DESIGN TOWARDS BETTER LIFE EXPERIENCE: CLOSING THE GAP BETWEEN PHARMACEUTICAL PACKAGING DESIGN AND ELDERLY PEOPLE

Carli Lorenzini, Giana; Olsson, Annika
Lund University, Sweden

Abstract

The aging of the population is a worldwide trend, especially in Western countries. The increased number of people living past 65 years is also a trend for polypharmacy (the multiple use of medication) among elderly people. In terms of market orientation, the pharmaceutical industry is well-developed, but the same cannot be said in terms of design orientation. Previous studies indicate that packaging is one of the biggest issues in the use of medications by elderly people, with a lack of inclusivity of older patients. Since interest in pharmaceutical packaging is growing, an explorative review of design approaches for inclusion of senior citizens by the industry is needed. This paper reviews how design research and current design practices have been conducted in pharmaceutical packaging design. It mainly concerns the choices of methods to understand and to integrate the needs of elderly people. The paper also presents four propositions for future empirical studies in the field.

Keywords: Design practice, Inclusive design, Integrated product development, Elderly people, Packaging design

Contact:
Giana Carli Lorenzini
Lund University
Design Sciences
Sweden
giana.lorenzini@plog.lth.se

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1 INTRODUCTION

The increasing number of elderly people is a major trend worldwide, especially in the Western world (Coleman, 1993, Lutz et al., 2008). Currently, 17% of the European population is older than 65 years – this represents about 85 million people. By 2030, the number of elderly people is expected to increase to 23% and by 2060, about one third will be 65 or older (Olsson, 2014).

Although populations are getting older, these seniors have a societal and economic impact because they are living longer than their previous cohorts (Crews and Zavotka, 2006, Lee, 2011). The extension of people's lives means the extension of the use of products over the years (Haigh, 1993). This represents a massive use of products that are not always desired, but that are necessary. Pharmaceutical products fit in this category.

Commonly defined as medicines, pharmaceutical products are an option people can take to reestablish or to sustain an ideal health condition. Because of that, these products are prescribed to be used rationally and they are expected to be safe, effective and of good quality (WHO, 2014). The consumption of pharmaceutical products has also been impacted by the aging population. Elderly people consume a wide range of medications simultaneously. Polypharmacy – the multiple use of medication – is a risk factor for drug interaction, morbidity and mortality, especially when managed by seniors who live alone and independently (Jyrkka et al., 2009, Hajjar et al., 2007, Kaplan et al., 2013).

The multiple use of medication associated with the aging process has attracted attention, mainly connected with the pharmaceutical packaging. As with the majority of consumer products, pharmaceutical products also come wrapped in packages "to deliver a combination of product protection, quality, tamper evidence, patient comfort and security needs" (Zadbuke et al., 2013). The packaging of pharmaceutical products is essential to guide the patient through the modes of use of medication and the compliance of the treatment (Weiss, 2009). The pharmaceutical containers also have influence on the usability (Mühlfeld et al., 2012) and on the acquisition of information by the patients (Wogalter, 1999). The literature and practical experience have reported inherent problems elderly people have related to the use of medication through its packaging (Atkin et al., 1994, Beckman et al., 2005, Nayak, 2002, Schneider et al., 2008). The key role of the pharmaceutical packages and the problems reported indicate it is important to review not only the packaging itself, but the design methods and practices when approaching the needs of users in the packaging development process (Ward et al., 2010).

Based on the context described, this paper presents a review about how design research and current design practices have been conducted in pharmaceutical packaging design – mainly regarding the choices of methods – in order to understand and integrate the needs of elderly people. The paper also defines four propositions for future empirical studies in the field.

2 RESEARCH APPROACH

The research approach is primarily exploratory, driven by previous investigations in the field of packaging design (Vernuccio et al., 2010, Azzi et al., 2012, Metcalf et al., 2012), and the growing potential for the pharmaceutical industry (Zadbuke et al., 2013). This study starts out by reviewing the concepts of design research and inclusion, with an emphasis on the elderly and the process of aging. Universal design (Mace et al., 1997), inclusive design (Clarkson and Coleman, 2015) and design for all (EIDD, 2008) are then presented as *design approaches*. In this paper, the design approaches are elaborated and summarized with the purpose to support the industry in its efforts to include the needs of the elderly in the design process. These three approaches provide conceptual and social background for the discussion about the shift from an aging-oriented design to a generation-orientated design.

Special attention has been paid to the pharmaceutical industry in connection with user needs, since the design approaches for inclusivity have not been further explored in regard to pharmaceutical packaging development. The pharmaceutical industry is highly driven by the market, but not yet design-driven, even though elderly people are seen as a current and future target segment. Thus, relevant papers in the field were selected to support the discussion about pharmaceutical packaging in terms of use by the elderly, design and development processes, as well as external impacts from regulations. The aim was to understand current practices in design research and to expand the

perspectives of possible design approaches and opportunities to develop inclusive pharmaceutical packaging.
The inputs from the literature have resulted in four propositions for future empirical studies. The current paper is connected to a project in progress at Lund University, Sweden. The next step will be dialogues with experts, an analysis of design tools and processes in the pharmaceutical industry as well as observations of elderly users.

3 DESIGN APPROACHES FOR GENERATIONS

People are not identical. As affirmed by Clarkson and Coleman (2015), "we live in a world increasingly shaped by human intervention where design can enable or disable people. It is imperative that we design a world that best matches the diversity present within the population". This diversity brings a diversity of needs that can vary in terms of income, culture, religion, capabilities and impairments (Khalid, 2006).
Disabilities or handicaps arise when society imposes abilities that do not correspond to the individual reality, thus creating a discrepancy between the people and the product, environment, or task (Nordby, 2004). When launching *Design for the Real World*, Papanek (1971) established a stance for a discussion about design and its impact in society (Margolin and Margolin, 2002). More than a concept of style, design was then presented as attending to real human needs (Clarkson and Coleman, 2015). Since Papanek (1971), new landscapes for design research have presented alternatives for reducing the mismatch between people and products.
In the 1990s, new nomenclatures emerged for better classification and analysis of design research. Universal design, inclusive design, and design for all are the most well-known schools of thoughts focused on making the world more equitable through design (Burrows, 2013).

3.1 Universal design

Universal design originates in the US, and is currently expanding in Japan and India (Clarkson and Coleman, 2015). This design approach was established by Ron Mace et al. (1997) when leading the Center for Universal Design at North Carolina State University (Crews and Zavotka, 2006). Universal design is grounded on three tracks of on-going activity: legislation fueled by the disability rights movement emergent after World War II, the barrier-free design to universal design movement, and advances in rehabilitation engineering and assistive technology.
As opposed to the notion of two populations – a normal population and a population diverging from normality – universal design is guided by the perception of "only one population, comprised of individuals representing diverse characteristics and abilities" (Iwarsson and Ståhl, 2003).
Crews and Zavotka (2006) explained that what makes universal design so attractive is its philosophy, rather than it being an enforceable code. Universal design opens the possibilities for designers to creatively work through seven principles: equitable use, flexibility in use, simple and intuitive, perceptible information, tolerance for error, low physical effort, size and space for approach and use. Universal design is often summarized as: "The design of products and environments to be usable to the greatest extent possible by people of all ages and abilities" (The Center for Universal Design, 2008). This approach is widely linked to discourses of social inclusion and human diversity (Barnes, 2011).

3.2 Inclusive design

Design has the potential to include or exclude individuals due to variation in capabilities (Inclusive Design Toolkit, 2012). The contemporary war conflicts and the enlarged number of disabled survivors engaged interests for the birth of the inclusive design approach, introduced by Coleman (1994) in the UK (Clarkson and Coleman, 2015). According to Clarkson and Coleman (2015), inclusive design emerged "(…) not as a new approach to design, but rather as a synthesis of initiatives, experiments and insights dating back to the 1960s and beyond".
As stated by the European Design for All e-Accessibility Network (EDeAN, 2007), inclusive design is a "process-driven approach whereby designers and industry ensure that products and services address the needs of the widest possible consumer base, regardless of age or ability. Emphasis is placed on working with critical users' to stretch design brief".
Inclusive design works in respect to the full range of human diversity in terms of ability, language,

culture, gender, age and other forms of human difference (Inclusive Design Institute, 2014). Instead of seeing elderly people and those who are disabled as a subset of the population, inclusive design integrates them as individuals in mainstream society. This results in not only better experiences with products, services, environments, but also represents an opportunity for growing business and for capturing brand advantages (Clarkson and Coleman, 2015).

3.3 Design for all

In Europe, and especially in the Scandinavian countries, design for all is related to the public and voluntary sectors (Burrows, 2013, Clarkson and Coleman, 2015). EIDD (2008) and EDeAN (2007) are the two institutions that work with this approach of design. "Design for all is design for human diversity, social inclusion and equality. This holistic and innovative approach constitutes a creative and ethical challenge for all planners, designers, entrepreneurs, administrators and political leaders" (EIDD, 2008). Design for all presents a wide-range approach to enable people to have equal conditions to participate in every social aspect. All people should be included no matter their age or ability. Differences among people and the aging population are considered the major drivers for inclusion in the mainstream society, recognizing that "(…) design for all can be a tool for commercial growth; and growing anti-discrimination legislation" (EIDD, 2008).

3.4 Comparison of the approaches

The idea of integration through design has been manifested in different ways depending on ideological, historical and cultural circumstances (Olander, 2011). What universal design, inclusive design and design for all have in common is the principle of integration of elderly and disabled people into mainstream society, instead of viewing them as sub-sets of the population (Clarkson and Coleman, 2015). These three design approaches share similar issues and interests, and have clarified that there are possibilities to achieve market goals through a more social orientation. There are nuances in their choices of concepts and background, however this provides also different opportunities on design research. Figure 1 positions the approaches.

Universal design has the main goal to "(…) achieve universal performance of designed products, buildings and environments, meaning flexibility in use, especially at an urban level". Consequently, universal design works for policies and planning of all aspects in society (Björk, 2014). Design for all moves in a similar direction, mainly explored in the Nordic European context.

For market-based industries, the inclusive design approach seems more plausible. Goodman et al. (2006) present drivers that can guide the establishment or introduction of inclusive design into companies. The most relevant factors of the results are legislation, national standards, social responsibility, demographic and consumer trends, and brand enhancement. Still, the implementation of inclusivity struggles with lack of time, budget limitations, lack of knowledge and tools for practicing, and lack of perception of inclusive design as a need for the end user (Goodman et al., 2006).

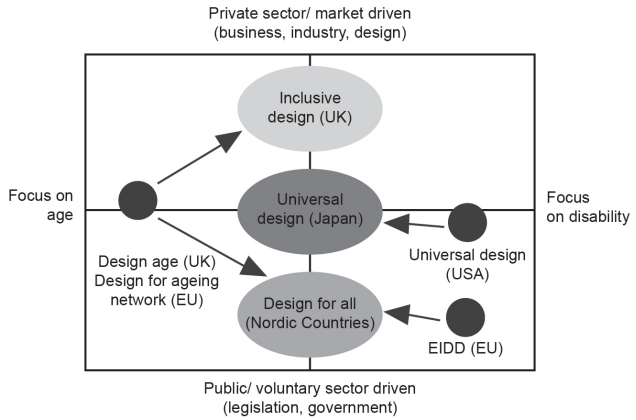

Figure 1. Origins of influences and ideas on inclusive design

Adapted from Clarkson and Coleman (2015)

4 FROM AN AGING-ORIENTED TO A GENERATION-ORIENTED APPROACH

Understanding seniors means understanding the concept of age, which can differ among cultures, societies, and lifestyles (Barnes, 2011, Sudbury-Riley, 2014). Sudbury-Riley (2014) proposed three concepts of aging associated with design: physical aging, psychological aging, and social aging.
Physical aging is about the changes of the body that impact vision, hearing, muscular strength, etc. This highlights eyesight, hearing and hand functions as the principal physical capabilities under consideration (Haigh, 1993). Physical aging differs from illness, but it can be associated with some chronic diseases such as arthritis or with gender (Ward et al., 2010). *Psychological aging* relates to the feelings of physical vulnerability, along with feelings of uselessness, embarrassment, frustration and anger in association with the failure of being able to carry out daily tasks. One of these is opening packages (Sudbury-Riley, 2014). Finally, *social aging* connects the sense of age and well-being. One's positive sense of well-being (Sheldon and Kasser, 2001) can be impacted by the "(…) atrophy of skills, together with the internalization of feelings of uselessness can lead an older person to acting that role as they identify with the negative feelings" (Sudbury-Riley, 2014).
For decades, the focus of design has been on working life (Coleman, 1993); older people were mainly associated with disability. Together with the design approaches for inclusivity, a shift in the interpretation of seniors and their needs that goes beyond limitations and impairments has started a new interest in design research. Instead of just compensating for the loss of job skills, design research should also focus on compensation for impariments that result from increased age and the consequent decline in functions (Fisk, 1993).
Elderly people can be active in consuming, living, traveling – activities that attract the attention of different sectors. They represent an active target group of consumers, composed of individuals who do not always consider themselves as "old" (Sudbury-Riley, 2014). Botero and Hyysalo (2013), launched the concept of *active seniors* to extend and to evolve "design engagement with ordinary communities in their everyday life practices". Based on that, a co-design agenda was proposed to engage the developers and the old users in the design activities. Initiatives like this reinforce the attention on elderly people, and represent a design effort that wants to shift from an aging-orientated to a generation-orientated approach (Liu and Joines, 2012), which views older people as still being capable in their own terms.

5 PACKAGING DESIGN

The development of consumer packages has been mainly influenced by the changes in needs and concerns of people, increased competition in the market, events such as wars, shifting lifestyles, discoveries and inventions (Berger, 2005). Often the process of developing packaging is shortened because of time and cost demands, and packaging considerations are usually taken up in the final phases of product development (Bramklev, 2009). Yet, the product and its packaging work as an integrated system to meet the needs of the supply chain, "(…) which means that the package design will influence the efficiency of the entire chain in terms of functions, features, information and cost aspects" (Olsson and Larsson, 2009).
The primary functions of packaging are protection of the product, promotion of the product, and information about its usage, health and safety, and disposal. Other important functions are enabling transportation and use, allowing unitization through the supply chain, and supporting efficient handling (Paine, 1990, Robertson, 1990, The Consumer Goods Forum, 2011).

5.1 Pharmaceutical packaging design

Plenty of associations have been made between packaging and food, and the majority of research in the packaging design field is related to food packaging. Different studies have emphasized the functions of packaging closer to the end-user, conveying the additional advantages of the contents including pleasure, desire, and expectations regarding its use (Olsson and Larsson, 2009, Sonneveld, 2000).
According to Zadbuke et al. (2013), the functions of pharmaceutical packaging are similar to the functions of the packaging in general, with a high emphasis on the protective and safety functions. Packaging protection for pharmaceutical products means high quality barriers against external influences (such as light, moisture, oxygen, biological contamination, mechanical damage). Protection

also means innovative solutions against counterfeiting along the supply chain (Hosseini et al., 2011). However there are differences in the way pharmaceutical packages are designed. As explained by Ward et al. (2010), the functions of the pharmaceutical packaging are extended to supplement functions that the healthcare system is supposed to fulfil – such as providing clear dosing instructions. Other basic functions regarding the user, such as presentation, information, identification, and convenience are guided in the pharmaceutical industry by regulatory standards and policies.

6 CHALLENGES OF DESIGNING PHARMACEUTICAL PACKAGING

According to Margolin and Margolin (2002), design relies on the dichotomy of orientations: market and social. The market orientation is already well-developed and enhanced by the creation of value for sale. In such a context, design is business-oriented, working for competitive advantages and for supplying other industries (Power et al., 2006). It uses creativity to better understand the market, the users and the opportunities for innovation. The other orientation is social (Papanek, 1971), and it works for inclusion. Socially, it is part of the design goals to help make life safer and easier (Power et al., 2006). Even when studied separately, social and market orientations for design are close in reality, since "(…) many products designed for the market also meet a social need" (Margolin and Margolin, 2002).

The literature review on pharmaceutical packaging design and its main functions highlights three main challenges for further investigation. The first challenge regards the use of pharmaceutical packaging by the elderly and the modes of use in different contexts. The literature shows that specific needs of the elderly are commonly generalized, rather than considered based on the specific context of use. The second challenge concerns the development and production of the packaging itself. The protective function is usually emphasized, but not always in connection with accessibility and inclusiveness. The third challenge regards the dilemma of safety for children versus user friendliness for seniors, which directly impacts on how pharmaceutical packaging is developed and regulated.

6.1 The challenge of use

Observations and interviews are common methodological choices for assessing the needs of the elderly and inclusivity (Table 1).

Table 1. Selected papers orientated to the challenges of use

Study	Setting	What assessed	Data collection method
Wogalter et al. (1999)	Experiment 1: 60 (19 males; 41 females), mean age 75.1 y; experiment 2: 75 (17 males; 56 females), mean age 79 y	Information provided in over-the-counter pharmaceutical container labels	Individual experimental session with participants for label assessment
Ringe et al. (2006)	164 cohort postmenopausal women, mean age 69 y	Preferences regarding combined *Biphosphenate* packaging	Semi-structured interviews, assessment of packaging
DeLorme et al. (2007)	25 in-depth interviews with seniors, age ≥65 y	The use of prescription drug information source	In-depth, unstructured interviews
Kauppinen-Räisänen (2011)	106 subjects (35 males; 71 females): 56 seniors (range age 60-85 y); 50 young adults (range age 18-30 y)	The impact of design attributes on preferences of pharmaceutical products	Conjoint analysis based on sessions with the subjects and the 16 packages
Mehuys et al. (2012)	338 home-dwelling, (157 male, 181 female), age ≥70 y	Medication management among home-dwelling older adults	Cross-sectional observational study

Mühlfeld et al. (2012)	141 participants, 48 male, 93 female (115 home dwelling; 26 assisted-living patients), age ≥80 y	Relationship between blister pack design and utilization problems among older adults	Test and task performance; assessment of the blisters
Sino et al. (2014)	95 patients (32 males, 63 females), age ≥75 y	Polypharmacy management	Medication Management Capacity (MMC) questionnaire; self-management ability test (SMAS30); clock drawing

These methodological choices often position the researcher closer to the subjects of study, with the limitation of expansion to a whole target group. In addition, the focus of the literature when studying the elderly and pharmaceutical packaging is on an "aging-oriented approach", with different analyses of physical, psychological and social aspects. Furthermore, a stronger link with the industry is missing, since most of the studies preferred to assess only the elderly or the healthcare professionals, without a review of the design process within the industry.

6.2 The challenge of packaging development and production

The development of pharmaceutical packaging has focused on safety of the product during distribution and the extension of product shelf life, where the pharmaceutical packaging design has been found as a critical element for improvement related to these matters.

It is common in the research on pharmaceutical packaging production to have a methodological approach using mathematical models, laboratory tests and prototypes to simulate adverse conditions (White et al., 2005, Zema et al., 2010). Even when the product has been planned for the final user, these studies have prioritized the assessment of the packages without including patients.

Some examples can be cited in regard to prototypes of the packages. Weiss (2009) presented a prototype for a compliance packaging, improved in the safety function, and planned for over-the-counter (OTC) drug products that are sold as pills inside blister packs. McCall et al. (2012) instead have described a RFID-based medication adherence intelligence system, called RMAIS. With that, patients can organize the medication by means of a RFID tag attached to the medicine container, providing for safer use. Browe and Wang (2007) also have presented an electronic device – a web-enabled product ID system – that uses uniquely coded packaging to authenticate the drug's validity, promote marketing activities among patients, and increase data about consumption patterns.

6.3 The challenge of safety

The challenge of safety is centered on the dilemma of how to produce pharmaceutical packages that enable access by the elderly, while preventing misuse by children (Nayak, 2002, Bix et al., 2009, Yoxall et al., 2013). The literature mainly stresses this issue, based on reports and statistical analyses (Sinicina et al., 2005, Lovegrove et al., 2013, Chien et al., 2003). Safety has been shown to be directly related to how the packages are produced and delivered, and how they are used later on by people in different situations. This also forwards the discussion about the ethical aspects, since the protocols for testing the safety of pharmaceutical packaging are still oriented to the average adult, which contributes to the reports of many seniors not being able to use the medication due to the packaging (Bix et al., 2009).

7 PROPOSITIONS FOR FUTURE EMPIRICAL STUDIES ON PHARMACEUTICAL PACKAGING DESIGN

Still today the literature extensively supports design recommendations based on an "aging-oriented approach" (Liu and Joines, 2012) – characterized by the relationship between age and the decline in physical, sensory and cognitive abilities. As with the challenge of the use of packaging, the focus of the methods to assess the pharmaceutical packaging and the elderly were mainly based on general qualitative approaches, not inspired or centered on proposing new design solutions. The reality of the research in the area shows the repetition of the same problems and the same ways of assessing it.

Back to the concept of *active seniors*, the idea of involving elderly people in a more sustained and open collaborative design engagement with professionals is needed (Botero and Hyysalo, 2013). This

provides inspiration for the following propositions aligned with the design approaches. The propositions can be the basis for future empirical studies on senior users, the regulations and the processes of developing pharmaceutical packaging. The context of the studies would also include some cultural aspects that potentially have influence on elderly's lives, in business and in the openness for design and innovation through the supply chain:

- Proposition 1. To further investigate the feelings and expressions of the elderly. The literature has been based on assessing and expressing the disability of seniors with their medicines (Atkin et al., 1994, Beckman et al., 2005, Mühlfeld et al., 2012). Even if this is important, other perspectives of design can be interpreted in terms of feelings and choices of expression of the elderly. New design mindsets could be explored to get a better understanding of the general needs and of the needs regarding the use of pharmaceutical medication.
- Proposition 2. To carry out a joint dialogue between industry and policy makers for an improved debate on inclusivity (Goodman et al., 2006). The development of inclusive packaging and a revision of general protocols for pharmaceutical packaging have already proved to be necessary (Nayak, 2002, Bix et al., 2009). Only a few previous investigations have been presented, focused on the decades of user problems (Atkin, 1994, Beckman, 2005, Mühlfeld et al., 2012), but they do not offer solutions to the problems for active stakeholders. The assessment of models to reduce the stress of using the packaging (Yoxall et al., 2013) can be expanded by models adapted to pharmaceutical packaging. More quantitative knowledge about the strengths and abilities of old people would enable further development of design standards for inclusion (Carse et al., 2010).
- Proposition 3. To carry out dialogues with the actors along the supply chain. Recent studies have already presented an interest in combining the analysis of the users with the expertise of package developers and designers (Ward et al., 2010, Azzi et al., 2012). As reported, packages and products can evolve and move together along an extensive and complex chain (Bramklev, 2009). In the pharmaceutical context, more can be done about the relationship between packaging and product development, and the lacks that still exist. A design orientation can be made possible by exploring how inclusive design is currently established (Clarkson and Coleman, 2015), how it is applied and the reasons for the decisions on design in the pharmaceutical packaging development. Medication packages can be perceived through design, but beyond designers.
- Proposition 4. To explore the cultural context where the elderly have access to their medicines (Kauppinen-Räisänen, 2011), mapping their involvement in the healthcare system and current connections with hospitals, nurses, caretakers, etc. (Schneider et al., 2008). It is a proposition to run in parallel and in complement to the other propositions. An in-depth analysis can be performed regarding semantic aspects of the packaging, the meanings and emotions established through it. This work will be grounded in a European context, and specifically in a Nordic context.

REFERENCES

Atkin, P. A., Finnegan, T. P., Ogle, S. J. and Shenfield, G. M. (1994) Functional ability of patients to manage medication packaging: a survey of geriatric inpatients. Age and Ageing, Vol. 23, No. 2, pp. 113-116.

Azzi, A., Battini, D., Persona, A. and Sgarbossa, F. (2012) Packaging design: general framework and research agenda. Packaging Technology and Science, Vol. 25, No. 8, pp. 435-456.

Barnes, C. (2011) Understanding disability and the importance of design for all. Journal of Accessibility and Design for All, Vol. 1, No. 1, pp. 55-80.

Beckman, A., Bernsten, C., Parker, M. G., Thorslund, M. and Fastbom, J. (2005) The difficulty of opening medicine containers in old age: a population-based study. Pharmacy World and Science, Vol. 27, No. 5, pp. 393-398.

Berger, K. R. (2005) A brief history of packaging. University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, EDIS.

Bix, L., De La Fuente, J., Pimple, K. D. and Kou, E. (2009) Is the test of senior friendly/child resistant packaging ethical? Health Expectations, Vol. 12, No. 4, pp. 430-437.

Björk, E. (2014) A Nordic charter for universal design. Scandinavian Journal of Public Health, Vol. 42, No. 1, pp. 1-6.

Botero, A. and Hyysalo, S. (2013) Ageing together: steps towards evolutionary co-design in everyday practices. CoDesign, Vol. 9, No. 1, pp. 37–54.

Bramklev, C. (2009) On a proposal for a generic package development process. Packaging Technology and Science, Vol. 22, No. 3, pp. 171–186.
Browe, C. and Wang, C. L. (2007) Web-enabled product ID system as a tool in pharmaceutical marketing. International Journal of Pharmaceutical & Healthcare Marketing, Vol. 1, No. 3, pp. 226-233.
Burrows, A. B. (2013) Designing out-of-box experiences for older adults: exploring the boundaries of inclusive design. Doctoral thesis, Loughborough, UK, Loughborough University.
Carse, B., Thomson, A. and Stansfield, B. (2010) Use of biomechanical data in the inclusive design process: packaging design and the older adult. Journal of Engineering Design, Vol. 21, No. 2-3, pp. 289–303.
Chien, C., Marriott, J. L., Ashby, K. and Ozanne-Smith, J. (2003) Unintentional ingestion of over the counter medications in children less than 5 years old. Journal of Paediatrics & Child Health, Vol. 39, No. 4, pp. 264-269.
Clarkson, P. J. and Coleman, R. (2015) History of inclusive design in the UK. Applied Ergonomics, Vol. 46, pp. 235-247.
Coleman, R. (1993) A demographic overview of the ageing of First World populations. Applied Ergonomics, Vol. 24, No. 1, pp. 5-8.
Coleman, R. (1994) Design research for our future selves. Royal College of Art Research Papers, Vol. 1, No. 2, London: Royal College of Arts.
Crews, D. E. and Zavotka, S. (2006) Aging, disability, and frailty: implications for universal design. Journal of Physiological Anthropology, Vol. 25, No. 1, pp. 113-118.
DeLorme, D. E., Huh, J. and Reid, L. N. (2007) Seniors' perceptions of prescription drug information sources. International Journal of Pharmaceutical & Healthcare Marketing, Vol. 1, No. 2, pp. 107-127.
European Design for All E-Accessibility Network (EDeAN) (2007) [online], http://www.edean.org/ (November 2014).
European Institute for Design and Disability (EIDD). (2008) Design for All Europe [online], http://www.designforalleurope.org/Design-for-All/ (November 2014).
Fisk, J. (1993) Design for the elderly: a biological perspective. Applied Ergonomics, Vol. 24, No. 1, pp. 47-50.
Goodman, J., Dong, H., Langdon, P. and Clarkson, P. J. (2006) Increasing the uptake of inclusive design in industry. Gerontechnology, Vol. 5, No. 3, pp. 140-149.
Haigh, R. (1993) The ageing process: a challenge for design. Applied Ergonomics, Vol. 24, No. 1, pp. 9-14.
Hajjar, E. R., Cafiero, A. C. and Hanlon, J. T. (2007) Polypharmacy in elderly patients. The American Journal of Geriatric Pharmacotherapy, Vol. 5, No. 4, pp. 345-351.
Hosseini, S. A. R., Darbooy, S., Tehrani Banihashemi, S. A., Naseri, S. M. and Dinarvand, R. (2011) Counterfeit medicines: report of a cross-sectional retrospective study in Iran. Public Health, Vol. 125, No. 3, pp. 165-171.
Inclusive Design Institute (2014) [online], http://inclusivedesign.ca/ (November 2014).
Inclusive Design Toolkit (2012) [online], http://www.inclusivedesigntoolkit.com/betterdesign2/ (November 2014).
Iwarsson, S. & Ståhl, A. (2003) Accessibility, usability and universal design – positioning and definition of concepts describing person-environment relationships. Disability & Rehabilition, Vol. 25, No. 2, pp. 57-66.
Jyrkka, J., Enlund, H., Korhonen, M. J., Sulkava, R. and Hartikainen, S. (2009) Patterns of drug use and factors associated with polypharmacy and excessive polypharmacy in elderly persons. Drugs Ageing, Vol. 26, No. 6, pp. 493-503.
Kaplan, W., Wirtz, V. J., Mantel-Teeuwisse, A., Stolk, P., Duthey, B. and Laing, R. (2013) Priority medicines for europe and the world: 2013 update [online]. World Health Organization, http://www.who.int/medicines/areas/priority_medicines/MasterDocJune28_FINAL_Web.pdf, accessed on November, 2014
Kauppinen-Räisänen, H. (2011) The impact of salient product cues on aging adults. Journal of Medical Marketing: Device, Diagnostic and Pharmaceutical Marketing, Vol. 11, No. 4, pp. 294-302.
Khalid, H. M. (2006) Embracing diversity in user needs for affective design. Applied Ergonomics, Vol. 37, No. 4, pp. 409-418.
Lee, R. (2011) The outlook for population growth. Science, Vol. 333, No. 6042, pp. 569-573.
Liu, S. and Joines, S. (2012) Developing a framework of guiding interface design for older adults,Proceedings of the Human Factors and Ergonomics Society 56th Annual Meeting: SAGE Publications, pp. 1967-1971.
Lovegrove, M. C., Hon, S., Geller, R. J., Rose, K. O., Hampton, L. M., Bradley, J. and Budnitz, D. S. (2013) Efficacy of flow restrictors in limiting access of liquid medications by young children. Journal of Pediatrics, Vol. 163, No. 4, pp. 1134-1139.
Lutz, W., Sanderson, W. and Scherbov, S. (2008) The coming acceleration of global population ageing. Nature, Vol. 451, No. 7179, pp.716-719.

Mace, R. L., Ostroff, E., Connell, B. R., Jones, M., Mueller, J., Mullick, A., Sanford, J., Steinfeld, E., Story, M. and Vanderheiden, G. (1997) The Principles of Universal Design [online]. Center for Universal Design, NC State University, http://www.ncsu.edu/project/design-projects/udi/center-for-universal-design/the-principles-ofuniversal-design/, accessed on November 2014.
Margolin, V. & Margolin, S. (2002). A "social model" of design: issues of practice and research. Design Issues, Vol. 18, No. 4, pp. 24-30.
McCall, C., Maynes, B., Zou, C. C. and Zhang, N. J. (2013) An automatic medication self-management and monitoring system for independently living patients. Medical Engineering & Physics, Vol. 35, No. 4, pp. 505-514.
Mehuys, E., Dupond, L., Petrovic, M., Christiaens, T., Bortel, L., Adriaens, E., Bolle, L., Tongelen, I., Remon, J. and Boussery, K. (2012) Medication management among home-dwelling older patients with chronic diseases: possible roles for community pharmacists. Journal of Nutrition, Health & Aging, Vol. 16, No. 8, pp. 721-726.
Metcalf, L., Hess, J. S., Danes, J. E. and Singh, J. (2012) A mixed-methods approach for designing market-driven packaging. Qualitative Market Research: An International Journal, Vol. 15, No. 3, pp. 268-289.
Mühlfeld, L., Langguth, P., Hausler, H. and Hagels, H. (2012) Influence of blister package design on usability among older adults. International Journal of Clinical Pharmacy, Vol. 34, No. 4, pp. 553-560.
Nayak, U. (2002) Can older adults use child resistant closures? Gerontechnology, Vol. 2, No. 2, pp. 198-202.
Nordby, K. (2004) eAccessibility for All: The role of standardisation in shaping the end-users' tel-eEurope. In: Lehne, P. H. (ed.), 100th anniversary issue: Perspectives in telecommunications: Telenor, pp. 4-13.
Olander, E. (2011) Design as reflection. Doctoral thesis, Lund, Sweden, Lund University.
Olsson, A. and Larsson, A. (2009) Value creation in PSS design through product and packaging innovation processes. In: Lindahl, S. A. (ed.), Introduction to product/ service-system design. London, UK: Springer, pp. 93-109.
Olsson, S. (2014) Turning Demographic Ageing in Europe into Opportunities. Sweden: HeatlhAccess.
Paine, F. A. (1990) Packaging Design and Performance. Leatherhead, UK: Pira.
Papanek, V. (1971) Design for the Real World: Human Ecology and Social Change. New York, USA: Pantheon Books.
Power, D., Jansson, J. and Lorenzen, M. (2006) Nordic design for a global market [online]. Nordic Council of Ministers Nordic Innovations Centre, http://www.ico-d.org/database/files/library/nordic.pdf, accessed on November, 2014.
Ringe, J. D., Van Der Geest, S. A. P. and Möller, G. (2006) Importance of calcium co-medication in bisphosphonate therapy of osteoporosis: an approach to improving correct intake and drug adherence. Drugs & Aging, Vol. 23, No. 7, pp. 569-578.
Robertson, G. L. (1990) Good and bad packaging: who decides? International Journal of Physical Distribution & Logistics Management, Vol. 20, No. 8, pp. 37-40.
Schneider, P. J., Murphy, J. E. and Pedersen, C. A. (2008) Impact of medication packaging on adherence and treatment outcomes in older ambulatory patients. Journal of the American Pharmacists Association: JAPhA, Vol. 48, No. 1, pp. 58-63.
Sheldon, K. M. and Kasser, T. (2001) Getting older, getting better? Personal strivings and psychological maturity across life span. Developmental Psychology, Vol. 37, No. 4, pp. 491-501.
Sinicina, I., Mayr, B., Mall, G. and Keil, W. (2005) Deaths following methotrexate overdoses by medical staff. Journal of Rheumatology, Vol. 32, No. 10, pp. 2009-2011.
Sino, C., Sietzema, M., Egberts, T. and Schuurmans, M. (2014) Medication management capacity in relation to cognition and self-management skills in older people on polypharmacy. Journal of Nutrition, Health & Aging, Vol. 18, No. 1, pp. 44-49.
Sonneveld, K. (2000) What drives (food) packaging innovation? Packaging Technology and Science, Vol. 13, No. 1, pp. 29-35.
Sudbury-Riley, L. (2014) Unwrapping senior consumers' packaging experiences. Marketing Intelligence & Planning, Vol. 32, No. 6, pp. 666-686.
The Center For Universal Design (2008) [online], http://www.ncsu.edu/ncsu/design/cud/index.htm (November 2014).
The Consumer Goods Forum. (2011) A global language for packaging and sustainability: a framework and a measurement system for our industry [online], http://globalpackaging.mycgforum.com/allfiles/FinalReport_2011.pdf, November, 2015.
Vernuccio, M., Cozzolino, A. and Michelini, L. (2010) An exploratory study of marketing, logistics, and ethics in packaging innovation. European Journal of Innovation Management, Vol. 13, No. 3, pp. 333-354.
Ward, J., Buckle, P. and Clarkson, P. J. (2010) Designing packaging to support the safe use of medicines at home. Applied Ergonomics, Vol. 41, No. 5, pp. 682-694.
Weiss, S. (2009) Compliance packaging for over-the-counter drug products. Journal of Public Health, Vol. 17, No. 2, pp. 155-164.

White, S., Bennett, D. B., Cheu, S., Conley, P. W., Guzek, D. B., Gray, S., Howard, J., Malcolmson, R., Parker, J. M., Roberts, P., Sadrzadeh, N., Schumacher, J. D., Seshadri, S., Sluggett, G. W., Stevenson, C. L. and Harper, N. J. (2005) Exubera: pharmaceutical development of a novel product for pulmonary delivery of insulin. Diabetes Technology & Therapeutics, Vol. 7, No. 6, pp. 896-906.

World Health Organization (WHO). (2014) Pharmaceutical products [online], http://www.who.int/topics/pharmaceutical_products/en/ (December 2014).

Wogalter, M. S., Magurno, A. B., Dietrich, D. A. and Scott, K. L. (1999) Enhancing information acquisition for over-the-counter medications by making better use of container surface space. Experimental Aging Research, Vol. 25, No. 1, pp. 27-48.

Yoxall, A., Rodriguez-Falcon, E. M. and Luxmoore, J. (2013) Carpe diem, carpe ampulla: a numerical model as an aid to the design of child-resistant closures. Applied Ergonomics, Vol. 44, No. 1, pp. 18-26.

Zadbuke, N., Shahi, S., Gulecha, B., Padalkar, A. and Thube, M. (2013) Recent trends and future of pharmaceutical packaging technology. Journal of Pharmacy & Bioallied Sciences, Vol. 5, No. 2, pp. 98-110.

Zema, L., Sangalli, M. E., Maroni, A., Foppoli, A., Bettero, A. and Gazzaniga, A. (2010) Active packaging for topical cosmetic/drug products: a hot-melt extruded preservative delivery device. European Journal of Pharmaceutics & Biopharmaceutics, Vol. 75, No. 2, pp. 291-296.