. Centers for Disease Control and Prevention (CDC), National Center for Health Statistics, United States Department of Health and Human Services. Health Data Interactive (2004). www.cdc.gov/nchs/hdi.htm

12. Polivka, B.J., Wills, C.E., Darragh, A., Lavender, S., Sommerich, C., Stredney, D.: Environmental health and safety hazards experienced by home health care providers: a room-by-room analysis. J. Workplace Health Saf. **63**(11), 512–522 (2015)
13. Markkanen, P., Quinn, M., Galligan, C., Chalupka, S., Davis, L., Laramie, A.: There's no place like home: a qualitative study of the working conditions of home health care providers. J. Occup. Environ. Med. **49**(3), 327–337 (2007)
14. Beer, J.M., McBride, S.E., Mitzner, T.L., Rogers, W.A.: Understanding challenges in the front lines of home health care: a human systems approach. Appl. Ergon. **45**(6), 1687–1699 (2014)
15. Cellucci, C.: Accessibility of the home environment. In: Cluster in Progress: the Architectural Technology Network for Innovation. Maggioli Editore, Santarcangelo di Romagna (2016)
16. National Association of Home Builders: Aging in Place Remodeling Checklist. https://www.nahb.org/Education-and-Events/Education/Designations/Certified-Aging-in-Place-Specialist-CAPS/Additional-Resources/Aging-In-Place-Remodeling-Checklist
17. Parsons, K.S., Galinsky, T.L., Waters, T.: Suggestions for preventing musculoskeletal disorders in home healthcare workers: part 2: lift and transfer assistance for non–weight-bearing home care patients. J. Home Healthc. Nurse **24**(4), 227–233 (2006)
18. Aging in Place Guide for Building Owners: Recommended age-friendly residential building upgrades. Technical report, AIA New York Design for Aging Committee (2017)
19. Brookfield, K., et al.: The home as enabler of more active lifestyles among older people. J. Build. Res. Inf. **43**(5), 616–630 (2015)
20. Lee, B.C., Xie, J.: How do aging adults adopt and use a new technology? New approach to understand aging service technology adoption. In: Stephanidis, C. (ed.) HCI 2018. CCIS, vol. 851, pp. 161–166. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-92279-9_22
21. Ferrante, T.: Evaluation of Perceived Quality. Franco Angeli, Milano (2013)
22. Exley, C., Allen, D.: A critical examination of home care: end of life care as an illustrative case. Soc. Sci. Med. **65**(11), 2317–2327 (2007)
23. May, C.: Mobilizing modern facts: health technology assessment and the politics of evidence. J. Sociol. Health Illn. **28**(5), 513–532 (2006)
24. Ferrante, T.: EBD & EBM: quality of spaces & quality of care. J. Ergon. **15** (2017)